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Information technology — Telecommunications and information exchange between systems — Protocol for exchange of inter-domain routeing information among intermediate systems to support forwarding of ISO 8473 PDUs

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Protocole pour échange d'information inter-domaine de routage parmi les systèmes intermédiaires supportant la transmission de PDUs de l'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. 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 10747 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

Annexes A and B form an integral part of this International Standard. Annexes C, D, E, F, G, H, J, K and L are for information only.

Introduction

This Protocol is one of a set of International Standards which facilitate the interconnection of open systems. They cover the services and protocols required to achieve such interconnection.

This Protocol is positioned with respect to other related standards by the layered structure defined in ISO 7498, and by the Network layer organization defined in ISO 8648. It is located at the top of the Network layer and relies on the services of ISO 8473. This protocol permits a routeing domain to exchange information with other routeing domains to facilitate the operation of the routeing and relaying functions of the Network Layer. It applies to the following categories of routeing, which are described in ISO/IEC TR 9575, making no distinction between them:

— Intra-Administrative Domain routeing between routeing domains
— Inter-Administrative Domain routeing between routeing domains.

Within the hierarchical relations between routeing protocols, as described in ISO/IEC TR 9575, this protocol is situated above the intra-domain routeing protocols. That is, this Inter-domain IS-IS protocol:

— maintains information about the interconnections between routeing domains, but does not require detailed information about their internal structures
— calculates path segments on a hop-by-hop basis

This protocol calculates path segments which consist of *Boundary Intermediate systems* and the links that interconnect them. An NPDU destined for an End system in another routeing domain will be routed via Intra-domain routeing to a Boundary Intermediate system (BIS) in the source routeing domain. Then, the BIS, using the methods of this inter-domain routeing protocol, will calculate a path to a Boundary Intermediate system in an adjacent routeing domain lying on a path to the destination. After arriving at the next routeing domain, the NPDU may also travel within that domain on its way towards a BIS located in the next domain along its path. This process will continue on a hop-by-hop basis until the NPDU arrives at a BIS in the routeing domain which contains the destination End system. The Boundary IS in this routeing domain will hand the incoming NPDU over to the domain's intra-domain routeing protocol, which will construct a path to the destination End system.

This inter-domain IS-IS routeing protocol places requirements on the type of information that a routeing domain must provide and on the methods by which this information will be distributed to other routeing domains. These requirements are intended to be minimal, addressing only the interactions between Boundary ISs; all other internal operations of each routeing domain are outside the scope of this protocol. That is, this Inter-domain routeing protocol does not mandate that a routeing domain run a particular intra-domain routeing protocol: for example, it would be a local choice as to whether a domain implements a standard intra-domain protocol (such as ISO/IEC 10589) or a private protocol.

The methods of this protocol differ from those generally adopted for an intra-domain routeing protocol because they emphasize the interdependencies between efficient route calculation and the preservation of legal, contractual, and administrative concerns. This protocol calculates routes which will be efficient, loop-free, and in compliance with the domain's local routeing policies. IDRP may be used when routeing domains do not fully trust each other; it imposes no upper limit on the number of routeing domains that can participate in this protocol; and it provides isolation between its operations and the internal operations of each routeing domain.

Information technology - Telecommunications and information exchange between systems - Protocol for exchange of inter-domain routeing information among intermediate systems to support forwarding of ISO 8473 PDUs

1 Scope

This International Standard specifies a protocol to be used by Boundary Intermediate systems (defined in 3.6) to acquire and maintain information for the purpose of routeing NPDUs between different routeing domains. Figure 1 illustrates the field of application of this International Standard.

This International Standard specifies:

— the procedures for the exchange of inter-domain reachability and path information between BISs
— the procedures for maintaining inter-domain routeing information bases within a BIS
— the encoding of protocol data units used to distribute inter-domain routeing information between BISs
— the functional requirements for implementations that claim conformance to this International Standard

The procedures are defined in terms of:

— interactions between Boundary Intermediate systems through the exchange of protocol data units
— interactions between this protocol and the underlying Network Service through the exchange of service primitives
— constraints on policy feasibility and enforcement which must be observed by each Boundary Intermediate system in a routeing domain

The boundaries of Administrative Domains are realized as artifacts of the placement of policy constraints and the aggregation of network layer reachability information; they are not manifested explicitly in the protocol. The protocol described in this International Standard operates at the level of individual routeing domains. The establishment of administrative domains is outside the scope of this International Standard.

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.*

ISO 7498/Add. 1:1984, *Information processing systems - Open Systems Interconnection - Basic Reference Model - Addendum 1: Connectionless-mode transmission.*

ISO 7498-3:1989, *Information processing systems - Open Systems Interconnection - Basic Reference Model - Part 3: Naming and addressing.*

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

ISO/IEC 8208:1990, *Information technology - Data communications - X.25 Packet Layer Protocol for Data Terminal Equipment.*

ISO/IEC 8348:1993, *Information technology - Network Service Definition.*

ISO 8473:1988, *Information processing systems - Data communications - Protocol for providing the connectionless-mode network service.*

ISO 8648: 1988, *Information processing systems - Telecommunications and information exchange between systems - Internal organization of the Network Layer.*

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).*

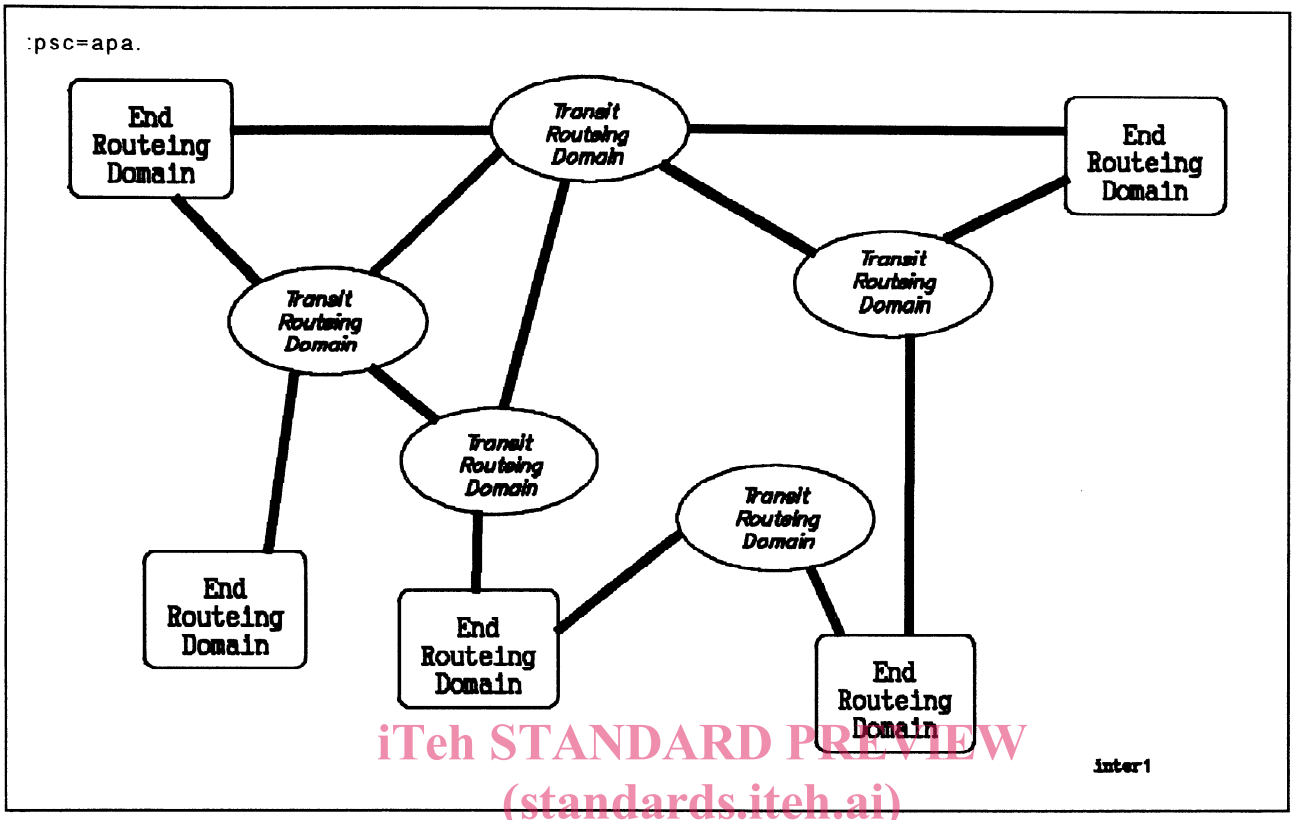

Figure 1 – Field of Application: The Inter-domain Routeing Protocol operates between routeing domains; intra-domain routeing is not within its scope.

ISO/IEC TR 9575:1990, *Information technology - Telecommunications and information exchange between systems - OSI Routeing Framework.*

ISO/IEC TR 9577:1993, *Information technology - Telecommunications and information exchange between systems - Protocol identification in the Network Layer.*

ISO/IEC 10030:1990, *Information technology - Telecommunications and information exchange between systems - End System Routeing Information Exchange Protocol for use in conjunction with ISO 8878.*

ISO/IEC 10589:1992, *Information technology - Telecommunications and information exchange between systems - Intermediate system to intermediate system intra-domain routeing routine information exchange protocol for use in conjunction with the protocol for providing the connectionless-mode Network Service (ISO 8473).*

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

ISO/IEC 10165-2:1992, *Information technology - Open Systems Interconnection - Structure of management information: Definition of management information.*

3 Definitions

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

3.1 Reference model definitions

This International Standard uses the following terms defined in ISO 7498:

a) Network entity
b) Network Layer
c) Network Protocol
d) Network Protocol Data Unit
e) Network relay
f) Network Service Access Point
g) Network Service Access Point Address
h) Real system
i) Routeing

This International Standard uses the following term defined in ISO 7498-3:

a) (N)-entity title

3.2 Network layer architecture definitions

This International Standard uses the following terms defined in ISO 8648:

a) End system
b) Intermediate System
c) Subnetwork

3.3 Network layer addressing definitions

This International Standard uses the following term defined in ISO/IEC 8348:

a) Subnetwork point of attachment

3.4 Routeing framework definitions

This International Standard uses the following terms defined in ISO 9575:

a) Administrative Domain
b) Common Domain
c) Fire wall
d) Routeing Domain

3.5 Intra-domain routeing definitions

This International Standard uses the following terms defined in ISO 10589:

a) Adjacency
b) Link

3.6 Additional definitions

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

3.6.1 Intra-domain IS-IS routeing protocol: A routeing protocol that is run between Intermediate systems in a single routeing domain to determine routes that pass through only systems and links wholly contained within the domain.

NOTE 1: Unless reference is made to a specific protocol, this term is used as a general designator, encompassing both private and internationally standardized protocols.

3.6.2 Inter-domain link: A real (physical) or virtual (logical) link between two or more Boundary Intermediate systems (see Figure 2). A link between two BISs in the same routeing domain carry both intra-domain traffic and inter-domain traffic; a link between two BISs located in adjacent routeing domains can carry inter-domain traffic, but not intra-domain traffic.

3.6.3 Boundary Intermediate system: An intermediate system that runs the protocol specified in this International Standard, has at least one inter-domain link attached to it, and may optionally have intra-domain links attached to it.

3.6.4 End Routeing Domain: A routeing domain whose local policies permit its BISs to calculate inter-domain path segments only for PDUs whose source is located within that routeing domain. There are two varieties of End routeing domains: stub and multi-homed. A stub ERD has inter-domain links to only one adjacent routeing domain, while a multi-homed ERD has inter-domain links to several adjacent routeing domains.

For example, the domains labelled as multi-homed ERDs in Figure 2 have policies which prohibit them from providing relaying functions; it is these policies, not the topology of their interconnections, that make them ERDs.

3.6.5 Transit Routeing Domain: A routeing domain whose policies permit its BISs to calculate inter-domain path segments for PDUs whose source is located either in the local routeing domain or in a different routeing domain. That is, it can provide a relaying service for such PDUs. See Figure 2 for an illustration of TRDs.

3.6.6 Adjacent RDs: Two RDs ("A" and "B") are adjacent to one another if there is a at least one pair of BISs, one located in "A" and the other in "B", that are attached to each other by means of a real subnetwork.

3.6.7 RD Path: A list of the RDIs of the routeing domains and routeing domain confederations through which a given UPDATE PDU has travelled.

3.6.8 Routeing Domain Confederation: A set of routeing domains which have agreed to join together and to conform to the rules in 7.13 of this International Standard. To the outside world, a confederation is indistinguishable from a routeing domain.

3.6.9 Nested RDCs: A routeing domain confederation "A" (RDC-A) is nested within RDC-B when all of the following conditions are satisfied simultaneously:

a) all members of RDC-A are also members of RDC-B
b) there are some members of RDC-B that are not members of RDC-A

3.6.10 Overlapping RDCs: A routeing domain confederation (RDC-A) overlaps RDC-B when all the following conditions are satisfied simultaneously:

a) there are some members of RDC-A that are also members of RDC-B, and
b) there are some members of RDC-A that are not members of RDC-B, and
c) there are some members of RDC-B that are not members of RDC-A.

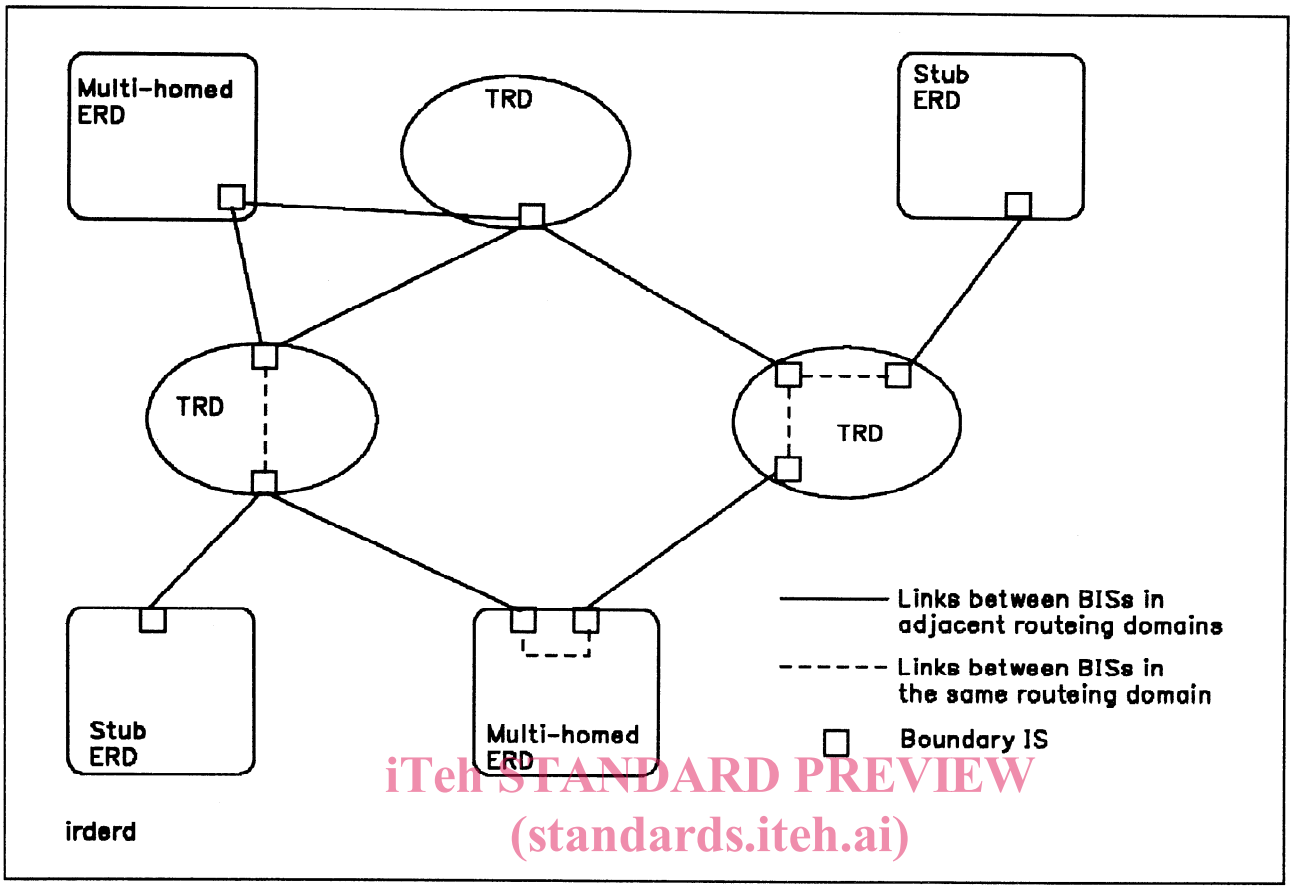

Figure 2 – Intermediate Routeing Domains and End Routeing Domains: The classification of a routeing domain as an TRD or an ERD depends upon its relaying policies.

3.6.11 Disjoint RDCs: Two routeing domain confederations, RDC-A and RDC-B, are disjoint from one another when there are no routeing domains which are simultaneously members of both RDC-A and RDC-B.

3.6.12 Policy Information Base: The collection of routeing policies that a BIS will apply to the routeing information that it learns using this International standard. It is not required that all routeing domains use the same syntax and semantics to express policy; that is, the format of the Policy Information Base is left as a local option.

3.6.13 Route Origin: Each route or component of an aggregated route has a single unique origin. This is the RD or RDC in which the route's destinations are located.

4 Symbols and abbreviations

The symbols, acronyms, and abbreviations listed in the following clauses are used in this International Standard.

4.1 Data unit abbreviations

BISPDU	Boundary Intermediate System PDU
DT PDU	ISO 8473 Data Protocol Data Unit
ER PDU	ISO 8473 Error Protocol Data Unit
NPDU	Network Protocol Data Unit
NSDU	Network Service Data Unit
PDU	Protocol Data Unit

4.2 Addressing abbreviations

AFI	Authority and Format Identifier
DSP	Domain Specific Part
IDI	Initial Domain Identifier
IDP	Initial Domain Part
LSAP	Link Service Access Point
NET	Network Entity Title
NPAI	Network Protocol Address Information

NSAP Network Service Access Point

SNPA Subnetwork Point of Attachment

4.3 Other abbreviations

BIS Boundary Intermediate System

CL Connectionless Mode

CLNS Connectionless Mode Network Service

CM Confederation Member

ERD End Routeing Domain

ES End System

FIB Forwarding Information Base

FSM Finite State Machine

IDRP Inter-domain Routeing Protocol (an acronym for the protocol described in this International Standard)

IPI Initial Protocol Identifier

MIB Management Information Base

NLRI Network layer reachability information

NLSP Network layer security protocol

OSIE OSI Environment

PCI Protocol Control Information

PIB Policy Information Base

QOS Quality of Service

RDC Routeing Domain Confederation

RDI Routeing Domain Identifier

RIB Routeing Information Base

SPI Subsequent Protocol Identifier

SNICP Subnetwork independent convergence protocol

TRD Transit Routeing Domain

5 General protocol information

IDRP is a routeing information exchange protocol which is located within the Network layer and interfaces to ISO 8473, which serves as a SNICP (see Figure 3). In particular, BISPDUs are encapsulated as the data portion of ISO 8473 NPDUs. IDRP is a connection-oriented protocol which is implemented only in Intermediate systems. Routeing and control information is carried in BISPDUs (as in clause 6), which flow on connections between pairs of BISs. Each BISPDU is packaged within one or more NPDUs for transmission by the underlying Network service.

IDRP relies on the underlying Network service to provide for fragmentation and reassembly of BISPDUs. IDRP queues Outbound BISPDUs as input to the underlying Network Layer service, retaining a copy of each BISPDU until an acknowledgement is received. Similarly, inbound BISPDUs are queued as input to the BISPDU-Receive process.

IDRP exchanges BISPDUs in a reliable fashion. It provides mechanisms for the ordered delivery of BISPDUs and for the detection and retransmission of lost or corrupted BISPDUs. The mechanisms for achieving reliable delivery of BISPDUs are described in 7.7; methods for establishing BIS-BIS connections are described in 7.6.

IDRP is consistent with the routeing model presented in ISO TR 9575. To emphasize its policy-based nature, the IDRP routeing model includes a Policy Information Base, as shown in Figure 4. IDRP can be described in terms of four major components:

a) **BISPDU-Receive Process:** responsible for accepting and processing control and routeing information from the local environment and from BISPDUs of other BISs. This information is used for a variety of purposes, such as receiving error reports and guaranteeing reliable reception of BISPDUs from neighboring BISs. (For example, the Update-Receive process (see 7.14) is the part of the BISPDU-Receive process that deals with the reception of routeing information after a BIS-BIS connection has been established.)

b) **BISPDU-Send Process:** responsible for constructing BISPDUs which contain control and routeing information. BISPDUs are used by the local BIS for a variety of purposes, such as advertising routeing information to other BISs, initiating BIS-BIS communication, and validating BIS routeing information bases.

c) **Decision Process:** responsible for calculating routes which will be consistent with local routeing policies. It operates on information in both the PIB and the Adj-RIBs, using it to create the Local RIBs (Loc-RIBs) and the local Forwarding Information Bases (see 7.10).

d) **Forwarding Process:** responsible for supplying resources to accomplish relaying of NPDUs to their destinations. It uses the FIB(s) created by the Decision Process.

5.1 Inter-RD topology

This protocol views the overall global OSIE as an arbitrary interconnection of Transit Routeing Domains and End Routeing Domains which are connected by real inter-domain links placed between BISs located in the respective routeing domains. This International

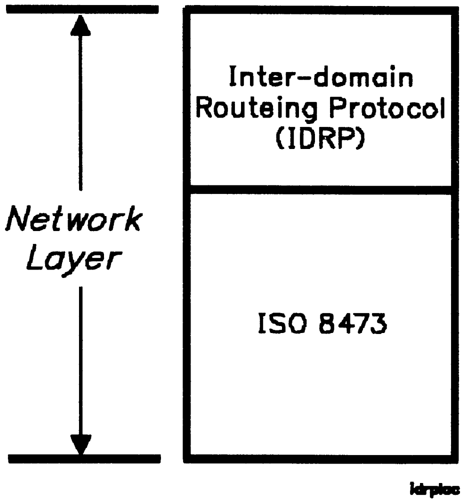

Figure 3 – Position of IDRP within Network Layer

Standard provides for the direct exchange of routeing information between BISs, which may be located either in the same routeing domain or in adjacent routeing domains.

5.2 Routeing policy

The direct exchange of policy information is outside the scope of IDRP. Instead, IDRP communicates policy information indirectly in its UPDATE PDUs which reflect the effects of the local policies of RDs on the path to the destination. Since all BISs within a routeing domain must enforce consistent active routeing policies, IDRP provides methods for detecting the existence of active inconsistent policies within a routeing domain. However, the semantics of routeing policies and the methods for establishing them are outside the scope of this International Standard.

NOTE 2: Annex L illustrates a policy description method and its associated semantics as one example of how policies might be expressed.

Each routeing domain chooses its routeing policies independently, and insures that all its BISs calculate inter-domain paths which satisfy those policies. Local routeing policies are applied to information in the Routeing Information Base (RIB) to determine a degree of preference for potential paths (see 7.16). From those paths which are not rejected by the routeing policy, a BIS selects the paths which it will use locally; from the locally selected paths, the BIS will then select the paths that it will advertise externally.

To enforce routeing policies and to insure that policies are both feasible and consistent, this protocol:

— carries path information, expressed in terms of Routeing Domain Identifiers (RDIs) and various path attributes, in its UPDATE PDUs

— permits a routeing domain to selectively propagate its reachability information to a limited set of other routeing domains

— provides a method to detect policy inconsistencies within the set of BISs located in a single routeing domain

— permits each routeing domain to set its policies individually: that is, global coordination of policy is not required.

The set of rules that comprises the routing policy enforced by a BIS are held in a Policy Information Base (PIB), which is separate from the RIB. Depending on local Security and QOS requirements, the PIB may also contain:

a) rules for the aggregation of routes that include the SECURITY and LOCALLY DEFINED QOS path attributes (see 7.18.2)

b) rules for enforcing local QOS Maintenance Policies and the effective Security Policy, during NPDU forwarding

c) rules for updating SECURITY and LOCALLY DEFINED QOS path attributes in routes that are re-advertised to external routeing domains.

5.3 Types of systems

An Intermediate system that implements the protocol described in this International Standard is called a Boundary Intermediate system (BIS). Each BIS resides in a single routeing domain, and may optionally act simultaneously as a BIS and as an intra-domain IS within its own routeing domain. For example, a single system could simultaneously play the roles of a BIS for Inter-domain routeing and a level-2 IS for Intra-domain routeing as described in ISO/IEC 10589.

5.4 Types of routeing domains

The protocol described in this International Standard recognizes two types of routeing domains, end routeing domains and transit routeing domains; each of them may contain both ISs and ESs.

5.5 Routeing domain confederations

IDRP provides support for Routeing Domain Confederations (RDCs); this optional function permits groups of routeing domains to be organized in a hierarchical fashion.

An RDC is formed by means outside the scope of this protocol, and composed of a set of *confederation members*. Confederation members (CMs) are either individual routeing domains or routeing domain confederations. Thus, the definition of an RDC is recursive: a confederation member may be a single routeing domain or another confederation.

5.6 Routes: advertisement and storage

For purposes of this protocol, a *route* is defined as a unit of information that pairs destinations with the attributes of a path to those destinations:

— *Routes* are advertised between a pair of BISs in UPDATE PDUS: the *destinations* are the systems whose NSAP prefixes are reported in the NLRI field, and the *path* is the information reported in the path attributes fields of the same UPDATE PDU.

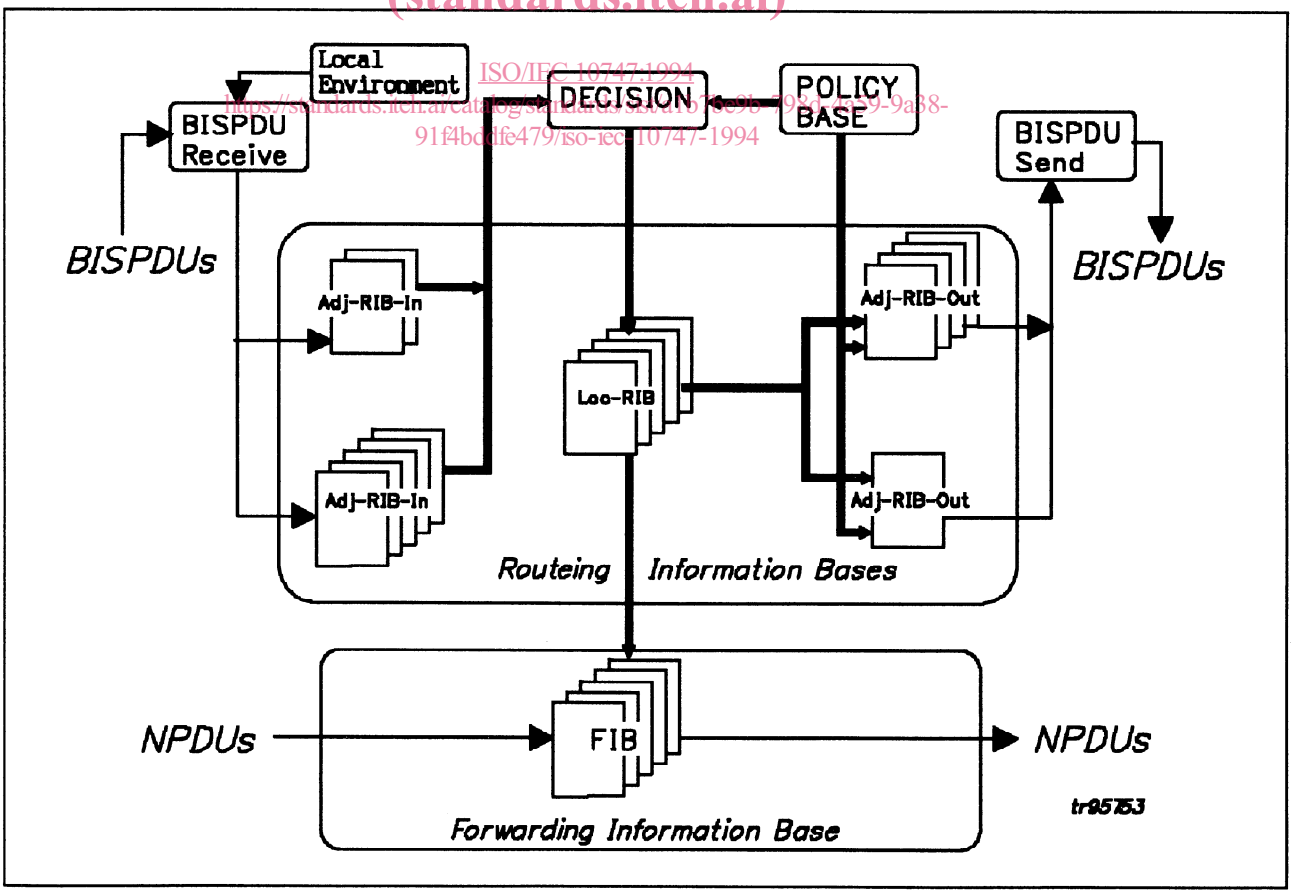

Figure 4 – Inter-domain Routeing Components