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SERIES X: DATA NETWORKS AND OPEN SYSTEM
COMMUNICATION

Public data networks – Network aspects

**International routing principles and routing plan
for public data networks**

ITU-T Recommendation X.110

(Previously CCITT Recommendation)

ITU-T X-SERIES RECOMMENDATIONS
DATA NETWORKS AND OPEN SYSTEM COMMUNICATION

PUBLIC DATA NETWORKS	X.1–X.199
Services and facilities	X.1–X.19
Interfaces	X.20–X.49
Transmission, signalling and switching	X.50–X.89
Network aspects	X.90–X.149
Maintenance	X.150–X.179
Administrative arrangements	X.180–X.199
OPEN SYSTEM INTERCONNECTION	X.200–X.299
Model and notation	X.200–X.209
Service definitions	X.210–X.219
Connection-mode protocol specifications	X.220–X.229
Connectionless-mode protocol specifications	X.230–X.239
PICS proformas	X.240–X.259
Protocol Identification	X.260–X.269
Security Protocols	X.270–X.279
Layer Managed Objects	X.280–X.289
Conformance testing	X.290–X.299
INTERWORKING BETWEEN NETWORKS	X.300–X.399
General	X.300–X.349
Satellite data transmission systems	X.350–X.399
MESSAGE HANDLING SYSTEMS	X.400–X.499
DIRECTORY	X.500–X.599
OSI NETWORKING AND SYSTEM ASPECTS	X.600–X.699
Networking	X.600–X.629
Efficiency	X.630–X.649
Naming, Addressing and Registration	X.650–X.679
Abstract Syntax Notation One (ASN.1)	X.680–X.699
OSI MANAGEMENT	X.700–X.799
Systems Management framework and architecture	X.700–X.709
Management Communication Service and Protocol	X.710–X.719
Structure of Management Information	X.720–X.729
Management functions	X.730–X.799
SECURITY	X.800–X.849
OSI APPLICATIONS	X.850–X.899
Commitment, Concurrency and Recovery	X.850–X.859
Transaction processing	X.860–X.879
Remote operations	X.880–X.899
OPEN DISTRIBUTED PROCESSING	X.900–X.999

For further details, please refer to ITU-T List of Recommendations.

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation X.110 was revised by ITU-T Study Group 7 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 5th of October 1996.

NOTE

In this Recommendation, the expression “Administration” is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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CONTENTS

	<i>Page</i>
1 Introduction	1
2 References	1
3 Description of an international route	3
4 General routing principles	4
5 Specific routing possibilities through the IPDN	4
5.1 Routing possibilities required for maintaining the quality of service	4
5.2 Service characteristics associated with a route	5
5.3 Specific conditions associated with a route	5
6 Routing procedures applicable to international interworking between PDNs of the same type and also between PSPDNs and ISDNs and/or PSTNs	5
7 Identification of IDSEs and ISDNs involved in an international call	6
8 Multiple IDSEs provided by one Administration	6
8.1 In the originating or destination country	6
8.2 In a transit country	6
9 International routing plan	7
10 Network information required to enable optimum routings to be planned	7
Annex A – Terms and definitions related to routing in the PDN	7
Annex B – The use of satellite links in overall CSPDN routes	8
B.1 General considerations	8
B.2 Principles in each PDN	8
Annex C – Routing information	9
Appendix I – International routing plan – Examples of routes	9
I.3 Rerouting	13

SUMMARY

This Recommendation specifies the routing principles that should be applied for the establishment of packet-switched virtual calls or circuit switched calls when interconnecting public data networks. This Recommendation contains the guidelines which Administrations should follow with the aim of encouraging the spread of public data networks internationally and foster commonality of understanding leading to an orderly development of the international network, making effective and economical use of network resources.

INTERNATIONAL ROUTING PRINCIPLES AND ROUTING PLAN FOR PUBLIC DATA NETWORKS

(Revised in 1996)

1 Introduction

1.1 This Recommendation specifies the routing principles that should be applied for the establishment of circuit-switched calls or packet-switched virtual calls when interconnecting public data networks.

This Recommendation should be applied to public data networks and referred to when Administrations are planning an interconnection between public data networks. This Recommendation contains guidelines which Administrations should follow and also gives examples of specific routings. Its aim is to encourage the spread of public data networks internationally and foster a commonality of understanding leading to an orderly development of the international network, making effective and economical use of network resources. It is hoped that its use will enable the evolution of inter-networking to take place between public data networks, ISDNs, international telephone networks and other public networks. It is recognized that the plan will need to be reviewed periodically to ensure that it is in step with actual practice taking place within the international public data networks. In order to aim at a better understanding of the international routing plan for public data networks, an international public data network model is illustrated in Figure 1. This model consists of a set of national public networks and shows the interconnection of national public data networks and International Data Switching Exchanges (IDSEs). Public data networks have evolved in different ways in many countries. The model shown illustrates six types of networks that have evolved as follows:

- a) Some countries may have more than one PDN and also more than one IDSE. See country A in Figure 1.
- b) Some countries may have one IDSE which stands alone from that country's PDN. See country B in Figure 1.
- c) Some countries may have one PDN and gain international access through one IDSE. See country C in Figure 1.
- d) Some countries may not have a PDN but utilize an IDSE for international connections. See country D in Figure 1.
- e) Some countries may have more than one PDN each with its own IDSE. See country E in Figure 1.
- f) Some countries may have more than one PDN each sharing one or more IDSE. See country F in Figure 1.

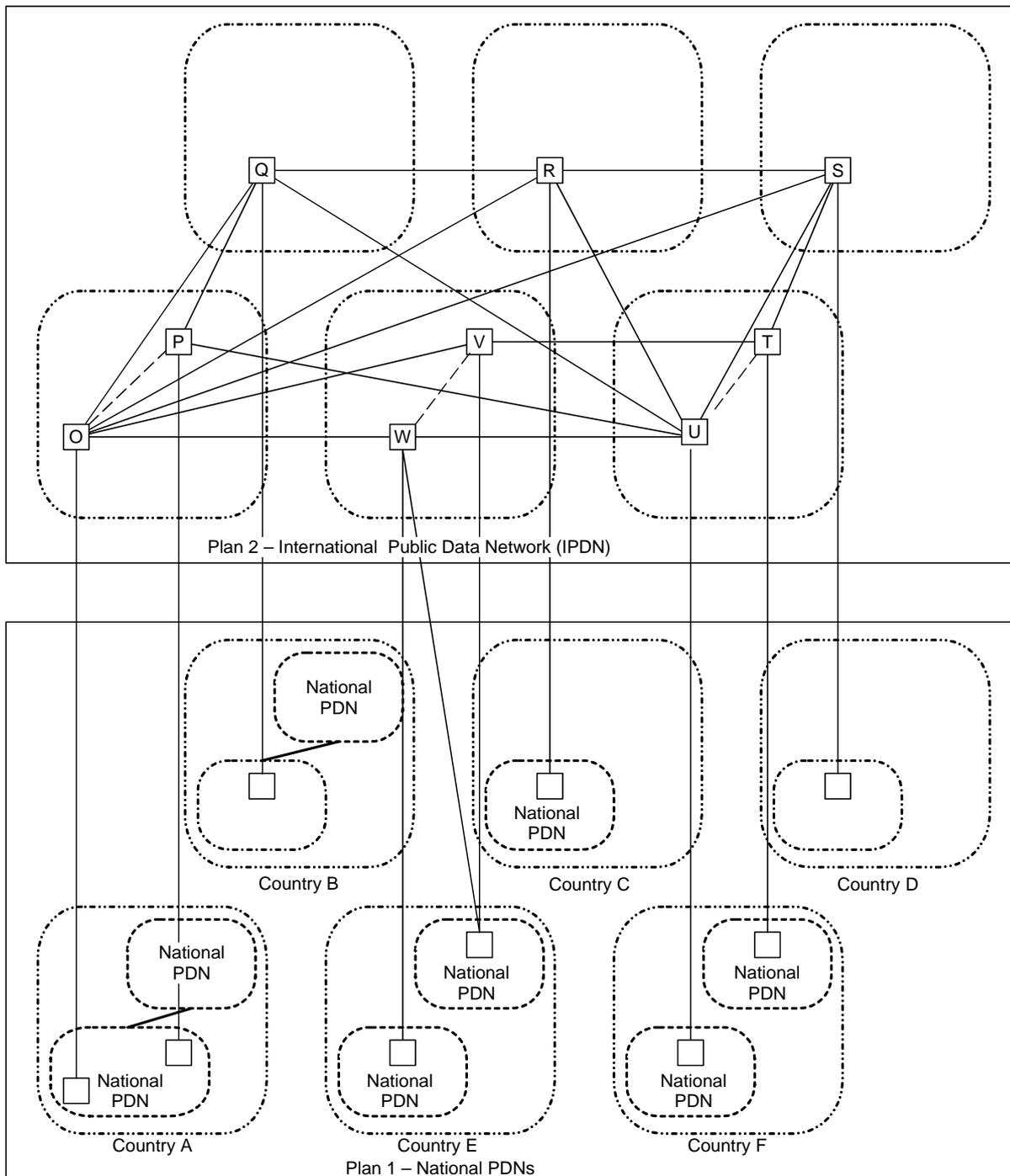
1.2 Circuits between IDSEs in the same country are not classed as international links.

1.3 A list of the terms and definitions used in this Recommendation are recorded in Annex A.

2 References

The following Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- ITU-T Recommendation X.1 (1996), *International user classes of service in, and categories of access to, public data networks and Integrated Services Digital Networks (ISDNs)*.
- ITU-T Recommendation X.7 (1996), *Technical characteristics of data transmission services*.



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-  National PDN
-  Refer to 1.1, items b) and d)
-  Indicates a country or a geographical area
- Possible data links which may be classified as part of an international data connection

FIGURE 1/X.110
International public data network model

- CCITT Recommendation X.60 (1988), *Common channel signalling for circuit switched data applications.*
- CCITT Recommendation X.61 (1988), *Signalling System No. 7 – Data user part.*
- CCITT Recommendation X.70 (1988), *Terminal and transit control signalling system for start-stop services on international circuits between anisochronous data networks.*
- CCITT Recommendation X.71 (1988), *Decentralized terminal and transit control signalling system on international circuits between synchronous data networks.*
- ITU-T Recommendation X.75 (1996), *Packet-switched signalling system between public networks providing data transmission services.*
- ITU-T Recommendation X.115 (1995), *Definition of address translation capability in public data networks.*
- ITU-T Recommendation X.116 (1996), *Address translation registration and resolution protocol.*
- ITU-T Recommendation X.121 (1996), *International numbering plan for public data networks.*
- ITU-T Recommendation X.122/E.166 (1996), *Numbering plan interworking for the E.164 and X.121 numbering plans.*
- ITU-T Recommendation X.123 (1996), *Mapping between escape codes and TOA/NPI for E.164/X.121 numbering plan interworking during the transition period.*
- CCITT Recommendation X.130 (1988), *Call processing delays in public data networks when providing international synchronous circuit-switched data services.*
- CCITT Recommendation X.131 (1988), *Call blocking in public data networks when providing international synchronous circuit-switched data services.*
- CCITT Recommendation X.135 (1992), *Speed of service (delay and throughput) performance values for public data networks when providing international packet-switched services.*
- CCITT Recommendation X.136 (1992), *Accuracy and dependability performance values for public data networks when providing international packet-switched services.*
- CCITT Recommendation X.353 (1988), *Routing principles for interconnecting public maritime mobile satellite data transmission systems with public data networks.*

3 Description of an international route

3.1 The basic function of routing a call (or selecting a route for a call) consists of selecting the network equipment (i.e. outgoing link) that will be used for transferring data for that call.

3.2 The route used for an international call always consists of three parts:

- an originating national network part, from the calling DTE to the originating IDSE (i.e. through the originating PDN);
- an international network part, from the originating IDSE to the destination IDSE (i.e. through the international public data network IPDN);
- a destination national network part, from the destination IDSE to the called DTE (i.e. through the destination PDN).

NOTE – For maritime satellite data transmission systems a Maritime Satellite Data Switching Exchange (MSDSE) would function as the originating and destination IDSE.

3.3 The planning of the international network part is subject to ITU-T study.

3.4 The planning of the originating and destination national network parts is a national matter; however, the quality of service (e.g. transfer delay) provided on international connections should be considered in these national networks.

4 General routing principles

4.1 The planning of international data traffic routes is the responsibility of the Administrations concerned and is subject to bilateral agreements.

4.2 The traffic route within the international network part should be so planned as to encompass no more than four international data links in tandem.

4.3 When planning traffic routes, Quality of Service (QOS) requirements should be taken into account. One such QOS requirement is the overall transfer delay of the connection. In considering the overall transfer delay, the number of satellite links is of major significance. However, it is noted that transfer delay in PSPDNs exclusive of satellite links, may also be significant and is for further study.

4.4 In accordance with Recommendation X.92, no more than three satellite links should normally be included in an overall PDN route. The international network part should normally not include more than two satellite links. (Refer to Annex B.)

4.5 Traffic routes will normally comprise direct call routes and alternative call routes.

4.6 Traffic routes should be planned so as to avoid the possibility of circular call routings.

4.7 When planning traffic routes, use should be made of time-zone differences.

4.8 The routing of a call is a matter under the responsibility of Administrations and should, where possible, follow one of the traffic routes agreed to in 3.1.

4.9 All Administrations concerned with the routing of a given call should be able to obtain the necessary information for that call (e.g. the DNIC of each network concerned).

NOTE – The application of this principle to circuit-switched networks is for further study.

4.10 The international network part for a call should be selected on a link-by-link basis by the IDSEs concerned.

4.11 The international call route for a connection is selected by the IDSEs concerned. Under normal conditions, when a call route for a specific call has been established, that call route should be used for the entire duration of that call.

4.12 Calls should be routed using the minimum number of international data links taking into account the economics and practicalities of the situation.

4.13 If a trunk cannot satisfy the throughput requirements made by the originating subscriber, it will be necessary to select one of the possible alternative call routes.

5 Specific routing possibilities through the IPDN

5.1 Routing possibilities required for maintaining the quality of service

Specific routing possibilities may be considered for maintaining a good quality of service, for example:

- the selection of a reliable route for a call, in order to avoid clearing of the call by the network (or reset of the call in the case of a virtual call), due to internal network problems;
- the availability of more than one call route between originating and destination networks, in order to avoid a call request being barred if one call route is temporarily not available.

5.2 Service characteristics associated with a route

During a call establishment, a public data network may have to consider some aspects of the network service characteristics to make routing decisions.

Whenever several traffic routes can be used between two users, in addition to the availability of those traffic routes at a given time, it is important that the service characteristics associated with any one of those traffic routes be considered (e.g. throughput available, acceptance of some facilities, etc.).

5.3 Specific conditions associated with a route

During call establishment, a public data network may have to consider specific conditions such as reverse charge request, access protection (closed user group, incoming calls barred), etc. Under such circumstances, as far as possible, the Administrations should endeavour to provide call routings subject to:

- a) the availability of the facilities required;
- b) bilateral agreement.

Failing that, the call should be barred.

6 Routing procedures applicable to international interworking between PDNs of the same type and also between PSPDNs and ISDNs and/or PSTNs

6.1 International Data Switching Exchanges (IDSEs) will recognize the calling and the called Data Network Identification Codes (DNICs) or Data Country Codes (DCCs) to determine the destination of a call and the call route. (See Notes 1, 2, 3 and 4.)

NOTE 1 – The application of this principle to circuit-switched networks is for further study.

NOTE 2 – For PSPDN to PSPDN interworking, possible digit analysis of the first one or more digit(s) beyond the 4 digit DNIC field is to be determined on a bilateral basis if necessary.

NOTE 3 – For routing of calls to ISDN, PSTN and Mobile Satellite Systems from PSPDN, a digit of at least 1 digit beyond the 4 digit DNIC field is required.

NOTE 4 – ROA selection shall have no influence on the determination of the call route between the IDSEs.

6.2 A call from an ISDN (or PSTN) to a PSPDN, a PSPDN to an ISDN (or PSTN) and calls routed through networks using a different numbering plan to that of the originating or destination network are examples of inter-networking which require the need for numbering plan interworking. Numbering Plan Interworking is a fundamental requirement for the successful completion/routing of calls between networks utilizing different numbering plans.

Interworking from a terminal on a PSPDN (numbered under X.121) to a terminal on an ISDN/PSTN numbered under the E.164 numbering plan can be achieved by use of the X.121 escape code method in the calling PSPDN when the called address (including prefixes and escape codes) is not greater than 15 digits. The escape code method can be used to signal a 14-digit E.164 number if a prefix is not used or a 13-digit E.164 number if a prefix is used (see Recommendation X.122).

The presence of an escape code, 0 or 9, as defined in Table 2/X.121 will have special significance for PSPDN to ISDN and PSTN routing as follows:

- i) a value of 0 for the escape code will require that the IDSE route the call either to a digital interface to an ISDN or to a transit IDSE (see Note);
- ii) a value of 9 for the escape code will require that the IDSE route the call either to an analogue interface to a PSTN, an ISDN or to a transit IDSE (see Note).

NOTE – To select a route, an IDSE may choose to examine up to 5 digits (escape code and **first** four digits of E.164 number).

6.3 An alternative to the use of the X.121 escape codes for numbering plan interworking is the use of the Type of Address/Numbering Plan Identifier (TOA/NPI) which is carried in the address field within a call set-up signalling message. Within the PSPDN domain, the TOA/NPI approach is required when the called E.164 address length field (including prefixes and escape codes) is greater than 15 digits. PSPDNs/ISDNs will route calls by analyzing the appropriate digits (e.g. DCC, DNIC or PNIC).

6.4 The selection of links (e.g. satellite and/or submarine cable) for a given call route should be determined by the Administrations concerned on a per call basis.

6.5 The same call route will be maintained for the duration of a call.

6.6 Barring procedures for particular call routes will be provided by each Administration and will be the subject of bilateral agreement.

6.7 Transit networks will check routing information of each call to prevent circular routings.

7 Identification of IDSEs and ISDNs involved in an international call

Any Administration involved in providing transit IDSE(s) or ISDN(s) for an international call should be identified at the time of the call establishment by means of a DNIC or 4-digit ISDN Identification Code allocated to that Administration (see Notes 1, 2).

NOTE 1 – Exceptionally, a DNIC or ISDN Identification Code may need to be allocated to an Administration that would offer transit only and no direct subscriber access, for the purpose of identifying the transit IDSE(s) or ISDN(s).

NOTE 2 – The Administrations of the originating and destination networks are already identified within the calling and called DTE terminal addresses, and therefore do not require any additional identification at the time of the call establishment.

There may be more than one IDSE provided by the same Administration. Several independently operated networks may be provided by the same Administration. Independently operated networks may need to be identified even when the same Administration is concerned. Two or more IDSEs provided within the same independently operated network should be identified by the same DNIC (see Note 3).

NOTE 3 – The provision of one DNIC or ISDN Identification Code for a transit, independently operated network is considered to be sufficient for covering the international accounting requirements, and for avoiding unexpected loops of calls between independently operated networks. The identifications needed for tracing the exact path of a call for maintenance are for further study.

8 Multiple IDSEs provided by one Administration

8.1 In the originating or destination country

The use by some Administrations of multiple originating and/or destination IDSEs could, in some cases, result in the routing of a call over a circuit between two IDSEs in the originating or destination country. Such circuits may be regarded as national links in applying this Recommendation.

8.2 In a transit country

Some Administrations may find it desirable to route transit traffic between two IDSEs in their own country. Such circuits need not be counted as one of the four international links allowed in this Recommendation, but from a transmission point of view must be counted as an additional international circuit.

9 International routing plan

- 9.1 Administrations may plan any traffic route providing it conforms to the principles in this Recommendation.
- 9.2 Since traffic routes can comprise direct and alternative routes, individual call routes should use the minimum number of IDSEs.
- 9.3 Many combinations of call routes are possible, some examples of which are contained in Appendix I.
- 9.4 Call rerouting can be planned if the required network management signals are available. An example of call rerouting is contained in Appendix I.

10 Network information required to enable optimum routings to be planned

Administrations should compile information concerning the quality of service parameters and network status of their networks for dissemination, on request, to those other interested Administrations who may wish to utilize it. These exchanges of information will enable Administrations to make optimum routing decisions when planning networks. Annex C contains a typical list of information of the type that should be available.

Annex A

Terms and definitions related to routing in the PDN

This annex contains terms and definitions that will be utilized in the PDN routing plan. These terms and definitions are based, as far as possible, on the currently available documentation both with ITU-T and IEC (International Electrotechnical Commission, Chapter 701).

To aid understanding, Figure A.1 records the relationship between the terms traffic route, alternative traffic route, call route, originating IDSE (IDSE-O), destination IDSE (IDSE-D), transit IDSEs (IDSE-X and IDSE-Y).

- A.1 **traffic route:** A predetermined sequence of *trunk circuits* that is used to carry traffic between two points.
- A.2 **alternative traffic route:** Between two given points more than one *traffic route* may exist. The availability of the option of using one of several routes is referred to as alternative traffic route.
- A.3 **call route:** The sequence of circuits that is used to provide a *connection* between two points.
- A.4 **call routing** The action taken by an exchange of selecting a given *call route* from a number of *traffic routes*.
- A.5 **call rerouting:** The action of changing a proposed *call route* during the attempted establishment of a *connection*.
- A.6 **originating PDN:** A set of equipment and/or circuits which enable connection of a calling DTE to the originating IDSE.
- A.7 **destination PDN:** A set of equipment and/or circuits which enable connection of a destination IDSE to the called DTE.

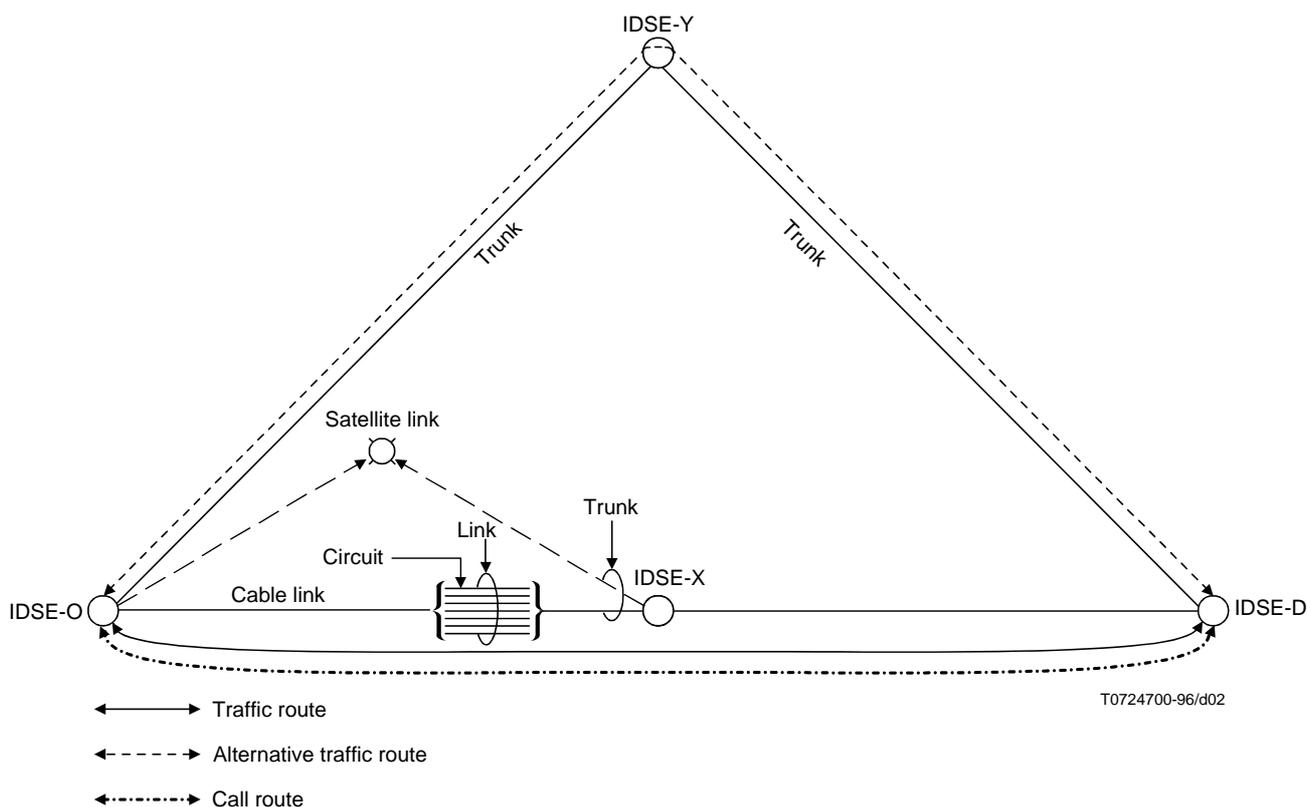


FIGURE A.1/X.110
 The network part of the International Public Data Network (IPDN)

Annex B

The use of satellite links in overall CSPDN routes

B.1 General considerations

- 1) When a satellite circuit is selected as the transmission path in an international connection, it should be noted that satellite circuits have some specific characteristics which need to be taken into account when used in PDNs.
- 2) It should be allowed to include a satellite link in the transmission path of a national network part of an international connection, recognizing that, in some cases, subscriber access may only be available via national or regional satellite systems.
- 3) It should be noted that in the international maritime satellite system for data communication services, only satellite paths are available in each ocean region.

In considering the above, the maximum number of satellite links allowed in an international connection, including both international and national network parts, should be three.

B.2 Principles in each PDN

B.2.1 Originating national PDN

It would be preferable to select routes which have a higher quality and minimum transfer delay for the national network part in the international connection. This would afford the maximum flexibility in the selection of the international links.

B.2.2 Originating/transit IDSEs

No more than two satellite links should be used in the international network part of the connection.

For calls to and from the maritime satellite data transmission system no more than one satellite link should be used in the international network part of the connection.

B.2.3 Destination IDSE

It is for further study to establish if the number of satellite links which have been applied to each call should be conveyed to the national PDNs in its call establishment stage.

If three satellite links have already been used in the connection so far, the use of a further satellite link in the destination Administration to complete the call should only be allowed with the consent of the Administrations concerned.

B.2.4 Destination national PDN

It would be preferable not to select any satellite links except in the case where no other possible route is available for this call.

Annex C

Routing information

The following information is typical of that which may be exchanged by Administrations during traffic routing negotiations:

- 1) name of country and DNIC to which their IDSEs are connected, indicating 1, 2, 3 or 4 link connections;
- 2) number of circuits and speed of transmission on each link using satellite or cable;
- 3) mode of working;
- 4) busy hour for each trunk and IDSE;
- 5) alternative traffic routes;
- 6) quality of service requirements;
- 7) facilities provided;
- 8) internetworking provided.

Appendix I

International routing plan – Examples of routes

I.1 Administrations will wish to provide their routes in an economical way. When high volumes of traffic are forecast, a direct route with no intermediate IDSE will be planned and routes with low volumes will be switched at one or more transit IDSEs. Alternative routes will be provided over which the traffic will be carried when the direct route is unavailable. The routing algorithm will normally be: high usage route (direct), alternative route 1, alternative route 2. Administrations can make use of their agreed routes by offering them to third party Administrations for their own routes. Care should be taken to ensure that no routes planned in this way would involve inclusion of any more than 4 international links.

I.2 Figures I.1 to I.3 depict some typical routes that Administrations are likely to plan.

I.2.1 Direct route (high usage route)

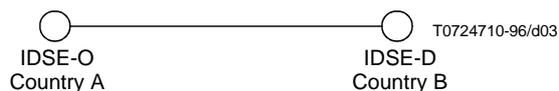


FIGURE I.1/X.110

Direct route

I.2.2 Routes via intermediate countries (low volumes of traffic)

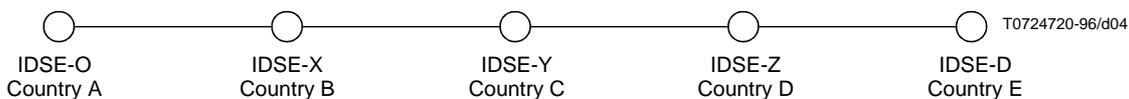
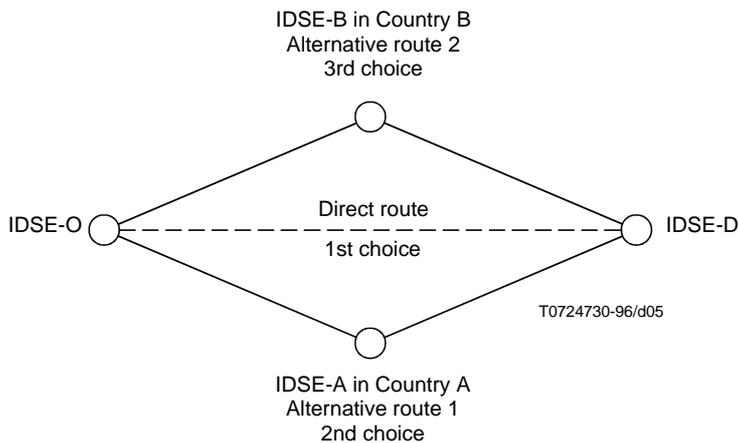


FIGURE I.2/X.110

Limiting condition route via 3 intermediate IDSEs

1.2.3 Alternative route



NOTE 1 – Likely routing selection process:

- First choice – Direct route
- Second choice – Alternative 1 via IDSE-A
- Third choice – Alternative 2 via IDSE-B.

NOTE 2 – A similar routing algorithm may exist at intermediate IDSEs and care should be taken to ensure that the call is not routed using more than four links.

FIGURE I.3/X.110

Alternative route

I.2.4 Routing plan in cases where direct routes are available

Within the economic and political constraints of a country, the alternative routes should be selected with the following sequences for some particular connections.

The first alternative route selection would be made in the originating IDSE to one of the transit IDSEs which have direct routes to the destination IDSE (see Figure I.4). If this is not the case, selection will be made to the transit IDSE without a direct route to the destination.

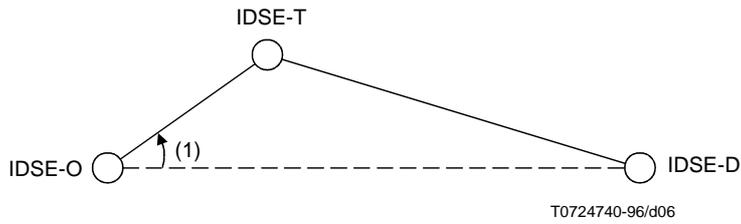


FIGURE I.4/X.110

The second alternative routing will be made in the first transit IDSE IDSE-T₁ to the second transit IDSE IDSE-T₂ with a direct route to the destination of this connection (see Figure I.5).

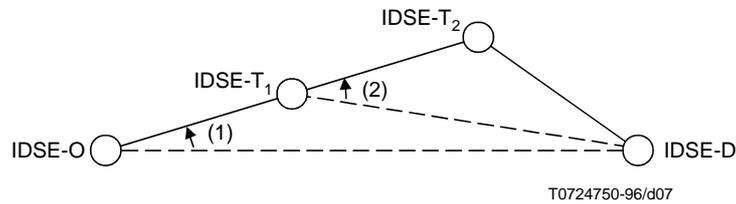


FIGURE I.5/X.110

The third alternative routing should be made in the same way, indicated in Figure I.6.

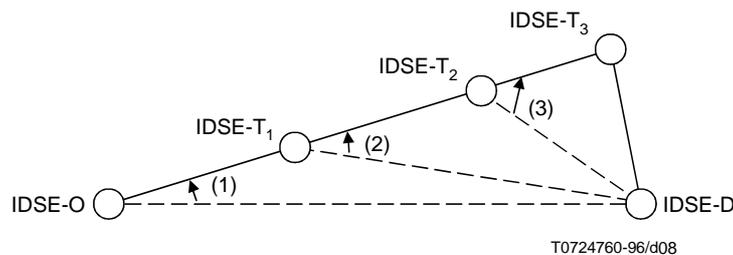


FIGURE I.6/X.110

I.2.5 Routing plan in cases where no direct route is available

In the case of traffic congestion between IDSE-O and IDSE-T₁, it is preferable to take another transit IDSE which has a direct route to the destination IDSE-D, if possible (see Figure I.7).

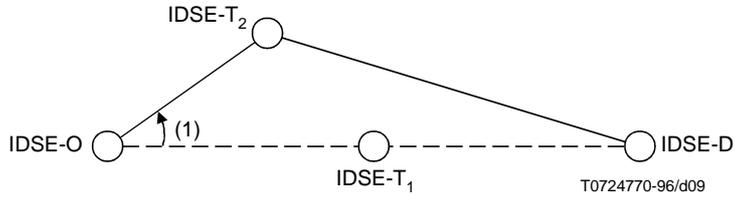


FIGURE I.7/X.110

If the originating IDSE-O must select a route to the transit IDSE-T₂ which has no direct route available to the destination IDSE-D, the subsequent transit IDSE may be the IDSE-T₁ (see Figure I.8) or IDSE-T₃ (see Figure I.9) if no direct route is available between IDSE-T₂ and IDSE-D.

The routing plan for the connection from IDSE-T₁ to IDSE-D would be the same as the plan indicated in I.2.4 above.

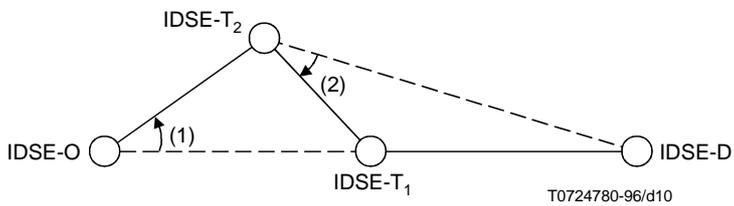


FIGURE I.8/X.110

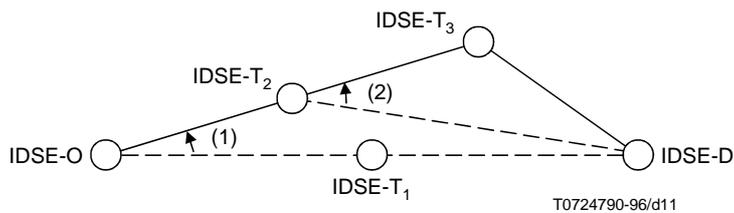
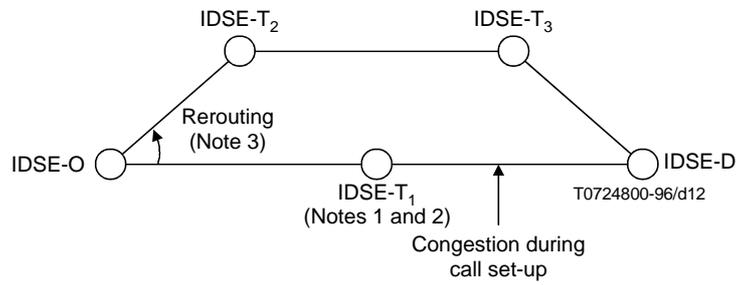


FIGURE I.9/X.110

I.3 Rerouting

The concept of rerouting considers calls that fail at an intermediate IDSE during call set-up. The details of call rerouting are for further study; however, Figure I.10 records the concept.



NOTE 1 – Call attempt reaches IDSE-T₁.

NOTE 2 – No route is provided between IDSE-T₁ and IDSE-T₃.

NOTE 3 – Call rerouting is attempted via IDSE-T₂, IDSE-T₃ and IDSE-D.

FIGURE I.10/X.110

ITU-T RECOMMENDATIONS SERIES

- Series A Organization of the work of the ITU-T
- Series B Means of expression: definitions, symbols, classification
- Series C General telecommunication statistics
- Series D General tariff principles
- Series E Overall network operation, telephone service, service operation and human factors
- Series F Non-telephone telecommunication services
- Series G Transmission systems and media, digital systems and networks
- Series H Audiovisual and multimedia systems
- Series I Integrated services digital network
- Series J Transmission of television, sound programme and other multimedia signals
- Series K Protection against interference
- Series L Construction, installation and protection of cables and other elements of outside plant
- Series M Maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
- Series N Maintenance: international sound programme and television transmission circuits
- Series O Specifications of measuring equipment
- Series P Telephone transmission quality, telephone installations, local line networks
- Series Q Switching and signalling
- Series R Telegraph transmission
- Series S Telegraph services terminal equipment
- Series T Terminals for telematic services
- Series U Telegraph switching
- Series V Data communication over the telephone network
- Series X Data networks and open system communication**
- Series Z Programming languages