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SERIES X: DATA COMMUNICATION NETWORKS:
TRANSMISSION, SIGNALLING AND SWITCHING,
NETWORK ASPECTS, MAINTENANCE AND
ADMINISTRATIVE ARRANGEMENTS

Data communication networks – Network aspects

**INTERNATIONAL ROUTING PRINCIPLES
AND ROUTING PLAN FOR PUBLIC DATA
NETWORKS**

Reedition of CCITT Recommendation X.110 published in
the Blue Book, Fascicle VIII.3 (1988)

NOTES

- 1 CCITT Recommendation X.110 was published in Fascicle VIII.3 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).
- 2 In this Recommendation, the expression “Administration” is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Recommendation X.110

INTERNATIONAL ROUTING PRINCIPLES AND ROUTING PLAN FOR PUBLIC DATA NETWORKS

*(Geneva, 1980; amended at Malaga–Torremolinos, 1984,
and Melbourne, 1988)*

The CCITT,

considering

- (a) that Recommendation X.1 defines the international user classes of service for public data networks;
- (b) that Recommendation X.92 defines the hypothetical reference connection for public synchronous data networks;
- (c) that Recommendation X.121 defines the international numbering plan for public data networks;
- (d) that Recommendation X.122 defines numbering plan interworking between a PSPDN and an ISDN or PSTN in the short-term;
- (e) that Recommendations X.130 and X.131 define the quality of service parameters for circuit-switched public data networks (CSPDN);
- (f) that Recommendations X.135 and X.136 define the quality of service parameters for packet-switched public data networks (PSPDN);
- (g) that Recommendation X.75 defines terminal and transit call control procedures and data transfer systems on international circuits between packet-switched public data networks;
- (h) that Recommendations X.70, X.71, X.60 and X.61 define the signalling systems for circuit-switched public data networks;
- (i) that Recommendation X.353 defines the routing principles interconnecting PDNs with mobile-satellite systems,

unanimously declares

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

Note – There is a requirement for a Recommendation that defines the dimensioning of routes to enable a specified grade of service to be met. (This requires further study).

1 Introduction

1.1 This Recommendation should be applied to public data networks and referred to when Administrations are planning an interconnection between public data networks. The 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/X.110. 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/X.110;
- b) some countries may have one IDSE which stands alone from that country's PDN. See country B in Figure 1/X.110;

- c) some countries may have one PDN and gain international access through one IDSE. See country C in Figure 1/X.110;
- d) some countries may not have a PDN but utilize an IDSE for international connections. See country D in Figure 1/X.110;
- e) some countries may have more than one PDN each with its own IDSE. See country E in Figure 1/X.110;
- f) some countries may have more than one PDN each sharing one or more IDSE. See country F in Figure 1/X.110.

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 Description of an international route

2.1 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.

2.2 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.

2.3 The planning of the international network part is subject to CCITT study.

2.4 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.

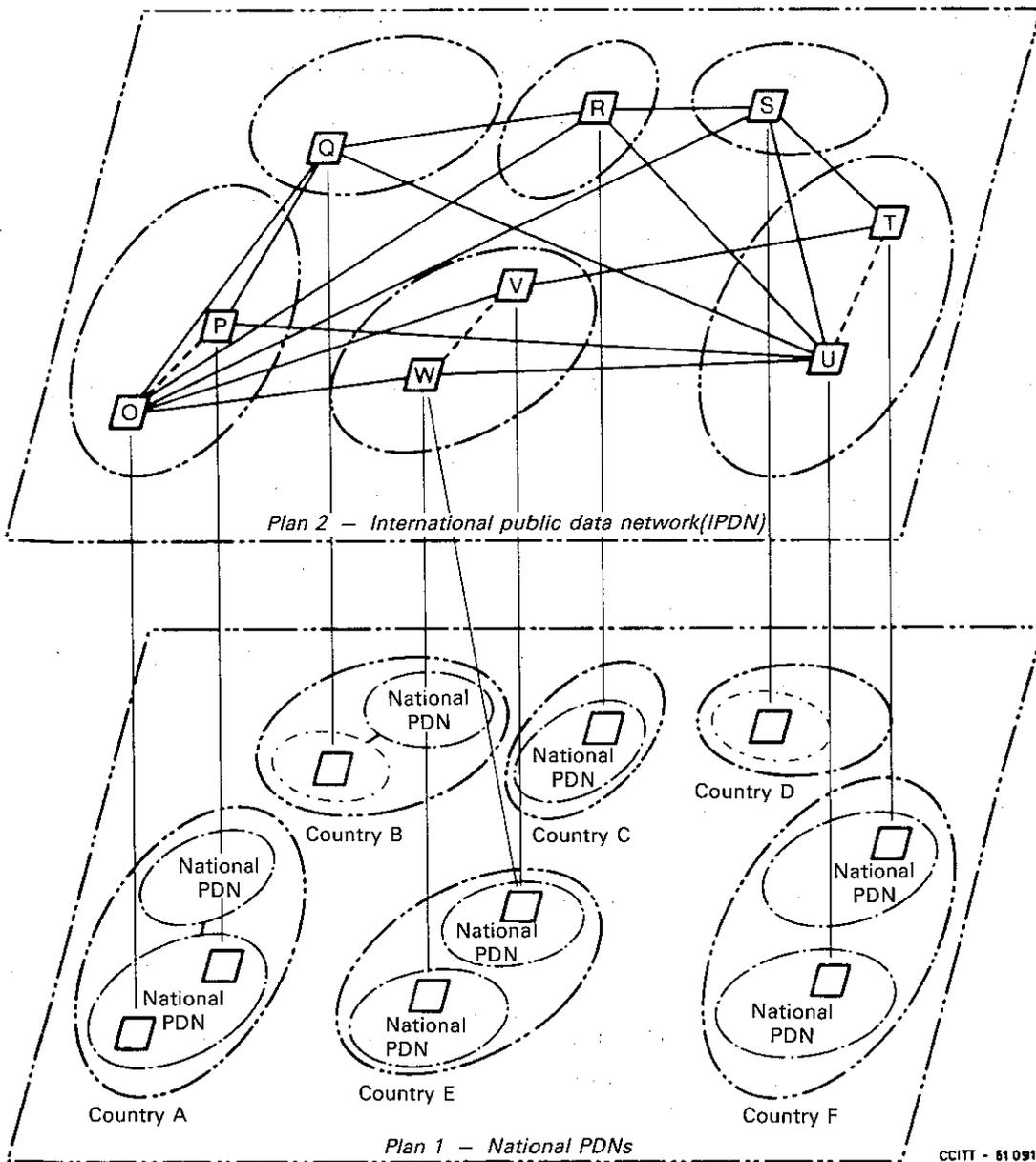
3 General routing principles

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

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

3.3 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.

3.4 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.)



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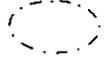
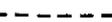
-  National PDN
-  Refer to § 1.1, items b) and d)
-  Indicates a country or a geographical area
-  Possible data links which may be classified as part of an international data connection

FIGURE 1/X.110

International public data network model

- 3.5 Traffic routes will normally comprise direct call routes and alternative call routes.
- 3.6 Traffic routes should be planned so as to avoid the possibility of circular call routings.
- 3.7 When planning traffic routes, use should be made of time–zone differences.
- 3.8 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.
- 3.9 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.
- 3.10 The international network part for a call should be selected on a link–by–link basis by the IDSEs concerned.
- 3.11 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.
- 3.12 Calls should be routed using the minimum number of international data links taking into account the economics and practicalities of the situation.
- 3.13 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.

4 Specific routing possibilities through the IPDN

4.1 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.

4.2 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.).

4.3 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.

5 Routing procedures applicable to international interworking between PDNs of the same type and also between PSPDNs and ISDNs and/or PSTNs in the short term

5.1 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 analysis capability of at least 1 digit beyond the 4 digit DNIC field is required.

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

5.2 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).

5.3 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.

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

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

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

6 Identification of IDSEs and ISDNs involved in an international call in the short term

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 (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 ISDE(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 ISDE 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 (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.

7 Multiple IDSEs provided by one Administration

7.1 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.

7.2 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.

8 International routing plan

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

9 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

(to Recommendation X.110)

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 CCITT and IEC (International Electrotechnical Vocabulary, Chapter 701).

To aid understanding, Figure A-1/X.110 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.

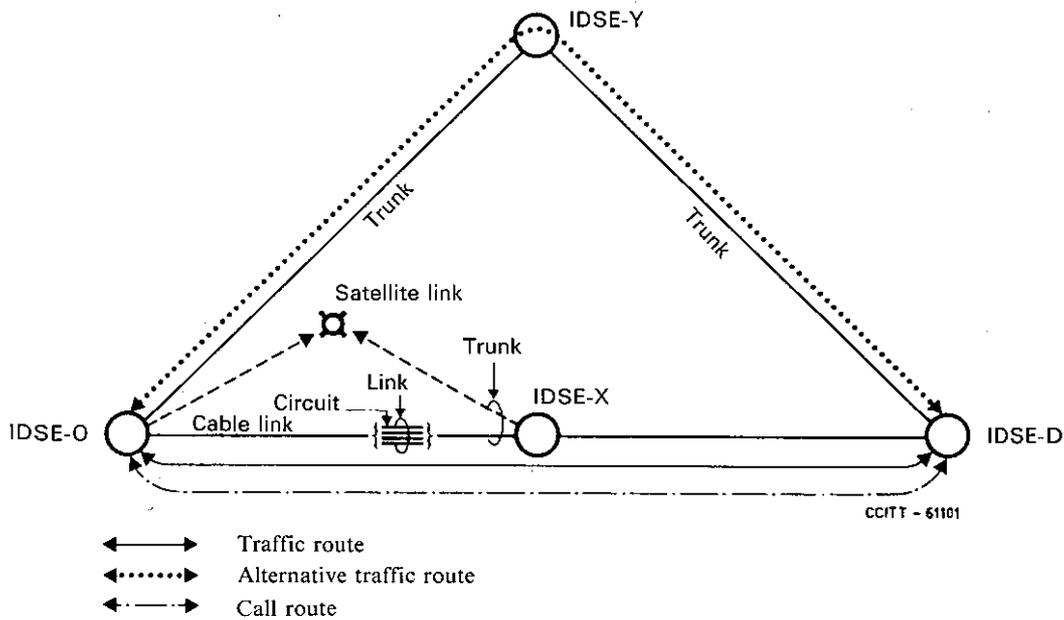


FIGURE A-1/X.110

The network part of the international public data network (IPDN)

ANNEX B

(to Recommendation X.110)

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

(to Recommendation X.110)

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

(to Recommendation X.110)

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/X.110 to I-3/X.110 depict some typical routes that Administrations are likely to plan.

I.2.1 *Direct route* (high usage route)

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



FIGURE I-1/X.110

Direct route

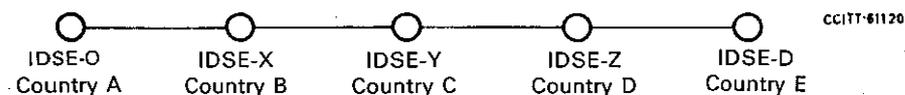
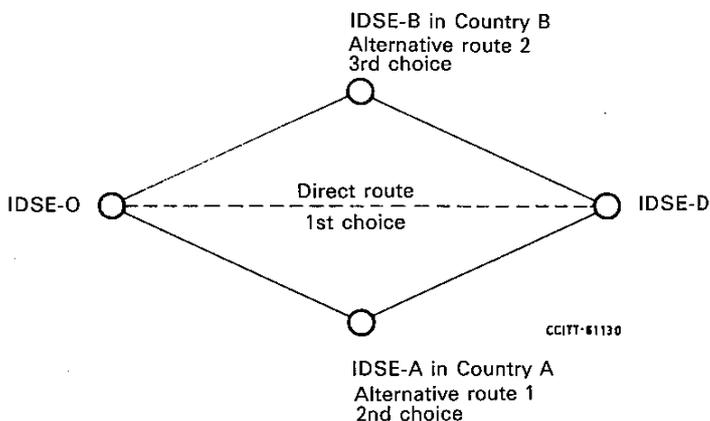


FIGURE I-2/X.110

Limiting condition route via 3 intermediate IDSEs

I.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 (Figure I-4/X.110). If this is not the case, selection will be made to the transit IDSE without a direct route to the destination.

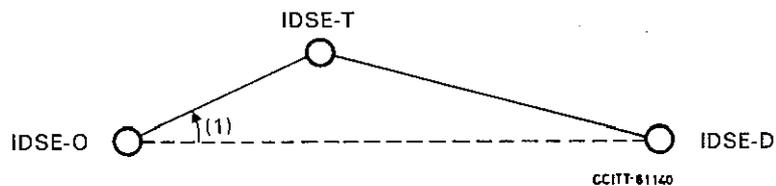


FIGURE I-4/X.110

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 (Figure I-5/X.110).

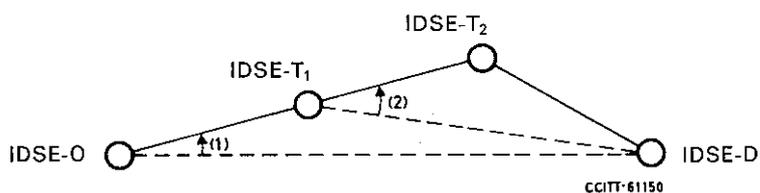


FIGURE I-5/X.110

The third alternative routing should be made in the same way, indicated in Figure I-6/X.110.

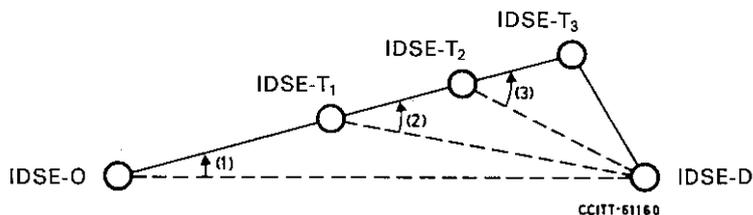


FIGURE I-6/X.110

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 (Figure I-7/X.110).

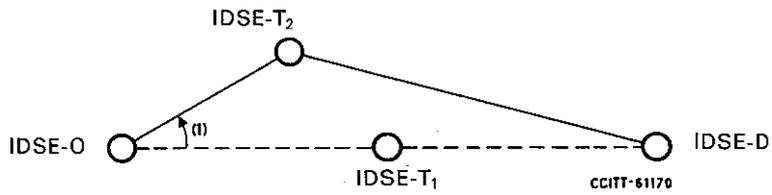


FIGURE I-7/X.110

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 (Figure I-8/X.110) or IDSE-T₃ (Figure I-9/X.110) 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.

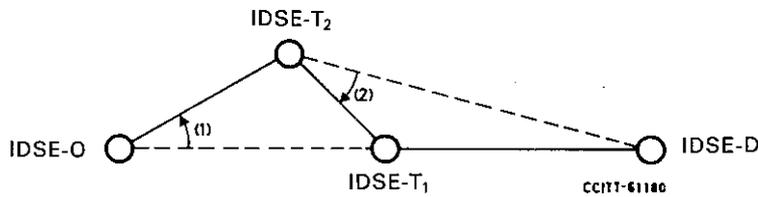


FIGURE I-8/X.110

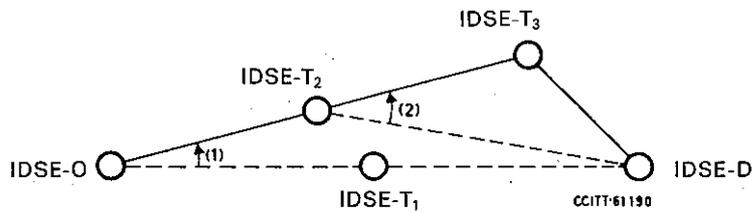
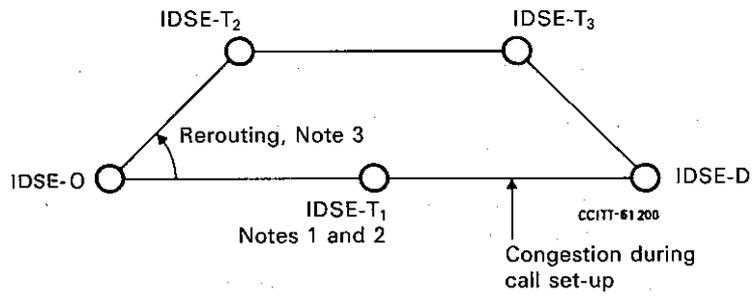


FIGURE I-9/X.110

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/X.110 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

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