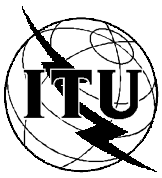

INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

E.172

(10/92)

TELEPHONE NETWORK AND ISDN

OPERATION, NUMBERING, ROUTING AND MOBILE SERVICE

ISDN ROUTING PLAN

Recommendation E.172

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT 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 Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation E.172 was prepared by Study Group II and was approved under the Resolution No. 2 procedure on the 30th October 1992.

CCITT NOTE

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

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Recommendation E.172

ISDN ROUTING PLAN

(1992)

1 Introduction and scope

1.1 ISDN capabilities are currently being introduced into national and international networks. ISDN provides access to a wide range of services, each of which must be supported by a minimum level of network capabilities. For each service requested by a user, the network must provide the appropriate switching, signalling and transmission capabilities required to successfully complete the call. In practical ISDN implementations some of the ISDN functions will be implemented within the same network elements whereas other ISDN functions, such as those required for interworking, packet handling, etc. will be implemented in "special" network elements.

1.2 The purpose of this Recommendation is to provide network operators with the information necessary to ensure that ISDN services can be routed effectively and efficiently by the various networks which support them.

1.3 The Recommendation establishes basic principles on which to base network design and routing decisions. It provides detailed information on the mapping between ISDN bearer services, ISDN connection types and network capabilities (e.g. transmission links, signalling systems, etc.) required to support a call. Guidance on the conveyance and use of routing information within network components is also included. Further information on the routing implications of network interworking is included at Annex C.

1.4 The Recommendation is intended to provide a single definitive reference Recommendation for ISDN routing. It supersedes earlier ISDN routing Recommendations, specifically Recommendation E.172 (1988) – Call routing in the ISDN era, and Recommendation I.335 (1988) – ISDN routing principles.

1.5 The scope of the Recommendation is limited to circuit and packet switched bearer services. It is further limited to services supported by Recommendation Q.767. Broadband services routing requirements are for further study.

2 References and related Recommendations

The related Recommendations and their relationship to Recommendation E.172 are depicted below in Figure 1/E.172.

3 ISDN routing principles

3.1 The following basic ISDN routing principles are recommended to assist in managing the trade-off between customer satisfaction and network optimization.

a) complete as many calls as possible;

b) utilize network resources efficiently:

- match network capability to service demand;
- minimize the use of "overmatching" network capability;
- minimize the number of links in a route;

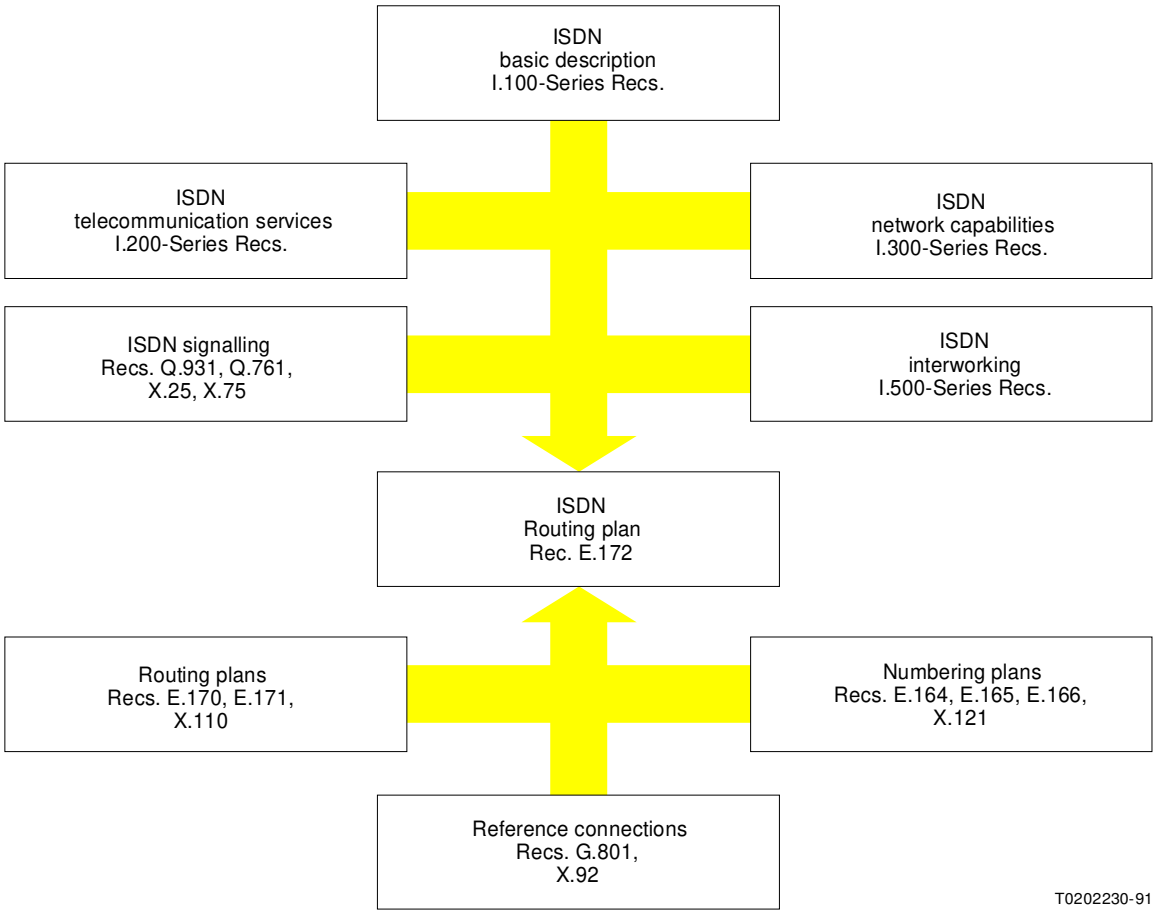

FIGURE 1/E.172

c) adhere to network performance parameters:
   - delay (call set up delay, transfer delay, post-dialling delay);
   - transmission quality;
   - error rates;
   - throughput;
   - availability;

d) minimize translation complexity;

e) minimize digit analysis and manipulation;

f) ensure efficient access to special network functionalities, such as:
   - signalling systems;
   - modems;
   - echo control devices;
   - mobile interfaces;
   - data bases;

g) avoid “non-standard” arrangements.

4 The concept of service defined network connections

4.1 In the Public Switched Telephone Network (PSTN) environment a single level of network performance is assured. That level of network performance ensures, within certain parameters, that services such as speech, facsimile and data will be supported. No standard means exists in the PSTN, on a call-by-call basis, to influence the type or capability of network components which are selected by the network to establish a connection. Routing in the PSTN is basically performed through analysis of the called address to allow selection of the chain of physical trunk routes to the destination. Many techniques have been introduced to improve completion rates and efficiencies (see Recommendation E.170), and all are based on finding an available path to a destination using the called address, with no consideration given to service variables.

4.2 ISDN introduces the concept of customer selected service requirements on a call-by-call basis. Each telecommunication service demands a predefined minimum level of network capability to support the connection. Networks are in a constant state of evolution, and consequently contain varying levels of capabilities. The matching between the telecommunication service request and network component capability is a new dimension of routing introduced by ISDN.

4.3 Telecommunication services must be viewed from two perspectives:

- feature capabilities as seen by the customer;
- network, operational and commercial attributes as seen by the service providers.

4.4 From a network routing perspective, the physical requirements of a network connection may be determined through analysis of parameters (assessed in detail in § 7). Bearer service definitions dictate the minimum capability for information transfer between ISDN access points. The service aspect of ISDN routing is based primarily on the bearer service requested by the customer. ISDN bearer services are defined in Recommendation I.230.

4.5 This Recommendation provides guidance on the incorporation of service requirements into the network routing process.

5 Routing process

5.1 *General*

5.1.1 This subsection describes the ISDN routing process. Information generated and processed from the originating terminal equipment, signalling links and switching nodes is discussed. The basic reference for the ISDN architecture is taken from Recommendation I.324.

5.1.2 The routing process is the sequence of functions required to establish a connection between the originating terminal equipment and the terminating terminal equipment or network service node.

5.2 *User-Network Interface*

5.2.1 The user initiates a request for service through ISDN capable terminal equipment. The user provides, through the terminal equipment the following information:

- service request details (including supplementary service);
- called address;
- calling address;
- other information required for call set up.

5.2.2 The terminal equipment converts this information into a Recommendation Q.931 (network layer protocol standard) call setup message which is transmitted to the originating local exchange.

5.3 *Originating local exchange*

5.3.1 The originating local exchange performs the most critical function in ISDN call routing. That function is to assemble essential call routing information, which is uniquely available to it, into an information package which will be used by all subsequent exchanges to make the required routing decisions.

5.3.2 The originating local exchange uses:

– call specific information provided in the Recommendation Q.931 call setup message;

– customer subscription profile data in exchange memory;

– environmental and administrative conditions;

to establish:

– the route treatment of that specific call (i.e. route selection, block, etc.);

– the routing parameters which are associated with the call for use at subsequent exchanges in the connection.

5.3.3 The originating local exchange therefore defines the minimum network resources (switching, signalling, transmission) which are needed to support the service request. These call/routing parameters are transported through the network via SS No. 7.

5.3.4 Details of ISDN call routing parameters and their application and/or generation at various exchanges are contained in § 7.

5.4 *Transit exchanges (national and international)*

5.4.1 Each transit exchange in the route sequence will receive the routing parameters generated by the previous exchange. These parameters will be used as the basis for selecting an appropriate outgoing route. In addition, routing parameters may be added to or modified to update such information as connection history.

5.4.2 This process continues until either the terminating local exchange is reached or the call is failed due to conditions encountered in the network.

5.4.3 The incoming and outgoing Initial Address Message (IAM) contains the following parameter fields which may be used for routing purposes:

– nature of connection indicators;

– forward call indicators (including ISUP preference indicator);

– calling party's category;

– transmission medium requirement (TMR);

– called party number;

– user service information (USI);

– transit network selection (for further study).

5.4.4 The IAM message may contain other parameters whose presence may influence the choice of signalling systems capability for the call. These parameters are

– call reference;

– calling party number;

– optional forward call indicators;

– redirecting number;

– CUG interlock code;

– connection request;

– user-to-user information;

– access transport.

5.4.5 In the international network, the TMR is set to the value that represents the minimum network capability to provide the requested service and is not modified.

5.4.6 The parameters listed within this sub-section contain all the signalling information needed to perform routing in the international network.

5.4.7 In summary it should be noted that while many new parameters are potentially involved in selecting an ISDN route, most calls can be successfully completed by matching the service request with idle facilities which are capable of supporting it.

6 Network structure

6.1 *Circuit switched services*

6.1.1 In the ISDN era, it is suggested that

a) the network structure should be non-hierarchical;

b) for call routing purposes the network can be sub-divided into national and international connection elements; the national element being sub-divided into local and trunk if appropriate;

c) Administrations should be free to change their own call routing arrangements providing they are still within the guidelines outlined in this plan;

d) the routing concepts outlined in Recommendation E.170 can apply in any network element (e.g. local, national or international) but only by agreement should they be used across a connection element boundary.

6.1.2 The network structure for ISDN has been taken from Recommendation G.801 which provides a hypothetical reference connection for the digital environment. From that Recommendation the maximum allocations established for circuit switched services are as shown in Table 1/E.172.

TABLE 1/E.172

Maximum allocation of nodes and links for circuit switched services in ISDN

National element		International element		National element	
Nodes	Links	Nodes	Links	Nodes	Links
4	4	5	4	4	4

6.1.3 The limiting case on any routing configuration will be when an international extension is required. It is assumed that all special and manual nodes will be taken from the national links and node allocation.

6.2 *Packet switched services*

6.2.1 For international packet switched calls in ISDN the network structure consists of two circuit switched elements (or packet switched in the D-channel) and three packet switched elements as shown in Table 2/E.172.

TABLE 2/E.172

Elements of an international packet switched call between ISDN subscribers

National element		International element	National element	
Circuit switched (Note)	Packet switched	Packet switched	Packet switched	Circuit switched (Note)

Note – Could be packet switched in the D-channel.

6.2.2 The network structure for the packet switched elements has been taken from Recommendation X.92, which provides a hypothetical reference connection for public synchronous data networks, and Recommendation G.801 for the national circuit switched part of the connection. From these Recommendations the maximum allocations established are as shown in Table 3/E.172.

TABLE 3/E.172

Maximum allocation of nodes and links for packet switched services in ISDN

National element				International element		National element			
Circuit switched (Note 1)		Packet switched		Packet switched		Packet switched		Circuit switched (Note 1)	
Nodes	Links	Nodes	Links	Nodes	Links	Nodes	Links	Nodes	Links
4 (Note 3)	4	Further study		5 (Note 2)	4	Further study		4 (Note 3)	4

Note 1 – Could be packet switched in the D-channel.

Note 2 – The maximum allocation of nodes and links in the international element of PSPDN is 5 and 4 respectively. The allocation for ISDN is for further study.

Note 3 – The maximum allocation of nodes and links in the national ISDN circuit switched element is 4. The allocation for packet switched calls is for futher study.

7 Information analysis

The type of information that requires analysis for call routing purposes will vary depending on the progress of the call through the network. Consequently this will place different requirements on the network nodes as shown in Table 4/E.172.

All the functions in Table 4/E.172 need not be available at all network nodes, but a minimum set will be required to ensure efficient, and effective routing.

7.1 *Calling party*

Depending on the calling party's service arrangement, a check of authorized and unauthorized service requests will be performed before the outgoing route is selected.

TABLE 4/E.172

Application of routing information at network nodes

Information for call routing	Information to be taken into account (Note 1)				
	Originating exchange	National transit exchange	International exchange (ISC)	National transit exchange	Terminating exchange
a) Calling party	X	X	X	X	
b) Incoming route		X	X	X	X
c) Called number (Note 2)	X	X	X	X	X
d) Basic telecommunication service request	X				
e) Supplementary service request	X (Note 3)				
f) User service information (Note 4)	Generated X	(Note 5) (Note 6)	(Note 5)		
g) Transmission capability (Note 7)	Generated X	X	X	X	
h) Signalling capability (Note 8)	Generated X	X	X		
i) Network management conditions	X	X	X	X	
j) Transit RPOA selection if permitted by operating agreements	For further study	For further study	For further study	For further study	
k) Connection history	(Note 9)	X	X	X	
l) Date and time periods	X	X	X	X	

Note 1 – This table identifies the data normally used to route calls in many fundamental circumstances. The use of data not marked with a cross is not precluded at any routing stage in special circumstances.

Note 2 – The called number includes Recommendation Q.931 NPI/TON information if present.

Note 3 – The supplementary service request is used to set the value of the ISUP preference indicator.

Note 4 – This information is the USI parameter where SS No. 7 ISUP is used.

Note 5 – Depending on the network operator's policy, it may be necessary to examine the USI in the originating network, in order to correctly set the TMR at the outgoing gateway exchange.

Note 6 – For packet switched calls (Case B, B-channel) the national transit exchange may analyse the USI to route the call towards the packet handler.

Note 7 – This information is the TMR parameter where SS No. 7 ISUP is used.

Note 8 – This information is the ISUP preference indicator where SS No. 7 is used.

Note 9 – May be generated for some parameters.

7.2 *Incoming route*

A match check may be required to ensure compatibility between incoming and outgoing circuit groups.

7.3 *Called number*

The called number uniquely identifies a destination, on which an outgoing route choice is based.

7.4 *Basic telecommunication service request*

The basic telecommunication service request, i.e. Bearer service (e.g. 64 kbit/s unrestricted) or teleservice (e.g. telephone) is contained in the signalling information received from the calling party at the originating exchange (e.g. in the Q.931 SETUP message in case of D-channel signalling). It must be analysed to set the signalling capability information (see §§ 7.7 and 7.8 below). For packet switched calls using the D-channel between the user and the network (Case B, D-channel) the bearer service is identified through a specific value on the link level address field (Service Access Point Identifier for outgoing calls and Terminal Endpoint Identifier for incoming calls).

7.5 *Supplementary service request*

Both ISDN and PSTN may support various supplementary services which may require analysis before the outgoing route is selected. The services can be split into those supported by both the ISDN and PSTN and those only supported by the ISDN. Within each of these two groups, some supplementary services may be realized as a function of the originating exchange (e.g. short code dialling) whereas others will require cooperation on an end-to-end basis across the network. The provision of these latter supplementary services can influence call routing in terms of the signalling capability required.

7.6 *User Service information (encoded as USI in SS No. 7 ISUP)*

It may sometimes be necessary to examine the User Service Information to set other parameters.

7.7 *Transmission capability (encoded as TMR in SS No. 7 ISUP)*

This parameter indicates the transmission medium required to support the telecommunication service requested. Its value will therefore depend on

i) bearer service or teleservice requested when the calling party is an ISDN subscriber;

ii) the nature of the calling party in the other cases (e.g. analogue PSTN subscriber).

For calls between networks, the TMR should be set to the minimum transmission resource required to support the call, and must be carried unchanged within the international network. Within the originating network, the TMR may be modified, according to the network operator's policy. In this case, the outgoing gateway exchange must examine the USI field containing the Bearer Capability (BC), in order to set the TMR to reflect the service requested.

TMR values for some key ISDN services, to be used across international and internetwork boundaries, are given in § 8.

7.8 *Signalling capability (encoded in SS No. 7 as ISUP preference indicator – see Recommendations Q.762 and Q.763)*

This parameter is derived at the originating exchange from the Bearer Service or Teleservice Request and Supplementary Service Request contained in the message sent by the calling party to establish the call (Recommendation Q.931 SETUP message in D-channel signalling). Its analysis in the network nodes allows the selection of an outgoing circuit group supporting the most suitable signalling system.

This indicator, contained within the "Forward Call Indicators" parameter field of ISUP, is sent in the forward direction indicating whether or not the ISDN User Part is required, preferred or not required in all parts of the network connection. The setting and interpretation of the ISUP preference indicator is described in § 10.

7.9 *Network management conditions*

There will be cases where network management control activation will require modification to normal network routing decisions.

7.10 *Transit RPOA selection*

This is for further study.

7.11 *Connection history*

In order to ensure that the number of links, the number of satellite hops and any other network limiting functions are not exceeded in a connection, a connection history should be available for interrogation prior to route selection. In some cases even an explicit knowledge of the previous node may be needed.

This is provided in ISUP by the "Nature of Connection indicators" parameter field (see Recommendations Q.762 and Q.763). This field is generated at the originating exchange and modified at subsequent transit exchanges each time a relevant parameter (see number of satellite links) is affected as a result of the transmission path chosen. Examples of indicators in this field are

- Satellite indicator;
- Echo Control device indicator.

7.12 *Date and time periods*

Because of varying traffic distribution during a day, week, year, etc., it may be advantageous to change the call routing arrangements dependent on time (time of day, periods, holidays, etc.). The same change may be needed by freephone, inquiry, and other special calls where the destination terminal number of the called subscriber may vary according to time.

8 Relationship between requested service and TMR values

8.1 For international calls and calls between networks, the TMR should be set to the minimum transmission resource required to support the call. This subsection gives TMR values for services to be used across international and internetwork boundaries (see Note 4).

8.2 *Bearer services*

Service	TMR value
Speech	Speech
3.1 kHz audio	3.1 kHz audio
64 kbit/s unrestricted	64 kbit/s unrestricted
Packet mode case A: B-channel	64 kbit/s unrestricted (Note 1)
Packet mode case B: B-channel	64 kbit/s unrestricted
Packet mode case B: D-channel	(Note 2)

8.3 *Teleservices*

Service	TMR value
Telephony 3.1 kHz	Speech
Telefax (Group 4)	64 kbit/s unrestricted
Teletex	64 kbit/s unrestricted
Telephony 7 kHz without fallback	64 kbit/s unrestricted
Videotex alphageometric	64 kbit/s unrestricted
Videotelephony mode 2 call 1	64 kbit/s unrestricted (Note 3)
Videotelephony mode 2 call 2	64 kbit/s unrestricted (Note 3)

8.4 *PSTN services*

Services	TMR value
Telephony	3.1 kHz audio
Telefax (Group 3)	3.1 kHz audio
Voice-band data	3.1 kHz audio
Digital connectivity	64 kbit/s unrestricted

Note 1 – If implemented through the use of an on-demand or a semi-permanent connection basis between the X.25 terminal and the packet handler.

Note 2 – The packet mode case B: D-channel does not use TMR.

Note 3 – The videotelephony mode 2 call is set up as two independent calls (call 1 to establish the speech circuit, call 2 to establish the video circuit) within the network.

Note 4 – The routing of calls where fallback is allowed, e.g. 7 kHz telephony or videotelephony, is for further study. One possible mechanism under consideration is the adoption of a new TMR value entitled "64 kbit/s unrestricted preferred". When the network implications of this mechanism are fully understood, this Recommendation will be revised to include appropriate routing rules.

9 Network capability (switching and transmission)

9.1 In order to route ISDN calls successfully network planners must match the bearer service request to the switching and transmission capabilities as depicted in Table 5/E.172.

TABLE 5/E.172

	Bearer service	Aspects of network capabilities							
		Transmission							
	Bearer service	Analogue	Digital, 24 circuits	Digital, 32 circuits	A-μ conversion	ADPCM (Note 7)	CME/DSI	Analogue Satellite	Digital Satellite (Note 4)
PSTN	Voice	√	√	√	√	√	√	√ (Note 4)	√
	Voice-band data (Note 5)	√	√	√	√	√	(Note 2)	(Note 4)	√
ISDN	64 kbit/s unrestricted	No	√ (Note 1)	√	No	No	No	No	√
	Speech (Note 6)	√	√	√	√	√	√	(Note 4)	√
	3.1 kHz audio (Note 5)	√	√	√	√	(Note 5)	(Note 2)	(Note 4)	√
	Packet mode	No	√ (Note 1)	√	No	No	No	No	√

Note 1 – Provided the transmission line code is bit sequence independent. Otherwise only 64 kbit/s restricted is possible.

Note 2 – DSI/CME could be included in a connection element selection for a voice-band data call. However, the constant activity of assignment for the duration of the call, thereby reducing the potential DSI gain.

Note 3 – The echo control equipment can be disabled either by the "user" or the "exchange". This is for further study.

Note 4 – On voice/speech calls only single satellite hops are permitted (see Recommendation E.171). Data calls in the ISDN are for further st

Note 5 – The maximum modem bit rate that can be supported depends on the transmission performance within or between Administrations. The network may include signal processing techniques, provided they are appropriately modified or functionally removed prior to information tra

Note 6 – Does not guarantee the support of voice-band data.

Note 7 – Currently only 32 kbit/s ADPCM in accordance with Recommendation G.721.

Note 8 – For the number of links in the total connection, see § 6, and for satellite links see Recommendation E.171.

Note 9 – Echo control equipment is disabled by the "user" (e.g. modem tone).

10 Signalling capability

10.1 *General*

The signalling capability required on a connection is indicated by the ISUP preference indicator, described in Annex A. There are three possible values of the indicator:

- ISUP required;
- ISUP preferred;
- ISUP not required.

ISUP signalling may be required or preferred on a connection for a number of reasons, e.g.:

- to carry an indication of the information transfer capability required;
- to pass Higher Layer Compatibility (HLC) information in order to support telematic teleservices such as teletex;
- to support certain supplementary services.

10.2 *Setting the ISUP preference indicator*

The criteria for setting the ISUP preference indicator to required, preferred or not required are shown in Annex B.

10.3 *Interpretation of the ISUP preference indicator*

The different values of ISUP preference indicator should be interpreted at intermediate switching nodes as follows:

10.3.1 *ISUP required*

Only signalling systems having at least the signalling capabilities of ISUP shall be used. If no such signalling system is available then the call must be failed. However, if another ISDN signalling system is available nationally, then this may be selected provided that it can support the service requested.

10.3.2 *ISUP preferred*

A signalling system that has at least the signalling capabilities of ISUP should be used if available.

If it is not available because no ISUP route exists to the destination network, then a signalling system having lower capabilities, e.g. R2, may be used and the call continued.

If it is not available because the existing ISUP route is congested or has failed then the call should be rejected, unless the information transfer capability required is speech or 3.1 kHz audio, in which case an alternative signalling system should be used and the call continued.

10.3.3 *ISUP not required*

Any signalling systems may be used, with no preferential selection.

Table 6/E.172 summarizes these interpretations of ISUP preference indicator.

11 History

First published 1988 (*Blue Book*).

Revised 1992.

TABLE 6/E.172

Information transfer capability	ISUP preference indicator	ISUP route not provided	ISUP route busy/failed
64 kbit/s unrestricted	ISUP required	R (Note 1)	R (Note 1)
	ISUP preferred	√ (Notes 2, 3)	R (Note 1)
	ISUP not required	Not applicable	
Speech 3.1 kHz audio	ISUP required	R (Note 1)	R (Note 1)
	ISUP preferred	√ (Note 3)	√ (Note 3)
	ISUP not required	√	√

A tick (√) indicates that a signalling system having a lower capability than ISUP can be selected, provided that the bearer capability requirements can be met.

An (R) indicates that the call should be rejected.

Note 1 – If another ISDN signalling system is available nationally then this may be selected, provided that it can support the service requested.

Note 2 – If a non-ISUP route is selected then it must be possible to convey the information transfer capability indication by other means, e.g. path of entry or J bit in TUP.

Note 3 – Loss of ISDN supplementary services.

ANNEX A

(to Recommendation E.172)

Setting the ISUP preference indicator

The ISUP preference indicator should be set at the originating exchange according to the following criteria, by analysis of the bearer service or teleservice request and supplementary service request contained in the Recommendation Q.931 SETUP message, as indicated in § 7.8 of this Recommendation.

A.1 *Bearer service or teleservice request*

- If the BC is 64 kbit/s unrestricted and a telematic teleservice (e.g. teletex) is requested, then the indicator should be set to ISUP "Required". This is to ensure that Higher Layer Compatibility (HLC) information can be passed across the network for terminal compatibility checking (see Recommendations I.210 and I.212) (see Note 1).
- For bearer services speech and 3.1 kHz audio the supplementary service request will determine the value of the ISUP preference indicator (see below).
- For calls originating from the PSTN, the indicator should be set to ISUP "Not required".

Note 1 – For telematic teleservices "ISUP Required" is suggested to ensure terminal compatibility with other Telematic terminals. "ISUP Required" calls, however, cannot interwork with dedicated networks. For cases in which such interworking is desired networks may set the ISUP preference indicator to "ISUP Preferred".

A.2 *Supplementary service request*

- For all supplementary services, invoked at initial call request, except for those shown below, the indicator should be set to ISUP "Preferred".
- For the following supplementary services, invoked at initial call request, the indicator must be set to ISUP "Required":
  - Closed User Group (CUG) (see Note 1).
  - Reverse charging.
  - Completion of calls to busy subscribers (CCBS) (see Note 2).
- In order to allow supplementary services involved after initial call request to succeed, all calls from ISDN callers should be set to ISUP "Preferred", as a minimum.

Note 1 – Non-CUG calls, from subscribers with CUG outgoing access should be set to ISUP Preferred.

Note 2 – For the CCBS supplementary service, the call resulting from the acceptance of the CCBS recall may need the ISUP preference indicator to be set to ISUP Required; this is for further study.

A.3 It is recognized that this list of criteria is not exhaustive and further study is required on the impact of other supplementary services on the setting of the ISUP preference indicator.

ANNEX B

(to Recommendation E.172)

Use of SS No. 7 ISUP parameters for route selection

In the following examples, calls are offered to Exchange A on the incoming 64 kbit/s PCM route using SS No. 7 ISUP signalling (see Figure B-1/E.172).

Example 1 – Telephony call with supplementary service to Exchange B

ISUP Parameters

- TMR = SPEECH
- ISUP preference indicator = ISUP PREFERRED

Routing

- First choice: Route 1
- Second choice: Route 2 (but supplementary service may not be provided).

Example 2 – Telephony call with CUG without outgoing access to Exchange B

ISUP Parameters

- TMR = SPEECH
- ISUP preference indicator = ISUP REQUIRED

Routing

- Route 1 only.

Example 3 – Teleservice Group 4 facsimile call to Exchange C

ISUP Parameters

– TMR = 64 kbit/s unrestricted

– ISUP preference indicator = ISUP REQUIRED

Routing

– Route 1 to Exchange B then Route 4 to Exchange C (provided:

a) all echo control and ADPCM devices are disabled; and

b) if Route 4 is a national variant of SS No. 7 ISUP, it can support the service request).

Example 4 – Voice-band data call to Exchange C

ISUP Parameters

– TMR = 3.1 kHz AUDIO

– ISUP Preference Indicator = ISUP NOT REQUIRED

Routing

– Either:

a) Route 3; or

b) Route 1 to Exchange B then Route 4 to Exchange C; or

c) Route 2 to Exchange B then Route 4 to Exchange C.

Note – In this example, it is necessary to remove echo control and ADPCM devices from all routes used. This may preclude the use of Route 2 if the 3.1 kHz audio requirement is not indicated to Exchange B.

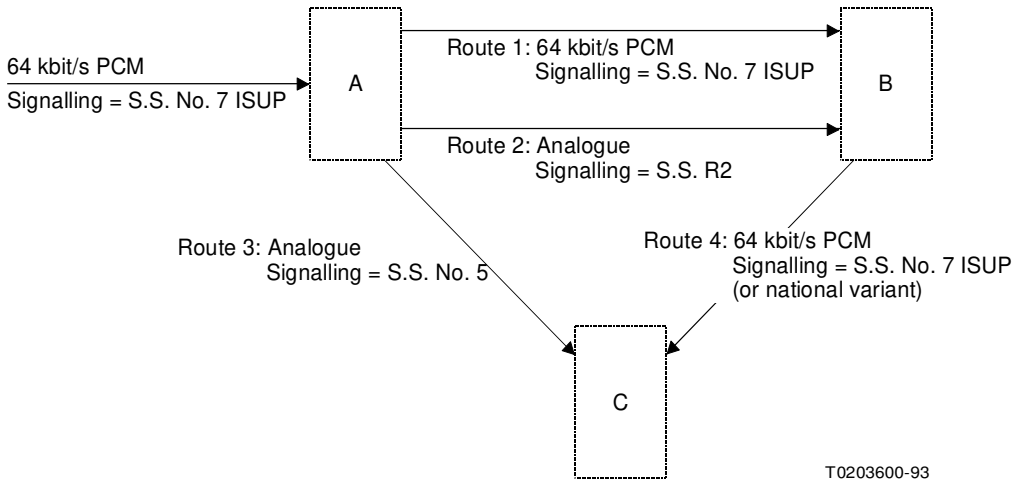

FIGURE B-1/E.172

Use of SS No. 7 ISUP parameters for route selection

ANNEX C

(to Recommendation E.172)

Routing guidelines for network interworking

C.1 *Introduction*

ISDN capabilities are currently being introduced into the world's telecommunications networks. However, for some period of time the majority of calls will continue to originate or terminate on existing networks, specifically voice calls on the PSTN, packet data calls on the PSPDN, etc.

Until such time as there is a single ubiquitous ISDN in the world, there will be a need to establish connections between subscribers on dissimilar networks or to transit a dissimilar network in order to successfully complete a call. These call types involve network interworking. Thus, network interworking is considered to take place whenever end-to-end communication has been provided between two dissimilar networks or between similar networks via a dissimilar transit network.

The routing impacts of network interworking are directly related to the network architectures deployed by network operators. Networks are constantly evolving to reflect technical and economic realities. Therefore it is assumed that there will exist an infinite number of network interworking scenarios and that no standard will be established.

This annex provides guidelines on the specific routing requirements and restrictions imposed by network interworking.

C.2 *Interworking categories*

Network interworking from a routing perspective can be divided into two fundamental categories.

In the first case, the originating subscriber indicates the desire to interwork through the input of a terminating address in a dissimilar network. In this case the originating network must invoke the necessary routing to ensure termination in the customer selected dissimilar network.

These interworking scenarios are described, from a numbering plan perspective, in Recommendation E.166 (Numbering plan interworking in the ISDN era). In this circumstance, some ISDN capabilities may not be available because they are not supported in the customer selected terminating or transit network.

In the second case, a network operator (originating, transit, or terminating) may determine to route a call via "non-ISDN" network components. The decision to route in this manner will normally be based on technical network design and/or commercial considerations. Network interworking in this case must be achieved in such a way as to ensure that service availability and quality are not impaired, in fact the subscriber(s) should not be aware that interworking has occurred.

C.3 *Scope*

The interworking combinations considered in this annex are shown in Table C-1/E.172.

C.4 *Interworking considerations*

The following areas should be taken into consideration when network interworking is required:

C.4.1 *Modems, modems pools, access to modems*

Certain types of data calls require a modulation/demodulation process which is provided by modems. In the existing networks modem functionality is provided in the terminal (PSTN) or in the network (PSPDN). Initial ISDN implementations provide no such assured access to modems. Therefore, calls originating or terminating on ISDN, which require modems, must be routed to ensure the proper and efficient access to modems, e.g. to a modem pool in another network.

TABLE C-1/E.172

Interworking scenarios considered in this annex

Originating network	Transit network	Terminating network	Customer initiated	Network initiated	Notes
a) PSTN		ISDN		X	(Note 1)
b) PSTN		PSPDN	X		
c) ISDN	PSTN	ISDN		X	
d) ISDN	PSPDN	ISDN		X	
e) ISDN		PSTN		X	(Note 1)
f) ISDN		PSPDN	X		
g) ISDN		CSPDN	X	X	
h) ISDN		Telex	X		
i) ISDN		Private			(Note 2)
j) Private	ISDN	Private	X		(Note 3)

CSPDN: Circuit-switched public data networks

Note 1 – Interworking cannot be considered to be customer initiated because the customer cannot differentiate between ISDN and PSTN addresses.

Note 2 – Private networks, using private numbering plans, must be reached through a point-of-presence with a public (Recommendations E.164 and X.121) address. Routing interworking beyond this public point-of-presence is not considered in this Recommendation.

Note 3 – Through the use of the Numbering Plan Identifier field set to Private numbering plan.

C.4.2 *Interworking Units/Functions (IWU/IWF)*

The necessity to cross between networks of varying technical capabilities has introduced the concept of centralizing interworking functions in Interworking Units (IWU). Some potential IWU functionalities include:

– protocol conversion;

– digital conversion/manipulation;

– modulation/demodulation;

– rate adaption;

– signal conversion.

Accessing IWUs may impose special routing requirements.

C.4.3 *Transit RPOA selection*

Customer selection of a specific RPOA may impose network interworking requirements which impact call routing.

C.4.4 *Facility type/selection requirements*

Network interworking may cause special route selection to include, or, avoid facilities based on DCME or no DCME, satellite versus terrestrial, digital versus analogue, etc.

C.4.5 *Switching systems translations*

Switching systems utilize numerical address translation in conjunction with trunk route selection tables to determine routing on a call by call basis. Network planners are cautioned to take full account of the administrative overhead which is imposed by complicated and/or multitudinous translations required for network interworking.

C.4.6 *Call processing systems*

ISDN introduces new information fields on which to base routing decisions, i.e. connection history, bearer service, transmission medium requirement, etc. Interworking with networks which do not have such capabilities may impose special routing requirements.

C.4.7 *Signalling system requirements*

Signalling system capabilities vary significantly between networks, not only in terms of basic capabilities and functionalities, but also in terms of the meaning of information. Routing to successfully support interworking must take into account the various signalling systems deployed in different networks.

C.4.8 *Routing sequence*

Network routing takes place on a link-by-link basis, therefore each switching node must be provided with sufficient incoming information to accurately select an outgoing route. Network designers must ensure that all pertinent information is available to allow proper routing – this is a potentially complicated and onerous process in network interworking scenarios.

C.4.9 *Escape methodologies*

Recommendations E.166/X.122 provide detailed information of when and how network numbering plans provide the escape (and re-entry) mechanism required for network interworking. Network routing must deal effectively with both short-term (escape codes) and long-term (Numbering Plan Indicator) network interworking requirements imposed by customers through network address information.

C.4.10 *Service variations*

ISDN, by definition, supports a wide variety of services. Special routing may be required to support different service types in an interworking circumstance. It is also highly probable that certain bearer services will not be supported in an interworking situation, e.g. unrestricted 64 kbit/s cannot be supported using the PSTN as a transit network.

C.4.11 *Default decision/situation*

As calls traverse different types of networks, there may be circumstances when critical pieces of routing information are missing, lost, or transformed. An example is a call entering the ISDN from a PSTN will not bring a bearer service indication with it – the ISDN default decision in this case (based on the incoming trunk type) will be to mark this call with "3.1 kHz" bearer service. This information (Bearer service = 3.1 kHz) will then be passed through the ISDN to ensure ongoing route selection. There are potentially many circumstances similar to this brought on by the variety of network capabilities involved in interworking. Network designers must ensure that all default situations are covered in any given network interworking implementation in order to ensure that accurate routing can be accomplished.