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**Integrated Services Digital Network (ISDN);
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Routeing in support of ISDN User Part (ISUP) version 2 services**

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Foreword

This European Telecommunication Standard (ETS) has been prepared by the Network Aspects (NA) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Voting phase of the ETSI standards approval procedure.

This ETS is based upon the following source documents:

- CCITT Recommendation E.172 [1]; and
- ETS 300 100 [2].

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1 Scope

This European Telecommunication Standard (ETS) gives guidance on international call routing during the implementation of the Integrated Services Digital Network (ISDN) User Part version 2 of signalling system No. 7 (ISDN User Part (ISUP) version 2) in the European ISDN (see ETS 300 356-1 [3]).

This ETS is applicable to the functions required at ISDN international gateways and international transit exchanges for routing and network planning in order to achieve practical international interconnection of networks.

The relevant CCITT routing Recommendation is identified and clarifications and additions to this are provided, where necessary. In addition, CCITT Recommendations E.170 and E.171 need to be considered.

This ETS covers services offered during the implementation of ISDN, using ISUP version 2 in the international network. The list of services can be found in table 2 of this ETS.

2 Normative references

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- [1] CCITT Recommendation E.172 (1992): "ISDN Routing Plan".
- [2] ETS 300 100: "Integrated Services Digital Network (ISDN); Routing in support of ISUP version 1 services".
- [3] ETS 300 356-1: "Integrated Services Digital Network (ISDN); Signalling System No.7; ISDN User Part (ISUP) version 2 for the international interface; Part 1: Basic services [ITU-T Recommendations Q.761 to Q.764 (1993), modified]".

3 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

CUG	Closed User Group
DCME	Digital Circuit Multiplication Equipment
DTX	Discontinuous Transmission
GMSC	Gateway Mobile Switching Centre
ISC	International Switching Centre
IDN	Integrated Digital Network
IPI	ISUP Preference Indicator
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
MOC	Mobile Originated Call
PD	Propagation Delay
PDC	Propagation Delay Counter
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
PSPDN	Public Switched Packet Data Network
TMR	Transmission Medium Requirement
TUP	Telephone User Part
TUP+	Enhanced Telephone User Part

4 Additions and/or Clarifications to CCITT Recommendation E.172

4.1 CCITT Recommendation E.172, subclause 10: Signalling capability

Subclause 5.3 of this ETS contains the application of the criteria for setting the ISUP Preference Indicator (PI) parameter for the implementation of ISDN in Europe for ISUP version 2.

4.2 CCITT Recommendation E.172, subclause 7 k): Connection history

Subclause 5.4 of this ETS contains the application of the Propagation Delay Counter (PDC) for routing purposes and subclause 5.5 describes the influence of Digital Circuit Multiplication Equipment (DCME) links on routing in ISUP version 2.

4.3 CCITT Recommendation E.172, subclause 8: Relationship between requested services and transmission medium requirement values

The information in CCITT Recommendation E.172 [1], subclause 8 is extended in subclauses 5.1 and 5.2 of this ETS, to cover the implementation of ISDN in Europe for ISUP version 2. The service interworking situation from the Public Switched Telephone Network (PSTN) to the ISDN is further detailed in clause 6 of this ETS.

4.4 CCITT Recommendation E.172, annex 1

The application of the criteria defined in CCITT Recommendation E.172 [1], annex 1, to the implementation of ISDN in Europe for ISUP version 2 is specified in subclause 5.3 of this ETS.

4.5 CCITT Recommendation E.172, annex 3

The application of parts of the criteria defined in CCITT Recommendation E.172 [1], annex 3, this annex to the implementation of ISDN in Europe for ISUP version 2 is specified and extended in clause 6 of this ETS.

5 Additional information on parameters used for routing

5.1 Use of the transmission medium requirement parameter

The use of the ISUP Transmission Medium Requirement (TMR) parameter for routing is described in CCITT Recommendation E.172 [1], subclause 7 g). In addition to the statements made in CCITT Recommendation E.172 [1], the following shall apply:

- for a specific service request, one TMR value shall be used in the international network and across internetwork boundaries. The changing of TMR values shall only be allowed when fall-back occurs. For its value, see subclause 5.2.

It is recommended that national networks use the same TMR values as the international network. Conversion from the requested service to the TMR value can then be performed in the originating local exchange. If not done there, then the TMR shall be available at the outgoing international gateway and onwards. It shall then be forwarded to following exchanges, if possible, even up to the destination exchange.

At international transit exchanges, as well as at incoming international gateway exchanges, the TMR shall be examined for routing purpose, irrespective of the service requested. This does not preclude that incoming gateway exchanges may need to examine additional information available to determine national routing.

5.1.1 Use of the TMR value "64 kbit/s unrestricted preferred"

In addition to the TMR values mentioned in CCITT Recommendation E.172 [1], subclause 8, a new TMR value has been created for the purpose of indicating when fall-back from 64 kbit/s unrestricted to speech or 3,1 kHz audio is allowed. The value of this TMR is "64 kbit/s unrestricted preferred".

The settings and the procedure at an interworking point for this TMR value are described in subclause 7.3.35 of ETS 300 356-1 [3].

If, at an interworking point, there is no route available supporting TMR "64 kbit/s unrestricted preferred", then the fallback procedure should be carried out at this point.

5.1.2 Multirate connection types

Multirate connections are multiple circuit switched connections ($n \times 64$ kbit/s) with a bandwidth between 128 kbit/s and 1 920 kbit/s.

$n \times 64$ kbit/s connections are restricted to operate within a 2 Mbit/s system. The following TMR values are given in ETS 300 356-1 [3]:

- 2 x 64 kbit/s unrestricted (not used);
- 384 kbit/s unrestricted;
- 1 536 kbit/s unrestricted;
- 1 920 kbit/s unrestricted.

5.2 Relationship between requested service and TMR values

Table 1 gives TMR values for ISDN services to be used across international and internetwork boundaries.

Table 1

Requested Service		TMR value			
		speech	3,1 kHz audio	64 kbit/s unrestricted	64 kbit/s unrestricted preferred (note 3)
Bearer service	64 kbit/s unrestricted			X	
	3,1 kHz audio		X		
	speech	X			
	Packet mode case A:B-c			X (note 1)	
	Packet mode case B:B-c			X (note 1)	
	Packet mode case B:D-c			X (notes 1, 2)	
Tele service	Telephony 3,1 kHz	X			
	Telefax Group 4			X	
	Teletex			X	
	7 kHz telephony without fall-back			X	
	7 kHz telephony with fall-back				X (note 3)
	Videotelephony call 1 without fall-back			X	
	Videotelephony call 1 with fall-back				X (note 3)
	Videotelephony call 2			X	
	ISDN syntax-based videotex			X	
PSTN/IDN service	Telephony		X		
	Facsimile Group 3		X		
	Voice band data		X		
	Digital connectivity			X	
NOTE 1:	If implemented through the use of an on demand connection basis between the X.25 terminal and the packet handler. (This note differs from that in CCITT Recommendation E.172 [1]).				
NOTE 2:	The packet mode case B D-channels only use the TMR between the Frame Handler and Packet Handler, in case a dynamic Bd channel needs to be established.				
NOTE 3:	If fall-back occurs, the TMR will be changed to 3,1 kHz audio or speech.				

5.3 ISUP preference indicator values for ISDN services

CCITT Recommendation E.172 [1] describes the use of the IPI and sets out criteria for setting the IPI to one of the three possible values. This subclause applies these criteria to the ISDN services and assigns IPI values to them.

If the IPI value in an incoming address message is "required" or "preferred", and routes with different ISUP capabilities towards the called subscriber exist, then a route with ISUP version 2 capabilities should be selected if possible.

Where more than one service is requested and one of the service requests is for a more restrictive IPI value, then the more restrictive IPI value shall be used.

EXAMPLE: In the case of a joint request for services: Closed User Group (CUG) (without outgoing access); "ISUP required"; and subaddress; "ISUP preferred", then the IPI value "ISUP required" shall be used.

5.3.1 Services requiring "ISUP required"

- CUG without outgoing access;
- user-to-user signalling services 2 and 3, essential;
- add-on-conference (between the conference controller and the conference bridge).

5.3.2 Services requiring ISUP preferred

The value "ISUP preferred" is a minimum for all calls initiated by ISDN subscribers, in order to allow provision of supplementary services invoked after initial service request.

5.3.3 Services requiring "ISUP not required"

Calls originating in the PSTN require the value "ISUP not required".

5.4 Evaluation of the propagation delay counter for routing purposes

5.4.1 General

For international calls the Propagation Delay (PD) shall be considered on a per call basis in incoming, outgoing and transit International Switching Centres (ISCs). There is a strong likelihood in the international network that the overall delay time (between the A and B-subscriber) will be unacceptably high. The PDC, already used for echo control purposes, shall be evaluated. According to the received value of the PDC in an exchange, the scan order of routes shall be designed in such a way that unsuitable links can be avoided. The satellite indicator shall also be evaluated, as in some circumstances it may give additional information which is not in the PDC (see also annex A).

5.4.2 Limits and actions

For simplification of the procedure just one threshold for an action is considered. For calculation of this threshold and for additional background information, refer to annex B. For using the PDC in a proper way for routing purposes, the following should be performed:

- if the PD value is greater than 70 ms, or the satellite indicator is set, routes with the least possible transmission delay are preferred;
- as a further step, to select between routes with equivalent propagation delay, then, optionally, routes with digital capability may be preferred.

In this way, two clipping systems (DCME and Discontinuous Transmission (DTX) of the digital mobile networks) in series can also be avoided.

5.5 DCME links and their influence on routing

DCMEs produce clipping. For a better quality of service, two or more clipping elements in one connection shall be avoided. Therefore, the following should be performed:

- for international incoming and outgoing calls, national links with DCME should be avoided;
- for international transit traffic, routes with DCME should be avoided, except the last international link;
- if the destination network is a digital mobile network, and this can be determined by analysing the three leading digits of the national number, DCME routes should be avoided all the way.

6 Impact of services interworking, terminal interworking and fallback on routing

The interworking of services in the ISDN (e.g. videotelephony, 7 kHz audio telephony or telefax group 4) with services within the PSTN (e.g. telephony, telefax group 3) is a basic requirement for the ISDN services. Also the interworking of different services in the ISDN (terminal interworking) e.g. 3,1 kHz (ISDN) telephony with 7 kHz (ISDN) telephony, is a fundamental requirement within the ISDN.

If an incoming call is incompatible with the capability of the terminals connected to an access, a fall-back will occur if possible, or the call is released.

In order to allow calls between ISDNs with full bearer and signalling capabilities and networks with reduced capability, the interworking point, which has no knowledge of the terminal connected to the destination access, shall not release the call, if the appropriate bearer capability can be provided on the selected route. Networks with reduced capability include:

- ISDNs with limited signalling capabilities (e.g. ISUP version 1); and
- non-ISDN networks not providing the ISDN signalling capabilities, but providing the bearer capabilities.

Considering the bearer services and teleservices and assuming the selected route has the appropriate bearer capability, table 2 gives the possible network initiated interworking cases (indicated by an "X" and/or a NOTE number), where the selection of a route with lower capabilities is allowed, or a fall-back within the network occurs.

Table 2

Incoming requested services	Outgoing provided services																			
	Bearer service circuit mode			Packet mode service			Teleservice										PSTN/IDN service			PSPDN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1	Speech	X														X				
2	64 kbit/s unrestricted		X		X	X	X												2)	
3	3,1 kHz audio			X												1)	1)	1)		
Bearer service packet mode																				
4	Case A B-channel		X		5)	5)													2)	X
5	Case B B-channel		x			5)														X
6	Case B D-channel					5)														X
Teleservices																				
7	Telephony (3,1 kHz)	X					X													
8	Teletex		3)					X											2)	
9	Telefax Group 4		3)						X										2)	
10	Telephony (7 kHz) with fall-back	6)	X	6)			6)			X					6)					
11	Telephony (7 kHz) without fall-back		3)								X								2)	
12	Videotelephony call 1 with fall-back	6)	X	6)			6)					X			6)					
13	Videotelephony call 1 without fall-back		3)									X							2)	
14	Videotelephony call 2		X										X							
15	Syntax based videotex		3)												X				2)	
PSTN/IDN services																				
16	Telephony			1)												X				
17	Facsimile Group 2/3			1)													X			
18	Voice band data			1)														X		
19	Digital connectivity		4)																X	
NOTE 1:	The PSTN is considered to provide the equivalent of 3,1 kHz audio bearer service.																			
NOTE 2:	Bearer capability supported, signalling capability lost.																			
NOTE 3:	If a teleservice is not supported by a signalling system, the call can be set up by using the appropriate bearer services, if supported by the terminal. The service indication is lost.																			
NOTE 4:	No BC is delivered from the PSTN, but the service may be indicated by other means (e.g. Telephone User Part (TUP) J bit, calling party category or access code) only TMR is used for routing in the ISDN.																			
NOTE 5:	The bearer service is supported through the packet handler network. For packet mode bearer service, TMR 64 kbit/s is always needed. The BC information element is not allowed to be changed at an interworking point in the ISDN.																			
NOTE 6:	Possible after fall-back has occurred.																			

TMR and IPI assist the routing process.

7 Selection of path/traffic distribution

This clause contains guidelines on the means of avoiding loss of calls, where carriers to the same destination offer different facilities, i.e. PSTN and ISDN. The means of implementing these guidelines, and use of the traffic distribution facility, is a matter for individual operators and administrations.

The bearer capabilities and signalling capabilities to support ISDN services will not be provided simultaneously by all carriers to a destination network, e.g. PSTN.

The different scenarios which may occur are as follows:

- carriers providing ISDN services only;
- carriers providing PSTN services only;
- carriers providing ISDN and PSTN services on the same link;
- carriers providing ISDN and PSTN services on separate links:
 - one for ISDN (e.g. ISUP or Enhanced Telephone User Part (TUP+));
 - one for PSTN (e.g. TUP or channel associated signalling).

If a call routed to a specific carrier cannot be completed because the carrier does not provide the necessary signalling capability, or because a particular supplementary service has not been agreed upon, the call should not fail. The possibility of failure will be reduced if PSTN and ISDN traffic are separated.

An example of a functional model for such a separation is shown in figure 1.

If for a given destination, all carriers can provide ISDN and PSTN services on the same link, the separation between ISDN and PSTN traffic is not needed. Furthermore, to route PSTN traffic with ISDN signalling allows the PSTN traffic to get some benefits of the advanced signalling system: performance; maintenance; and testing.

Where carriers provide both ISDN and PSTN services, traffic distribution should be agreed upon separately for ISDN and PSTN traffic. The traffic separation function could also be used to separate traffic based on other criteria, e.g. bearer capability requirement (TMR).

The functions for destination dependent routing and the separation of ISDN and PSTN traffic on one side and the distribution function on the other side, should be logically separated.

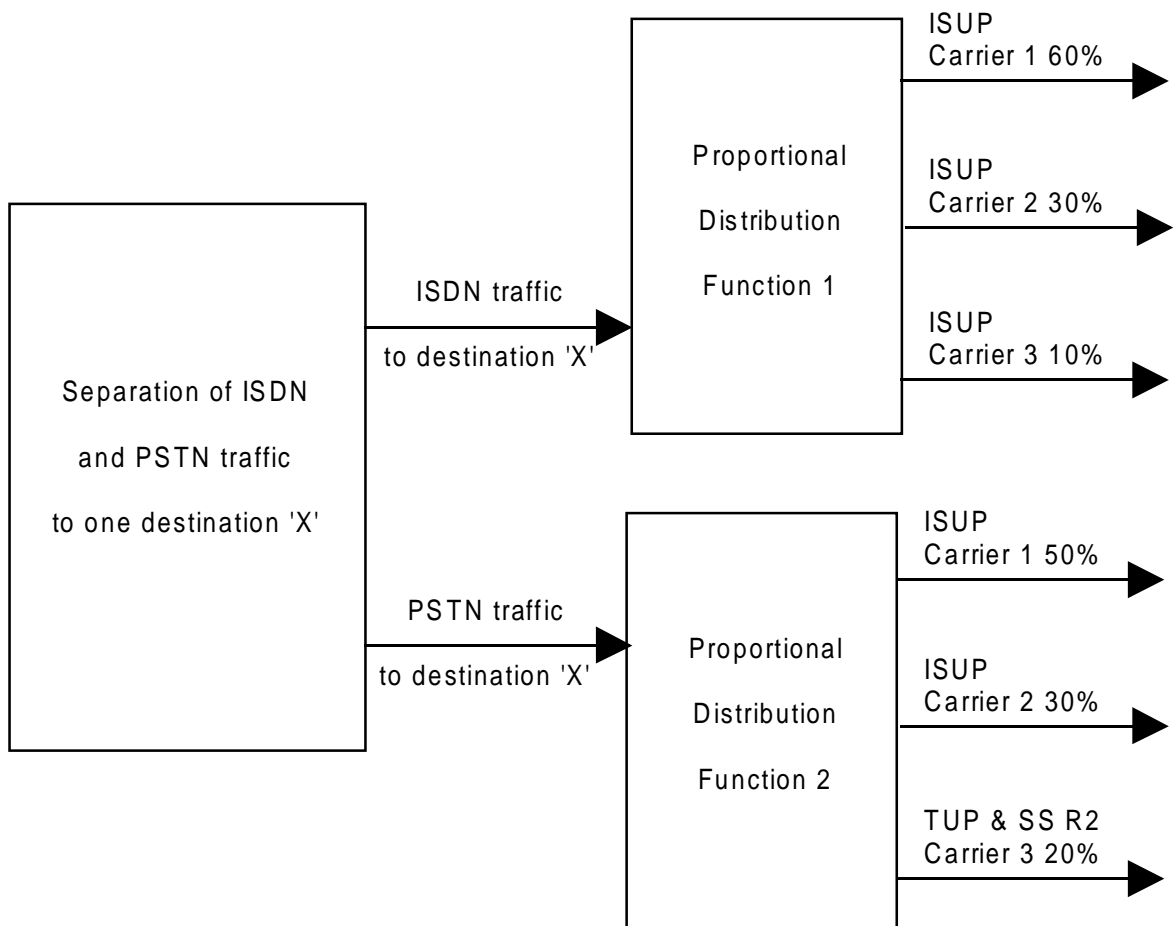


Figure 1

Annex A (informative): Examples of the effect of PD and DCME on routing

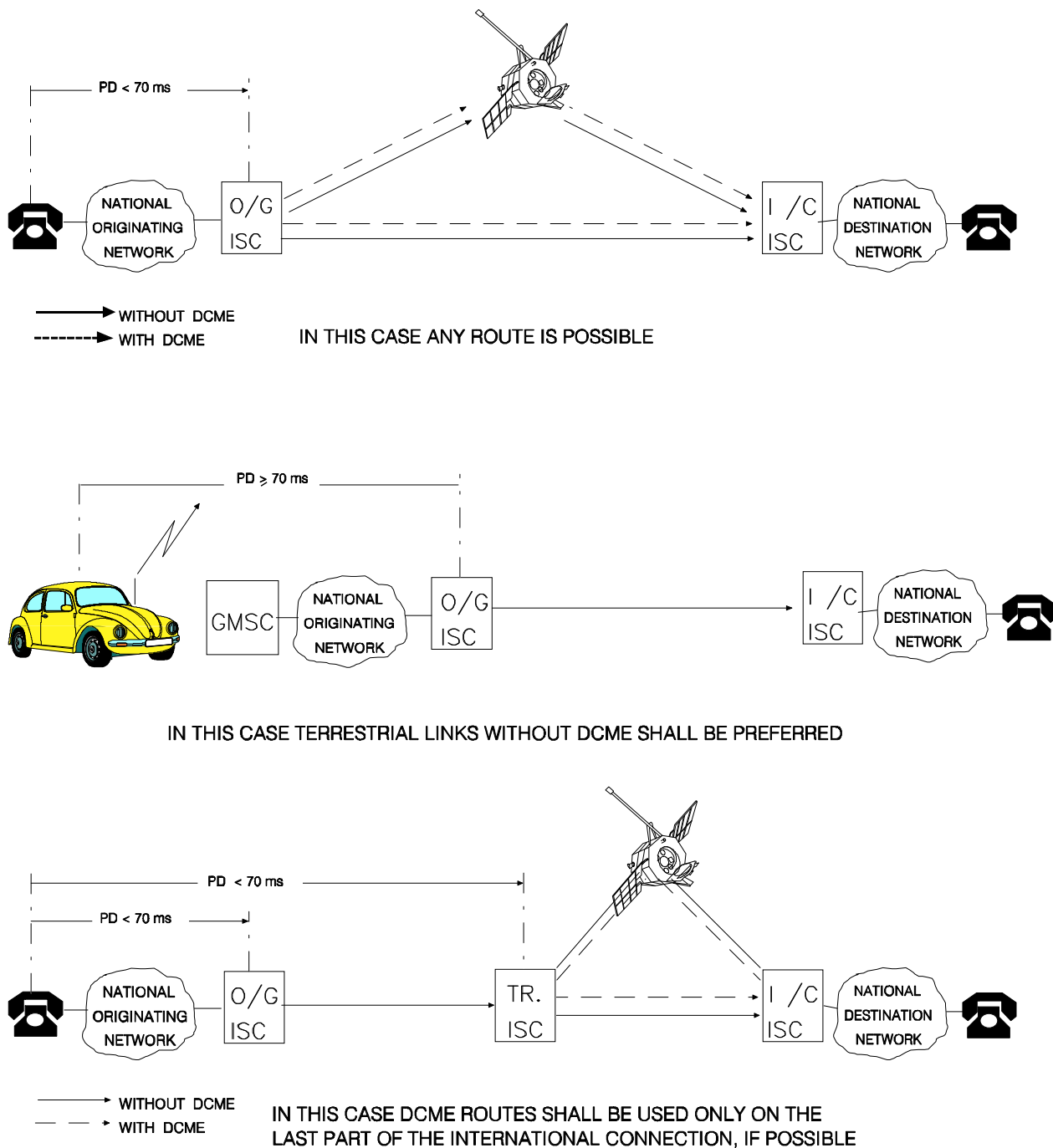


Figure A.1

Annex B (informative): Background information on propagation delay

B.1 General

This annex provides some background information about the use of the PDC for the routing process and the calculation of the 70 ms threshold value.

B.2 Transmission mediums and systems taking a considerable propagation delay

Table B.1 shows a list of most common transmission medium and systems with their corresponding propagation delay values.

Table B.1

Technical facilities	One way propagation time
Coaxial cable, radio links	0,004 ms/km
Optical fibre	0,005 ms/km
DCME	28 ms
Digital mobile networks	90 ms
Satellite systems	260 ms

For the national part in an European destination country, a delay time of 20 ms (15 ms for the public network plus 5 ms for private networks) is assumed as worst case, if no digital mobile network, national DCME or national satellite is involved.

B.3 Indication of mobile originated calls

In ISUP version 2 there is no possibility to indicate Mobile Originated Calls (MOCs) in the connection's history, however, a PD value greater than 90 ms received from the national network can be considered as mobile originated. If there are other network elements involved producing the same or a greater PD, these calls shall be handled in the same way as MOCs.

B.4 Routing for mobile originated calls

A target for the routing of MOCs is to avoid satellites and DCMEs in the overall connection if possible, because this provides a better quality of service by means of less PD less clipping.

B.5 Threshold

Taking into account that in future there will be new network elements installed, with significant propagation delay, a threshold of 70 ms was chosen. The value of 70 ms is a compromise, taking into account economic consideration and the necessity to avoid service degradation, especially long PD in the case of digital MOCs. The permissible PD for a speech call is 400 ms (refer to CCITT Recommendation G.114) however, for providing a better quality of service, the actual value of PD should be below this limit.

B.6 Examples of calculation of the 70 ms threshold

Assuming a 5 000 km link in the international network, this leads to the following worst case calculations:

EXAMPLE 1: Terminating Network is PSTN/ISDN

Originating network	< 70 ms	> 70 ms
Terrestrial link		25 ms
Satellite link:	260 ms	
DCME:	28 ms	
Destination network:	20 ms	20 ms
Total propagation delay	< 378 ms	> 115 ms

EXAMPLE 2: Terminating Network is Public Land Mobile Network (PLMN)

Originating network	< 70 ms	> 70 ms
Terrestrial link		25 ms
Satellite link:	260 ms	
DCME:	28 ms	
Destination network:	90 ms	90 ms
Total propagation delay	< 448 ms	> 185 ms

Annex C (informative): Bibliography

The following references have been used during the preparation of this ETS.

- 1) CCITT Recommendation E.170: "Traffic routing".
- 2) CCITT Recommendation E.171: "International telephone routing plan".
- 3) CCITT Recommendation E.172: "Call routing in the ISDN era".
- 4) CCITT Recommendation G.114: "Mean one-way propagation time".
- 5) CCITT Recommendation I.530: "Network interworking between an ISDN and a public switched telephone network (PSTN)".
- 6) CCITT Recommendation Q.761: "Functional description of the ISDN user part of Signalling System No. 7".
- 7) CCITT Recommendation Q.762: "General function of messages and signals".
- 8) CCITT Recommendation Q.763: "Formats and codes".
- 9) CCITT Recommendation Q.764: "Signalling procedures".
- 10) CCITT Recommendation Q.767: "Application of the ISDN user part of CCITT signalling system No. 7 for international ISDN interconnections".
- 11) ETS 300 121 (1992): "Integrated Services Digital Network (ISDN); Application of the ISDN User Part (ISUP) of CCITT Signalling System No.7 for international ISDN interconnections (ISUP version 1)".

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