SECTION 6

INTERNATIONAL ROUTING PLAN

Recommendation E.170

TRAFFIC ROUTING

1 Introduction

1.1 *Objective of traffic routing*

The objective of routing is to establish a successful connection between any two exchanges in the network. The function of traffic routing is the selection of a particular circuit group, for a given call attempt or traffic stream, at an exchange in the network. Thus, the selection of individual circuits within a circuit group is not considered in this Recommendation. The choice of a circuit group may be affected by information on the availability of downstream elements of the network.

1.2 *Scope of Recommendation*

This Recommendation takes account of the range of new traffic routing and control techniques which are provided by stored program controlled (SPC) exchanges and common channel signalling systems.

Additional routing information is contained in Recommendation E.171 (International telephone routing plan) and Recommendation E.172 (Call routing in the ISDN era).

Failure or overload conditions may require temporary changes to routing patterns or algorithms. This is considered to be a network management action and is described in the E.400 Series Recommendations.

1.3 *Network topology*

1.3.1 *Network elements*

A network comprises a number of nodes (switching centres) interconnected by circuit groups (engineering routes). There may be several direct circuit groups between a pair of nodes and these may be unidirectional or bothway. Figure 1/E.170 illustrates a number of possible situations.

A direct route consists of one or more circuit groups connecting adjacent nodes. An indirect route is a series of circuit groups connecting two nodes providing an end-to-end connection via other nodes.

Figure 1/E.170, p.

1.3.2 *Network architecture*

Within national networks it is often appropriate to adopt a hierarchy of switching units (e.g. local, area, trunk, regional trunk, international) with each level of the hierarchy performing different functions. For the international network, there is no recommended hierarchy for international switching centres (ISCs) with Administrations being free to determine the most suitable utilization of their individual ISCs. (Recommendation E.171 refers.)

2 Logic of routing

2.1 *Routing structure*

It is important to note that the concept of hierarchical routing need not be directly related to the concept of a hierarchy of switching centres (as described above).

A routing structure is hierarchical if, for all streams, all calls offered to a given route, at a specific node, overflow to the same set of routes irrespective of the routes already tested. The routes in the set will always be tested in the same sequence although some routes may not be

available for certain call types. The last choice route is final in the sense that no traffic streams using this route may overflow further.

A routing structure is non-hierarchical if it violates the above-mentioned definition (e.g., mutual overflow between circuit groups originating at the same exchange).

A example of hierarchical routing in a non-hierarchical network of exchanges is illustrated in Figure 2/E.170.

Figure 2/E.170, p.

2.2 *Routing scheme*

The routing scheme defines how a set of routes is made available for calls between a pair of nodes.

Fixed: The set of routes in the routing pattern is always the same.

Dynamic: The set of routes in the routing pattern varies.

2.2.1 *Fixed routing scheme*

Routing patterns in the networks may be fixed, in that changes to the route choices for a given type of call attempt require manual intervention. Changes then represent a ‘‘permanent’’ change to the routing scheme (e.g., the introduction of new routes require a change to a fixed routing scheme).

2.2.2 *Dynamic routing schemes*

Routing schemes may also incorporate frequent automatic variations. Such changes may be time and/or state dependent.

The updating of routing patterns may take place periodically or aperiodically, predetermined or depending on the state of the network.

Time-dependent routing :

Routing patterns will be altered at fixed times during the day (or week) to allow changing traffic demands to be provided for. It is important to note that these changes are pre-planned and will be implemented consistently over a long time period.

State-dependent routing :

Routing patterns will vary automatically according to the state of the network. Such routing schemes are said to be adaptive.

In order to support this type of routing scheme, it is necessary to collect information about the status of the network. For example, each

exchange may compile records of successful calls or outgoing trunk group occupancies. This information may be distributed through the network to other exchanges or passed to a centralized database.

Based on this network status information, routing decisions will be made either in each exchange or at a central processor serving all exchanges. See Figure 3/E.170.

Figure 3/E.170, p.

2.3 *Route selection*

Route selection is the action to actually select a definite route for a specific call.

Sequential: The routes in a set are always tested in sequence and the first available route is chosen.

Non-sequential: The routes in a set are tested in no specific order.

The decision to select a route can be based on the state of the outgoing circuit group or the states of the series of circuit groups in the route. In either case, it can also be based on the incoming path of entry, class of service, or type of call to be routed. One example of the above is selective trunk reservation.

3 Call control procedures

Call control procedures define the entire set of interactive signals necessary to establish, maintain and release a connection between exchanges. Described below are two main types of call control procedures:

3.1 *Progressive call control*

Progressive call control uses link-by-link signalling to pass supervisory controls sequentially from one exchange to the next. This type of call control can be either irreversible or reversible. In the irreversible case, call control is always passed downstream towards the destination exchange. Call control is reversible when it can be passed backwards (maximum one node), towards the originating exchange, using automatic rerouting or crankback possibilities.

3.2 *Originating call control*

Originating call control requires that the originating exchange maintain control of the call set-up until a connection between the originating and terminating exchanges has been completed.

4 Applications

4.1 *Automatic alternative routing*

A particular type of progressive (irreversible) routing is automatic alternative routing (AAR). When an exchange has the option of using more than one route to the next exchange, an alternative routing scheme can be employed.

Two main types are available:

— when there is a choice of direct circuit groups between the two exchanges;

— when there is a choice of direct and indirect routes between the two exchanges.

Alternative routing takes place when all appropriate circuits in a group are busy. Several circuit groups may be tested sequentially. The testing order will be fixed or time-dependent.

4.2 *Automatic rerouting (crankback)*

Automatic rerouting (ARR) takes place upon receipt of a signal at A from a downstream exchange B, indicating that a call once routed to B encountered an ‘‘all circuits busy’’ state on circuit groups out of that exchange. This application is also referred to as crankback.

In the example of Figure 4/E.170, a call from A to D is routed via C because the circuit group BD is congested.

With ARR, care must be taken to avoid circular routings which return the call to the point at which blocking occurred.

Figure 4/E.170, p.

4.3 *Load sharing*

All routing schemes result in the sharing of traffic load between network elements. Routing schemes can however be developed to ensure that call attempts are offered to route choices according to a preplanned distribution.

Figure 5/E.170 illustrates this application of load sharing which can be made available as a software function of SPC exchanges. The system works by distributing the call attempts to a particular destination in a fixed ratio between the specified outgoing routing patterns.

Figure 5/E.170, p.

4.4 *Dynamic routing*

4.4.1 *Example of state-dependent routing*

A centralized routing processor is employed to select optimum routing patterns on the basis of the actual occupancy levels of the circuit groups and exchanges in the network which are monitored on a periodical basis (e.g., 10 s), see Figure 6/E.170. In addition, qualitative traffic parameters may also be taken into consideration in the determination of the optimal routing pattern.

This routing technique inherently incorporates fundamental principles of network management in determining routing patterns. These include:

— avoiding occupied circuit groups,

— not using overloaded exchanges for transit,

— in overload circumstances, restriction of routing direct connections.

Figure 6/E.170, p.

4.4.2 *Example of time-dependent routing*

For each originating and terminating exchange pair, a particular route pattern is planned depending on the time of day and day of week, see Figure 7/E.120. A weekday, for example, can be divided into different time periods, with each time period resulting in different route patterns being defined to route traffic streams between the same pair of exchanges.

This type of routing takes advantage of idle circuit capacity in other possible routes between the originating and terminating exchanges which may

exist due to non-coincident busy periods. Crankback may be utilized to identify downstream blocking on the second link of each two-link alternative path.

Figure 7/E.170, p.

Recommendation E.171

INTERNATIONAL TELEPHONE ROUTING PLAN

1 Introduction

1.1 This plan describes an international telephone routing plan designed to enable Administrations to select routings for their traffic which will result in a satisfactory connection between any two telephone stations in the world. The Plan relates to automatic and semi-automatic telephone traffic from fixed and mobile (both land and maritime) stations. The Plan is necessary to allow the objective to be achieved with maximum economy by the most efficient use of costly circuits and switching centres while safeguarding the grade of service and quality of transmission.

1.2 The Plan is one of the basic CCITT Recommendations which influence many other Recommendations, for example the transmission plan (Recommendation G.101).

1.3 In practice the large majority of international telephone traffic is routed on direct circuits (i.e., no intermediate switching point) between International Switching Centres (ISCs). It should be noted that it is the rules governing the routing of connections consisting of a number of circuits in tandem that this Recommendation primarily addresses. These connections have an importance in the network because:

— they are used as alternate routes to carry overflow traffic in busy periods to increase network efficiency,

— they can provide a degree of service protection in the event of failures of other routes,

— they can facilitate network management when associated with ISCs having temporary alternative routing capabilities.

1.4 This Plan replaces the previous one established in 1964 and it can be applied to all existing switching equipment and signalling systems and is intended to be flexible enough to incorporate new switching and signalling developments.

Nevertheless, it is recognized that the Plan, which is complementary to the plan contained in Recommendation E.172, will have to be reviewed and revised to take account of developments in telecommunications.

1.5 The Plan accomplishes its basic purposes unconstrained by, and requiring no changes to, the numbering plan , the rules for charging the calling subscriber and the rules for the apportionment of charges (international accounting).

2 Principles

2.1 The Plan preserves the freedom of Administrations:

a) to route their originating traffic directly or via any transit Administration they choose;

b) to offer transit capabilities to as wide a range of destinations as possible in accordance with the guidelines which it provides.

2.2 The Plan provides guidance on possible international routings. Any routing chosen must be subject to agreements between the Administrations involved before implementation.

The freedom of Administrations to choose the routing of their terminal and transit traffic may be limited by technical, commercial and administrative considerations including:

— the capability of precisely measuring traffic volumes for accounting purposes,

— the need to maximize route profitability,

— the desirability of simplicity in international accounting.

2.3 The governing features of this Plan are:

a) it is not hierarchical;

b) Administrations are free to offer whatever transit capabilities they wish, providing they conform to this Recommendation;

c) direct traffic should be routed over final (fully provided) or high usage circuit groups;

d) no more than 4 international circuits in tandem should be involved between the originating and terminating ISCs;

e) advantage should be taken of the non-coincidence of international traffic by the use of alternative routings to effect circuit economies and provide route diversity (Recommendation E.523);

f) the routing of transit switched traffic should be planned to avoid the possibility of circular routings ;

g) when a circuit group has both terrestrial and satellite circuits the choice of routing should be governed by:

— the guidance given in Recommendation G.114,

— the number of satellite circuits likely to be utilized in the overall connection,

— the circuit which provides the better transmission and overall service quality ;

h) the inclusion of two or more satellite circuits in the same connection should be avoided in all but exceptional cases. Annex A contains details on the effects of satellite communications.

Recommendation Q.14 defines the means to control the number of satellite links in an international telephone connection;

i) both originating and transit traffic should be routed over the minimum number of international circuits in tandem unless this is in conflict with one of the above-mentioned features.

3 Number of circuits in tandem

3.1 *International circuits*

For reasons of transmission quality as well as the minimization of post-dialling and answer signal delays and the avoidance of signalling time-outs, it is desirable to limit the number of circuits in tandem in an overall connection (Recommendations G.101 and G.114, § 1). Recommendation Q.7 gives signalling considerations on tandem routings.

In this Plan the number of international circuits in a connection is limited to a maximum of 4. (See § 3.3.2 for a special case with multiple ISCs within the area of one Administration.)

3.2 *National circuits*

Limitations in the national section of the international connection are given in Recommendation G.101, § 3.1.

Many Administrations have fulfilled the requirements of Recommendation G.101, § 3.1 by establishing a national routing plan based on a theoretical final route structure with low-loss-probability circuit groups between switching centres of different categories.

The actual structure in many cases involves direct routes which bypass the theoretical final route or part of it, the structure being rather similar to the former international routing plan.

Note — The former international routing plan was last published in the Orange Book, Volume II.2, Recommendation E.171.

When there are circuits between ISCs using different geographical routes with different transmission means, preference should be given to those circuits which provide better transmission quality as long as this is not conflicting with any other part of this Recommendation.

3.3 *Multiple ISCs in a country*

3.3.1 *In the originating or terminating country*

Administrations may find it advantageous for technical or economic reasons, or for the protection of service, to use multiple originating and/or terminating ISCs. In some cases, this could result in a routing for a call which includes a circuit between two ISCs in the originating or terminating country. Such circuits may be regarded as national circuits in applying this Plan, and as such should be included in the national link allocation, see Recommendation E.172.

3.3.2 *In a transit country*

Some Administrations may find it desirable to route transit traffic between two ISCs in their own country. In this case the allowable number of international circuits in tandem may be increased from 4 to 5 (this is the only exception to § 3.1 above).

4 Routing techniques

With advanced SPC exchanges and enhanced signalling systems new routing techniques are emerging (see Recommendation E.170). These techniques can be used nationally as found necessary by individual Administrations or bilaterally between Administrations.

5 Basic routing rules

5.1 *Originating traffic*

5.1.1 Originating traffic at an ISC may be offered to any route, taking into account all factors in this Plan, and the following guiding principles, to ensure good overall service quality for the call connection:

a) an originating ISC should first select the direct route to the destination, if it is available;

b) if the direct route is unavailable (because all circuits are busy or because no direct route is provided) then the originating ISC may select the route to any transit ISC which conforms to the principles in § 4.2 below. An agreement should first be reached between the originating, terminating and transit Administrations involved, for the use of this transit route.

5.1.2 A circuit group may be designed as a high usage circuit group (see Recommendation E.522) or as a final circuit group (see Recommendations E.520 or E.521).

5.1.3 Examples of some possible routings are given in Annex B.

5.2 *Transit traffic*

5.2.1 *Two and three international circuits in tandem*

An Administration offering transit capabilities may do so without special arrangements or restrictions to all destinations served by:

a) direct circuit groups, or

b) switching via an additional transit ISC that has a direct final circuit group to the destination, or

c) a combination of a) and b).

Examples of two and three international circuits in tandem are given in b) to e) of Figure B-1/E.171.

5.2.2 *Four international circuits in tandem*

If an Administration has provided a routing for its originating traffic that involves a maximum of 3 international circuits in tandem to a destination, it may offer this capability to other Administrations for transit traffic. In this case, these other Administrations must not themselves offer transit capabilities to the same destination as this would exceed 4 international circuits in tandem.

Examples of 4 international circuits in tandem are given in f) and g) of Figure B-1/E.171.

5.2.3 A circuit group may be designed as a high usage circuit group (see Recommendation E.522) or as a final circuit group (see Recommendations E.520 or E.521).

5.2.4 *Special arrangements*

Some Administrations may route transit traffic differently from their own originating traffic to a given destination. These routings will in some cases involve offering transit traffic to direct routes, but not to overflow routes via alternative transit ISCs. On the other hand, originating traffic offered to the same direct routes is given access to overflow routes.

This arrangement may be used for:

a) limiting the number of international circuits in tandem for transit calls, yet allowing originating calls up to the maximum of 4 international circuits in tandem.

b) preventing transit traffic from overflowing from direct routes, to minimize subsequent transit charges.

c) minimizing transmission propagation delay for transit calls.

In such cases, care must be exercised to avoid grade of service problems. Consideration should be given to :

i) the analysis of 24-hour traffic profiles ;

ii) the exchange of network status information between Administrations.

In implementing such arrangements, Administrations offering transit capability should provide the necessary information on traffic profiles and network status capabilities. Originating Administrations should evaluate such information taking into account transmission costs, and call completion factors. (See Recommendations E.522 and E.523.)

Examples of some routings involving special arrangements are given in a) and b) of Figure B-2/E.171.

6 List of international transit capabilities

6.1 To aid in the application of transit routings, a list of international transit capabilities via an Administration is desirable.

6.2 Each Administration that wishes to offer transit capabilities should develop and distribute its own list.

6.3 Annex C details the essential information that should be contained in a list of international transit capabilities plus additional information that might also be distributed by Administrations offering transit capabilities or might be requested by Administrations seeking transit routings.

ANNEX A
(to Recommendation E.171)

The effects of satellite communication

A.1 The use of geostationary satellite circuits does not call for any alteration in the basic principles and rules of this Plan. However, because of the mean propagation time on satellite circuits, the precautions specified in Recommendation G.114 must be observed.

A.2 At originating ISCs, calls which are to be transit switched at another ISC and likely to use a satellite circuit elsewhere in the connection should be routed using terrestrial circuits from the originating ISC, if available.

A.3 At ISCs arrangements should be made to guard against the inclusion of two or more satellite circuits in the same connection in all but exceptional cases. (See § A.6 below.)

Avoidance of two or more satellite circuits is made more feasible when the signalling systems used have signals indicating whether the connection already includes a satellite circuit. (See Recommendation Q.7.)

In those cases when the signalling system does not provide the necessary information, bilateral agreement should be sought between the Administrations involved to establish a special circuit group on which traffic can be routed that has already one or more satellite circuits in the connections. (See Figure A-1/E.171.)

A.4 The use of national satellite circuits for international originating and terminating connections should be avoided to the extent possible.

A.5 Connections (originating, terminating or transit) to and from the international maritime mobile satellite service should not, so far as possible, comprise other satellite circuits. In the shore-to-ship direction the country codes allocated to the maritime mobile satellite service should be analysed in order to apply this provision.

A.6 There will be cases when the above provisions cannot be fully applied. These are:

a) routing to and from Administrations with exclusive or almost exclusive use of satellite circuits for international service;

b) routings containing more than one international circuit in tandem in which the signalling systems used on one or more of the circuits in the connection does not provide nature of circuit indicators, or when no agreement can be reached with respect to the special circuit group;

c) when no other reliable means of communication is available; then two or more satellite circuits in one connection may be used.

Note — When it is unavoidable to use more than one satellite circuit in an international connection, attention to echo control as indicated in Notes 2 and 3 of Recommendation G.114 should be exercised.

A.7 Control methods for echo suppressors are given in Recommendation Q.115.

A.8 The use of demand assigned satellite systems in international telephony (e.g., SPADE) is governed by the same general and special considerations given above. The entirety of a demand assigned system and its access circuits may be regarded as a single international circuit for transmission purposes and as a transit ISC for routing purposes.

Figure A-1/E.171, p.

Echo cancellers are also now in use.

ANNEX B

(to Recommendation E.171)

Examples of possible routings and special arrangements

Figure B-1/E.171, p.

Figure B-2/E.171, p.

ANNEX C

(to Recommendation E.171)

List of international transit capabilities

C.1 *Essential information on international transit capabilities*

C.1.1 *Use*

Every Administration offering transit capabilities should compile and distribute a list including at least the information shown below in order to enable other Administrations to make a first choice of possible transit routings.

C.1.2 *Suggested format*

See Figure C-1/E.171.

Figure C-1/E.171 [T1.171] p.

C.1.3 *Instructions for completing the list*

Item A — Administration or RPOA

Enter the name of the Administration or recognized private operating agency responsible for preparing this list.

Item B — Date of Information

Enter the date for which the information below applies.

Item C — Address for Inquiries

Enter the name, address, telex and telephone number of the organizational unit or individual who will respond to enquiries concerning transit capabilities.

Column 1 — Destination country or Administration

Enter the name of the destination country or Administration. These destinations should be listed alphabetically within each World Zone grouping. Only those destinations for which this ISC can carry automatic transit traffic should be listed in this column. All destinations for which transit capabilities are being offered should be listed.

Column 2 — Transit ISCs

Enter the name or location that identifies the international switching centre(s) that has automatic transit access to the destinations in column 1. For multiple transit ISCs within the same Administration list each ISC in sequence.

Column 3 — Route Type

Enter whether the transit route to the destination is either:

DIR — If ‘‘direct’’ to the terminating ISC.

IND — If ‘‘indirectly’’ first routed via a further transit ISC. The name of the further transit ISC should also be entered.

ALT — If either the ‘‘DIR’’ or ‘‘IND’’ route automatically overflows to an ‘‘alternative’’ transit ISC. The name of the alternative transit ISC should also be entered.

Column 4 — Terrestrial possible

Enter YES if at least some transit calls to this destination can obtain an all terrestrial route beyond the transit ISC.

Enter NO if all transit calls to this destination will use a satellite circuit in the route beyond the transit ISC.

Column 5 — Special restrictions

Enter YES if the transit traffic is subject to overflow restrictions (see § 5.2.4) that might affect the grade of service achieved.

Enter NO if no such restrictions apply.

C.2 *Additional information on international transit capabilities*

C.2.1 *Use*

The information shown below is of value in comparing and selecting possible transit routes. Administrations offering transit capabilities might choose to compile and distribute some or all of these items with their basic list of international transit capabilities. Alternatively Administrations selecting a transit route may use the items shown below as a basis for enquiries.

C.2.2 *Format*

No particular format is suggested for this information. However, it is recommended that both transit and originating Administrations use the terminology and definitions given below.

If changes are planned in any of the items the change should be indicated together with the effective date.

C.2.3 *Details of additional items*

Traffic profile

Under this item the busy hour traffic on the circuit group used beyond the transit ISC should be given together with an indication of the traffic variations during the day. Preferably the variations should be presented in the form of hourly traffic distributions as shown in Recommendation E.523.

Transit charges

Under this item details of the applicable transit charges should be given.

Grade of service

The grade of service normally experienced to the destination should be given. This may be supplemented by time of day variations. If overflow restrictions for transit traffic apply, the information must include at least the hours during which the grade of service is 1% or better.

Circuit quantities

The total circuit quantities available and subtotals for each type of transmission medium should be given.

If indirect routing is used this information should be given for the circuit groups to the next transit ISC.

Signalling

The signalling systems used for the onward routing from the transit ISC should be listed.

Restoration

This item should outline the restoration policy in the case of a major transmission facility outage in the onward routing.

Echo Control

This item should list the echo control capabilities at the transit ISC.

Prevention of two or more satellite circuits in tandem

This item should explain the capabilities at the transit ISC for preventing the connection of two satellite circuits in tandem.

Where indirect routing is used, this item should also identify whether a specially designated circuit group has been agreed to allow prevention of two satellite circuits in the same connection at a subsequent ISC.

Recommendation E.172

CALL ROUTING IN THE ISDN ERA

1 Introduction and scope

National ISDNs are progressively being introduced, thus a demand for international interconnection is emerging. It is inevitable that different national variants of ISDN will be introduced which will require interworking across the international boundary.

This Recommendation establishes a routing plan for calls both within and between PSTNs and ISDNs. It is therefore complementary to Recommendation E.171, the international telephone routing plan.

The ISDN routing principles are contained in Recommendation I.335 which includes a mapping between ISDN bearer services and the one or more ISDN connection types that will support them. The main purpose of this Recommendation is to provide a mapping between these connection types and the real network components (e.g. transmission links, signalling systems) needed to support the call, and to indicate how information to be used for routing is conveyed in the relevant signalling system parameter fields.

The impact of routing the packet mode bearer service over the ISDN is for further study.

2 Service, network and signalling aspects of the ISDN

The concepts and principles of an ISDN are described in Recommendation I.120. The services supported by an ISDN are given in the I.200 Series of Recommendations. The network capabilities to support these services are defined in the I.300 Series of Recommendations. ISDN signalling protocols are defined in Recommendations Q.931 (access) and Q.761-Q.764 [Signalling System (S.S.) No. 7, ISDN User Part].

3 Network structure

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 subdivided into national and international connection elements, the national element being subdivided into local and trunk elements 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.

The network structure for ISDN has been taken from Recommendation G.801 which provides a hypothetical reference connection for the digital environment. From this Recommendation the maximum allocation is established as shown in Table 1/E.172.

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

H.T. [T1.172]

TABLE 1/E.172

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

Table 1/E.172 [T1.172], p.

4 Routing configuration

In the ISDN various routing configurations will emerge for access:

— between two customers on the ISDN/PSTN;

— between a customer and the operator service;

— between the ISDN/PSTN and other dedicated networks (see also Recommendation E.166);

— between the ISDN/PSTN and special nodes and services.

5 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 2/E.172.

H.T. [T2.172]
TABLE 2/E.172

Information for call routing	Originating exchange	National transit exchange	International exchange (ISC)
a) Calling customer	X		
b) Incoming route		X	X
c) Called number (including Q.931 NPI/TON information if present)	X	X	X
d) Destination network	X	X	X
e) Basic telecommunication service request	X		
f) Supplementary service request	X (Note 2)		
g) User service information (USI)	Generated	(Note 3)	(Note 3)
h) Transmission medium requirement (TMR)	Generated	X	X
i) ISUP preference indicator	Generated	X	X
j) Environment of the connection	X		
k) Network management conditions	X	X	X
l) Transit RPOA selection if permitted by operating agreements	X	X	
m) Connection history	Generated	X	X
n) Time of day	X	X	{
X ISUP ISDN User Part NPI Numbering plan identifier RPOA Recognized private operating agency TON Type of number			

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 supplementary service request is used to set the value of the ISUP preference indicator.

Note 3 — Depending on the network operator’s policy, it may be necessary to examine the USI in the originating network, in order to set correctly the TMR at the outgoing gateway exchange.

Table 2/E.172 [T2.172], p.

All the functions listed in Table 2/E.172 need not be available at all network nodes, but a minimum set will be required to ensure efficient and effective routing. (This requires further study.) Call charging and accounting considerations are also for further study.

a) *Calling customer*

Depending on the customer's contract with the Administration, a map of authorized and unauthorized service requests will require interrogation before the outgoing route is seized.

b) *Incoming route*

As with the calling customer, some incoming routes may require special treatment (e.g., not allow access to all outgoing routes).

c) *Called number*

Access may be barred to a particular customer, under either administrative or network management control, by analysis of the called number.

d) *Destination network*

Access may be barred to a particular network, under either administrative or network management control, by analysis of the called number.

e) *Basic telecommunications service request*

The Basic telecommunication service request, i.e. bearer service (e.g. 64 kbit/s unrestricted) or teleservice (e.g., Teletex) is contained in the Q.931 SETUP message at the originating exchange. It must be analysed in order to set the TMR and ISUP preference indicators in S.S. No. 7 ISUP — see items h) and i) below.

f) *Supplementary service request*

Both ISDN and PSTN service may invoke 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) while others will require cooperation on an end basis across the network (e.g., closed user group). The provision of the latter supplementary services can influence call routing in terms of the signalling capability required.

g) *User services information (USI)*

The USI is the encoding of the Q.931 bearer capability (BC) into S.S. No. 7 ISUP. It may be used in conjunction with the transmission medium requirements parameters — see item h) below.

h) *Transmission medium requirement (TMR)*

The TMR is a parameter in S.S. No. 7 ISUP which indicates the transmission medium required to support the telecommunication service requested. The value of the TMR will therefore depend on the bearer service or teleservice requested.

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 these cases, the outgoing gateway exchange (e.g., outgoing ISC) 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 Annex A.

i) *ISUP (ISDN User Part) preference indicator (Reference Recommendations Q.762, § 2.47, and Q.763, § 3.20)*

This is an indicator contained within the ‘‘forward call indicators’’ parameter field of ISUP, sent in the forward direction indicating whether or not the ISUP is required, preferred or not required in all parts of the network connection. This information is derived at the originating exchange from the bearer service or teleservice request and supplementary service request contained in the Q.931 SETUP message. The setting and interpretation of the ISUP preference indicator is described in § 6.

j) *Environment of the connection*

This embraces the three secondary attributes of the requested bearer service that may influence the routing process, namely:

i) the establishment of communication (demand, reserved, permanent);

ii) the configuration of the communication (point-to-point, multipoint, broadcast);

iii) the symmetry (symmetric, asymmetric).

These secondary attributes are contained in the Q.931 BC information element and are directly transposed by the originating exchange into the ISUP ‘‘user service information’’ parameter field (Reference Recommendation Q.763, § 3.33).

Note — Each of these three secondary attributes may require special arrangements that may be necessary to establish, for example, point-to-multipoint, or asymmetric calls.

The impact of the environment of the connection parameter on TMR for future studies is for further study.

k) *Network management conditions*

There may be cases where under network management control the routing will require modification to maintain quality of service, and as such the exchange must be capable of providing this facility.

l) *Transit RPOA selection*

The subject of transit RPOA selection is for further study.

m) *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. This is provided in ISUP by the ‘‘nature of connection indicators’’ parameter field. (Reference Recommendations Q.762, § 2.67, 2.35, 2.39, and Q.763, § 3.24). This field is generated at the originating exchange and modified at a subsequent transit exchange each time a relevant parameter (e.g., number of satellite links) is affected as a result of the transmission path chosen. The field has three indicators:

— satellite indicator,

— continuity check indicator,

— echo control device indicator.

Code points for the number of sections with echo control devices, and indicators for the digital circuit multiplication equipment (DCME) and A/μ-law converters are not included since these should be taken into account in accordance with the hypothetical digital reference connection (HDRC) at the exchange routing data planning stage. This is for further study.

n) *Time of day*

Because of varying traffic distributions during a 24-hour period, it may be advantageous to change the call routing arrangements dependent on time of day.

6 Signalling capability

6.1 *General*

The signalling capability required on a connection is indicated by the ISUP preference indicator, described in § 5, i). 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.

6.2 *Setting the ISUP preference indicator*

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

6.3 *Interpretation of the ISUP preference indicator*

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

6.3.1 *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 should be failed. However, if another ISDN signalling system is available nationally, then this may be selected provided that it can support the service requested.

6.3.2 *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, shall 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.

6.3.3 *ISUP not required*

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

Table 3/E.172 summarises these interpretations of the ISUP preference indicator.

H.T. [T3.172]
TABLE 3/E.172

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

A check mark (√) 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.

Table 3/E.172 [T3.172], p.

7 Network capability

In order to establish if a connection can be made, it is necessary for the network node to consider the items outlined in § 5 together with the network elements (see Table 4/E.172).

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TABLE 4/E.172

	Service	{	
		Transmission	Switching

Information transfer capability }	{ Analogue	Digital 24 circuits	Digital 32 circuits	A-u conversion	ADPCM (Note 7)	CMI
P S T N *)	Voice Voice band data (Note 5)	√ √	√ √	√ √	√ √	

I S D N	64 kbit/s unrestricted Speech (Note 6)	No √	√ (Note 1) √	√ √	No √	No √	No √	No (Note 4)	√ √	√ √	No √	
	No	√ (Note 1)	√	FS	No	No	No	√	√	FS	No	

Tableau 4/E.172 [1T4.172] A L'ITALIENNE, p. 15

H.T. [2T4.172]

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 voice-band data would cause permanent trunk/channel assignment for the duration of the call, thereby reducing the potential DSI gain.

Note 3 — Switching at these bit rates is for further study.

Note 4 — For voice/speech calls, only single satellite hops are permitted (see Recommendation E.171). For data calls in the ISDN, the subject is for further study.

Note 5 — The maximum modem bit rate that can be supported depends on the transmission performance within or between Administrations. The extent of this support is a bilaterally agreed matter. The network may include signal processing techniques, provided they are appropriately modified or functionally removed prior to information transfer.

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 § 3 of this Recommendation, and for satellite links see Recommendation E.171.

Note 9 — Echo control equipment is disabled by the ‘‘user’’ (e.g., modem tone).

Note 10 — The echo control equipment can be disabled either by the ‘‘user’’ or the ‘‘exchange’’. This is for further study.

Note 11 — Within national networks it is sometimes possible to provide digital end-to-end connectivity, this is also possible across international boundaries subject to bilateral agreement.

Note 12 — 2 **|** (mu **|** 4 kbit/s service is for further study. **Tableau 4/E.172 suite (remarques) [2T4.172] A L’ITALIENNE, p. 16**

8 Routing process using S.S. No. 7 ISUP parameter fields

The route selection and subsequent circuit selection will depend on the outcome of the analysis of the above information. In some cases this analysis will require the call to be rejected; in others it may be necessary to select dedicated routes. The actual route selection process using S.S. No. 7 ISUP is shown in Figure 1/E.172.

Figure 1/E.172, p.

9 Change of service during a call

Recommendation I.211 identifies one bearer service (as defined in § 2.1.5 of that Recommendation) for which the value of the information transfer capability attribute can alternate between speech and 64 kbit/s unrestricted. When the user requests this bearer service, the initial value of this alterable attribute value must be identified in the Q.931 signalling messages during call set-up. During the call, the user will also use signalling messages to request a change in absolute value of this attribute when it is actually desired; and the network will confirm the request for change (see Recommendation Q.763, § 3.4).

The capability for change of service during a call can be implemented relatively easily when no echo control or A-µ law conversion is present in the connection, e.g., intra-Europe. However, the implementation of the network capability to support change of service during a call is for further study in the following areas:

— disablement/bypass/introduction of echo control,

— disablement/bypass/introduction of A-µ law conversion,

— disablement/bypass/introduction of CME/DSI equipment.

10 Path selection

This is for further study.

11 Summary

This Recommendation describes call routing in the ISDN era in terms of both network design and the route selection process.

For network design, Table 1/E.172 shows the number of links allowed, while Table 4/E.172 should be used to determine which real network components may comprise the links, depending on the ISDN services they are required to support.

For route selection, Table 2/E.172 shows the types of information which may be analyzed at various stages of the call routing process. Of these, two of the most significant for ISDN calls are the S.S. No. 7 ISUP parameters — transmission medium requirement (TMR) and ISUP preference indicator. To further illustrate the use of these parameters, Annex C shows a hypothetical network with examples of route selection for different types of call.

ANNEX A

(to Recommendation E.172)

Transmission medium requirement (TMR) values

As outlined in § 5 h), for calls between networks, the TMR should be set to the minimum transmission resource required to support the call. This Annex gives TMR values for ISDN services, to be used across international and internetwork boundaries.

A.1 *Bearer services*

Service TMR value Speech Speech 3.1 kHz Audio 3.1 kHz Audio 64 kbit/s unrestricted 64 kbit/s unrestricted Alternate speech, 64 kbit/s unrestricted a) Initial mode = speech Speech, 64 kbit/s unrestricted b) Initial mode = 64 kbit/s unrestricted 64 kbit/s unrestricted, Speech

A.2 *Teleservices*

Service TMR value Telephony Speech Telefax (Group 4) 64 kbit/s unrestricted Teletex 64 kbit/s unrestricted Videotex For further study Video telephony For further study Interworking from PSTN

A.3 When interworking from a PSTN, the TMR should normally be set to 3.1 kHz audio. However, it is recognized that in some interworking cases this may be inappropriate (see Recommendation I.335). The routing impact of interworking between networks is for further study.

A.4 Other services are for further study.

ANNEX B
(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 Q.931 SETUP message, as indicated in § 5, i).

B.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 (Recommendations I.210 and I.212 refer). (See Note.)

— For the 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 — 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’’.

B.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’’:

a) closed User Group (CUG), see Note 1,

b) reverse charging,

c) completion of Calls to Busy Subscribers (CCBS), see Note 2.

— In order to allow supplementary services invoked 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 with outgoing access, should be set to ISUP Preferred.

Note 2 — For the CCBS Supplementary service, the call resulting from acceptance of the CCBS recall may need the ISUP Preference Indicator to be set to ISUP Required; this is for further study.

It is recognised that this list of criteria is not exhaustive and furher study is required on the impact of other supplementary services on the setting of the ISUP preference Indicator.

ANNEX C
(to Recommendation E.172)

Use of S.S. 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 S.S. No. 7 ISUP signalling (see Figure C-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 that:

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

b) if Route 4 is a national variant of S.S. 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.

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 C-1/E.172, p.

MODELS FOR INTERNATIONAL NETWORK PLANNING

1 Introduction

Network planning plays an important role in the overall responsibility to provide telecommunications and due consideration has to be given to a number of relevant factors, e.g. technical, economic and operational. International planning involves, by definition, a number of Administrations which may have different national objectives and may operate under different economic constraints. It is apparent, therefore, that these differences must be reconciled if cooperative planning is to be achieved. This Recommendation describes a possible method for concerned Administrations to organize a procedure to implement this cooperative network planning process.

2 Basic purpose of an international network planning model

Network planning involves a number of defined planning activities such as forecasting , routing , circuit number calculation and other relevant traffic engineering issues, all of which are interactive in the planning process. The basic purpose of an international network planning model should be to organize all these activities in implementing an orderly overall planning process. The model should assist Administrations in making timely decisions on questions concerning facility selection, circuit routing, etc. This would enable Administrations to perform efficient long-term planning and thus avoid being restricted to a limited number of planning options which, while optimum in the short term, may lead to an expensive network in the long run.

Where such a model produces results consistent with the national objectives of the Administrations involved, it will provide a valuable aid to network planning. Nevertheless, it must be recognized that no model can be appropriate in all cases and final decisions on network plans can only be made on the basis of the preferences of the interested parties.

3 General layout of an international network planning model

Annex A gives a possible method on how to organize the international planning process flowchart with a number of interactive ‘‘planning steps’’. Each step includes one or more activities, which may require separate consideration. To further assist Administrations in the implementation of the planning process, reference is given below to the most relevant CCITT Recommendations and/or other documentation which should be taken into account.

— Recommendation E.170: Traffic routing (steps II, III).

— Recommendation E.171: International routing plan (steps II, III).

— Recommendation E.501: Estimation of traffic offered to international circuit groups (step III).

— Recommendation E.506: Forecasting international telephone traffic (step II).

— Recommendation E.510: Determination of the number of circuits in manual operation (step III).

— Recommendation E.520: Number of circuits to be provided in automatic and/or semiautomatic operation, without overflow facilities (step III).

— Recommendation E.521: Calculation of the number of circuits in a group carrying overflow traffic (step III).

— Recommendation E.522: Number of circuits in a high-usage group (step III).

— Recommendation E.540—E.543 on grade of service (step III).

— Series D Recommendations: Accounting rules (step II).

— Supplement No. 4 to Series E Recommendations: Use of computers for network planning and circuit group dimensioning (step I).

— GAS 3 Manual: *General Network Planning* , Chapter II: General survey of network planning concepts (step I).

— *Ibid* , Chapter VIII: Economic aspects of network planning (steps I, II, III, IV).

— *Ibid* , Chapter IX: Forecasting for network plans (step II).

— *Ibid* , Chapter X: Network dimensioning and optimization (steps I, II, III).

— *Ibid* , Chapter XI: Computer aids to network planning (step I).

ANNEX A

(to Recommendation E.175)

Flowchart of the international planning process

Step I — Agree on study methods

A meeting of the interested parties is required to agree on the methods by which the planning study is to be conducted. These methods could include such factors as:

— manual or computer model study;

— type of computer model;

— study period;

— cost of capital;

— method of financial comparison (e.g. present value);

— other economic parameters;

— types of input information required;

— form of results to be provided.

Step II — Gather required input information

The interested parties should then obtain the input information agreed to in Step I for their respective Administrations. This information could include items such as:

— traffic forecasts (bilateral);

— administration preferences:

a) routing,

b) diversity,

c) satellite/cable mix,

d) restoration;

— ownership in existing facilities;

— facility exhaust dates;

— new facilities;

a) capacity,

b) costs,

c) availability,

— quality of service requirements.

Step III — Route traffic on proposed network

If a manual process is being used, the routing of traffic could then be performed by a study group selected by the interested parties. These traffic loads on the various facilities in the network would then be used in the selection of the appropriate facilities (Step IV) that would either be loaded (in the case of existing facilities), or that would have to be constructed in the study period.

In the case of a computer modelling process, the Steps III and IV could either be separate or merged, depending on the model chosen.

In either case of manual or computer processing, some iteration of Steps III and IV is usually required in the process, i.e., the loading of circuits on the various links of the network depends on the costs of these facilities, while the facilities selected (and therefore their costs) depend on the number of circuits loaded on them.

Step IV — Select new facilities

The selection process used by the study group should reflect the operational, technical and commercial requirements of the interested parties. Facilities should be dimensioned so as to result in the lowest practical network cost consistent with the preferences of the individual parties. Also (as stated in Step III) it is possible that the facilities chosen could result in costings that could make the rerouting of circuits advantageous.

Steps III and IV should be repeated as necessary to obtain consistent results between routing and facility selection.

Step V — Allocate costs by potential participants

Network costs should then be broken down by potential participants. These costs should be broken into:

— capital costs by facility;

— maintenance costs by facility;

— extension costs;

— satellite space segment related costs.

Special participant reports could be required as determined in Step I.

Step VI — Check results with potential participants

At this point, the special study group should present results to the potential participants. If results are agreeable to this body, then the process could proceed. If, however, the results are not agreeable, then the process should return to Step II to reflect the problems and concerns of the participants. It is possible that more than one alternative network solution may be requested by the participants.

Step VII — Obtain agreement on final plan

If the results in Step VI are agreeable to the potential participants, then the process can continue to the signing of commitments for any new facilities required by the study.

Step VIII — Implement early period facilities

The process of providing the facilities required in the early part of the study period can then begin, leaving the new construction required in the later study period for further reconsideration as conditions warrant.

Step IX — Restudy area as conditions warrant

The network plan should be restudied periodically as new information becomes available. This could include changes in economic conditions, traffic forecasts, costs, new technologies, or political conditions.

Figure A-1/E.175, p.