INTERNATIONAL TELECOMMUNICATION UNION

CCITT

E.173

THE INTERNATIONAL
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TELEPHONE NETWORK AND ISDN

**OPERATION, NUMBERING, ROUTING
AND MOBILE SERVICE**

ROUTING PLAN FOR INTERCONNECTION BETWEEN PUBLIC LAND MOBILE NETWORKS AND FIXED TERMINAL NETWORKS

Recommendation E.173

Geneva, 1991

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.173 was prepared by Study Group II and was approved under the Resolution No. 2 procedure on the 23rd of August 1991.

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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.173

ROUTING PLAN FOR INTERCONNECTION BETWEEN
PUBLIC LAND MOBILE NETWORKS AND FIXED TERMINAL NETWORKS

1   Introduction

1.1   With the worldwide introduction of public land mobile service there exists a need for interconnection between public land mobile networks (PLMN) and fixed terminal networks (e.g. PSTN/ISDN and PSPDN).

1.2   This Recommendation covers the routing plan for interconnection between PLMN and the public switched telephone network/integrated services digital network (PSTN/ISDN) and between PLMN and the public data networks (PDN).

1.3   It provides guidelines for routing when interconnecting PLMN and fixed terminal networks, and indicates some basic rules for routing of calls between the networks. Routing between networks must adhere to regulatory conditions which exist within a given country or Administration. Bilateral agreements may be required to establish the actual interconnection arrangements between network operators.

1.4   This Recommendation covers terrestrial-based PLMNs. Satellite-based PLMNs are for further study.

1.5   Routing requirements within fixed terminal networks are described in the following Recommendations:

    E.171   International telephone routing plan;

    E.172   Call routing in the ISDN era;

    X.110   International routing principles and routing plan for public data networks;

    G.173 (Draft) Transmission planning aspects of the speech service in digital public land mobile networks.

2   Terminology

    CSPDN   Circuit swiched public data network

    DCME   Digital circuit multiplexing equipment

    DSI   Digital speech interpolation

    DTEData terminal equipment

    FDTE   Fixed data terminal equipment, e.g. a DTE connected to the (PDN)

    IDSE   International data switching exchange

    ISC   International switching centre

    ISDN   Integrated services digital network (within this Recommendation ISDN means the circuit switched part of the network; for the packet switched part see PDN)

    LMDTE Land mobile data terminal equipment, e.g. a DTE connected to PLMN

    LMS   Land mobile station

    LRE   Low rate encoding

    MSC   Mobile switching centre (this is a centre that handles mobile traffic)

PDN   Public data network, e.g. CSPDN, PSPDN or PHPDN in ISDN

PHPDN   Packet handler public data network

PLMN   Public land mobile network

PSPDN   Packet switched public data network

PSTN   Public switched telephone network

QOS   Quality of service

TASI   Time assignment speech interpolation

TE   Terminal equipment

3   Scope

3.1   This Recommendation includes the routing of calls between users of PLMN and the users of PSTN/ISDN or PDN. The term "call" encompasses all types of user-to-user communication, e.g. normal speech calls, data calls, text messages and emergency calls.

3.2   The following interconnection cases are considered:

PLMN <——> PSTN/ISDN (see Note 1)

PLMN <——> PSTN/ISDN <——> PLMN (see Note 1)

PLMN <——> PDN (see Note 2)

PLMN <——> PDN <——> PLMN (see Note 2)

PLMN <——> PSTN/ISDN <——> PDN (see Note 2)

PLMN <——> PSTN/ISDN <——> PDN <——> PSTN/ISDN <——> PLMN (see Note 2)

Note 1 – The abbreviation PSTN/ISDN means one or more networks of the same type in series.

*Note 2* – The abbreviation PDN means one or more networks of the same type in series.

3.3   A PLMN may be configured either as an extension of PSTN/ISDN or as an integral part of PSTN/ISDN. This Recommendation deals only with the first case. When PLMN and PSTN/ISDN are integrated, the routing of calls shall follow the routing Recommendations E.171 for the PSTN and E.172 for the ISDN era.

4   Network structure

The network structure shows the last choice routes, e.g. normally the route with the highest number of circuits in tandem. The last choice route will be determined by the type of traffic (e.g. speech versus packet data) and the location of the originating and terminating terminals.

4.1   *Between PLMN and PSTN/ISDN*

To minimize the administrative and operational burden on international switching centres (ISC), the interconnection between PLMN and PSTN/ISDN should take place nationally. The network structure for the traffic between PLMN and PSTN/ISDN is shown in Figure 1/E.173. It indicates the last choice route between two mobile stations in different countries.
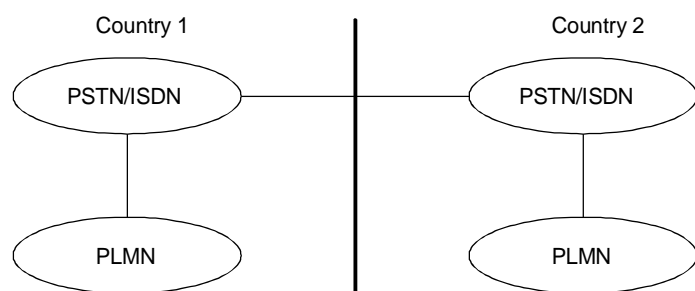
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FIGURE 1/E.173

**Network structure for the traffic
between PLMN and PSTN/ISDN**

4.2 *Between PLMN and PDN*

4.2.1 To minimize the administrative and operational burden on international data switching exchanges (IDSE) the interconnection between PLMN and PDN should take place nationally, either directly between PLMN and PDN or indirectly via PSTN/ISDN. The method for interconnection is a national matter.

4.2.2 The last choice route between two LMDTEs or between LMDTE and a FDTE in PDN in two different countries will depend upon how the interconnection between PLMN and PDN is implemented.

The network structure for the traffic between PLMN and PDN is shown in Figure 2/E.173.
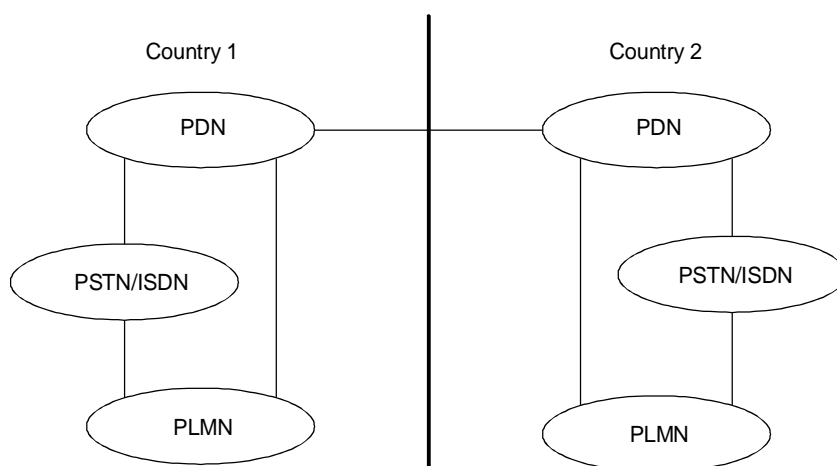
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Note – The method for interconnection of PLMN and PDN is a national matter.

FIGURE 2/E.173

Network structure for the traffic between PLMN and PDN

5   Maximum number of circuits in tandem

Recommendation E.172 gives the maximum allocation for the number of nodes and links in the national and international part of PSTN/ISDN for call routing in the ISDN era, and Recommendation X.110 gives the maximum allocation of links in tandem in the international part of PDN for call routing within PDN.

5.1   *Via PSTN/ISDN*

5.1.1   The maximum number of circuits in tandem will be on an international call between two land mobile stations, that follows the last choice route indicated in Figure 1/E.173. The last choice route is composed of two national and one international element as shown in Figure 3/E.173. Each national element consists of a PLMN part and a PSTN/ISDN part. The international element consists only of PSTN/ISDN.
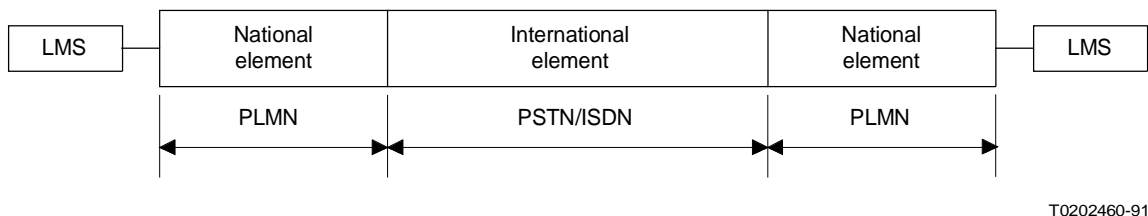
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FIGURE 3/E.173

Elements of an international call between land mobile stations

5.1.2   With more than two national elements in series the planning of national networks and interconnection between PLMN and PSTN/ISDN may be significantly affected, due to the fact that the maximum number of circuits in tandem should not be exceeded. Therefore, placing more than two national elements in the last choice route between two land mobile stations in different countries should be avoided.

5.1.3   Table 1/E.173 shows the maximum allocation of nodes and links in the national element when interconnecting PLMN and PSTN/ISDN. The maximum number of nodes and links are taken from the national node and link allocation in Recommendations E.172 and G.801.

The maximum number of nodes and links in the international element is given in Recommendation E.171.

5.2   *Via PDN*

5.2.1   The maximum number of circuits in tandem will be on an international call between two LMDTEs in different countries. Normally the host computer will be a FDTE connected to PDN, but the limiting case will be between LMDTEs in two different countries as shown in Figure 4/E.173. The national element on each side consists of the interconnection between the different networks. The international element consists of one or more PDNs.

TABLE 1/E.173

Maximum allocation of nodes and links

National element			
Nodes		Links (Note)	
PLMN	PSTN/ISDN	PSTN/ISDN	PLMN
0	4	4	0
1	3	4	0
2	2	3	1
3	1	2	2
4	0	1	3

Note – The interconnecting link between PSTN/ISDN and PLMN belongs to the PSTN/ISDN.
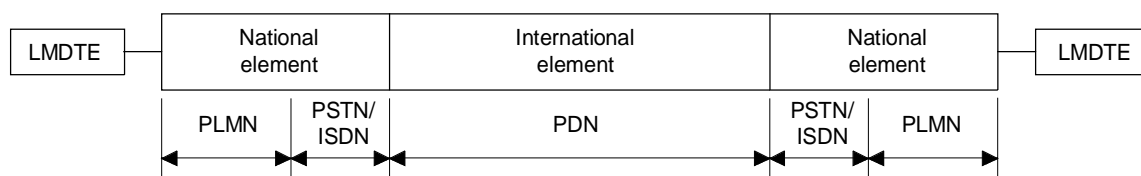
FIGURE 4/E.173

Elements of an international data call between two land mobile data terminal equipments

5.2.2   The maximum number of nodes and links in the national element is a national matter, however the Quality of Service (QOS) parameters (e.g. congestion, call setup time, data transfer delay) must be considered when structuring the interconnection between PLMN and PDN.

For the PDN part of the connection, the QOS parameters are given in Recommendations X.130, X.131, X.135, X.136 and X.137.

The maximum number of nodes and links in the international element is given in Recommendation X.110.

5.2.3   More than two national elements in the last choice route between two LMDTEs should be avoided (see § 5.1.2).

6   Services

The impact of services on routing is for further study.

7 Number of satellites and quality of service

The use of satellites does not have influence upon the maximum number of nodes and links given in §§ 5.1.2 and 5.2.2. A satellite together with its up-link and down-link is, from a routing point of view, considered as a single link (satellite link).

7.1 *PLMN speech/audio calls*

7.1.1   Speech and audio calls cover the voice and voice-band data service in PSTN and the speech and 3.1 kHz audio service in ISDN. Recommendation E.171 states that the speech/audio calls in PSTN/ISDN may use only one satellite link, and that the inclusion of two or more satellite links in the same connection should be avoided where possible. The satellite link may be part of the national or international element.

7.1.2   Use of satellites in a call between two land mobile stations or between a land mobile station and a subscriber connected to the fixed network, may result in conversational difficulties due to delay. Network planners should take this into account when implementing digital PLMNs.

7.1.3   Use of DCME (digital circuit multiplexing equipment), TASI (time assignment speech interpolation), DSI (digital speech interpolation) and LRE (low rate encoding) equipment may result in degradation of service quality. Further study is required.

7.1.4   Table 2/E.173 shows the recommended maximum number of satellite links in an international voice/speech call between two land mobile stations.

TABLE 2/E.173

Recommended maximum number of satellite links for speech/audio calls

National element		International element	National element	
PLMN	PSTN/ISDN	PSTN/PLMN (Note)	PSTN/ISDN	PLMN
1	0	0	0	0
0	1	0	0	0
0	0	1	0	0
0	0	0	1	0
0	0	0	0	1

Note – The use of PLMN in the international element assumes that PLMNs in different countries may be interconnected.

7.2 *PLMN data calls*

7.2.1   Data calls are calls between DTEs irrespective of the mode of operation (circuit or packet mode).

7.2.2   Recommendation X.110 states that for calls within PDN no more than three satellite links should normally be included, and the international element of the connection should normally not include more than two satellite links.

7.2.3   The use of national or international satellite links for calls between DTEs in PLMN or between PLMN and PDN, may degrade the quality to such an extent that it becomes unsuitable for some data services. Network planners should take this into account when implementing digital PLMNs.

7.2.4   Table 3/E.173 shows the maximum number of satellite links in the different elements of an international call between two LMDTEs in different countries.

TABLE 3/E.173

Recommended maximum number of satellite links for data calls

National element	International element	National element
0	2	1 (Note 1)
0	1	2 (Note 2)
1 (Note 1)	2	0
1 (Note 1)	1	1 (Note 1)
1 (Note 1)	0	2 (Note 2)
2 (Note 2)	1	0
2 (Note 2)	0	1 (Note 1)

*Note 1* – The satellite link may be used in PLMN or PSTN/ISDN.

Note 2 – The satellite links may be used in PLMN and/or PSTN/ISDN.

8   Path selection

To ensure that the Quality of Service is maintained when interconnecting PLMN and other networks, a set of rules and guidelines for planning of such interconnections and for the routing of calls are provided.

8.1   *Between PLMN and PSTN/ISDN*

8.1.1   To minimize the administrative and operational burden on the international switching centres in PSTN/ISDN and PLMN, the routing of calls between PLMN and PSTN/ISDN should be as shown in Figure 5/E.173.
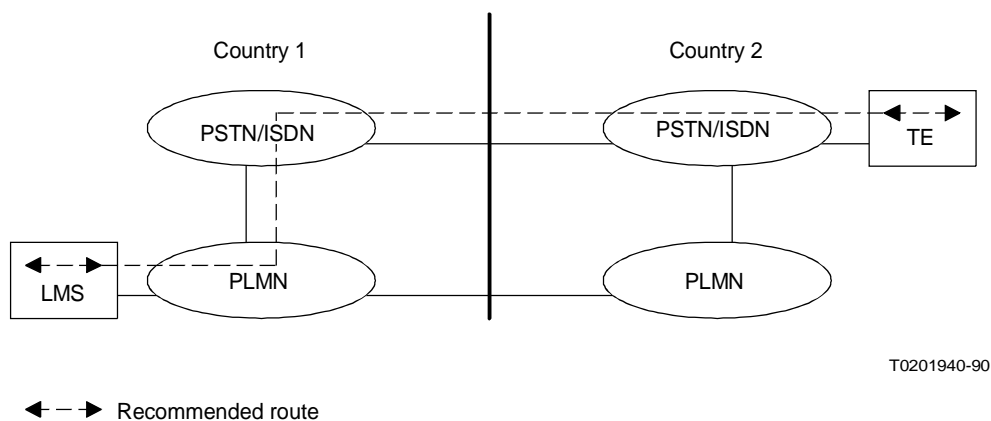
Note – National regulatory conditions may restrict direct interconnection between PLMNs.

FIGURE 5/E.173

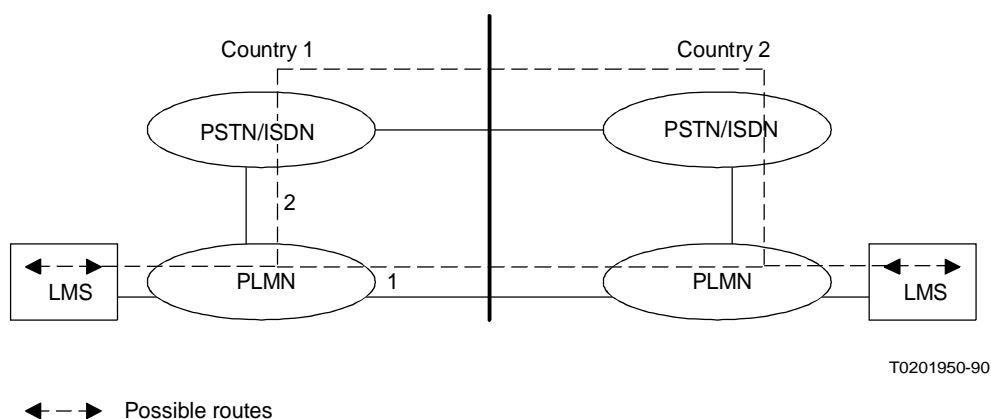**Routing of calls between PLMN and PSTN/ISDN**

8.1.2 International calls generated in PSTN/ISDN and destined for PLMN in another country should remain in the fixed network (PSTN/ISDN) for as long as possible. The connection from PSTN/ISDN to PLMN should take place in the destination country.

8.1.3 The international routing of calls between PLMN and PSTN/ISDN is independent of a possible PLMN-PLMN interconnection.

8.2 *Between PLMNs via PSTN/ISDN*

8.2.1 Where national regulations permit direct interconnection between PLMNs in different countries, the network operators can establish bilateral agreements to interconnect their PLMNs. The traffic, technical, economical and administrative advantages/disadvantages should be considered before such an interconnection is proposed.

8.2.2 The routing of international speech/audio calls between two PLMNs which are interconnected should be as shown in Figure 6/E.173.

Note 1 – National regulatory conditions may restrict direct interconnection between PLMNs.

Note 2 – 1 and 2 indicates the order of preference when selecting routes.

FIGURE 6/E.173

Routing of calls between PLMNs

8.2.3   When the PLMNs are not interconnected, the speech/audio calls should follow route 2 in Figure 6/E.173.

8.2.4   When the PLMN cannot determine that the call is destined for a PLMN in country 2, the call must be routed via route 2.

8.3   *Via PDN*

8.3.1   Users of data calls often require higher Quality of Service (e.g. shorter call set-up delay and data transfer delay) than speech/audio calls. Performance values for calls within PDN are defined in Recommendations X.130 and X.131 for the circuit switched data services and in Recommendations X.135, X.136 and X.137 for the packet switched data services. Some of the performance values given for PDN are in the same range as the corresponding values for PSTN/ISDN.

8.3.2   To avoid unnecessary degradation of the performance values between two LMDTEs in PLMN, or between a LMDTE in PLMN and a FDTE in PDN, a data call between LMDTEs or between LMDTE and FDTE should follow the PDN as long as possible. The international routing of calls should then be as shown in Figure 7/E.173.
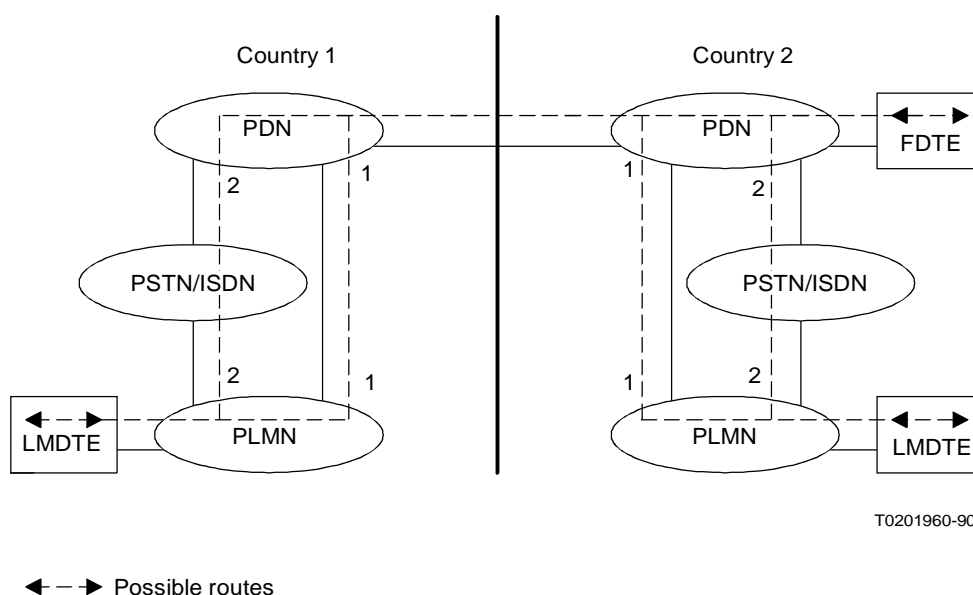

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◄ — ► Possible routes

Note 1 – The method for interconnection of PLMN and PDN is a national matter.

Note 2 – 1 and 2 indicates the order of preference if both connections exist.

FIGURE 7/E.173

Routing of calls between PLMN and PDN

8.3.3   The routing of data calls between LMDTEs and between LMDTE and FDTE is independent of possible PLMN-PLMN and PSTN/ISDN-PSTN/ISDN connections.

9 Routing and echo control

In digital PLMN, electrical echo is eliminated through the use of 4-wire terminal sets. At the interconnection points between PLMN and PSTN/ISDN, PLMN can be regarded as having a half-echo control device connected, which requires that the other half-echo control device be connected for each call between PLMN and PSTN/ISDN.

The routing should be performed in such a way that by means of signalling and analysis capabilities, proper echo control is achieved.

10 Routing between networks after international handover

By international handover is meant the action of switching a call in progress between base stations of PLMNs in different countries. The handover procedures are described in Recommendation Q.1005.

10.1 *Between PLMN and PSTN/ISDN*

10.1.1 Routing after handover within one national PLMN is a national matter. This section deals with routing between PLMNs in different countries after international handover. Figure 8/E.173 illustrates the route between two LMSs in different countries before handover.
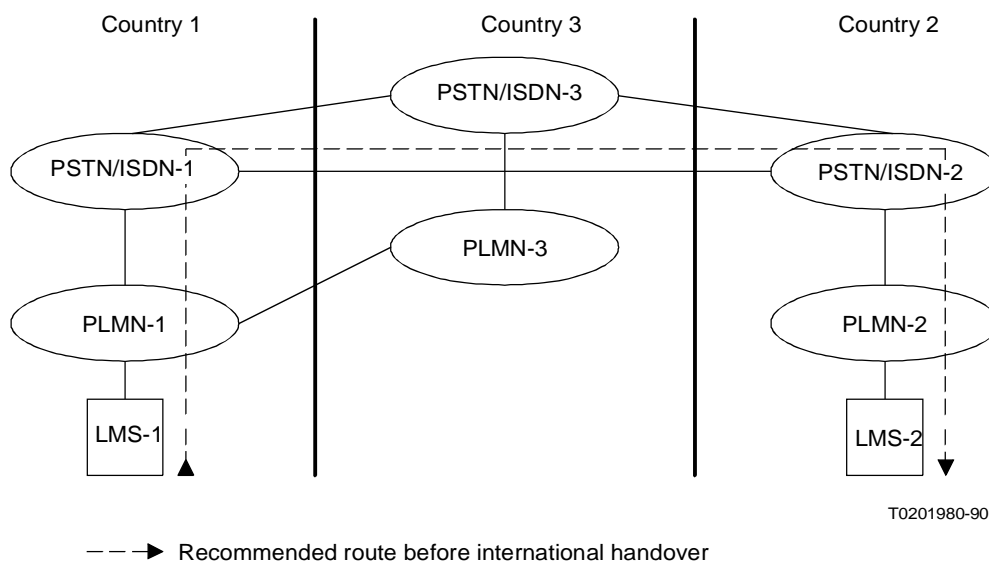
— — ▶ Recommended route before international handover

Note – National regulatory conditions may restrict direct interconnection between PLMNs.

FIGURE 8/E.173

Routing of calls between PLMNs before international handover

10.1.2   The controlling MSC(MSC-A) is the MSC which first established the radio connection to or from a land mobile station. This MSC will be the call controlling MSC for the duration of the call and also when the call is handed over to another MSC in another PLMN. This means that after handover to PLMN-3 in Figure 9/E.173, the only route available for the call will be:

$$LMS1 \to PLMN3 \to PLMN1 \to PSTN/ISDN1 \to PSTN/ISDN2 \to PLMN2 \to LMS2$$

This route may contain three national elements, and should, according to § 5.1.2, be avoided. Since the controlling MSC in PLMN-1 has to be part of the route after handover, there are at present no possibilities to avoid PLMN-1. This can reduce the QOS of the call to such an extent that it could be considered lost.

10.1.3   It is a long-term objective that the routing of calls between PLMNs after international handover should be as shown in Figure 9/E.173. This is for further study.
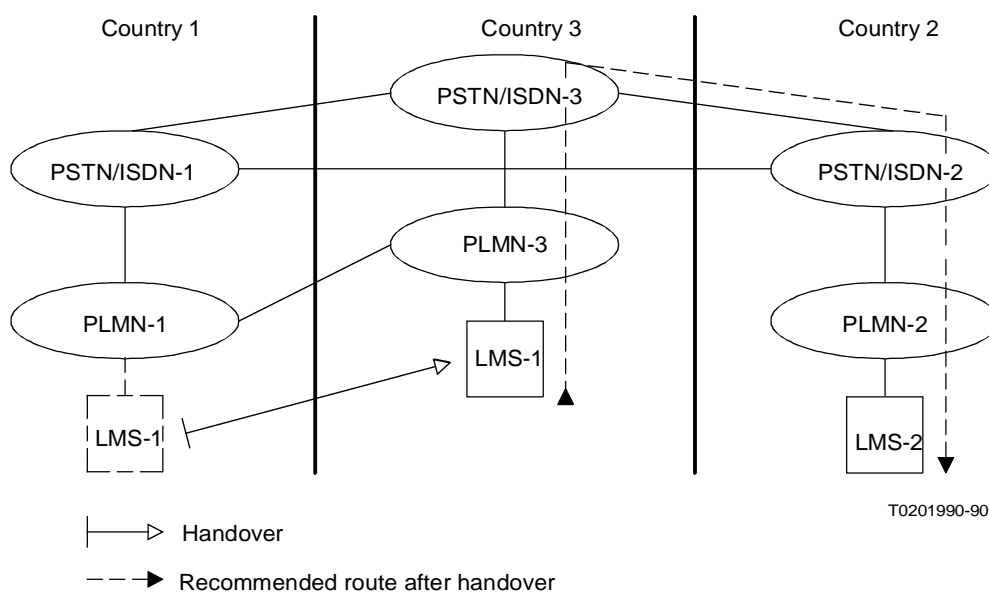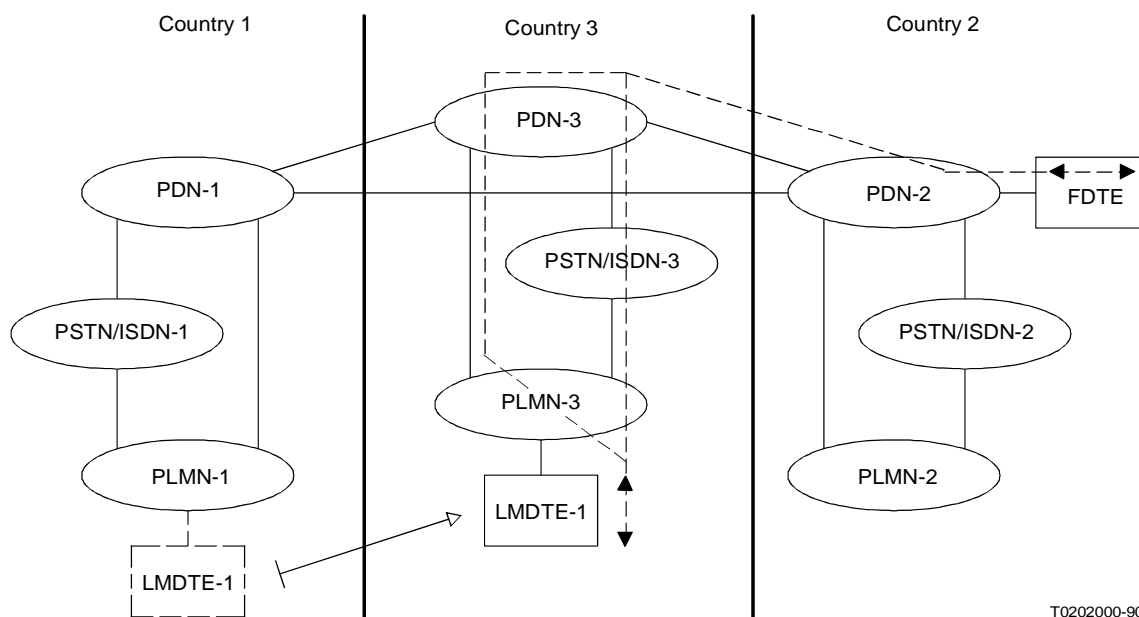

FIGURE 9/E.173

Routing of calls between PLMNs after international handover

10.2   *Between PLMN and PDN*

10.2.1   Routing within PLMN after national handover is a national matter. Section 8.3.2 recommends that an international call between PLMN and PDN should follow the PDN path as long as possible. Figure 7/E.173 indicates the possible routes between PLMN and PDN before international handover.

10.2.2   The comments regarding the controlling MSC in § 10.1.2 is also valid for calls between PLMN and PDN.

10.2.3   It is a long-term objective that the routing of calls between PLMN and PDN after international handover should be as shown in Figure 10/E.173. This is for further study.

Country 1   Country 3   Country 2

Handover

Possible routes after handover

Note 1 – The method for interconnection of PLMN and PDN is a national matter.

Note 2 – The direct interconnection between PDN and PLMN should not affect the terms of subscription for the LMDTE.

FIGURE 10/E.173

Routing of calls between PLMN and PDN after international handover

10.2.4 The routing of calls between PLMN and PDN after international handover should be independent of possible international PLMN-PLMN or PSTN/ISDN-PSTN/ISDN connections.

11 Routing of emergency calls

Emergency calls terminate today in the PSTN and will terminate in PSTN/ISDN in the future. As land mobile subscribers often are among the first witnesses to accidents, it is important to have an effective way of accessing the proper emergency centres. Emergency calls generated from land mobile stations should use the most direct route to the emergency centres in PSTN/ISDN.

Note – Routing of emergency calls is a national matter, but the introduction of public land mobile networks (PLMN) in an ever-increasing number of countries makes it desirable to standardize the emergency procedures used in different parts of the world. The CEPT countries have agreed to implement a Europe-wide emergency number "112" before 1995.

12 Recommendation history

First published in 1991.

12 Recommendation E.173