

# ETSI TS 100 541 V7.0.0 (1999-08)

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*Technical Specification*

**Digital cellular telecommunications system (Phase 2+);  
Routing of calls to/from Public Data Networks (PDN) and the  
GSM Public Land Mobile Network (PLMN)  
(GSM 03.70 version 7.0.0 Release 1998)**

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**GSM**®

GLOBAL SYSTEM FOR  
MOBILE COMMUNICATIONS



Reference

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**ETSI**

Postal address

---

F-06921 Sophia Antipolis Cedex - FRANCE

Office address

---

650 Route des Lucioles - Sophia Antipolis  
Valbonne - FRANCE  
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16  
Siret N° 348 623 562 00017 - NAF 742 C  
Association à but non lucratif enregistrée à la  
Sous-Préfecture de Grasse (06) N° 7803/88

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## Foreword

This Technical Specification (TS) has been produced by the Special Mobile Group (SMG).

The present document identifies the routing scenarios possible for calls between Public Data Networks (PDN's) and the digital cellular telecommunications system.

The contents of the present document is subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of the present document, it will be re-released with an identifying change of release date and an increase in version number as follows:

Version 7.x.y

where:

- 7 indicates Release 1998 of GSM Phase 2+
- x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- y the third digit is incremented when editorial only changes have been incorporated in the specification.

The specification from which the present document has been derived was originally based on CEPT documentation, hence the presentation of the present document may not be entirely in accordance with the ETSI rules.

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# 1 Scope

The present document identifies the routing scenarios possible for calls between Public Data Networks (PDN's) and the GSM PLMN. As one of the prime means of routing is based on the subscriber number, this recommendation initially defines the numbering principles for interworking between PLMN's and PDN's. These principles indicate:

- present PDN procedures when aiming at single stage interworking for the near term; and
- future PDN procedures exploiting the 15 digit and intelligent signalling capabilities of the ISDN as the long term solution.

Further routing scenarios are presented for PDN originated calls to mobile subscribers who are roaming on a foreign PLMN.

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# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release 1998 document, references to GSM documents are for Release 1998 versions (version 7.x.y).

- [1] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".
- [2] GSM 03.03: "Digital cellular telecommunications system (Phase 2+); Numbering, addressing and identification".
- [3] GSM 04.08: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface layer 3 specification".
- [4] GSM 04.21: "Digital cellular telecommunications system (Phase 2+); Rate adaption on the Mobile Station - Base Station System (MS - BSS) interface".
- [5] GSM 09.04: "Digital cellular telecommunications system (Phase 2+); Interworking between the Public Land Mobile Network (PLMN) and the Circuit Switched Public Data Network (CSPDN)".
- [6] GSM 09.05: "Digital cellular telecommunications system (Phase 2+); Interworking between the Public Land Mobile Network (PLMN) and the Packet Switched Public Data Network (PSPDN) for Packet Assembly/Disassembly facility (PAD) access".
- [7] GSM 09.06: "Digital cellular telecommunications system (Phase 2+); Interworking between a Public Land Mobile Network (PLMN) and a Packet Switched Public Data Network/Integrated Services Digital Network (PSPDN/ISDN) for the support of packet switched data transmission services".
- [8] GSM 09.07: "Digital cellular telecommunications system (Phase 2+); General requirements on interworking between the Public Land Mobile Network (PLMN) and the Integrated Services Digital Network (ISDN) or Public Switched Telephone Network (PSTN)".
- [9] CCITT Recommendation E.163: "Numbering plan for the international telephone service".
- [10] CCITT Recommendation E.164: "Numbering plan for the ISDN era".

- [11] CCITT Recommendation E.165: "Timetable for co-ordinated implementation of the full capability of the numbering plan for the ISDN era".
- [12] CCITT Recommendation E.166: "Numbering plan interworking in the ISDN era".
- [13] CCITT Recommendation E.213: "Telephone and ISDN numbering plan for land mobile stations".
- [14] CCITT Recommendation I.332: "Numbering Principles for interworking between ISDNs and Dedicated Networks with different Numbering Plans".
- [15] CCITT Recommendation X.25: "Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit".
- [16] CCITT Recommendation X.110: "International routing principles and routing plan for public data networks".
- [17] CCITT Recommendation X.121: "International numbering plan for public data networks".
- [18] CCITT Recommendation X.122: "Numbering plan interworking between a packet switched public data network (PSPDN) and an integrated services digital network (ISDN) or public switched telephone network (PSTN) in the short term".
- [19] ETS 300 099: "Integrated Services Digital Network (ISDN); Specification of the Packet Handler access point Interface (PHI)".

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## 3 Definitions and abbreviations

In addition to those below, abbreviations used in the present document are listed in GSM 01.04.

**Concept of time "T":** CCITT Recommendation E.165 specifies that by the time "T" (set to 31.12.1996) full capability of the numbering plan for the ISDN era (CCITT Recommendation E.164) will be implemented.

**Short Code:** see GSM 09.06

Cd	Called Number
Cg	Calling Number
CRP	Call Request Packet in CCITT Recommendation X.25

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## 4 Introduction

The GSM PLMN uses the same numbering plan as the ISDN. PDN's - in particular the CSPDN and the PSPDN - are dedicated networks which use a non ISDN/GSM PLMN numbering plan. Because of the disparity in the networks (PLMN/ISDN to PDN), calls from subscribers on one network to a subscriber on the other network need to be directed via gateways, housing Interworking Functions (IWF's). This requires the originating network to determine an unambiguous indication of the gateway/route to take, which may not be possible on the basis of the called party number alone. This constitutes a major interworking issue which has been dealt with for the ISDN/PDN case already by CCITT. Because of the affinity of the ISDN and GSM PLMN numbering plans it is therefore obvious to try to seek some commonality between the ISDN and the PLMN in the approach for routing.

Two prime routing scenarios have been considered:

- a) interworking between the PLMN and the PDN will be by means of an intermediate ISDN/PSTN e.g. the PLMN interworks to the ISDN, with the ISDN then providing the necessary interworking to the PDN;
- b) interworking directly between the PLMN and the PDN.

## 4.1 Short and long term network characteristics

In the CCITT Recommendation. I.332 the distinction is made between a short term and a long term solution for ISDN-numbering interworking with PDNs. The commencement of the long term solution is determined by the concept of Time "T". Further the directive is given, that "Between now and "T", any network or user equipment, in ISDNs, or networks intending to interwork with ISDNs, should be installed with the identified relevant post-"T" capability(ies)."

The implications on the routing requirements for pre and post-"T" are:

The post-"T" phase is mainly characterized by the:

- obligation to use the NPI/TON indication in the signalling at least at the international boundary;
- allowed exploitation of the 15 digit capability of the ISDN Number (E.164);

while the pre-"T" phase is characterized by the:

- 12 digit capability according to CCITT Recommendation. E.163;
- ESCAPE Code concept with its limited set of codes according to CCITT Recommendation. X.121;
- DNIC according to "non-zoned services" of CCITT Recommendation.X.121;
- Potential need for allocating a number from the X.121 Number Plan to a GSM PLMN subscriber in order to meet specific numbering requirements within the respective PDN;
- Potential limitations for national PDNs to examine additional digits for routing purposes.

---

## 5 General discussion of numbering related issues on routing to and from a PDN

Concerning the issue of numbering for GSM PLMN/PDN interworking, the concept of time "T" will be applied in the following. This entails distinguishing between a pre-"T" and a post-"T" phase.

### 5.1 Routing from and to a PSPDN

The interworking with the PSPDN will be provided in accordance with ETS 300 099 (see GSM 09.06).

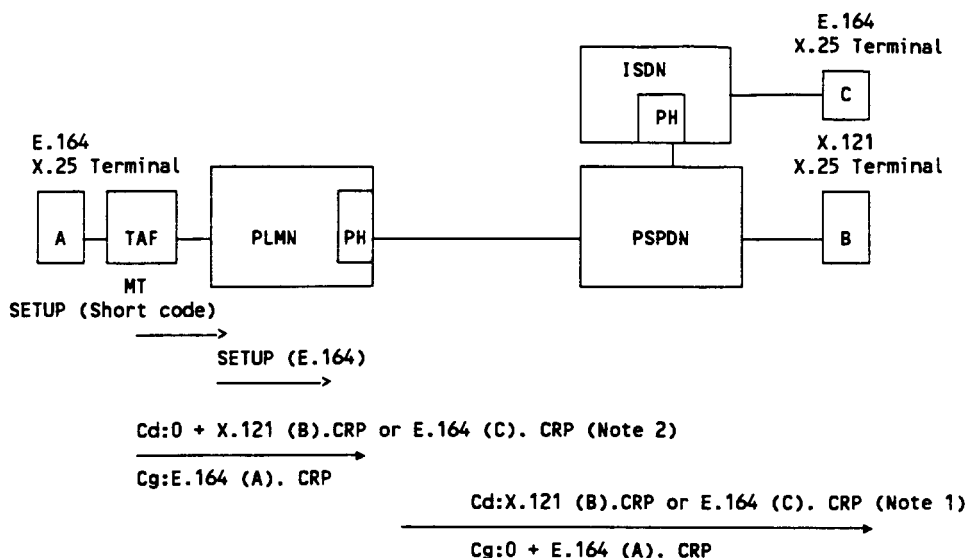
An E.164 number (provided by the user or inserted by the network) will be used to access the Packet Handler (PH). Standard PLMN procedures will be used to route to this number.

The routing from the PH to the destination DTE and from the destination DTE to the PH is based on the called address in the X.25 call packets. This information is not used in the PLMN (it is transparent and not visible to the PLMN). The presentation of this address information depends for the basic packet mode access on the accessed PH. For the dedicated GSM packet mode access an address presentation is defined in order to allow user friendly roaming.

#### 5.1.1 Mobile originated PSPDN terminated connection

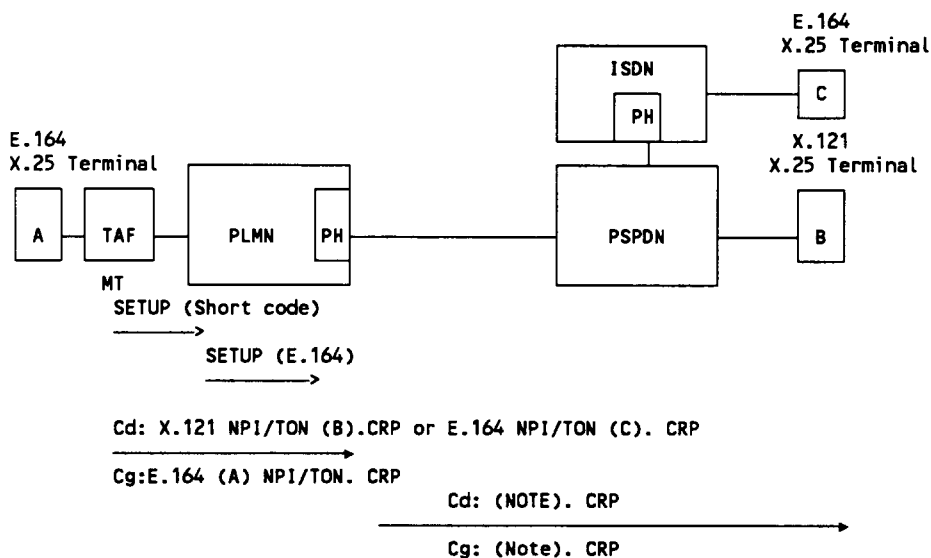
There are no specific requirements for the basic packet mode. Calls are always routed to the called address given by the user in the SETUP message. As circuit switched calls are always routed to the home PH, international addresses must be supported by the PH. The address information in the Call Request Packet (CRP) depends on the requirement of the home PH.

The routing scenarios for the dedicated packet mode are given in figures 03.70/1 and 03.70/2.



NOTE 1: The PH is required to remove and insert ESCAPE code digit(s) as appropriate.  
 NOTE 2: The PLMN customer may be able to utilize a variety of services offered by the PSPDN by dialling an E.164 number. In some situations the E.164 may mean (9/0 + X.121) number.

**Figure 03.70/1: Numbering Plan Interworking PLMN to PSPDN for Dedicated Packet Mode Services, Use of ESCAPE Code**



NOTE: A specific PSPDN or ISDN may use NPI/TON or ESCAPE Code as required.

**Figure 03.70/2: Numbering Plan Interworking PLMN to PSPDN for Dedicated Packet Mode Services, Use of NPI/TON indication**

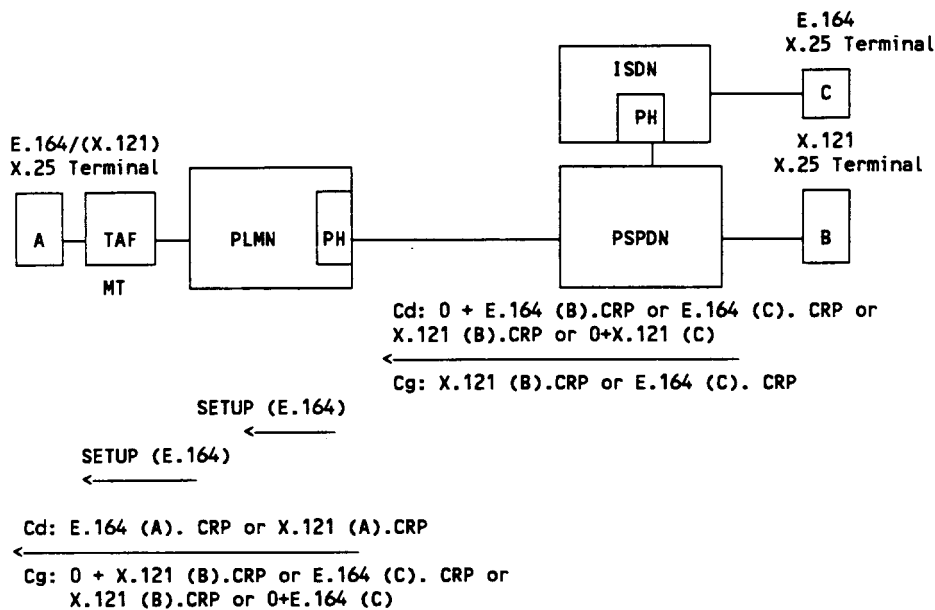
### 5.1.2 PSPDN/ISDN originated Mobile terminated connection

Only the Basic Packet Mode supports mobile terminated connections.

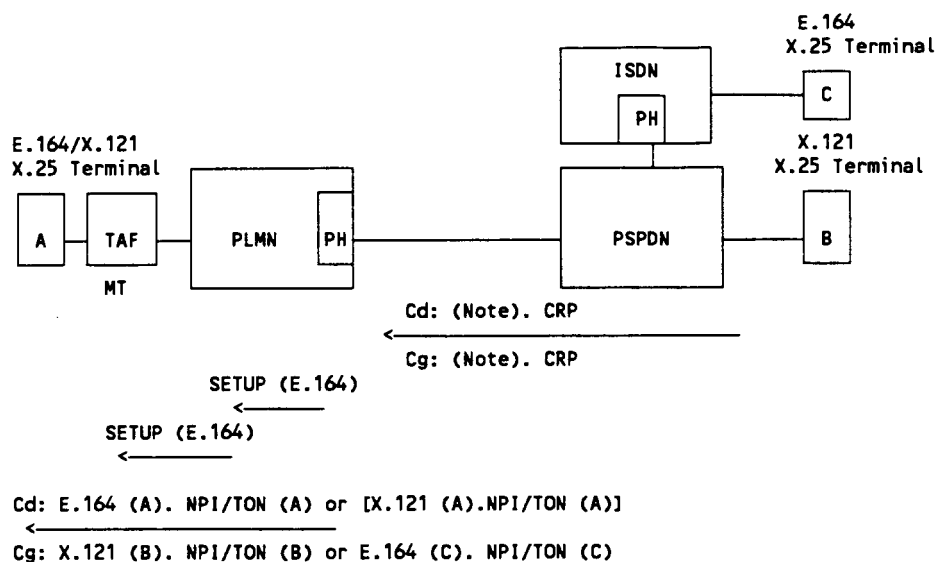
The call is routed in the PSPDN according to the called address (E.164 or optionally X.121). The PH sets up a circuit switched connection to the MS if it does not already exist. For this call the E.164 of the MS is used (either available from the calling user or translated in the PH from the X.121 number).

The addresses in the X.25 call packets (invisible to PLMN) is as required by the home PH. An example is given in figures 03.70/3 and 03.70/4.





**Figure 03.70/3: Example of Numbering Plan Interworking PSPDN to PLMN for Basic Packet Mode Services, Use of ESCAPE Code**



NOTE: A specific PSPDN or ISDN may use NPI/TON or ESCAPE Code as required.

**Figure 03.70/4: Example of Numbering Plan Interworking PSPDN to PLMN for Basic Packet Mode Services, Use of NPI/TON indication**

## 5.2 Routing from and to other PDNs

### 5.2.1 Mobile originated PDN terminated connection

As a general case in establishing a connection from the PLMN to the PDN, routing will be possible by either direct means or via the ISDN/PSTN. The PLMN will be able to determine that a connection needs to be established to a PDN by analysis of the called number in conjunction with either:

- an ESCAPE code; or
- NPI/TON indication or equivalent in the call set up message.

### 5.2.1.1 Use of ESCAPE Code

Within the framework of existing types of PDNs the use of an ESCAPE code will be constrained by the need to define an unique value to it. Additionally interworking may be necessary both to the ISDN/PSTN - to generate nationally used PREFIX code - and for direct connections to remove the ESCAPE code.

The structure of the called and calling number applicable to the individual connection elements in case of mobile originated PDN terminated connections following the ESCAPE code approach is shown in figure 03.70/5.

Interworking through ISDN.

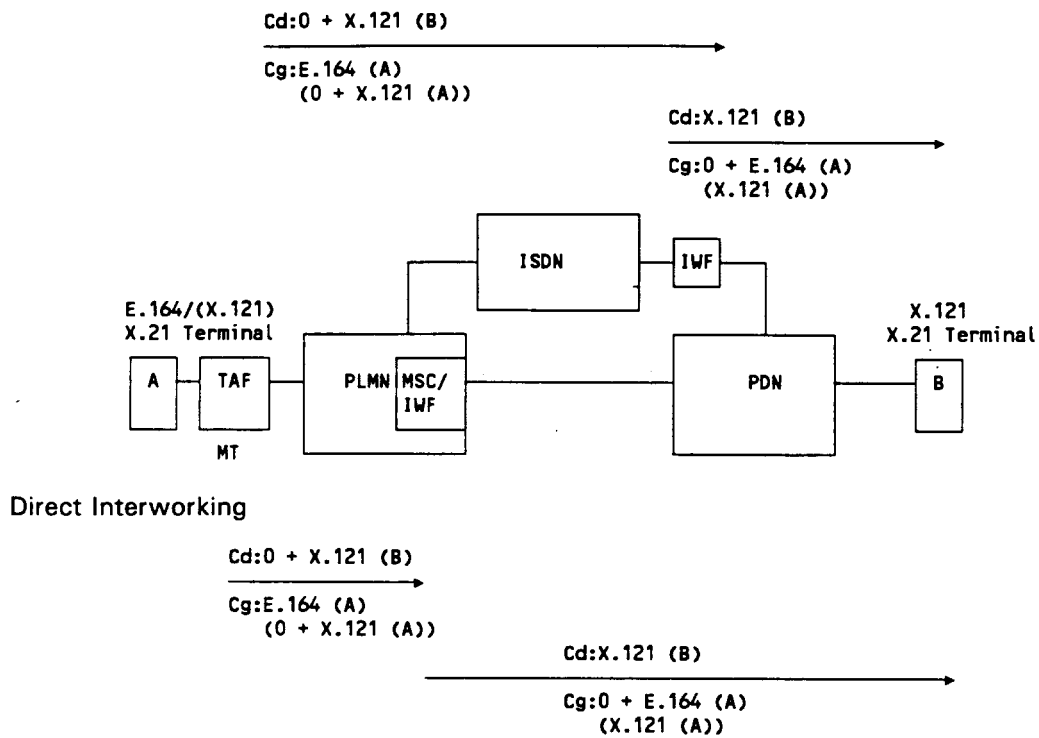
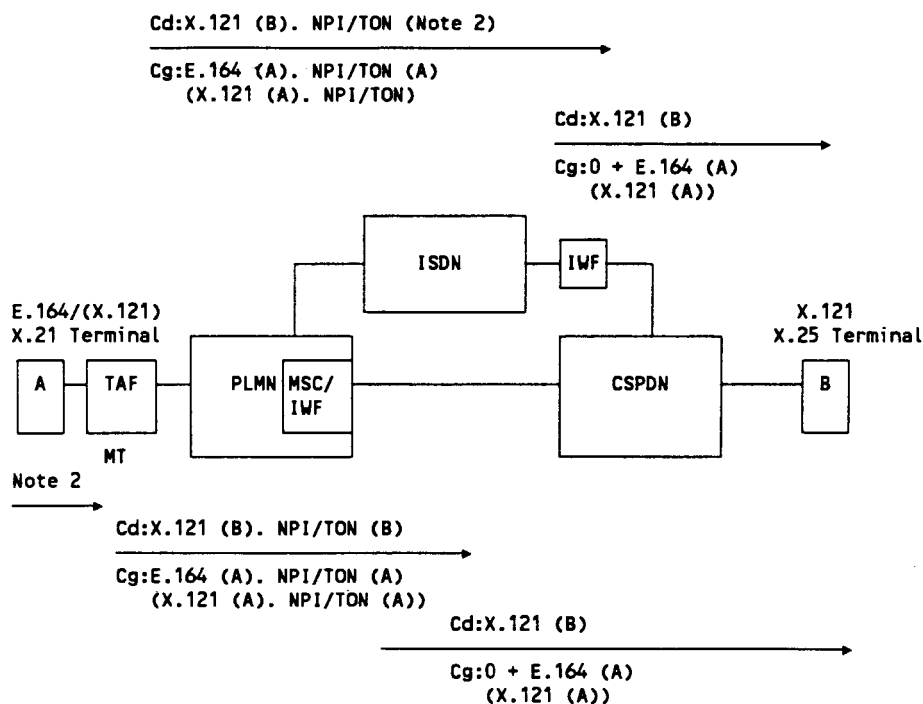


Figure 03.70/5: Numbering Plan Interworking PLMN to PDN, Use of ESCAPE Code

### 5.2.1.2 Use of NPI/TON indication

The use of NPI/TON has no constraints for either direct or via ISDN interworking. Figure 03.70/6 shows the CSPDN case. It should be noted that the procedures at the Man Machine Interface (MMI) are not yet defined.



NOTE 1: It is understood that the signalling protocol mapping function implemented in TAF will support NPI/TON as defined in GSM 04.08.

NOTE 2: TAF provides mapping from X.21/X.21bis protocol to D-channel protocol.

**Figure 03.70/6: Numbering Plan interworking PLMN to CSPDN for Circuit Switched Data Services (Short-Term and Long-Term)**

## 5.2.2 PDN originated mobile terminated connection

In the case of establishing a connection from the PDN to PLMN the routing possibilities are constrained by the capabilities of the originating PDN some of which have been already listed under subclause 4.1 for the pre-"T" phase. The various options are described below.

### 5.2.2.1 Pre T Phase Case

The following is a list of possible options which provide for interworking between the PDN and the PLMN. This list places no constraints on the mobile network operator as to which option should be provided. The choice will largely depend upon the capabilities of the national PDN/ISDN.

5.2.2.1.1 Interworking via the ISDN, MS has E.164 number, PDN supports ESCAPE code concept

All the calls from the individual PDN to the PLMN are routed via the ISDN. In this case the Mobile Station terminal has an E.164 number only, which is the directory number of the MS and is applicable to the respective Bearer Service as described in GSM 09.07 subclause 9.2.2.

The PDN works on E.164 numbers on the basis of the CCITT defined concept of ESCAPE CODES by analysing up to the four first digits for routeing. The PDN on identifying the ISDN ESCAPE code routes the call to the ISDN. The ISDN routes then to the PLMN on the basis of the requested E.164 number.

This procedure is fully in harmony with the CCITT defined ISDN/PDN interworking, constituting therefore a solution commonly applicable to all PDNs and leaving the ISDN/PLMN free from any burden due to routeing on and administration of X.121 numbers for incoming calls.

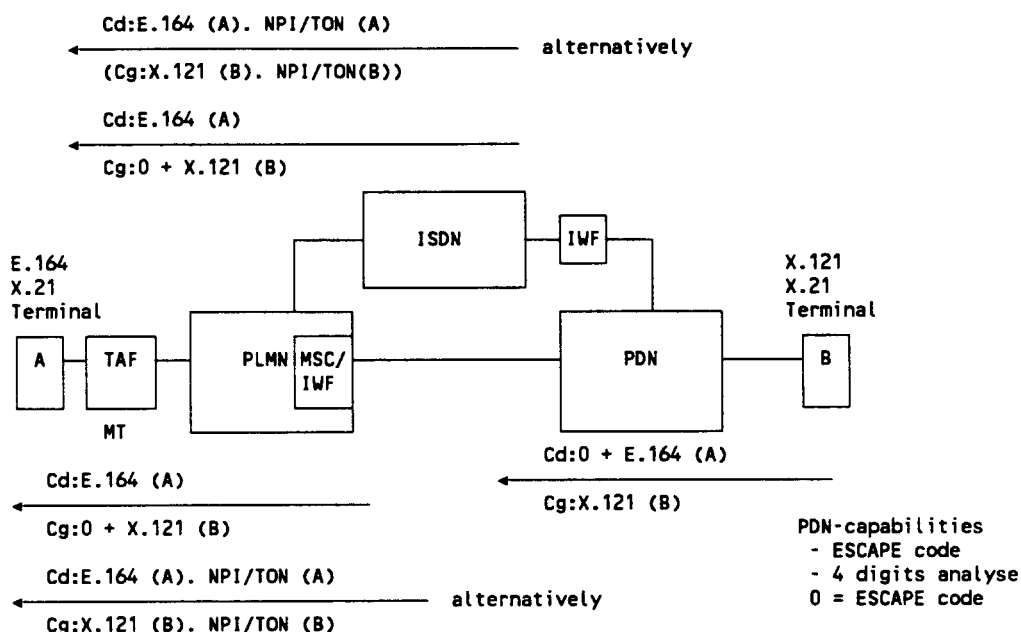


Figure 03.70/7: Interworking PDN-ISDN-PLMN (PDN 4 digits analysis)

5.2.2.1.2 Interworking between PLMN and PDN via ISDN, MS has X.121 number, PDN supports non-zoned service concept

All calls from the individual PDN to the PLMN are routed via the ISDN. In this case the ISDN/PLMN may use NPI/TON for signalling.

The MS terminal has an X.121 number in addition to the E.164 directory number of the MS, which is applicable to the respective Bearer Service on the same way as described in GSM 09.07 subclause 9.2.2.

The PDN is capable of dealing with, and the organization of the PDNs in the individual country allows for a dedicated DNIC for the ISDN identifier e.g. as a "non-zoned service", in conformance with CCITT and routes all calls on that basis to the ISDN. The ISDN has to provide the necessary function for converting the X.121 number into the required E.164 number suitable for routing use within the ISDN and the PLMN.

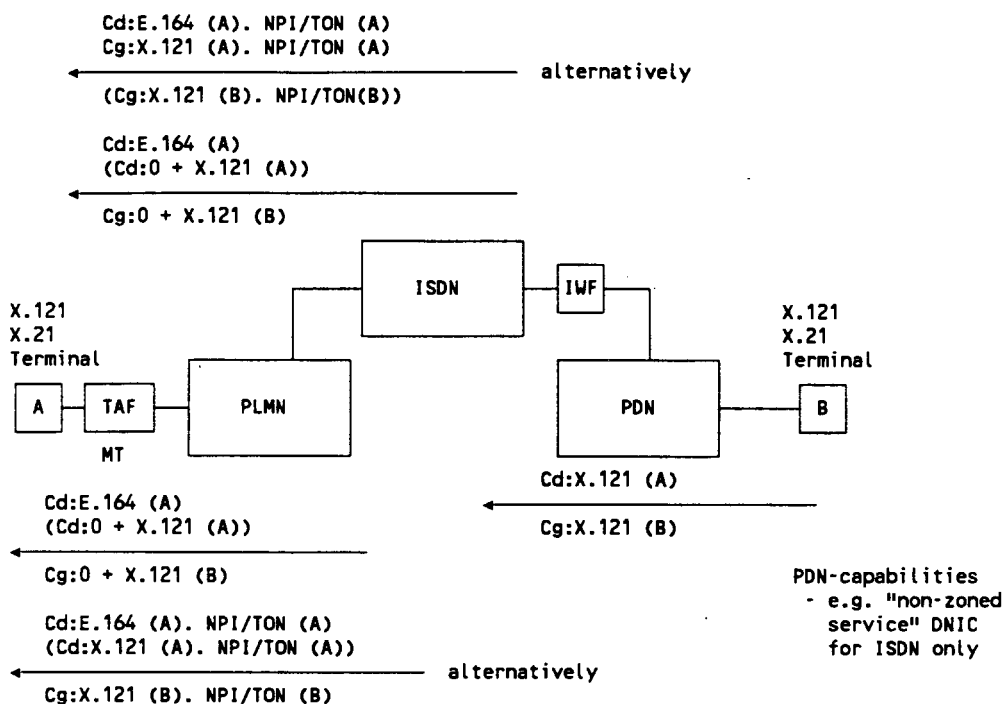


Figure 03.70/8: Interworking PDN-ISDN-PLMN (PDN "ISDN non-zoned service DNIC")

5.2.2.1.3 Interworking directly from PDN to PLMN, MS has E.164 number, PDN supports ESCAPE code and additional number analysing capabilities

All calls from the individual PDN to the PLMN are routed directly to the PLMN via the MSC/IWF. The MS of the PLMN has an E.164 number. The PDN works on E.164 numbers on the basis of the CCITT defined concept of ESCAPE codes. In this case the PLMN may use NPI/TON for signalling.

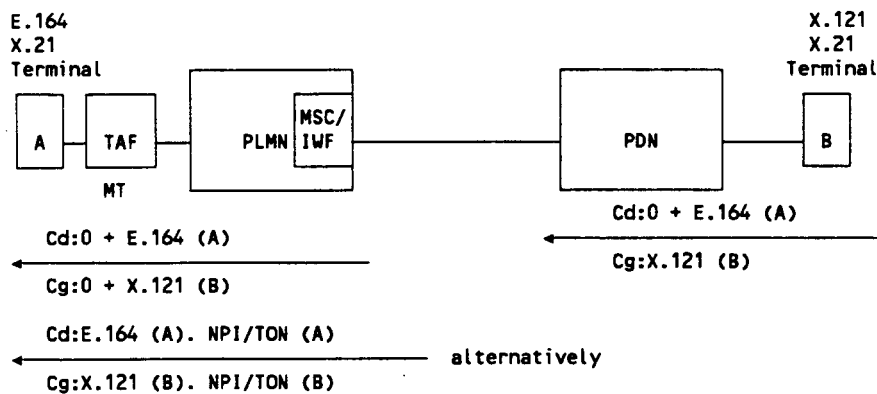


Figure 03.70/9: Direct-Interworking PDN-PLMN

5.2.2.1.4 Interworking directly from PDN to PLMN, MS has X.121 number, PDN supports non-zoned service concept

All calls from the individual PDN to the PLMN are routed directly to the PLMN via the MSC/IWF.

The PLMN's MS terminal has an X.121 number in addition to the MS's E.164 one, which is applicable to the respective Bearer Service in the same way as described in GSM 09.07.

The PDN is capable of dealing with, and the organization of the PDN in the individual country allows for, a dedicated DNIC for the PLMN e.g. as a "non-zoned service" in conformance with CCIT. This routes all PLMN destined calls identified by that DNIC directly to the PLMN via the MSC/IWF.

The PLMN (MSC/IWF) has to provide the necessary functions for converting the X.121 number into required E.164 number suitable for routing use within the PLMN:

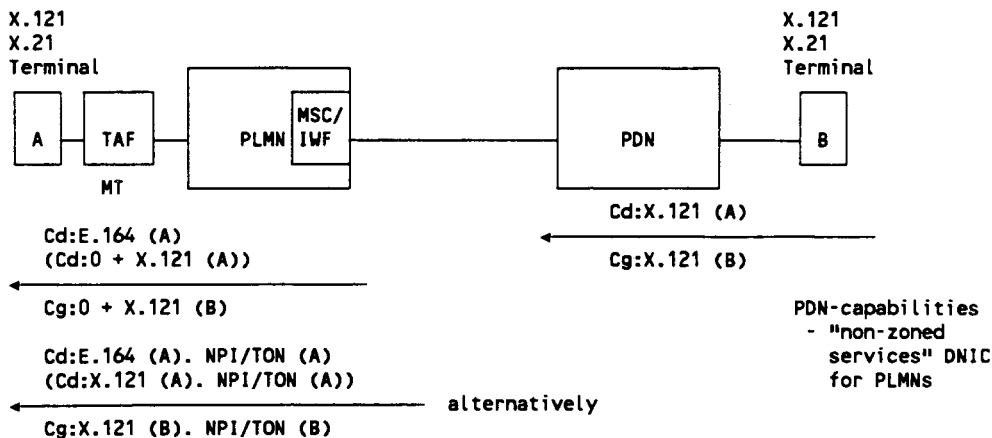


Figure 03.70/10: Direct Interworking PDN-PLMN (PDN "non-zoned services" DNIC for PLMNs)

5.2.2.2 Post-T Phase Case

The transition to this phase enforces at least at the international boundary the use of the NPI/TON for signalling in case of interworking with ISDN and allows the exploitation of the 15 digits capability of the ISDN number. Networks not following this procedure must not burden those which do follow it. This removes any limitation on number plan identification capacity.

5.2.2.2.1 Interworking between PLMN and PDN via ISDN, MS has E.164 number, PDN supports NPI/TON capability.

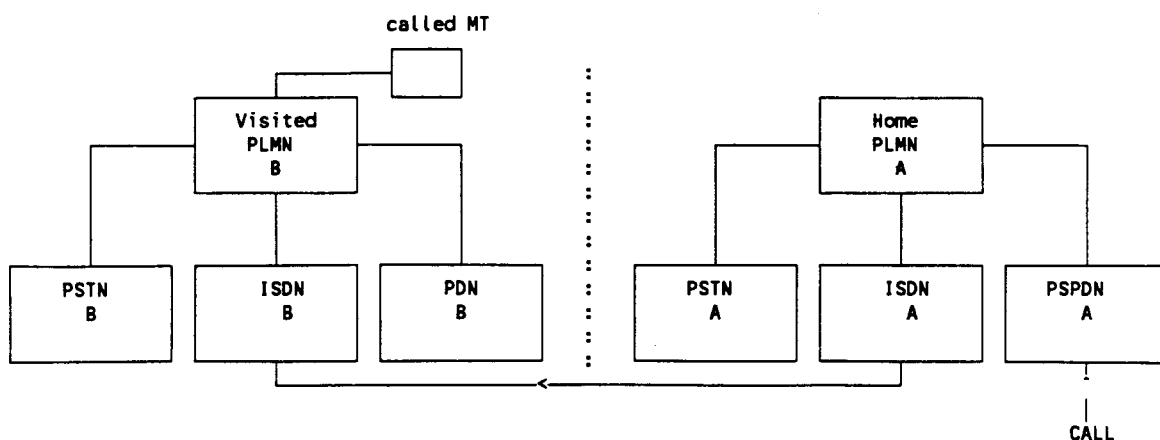
PDN routes calls to the ISDN on the basis of the NPI/TON indication and E.164 number. The ISDN IWF will route the connection to the PLMN on the basis of the E.164 number indicated.

# 6 Routeing scenarios to cater for roaming mobiles for PDN originated calls

## 6.1 Routeing scenarios to cater for roaming mobiles for PSPDN originated calls

Mobile terminated calls are currently only possible for the Basic Packet Mode Access (see GSM 09.06). The call is always routed to the Home PSPDN and from there to the Home PLMN. Only the Home PLMN has access to the HLR. The HLR provides the information about the location of the called user. The Home PLMN establishes then a circuit switched connection to the user on the VPLMN. Details are given in the following sections.

### 6.1.1 Basic Packet Mode Access; PH is part of PLMN/PSPDN



Terminals with E.164 numbers:

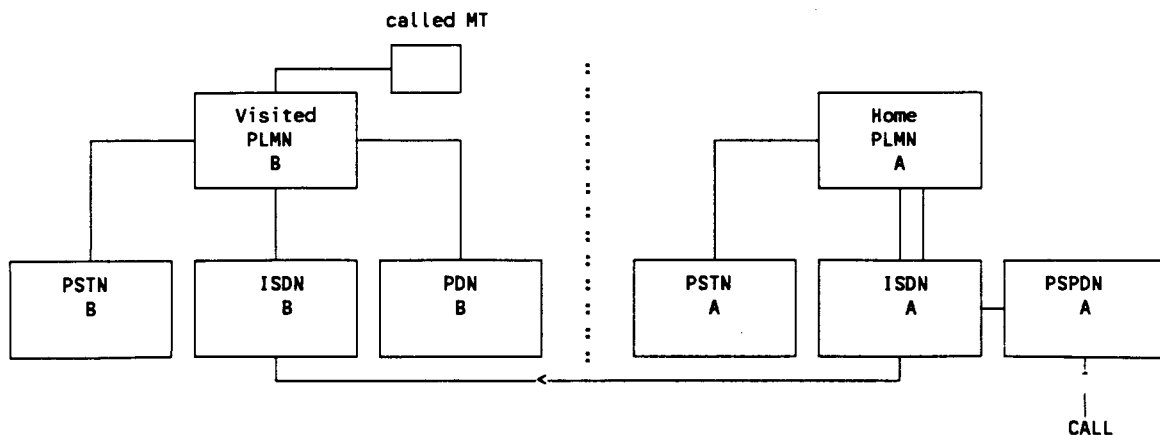
Routeing:

PSPDN A to Home PLMN A to ISDN A to ISDN B to Visited PLMN B to the called user

Terminals with X.121 Numbers:

Routeing as above for E.164 numbers. Calls are routed on the X.121 number in the PSPDN. The PH translates the X.121 number into an E.164 number. This E.164 number is used to establish a circuit switched connection from the PH to the called user. X.121 numbers may then be used in X.25 call packets. This is transparent to the PLMN.

### 6.1.2 Basic Packet Mode Access; PH is part of ISDN/PSPDN



Terminals with E.164 numbers

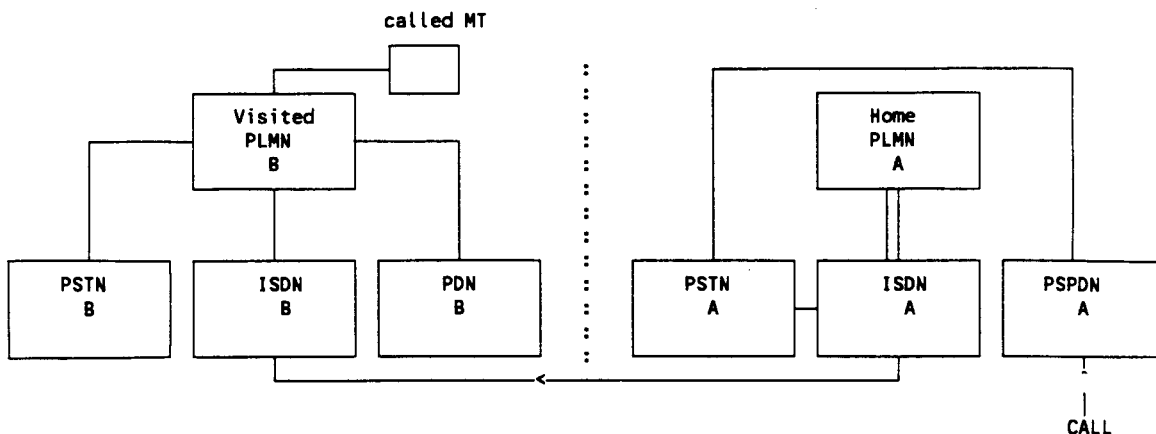
Routeing:

PSPDN A to ISDN A to Home PLMN A to ISDN A to ISDN B to Visited PLMN B to the called user

Terminals with X.121 Numbers

Routeing as above for E.164 numbers. Calls are routed on the X.121 number in the PSPDN. The PH translates the X.121 number into an E.164 number. This E.164 number is used to establish a circuit switched connection from the PH to the called user. X.121 numbers may then be used in X.25 call packets. This is transparent to the PLMN.

### 6.1.3 Basic Packet Mode Access; X.32 dial port (modem in PSPDN)



Terminals with E.164 numbers

Routeing:

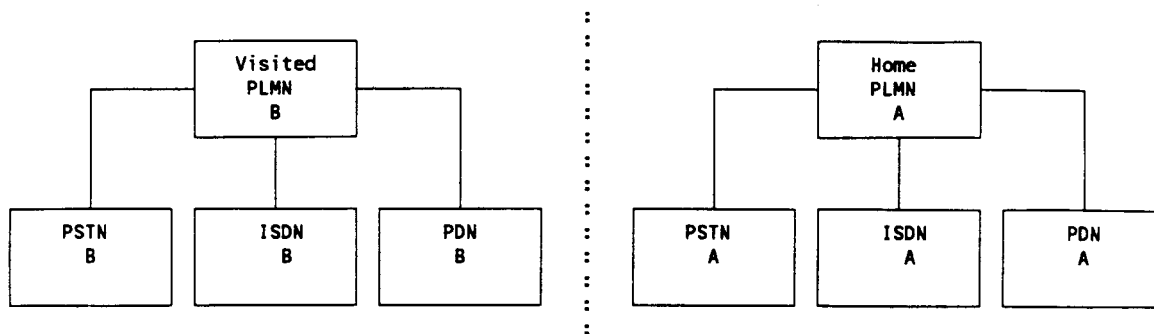
PSPDN A to PSTN A to ISDN A to Home PLMN A to ISDN A to ISDN B to Visited PLMN B to the called user

Terminals with X.121 Numbers

Routeing as above for E.164 numbers. Calls are routed on the X.121 number in the PSPDN. The PSPDN translates the X.121 number into an E.164 number. This E.164 number is used to establish a circuit switched connection from the PSPDN to the called user. X.121 numbers may then be used in X.25 call packets. This is transparent to the PLMN.



## 6.2 Scenarios to cater for interworking with other PDNs



Assuming the NPI/TON information exists, or the use of the ESCAPE code 0.

Assuming the NPI/TON information exists, or the use of the ESCAPE code 0.

Terminals with E.164 numbers

Routeing Options recognized:

- 1) PDN A to ISDN B
- 2) ISDN A to ISDN B
- 3) ISDN A to PDN A to PDN B
- 4) ISDN A to PDN A to PDN B to ISDN B
- 5) PDN A to PDN B to ISDN B

There is no way to ensure which route will be used, except if the PLMNs agree bilaterally which is the primary or preferred route.

Terminals with X.121 Numbers

Routeing options as above for E.164 numbers.

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## Annex A (informative): Change Request History

<b>Change history</b>					
<b>SMG No.</b>	<b>TDoc. No.</b>	<b>CR. No.</b>	<b>Section affected</b>	<b>New version</b>	<b>Subject/Comments</b>
SMG#08				4.0.3	ETSI Publication
SMG#20				5.0.0	Release 1996 version
SMG#27				6.0.0	Release 1997 version
SMG#29				7.0.0	Release 1998 version

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# History

<b>Document history</b>		
V7.0.0	August 1999	Publication