RELEASE NOTE

Recommendation GSM 03.70

Routing of Calls to/from PDNs

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1. Reason for changes

No changes since the previously distributed version.

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Technical

Specification

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Version 3.0.0

European digital cellular telecommunication system (phase 1);

Routing of Calls to/from PDNs

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1. SCOPE

This recommendation 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.

2. 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 i.e. 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.

2.1. Short and long term network characteristics

In the CCITT Rec. 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 new 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 date for "T" has been set to the 31.12.1996.

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

The post-"T" phase is mainly characterised 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 characterised by the

- 12 digit capability according to CCITT Rec. E.163

- ESCAPE Code concept with its limited set of codes according to CCITT Rec. X.121

- DNIC according to "non-zoned services" of CCITT Rec. 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 PDN to examine additional digits for routing purposes.

3. REFERENCES

CCITT Rec. I.332: Numbering Principles for interworking between ISDNs and Dedicated Networks with different Numbering Plans

CCITT Rec. X.110: International Routing Principles and Routing Plan for Public Data Networks

CCITT Rec. X.121: International Numbering Plan for Public Data Networks

CCITT Rec. 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

CCITT Rec. E.164: Numbering Plan for the ISDN Era

CCITT Rec. E.166: Numbering Plan Interworking in the ISDN Era

CCITT Rec. E.213: Telephone and ISDN Numbering Plan for Land Mobile Stations in Public Land Mobile Networks (PLMN)

GSM Rec. 03.03: Numbering, Addressing and Identification

GSM Rec. 09.04: Interworking with CSPDN

GSM Rec. 09.05: Interworking between the PLMN and the PSPDN for PAD Access

GSM Rec. 09.06: Interworking with PSPDN sync.

GSM Rec. 09.07: General Requirements on Interworking between the PLMN and the ISDN or PSTN

4. DEFINITIONS

Concept of time "T"   A definite date decided by CCITT SG II, to ensure that the full capabilities of the E.164 are in place by that time (set to 31.12.1996).

NPI/TON   Numbering Plan Identifier and Type of Number.

MMI   Man Machine Interface

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. 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. 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 in the call request packet or

- NPI/TON indication or equivalent in the call set up message.

5.1.1. Use of ESCAPE code

Within the framework of existing types of PDN's the use of an ESCAPE code will be constrained by the need to define a unique value to it. Additionally interworking may be necessary both to the ISDN - 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 03.70/1. Further aspects peculiar to this solution are highlighted in a number of notes to this figure.
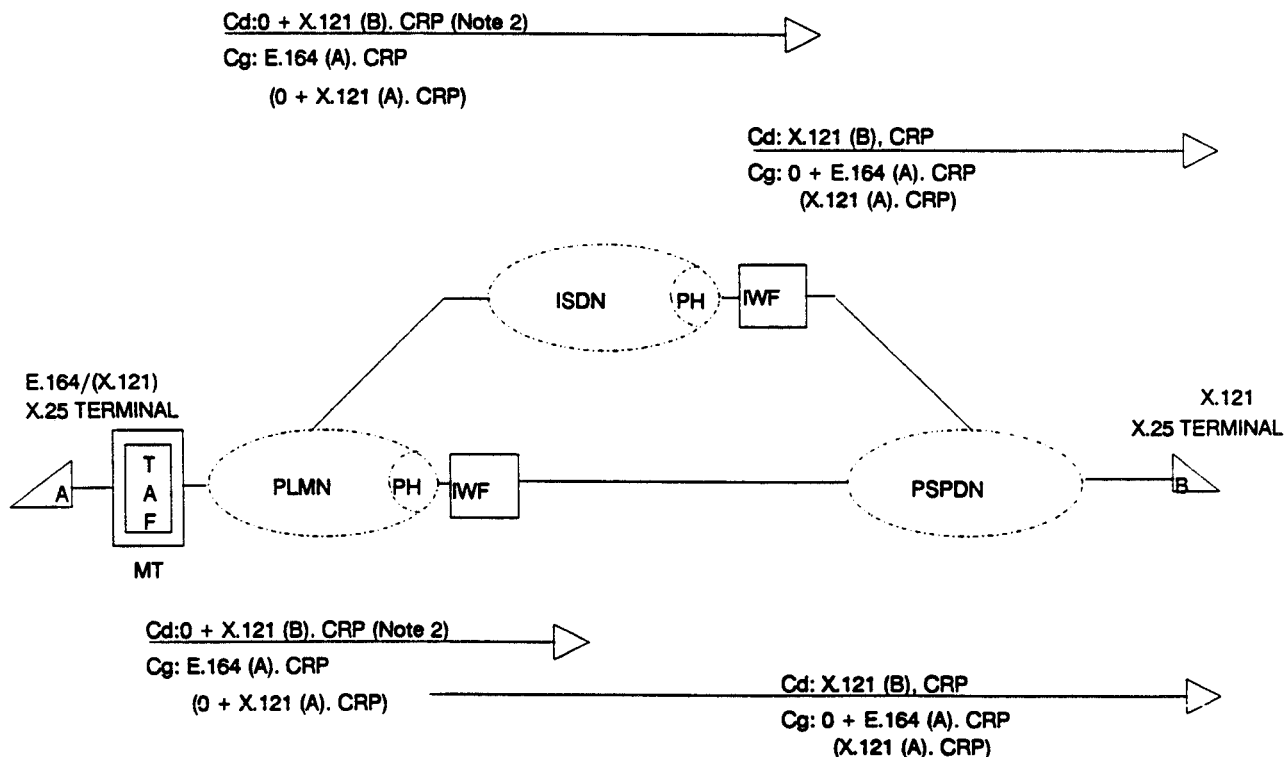
Note 1:   The PH is required to remove and insert ESCAPE code digit(s) as appropriate.

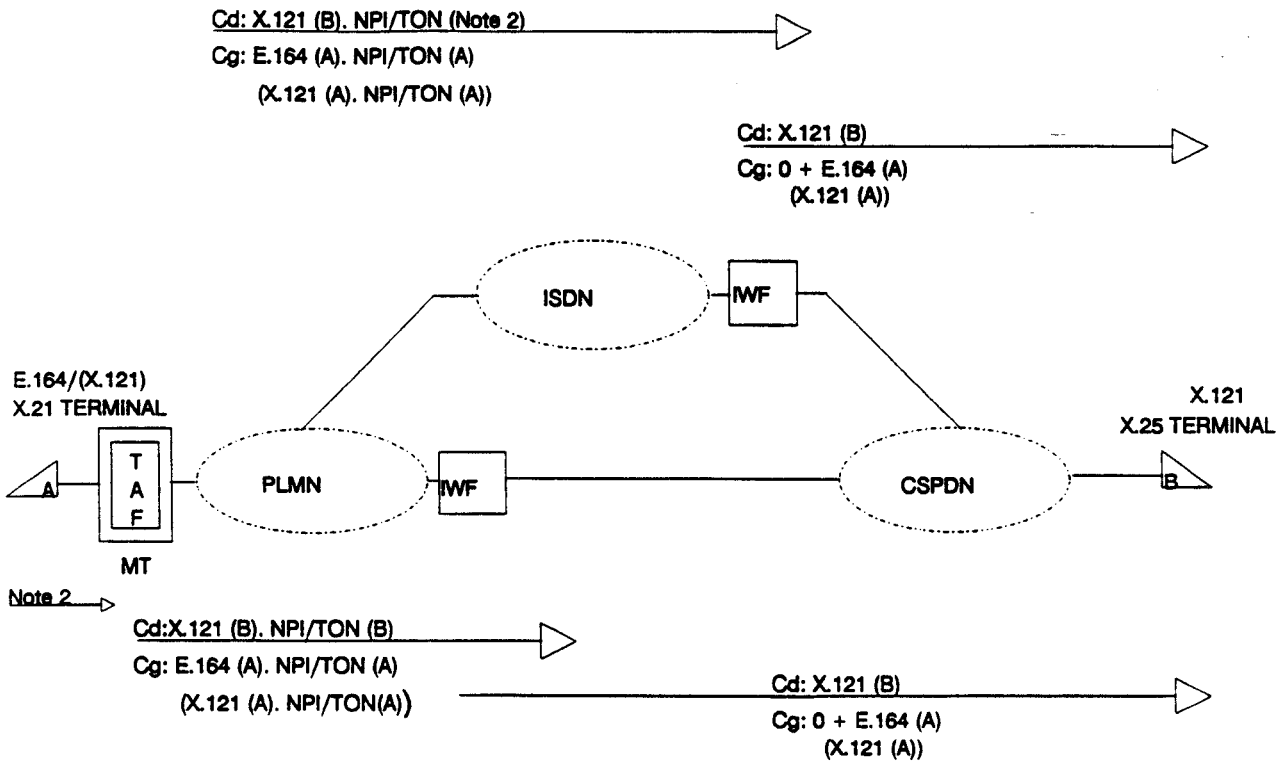Note 2:   Different prefix digit(s) which represent the same functionality as the internationally agreed ESCAPE code (digit 0) may be used. Translation from prefix to ESCAPE code "0" must be performed by the originating network (PH) prior to advancing the call. The choice of the prefix digit(s) is a national matter.

Note 3:   X.25 CRP will carry the E.164 (A) address.

Note 4:   Under some implementations (refer to revised Recommendation X.121) ESCAPE code digit 9 may also be used.

Note 5:   The PLMN customer may be able to utilise a variety of services offered by the PSPDN by dialling an X.121 number. In some situations the X.121 may mean 9/0 + E.164 number.

Cd	Called Number
Cg	Calling Number
IWF	Interworking Function
PH	Packet Handler
MT	Mobile Termination
NPI/TON	Numbering Plan Identifier/Type of Number as defined in GSM 04.08
TAF	Terminal Adapter Function
CRP	Call Request Packet in CCITT Rec. X.25

Figure 03.70/1

Numbering Plan Interworking PLMN to PSPDN for Packet Data Services, Use of ESCAPE Code

5.1.2. Use of NPI/TON indication

The use of NPI/TON has no constraints for either direct or via ISDN interworking. However, CSPDN and PSPDN will require a different representation of the called and calling number in case of using NPI/TON in PLMN. Figure 03.70/2 shows the CSPDN case, while the PSPDN case is depicted in Figures 03.70/3 and /4. It should be noted that the procedures at the Man Machine Interface (MMI) are not yet defined.

Cd: X.121 (B). NPI/TON (Note 2)

Cg: E.164 (A). NPI/TON (A)

    (X.121 (A). NPI/TON (A))

Cd: X.121 (B)

Cg: 0 + E.164 (A)

    (X.121 (A))

E.164/(X.121)
X.21 TERMINAL

A

T
A
F

MT

ISDN — IWF

PLMN — IWF

CSPDN

X.121
X.25 TERMINAL

B

Note 2

Cd:X.121 (B). NPI/TON (B)

Cg: E.164 (A). NPI/TON (A)

    (X.121 (A). NPI/TON(A))

Cd: X.121 (B)

Cg: 0 + E.164 (A)

    (X.121 (A))

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.21 bis protocol to D-channel protocol.

Figure 03.70/2

Numbering Plan interworking PLMN to CSPDN for Circuit Switched Data Services (Short-Term and Long-Term)

Cd: X.121 (B). NPI/TON (B)

Cg: E.164 (A). NPI/TON (A)

    (X.121 (A). NPI/TON (A))

Cd: X.121 (B), CRP

Cg: 0 + E.164 (A), CRP

    (X.121 (A)CRP)

E.164/(X.121)
X.21 TERMINAL

A

T
A
F

MT

ISDN \PH — IWF

PLMN \PH — IWF

PSPDN

X.121
X.25 TERMINAL

B

Cd:X.121 (B). NPI/TON (B)

Cg: E.164 (A). NPI/TON (A)

    (X.121 (A). NPI/TON(A))

Cd: X.121 (B), CRP

Cg: 0 + E.164 (A),CRP

    (X.121 (A), CRP)

FIGURE 03.70/3

Numbering Plan Interworking PLMN to PSPDN for Packet Data Services, use of NPI/TON Indication or Equivalent in the PLMN/ISDN, ESCAPE Code in PSPDN.

Cd: X.121 (B). NPI/TON (B)

Cg: E.164 (A). NPI/TON (A)

(X.121 (A). NPI/TON (A))

Cd: X.121 (B). NPI/TON (B)

Cg: E.164 (A). NPI/TON (A)
(X.121 (A). NPI/TON (A))

ISDN PH IWF

E.164/(X.121)
X.25 TERMINAL

X.121
X.25 TERMINAL

T
A
F

PLMN PH IWF

PSPDN

A

B

MT

Cd:X.121 (B). NPI/TON (B)

Cg: E.164 (A). NPI/TON (A)
(X.121 (A). NPI/TON(A))

Cd: X.121 (B). NPI/TON (B)
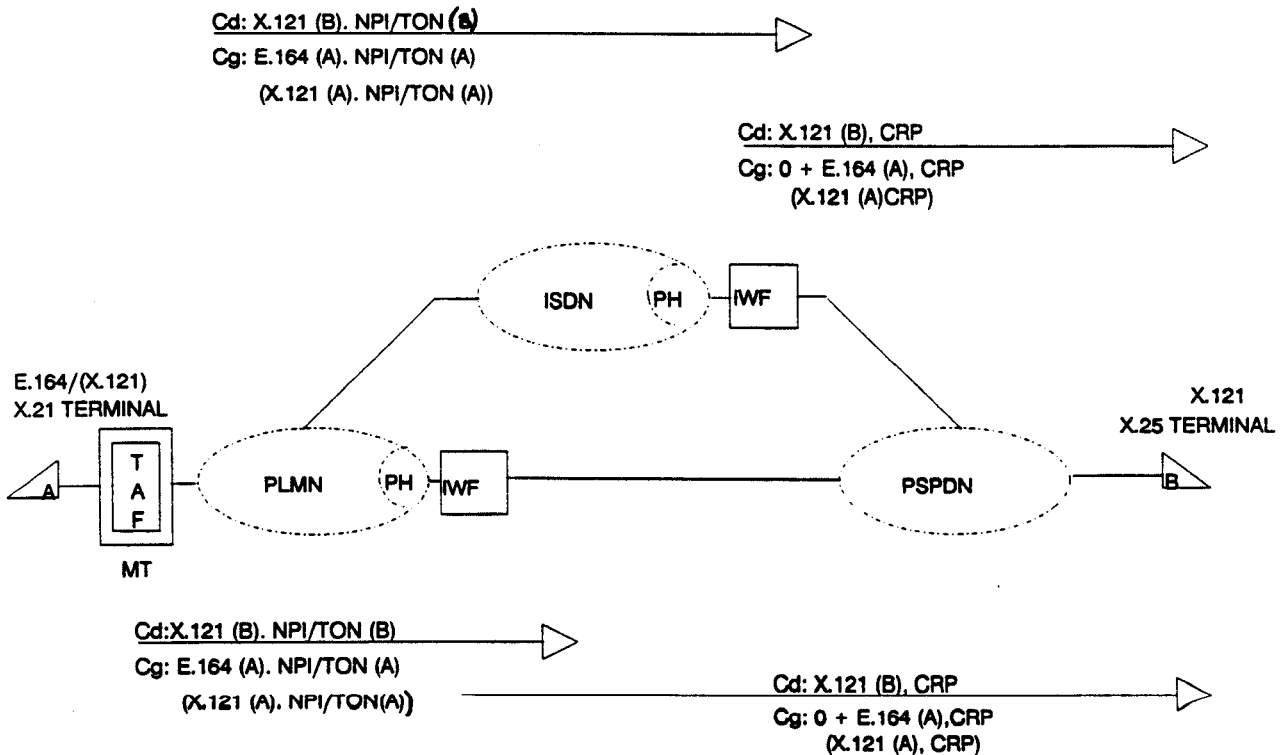
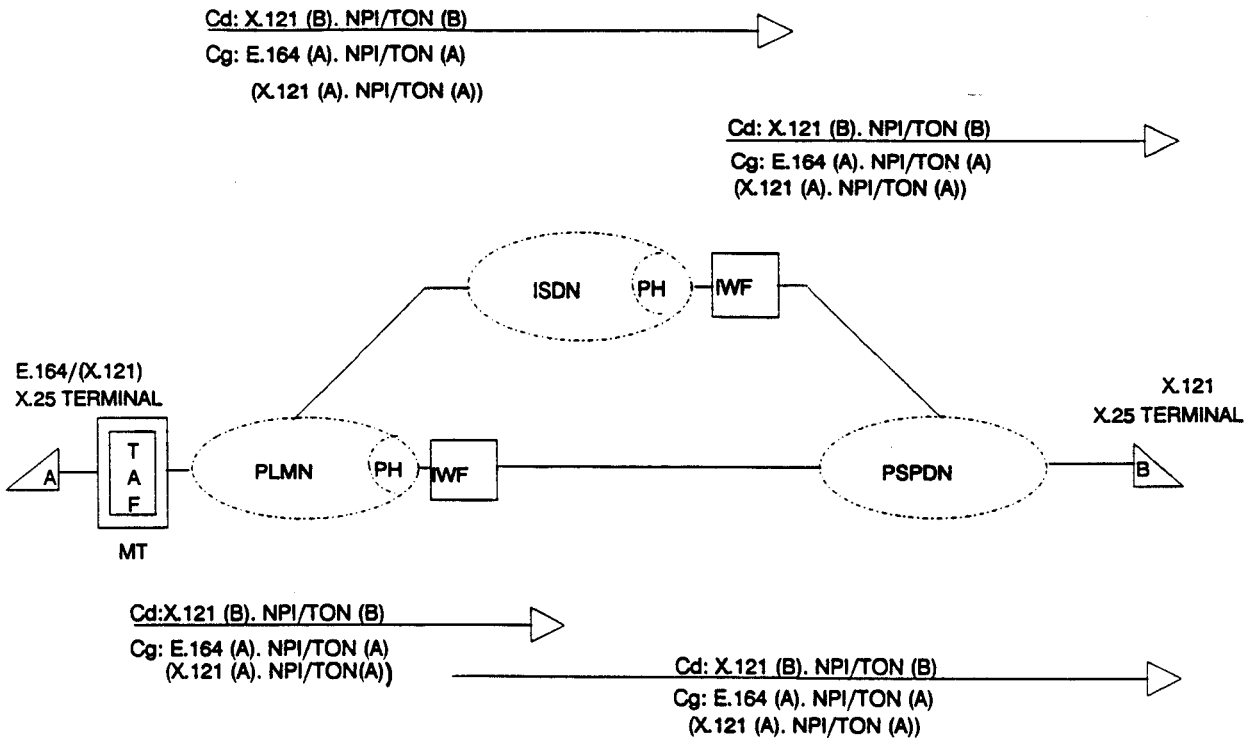Cg: E.164 (A). NPI/TON (A)
(X.121 (A). NPI/TON (A))

FIGURE 03.70/4

Numbering Plan Interworking PLMN to PSPDN for Packet Data Services, use of NPI/TON Indication or Equivalent in the PLMN/ISDN, NPI/TON or Equivalent in PSPDN.

5.2. PDN originated mobile terminated connection

In the case of establishing a connection from the PDN to the PLMN the routing possibilities are constrained by the capabilities of the originating PDN some of which have been already listed under para.2.1 for the pre-"T" phase. By analysis of the various options, routing options are described below.
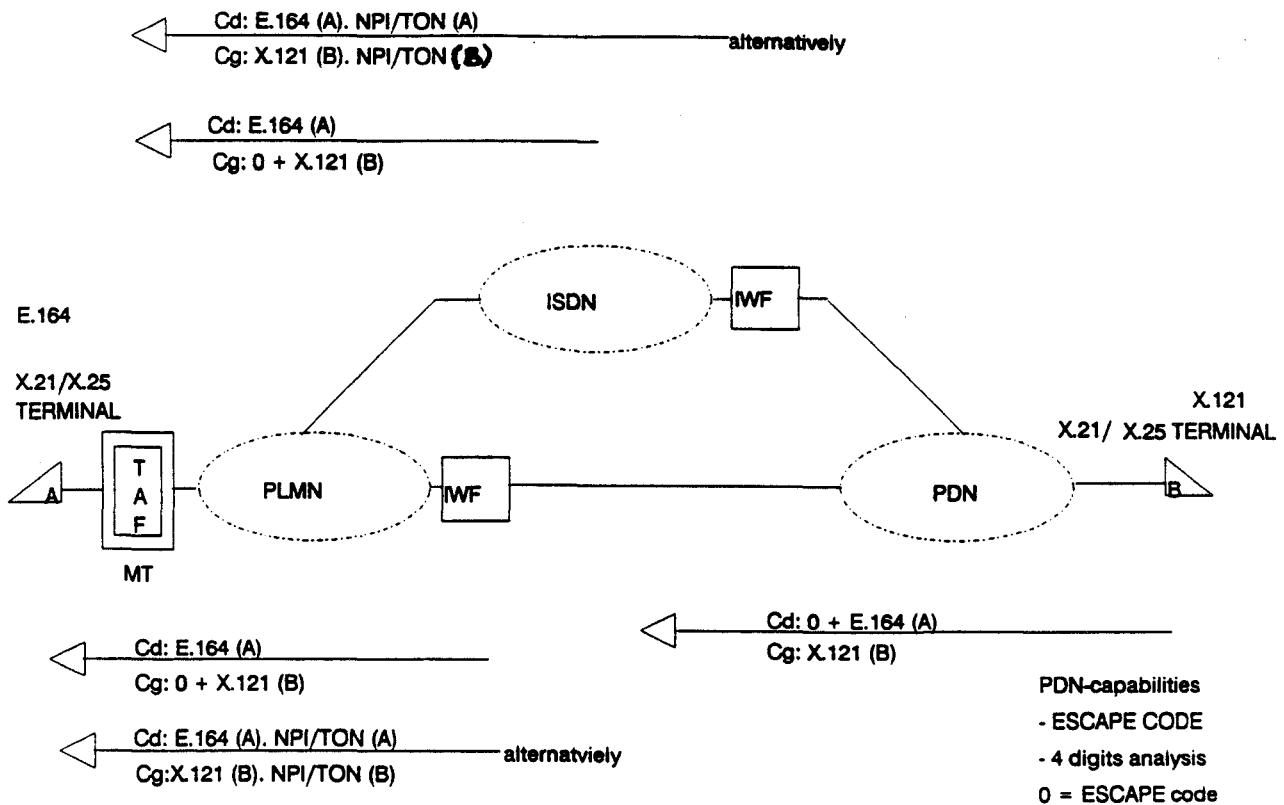
5.2.1. Pre "T" Phase case

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

5.2.1.1. Interworking via the ISDN, MS has E.164 terminal 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 Rec. 09.07 para. 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 routing. The PDN on identifying the ISDN ESCAPE code routes the call to the ISDN whose IWF handles the connection which is routed through the ISDN 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 routing on and administration of X.121 numbers for incoming calls.

Cd: E.164 (A). NPI/TON (A)

Cg: X.121 (B). NPI/TON **(B)**　　　　　alternatively

Cd: E.164 (A)

Cg: 0 + X.121 (B)

E.164

X.21/X.25
TERMINAL

```
        ....ISDN....──IWF
      /                    \
  ┌─────┐                    X.121
  │  T  │                    X.21/ X.25 TERMINAL
◄─│  A  │──..PLMN..──IWF──..PDN..──►B
  │  F  │                         
  └─────┘
    MT
```

Cd: 0 + E.164 (A)

Cg: X.121 (B)

Cd: E.164 (A)

Cg: 0 + X.121 (B)

PDN-capabilities

- ESCAPE CODE

Cd: E.164 (A). NPI/TON (A)　　　alternatviely

Cg:X.121 (B). NPI/TON (B)

- 4 digits analysis

0 = ESCAPE code

Note: Commoning of the figure for both CSPDN and PSPDN entailed the omission of the PH and the reference to the CRP in case of PSPDN
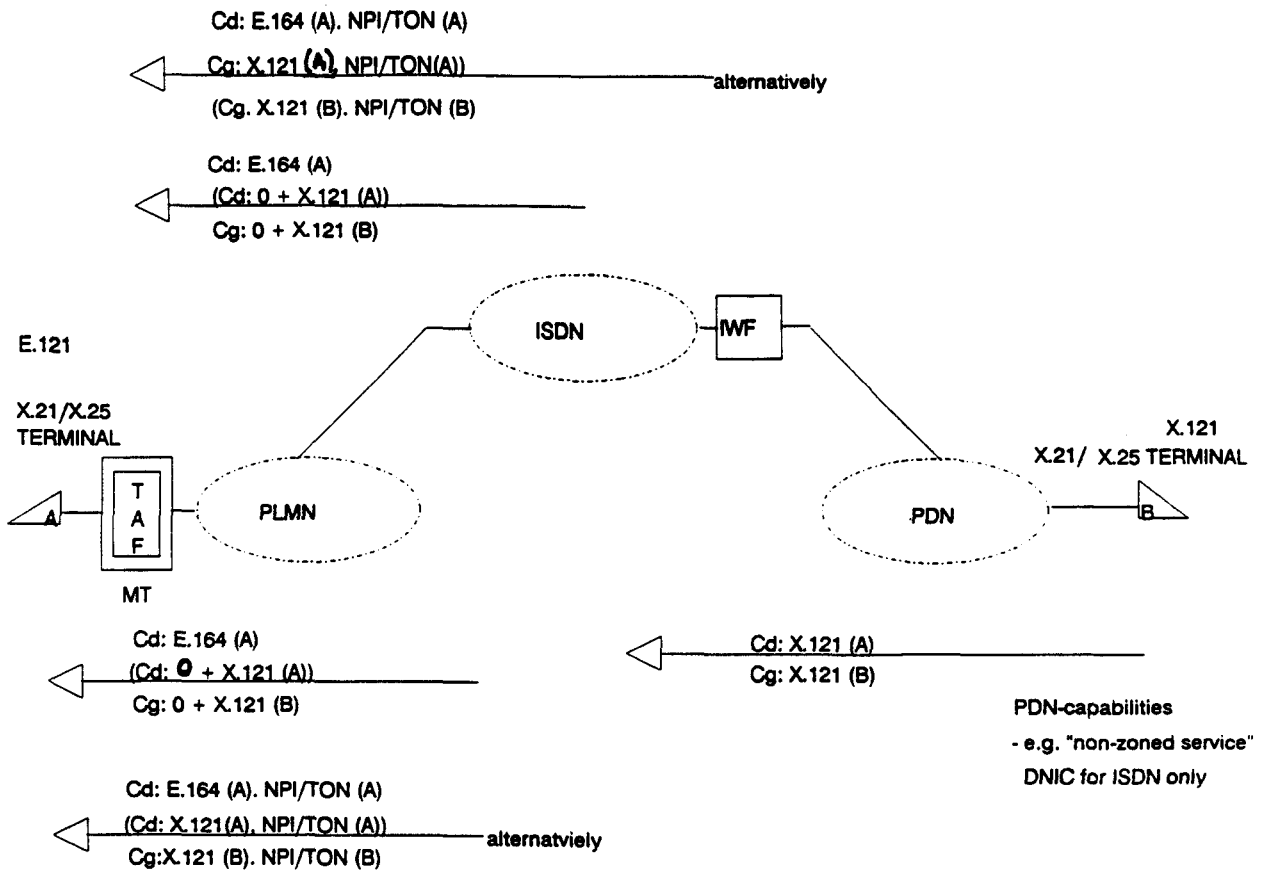
Figure 03.70/5

Interworking PDN-ISDN-PLMN (PDN 4 digits analysis)

5.2.1.2.　Interworking between PLMN and PDN via ISDN, MS has X.121 terminal 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 para. 9.2.2.

The PDN is capable of dealing with, and the organisation 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.

Cd: E.164 (A). NPI/TON (A)

◁ Cg: X.121 (A), NPI/TON(A))   alternatively

(Cg. X.121 (B). NPI/TON (B)

Cd: E.164 (A)

◁ (Cd: 0 + X.121 (A))

Cg: 0 + X.121 (B)

E.121

X.21/X.25
TERMINAL

                                        ISDN ── IWF

                                                            X.121
                                                X.21/ X.25 TERMINAL

◁A ─ T A F ── PLMN   PDN ── ▷B

MT

Cd: E.164 (A)   Cd: X.121 (A)

◁ (Cd: 0 + X.121 (A))   ◁ Cg: X.121 (B)

Cg: 0 + X.121 (B)

                                        PDN-capabilities
                                        - e.g. "non-zoned service"
                                        DNIC for ISDN only

Cd: E.164 (A). NPI/TON (A)

◁ (Cd: X.121(A), NPI/TON (A))   alternatviely

Cg:X.121 (B). NPI/TON (B)

Note: Commoning of the figure for both CSPDN and PSPDN entailed the omission of the PH and the
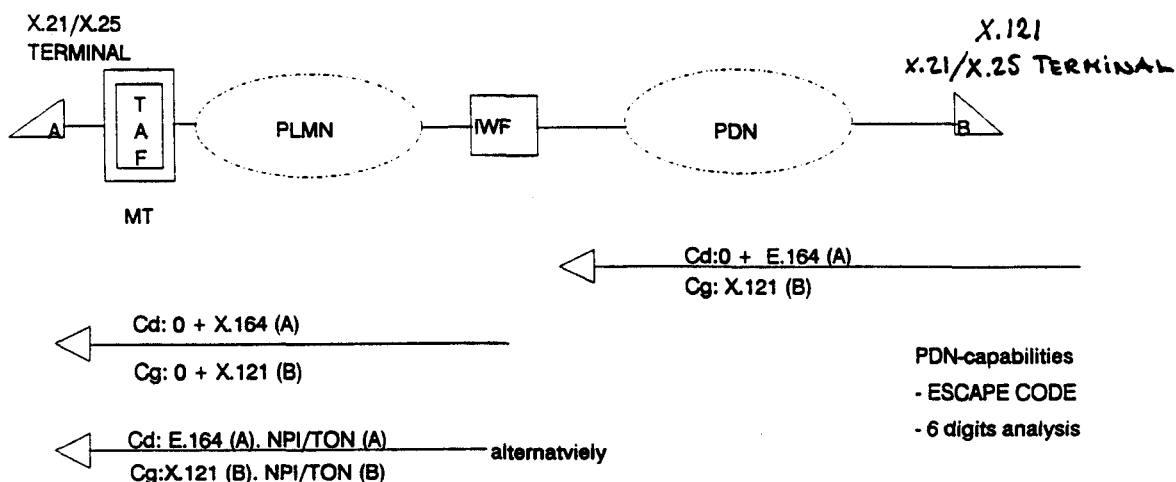reference to the CRP in case of PSPDN

Figure 03.70/6

Interworking PDN-ISDN-PLMN (PDN "ISDN non-zoned service DNIC")

**5.2.1.3.   Interworking directly from PDN to PLMN, MS has E.164 terminal 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 an appropriate IWF. The
MS of the PLMN has an E.164 terminal number. The PDN works on E.164 numbers on the basis of the
CCITT defined concept of ESCAPE Codes, but is capable of analysing up to the first six digits for routing,
i.e. more than the current CCITT Rec. states. Calls are routed from the PDN to the PLMN after analysis of
the six digits indicating that the call is for a mobile subscriber. In this case the ISDN/PLMN may use NPI/
TON for signalling.

E.164

X.21/X.25
TERMINAL

$X.121$
$X.21/X.25$ TERMINAL

```
  /A\──[T A F]───( PLMN )───[IWF]───( PDN )───/B\
       MT
```

◁── Cd:0 + E.164 (A)
        Cg: X.121 (B)

◁── Cd: 0 + X.164 (A)
        Cg: 0 + X.121 (B)

PDN-capabilities
- ESCAPE CODE
- 6 digits analysis

◁── Cd: E.164 (A). NPI/TON (A) ── alternatviely
        Cg:X.121 (B). NPI/TON (B)

Note: Commoning of the figure for both CSPDN and PSPDN entailed the omission of the PH and the reference to the CRP in case of PSPDN

Figure 03.70/7

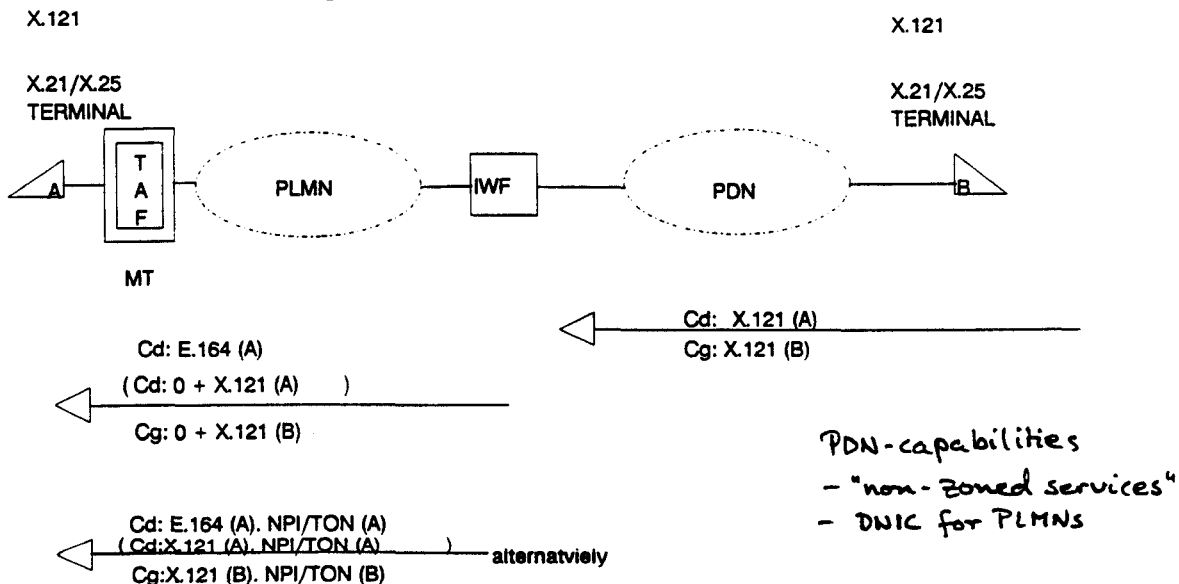Direct-Interworking PDN-PLMN (PDN 6 digits analysis)

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

All calls from the individual PDN to the PLMN are routed directly to the PLMN via an appropriate 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 para 9.2.2.

The PDN is capable of dealing with, and the organisation 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 CCITT. This routes all PLMN destined calls identified by that DNIC directly to the PLMN via the appropriate IWF.

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

X.121

X.121

X.21/X.25
TERMINAL

X.21/X.25
TERMINAL

```
  /A\──[T A F]───( PLMN )───[IWF]───( PDN )───/B\
       MT
```

◁── Cd: X.121 (A)
        Cg: X.121 (B)

Cd: E.164 (A)
(Cd: 0 + X.121 (A)   )
◁──
        Cg: 0 + X.121 (B)

PDN-capabilities
- "non-zoned services"
- DNIC for PLMNs

Cd: E.164 (A). NPI/TON (A)
◁── (Cd:X.121 (A). NPI/TON (A)   ) ── alternatviely
        Cg:X.121 (B). NPI/TON (B)

Note: Commoning of the figure for both CSPDN and PSPDN entailed the omission of the PH and the reference to the CRP in case of PSPDN

Figure 03.70/8

Direct Interworking PDN-PLMN (PDN "non-zoned services" DNIC for PLMNs)

5.2.2. 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.

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

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

5.2.2.2. Direct interworking between the PLMN and the PDN, MS has E.164 terminal number, PDN supports NPI/TON capability

This will have to utilise an additional number analysing capability in the PDN as indicated in section 5.2.1.3.
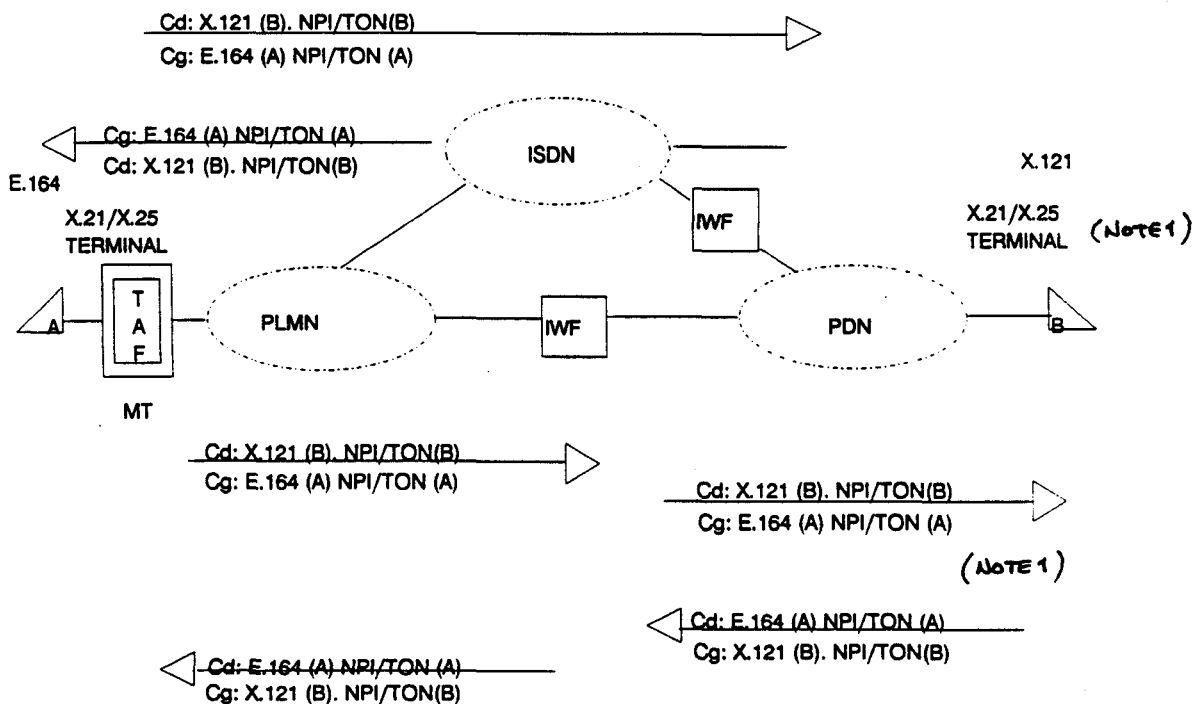

Note 1:   The CSPDN case (X.21) will be limited to the cases laid down in FIGURES 03.70/2 and 03.70/ 5.8 using the alternative number structure

Note 2:   Commoning of the figure for both CSPDN and PSPDN entailed the omission of the PH and the reference to the CRP in case of PSPDN

Figure 03.70/9

Interworking PLMN-(ISDN)-PDN and vica versa, post-time "T"

6. Routing scenarios to cater for roaming mobiles for PDN originated calls
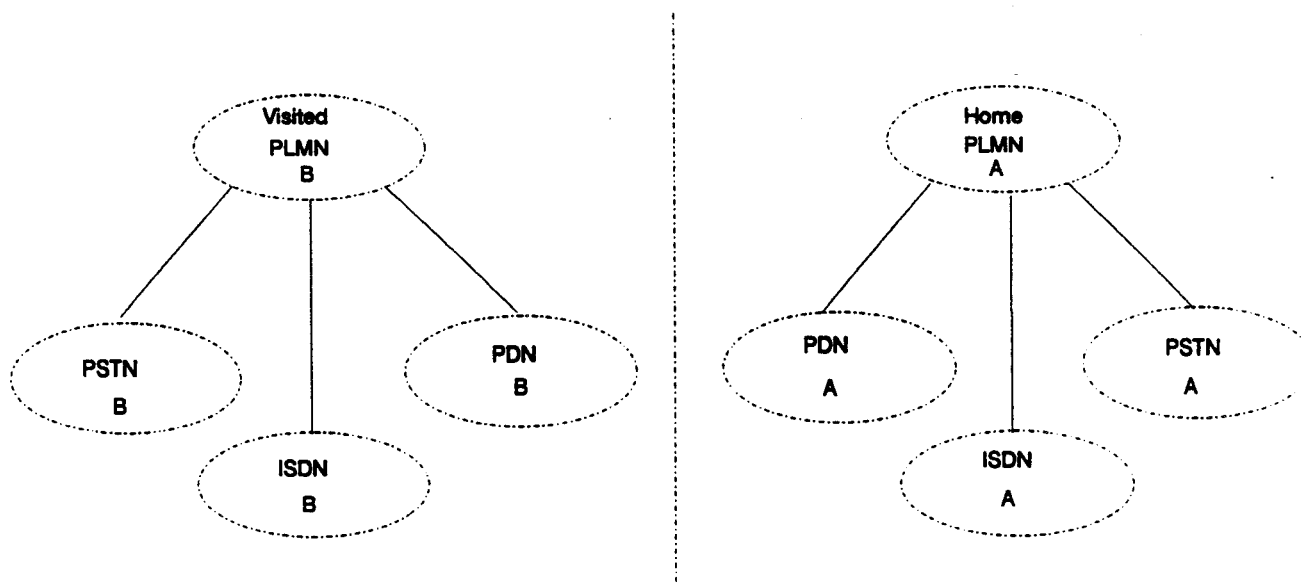
Assuming the NPI/TON information exists, or the use of the ESCAPE code 0

Terminals with E.164 Numbers

Routing Options recognized:
1) PDN A to PDN B (with 0 + E.164 number)
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

Routing options as above for E.164 numbers.