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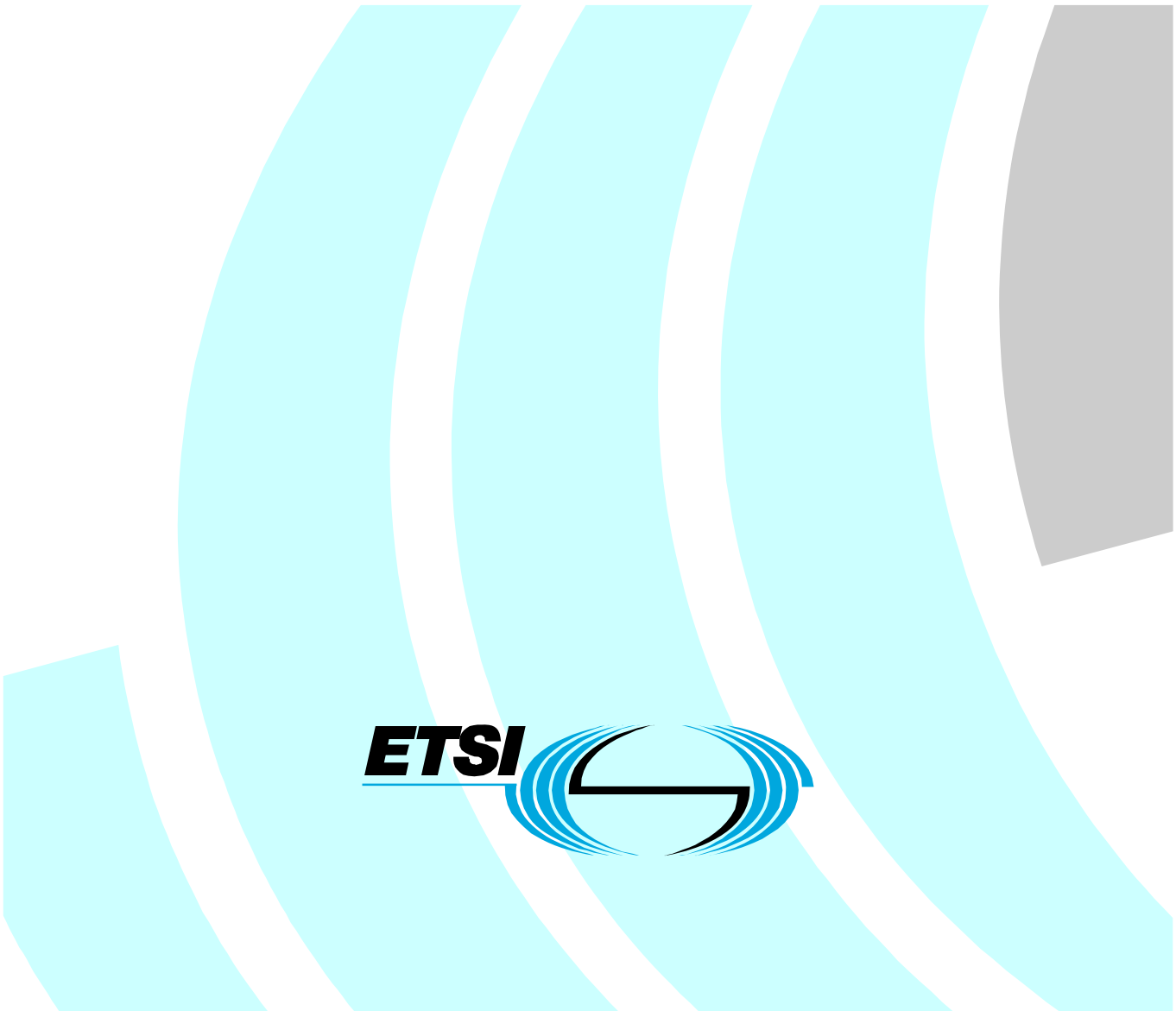
Technical Report

Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Portability of telephone numbers between operators for Next Generation Networks (NGNs)



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ETSI

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN).

1 Scope

The present document focuses on number portability (NP) for telephone numbers from national numbering plans (NNP) for Next Generation Networks (NGNs). These national numbering plans are based on ITU-T Recommendation E.164 [i.19]. Identifier Portability, i.e. portability of other public identifiers than telephone numbers (e.g. name based SIP URIs or SIP/tel URIs with a specific phone-context) is outside the scope of the present document, but it is recognized that this could be the topic of a future separate study.

The present document identifies ways to support portability of telephone numbers (e.g. E.164 numbers) between Service Providers (SP) - so called "service provider portability" (SPP). The term operator in the present document is used instead of Service Provider and the report identifies functionality needed to support the following portability scenarios:

- Between NGN operators;
- From NGN operators to PSTN/ISDN SPs;
- From PSTN/ISDN SPs to NGN operators.

NOTE: The types of telephone numbers that are subject to portability is a national matter, and are therefore not addressed in the present document.

The support for number portability can be divided in two distinct processes:

a) the process of porting a telephone number from one operator to another; and

b) the process to establish a call to a telephone number that may be ported.

The first process a) would include the actions from:

- the request of the telephone number to be ported;
- the distribution and storage of NP Data (NPD) that the telephone number is ported from one operator to another operator, and at which time the porting takes effect;
- making the necessary NPD available to the data base environment that are accessible in real time from the communication processing systems;
- allowing communication establishment to the operator that currently serves the telephone number.

The second process b) would include information:

- how data bases in the real time environment can be accessed and NPD can be retrieved;
- from where the NPD can be retrieved;
- how the NPD can be carried and used and transformed to NP Routing Information (NRI) for the establishment of the communication to the current operator.

The detailed process of porting a telephone number and storage and distribution of NPD is essentially an administrative process, that may differ very much from country to country. The present document considers mainly the following:

- NGN network architecture specific for number portability;
- how the NPD obtained from the real time data base environment is used to route sessions, based on NRI, within and between networks.

However, some information relating to the process of porting a telephone number is provided in annex A, and how to populate and make NPD and ENUM data available to the real time environment is provided in annexes B and C.

Clause 5 gives an high level framework concerning different kind of DBs in the real time and in the non-real time environment of the NGN on different levels (i.e. operator, national and international level).

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 101 119 (V1.1.1): "Network Aspects (NA); High level description of number portability".

[i.2] ETSI TR 101 122 (V1.1.1): "Network Aspects (NA); Numbering and addressing for Number Portability".

[i.3] ETSI TR 101 118 (V1.1.1): "Network Aspects (NA); High level network architecture and solutions to support number portability".

[i.4] ITU-T Supplement 2 to E.164/I.331/Q.11 (2009): "Supplement 2: Number portability".

[i.5] ETSI TR 101 697 (V1.1.1): "Number Portability Task Force (NPTF); Guidance on choice of network solutions for service provider portability for geographic and non-geographic numbers".

[i.6] ETSI TS 184 006: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Interconnection and Routeing requirements related to Numbering and Naming for NGNs; NAR Interconnect".

[i.7] IETF RFC 4769: "IANA Registration for an Enumservice Containing Public Switched Telephone Network (PSTN) Signaling Information".

[i.8] IETF RFC 4694: "Number Portability Parameters for the tel URI".

[i.9] ETSI TS 182 006: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IP Multimedia Subsystem (IMS); Stage 2 description (3GPP TS 23.228 V7.2.0, modified)".

[i.10] ITU-T Recommendation E.101 (2009): "Definitions of terms used for identifiers (names, numbers, addresses and other identifiers) for public telecommunication services and networks in the E-series Recommendation".

[i.11] IETF RFC 3761: "The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM)".

[i.12] ETSI TS 184 010: "Telecommunications and Internet Converged Services and Protocols for Advanced Networks (TISPAN) ENUM & DNS Principles for an Interoperator IP backbone network".

[i.13] ETSI TS 123 228: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Subsystem (IMS); Stage 2 (3GPP TS 23.228)".

[i.14] ETSI ES 282 002: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); PSTN/ISDN Emulation Sub-system (PES); Functional architecture".

[i.15] ETSI TS 129 235: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Interworking between SIP-I based circuit-switched core network and other networks (3GPP TS 29.235)".

[i.16] IETF RFC 3261: "SIP: Session Initiation Protocol".

[i.17] ETSI TR 101 698: "Number Portability Task Force (NPTF); Administrative support of service provider portability for geographic and non-geographic numbers".

[i.18] IETF RFC 3966: "The tel URI for Telephone Numbers".

[i.19] ITU-T Recommendation E.164 (2005): "The international public telecommunication numbering plan".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

data base query function: function whereby a data base is accessed in order to ascertain whether a telephone number is ported, and if it is, a Routeing Number or a domain name is obtained that may be used to route the call to a destination

donating network: network from which the number has been ported out in the last porting process

NOTE: Source TR 101 122 [i.2].

donor network: initial Network where a number was assigned by the Numbering Plan Administrator before ever being ported

E.164 number: string of decimal digits that satisfies the three characteristics of structure, number length and uniqueness specified in ITU-T Recommendation E.164 [i.19]

NOTE 1: The number contains the information necessary to route the call to the end user or to a point where a service is provided.

NOTE 2: Source ITU-T Recommendation E.101 [i.10].

ENUM data: data for mapping an E.164 number to an URI

NOTE: Mapping can be done directly or by providing pointers to other ENUM DBs according to ordinary DNS procedures.

ENUM DB: real time data base that store ENUM data. It is used to resolve E.164 numbers to URIs at session initiation

ENUM query: query made on the Shared ENUM infrastructure in order to resolve a specific E.164 number to an routable URI

location portability: ability of an end user to retain the same telephone number when moving from one location to another

National Operational Data Base (NOpDB): real time common data base that store data from the NPDB to be transformed to NRI used for routing by all operators within one country

NPA Data: off-line data published by the numbering plan administrator (NPA) which provide the number block assignments to operators that provides services within the jurisdiction of the NPA

NOTE: If the telephone numbers are subject to number portability the actual operator serving a specific telephone number may differ from the one provided by these data. In cases where telephone numbers are assigned directly to end users, the operator chosen by the end user to provide services is due to spread information that he is serving that telephone number.

NPA DB: non-real time data base that store NPA Data run by the NPA

NP Data (NPD): off-line data linked to ported telephone numbers as they are stored in and retrieved from the NPDB

NOTE: This data consist of a list of ported telephone numbers with associated domain names or routeing numbers and optionally further information of traffical and/or administrative nature. Normally these data are provided in a format which requests for further processing in order to render routeing information.

NPDB: non-real time data base that is used to store NP Data

NOTE: As an option the NPDB may contain information for all telephone numbers (i.e. also non-ported telephone numbers). Such additional information would be based on NPA Data.

NP query: query using the data base query function

NP Routing Information (NRI): information needed to complete the E.164 number based communications request to ported telephone numbers

OpDB: real time data base that store data from the NPDB to be transformed to NRI used for routing

operator: entity providing public telecommunications networks and/or public telecommunication services

ported number: number that has been subject to number portability

NOTE: Source TR 101 122 [i.2].

recipient network: network where a number is located after being ported

NOTE: Source TR 101 122 [i.2].

RefNPDB: non-real time reference NPDB

NOTE: It is national matter whether there is one physical RefNPDB or a logical one, which may be distributed over the operators involved

Service Provider Portability (SSP): ability of an end user to retain the same telephone number when changing from one service provider to another

service portability: ability of an end user to retain the same telephone number when changing from one type of service to another

Shared ENUM Infrastructure: inter-operator infrastructure according to ENUM technology as defined in RFC 3761 [i.11], used by the originating or an intermediate network to map a specific E.164 number into a URI that identifies the network actually serving that specific E.164 number

NOTE: Shared ENUM infrastructure is different from User ENUM infrastructure [i.11] where the end-user may register his E.164 number to be associated with a URI of his desire.

telephone number; directory number: number, derived from the E.164 numbering plan, used by the originating party to establish a call/communication to an end user or a service

NOTE 1: The number may also be used for identification/presentation services and may also be published in different directories and/or directory enquiry services.

NOTE 2: Source ITU-T Recommendation E.101 [i.10]. The E.101 definition has been modified here to be independent of the network technology, e.g. NGN, PSTN/ISDN and other technologies.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACQ	All Call Query
AGCF	Access Gateway Control Function
AGW	Access GateWay
AS	Application Server
BGCF	Breakout Gateway Control Function
CC	Country Code
CdPN	Called Party Number
CS	Circuit Switched
CSCF	Call Server Control Function
CS-IBCF	CS (domain) IBCF
CS-TrGW	CS (domain) TrGW
DB	Data Base
DN	Directory Number
DNS	Domain Name System
ENUM	tElephone NUMber mapping
FQDN	Fully Qualified Domain Name
I/S-CSCF	Interrogating/Serving Call Server Control Function
IAM	Initial Address Message
IBCF	Interconnection Border Control Function
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
INAP	Inteligent Network Application Protocol
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
IWF	InterWorking Function
LNP	Local Number Portability
MAP	Mobile Application Part
MGCF	Media Gateway Control Function
MGW	Media GateWay
MRFC	Multimedia Resource Function Controller
N(S)N	National (Significant) Number
NAPTR	Naming Authority Pointer
NDC	National Destination Code
NGN	Next Generation Network
NNP	National Numbering Plan
NOpDB	National Operational Data Base
NP	Number Portability
NPA DB	Numbering Plan Administrator Data Base
NPA	Numbering Plan Administrator
NPD	NP Data
NPDB	Number Portability Data Base
npdi	NP Database Dip Indicator
NRA	National Regulatory Authority
NRI	NP Routing Information
OP	Operator
OpDB	Operational Data Base
OR	Onward Routeing
OSS	Operations Support Systems
P-CSCF	Proxy-Call Session Control Function
PES	PSTN/ISDN Emulation Subsystem
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
RefNPDB	Reference Number Portability Data Base
rn	routing number
S-CSCF	Serving CSCF
SIP	Session Initiation Protocol
SIP-I	SIP with encapsulated ISUP

SLF	Subscription Locator Function
SN	Subscriber Number
SP	Service Provider
SPP	Service Provider Portability
SS7	Signalling System Number 7
SS-CF	Soft Switch Control Function
TCAP	Transaction Capabilities Application Part
TDM	Time Division Multiplexing
TGCF	Trunking Gateway Control Function
UE	User Equipment
UPSF	User Profile Server Function
URI	Uniform Resource Identifier

4 Background on portability of telephone numbers

The service features associated with portability of telephone numbers (Number Portability) are independent from the technology with which they are implemented. The requirements that have been defined by ITU-T and ETSI in the past are recommended to be carried forward to NGN.

In particular the service provider portability is referring only to the delivery of publicly available electronic communication services which are delivered by means of telephone numbers (e.g. E.164 numbers) and other capabilities related to them that ought to be implemented also through NGN networks.

The main focus of the present document is the portability of telephone numbers. Number Portability (NP) only refers to the E.164 number part of the user's public identifier that, in NGN, can be represented with either a tel URI or a SIP URI (the user part of SIP URI) with the parameter "user=phone".

In the PSTN/ISDN network environment, three types of number portability have been recognized:

- Service Provider portability (SPP);
- Location portability;
- Service portability.

Definitions for these are shown in clause 3.1.

Strictly, in the NGN environment we should be talking about "portability of public identifiers" between operators. The type of public identifier portability considered in the present document is portability between operators providing equivalent electronic communication services - the NGN equivalent of service provider portability as defined in clause 3.1. References to number portability elsewhere in the document should be taken to have this meaning.

The following portability types are out of the scope of this study:

- Location Portability;
- Service Portability.

The decision on the method of implementation of number portability in PSTN/ISDN networks within a particular country has been made at a national level and that will continue to be the case also in the NGN context. This decision will ultimately be made by National Regulatory Authorities (NRAs), with operators and equipment suppliers contributing to the process. For this reason, the present document does not mandate a particular implementation for NGNs.

Factors that may influence national decisions will include the following:

- the inherent capabilities offered by the NGN architecture;
- the relative costs of implementing the various options in an NGN environment;
- service interconnect scenarios and requirements;
- interoperability with existing legacy NP solutions;

- experience from existing NP solutions;
- different options to handle NP data in the non-real time environment and how to make this data available to the networks.

The responsibilities of the entity delivering service provider portability as described in TR 101 119 [i.1] are still valid and applicable in the NGN, in particular the responsibilities to route a call to the ported number are consistent with the Routeing Roles defined in the TS 184 006 [i.6] including donor, donating and recipient roles.

On the basis of the description provided by TR 101 122 [i.2] the NGN will not change the features of the service providers portability: the main routeing problem to solve when Number Portability (NP) is involved is to be able to route the call to the recipient network. Also appropriate non-real time number portability data base environment has to be agreed by operators in advance, assuring population and updating procedures to OpDBs, as a basis for voiceband calls/sessions routing process.

Triggering function for NP resolution can be provided by different operators acting specific NP role (originating, donor or donating).

It should be noted that, in a circuit-switched telephone network SPP technical solutions were based upon the use of the SS7 stack (specifically ISUP and Core INAP protocols). SPP solutions, also in an NGN environment focus are on services with telephone numbers and should be evaluated on NGN technologies and architectures; also query mechanisms have to be considered based on innovative and legacy technologies and data base systems.

Where NGN SPP functionality differs from that already in place, it is recommended that the NGN SPP functionality can co-exist and interoperate with the existing solution for services in the legacy networks.

NGN technology should consider utilizing existing technical capabilities such as Reference NPDB (RefNPDB) implementations where they can assist in providing the required functionality for distributing NPD to the real-time environment.

More detailed information on the various technical options appropriate to legacy networks has been provided in detail in earlier ETSI documents, as follows:

- TR 101 119 [i.1];
- TR 101 122 [i.2];
- TR 101 118 [i.3];
- TR 101 697 [i.5].

When examining Number Portability, it is instructive to consider the domains to which it applies. In addition to the portability domain (P), i.e. the scope of portability, there is another domain, the routeing domain (R) which describes that part of the network(s) that is able to recognize a number as ported, and route accordingly.

In figure 4.1, area 'P' is the domain over which it is possible to port a number, area 'R' is that part of the network that recognizes a number is ported, and carries out appropriate action. Domain W describes the rest of network, that has no way of detecting a number is ported, and therefore should route using normal principles. For portability of national telephone numbers domain 'R' is likely to be at most the national boundary, but other arrangements could exist where R might be outside the national boundary if so agreed in the specific case.

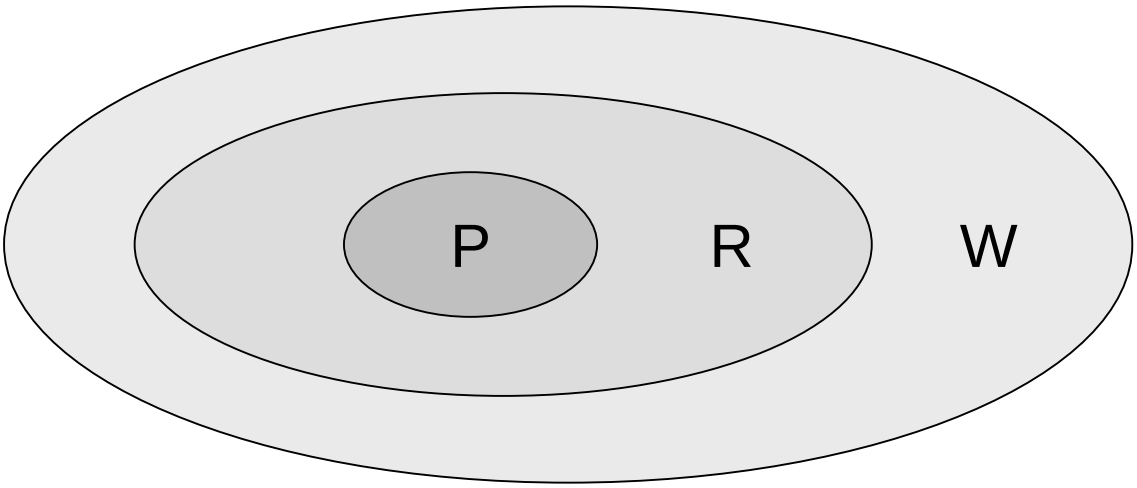

Figure 4.1

A telephone number can only be ported when certain restrictions are not overruled. These define the portability (P) domain.

Example possibilities for the definitions of the portability domain could be:

1) a Geographical area (e.g. domain of a local exchange, an NDC or a country etc.), a user may only port the telephone number if not moving outside the geographic area;

2) a Charging Zone, a user may only port the telephone number if not moving outside the charging zone;

3) a user may only have their telephone number ported if the type of telecommunication does not change, e.g. Freephone to Premium rate.

From the above one can understand that one of the reasons for restricting NP to a portability domain could be to prevent a caller, originating a call to a ported number, from being charged other than it is indicated by the dialled number.

5 Overview of Number Portability implementation options

5.1 High level framework of DBs for NGN real time and non-real time environment on different levels

This clause provides a high level framework of all the different kind of Data Bases (DBs) that can be used when Number portability is implemented in NGN and highlight some scenarios of DB installations.

Figure 5.1 gives an simplified overview of the DBs that may used in the real time and in the non-real time environments for the NGN, including distribution of NPD to the realtime environment and direct and indirect queries to retrieve NRI and ENUM data.

The process of uploading NPD in the non-real time environment and making that data available for use in the NGN real time environment is further described in annex B. Clause 5.2 includes a chart that describes the non-real time aspects of the distribution of NPD.

The process of uploading ENUM data and making that data available for use in the NGN real time environment is further described in annex C.

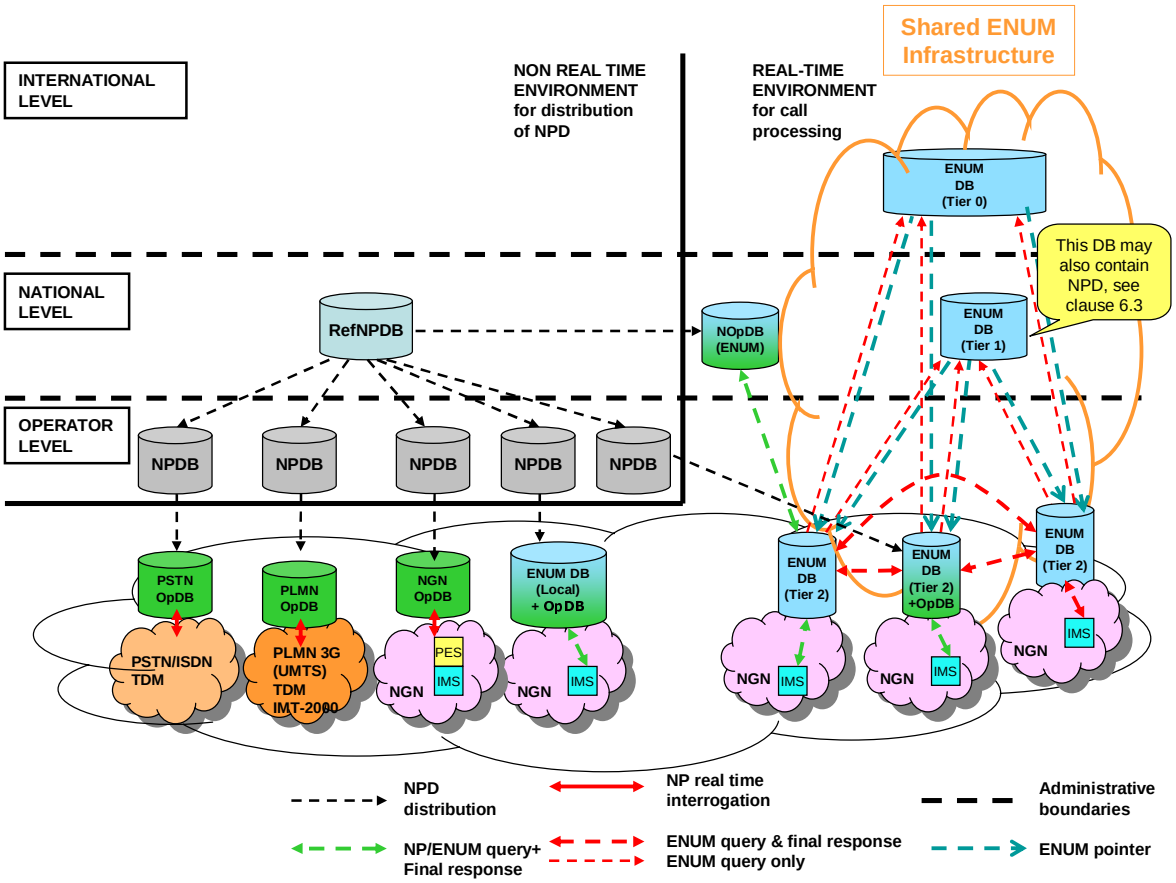

Figure 5.1: High level framework of DBs for Number Portability

5.2 General assumptions and requirements on the non-real time environment for number portability in NGNs

Figure 5.2 describes the non-real time aspects of the distribution of NP Data (NPD). It describes how the different source data may be distributed and merged to render a data base which can be used as input for the real time environment. Besides of that, consequences on the routeing capabilities of individual operators are shown, which depend on the overall data distribution policy implemented and the data usage policy adopted by the operator. It should be noted that the Number Portability Data Base (NPDB), which is defined to belong to the non-real environment, may also contain data about assigned number blocks.

These number blocks (e.g. 10 000) are assigned by the Numbering Plan Administrator (NPA) to operators within the jurisdiction of the NPA to be re-assigned to their subscribers. The original assignments are communicated by the NPA by the means of their choice (e.g. webpage). So, the information about which number blocks have been assigned to which operator is available to all operators. Based on this information the basic routeing capability "block based routeing" is given to every operator.

From the moment of the assignment, telephone numbers of the assigned blocks may be ported out to other operators, while telephone numbers belonging to blocks assigned to other operators within the portability domain, may be ported in. So at the starting point there are two kind of information available: the NPA Data and the per operator NPD as well as the per operator assigned number blocks, which match with the NPA Data.

Depending on the data distribution policy implemented the following consequences are given:

- **ENUM data available to all?** - if the operator specific ENUM data is not made available to other operators there may be no knowledge about users connected to the NGN. The consequence is that other operators have to relay on NPD (if available) for routeing.

- ② - the means to make operator specific ENUM data available to other operators is a shared ENUM infrastructure. This infrastructure may be accessible by a federation of operators, at national level or at international level. The functional description of such a shared infrastructure is given in clause 6.2. For further details refer to "ENUM & DNS Principles for an Interoperator IP Backbone Network" [i.12]. Process for uploading ENUM data is described in annex C.

- **NPD available to all?** - if data about porting processes are only known to the donor and recipient operator, all other 3rd party operators do not have any other option than implementing the block based routeing scheme. If it is agreed to make the per operator NPD available to all, every operator has an aggregated (jurisdiction wide) NPD-pool available, which allows for implementing potentially any routeing scheme.

- **Data used?** - there may be small operators which will not use the aggregated NPD because they have only interconnection to one big operator and thus have implemented a default routeing to his network. Other operators which will not use the NPD are pure service providers to whom number blocks are assigned and thus contribute to the overall porting process, but as they do not operate an own network, they do not care about routeing implications of number portability.

- **Blocks communicated?** - if the infrastructure used to exchange the per operator NPD is also used to communicate the assigned blocks, every operator has a merged (repository) data pool available which reflects the actual status of every assigned telephone number. This decision could be viewed as leading to a kind of "inline" process because the availability of the merged (repository) data is achieved without using the NPA Data.

- **Data merged?** - if the per operator assigned blocks are not communicated by the same means as the NPD, the merged (repository) data may be obtained by merging the aggregated NPD and the NPA Data. If this data merger is not done, the result is an "on the fly" merger which means, that at call set up, first the NPD are queried and in case of no entry, the NPA Data are used for routeing.

- ① - annex B provides some example of the means by which the NPD can be distributed to the operators Number Portability Data Base (NPDB. The data bases may contain also the number block allocations of the NPA i.e. the NPA data.

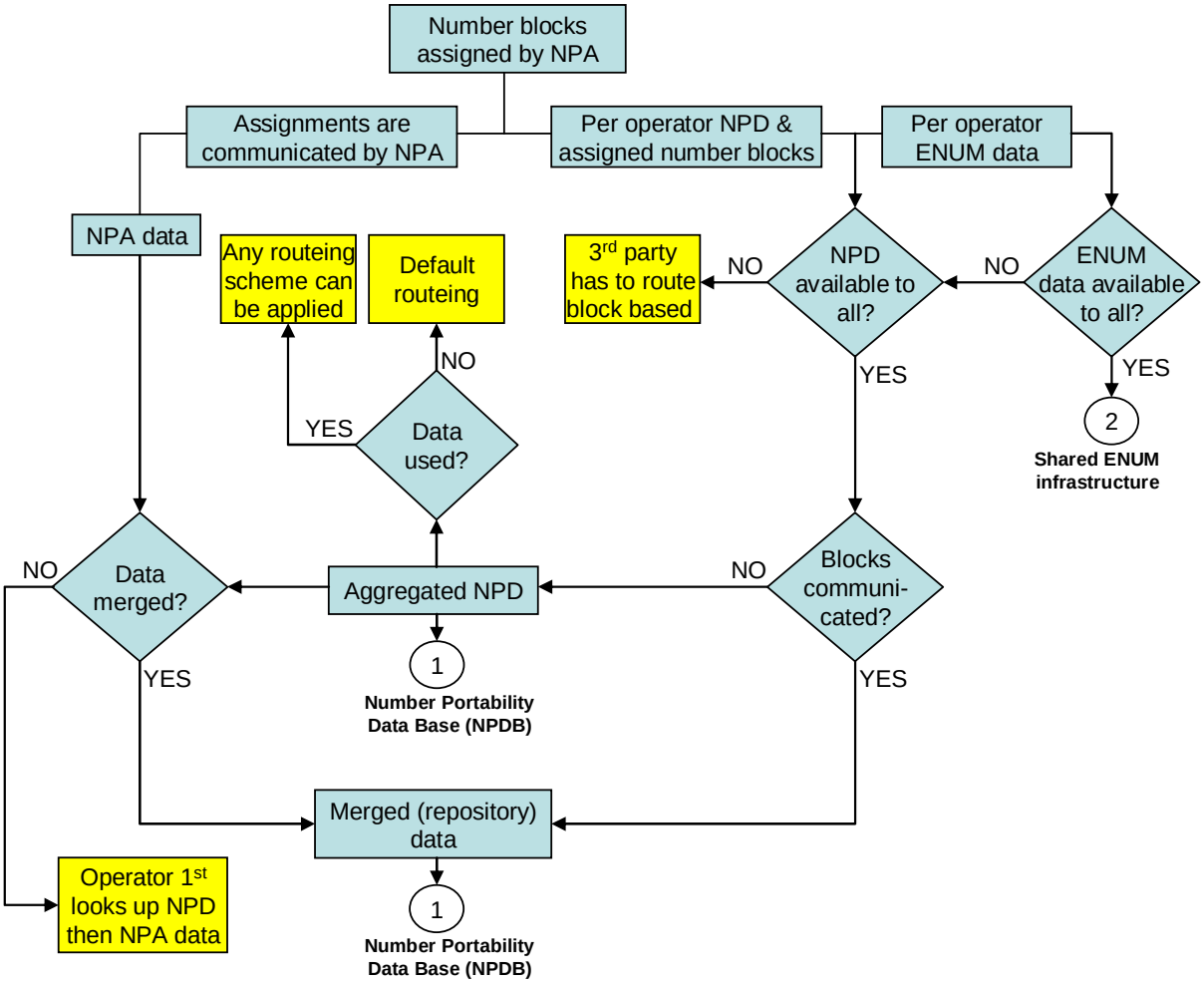
Number blocks assigned by NPA
Assignments are communicated by NPA
Per operator NPD & assigned number blocks
Per operator ENUM data
NPA data
Any routeing scheme can be applied
Default routeing
3rd party has to route block based
NO
NPD available to all?
NO
ENUM data available to all?
YES
2
Shared ENUM infrastructure
NO
YES
Data used?
YES
NO
Data merged?
Aggregated NPD
NO
Blocks communi-cated?
1
Number Portability Data Base (NPDB)
YES
YES
Merged (repository) data
Operator 1st looks up NPD then NPA data
1
Number Portability Data Base (NPDB)

Figure 5.2

5.3 Examples of DBs for NGN real time and non-real time environment

5.3.1 RefNPDB, Tier 1 ENUM DB synchronized with RefNPDB

This example shows the situation in a country that has a national RefNPDB, and a shared Tier 1 ENUM DB, where the NP data is synchronized with the RefNPDB, This may optionally be done via an NPDB.

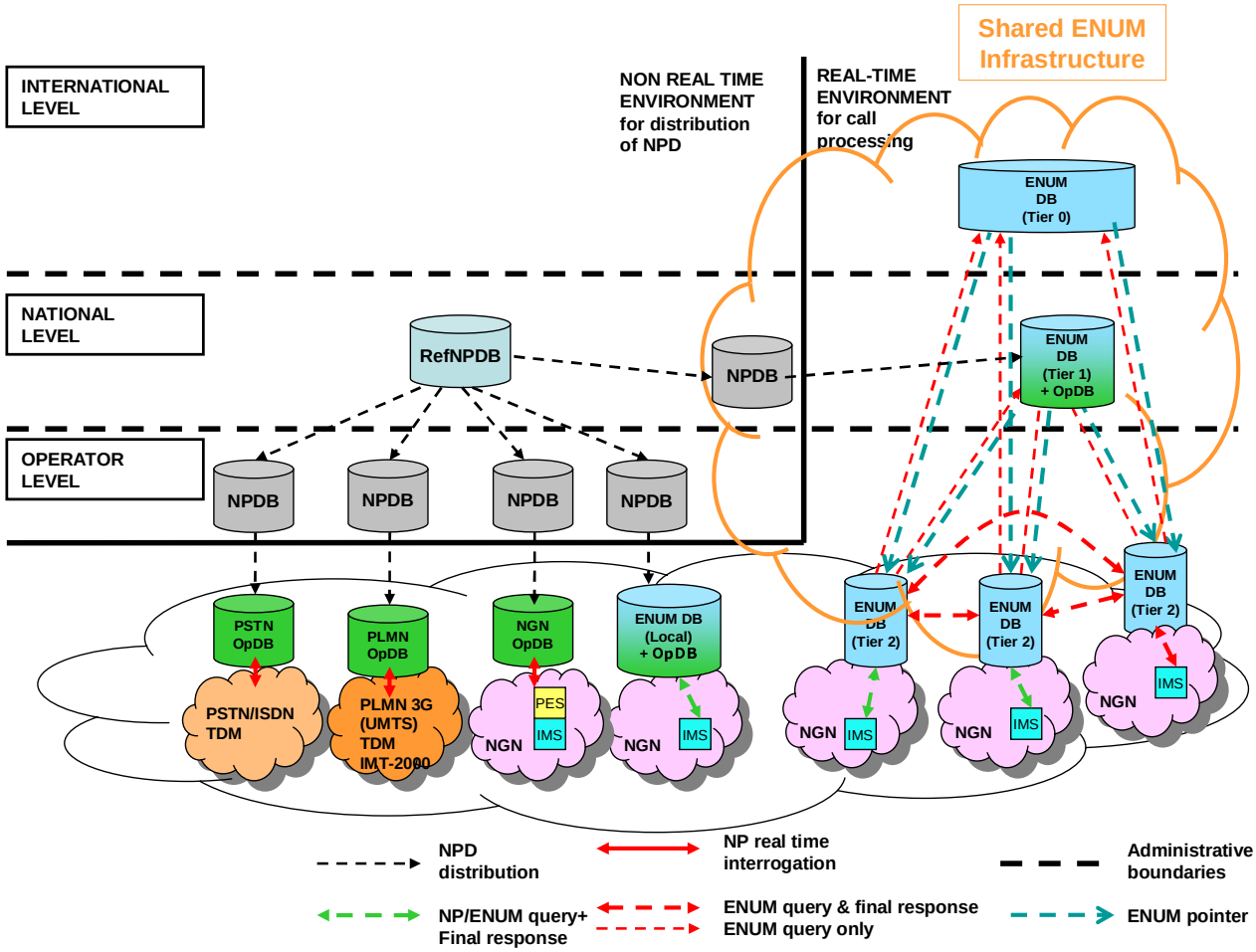

Figure 5.3

5.3.2 RefNPDB, no Tier 1 ENUM DB

This example shows the situation in a country that has a national RefNPDB, but no Tier 1 ENUM DB. Every operator is expected to have the full knowledge of the ported numbers in its local ENUM DB. The NPDB could be an "empty box" if the OpDB is synchronized directly with the RefNPDB.

In this configuration, IMS communication incoming from another country cannot directly be routed to the operator serving the ported number, but only via the number range holder (if known) who has to onward route the communication, or to a certain operator where the communication originating or intermediate operator has a (commercial) SLA with.

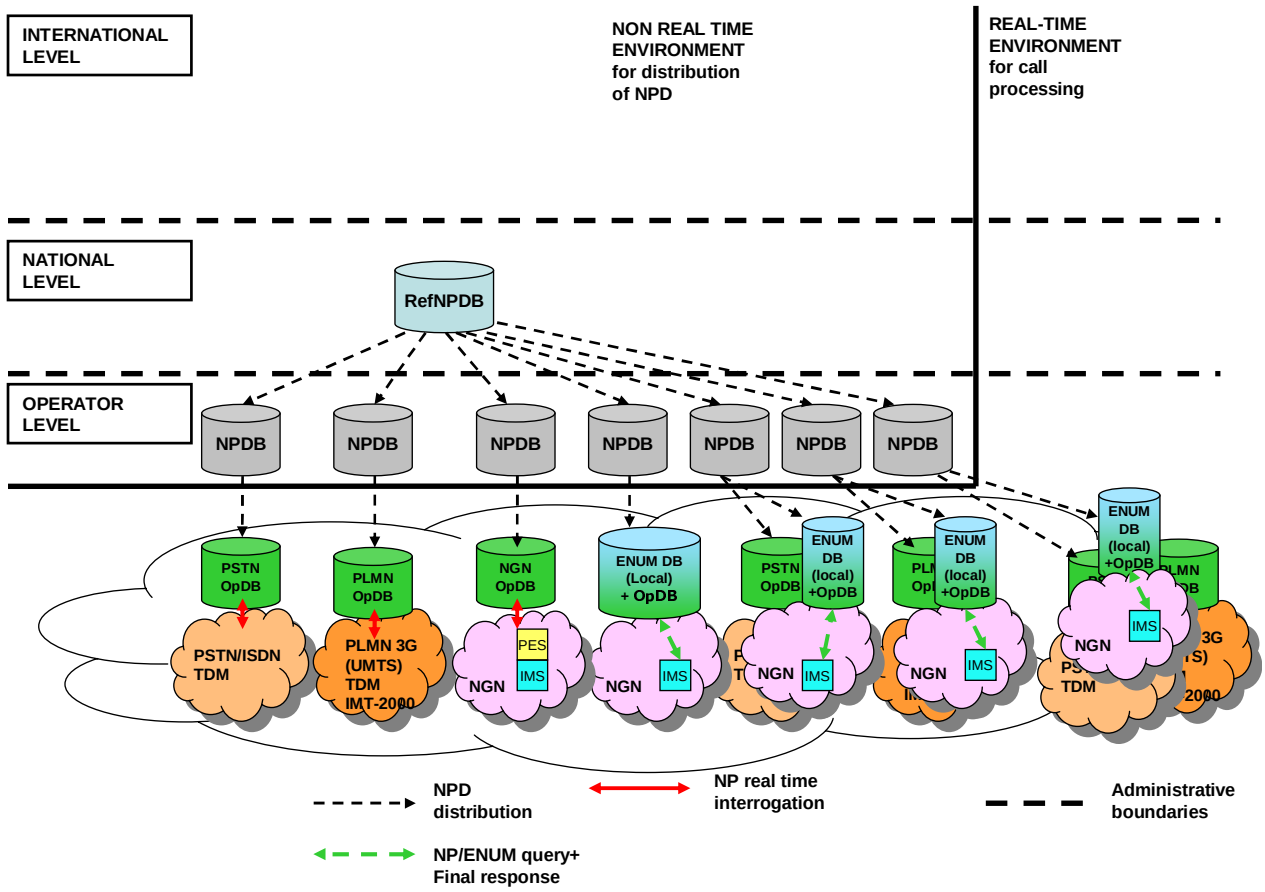

Figure 5.4

5.3.3 No physical RefNPDB, no Tier 1 ENUM DB

This example shows the situation in a country that has no physical RefNPDB, i.e. each operator has the full knowledge of all ported numbers. This corresponds to a logical DB with distributed NPD. There is no Tier 1 ENUM DB either. Every operator is expected to have the full knowledge of the ported numbers in its local DBs (NPDB and ENUM DB).

In this configuration, IMS communication incoming from another country cannot directly be routed to the operator serving the ported number, but only via the number range holder (if known) who has to onward route the communication, or to a certain operator where the communication originating or intermediate operator has a (commercial) SLA with.

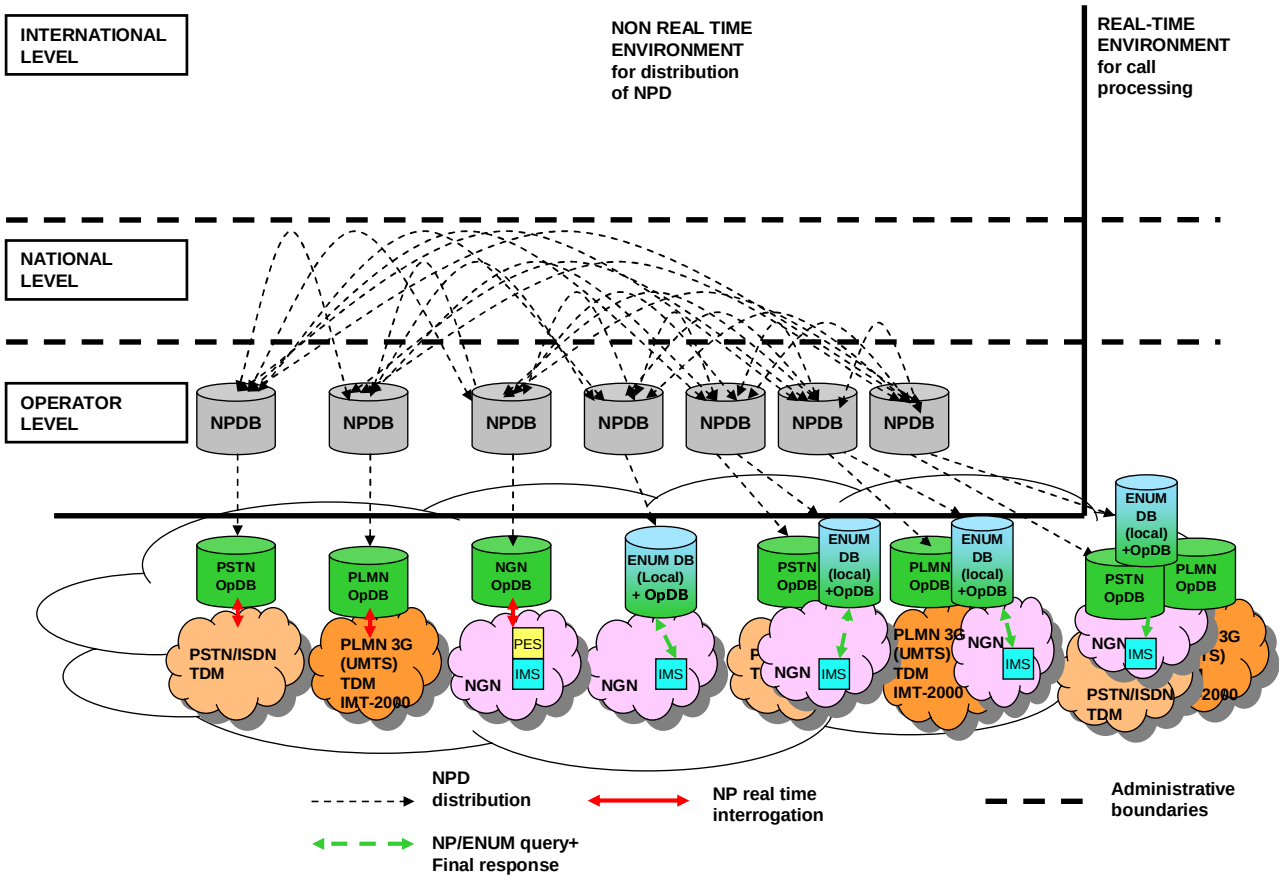

Figure 5.5: Logical RefNPDB

6 Real time environment for Number Portability in NGN

6.1 Accessing the Real-time Operational Data Base (OpDB) for Number Portability

Depending on which number portability domain the destination telephone number belongs to, different Operational Data Bases (OpDBs) may need be accessed to retrieve the NP Routing Information (NRI). Furthermore, the OpDB for each NP domain may require different methods to access the Data base.

With the introduction of NGN, the use of ENUM/DNS based mechanism are also introduced. Although, the use of ENUM as such is not mandated for NGN, it has the very nice feature that it naturally can provide information of the operator that serves a particular telephone number. The way this is done is by providing a domain name in the host part of a SIP URI given as a response to an ENUM query.

In a homogenous NGN environment this may be a viable solution, although it puts demand on that a Shared ENUM infrastructure is in place throughout the NGN network.

However, the reality is that we have and need to cope with a very heterogeneous network environment, and therefore the means to provide NP Data (NPD) need to consider inter-working with the legacy networks as well as NGN networks. The decision on the method of implementation of number portability in PSTN/ISDN networks within a particular country has been made at a national level and that will continue to be the case also in the NGN context.

When introducing the NGN networks a large portion of all calls originated from the NGN will be destined to the legacy networks. It is therefore reasonable to expect that the NGN may need to retrieve NP Routing Information (NRI) from the PSTN and PLMN OpDBs.

Traditionally the means to access the PSTN and PLMN OpDBs in legacy networks have been based on SS7 signalling mechanisms as e.g. INAP for the PSTN and MAP for PLMNs. Thus, it is of course a valid option for the NGN to retrieve the NRI using the legacy SS7 mechanisms. Another option, that do not require implementation of the SS7 mechanisms and access to the SS7 network from the NGN call control, would be that the OpDBs in the legacy networks implement DNS based interfaces for ENUM queries in addition to the legacy SS7 interfaces, or to provide to interworking functionality between ENUM/DNS and SS7. Figure 6.1 gives a number of examples how the NPD could be retrieved from OpDBs in the PSTN or in the PLMN.

Yet other possibilities to access the OpDBs is using state of the art general DB query mechanism not explicitly designed for use in Telecommunications.

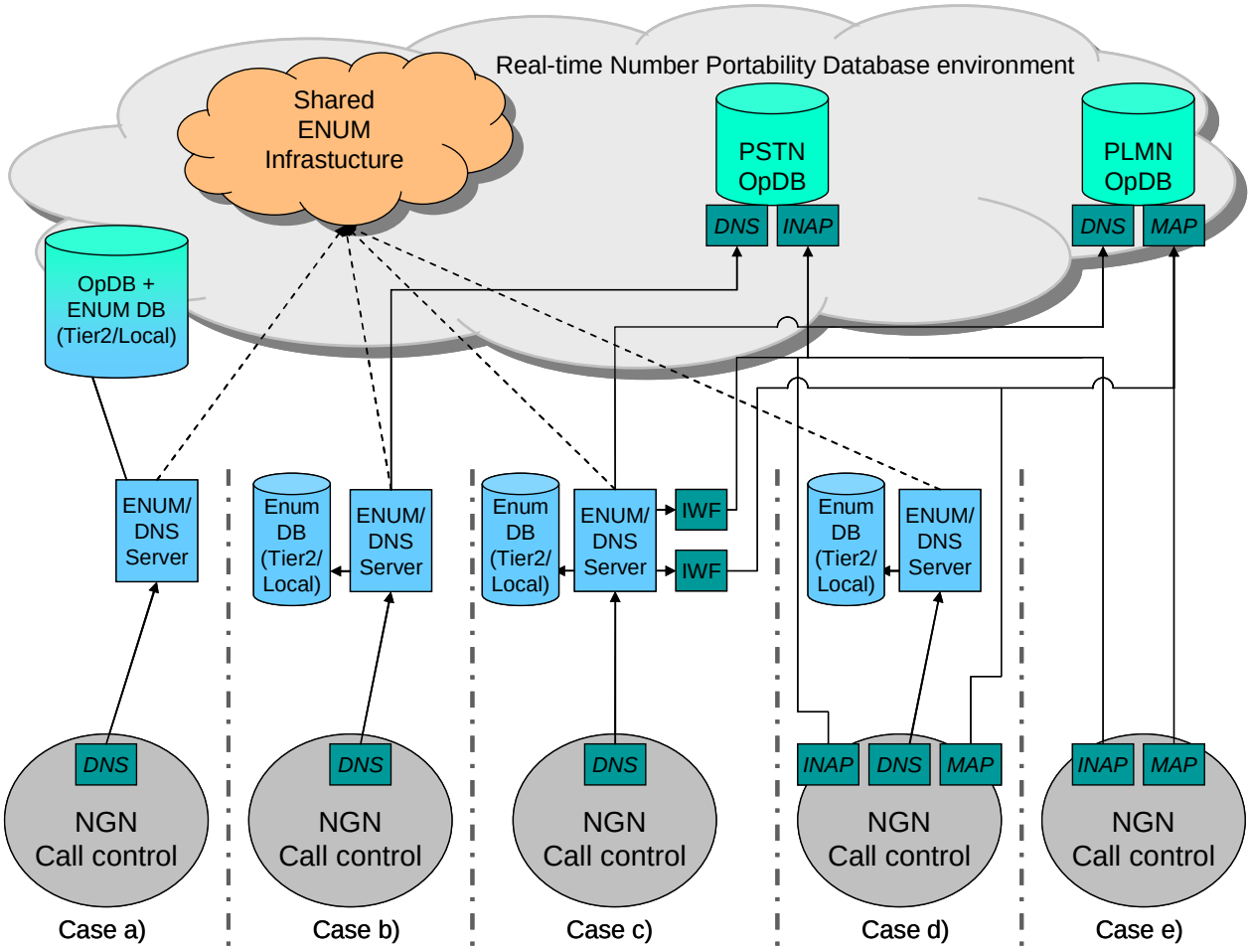

Figure 6.1: Examples of methods to access PSTN/PLMN OpDBs from the NGN

In figure 6.1, the ENUM DB (Tier 2/Local) is used to host information of the operators own NGN subscribers, while the combined OpDB + ENUM DB (Tier 2/Local) is intended to provide NRI for the complete portability domain. This may be achieved by each operators OpDBs containing the complete data base or by using the Shared ENUM infrastructure with a Tier 1 and Tier 2 structure where the Tier 2 for each operator would provide the authoritative information while the Tier 1 for each number would point to the correct authoritative Tier 2.

The NRI stored in the PLMN and PSTN OpDBs is normally not available in the URI format (SIP or tel) that is necessary for retrieval via the ENUM DNS systems as shown in cases b) and c). The necessary transformation of the legacy NRI, including setting of recipient operator domain name when a SIP URI is generated, need take place in the OpDB DNS interface logic and the IWF logic for case b) and c), respectively.

In addition to this transformation, the IWFs used in case c) will also perform signalling interworking between the DNS and legacy signalling protocol (e.g. INAP or MAP).

For cases d) and e) where the legacy databases (PSTN/PLMN OpDB) may be addressed directly from the NGN Call control, the above transformation of the NRI may or may not be needed depending on from where in the call control layer the queries are being made.

6.2 Using ENUM as OpDB for Number Portability in NGN

As already stated Shared ENUM Infrastructure have the feature that it provides information about the operator that serves a particular telephone number. However, Shared ENUM Infrastructure can of course not provide information for more than the E.164 numbers for which ENUM information have been entered into the Shared ENUM infrastructure.

Without going into details on how a Shared ENUM Infrastructure may be built, a common approach would be to build the ENUM feature in a Tiered way e.g. a international Tier 0, an national Tier 1, and an operator Tier 2.

An ordinary way of making information available to the ENUM function , as shown in figure 6.2, is that the Tier 2 provider informs the Tier 1 of which E.164 numbers that he supports ENUM NAPTR Records for. This may be done by indicating supported telephone number blocks and or individual telephone numbers. The processes for making this information available, have to be agreed amongst the members of the shared ENUM infra structure.

The Tier 1 server then stores information of which Tier 2 that supports a given number(-blocks) and when a query is made to the one that matches that stored information, The Tier 1 server provides a pointer to the Tier2 ENUM server that is authoritative for that E.164.number.

Note that each operator chooses, whether all or only a portion of the E.164 numbers he supports is announced to the Tier 1 server. An operator may for example choose to only announce E.164 number associated with IMS subscriptions to the Tier 1 server.

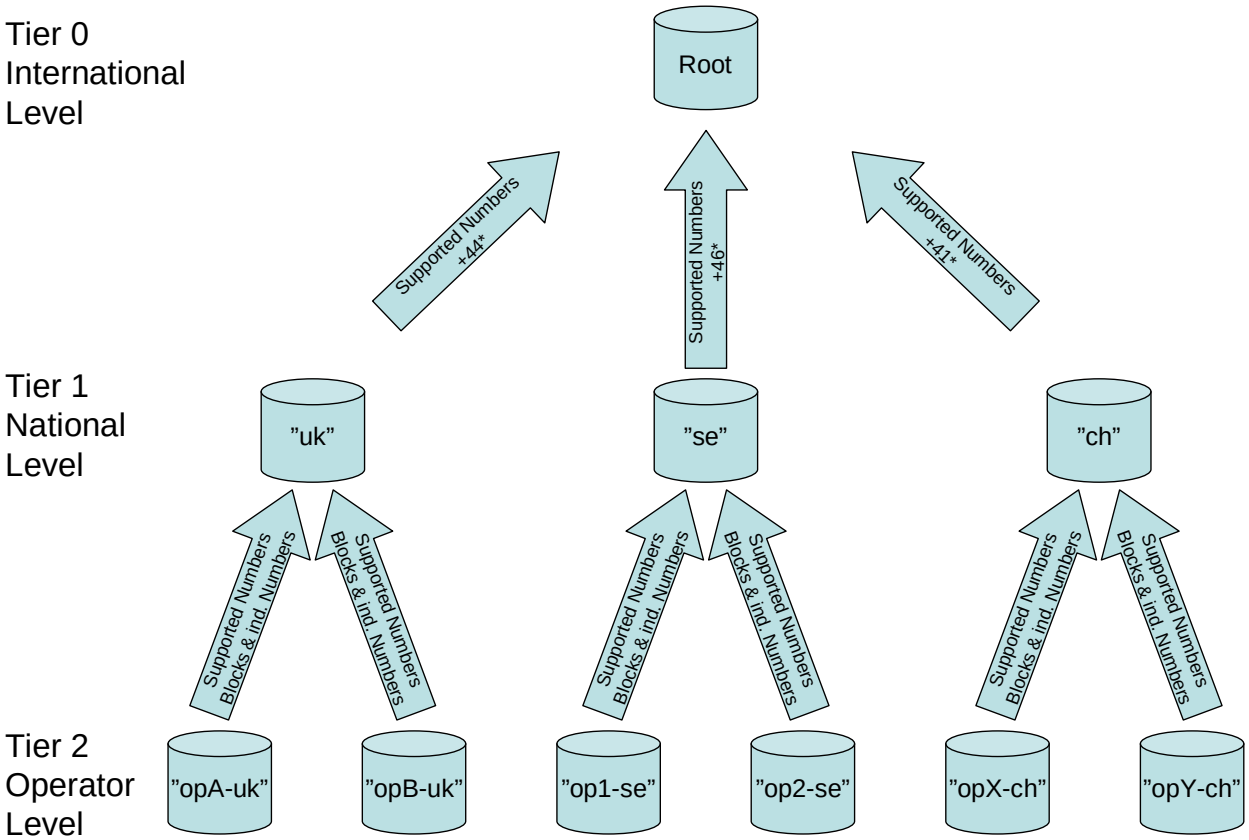

Figure 6.2: Making data available in the Hierarchical Shared ENUM Infrastructure

The key principle with Shared ENUM Infrastructure, is that it is the Tier 2 provider that is responsible for the ENUM NAPTR records, and that the normal way of operation is that the Tier 1 server only provide pointers to the Tier 2 server that hold the data.

From a number portability perspective, the Shared ENUM Infrastructure NAPTR records provided in responses to an ENUM query will provide the information needed to route a call to the serving operator. However, the restriction that this information can only be given for E.164 numbers that are made available into the Shared ENUM Infrastructure still apply.

To retrieve NRI for E.164 numbers that operators choose not to make available into the Shared ENUM Infrastructure and for E.164 number under the control of operators not participating in the Shared ENUM Infrastructure, using the ENUM, some linkage to the OpDBs for number portability may be needed.

There are several ways this may be achieved. Besides the cases described in clause 6.1 where each operator handles the access to the OpDBs from their ENUM/DNS servers, the access to NPD may be managed on national level (Tier 1) as well.

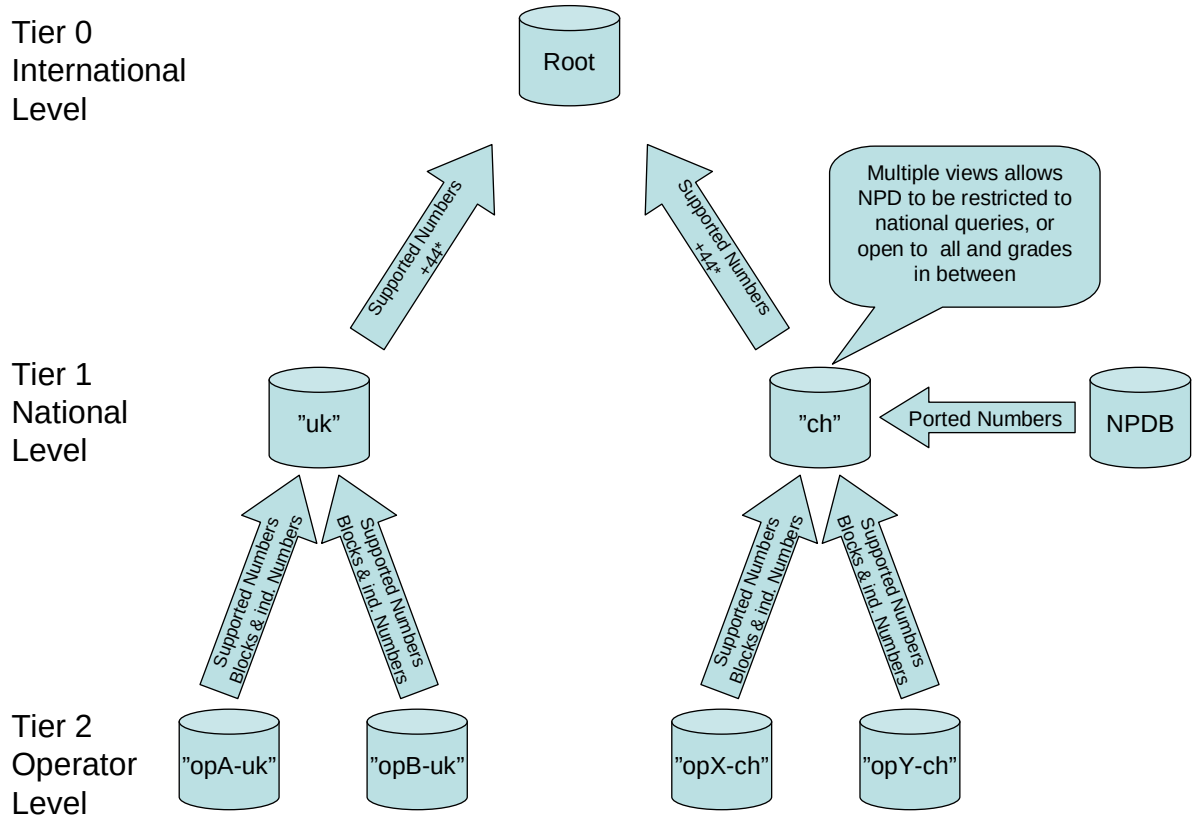

Figure 6.3

One way of doing this would be to incorporate NPD into the Tier 1 server, as shown in figure 6.3, such that if no Tier 2 would have announced support for a particular E.164 number, the Tier 1 server could provide the NRI information in a NAPTR record. However, if any Tier 2 server has announced support for the E.164 number that was queried, the Tier 1 servers has to respond with a point to that Tier 2 server instead. This is to allow the serving operator to provide the NAPTR records.

In case a National OpDB (NOpDB) exist, that supports ENUM DNS, an alternative to incorporating the NPD in the Tier 1 server, would be to provide a pointer to the PSTN/PLMN OpDB. However, this requires that the PSTN/PLMN OpDB can act as server in the Shared ENUM Infrastructure tree.

It should be noted that both methods for allowing access to NPD via the Tier 1 ENUM server as described above, allows for a way to provide international access to NRI, and thereby facilitating that the terminating operator can be identified from the originating side also for international communications.

However, in both cases above it would be possible to give access to the NRI based on from where the query is received. I.e. it would be possible to restrict or allow the access to NRI for queries from Tier 2 servers from other countries, by providing different responses (views) based on from where a query is made.

For example, if access to the NRI is restricted for queries from certain servers, and no Tier 2 server has indicated support for the E.164 number, then the Tier 1 server would provide an "NXDOMAIN" response instead of an NAPTR record with the NRI or a pointer to PSTN/PLMN OpDB.

6.3 NGN service layer architecture for Number portability

6.3.1 General

Within the NGN architecture it is mainly the PES subsystem and the IMS that are involved in and responsible for retrieval of NRI from real time data base environment, and acting on this NRI such that the call will be routed.

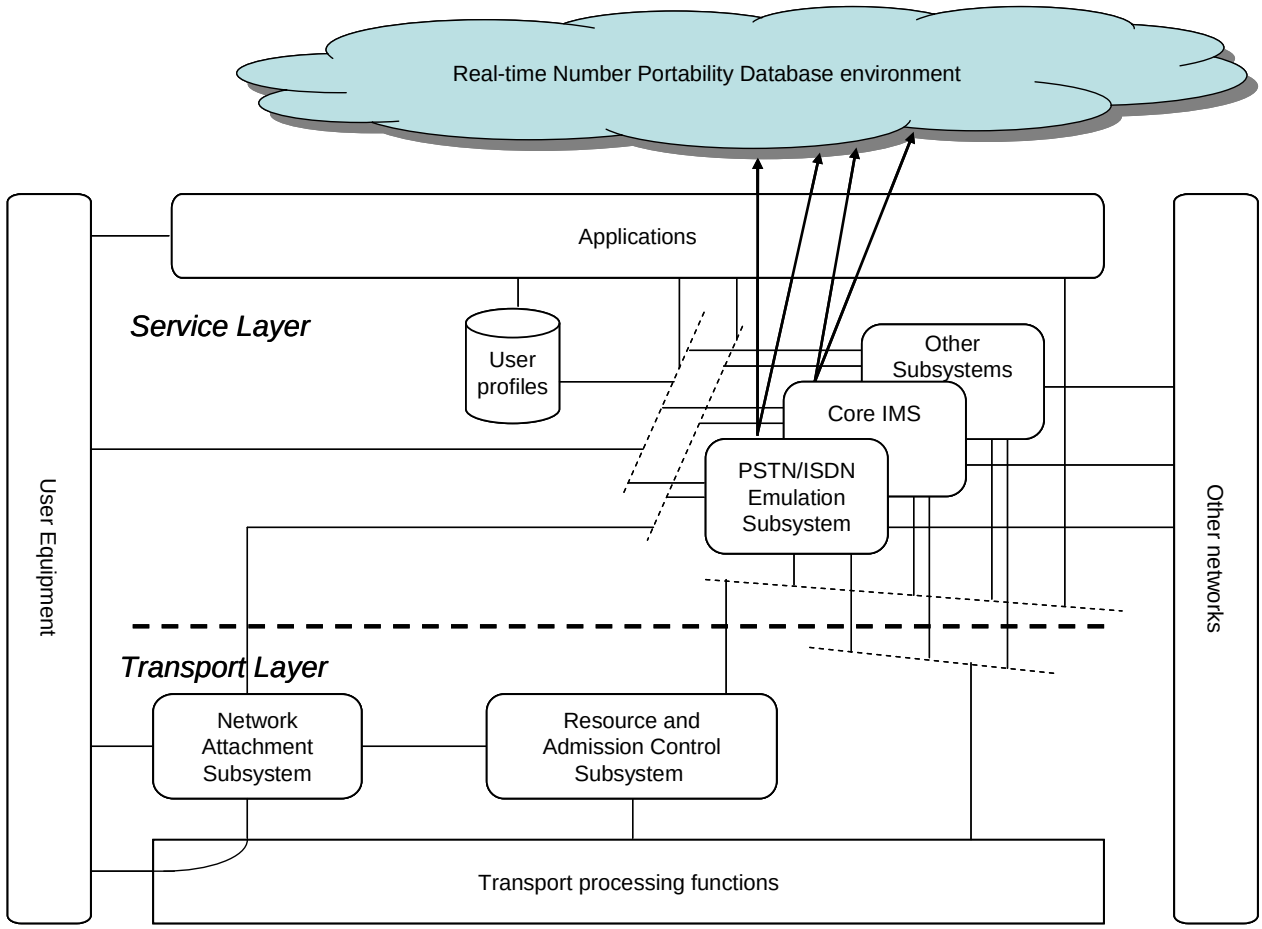

Figure 6.4: NGN subsystems accessing NRI

6.3.2 Architecture for the core IMS

Regarding Number Portability the following is specified in clause 4.18 of TS 123 228 [i.13].

"Number portability (NP) allows a user to retain their E.164 number when changing subscriptions from one operator to another. As such, NP applies to tel URIs and SIP URI with user=phone parameters. NP is subject to regional requirements and is accomplished through the retrieval of ported data from those data bases. The specification of these data bases is out of scope of the present document, but the NP data may be accessed through ENUM/DNS or accessed via existing (PSTN- and CS-domain) NP databases using the PSTN/CS-domain protocols, such as TCAP.

Support of NP within a network and the exact means to make the number portability data available to IMS, is subject to and configured per operator policy. NP is not mandated by this specification on any operator.

As configured per operator policy, IMS ENUM interfaces can be updated to support handling of the PSTN ENUM service per RFC 4769 [i.7], which provides a URI containing an E.164 number with NP routing information and NP dip indicators. The IMS entity receiving NP information as a result of an ENUM/DNS query, the S-CSCF as an example, needs to support, or not remove, NP protocol parameters retrieved as part of ENUM/DNS procedures contained in this specification. Subsequent network elements used to process the call to the PSTN do not remove the NP protocol parameters inserted in SIP messaging as part of the NP data retrieval procedure.

NP data can also be made available by means of direct access to PSTN/CS-domain NP Databases using the PSTN/CS-Domain interfaces and protocols. To support this existing interface within the network, the requesting and subsequent network elements need to support, or not remove, NP protocol parameters within SIP messages that result from the NP data retrieval procedures. The procedures to retrieve the NP data using the PSTN/CS-domain interfaces are out of scope of this specification.

Alternatively, per operator policy, the BGCF can retrieve NP data as part of the procedures to select an MGCF for PSTN connection. The interface used at the BGCF to retrieve the NP data is out of scope of this specification.

Alternatively, per operator policy, the MGCF may support legacy interfaces to retrieve number portability data.

NOTE: Although legacy protocols are used to access the number portability database, this does not imply that the IMS nodes (CSCFs, BGCFs) need to implement such protocols.

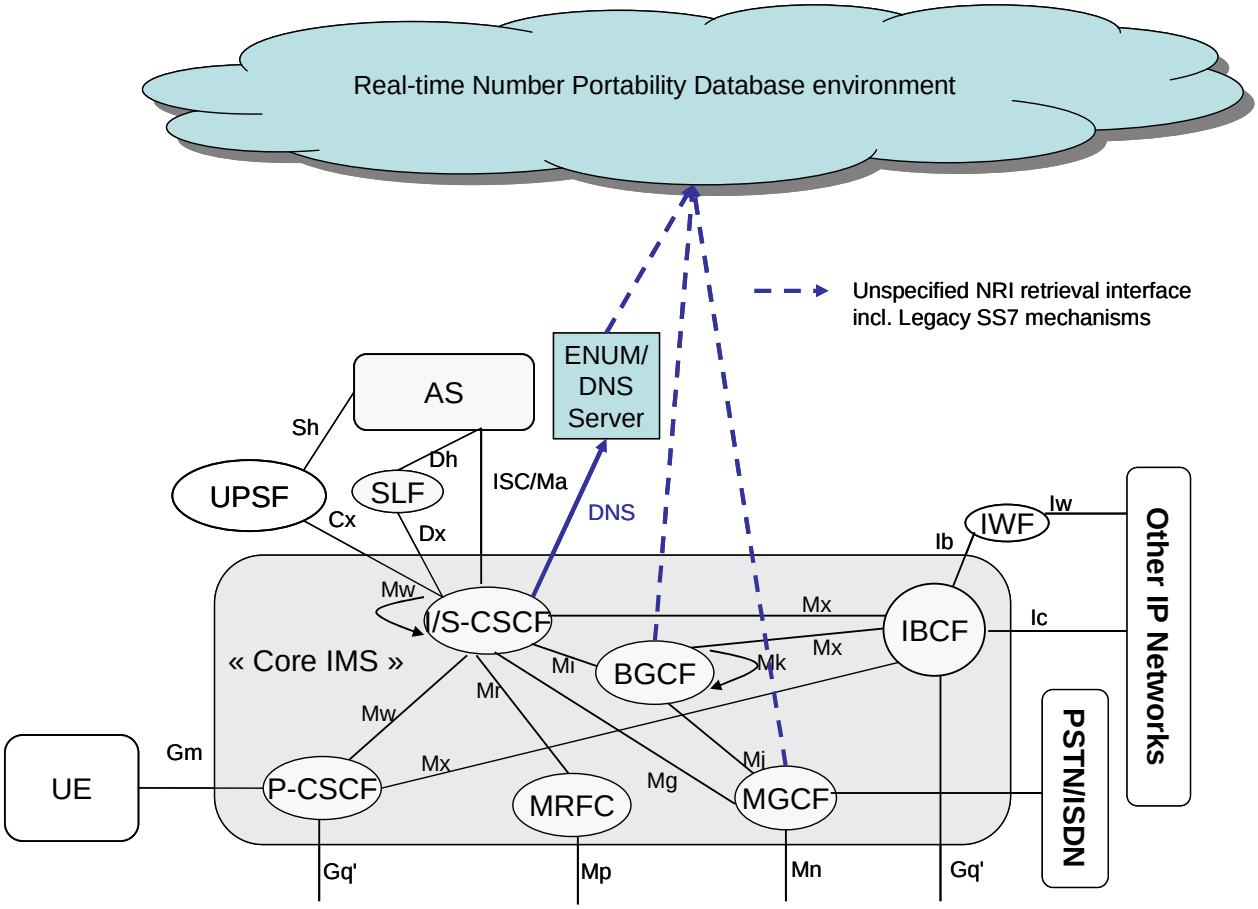

Figure 6.5: Examples of NRI retrieval interfaces from the Core IMS

6.3.3 Architecture for the PSTN/ISDN Emulation Subsystem

For the IMS-Based PSTN/ISDN Emulation subsystem, there is no reason to introduce any other principles then those defined for the Core IMS.

For the "Soft-switch based" PSTN/ISDN Emulation subsystem defined in ES 282 002 [i.14] no normative internal architecture is defined.

Nevertheless, an example architecture with possible interactions for retrieval of NRI is given in figure 6.6.

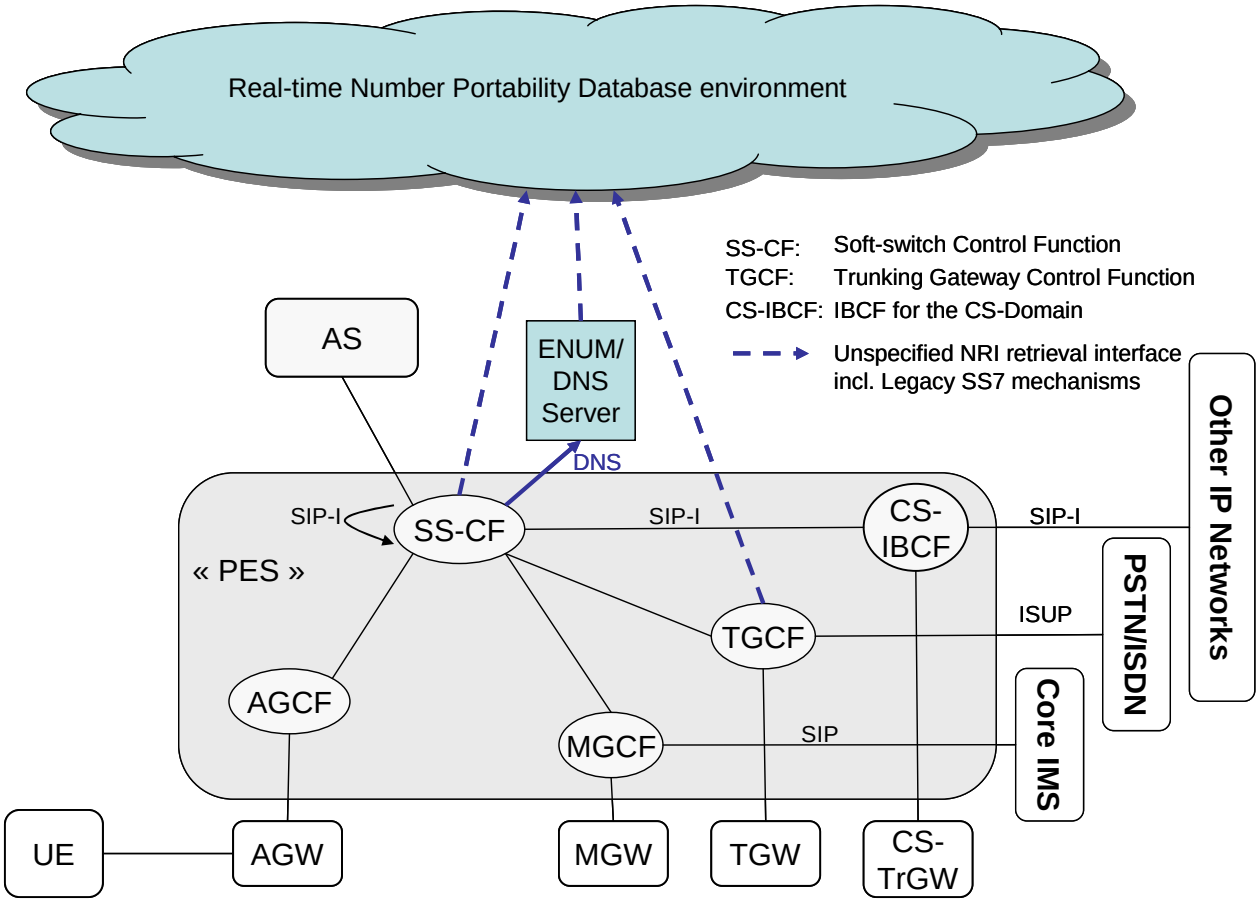

Figure 6.6: Examples of NRI retrieval interfaces from PES

For the PES example architecture in figure 6.6, does not claim to provide a complete architecture and is compiled by introducing a mix of components defined in ES 282 002 [i.14] and TS 129 235 [i.15].

7 NP Routing Information (NRI) and interconnection scenarios with other networks

7.1 Overview

This clause tries to identify interconnection scenarios that an NGN could be involved in for calls/sessions to ported telephone numbers. There are different kind of public telecommunications networks that could be interconnected to an NGN.

The interconnected networks could for example be:

- legacy networks (e.g. TDM-based PSTN/ISDN and TDM-based PLMNs based on the GSM system);
- hybrid networks (i.e. legacy networks enhanced with SIP and SIP-I for the NNI towards other networks);
- PLMNs based on the UMTS system;
- Internet and other non-NGN IP-based networks.

Figure 7.1 gives a simplified overview of these kind of networks.

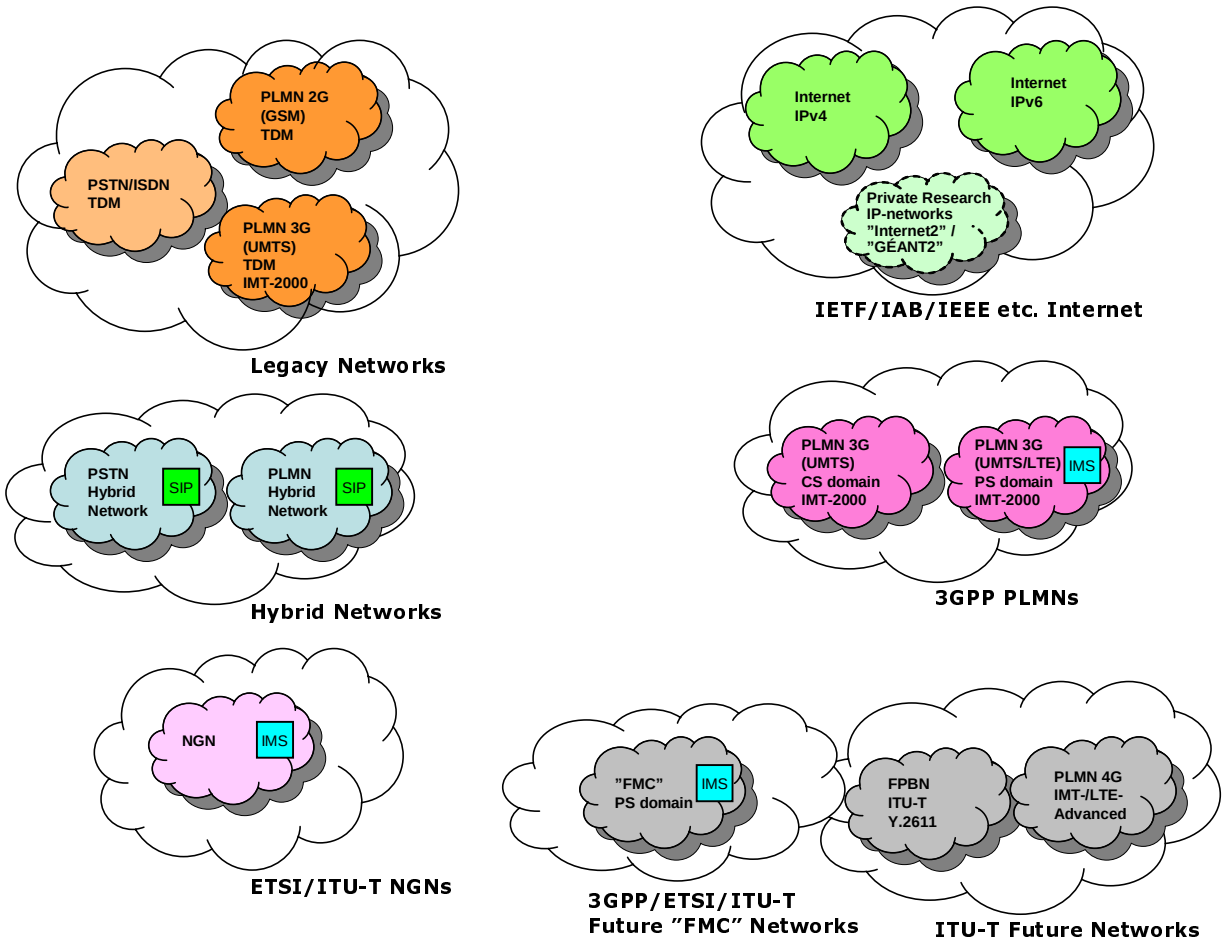

Figure 7.1

7.2 Method of providing NRI in signalling information in NGNs

Previous clauses have considered how NPD can be made available to networks, and how NRI information can be accessed by the NGN Service Layer. This clause considers the nature of that NRI and the available options for passing it within and between networks. A key point to be considered is that, as noted elsewhere in the document, ported calls may have to traverse both NGN and legacy networks. The NGN is therefore be capable of providing the NRI in a form which is usable by legacy networks: specifically this means that the NRI need to be made available in a numeric form (RN+DN) in case the actual destination is a user in the legacy network. If the destination is a user in the NGN the NRI can be in the form of a domain and provided only NGN NNIs will be traversed, no numerical NRI is necessary.

NOTE 1: In case the OpDB need to be accessible also from legecy networks, the NRI information need to be available in a numeric format. The format in which the NRI is provided from the OpDB can then be dependent on from where or via which methods the OpDB is queried.

NOTE 2: In cases where the two networks are interconnected via both legacy interfaces and NGN interfaces, it could be advantageous if the NRI was available as numeric (RN+DN) and as a domain name at the same time. This would allow flexibility to route the call forward using the most appropriate interconnect, without the need to make a second data base query.

There may for example exist agreements that certain type of media is routed using IMS inter-connects, while other media e.g. voice is routed via legacy interconnects.

7.2.1 IETF provisions for Number Portability

Therefore, it is worth noting that RFC 4769 [i.7] provides a means to return NRI as a result of an ENUM query, that also claims to work for numbers ported in the ISDN/PSTN/PLMN.

It is also worth saying that the use of ENUM to retrieve NPD/NRI has necessarily no bearing on which basic method for Number portability implementation is used, and is just as applicable to ACQ as to Call Drop Back.

One aspect of RFC 4769 [i.7] provisions is that instead of a pure substitution of a tel URI, it instead takes the notion of providing supplementary information for routing the call to the "ported-to OP".

In North America, and some other countries, PSTN NRI have traditionally been provided as separate parameters in ISUP, and both RFC 4769 [i.7] for providing LNP information from ENUM and RFC 4694 [i.8] for conveying this information in the Request URI of SIP signalling have been created based on this "tradition".

7.2.2 Potential means to convey NRI in SIP

In many European countries and also other parts of the world NRI has been provided as "prefixes" to the Called Party Number (CdPN).

As it is recognized that the method that use shared NPD between operators normally is a national matter to decide on, the way how the NRI is provided for routing to the "ported-to OP" may also be considered a national matter.

RFC 3261 [i.16], clause 19.1.6 "Relating SIP URIs and tel URLs" recommends to accommodate telephone addressing, the SIP specification includes a provision to incorporate a tel: URI telephone-subscriber (everything following the tel: prefix) directly into the user part of a SIP or SIPS URI, by setting the "user" parameter to "phone".

The following example shows how the mapping is done.

tel:<Local or global number including all parameters>

is mapped to a SIP URI as

SIP: <Local or global number including all parameters>@<host>;user=phone

The parameter "user=phone" accommodates, that SIP servers which are not authoritative for the host portion of a URI do not assume that they understand the semantics of the user info portion, and do not attempt to parse the user info portion of a URI as anything other than an opaque string of characters matching the user. On the other hand SIP servers which are authoritative for the host portion are responsible to parse the user info portion to get information for routing, termination and interworking.

As general overview a number of different ways to convey NRI can be identified for example:

a) Identifying the "ported-to-OP" by domain name in SIP URI:

- Sip:+CC-NDC-SN@Ported-to-OP;user=phone.
- E.g. Sip:+43234598765@provider5.net;user=phone.

b) Using a "prefix" PPPPP to the national (significant) number (N(S)N) to provide information on the "Ported-to-OP" user and indicating this by providing a national specific phone-context, e.g.:

- Tel: PPPPP-NDC-SN;phone-context=+CC.
- E.g. Tel:D1234234598765;phone-context=+49.

or corresponding "SIP: formats" in accordance to RFC 3261 [i.16], clause 19.1.6.

- Sip:PPPPP-NDC-SN ;phone-context=+CC@Ported-to-OP;user=phone.
- E.g. Sip:D1234234598765;phone-context=+49@provider5.net;user=phone.

c) Retaining the international E.164 number unmodified but using the RFC 4769 [i.7] and RFC 4694 [i.8] provisions to provide information on the "ported-to-OP" in the RFC 4694 [i.8] routing number parameter, e.g.:

- Tel:+CC-NDC-SN;npdi;rn=+CC-PPPPP.

- E.g. Tel:+49234598765;npdi;rn=+49-D1234 or.
- Tel:+CC-NDC-SN;npdi;rn=PPPPP;rn-context=+CC.
- E.g. Tel:+49234598765;npdi;rn=D1234;rn-context=+49. Or corresponding "SIP: formats" in accordance to RFC 3261 [i.16], clause 19.1.6.
- Sip:+CC-NDC-SN;npdi;rn=+CC-PPPPP@Ported-to-OP;user=phone.
- E.g. Sip:+49234598765;npdi;rn=+49-D123@provider5.net;user=phone.
- Sip:+CC-NDC-SN;npdi;rn=PPPPP;rn-context=+CC@Ported-to-OP;user=phone.
- E.g. Sip:+49234598765;npdi;rn=D1234;rn-context=+49@provider5.net;user=phone.

d) Retaining the international E.164 number unmodified but using the RFC 4769 [i.7] and RFC 4694 [i.8] provisions to provide information on the "ported-to-OP" in the RFC 4694 [i.8] routing number parameter in an interworking friendly fashion, e.g.:

- Tel:+CC-NDC-SN ;rn=PPPPP-NDC-SN;rn-context=+CC;npdi; or
- Tel:+CC-NDC-SN ;rn=+CCPPPPP-NDC-SN;npdi;
- Or corresponding "SIP: formats" in accordance to RFC 3261 [i.16], clause 19.1.6.

NOTE 1: In the examples in b) and c) above, the hexadecimal digit D is a national prefix used in Germany to indicate a carrier code in the next 3 digits.

NOTE 2: Ported-to-OP stands for administrative domain (e.g. provider5.net) of the ported number PPPPP stands for a national specific prefix + OP identifier, used in legacy networks for NRI.

Table 1 provides a comparison between the different methods a) through d) of providing NRI in SIP.

Table 1: Comparison between the different methods of providing NRI in SIP

Info of Ported-to-OP provided as	Orig/Transit network	Terminating ported-to-OP network	Interworking with PSTN networks using prefix-method
a) Domain name (FQDN) in right-hand side of Request URI: SIP:+CC1234@Ported-to-OP ;user=phone	Simple to route on Domain name only, no indication of ported number	If NGN user: simple to find, If non-NGN user: no info that NP query have been made	Info about Ported-to OP is lost, Cannot be used for interworking with PSTN/ISDN . NP information need to be retrieved from within the PSTN/ISDN
b) As prefix to National (Significant) Number and indicating National specific in phone context	Phone context specific tables for routing needed	Number need be modified before ENUM DB or subscriber DB (UPSF) can be accessed	Translates well to CdPN in IAM
c) use of RFC 4694 [i.8] rn= Prefix only or corresponding SIP URI domain field	Routing based on RN. RN specific tables needed or corresponding SIP URI domain field	The canonical form of R-URI can be used for OpDB access. No format checking of number translation needed	Manipulation of CdPN in IAM required to remove/add "prefix" and populate RN
d) use of RFC 4694 [i.8]; rn= full prefixed national (significant) number or corresponding SIP URI domain field	Routing based on RN. RN specific tables needed or corresponding SIP URI domain field	The canonical form of R-URI can be used for DB access. No format checking of number translation needed	To PSTN: RN translates well to CdPN. From PSTN: CdPN translates well to RN, Prefix need be removed (and the number as a global number according to RFC 3966 [i.18]) for "main user part"

7.2.3 Other aspects

For IMS the use of RFC 4769 [i.7] to acquire NRI is part in Release 8 and has also be incorporated in NGN Release 2 (TS 182 006 [i.9]) as one of the few "early" 3GPP Release 8 features.

For Stage 3 the use of RFC 4694 [i.8] is also accepted as part of the Common IMS SIP profile for 3GPP Release 8 as a standardized means to convey NRI in SIP.

It is recognised that decisions on which mechanism to use to convey NRI is a national matter. Nevertheless, it is recognised that using RFC 4694 [i.8] as a basis, provides the advantages of retaining the canonical form (without any parameters) of the Request URI untouched. This would also provide for a mechanism to distinguish the NRI identifying the serving operator from the called telephone number, and would allow such information be provided across national boundaries where so permitted.

8 Supplementary service aspects

Number portability does not have any impact on supplementary services.

9 Quality of Service aspects

Depending of implementation options of number portability it can have impact on the session set up time ("call set up time", also known as "post dialling delay").

Annex A: Administrative support/process for number portability and OSS aspects

ETSI have earlier produced a document (TR 101 698 [i.17]) that considers the inter-operator/service provider processes that is required to support Number Portability, in particular, the information transfer requirements. Processes include:

- service establishment (including initial contact, planning, implementation and testing);
- impact upon number administration;
- customer porting (including requests, validation, scheduling, contingency planning, porting);
- subsequent portability, cessation;
- service maintenance (including network changes, introduction of new number ranges);
- fault handling;
- ancillary system processes (which may include billing, directory enquiries, emergency;
- services, numbering plan administration and law enforcement agencies).

The subsequent amendment to a porting order, or postponement to a porting order is outside the scope of TR 101 698 [i.17].

Minor information about this process could also be found in clause 12 in in ITU-T Recommendation E.164 Supplement 2 [i.4].

Annex B:
Process foruploading and making Number portability data (NPD) available for the real time environment

B.1 Number Portability Data base (NPDB) implementation options

If it has been decided (see also clause 5.2) to implement a NPDB a basic decision has to be made, which is described by figure B.1.

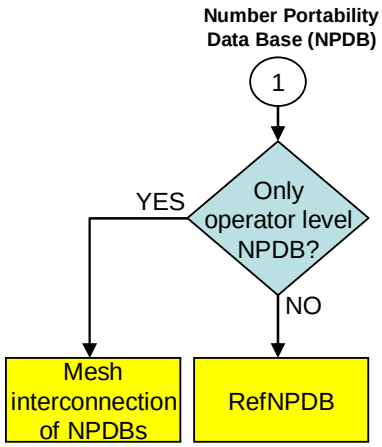

Figure B.1

This basic decision defines the topology of the NPDB. If it has been decided to use a central instance, i.e. the above question has been answered with "no", the available data pool has the potential to serve as a Reference Number Portability Data Base (RefNPDB). If no central instance is used, the infrastructure to exchange NPD is given as a mesh interconnection of (operator specific) NPDBs.

B.2 RefNPDB

The operational principle, when a RefNPDB is implemented is given in figure B.2.

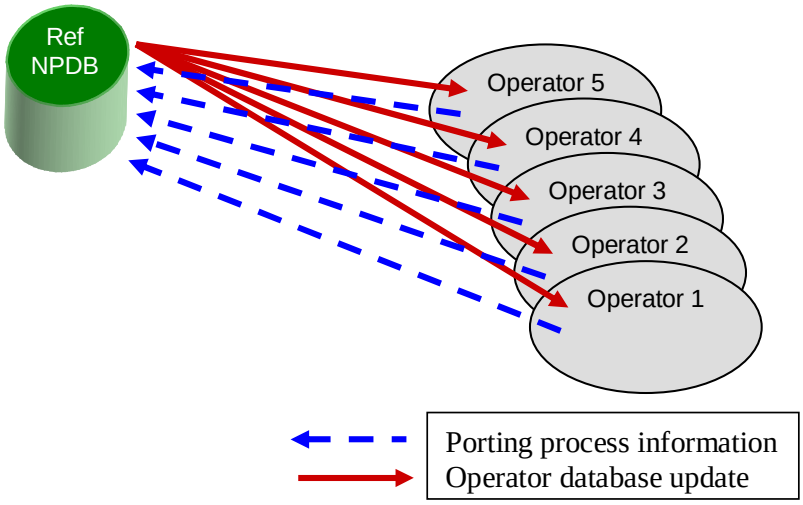

Figure B.2

Every operator reports his porting events to the RefNPDB. Conflicting data records about the same event are coped with by a consistency check. To resolve a potential conflict, an appropriated administrative process has to be implemented. The RefNPDB in turn updates the operator specific NPDBs. As a next step the operators convert the data to an appropriated format and feed them into their real time systems. By this way it is assured that every operator is routing on the basis of the same data.

This topology could further be enhanced by implementing a real time query capability at the RefNPDB. This leads to a National OpDB (NOpDB), whose processes of been fed with data are described in clause B.3

B.3 National OpDB (NOpDB)

If a NOpDB is to be implemented, the process of feeding it with NPD is basically the same than with the RefNPDB. The mayor difference is that the operator specific NPDs are not updated, as the NOpDB is queried for routeing purposes. So the operators do not need their own OpDBs. Figure B.3 shows the scenario.

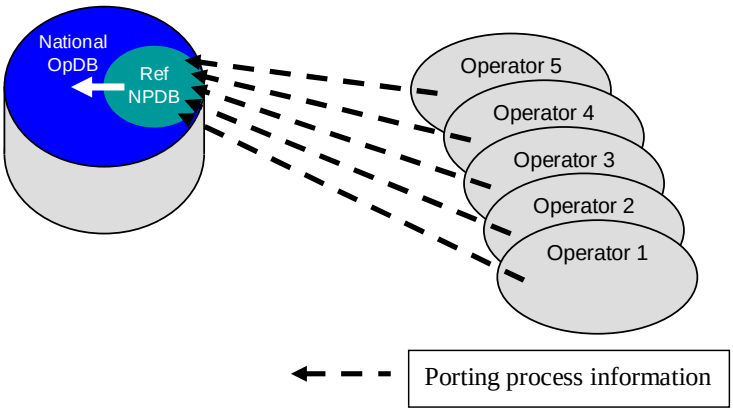

Figure B.3

The operators reports about porting events are fed to a functional entity which was already described as RefNPDB. After performing the consistency check on this data and resolving possible conflicts, the data are converted to an appropriated format and loaded to the real time query functional entity of the NOpDB.

B.4 Mesh interconnection of NPDBs

The topology of a meshed interconnection of NPDBs is given in figure B.4.

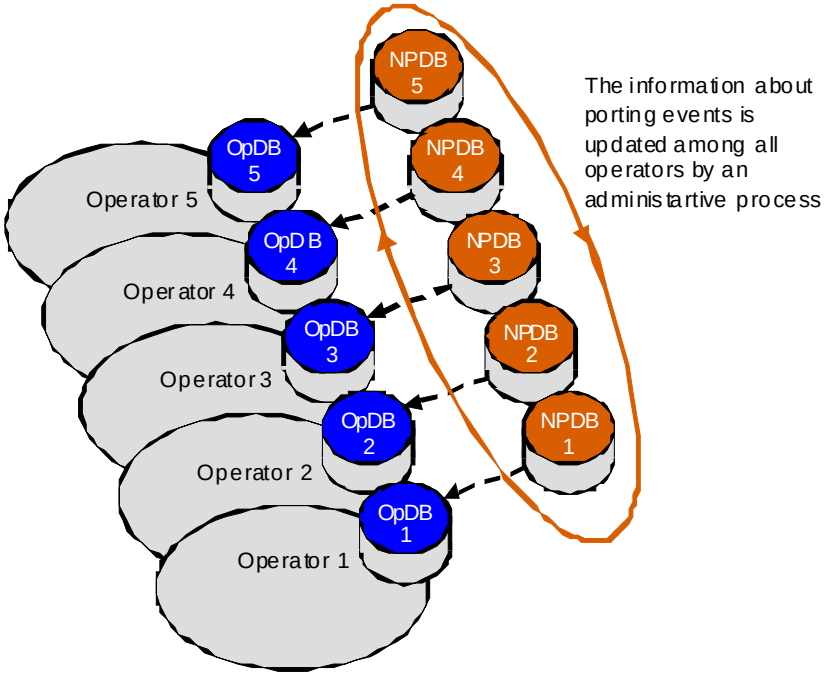

Figure B.4: Mesh interconnection of NPDBs

Within this topology the information about porting events is exchanged between all operators. This leads to a configuration where potentially every potentially operator has a "RefNPDB". Here there is a locical RefNPDB. Each Operator is in charge of his own NPD infrastructure. Due to mistakes and imperfections in reality this may be difficult to achieve. Therefore conflicting publications about the same porting event have to be coped with by a bilateral administrative process. After solving the conflict, both parties have to publish amended data records. These amended data records have to override the original ones within the systems of all other operators. As the implementation may be operator specific and the updates of the operator's NPDB lay within the responsibility of each operator, huge efforts have to be made to achieve a comparable data consistency to the central NPDB approach.

Annex C:
Process of uploading and making ENUM data in a Shared ENUM infrastructure available for the real time environement

ENUM data has to be provisioned on several Tiers:

- Tier 0: This ENUM DB delegates to the national Tier 1 DBs, and is therefore relatively static.
- Tier 1: Different princples for provisioning of this DB may apply in different countries. Not every country need to operate a Tier 1 Database. In some countries the Tier 1 database may also contain Number Portability Data (NPD). The exact details how NRI may be provisioned in an ENUM Tier 1 Data base is not covered by the present document.
- Tier 2: This is the active DB for each network, where ENUM Data is made available as part of subscriber data provisioning.

Further aspects relating to making ENUM Data available are provided for in [i.12].

History

Document history		
V3.1.1	June 2010	Publication