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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Network Aspects (NA).

1 Scope

The present document is to investigate, address and describe possible High level Network Architectures and Solutions for Number Portability of ITU-T Recommendation E.164 [3] numbers in the fixed telecommunications Network.

The following is included in the present document:

a) possible Network Architectures and solutions to support number portability;

b) Pros and Cons for described Number Portability solutions and influences on services;

c) management issues with regard to NP and selected Data Base solution;

d) the exchange of NP related information between Networks per solution;

e) routeing issues with relation to NP and described solution.

The following types of number portability is to be covered:

1) service provider portability of Geographic Numbers;

2) service provider portability of Non Geographic Numbers.

NP solutions both for Routeing of ordinary calls and for Routeing of connection less supplementary services (e.g. CCBS) are included.

2 References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case 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.

[1] ITU-T Recommendation E.164: "International telecommunications numbering plan".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document the following definitions apply:

In the following a number of definitions are listed, for used but not included definitions please see TR: "High Level Description of Number Portability".

Data Base (DB): A DB is, within the present document, the storage place where a translation of a Portable Number to a Routeing Number (RN) takes place. Other NP related information might exist in same place. The other information might be of either traffical or administrative nature. The other traffical information might be retrieved/used at same time as retrieving the RN.

The DB might be located exchange internal or external depending on Network solution.

Directory Number (DN): A DN is a number in the national numbering scheme that is allocated to a customer for a telephony service. Allocation of the DN is either made directly by the Numbering Plan Administration (NPA) to the customer, or indirectly when blocks of numbers are managed by Service Providers. The DN is the number that is dialled by the users to reach the customer (potentially with prefix and/or with suffix).

donor exchange: A donor exchange is the initial exchange where a number was located before ever being ported.

donor network: donor network is the initial network where a number was allocated by the NPA before ever being ported.

donor service provider: A donor service provider is the service provider from whom the number is ported.

essential service: An essential service is a service that should be executed to allow the call to be continued. Examples of essential services are User to User 1 essential and Closed User Group without outgoing access allowed.

The service is considered not possible to execute when transfer of the service related data is not possible, e.g. to protocol limitations or bilateral agreements.

Gateway Exchange (GW): A GW is, within the present document, an Exchange that has Point of Interconnection(-s) to Exchange(-s) in other Networks.

Geographic Number (GN): A GN is a DN from that part of the national numbering scheme that is used to identify fixed line termination. Prior to Number portability these numbers are geographical in that sense that they conveyed the detailed location of the customer.

Geographic Number Portability (GNP): See Service Provider Portability for Geographic Numbers.

Network Operator: A Network Operator is an entity that operates public telecommunications network in order to route calls.

Non Geographic Number (NGN): NGN is a Directory number that is not a Geographic Number. A Non-geographic Number does not imply the Geographic location of the customer.

Non Geographic Number Portability (NGNP): See Service Provider Portability for Non Geographic Numbers.

Number overview: The Table 1 below shows a simplified overview of Numbers involved in Number Portability, it also exemplifies Non-Geographic Numbers.

Table 1: Relationship between Geographic and Non Geographic Numbers

DIRECTORY NUMBER				
GEOGRAPHIC NUMBER	NON-GEOGRAPHIC NUMBER			
	ETNS Number	Mobile Number	Service Number	Other Non Geographic Number

NOTE: These are examples of non geographic numbers only, and are not prescriptive1

Mobile Number: A Mobile Number (MN) is a Directory Number from a specific range of the national numbering scheme reserved for customers to mobile service(s). MN Portability is outside the scope of this report.

Onward Routeing Exchange (ORE): An Onward Routeing Exchange is, within this document, an Exchange within an Onward Routeing Network (ORN) that makes use of a Routeing Number to route a call onward towards a Recipient Network/Exchange.

Onward Routeing Network (ORN): An Onward Routeing Network (ORN) is, within this document, a Network that makes use of a Routeing Number to route a call onward towards a Recipient Network/Exchange.

Originating Exchange: Originating Exchange IS the Exchange where the calling party is located.

For most incoming international calls, the Originating Exchange is effectively the international gateway Exchange.

For carrier selection, the first exchange of the selected carrier effectively becomes the Originating Exchange for routeing purposes.

Originating Network: Originating Network is the network where the calling party is connected.

For most incoming international calls, the originating network is effectively the network containing the international gateway.

For carrier selection, the first exchange of the selected carrier effectively becomes the originating network for routeing purposes.

Portable Number (PN): A PN)is, within the present document, a DN that a subscriber can port when changing Service Provider.

A PN can e.g. have one of the following statuses:

a) vacant and not ported;

b) used and not ported;

c) ported.

A Ported Number is both Ported-in (Recipient Network) and Ported-out Donor Network) at the same time.

Ported Number: A number that has been subject to number portability.

Ported-in Number: A ported-in number is, within this document, a Portable Number that has been ported into a Recipient Network/Exchange.

Ported-out Number: A ported-out number is, within this document, a Portable Number that has been ported out of a Donor Network/Exchange.

Recipient Exchange: A Recipient Exchange is the new Exchange where a number is located after being ported.

Recipient Network: Recipient Network is the Network where a number is located after being ported.

Recipient Service Provider: A Recipient Service Provider is the Service Provider to whom the number is ported.

Routeing Global Title (RGT): A Routeing Global Title (RGT) is, within this document, obtained from a NP DB by using a Called Party Number as input, it is used to route a connection less service towards Recipient Network or/and Recipient Exchange.

Routeing Number (RN): A Routeing Number is, within this document, a specific number that is added and used by the networks to route the call. The Routeing Number conveys information usable by the network. If the digits dialled by the user match the digits of a routeing number, the dialled digits should not be interpreted as a routeing number.

Service Provider (SP): A Service Provider is an entity that offers services to users involving the use of network resources. The "Service Provider" is understood in this document in a generic way and may have different status according to the service he provides. For example, "Service Provider" refers to a local loop operator in the case of Geographic Numbers, or to a mobile operator in the case of Mobile Numbers, or to a service operator / reseller in the case of Service Numbers.

Service Provider Portability for Geographic Numbers: Service Provider Portability for Geographic Numbers is a service that enables customers to resign their subscription with a Service Provider (Donor) and to contract another subscription with another Service Provider (Recipient) without changing their Geographic Number, without changing their location, and without changing the nature of the service offered.

This service is also known as GNP and also known as Local Number Portability (LNP).

Service Provider Portability for Non geographic Numbers (NGNP): Service Provider Portability for NGNP is a service that enables customers to resign their subscription with a Service Provider (Donor) and to contract another subscription with another Service Provider (Recipient) without changing their Non-geographic Number, and without changing the nature of the service offered.

This service is also known as **NGNP.**

Service Provider Portability for Pan-European Services: Service Provider Portability for Pan-European Services is a service that enables a user to resign their subscription with their current Pan European Service Provider and subscribe to a competitor without changing their pan European Service Number.

Serving Exchange (SE): A Serving Exchange (SE) is, within this document, an Exchange within a Serving Network (SN) that makes a data base (Exchange internal or external) access to retrieve Routeing Number for a call to a Portable Number.

Serving Network (SgN): A Serving Network (SgN) is, in this document, a Network that makes a data base (Network internal or external) access to retrieve Routeing Number for a call to a Portable Number, i.e. it determines whether a number has been ported, and, if so, provides an appropriate routeing number. This functionality may be distributed.

Signalling Point with Relay(SPR): A SPR consists of both the MTP and SCCP layers of ITU-T Signalling System number 7.

Transit Exchange: A Transit Exchange is an exchange between two exchanges, e.g. between the recipient exchange and the donor exchange.

Transit Network: Transit Network is a network between two networks, e.g. between the Recipient and the Donor Networks.

3.2 Abbreviations

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

In the following a number of document internal Symbols and Abbreviations are listed, for not included Symbols and Abbreviations please see "TR: High Level Description of Number Portability.

CCPF	Call Control Portability Functions
CFB	Call Forwarding Busy
CFNR	Call Forwarding No Reply
CFU	Call Forwarding Unconditional
CS	Carrier Selection
DB	Data Base
DN	Directory Number
GNP	Geographic Number Portability
ETNS	European Telephony Numbering Space
MSISDN	Mobile Station ISDN
ISPBX	ISDN PBX
NGNP	Non Geographic Number Portability
NPA	Numbering Plan Administration
NPCP	Number Portability Control Point
NPDP	Number Portability Data Point
NPMF	Number Portability Management Functions
PBX	Private Branch Exchange
PN	Personal Number
RN	Routeing Number
SCP	Service Control Point
SSP	Service Switching Point
SSCP	Service Switching and Control Point
SPR	Signalling Point with Relay functions
STP	Signalling Transfer Point
UAN	Universal Access Number
UPT	Universal Personal Telecommunications
VPN	Virtual Private Network

4 Definition of number portability

For the definition and scope of Number Portability please see TR: "High Level Description of Number Portability".

5 General assumptions and requirements on number portability

5.1 Assumptions

The following document internal assumptions have been made:

a) that Calling Line Identity (CLI) is required to be transported, with display information, unchanged to Recipient Network;

b) that Connected Line Identity (COLI) is required to be transported, with display information, unchanged to Originating Network;

c) that Initial Routeing arrangements have been defined and implemented prior the introduction of Routeing based on a Routeing Number;

d) it is assumed that Number Portability is not allowed to influence the carrier selection function;

e) It is assumed that a NP solution shall not influence functions in Private Branch Exchange (PBX's);

f) porting (i.e. reallocation) of complete number blocks is outside this report, works already.

For other General assumptions on Number Portability please see TR: " High Level Description of Number Portability".

5.2 Requirements

It is required that a High Level Network Architecture for Number Portability allows Network Operator(-s) freedom and privacy in the arrangement of the Network internals as long as the external requirements are fulfilled. External requirements to a Network could be e.g. supplementary service level transparency, post dialling delay, robustness and duration to support porting of Portable Numbers.

Number Portability data distribution aspects is also considered, this to allow evolution, smooth portability, safety and privacy.

For other Requirements on Number Portability please see TR: "High Level Description of Number Portability".

6 High level evolutionary network models to support call set-up when service provider portability is allowed for geographic numbers

6.1 Background information

To ease Routeing tables in the current Public Telecommunications networks (PSTN and ISDN), ITU-T Recommendation E.164 [3] numbers are normally handled and allocated to geographic areas in blocks of e.g. 10.000 subscriber numbers. Each of the blocks are then given to the care of one network provider. The network Operator then either allocates the full 10.000 block or parts of it (e.g. in sub blocks of 1.000 numbers) to a particular Local Exchange (LE), i.e. all subscribers having a subscriber number within a certain block may only be connected to the (local) Exchange handling the number block in question. An other fact has been that a subscriber moving into a new geographic area may only receive a number within the number block(-s) maintained by the new serving operator and new local Exchange to be connected to.

The Routeing of a call to subscriber part of PSTN/ISDN, is normally done based on the 10.000 number block the called subscriber number is part of. This traditional principle for Routeing of a call will need to change when introducing Service Provider Portability of Geographic Numbers, since the number series that the called number is part of will no longer have a relation to a particular operators network.

6.2 General introduction to described models

The following subclauses describes a high level evolutionary model for Service Provider Portability for Geographic Numbers. Non Geographic Numbers within scope of this report, is covered by own chapters.

The drawings in the figures and the descriptions are focused on:

a) the location in the telecommunications Network where NP information is maintained and stored, i.e. place of DB;

b) the location in the telecommunications Network where NP actions are initiated/triggered;

c) the location in the telecommunications Network where NP data is retrieved, i.e. place of DB query;

d) the location in the telecommunications Network where NP data is used for call Routeing;

e) interconnection issues.

NOTE: The emphasis on placing the NP DB in the figures is from where the DB access is performed and what triggered the DB access. Despite the figures show the location of the DB within the domain of a particular Network it shall be understood that the DB might very well be located outside that domain, e.g. commonly maintained by a third party.

Four main types of Networks are described and identified as involved (depending on the level of NP evolution in the Networks concerned) in setting up a call to a ported subscriber:

1) Originating Network;

2) Transit Network;

3) Donor Network;

4) Recipient Network.

NOTE: For most incoming International call the Originating Network will be the Network containing the incoming international gateway. The similar is applied for an incoming call from a PLMN, i.e. that the first incoming GW exchange in the fixed network is regarded as Originating Exchange unless the PLMN has NP DB query capabilities also for Numbers belonging to the fixed network.

Despite that management functions not are shown in the figures one should understand that such exist. The management functions might, depending on choices of solutions, be grouped in four areas:

A) Management of all the national numbers (i.e. all NP domains in a country);

B) Management of a single NP domain (e.g. domain of an Area code);

C) Management of NP within a Network providers domain;

D) Management of NP within a Network element (e.g. domain of a LE).

Depending on solution one, two or all four areas of management functions might exist. The Management functions for Number Portability are modelled and described in later chapters.

It shall be understood that other signalling systems than ISUP can be used despite arrows, e.g. IAM and REL, in the figures uses abbreviations that exist in the ISUP protocol.

The main discussions around loop and NP DB mismatch detection in run time is described in TR: " Numbering and Addressing for Number Portability".

6.3 Call re-routing initiated/performed by donor network

This subclause intends to describe possible High Level NP solutions in a Donor Network.

6.3.1 Call Re-routed from Donor Network by use of Onward Routeing principles

6.3.1.1 General Description

The first step/solution discussed for Number Portability is often that the Donor Network maintains the portability information, i.e. the complete Address to both Recipient Network and Exchange, for ported-out numbers and reroute incoming calls to ported-out numbers Onward towards the Recipient Network according to Onward Routeing principles outlined in figure 1.

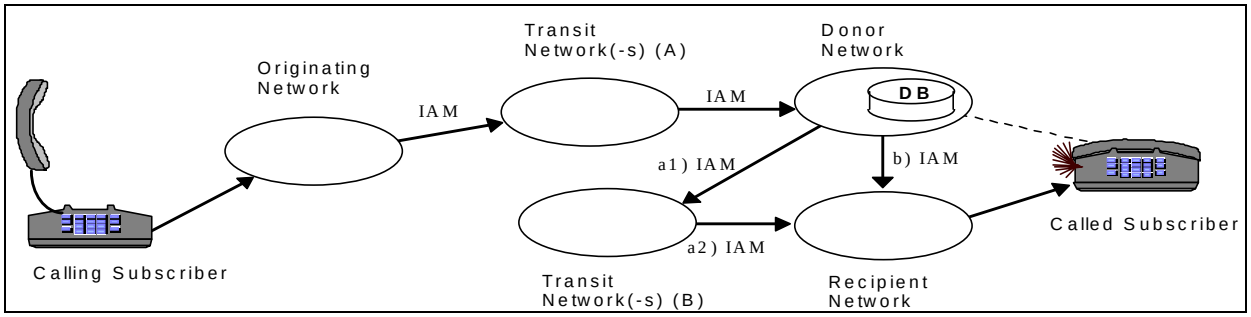

Figure 1: Call Re-routing to Recipient Network by Onward Routeing principles from Donor Network

In figure 1, the Donor Network receives an Incoming call. It then detects that the called number has been ported-out to another network, makes a DB query to retrieve a Routeing Number. It thereafter reroute the call onward towards the Recipient Network using retrieved Routeing information.

Option a1 and a2 is valid when Donor Network either has no direct interconnection to Recipient Network or when overflow traffic is placed via Transit Network B.

The option b is valid when direct interconnection exists between Donor Network and Recipient Network

Despite that the Donor Network acts as a "Onward Routeing" Network to preceding Networks it can use several of the NP techniques within the Network, see later subclauses for this.

Please note that the Transit Network(-s) are optional, i.e. direct interconnections connections between Originating Network and Donor Network might very well exist and the same also between Donor Network and Recipient Network. Note also that the Transit Network(-s) A and B can be the same depending on network structure and call case.

6.3.1.2 Interaction with supplementary services

The service level between Originating Network and Recipient Network is dependent on the level supported by the Donor Network since this scenario/solution requires that the Donor Network have at least the functionality level as the other involved networks, otherwise it will limit the service level for the ported subscribers i.e. some calls might fail with e.g. reason "incompatible destination", e.g. when a caller has requested User-User-1 essential and this service is not supported by Donor Network or that the service is not allowed over operator border to Donor.

The use of same inter-exchange protocol within all networks and also that the same interconnection agreements are established between all involved Networks would avoid the interference with supplementary services, but it is highly debatable if possible or even wanted to achieve.

6.3.1.3 Interaction with IN based services

The same is valid as for interactions with supplementary services, i.e. see previous subclause.

6.3.1.4 Interaction with carrier selection

No interaction identified, in the scope of this report.

6.3.1.5 Interaction with statistical counters

No interaction identified.

6.3.1.6 Required forward information transfer between networks

Routeing Information is mandatory in the forward direction, from Donor Network. The Information is needed to inform Transit and Recipient Networks the destination Recipient Network and Recipient Exchange.

In addition to the above there might be an interest of having a separate indication that a database lookup, for NP Re-routing, has been performed, this so that the Transit/Recipient Network(-s) easily can recognize/trap incoming calls towards ported subscribers. On the other hand, the reception of Routeing Number might very well be enough indication.

6.3.1.7 Required backward information transfer between networks

No new NP related data is identified in the backward direction, in the scope of this report.

6.3.1.8 NP Routeing loop detection issues

No additional loop cases identified, this since this solution only involves retrieval of Routeing information once.

6.3.1.9 Pros

The main advantages with this solution are that:

a) the Donor Network remains being responsible for the number series with ported-out numbers, it also continues maintenance of data related to the numbers, this possibly limits the impacts on management systems of Donor;

b) the preceding Networks do not need to know if called number has been ported or not, this possibly limits the impacts on management systems of Donor;

c) no new forward call indication is needed towards the Donor;

d) possibly limited impact on signalling systems;

e) additional processing capacity is only required for calls to ported-out numbers.

6.3.1.10 Cons

The main disadvantages with this solution are that:

a) the functionality level for the call is dependent on the Donor Network, i.e. calls with essential services (e.g. if U-U-1 essential) not supported by Donor will fail despite supported by other involved Networks. Non essential services will be suppressed if not supported by Donor;

b) the Network resources are not used as efficient as for calls to non ported subscribers;

c) new Routeing information is needed in forward direction from Donor towards Recipient Network;

d) call set-up time will differ between calls to ported-out and not ported numbers;

e) the recipient network(-s) should inform donor network(-s) when modifying network internal structure, i.e. it does not allow for privacy for Network Operators;

f) there is a risk that the subscriber context capabilities will be exhausted in Donor LE (if NP data is maintained exchange internal) since more numbers or even number blocks should be maintained to continue having same amount of subscribers connected.

6.3.2 Call re-routed by drop-back principles from donor network

6.3.2.1 General description

One possible enhancement of the previously described Onward Routeing solution, is that the Donor Network initiates the Re-routing of the call towards the Recipient Network according to "Drop-back" principles outlined in figures 2 and 3 below. Also in this scenario only the Donor Network maintains NP information, i.e. the complete Address to both Recipient Network and Exchange, for ported-out numbers.

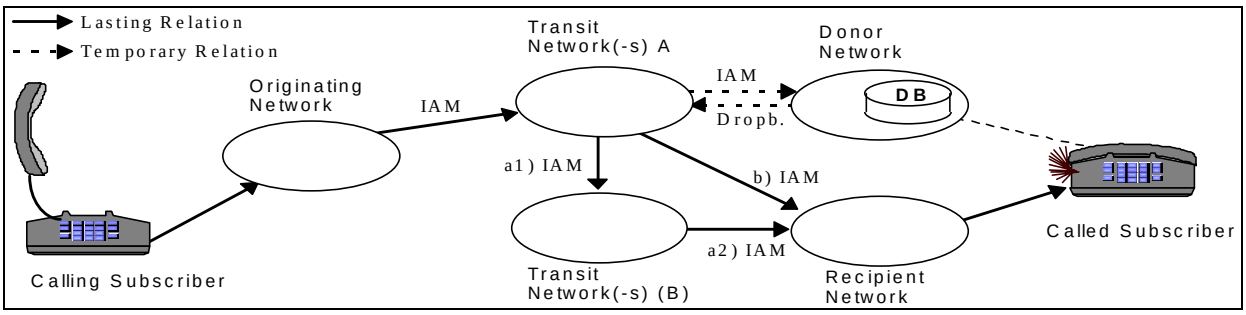

Figure 2: Drop-back with re-routing information and onward re-routing performed by a transit network

In figure 2, the Donor Network receives an Incoming call. It then detects that the called number has been ported-out to another network. It then determines, on basis of received signalling information, that one of the preceding Networks is capable of handling a "Drop-back" message. It thereafter releases the call with a special indication telling that number is ported-out and Re-routing information is enclosed. The transit network then traps the "Drop-back" and reroute the call onward towards the Recipient Network using received backward information.

Option a1 and a2 is valid when Transit Network A either has no direct interconnection to Recipient Network or when overflow traffic is placed via Transit Network B.

The option b is valid when direct interconnection exists between Transit Network A and Recipient Network.

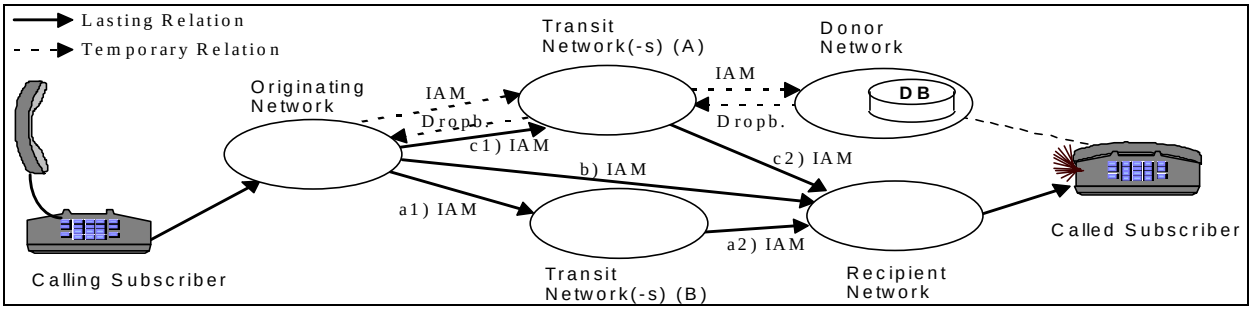

Figure 3: Drop-back with re-routing information and onward re-routing performed by the originating network

In figure 3, either the Transit Network A has no "Drop-back" capability or determines that the preceding Network has "Drop-back" capability. It therefore lets the Release pass through to Originating Network. The Originating Network, at reception of the Release reroute the call towards Recipient Network.

Despite that the Donor Network acts as a "Call Drop-back" Network to preceding Networks it can use several of the NP techniques within its Network, see later subclauses for this.

Please note that the Transit Networks are optional, i.e. direct connections between Originating Network and Donor Network might very well exist but on the other hand the Transit Network might exist (case a1 and a2) between the Onward Routeing (Transit or Originating) Network and Recipient Network.

A further evolution of the "Drop-back" principle outlined in the figure 2 is that the Drop-back message is sent back to the Originating Network as in figure 3. This evolution is mainly of interest if the Originating Network has direct interconnections to other Networks than the Transit Network used in the call attempt to the Donor Network.

Option a1 and a2, in figure 3, is valid when Originating Network either has no direct interconnection to Recipient Network or when overflow traffic is placed via Transit Network B.

The option b, in figure 3, is valid when direct interconnection exists between Originating and Recipient Networks.

The option c1 and c2, in figure 3, is required when Carrier Selection is valid for the call i.e. the Originating Networks reuses the Carrier Selection information after reception of Drop-back message. It could be debated if a selected carrier (e.g. TN A in figure 3) is allowed/recommended to transport the drop-back to Originating Network, but it has no option if it has no redirect on "Drop-back" capability.

6.3.2.2 Interaction with supplementary services

A risk of Interference exists for essential supplementary services since the Donor Network should be reached to get redirection information, i.e. call might be released prior reaching Donor Network. Interference might exist also for non essential services if the drop-back is not sent back to the Originating exchange.

A way out is that the all involved networks have same interconnection agreements, but this might not be enough e.g. the same signalling systems should also be used within all networks in the case call should travel until Donor Local Exchange to get Routeing Information.

The "Drop-back" should not be sent through the Exchange that has performed a Call forwarding service like CFU, Call Forwarding Busy (CFB) or Call Forwarding No Reply (CFNR) etc. this to avoid unwanted interference with these kind of services.

6.3.2.3 Interaction with IN based services

The "Drop-back" should not be sent through the Service Switching Point (SSP) that has performed an IN service like PN, Universal Personal Telecommunications (UPT), Virtual Private Network (VPN), Universal Access Number (UAN), etc. this to avoid unwanted interference with these kind of IN based services.

6.3.2.4 Interaction with carrier selection

An identified Interaction with carrier selection is described as option c1 and c2 in figure 3.

6.3.2.5 Interaction with statistical counters

Standards for Circuit quality counters/statistics should be mollified to handle Drop-back conditions, otherwise alarms might come for functioning circuits/destinations when number of calls to ported-out numbers are high. I.e. a drop-back message should not be handled as an ordinary release before answer.

6.3.2.6 Required forward information transfer between networks

In the forward direction (IAM), towards Donor, there is a need of an indication telling whether or not "Re-routing on Drop-back" is supported or not, this to inform succeeding Network if it should do the Re-routing or if the release can be sent backwards i.e. "Drop-back" can only be performed when a preceding Network has functionality to perform Re-routing based on returned Re-routing information.

An option, not requiring the indication, is the use of bilateral agreements, e.g. a route indicator telling if preceding Network has the QoR capability.

An other option, not requiring the indicator, is a homogeneous Network, i.e. all interconnection exchanges has "Re-routing on Drop-back" capability and that this can be assumed by, e.g. Donor.

What is described in subclause 6.3.1.4.1 is valid also here.

6.3.2.7 Required backward information transfer between networks

Re-routing information should be sent in Backward direction, from Donor, to inform preceding Networks about the Address to the Recipient Network and Recipient Exchange.

Possibly special release indication "Drop-back" is also needed to allow circuit quality counters be correctly stepped.

6.3.2.8 NP routeing loop detection issues

No additional loop cases identified, this since this solution only involves retrieval of Routeing information once.

6.3.2.9 Pros

The main advantages with this solution are that:

a) the Donor Network remains being responsible for the number series with ported-out numbers, it also continues maintenance of data related to the numbers, this possibly limits the impacts on management systems of Donor;

b) the preceding Networks do not need to know if called number has been ported or not, this possibly limits the impacts on management systems of Donor;

c) more efficient utilization of network resources, than in the Onward Routeing case;

d) if the drop-back is sent until Originating Network also the accounting will be same as for calls to non ported subscribers;

e) some additional non essential supplementary services might work (still problems exist with the essential ones), compared to the Onward Routeing case, this thanks to less networks involved (e.g. no Donor) in the final call set-up;

f) additional processing is only required for calls to ported subscribers.

6.3.2.10 Cons

The main disadvantages with this solution are that:

a) the functionality level for the call is dependent on the Donor Network, i.e. calls with essential services (e.g. if U-U-1 essential) not supported by Donor will fail despite supported by other involved Networks;

b) the Network resources are not used as efficient as for calls to non ported subscribers;

c) new Routeing information is needed towards Donor Network;

d) new Routeing information is mandatory in forward direction from Re-routing Network;

e) adaptations are required to ensure that Circuit quality counters will not become more or less useless when the percentage of calls to ported numbers is high;

f) the recipient network(-s) should inform donor network(-s) when modifying internal network structure, i.e. it does not allow for privacy for Network Operators;

g) there is a risk that the subscriber context capabilities will be exhausted in Donor LE (if NP data is maintained exchange internal) since more numbers or even number blocks should be maintained to continue having same amount of subscribers connected.

6.3.3 Call re-routing initiated by "Query on Release (QoR)" principles from donor network

6.3.3.1 General description

A similar case as the previously described "Drop-back" principle is when the preceding Network to Donor initiates NP actions, i.e. a NP DB query, at reception of a Release Message, this case is often referred to as "Query on Release (QoR)", see figure 4 and 5.

The release message contains a certain indication (e.g. special cause value or Diagnostics Information) telling that the called number is ported-out. Optionally no special indication is received in the release (REL) message, this case is valid when Donor network maintains no data for ported-out numbers.

The failure reason "destination incompatible" (and similar other failure reasons) should be included to trap cases where the Donor Network might be of lower functionality level than the Originating/Transit and an essential service was used, i.e. the DB should be queried to determine in the number is ported-out, if so then the call is redirected to Recipient.

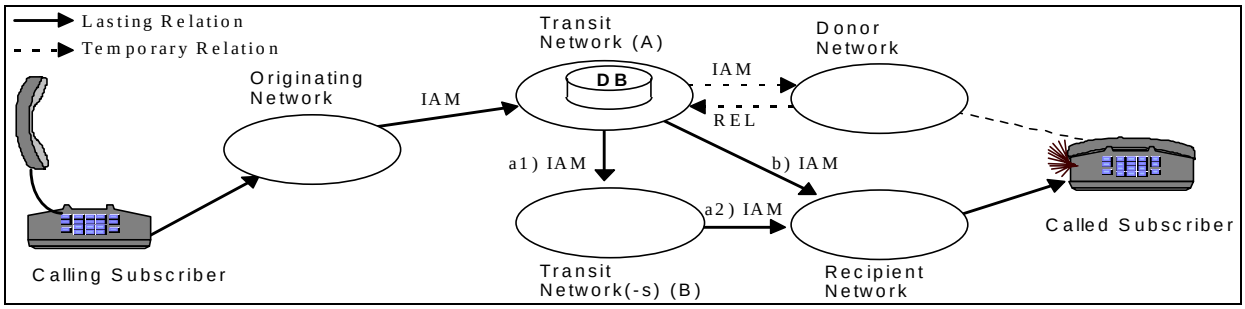

Figure 4: Query on release by transit network

In figure 4, the Donor Network receives an Incoming call. It then either detects that the called number has been ported-out to another network or optionally only that the number is just vacant in this network. It then determines that one of the preceding Networks has QoR capability by looking at received signalling information. It thereafter releases the call with or without a special indication telling that called number is ported-out. The transit network then traps the Release, determines that preceding network has no QoR capability, makes a NP data base query and reroute the call onward towards the Recipient Network. In this scenario the Transit Network has access to a NP DB with the complete Address to both Recipient Network and Exchange, at least for ported-out numbers.

Option a1 and a2, in figure 4, is valid when Transit Network A either has no direct interconnection to Recipient Network or when overflow traffic is placed via Transit Network B.

The option b, in figure 4, is valid when direct interconnection exists between Transit Network A and Recipient Network.

Please note in this case that the DB query might take place also in the Originating Network, i.e. that the DB could also exist in the origination Network as described in the figure 6 below.

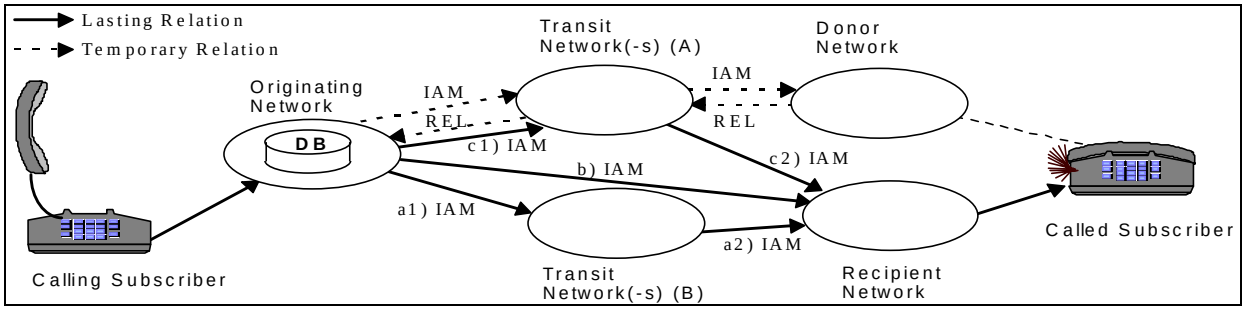

Figure 5: Query on release by originating network

In figure 5, either the Transit Network A has no QoR query capability or determines that the preceding Network has QoR capability. It therefore lets the Release pass through to Originating Network. The Originating Network, at reception of the Release queries its NP data base and reroute the call towards Recipient Network. In this scenario the Originating Network has access to a NP DB with the complete Address to both Recipient Network and Exchange, at least for ported-out numbers.

It shall be noted that despite the Number Portability DB is drawn within the domain of the Transit and Originating Networks, it shall be understood that the actual physical location of the DB might be within any of the Networks or even outside the Networks, e.g. maintained by a third party. The key issue is what triggers the query and in which of the Networks the query is performed.

A further evolution of the "Query on Release" principle outlined in the figure 4 is that the Release message is sent back to the Originating Network as in figure 5, this evolution is mainly of interest if the Originating Network has direct connections to other Networks than the Transit Network currently used.

Option a1 and a2, in figure 5, is valid when Originating Network either has no direct interconnection to Recipient Network or when overflow traffic is placed via Transit Network B.

The option b, in figure 5, is valid when direct interconnection exists between Originating and Recipient Networks.

The option c1 and c2, in figure 5, is required when Carrier Selection is valid for the call i.e. the Originating Networks reuses the Carrier Selection information after querying NP DB. It could be debated if a selected carrier (e.g. TN A in figure 5) is allowed/recommended to transport the "Drop-back" to Originating Network, but if it has no option if it has no redirect on "Drop-back" capability.

6.3.3.2 Interaction with supplementary services

Interference risk exists for essential supplementary services in the case that Transit Network should be reached to get redirection information. Interference risk might also exist for non essential services in the case that release message is not sent back to the Originating exchange.

No interference with supplementary services in the case that release message is returned back to the Originating local exchange and query is also made when release with "incompatible destination" is received.

The "Release" should not be sent through the Exchange that has performed a Call forwarding service like CFU, CFB or CFNR etc. this to avoid unwanted interference with these kind of services. In the number is found out to be really vacant, after the DB query, then a special release indication should be sent to indicate this. This to avoid DB query in preceding networks.

6.3.3.3 Interaction with IN based services

The "Release" should not be sent through the SSP that has performed an IN service like PN, UPT, VPN, UAN, etc. this to avoid unwanted interference with these kind of IN based services.

6.3.3.4 Interaction with carrier selection

An identified Interaction with carrier selection is described as option c1 and c2 in figure 6.

6.3.3.5 Interaction with statistical counters

Standards for Circuit quality counters/statistics should be mollified to handle QoR conditions, otherwise alarms might come for functioning circuits/destinations when number of calls to ported-out numbers are high. I.e. a drop-back message should not be handled as an ordinary release before answer.

6.3.3.6 Required forward information transfer between networks

In the forward direction there is a need of an indication telling whether or not Query on Release (QoR) is supported or not, this to inform succeeding Network if it should do the Query (and redirection) or if the release can be sent backwards. An option to this forward call indication, is incoming route data according to bilateral agreements principles (similar as for the drop-back case).

What is described in subclause 6.2.1.4.1 is valid also here.

6.3.3.7 Required backward information transfer between networks

New Re-routing information "Ported-out number" is sent backwards (e.g. by use of a special cause value or Diagnostics Information), i.e. when the Donor Network keeps some limited data also for ported-out numbers so that differing (compared to really vacant numbers) release information can be given when calls are made to these subscribers. This will reduce the number of DB queries made when few numbers are ported.

Optionally the new backward information above is not needed, i.e. when the Donor Network keeps no data for ported-out numbers and only returns "vacant number" also for calls to these numbers.

6.3.3.8 NP Routeing loop detection issues

No additional loop cases identified, this since this solution only involves retrieval of Routeing information once.

6.3.3.9 Pros

The main advantages with this solution are that:

a) it might allow the Donor Network to discontinue maintaining Routeing information for ported-out numbers;

b) more efficient utilization of network resources, than in the Onward Routeing case;

c) If the release is sent until Originating Network also the accounting will be same as for calls to non ported subscribers;

d) Both non essential and essential supplementary services might work , this in the case that the Release is sent to the Originating Network;

e) call set-up no longer dependent on Donor and might not be on Transit either;

f) Additional processing capacity only required for calls to ported-out (but optionally also to vacant) numbers.

6.3.3.10 Cons

The main disadvantages with this solution are that:

a) new Routeing information is needed towards Donor Network;

b) new Routeing information is needed in forward direction from Re-routing Network;

c) adaptations are required to ensure that Circuit quality counters will not become more or less useless when the percentage of calls to ported numbers is high;

d) donor might need to maintain an indication for ported-out numbers;

e) the recipient network(-s) should inform other network(-s) when modifying network internal structure, i.e. it does not allow for privacy for Network Operators.

6.4 Call re-routing initiated/performed by transit network prior to donor network

This subclause intends to describe possible High Level NP solutions in a Transit Network prior to a Donor Network.

6.4.1 Re-routing initiated by reception of re-routing information from succeeding network

Re-routing according to "Drop-back" principles when drop-back can not be returned to preceding Network is already described in previous subclause.

6.4.2 Re-routing initiated by reception of "number ported-out information" from succeeding network

Re-routing according to "Query on Release (QoR)" principles is already described in previous subclause.

6.4.3 Re-routing initiated by "all call query one step" principles

6.4.3.1 General description

A further evolution of NP solutions, compared to "Drop-back" and "Query on Release" principles, in a Transit Network is the principle of always query a NP Data Base prior Routeing the call towards Donor/Recipient Network, i.e. Re-routing according to "all call query one step" principles as outlined in figure 6 below.

In this scenario the Transit Network (TN) has access to a NP DB with the complete Address to both Recipient Network and Exchange, at least for ported-out numbers. Recipient Network need not do any own query in this scenario since complete address is obtained by TN.

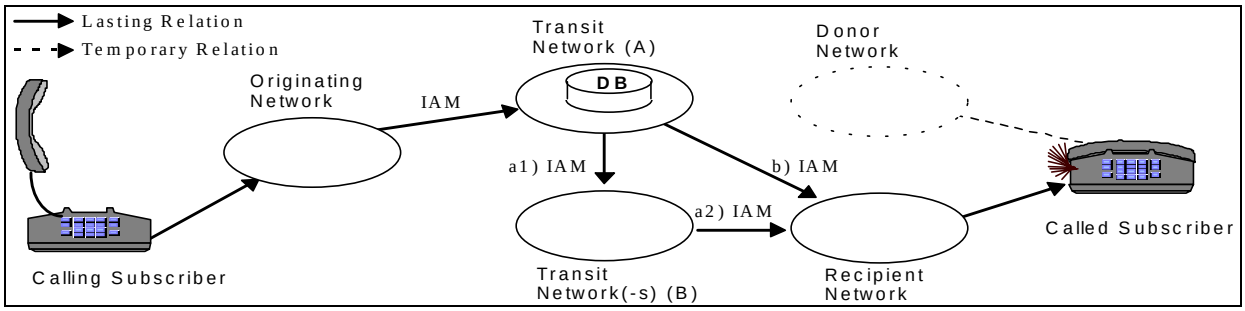

Figure 6: "All call Query" by transit network.

As can be seen from the figure 6 above the Donor Network is not involved at all in the call set up to the ported subscriber.

Calls might be onward routed back (i.e. tromboned), from Transit A, to Originating network in the case that Originating and Recipient networks are the same. A way out of this is that Originating network keeps track of ported-in subscribers and only uses Transit for Inter-network calls.

6.4.3.2 Interaction with supplementary services

Interference risk exists, i.e. call might not be delivered, for calls with essential supplementary services since the Transit Network should be reached to get redirection information. Interference risk might also exist for non essential services if the Originating Network for calls to non ported subscribers uses a direct interconnection to the Recipient Network i.e. the functionality level between Originating and Transit Network A and B might differ according to type of interconnection and bilateral agreements. Calls with not supported non essential services will still be delivered, but the not supported service(-s) are suppressed.

6.4.3.3 Interaction with IN based services

No interference/impact identified.

6.4.3.4 Interaction with carrier selection

If calling party has requested carrier selection then Transit Network(A) would be the requested carrier.

6.4.3.5 Interaction with statistical counters

No interference/impact identified.

6.4.3.6 Required forward information transfer between networks

What is described in subclause 6.2.1.4.1 is valid also here.

6.4.3.7 Required backward information transfer between networks

No new NP related information is identified in the backward direction for call Routeing purposes.

6.4.3.8 NP routeing loop detection issues

No additional loop cases identified, since this solution only involves retrieval of Routeing information once only, even for calls over Operator borders.

6.4.3.9 Pros

The main advantages with this solution are that:

a) it allows the Donor Network to discontinue maintaining data for subscriber numbers no longer in response of;

b) more efficient utilization of Network resources, than in the Onward Routeing case;

c) shorter call set-up time to poted-out subscribers, than in the QoR;

d) some additional supplementary services might work (less Networks involved);

e) statistical circuit quality counters will work as today thanks no release involved prior redirection;

f) Donor Network will not need to consider processing capacity for incoming calls to ported-out numbers;

g) equal treatment of calls to both ported and not ported subscribers;

h) calls to really vacant subscribers are trapped prior reaching Donor, this saving load (in Donor) and possible accounting costs (in Transit A) for non successful calls.

6.4.3.10 Cons

The main disadvantages with this solution are that:

a) the functionality level for the call is dependent on the Transit Network, e.g. calls with essential services (e.g. if U-U-1 essential) not supported by Transit will fail despite supported by other Originating and Recipient Networks. Non essential services might not work;

b) the Network resources might not be used as efficient as for calls to non ported subscribers;

c) new Routeing information is needed in forward direction from Re-routing Network, i.e. Transit A;

d) longer call set-up time for calls to not ported subscribers, than in the onward Routeing, Query on Release and Drop-back cases;

e) additional processing capacity (the query) is needed for all calls;

f) tromboning to Transit for intra network calls, compared to query performed in Originating Network;

g) the recipient network(-s) should inform other network(-s) when modifying internal network structure, i.e. it does not allow for privacy for Network Operators;

h) large processing capacity required in DB since all calls will require DB query.

6.5 Call re-routing performed by originating network

This subclause intends to describe possible High Level NP solutions in an Originating Network.

6.5.1 Re-routing initiated by reception of re-routing information from succeeding network

Re-routing according to "Drop-back" principles when drop-back can not be forwarded to preceding Network is already described in previous subclause and is valid also for Originating Networks since Drop-back will not be returned to subscriber.

6.5.2 Re-routing initiated by reception of "number ported-out information" from succeeding network

Re-routing according to "Query on Release (QoR)" principles is already described in previous subclause and is also valid for Originating Networks.

6.5.3 Re-routing initiated by "All call query one step" principles

6.5.3.1 General description

Same principles are valid as for Transit Network but for clarification the "All call query" principles is shown in the figure 7 below. In this scenario the Originating Network has access to a NP DB with the complete Address to both Recipient Network and Exchange, at least for ported-out numbers. This implies that only one NP DB lookup needs to be performed to complete the call.

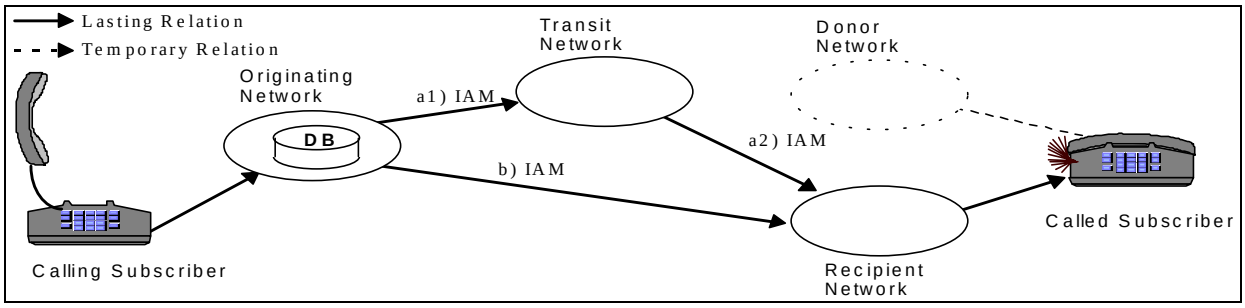

Figure 7: All call Query by Originating Network

As can be seen in the figure 7, the Donor Network is not involved in the call set-up at all, however optionally the Transit Network (see case a1 and a2 above) might be transiting the call to the Recipient Network.

6.5.3.2 Interaction with supplementary services

No interactions with supplementary services are foreseen if DB query is made in the Originating Local Exchange. Otherwise there might be some interference's with e.g. with services having subscriber attribute(-s) normally only available in the Originating LE.

6.5.3.3 Interaction with IN based services

No interference/impact identified.

6.5.3.4 Interaction with carrier selection

This case is not necessarily valid if calling party has requested carrier selection, i.e. If calling party has requested carrier selection then Originating Network would not need to do any NP DB query, instead the call can be routed directly to Transit Network which then is responsible for further Routeing towards recipient.

6.5.3.5 Interaction with statistical counters

No interference/impact identified.

6.5.3.6 Required forward information transfer between networks

Re-routing information should be sent over Network borders to inform about both the Recipient Network and Recipient Exchange.

6.5.3.7 Required backward information transfer between networks

No new NP related information is identified in the backward direction for call Routeing purposes.

6.5.3.8 NP Routeing loop detection issues

No additional loop cases identified, since this solution only involves retrieval of Routeing information once only, even for calls over Operator borders.

6.5.3.9 Pros

The main advantages with this solution are that:

a) it allows the Donor Network to discontinue maintaining data for subscriber numbers no longer in response of;

b) as efficient utilization of Network resources, as for calls to non ported numbers;

c) shorter call set-up time, than in the QoR case to ported subscribers;

d) all supplementary services will work, as for calls to non ported numbers, thanks to no dependency on other networks (than used for other calls) to set up the call to recipient;

e) Originating Network has full control over call Routeing;

f) Statistical circuit quality counters will work as today thanks no release involved prior redirection;

g) Donor Network will not need to consider processing capacity for incoming calls to ported-out numbers;

h) equal treatment of calls to both ported and not ported subscribers;

i) calls to really vacant subscribers are trapped already in Originating, this saving load (in both Transit and Donor) and possible accounting costs (in Originating) for non successful calls;

j) no interference with Carrier Selection;

k) robust network since no dependency on other networks in getting Routeing information for calls to ported subscribers.

6.5.3.10 Cons

The main disadvantages with this solution are that:

a) NP related Routeing information is mandatory in forward direction from Re-routing (i.e. Originating) Network;

b) longer call set-up time for calls to not ported subscribers, than in the Onward Routeing, Query on Release and Drop-back cases;

c) additional processing capacity (the query) is needed for all calls;

d) large processing capacity required in DB since all calls will require DB query;

e) more networks required to invest in DB techniques;

f) the recipient network(-s) should inform other network(-s) when modifying internal network structure, i.e. it does not allow for privacy for Network Operators.

6.6 Call re-routing to recipient performed by a two step number translation principle

6.6.1 General description

This subclause intends to describe a High Level NP solution when a two step number translation principle is used. The first step include a number translation to obtain partial Routeing information indicating recipient Network (optionally also point of Interconnection) and where the second step obtains the complete Routeing information indicating also the Recipient Exchange according to the following:

1 retrieval of partial Routeing information indicating recipient network only (optionally also point of Interconnection).

This step can either be initiated by:

a) Onward Routeing by Donor (only calls to ported-out numbers);

b) Drop-back from Donor (only calls to ported-out numbers);

c) Query on Release (only calls to ported-out numbers);

d) "all call Query" by Transit (all calls to portable numbers);

e) "all call Query" by Originating (all calls to portable numbers),

2 retrieval of complete Routeing information indicating also recipient Exchange.

Performed by Recipient Network either at reception of an incoming call with only partial Routeing Information or for all incoming calls (to portable number blocks).

The figure 8 below shows a NP solution where the Donor Network detects that the called number has been ported-out, makes a NP DB query on the received CdPN to retrieve a partial Routeing Number to address the Recipient Network. It then routes the call onward towards the Recipient Network either directly or via Transit Network(-s).

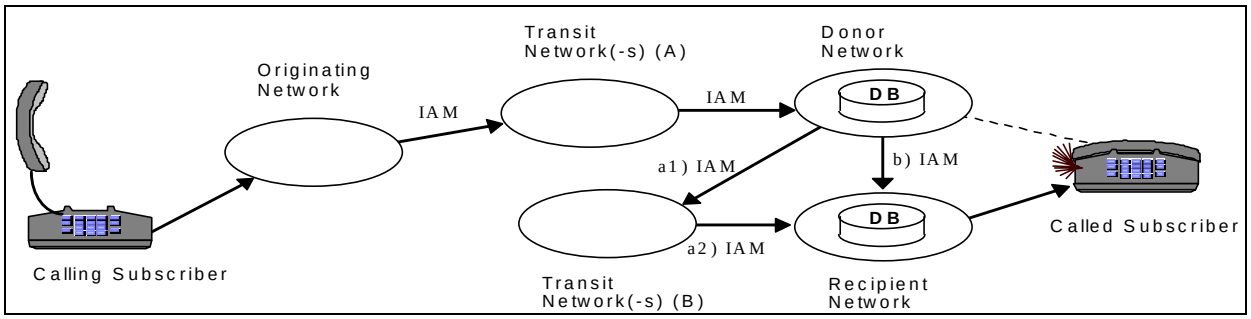

Figure 8: Onward routeing by donor combined with query by recipient network

The figure 9 below shows a NP solution where the Donor Network detects that the called number has been ported-out, makes a NP DB query on the received CdPN to retrieve a partial Routeing Number to address the Recipient Network. It then returns a release message which is sent all the way to Originating Network which uses the received Routeing Number, routes the call towards the Recipient Network either via Transit Network(-s) or directly.

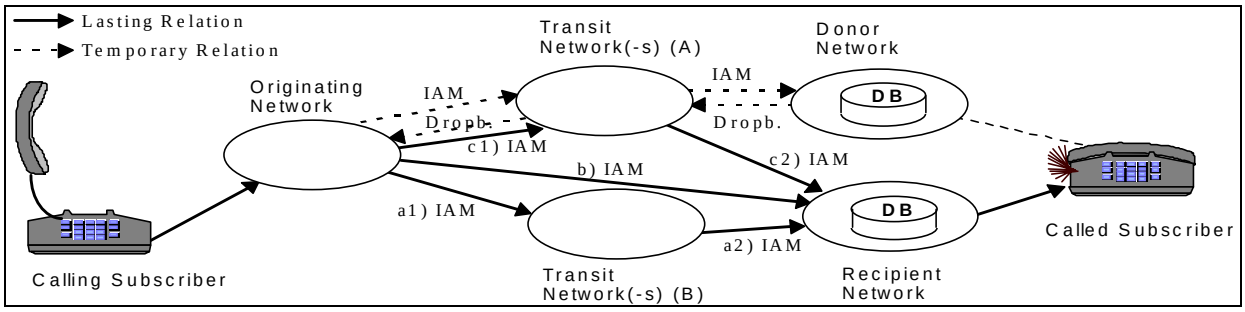

Figure 9: Drop-back combined with query by recipient network

The figure 10 below shows a NP solution where the Donor Network detects that the called number has been ported-out. It then returns a release message, with a special indication "ported" The release message is sent all the way to Originating Network. The Originating Network makes a NP DB query on the CdPN to retrieve a partial Routeing Number to address the Recipient Network, routes the call towards the Recipient Network either via Transit Network(-s) or directly.

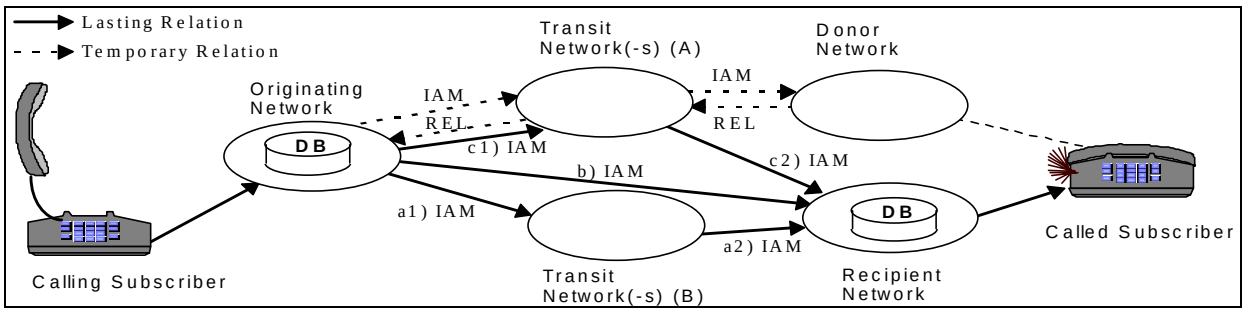

Figure 10: Query on release combined with query by recipient network

The figure 11 below shows a NP solution where the Originating Network routes the call towards the Donor, the Transit makes a NP DB query (e.g. for all outgoing calls) on the CdPN to retrieve a partial Routeing Number to address the Recipient Network. It then routes the call towards the Recipient Network either via another Transit Network(-s) or directly.

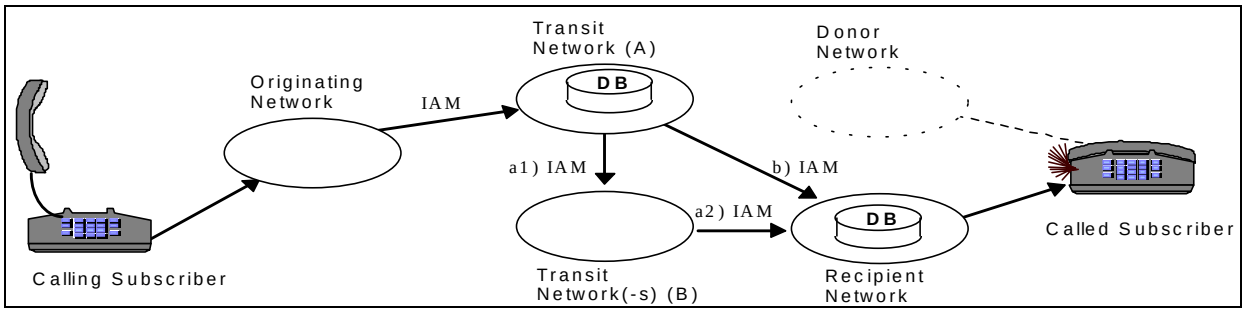

Figure 11: "All call query" by transit network combined with query by recipient network

The figure 12 below shows a NP solution where the Originating Network makes a DB query on the CdPN to retrieve a partial Routeing Number to address the Recipient Network, routes the call towards the Recipient Network either via Transit Network(-s) or directly (option b).

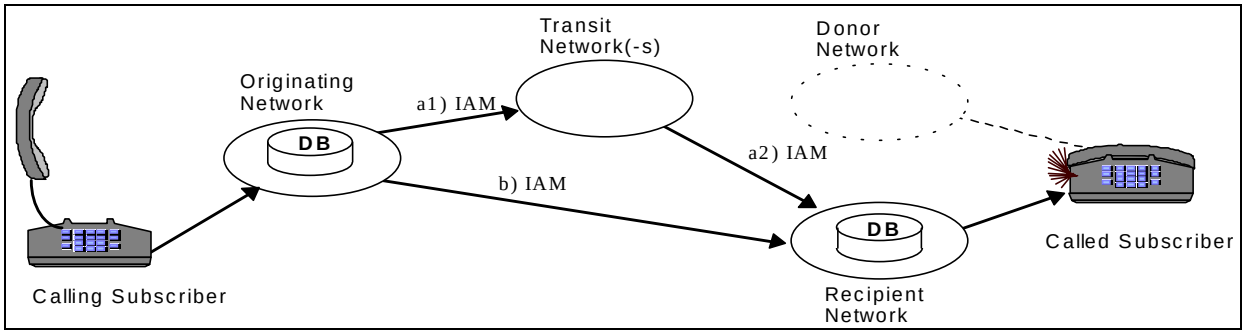

Figure 12: "All call query" by originating network combined with query by recipient network.

For the figures 8-12, the recipient network either traps all incoming calls or traps calls received with a special indication "ported call" or with a partial Routeing number. It then makes a query to "own" NP DB to obtain a complete Routeing number to address the recipient exchange.

In all the above solutions the NP DB outside the Recipient network contains Routeing Information to address the recipient Network only. This principle has two main advantages:

a it allows for privacy of the recipient network;

b) less DB updates are needed, since other Network Data Bases need not be updated e.g. when the recipient Network operator performs internal restructuring of its Network.

For all solutions, the Routeing number is enclosed in the forward message to avoid NP DB query in Transit Network(-s) and to enable trapping of NP DB mismatch by Recipient Network.

6.6.2 Interaction with supplementary services

Interactions with supplementary services are depending on the first Routeing step and are described in previous subclauses.

6.6.3 Interaction with IN based services

No interference/impact identified.

6.6.4 Interaction with carrier selection

Interactions with carrier selection is depending on the first Routeing step and are described in previous subclauses.

6.6.5 Interaction with statistical counters

Interactions with statistical counters is depending on the first Routeing step and are described in previous subclauses.

6.6.6 Required forward information transfer between networks

Forward Routeing information need to be sent over Network borders.

6.6.7 Required backward information transfer between networks

NP related backward information is depending on the first Routeing step and are described in previous subclauses.

6.6.8 NP routeing loop detection issues

Some loop cases are identified, since this solution involves retrieval of Routeing information two times, for a call over Network borders. Only one retrieval required if Originating and Recipient Networks are the same.

Loop and NP DB mismatch detection can easily be performed by recipient network by comparing received Routeing Number (indicating recipient Network ID i.e. own network) with the Routeing Number received from the own NP DB. I.e. the retrieved Routeing number should not indicate other network than own.

6.6.9 Pros

The main advantages with this solution are that:

a) network operators need not inform others when making changes in their internal network, i.e. privacy of network internals is maintained;

b) less NP DB updates are needed.

In addition to the above listed pros, please see relevant subclauses for each of the first step Routeing options.

6.6.10 Cons

The main disadvantages with this solution are that:

a) additional processing capacity (the query) is needed for all incoming calls to Recipient network.

In addition to the above listed cons, please see relevant subclauses for each of the first step Routeing options.

6.7 Call re-routing performed by using "all call query all involved networks" principles

6.7.1 General description

This subclause intends to describe a High Level NP solution when all involved Networks, at call set-up, has access to a Number Portability Database as outlined in figure 13 below.

The Originating Network makes a DB query on the dialled CdPN to retrieve a Routeing Number to address the Recipient Network, routes the call towards the Recipient Network either directly or via Transit Network(-s). The Routeing Number indicates either Recipient Network only or optionally also Point of Interconnection.

Transit Network(-s) receives the incoming call, makes a DB query again to retrieve a Routeing Number to Recipient Network, then it routes the call towards the Recipient Network either directly or via another Transit Network(-s). Again the Routeing Number indicates either Recipient Network only or optionally also Point of Interconnection.

The Recipient Network receives the incoming call, makes a DB query again to retrieve a Routeing Number to Recipient Exchange, then it routes the call towards the Recipient Exchange.

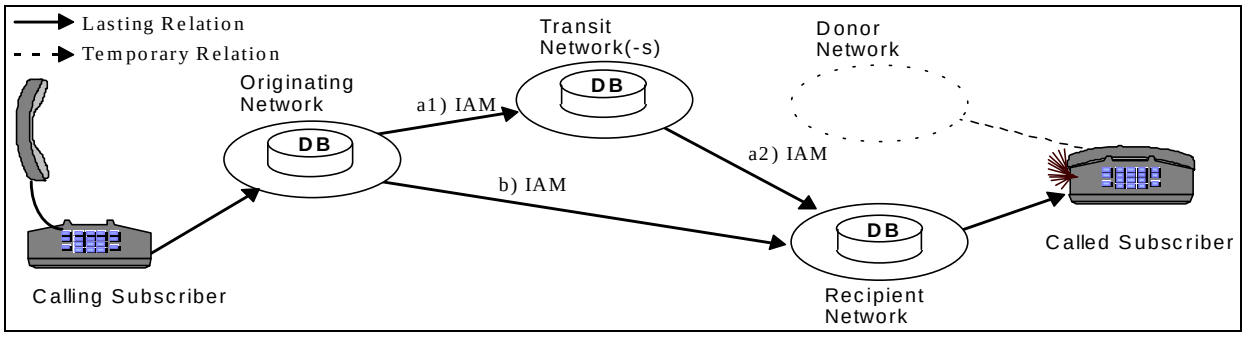

Figure 13: All call Query by all involved Networks

As can be seen in figure 13, all involved networks have access to a Number Portability Data Base, this opens the possibility of not needing to transfer NP related Routeing information between networks.

As also can be seen in the figure, the Donor Network is not involved in call set-up at all.

6.7.2 Interaction with supplementary services

No interactions with supplementary services are foreseen since DB query is made, prior call set-up, by all involved Networks, i.e. calls to ported-out numbers is routed as efficient as for calls to non ported numbers.

6.7.3 Interaction with IN based services

No interference/impact identified.

6.7.4 Interaction with carrier selection

If calling party has requested carrier selection then Originating Network would not need to do any NP DB query, instead the call would be routed directly to a Transit Network which then is responsible for further Routeing towards recipient, figure 11 is the relevant figure for this case.

6.7.5 Interaction with statistical counters

Interactions with statistical counters is depending on the first Routeing step and are described in previous subclauses.

6.7.6 Required forward information transfer between networks

Routeing information need not, but might optionally, be sent over Network borders.

6.7.7 Required backward information transfer between networks

No new NP related information is identified in the backward direction for call Routeing purposes.

6.7.8 NP routeing loop detection issues

Some loop cases are identified, since this solution involves retrieval of Routeing information several times, for a call over Network borders. Only one retrieval is required if Originating and Recipient Networks are the same.

6.7.9 Pros

The main advantages with this solution are that:

a) it allows the Donor Network to discontinue maintaining data for subscriber numbers no longer in response of;

b) as efficient utilization of Network resources, as for calls to non ported numbers;

c) all supplementary services will work, as for calls to non ported numbers, thanks to no dependency on other networks (than used for other calls) to set up the call to recipient;

d) originating Network has full control over call Routeing;

f) statistical circuit quality counters will work as today thanks no release involved prior redirection;

e) donor Network will not need to consider processing capacity for incoming calls to ported-out numbers;

f) equal treatment of calls to both ported and not ported subscribers;

g) calls to really vacant subscribers are trapped already in Originating, this saving load (in both Transit and Donor) and possible accounting costs (in Originating) for non successful calls;

j) no interference with Carrier Selection;

j) robust network since no dependency on other networks in getting Routeing information for calls to ported-out numbers;

k) network operators need not inform others when making changes in their internal network, i.e. privacy of network internals is maintained;

l) not mandatory to introduce Routeing Number transfer between networks;

o) Routeing can be based on Routeing number only, i.e. current Routeing scheme can be removed;

p) routeing number allocation can be network internal business if RN is not sent between networks.

6.7.10 Cons

The main disadvantages with this solution are that:

a) might be longer call set-up time for calls to not ported subscribers, than in the onward Routeing, Query on Release and Drop-back cases;

b) additional processing capacity (the query) is needed for all calls in all involved networks;

c) large processing capacity required in DB since all calls will require DB query;

d) all networks required to invest in DB techniques.

7 Examples of locations of number portability data base(-s) within networks

7.1 General description

Depending on the evolutionary level in a particular Network the NP data base will be located in different places of the Network or possibly even external to the Network, the following principles of NP data storing have been identified, described and evaluated:

a) exchange based (distributed) solutions;

b) exchange external (centralized) solutions.

The following options for NP data query places have been identified, described and evaluated:

1) originating Local Exchange;

2) gateway Exchange(-s);

3) transit or Gateway Exchange(-s);

4) donor Local Exchange(-s).

All combinations of the above could exist, as described in the following subclauses.

Regardless of data storing place, the Exchange/Network can act according to different NP principles, e.g. Onward Routeing the call, Dropping back the Re-routing information or even acting as a database and responding a query with Re-routing information.

The emphasis in this subclause is on network internal options which not are subjects for standardization but desired options need still to be described to support the development of NP standards allowing multivendor solutions.

NOTE 1: Despite figures show Local, Transit or Gateway Exchanges it should be understood that it is the functionality of these Exchanges that is intended, i.e. it shall be assumed that the functionality of Local, Transit and Gateway Exchanges can reside in the same physical Network Element. Incoming calls from other networks might very well be received directly to Transit or even Local Exchanges if this has been agreed on by bilateral agreements.

NOTE 2: The emphasis on the location of exchange external DB is from where the DB access is performed and what triggered the DB access. Despite the figures show the location of the DB within the domain of a particular Network it shall be understood that the DB might very well be located outside that domain, e.g. commonly maintained by a third party.

7.2 Network overview for geographic numbers

The figure 14 below shows an overview of an evolved Network supporting NP.

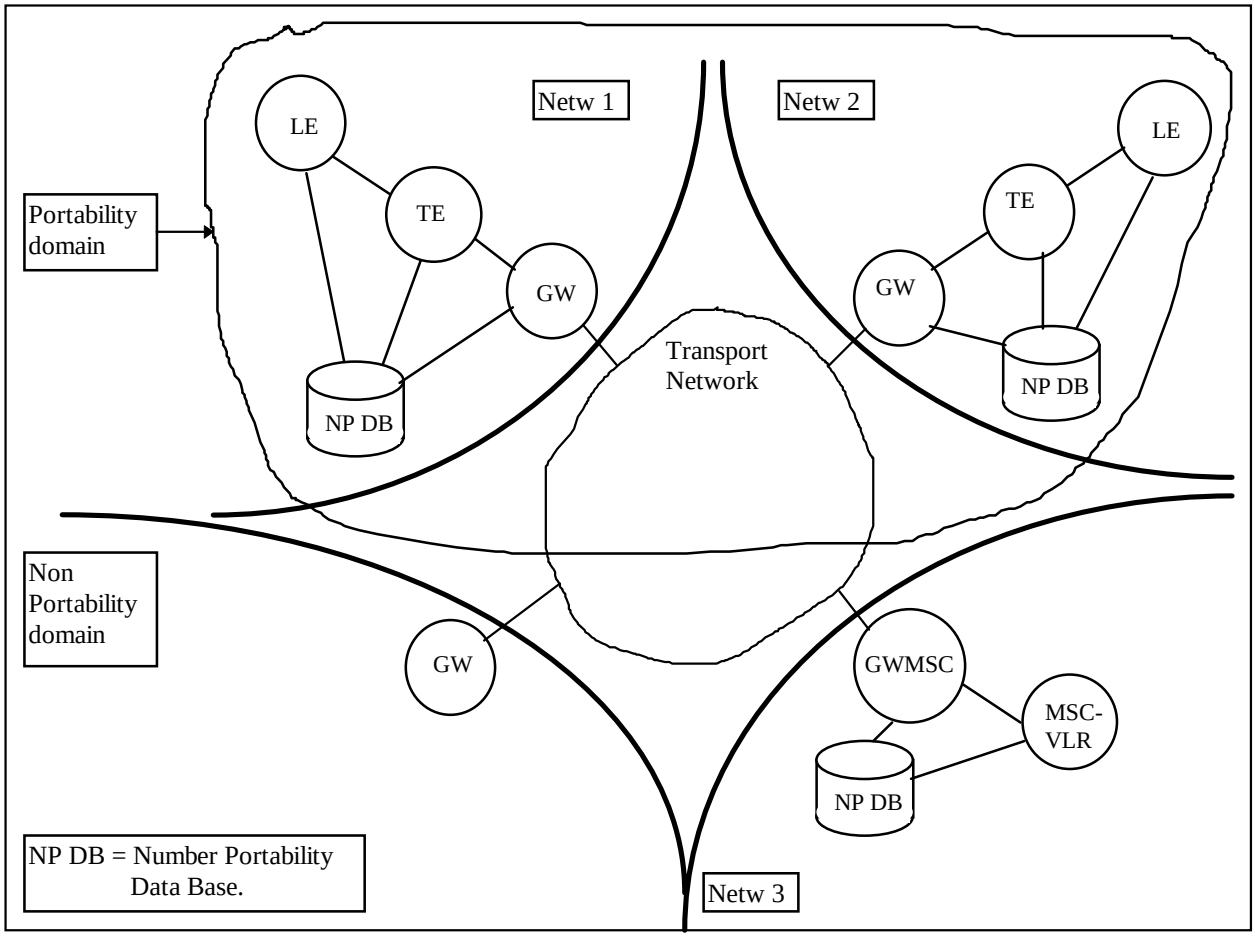

Figure 14: Network overview for number portability.

One should understand that it is up to each of the Network providers if the NP DB is located in a separate Network Element or replicated (i.e. NP DB in LE, TE or GW) in each of the nodes, e.g. this collocation might be the case for small Network providers.

The inclusion of Network 3 in the figure should be understood in such a way that despite the Network is not being part of the portability domain it could still maintain an own number portability database this to allow cost effective Routeing to right Network for its outgoing calls. It shall however be understand that Network 3 might or might not be part of an other portability domain than the one shared between Networks 1 and 2.

The inclusion of the Non portability domain should be understood in such a way that calls originated from this Network is allowed to be routed to the Networks 1 or 2 depending on the historical number series allocation, i.e. to Donor Network. The gateway in the call receiving Network will then trap this call and make a database query to retrieve Routeing information.

Despite not shown, one should keep in mind that the principals outlined in the figure 14 above will exist once per portability domain, i.e. the GW might be differing depending on geographic area, the service level of called subscribers etc.

7.3 NP re-routing data stored in donor network

7.3.1 NP re-routing data stored in donor local exchange

7.3.1.1 General description

The principle to store the Number Portability information in the Donor Local Exchange, as outlined in figure 15 below, is often the first solution proposed since at low portability level, no extra Network elements are needed to support NP. In this solution calls to ported-out numbers should first be routed to the Donor Local Exchange before the Routeing Information can be obtained.

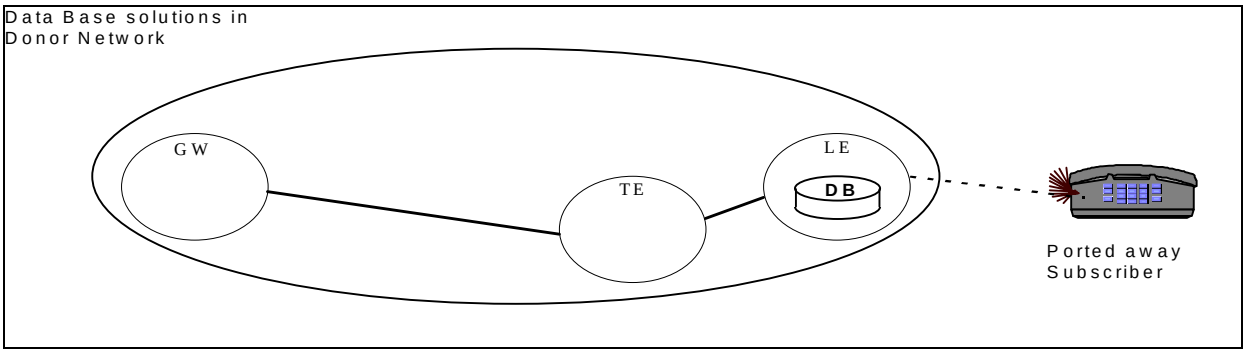

Figure 15: NP data stored in the donor local exchange

This DB location might be used for many of the high level solutions, e.g.:

a) incoming Call to ported-out subscriber is Onward Routed by Donor LE;

b) incoming Call to ported-out subscriber is Dropped-back to TE or GW, with Re-routing information.

Please note that the Drop-back might be restricted to the domain of the Donor Network, i.e. in that case the Donor Network would still, in a high level architecture, act as an Onward Routeing Network.

7.3.1.2 Interaction with supplementary services

The service level is dependent on Donor LE, there will be interaction, i.e. the call will fail, with essential services if the connection to the Donor exchange is of lower functionality level than the incoming interconnection used to the GW/TE. No additional interworking is foreseen for non essential services.

7.3.2 NP re-routing data stored in donor network transit exchanges

7.3.2.1 General description

The principle to store the Number Portability information in the Donor Transit Exchange(-s), as outlined in figure 16, is a possible enhancement compared storing data in Donor LE since calls to ported-out numbers do not necessarily need to reach the Donor local exchange before the Routeing Information can be obtained, i.e. if these calls are trapped in the transit level of Donor Network and then after retrieval of Routeing information routed to the correct Recipient Network/Exchange either by onward Routeing or Drop-back (to GW) principles. Still no extra Network element(-s) are needed to support NP.

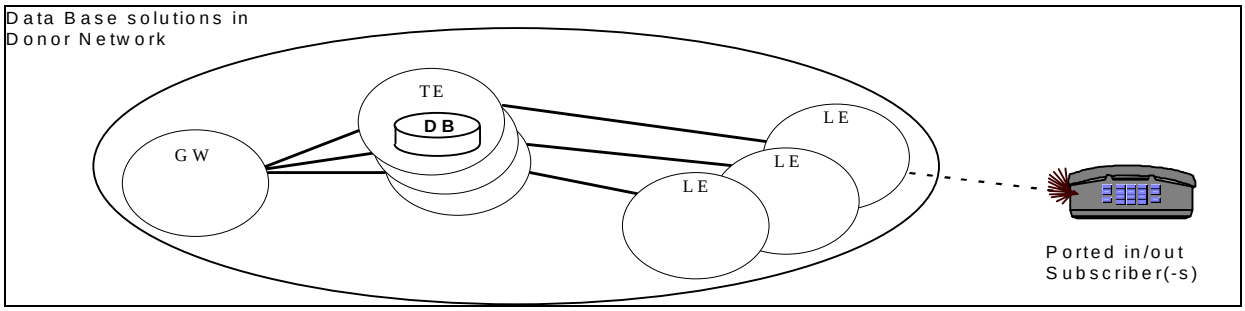

Figure 16: NP data stored in the donor transit exchange(-s)

An alternative to trapping the calls to ported-out numbers in TE is trapping these calls by Donor LE and then release them to TE according to QoR principles, i.e. TE only retrieves data after receiving a release indicating "ported".

This DB location might be used for many high level NP solutions, e.g.:

a) calls to ported-out subscribers are trapped and onward routed by Donor TE;

b) call Drop-back to GW, with Re-routing information, from TE;

c) query on Release (QoR), from LE.

The incoming calls are routed to the Transit Exchange(-s), so that the DB can be queried and call be re-routed to correct destination.

The Originating calls to ported-out numbers are e.g. handled in the following way:

1) first a check is made if called subscriber is defined/connected in own LE;

2) a) if so, the call is connected according to existing procedures;

   b) if not, the call is redirected to transit exchange.

   optionally with a special indication (e.g. a prefix) to simplify next step;

3) the transit exchange traps the call and makes the DB query;

4) the call is re-routed to correct destination.

At least two options exist to indicate that the subscriber has been ported out:

i) the ported-out number is marked as "ported" and only calls to "ported" subscribers are routed to TE;

ii) the ported-out number is marked as "vacant" and all calls to "vacant" subscribers are routed to TE, used if no data about ported-out numbers are stored in Donor LE.

A not so efficient option is to always route the Originating calls to transit Network and then trombone or drop them back to the LE, i.e. no try is made to connect the call locally first.

The procedures in the Originating LE discussed here are of course valid/defined per number block, i.e. the procedure is not needed in number blocks not opened for portability.

7.3.2.2 Interaction with supplementary services

The service level is no longer dependent on Donor Local Exchange.

7.3.3 NP re-routing data stored in donor network GW exchanges

Number portability data could theoretically be stored internally in Donor Network GW exchange(-s), but this is probably not yet a feasible/desirable solution due to amount of required data.

7.3.4 Re-routing data stored exchange external in donor network

7.3.4.1 General description

A further evolution of NP data management is that the data is stored centrally, i.e. Exchange external, this to simplify management.

The following different origination's of NP database queries have been identified:

a) query by the Donor Local Exchange;

b) query by transit exchange next to the Donor Local exchange;

c) query by gateway exchange(-s).

More than one principle can be applied in a certain Network at the same time, depending on evolution of the Network/exchange in question.

Please note that the "central database" can actually be several databases according to replicated or load sharing methods or both, e.g. two databases (mated pair) could serve a number of number series and two other DBs could serve other number series.

7.3.4.2 Query to central database by donor local exchange

7.3.4.2.1 General description

The principle of performing a DB query, as outlined in figure 17, in the Donor LE has advantages, compared to Local Exchange internal stored data, mainly with respect to simplified data management and also that it can easily be scaled up to other query methods (e.g. by Transit or Gateway exchanges).

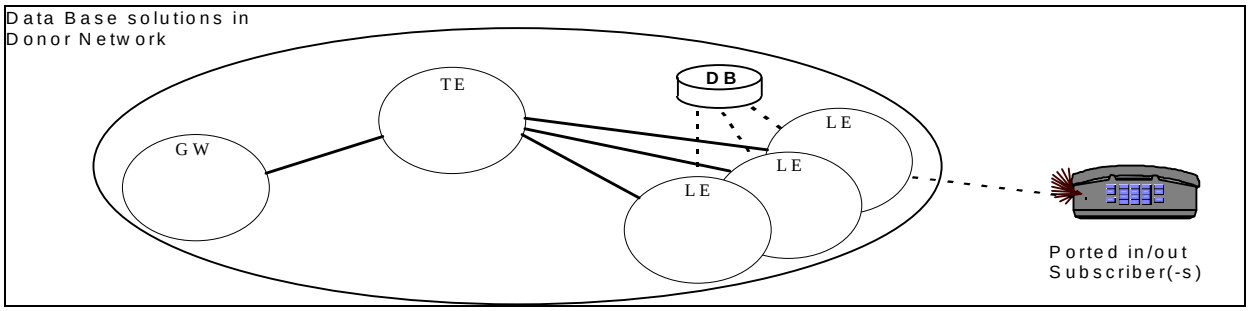

Figure 17: NP data stored exchange external and queried by donor local exchange(-s)

The same NP functions, as for Exchange internal data, are supported by this solution.

7.3.4.2.2 Interaction with supplementary services

Same as for Donor LE Exchange Internal NP DB.

7.3.4.3 Query to central database by donor transit exchange(-s)

7.3.4.3.1 General description

The principle of performing a DB query, as outlined in figure 18, in Donor TE, has advantages, compared to Query by Donor Local Exchange, mainly because it results in that calls to ported out subscribers do not reach the Donor local exchange, i.e. these calls are trapped in the transit level of Donor Network and then routed to the correct Recipient Network/Exchange.

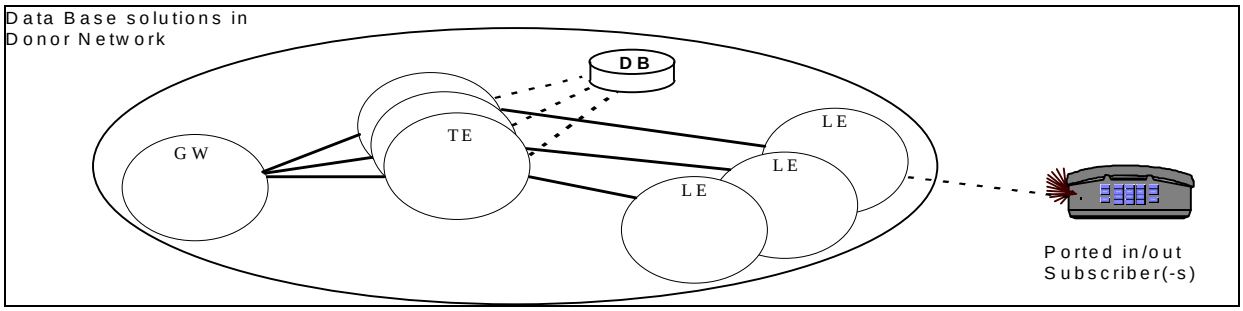

Figure 18: NP data stored switch external and queried by the donor transit exchange(-s)

7.3.4.3.2 Interaction with supplementary services

The interactions with supplementary services are the same as when NP DB is Donor TE Internal.

7.3.4.4 Query to central database by both donor local, transit and gateway exchange(-s)

7.3.4.4.1 General description

The principle of performing a DB query, as outlined in figure 19, by all Donor Exchanges, has advantages, compared to other methods, mainly because it results in that calls to ported out subscribers do not reach the Donor local exchange, i.e. these calls are trapped in the transit level (or even at Gateway) of Donor Network and then routed to the correct Recipient Network/Exchange.

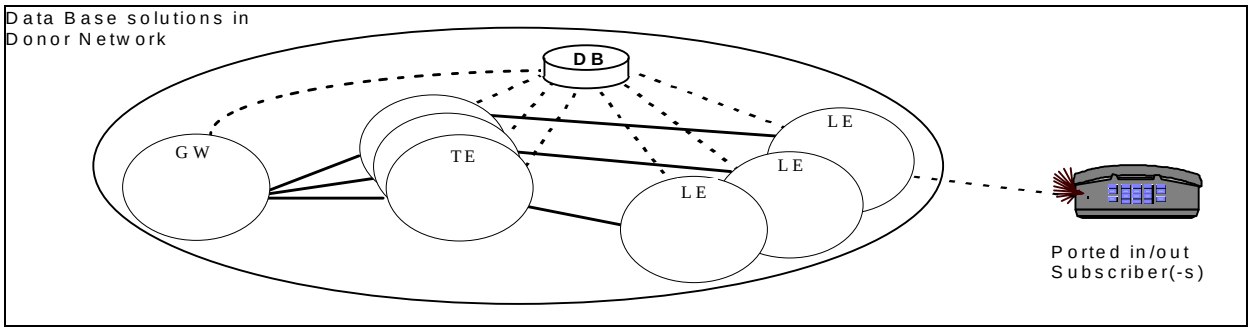

Figure 19: NP data stored exchange external and queried by all donor exchange(-s)

7.3.4.4.2 Interaction with supplementary services

The service level is no longer dependent on Donor Local/Transit Exchange, i.e. incoming calls to ported-out numbers can be trapped already in GW Exchange.

7.4 NP re-routing data stored/ accessed in transit network

7.4.1 NP re-routing data stored/accessed in transit network gateway exchange(-s)

Number portability data could theoretically be stored Exchange internal in a Transit Network, but this is probably not yet a feasible/desirable solution nor is advantages with this identified.

7.4.2 NP re-routing data stored/accessed centrally and accessed by transit network

7.4.2.1 General description

A further evolution of NP data management is that the data is not only stored/available in the Donor Network, instead also stored in e.g. Transit Networks, as outlined in figure 20, or stored centrally commonly accessible by all involved Networks. Examples for management of NP data to several networks can be found in other subclauses.

The main advantage here is a more efficient Routeing of calls and that call set-up no longer is depending on Donor Network only.

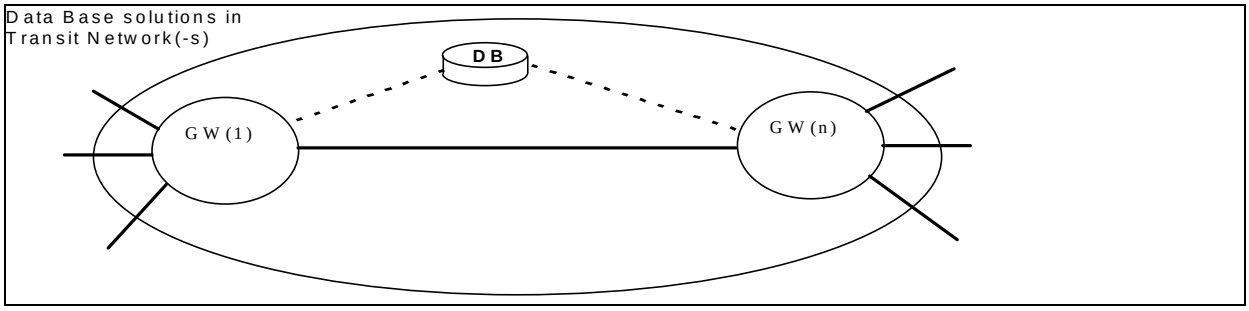

Figure 20: NP data stored exchange external and queried by transit network exchange(-s)

This location of NP DB can be used for several of the high level solutions, e.g.:

a) always query method,

   the Transit Network GW (or optionally also a TE) receives an incoming call traps the call being destined to a number series that is opened for NP makes a NP DB query to obtain a RN towards Recipient Network. Finally it routes the call with the use of RN;

b) Query on Release (QoR), the Transit Network GW (or optionally also a TE) receives a Release message indicating that the called number has been ported-out, makes a NP DB query to obtain a RN towards Recipient Network. Finally it routes the call with the use of RN.

An option to the above is that instead of using the RN to route the call onward towards recipient, the Transit network can return the RN to the previous network according to Drop-back principles. Drop-back could also be used within Transit Network in case QoR is performed in e.g. GW(n) and call is dropped back to GW(1).

7.5 NP re-routing data stored in originating network

7.5.1 NP re-routing data stored centrally and accessed by originating network

7.5.1.1 General description

A further evolution of NP data management is that the data is not only stored/available in the Donor Network, instead also stored in e.g. Originating, as outlined in figure 21, or stored centrally commonly accessible by all involved Networks. Examples for management of NP data to several networks can be found in other subclauses.

In this case the data is also stored/available within the Originating Network.

The main advantage here is equally efficient Routeing for calls to ported and not ported numbers and that call set-up is not depending on other Networks more than for non NP calls.

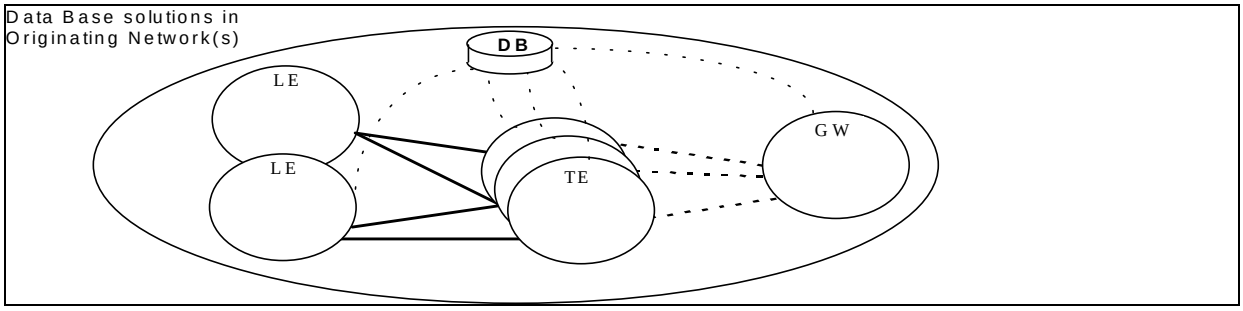

Figure 21: NP data stored exchange external and queried by transit network exchange(-s)

As can be seen in figure 21 Local, Transit and Gateway Exchanges have access to the NP DB, however one of the LEs do not have this capability.

This location of NP DB can be used for several of the high level solutions, e.g.:

a) always query method, the Originating Network LE, TE or GW receives a call originating within the network, traps the call being destined to a number series that is opened for NP makes a NP DB query to obtain a RN towards Recipient Network. Finally it routes the call with the use of RN;

b) Query on Release (QoR), the Originating Network LE, TE or GW receives a Release message indicating that the called number has been ported-out, makes a NP DB query to obtain a RN towards Recipient Network. Finally it routes the call with the use of RN.

Drop-back can also be used within the Originating Network e.g. in case QoR is performed in the GW and call is dropped back to Originating LE or TE.

The NP DB access from the TE can be used in case some of the LE do not have any access to the NP DB. The TE will trap incoming calls to numbers opened for NP, but do not have any RN, make a NP DB query to obtain a RN towards Recipient Network. Finally TE routes the call with the use of RN.

7.6 NP re-routing data stored in recipient network

The Recipient Network might need to access NP DB for several reasons:

a) receiving an incoming call to a ported-in number, without any RN or with incomplete RN, to obtain complete RN to Recipient Exchange,

b) in a "Query on Release" case for an originating call to a ported-in number,: this case is covered as an originating case.

c) in a "all call query" case for an originating call to a ported-in number. This case is covered as an originating case.

NP DB access in a Recipient Network (when acting as such) is only of interest in either GW Exchanges or TE since there is no need to access it if already in Recipient LE, see figure 22.

The main reason for accessing "own" NP DB for an incoming call to a ported-in number is not to expose network internal structure to other network operators, i.e. have privacy.

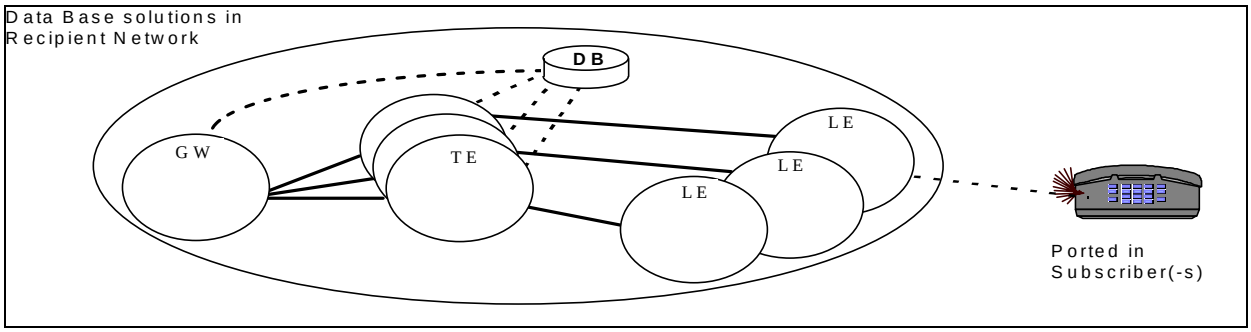

Figure 22: NP data stored exchange external and queried by recipient GW or TE

8 High level evolutionary model for np and sccp using services to geographic numbers

8.1 Background information

Some services (e.g. CCBS, CCNR) make use of non-circuit related signalling. Within ITU-T Signalling System No.7, non-circuit related signalling is supported almost exclusively by the SCCP layer.

SCCP allows messages to be addressed with Global Titles (GT), which may contain ITU-T Recommendation E.164 [1] numbers, including ITU-T Recommendation E.164 [1] numbers which are subject to portability. Where a called GT in an SCCP message contains a ported number the SCCP message should be delivered to the recipient network, and to the appropriate node within the recipient network.

Traditionally, SCCP GT Translation (GTT) functions and data have been implemented as distinct from the call control routeing functions and data, and have also typically only required to a few hundred entries.

With the advent of services which use ITU-T Recommendation E.164 [1] numbers as GTs, and particularly with the introduction of number portability, such GTT capability is insufficient. Hence solutions should be found which allow the correct delivery of SCCP messages addressed with ITU-T Recommendation E.164 [1] numbers, including ported numbers.

An example to highlight the problem, the CCBS/CCNR (as standardized by ETSI), uses the called party number (CdPN), as dialled by user, as Global Title, then SCCP will, in the Global Title Analysis (GTA) route the message, to the destination exchange, according to which number block the dialled number is part of. This e.g. means that the 4 last digits of the CdPN need not be analysed to determine destination Network and Exchange neither need data exist for the 4 last digits in the GTA, i.e. this reduces the amount of data in GTA by 10.000 (if called party number is part of a 10.000 number block).

The use of Called Party Number (CdPN), as entered by the calling subscriber, as Global Title, might no longer lead to the right local exchange since a particular dialled subscriber number, part of a certain 10.000 number block, might be relocated/ported to another operators Exchange.

One should not forget the impact on CCBS/CCNR requests initiated from an ISDN PBX (ISPBX), in this case the CCBS request is, from the Local Exchange point of view, handled transparently without any relation to the previously busy/no response call, i.e. either the Local Exchange or SS no. 7 network should be able to (re-)route these SCCP messages to the right destination Local Exchange with some new functionality.

8.2 Requirements on solutions for routeing of SCCP messages

The routeing of SCCP messages should be achieved by the SCCP, and data available to the SCCP, without reference to the application part providing the service. This is required because an end to end service supported by originating and terminating networks should be available even if the service application is not supported by the donor or transit networks.

The integrity of services provided by the SCCP layer should be maintained also in a NP environment. The main services provided by the SCCP are:

a) connectionless message service with sequencing not guaranteed;

b) connectionless message service with sequencing guaranteed;

c) notification of failure to deliver a connectionless message;

d) basic connection oriented service;

e) connection oriented service with flow control.

NOTE: Currently defined inter-operator non-circuit related services utilize only connectionless service.

Solutions should be easy to maintain and keep consistent with chosen solutions for calls to ported numbers. The maintenance of large GTT tables is a new function for most Network Operators, and solutions should aim to minimize the effort required for this activity. Inconsistency between GTT data and call routeing data could lead to incomplete service being offered to customers with ported numbers or customers calling these numbers.

Inconsistency between the GTT data held by different Network Operators may lead to circular routeing of messages.

8.3 Proposal for solutions

In all architectures identified for circuit related signalling, there exists one or more databases which assist the routeing of calls to a ported number. These Number Portability databases may be internal to an exchange (for example, in the donor exchange) or may be external to any exchange.

It is proposed to allow using these databases also to assist the routeing of SCCP messages. The database would be queried during execution of the GTT function for ITU-T Recommendation E.164 [1] numbers. The result of the query would be a modified GT which will be reanalysed within the SCCP to determine how to subsequently route the message.

8.4 General introduction to described models

The following subclauses describes a number of possible high level solutions to support supplementary services (e.g. CCBS, CCNR, etc.) using Global Title based Routeing in a NP environment.

Three main approaches are identified, i.e. that a Routeing Global Title (RGT) is retrieved and used:

a) by Donor Network that reroute the TCAP/SCCP message to correct destination;

b) by Originating LE;

c) by a SCCP Transit node, e.g. a SPR.

This case can also be evolved to use same NP DB (and data) as used for Routeing of calls.

For all solutions several techniques could be used.

8.4.1 SCCP routeing solutions in donor network/exchange

8.4.1.1 General description

In this NP solution for Routeing of TCAP/SCCP messages to the Recipient Exchange, the Donor Network/Exchange maintains all the data, e.g. a Routeing Global Title (RGT), for ported-out numbers. The NP DB is located either exchange internal or external of the LE.

As outlined in figure 23, the Originating Network/Exchange routes the TCAP/SCCP message according to the historical location of the Number Series that the called party Directory Number is part of.

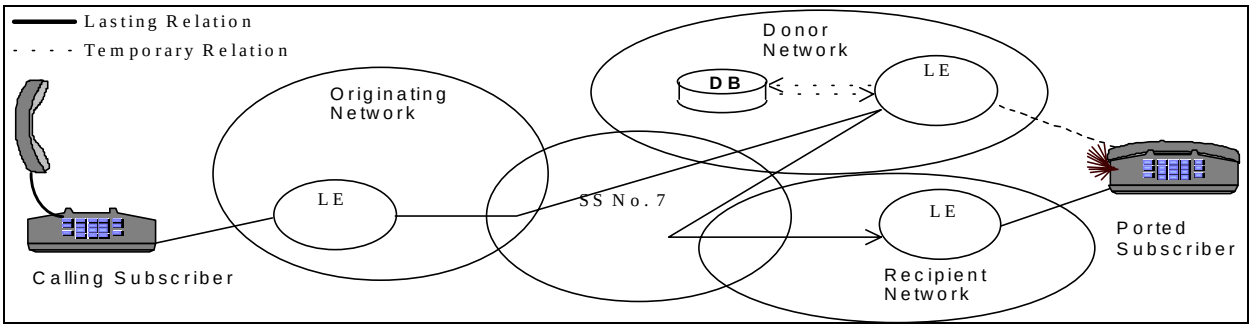

Figure 23: DB query and TCAP/SCCP message redirection performed by donor LE

The Donor Network (e.g. Local Exchange) detects that the called number has been ported-out, makes a DB query to retrieve a Routeing Global Title and replaces the received GT with this. Thereafter the TCAP/SCCP message is Onward routed towards the Recipient Exchange.

The Recipient Network need not make an own DB query since call is routed directly to Recipient Exchange.

This solution for Routeing of connection less services can be compared with the "onward Routeing" solution for ordinary call set-up as outlined in subclause 6.2.1.

8.4.1.2 Pros

The main advantages with this solution are that:

a) only the Donor Network/Exchange needs to maintain NP data for ported-out numbers;

b) no impact when addressing not ported subscribers.

8.4.1.3 Cons

The main disadvantages with this solution are that:

a) the recipient network(-s) should inform donor networks when modifying network internal structure, i.e. it does not allow for privacy for Network Operators;

b) impacts TCAP and SCCP layer if not two transaction ID are consumed per CCBS request.

8.4.2 SCCP routeing solutions in originating network/exchange

8.4.2.1 General description

In this NP solution, for Routeing of TCAP/SCCP messages to the Recipient Exchange, the Originating Network/Exchange has access to NP data for Portable Numbers.

As outlined in figure 24, the Originating Network/Exchange makes a DB query, to retrieve a Routeing Global Title prior Routeing the TCAP/SCCP message towards the Recipient Exchange. The Recipient Network need not make an own DB query since complete Routeing information is received at once.

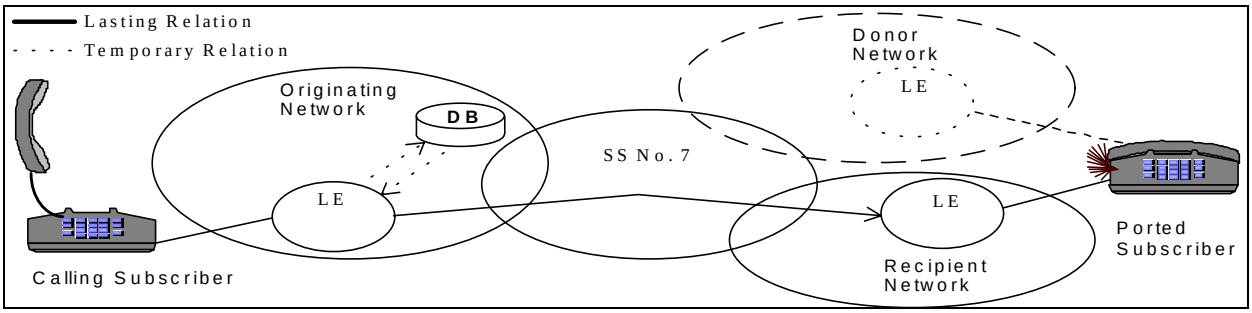

Figure 24: DB query and SCCP redirection performed by Originating LE

DB query made, to retrieve a Routeing Global Title (RGT), by Originating LE prior sending out the TCAP/SCCP message.

This principle is not backwards compatible to (Originating) Local Exchanges (e.g. outside NP domain) not intended/upgraded for Number Portability since required to have NP DB query capabilities.

As also can be seen in the figure, the Donor Network is not involved in call set-up at all.

This solution for Routeing of connection less services can be compared with the "all call query" Routeing solution for ordinary call set-up as outlined in subclause 6.4.3.

8.4.2.2 Pros

The main advantages with this solution are that:

a) the CCBS supplementary service is not dependent on the Donor Network/Exchange;

b) only one transaction ID is used per CCBS request;

c) efficient SCCP Routeing.

8.4.2.3 Cons

The main disadvantages with this solution are that:

a) the principle is not backwards compatible to (Originating) Local Exchanges not intended or not upgraded for Number Portability;

b) the donor network should inform all other networks when modifying internal network structure, i.e. it does not allow for privacy for Network Operators.

8.4.3 SCCP routeing solutions in originating and recipient network/exchange

8.4.3.1 General description

In the solution outlined in figure 25, the NP DB query is made firstly at Signalling Gateway (SPR) level of Originating Network, i.e. the SCCP level traps, by analysing the received Global Title, TCAP/SCCP messages directed towards number series that are allowed for Number Portability makes a DB query, alternative a, to obtain a Routeing Global Title to Recipient Network, modifies the Global Title and routes the message onward to Recipient Network.

The SPR of the Recipient Network traps the incoming TCAP message and makes a new DB query, alternative c, to obtain the Routeing GT of recipient Exchange) and routes the TCAP/SCCP message onward to Recipient Exchange.

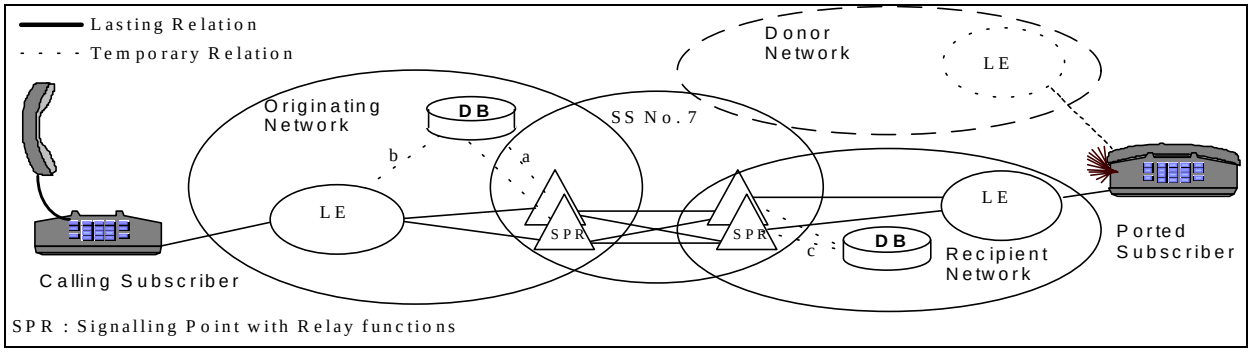

Figure 25: DB query and SCCP redirection performed at STP level

The solution above also allows for cases where some Local Exchange, see alternative b in figure 25, perform the NP DB query according to figure 24 but other LEs leaves this task to the Originating (or even a Transit) SPR of the SS no.7 network.

As also can be seen in the figure, the Donor Network is not involved in call set-up at all.

The DB could very well coexist in every (or some of) the SPR, i.e. the NP data being replicated into the GTT for load sharing reasons.

A variant of this solution is that the NP DB triggering point, i.e. the SPR, could also be enhanced to be collocated with a SSP/Service Control Point (SCP) or Service Switching and Control Point (SSCP), i.e. allowing IN techniques to be used to obtain the Routeing Global Title This would also allow the use of same NP DB for both call and connection less service Routeing, retrieving the same or differing Routeing information.

This solution for Routeing of connection less services can be compared with the two step "all call query" Routeing solution for ordinary call set-up as outlined in subclause 6.6.1 and figure 12.

8.4.3.2 Pros

The main advantages with this solution are that:

a) network operators need not inform others when main changes in their internal network, i.e. privacy of network internals is maintained;

b) thanks to "a" less administrative procedures between Networks.

8.4.3.3 Cons

The main advantages with this solution are that:

a) several (at least two) DB queries are needed per TCAP/SCCP message to portable numbers, i.e. regardless number is ported-out or not (only one query needed if the called number is served by the Originating Network).

9 Proposed generic distributed functional entity model for number portability

9.1 General information

A functional structure is needed to ease allocation of the different NP related tasks required, the figure 26 below is a proposal of a generic Distributed Functional Entity Model for Number Portability. This subclause addresses only Routeing related aspects. The figure also depicts the functional entities and their relationship.

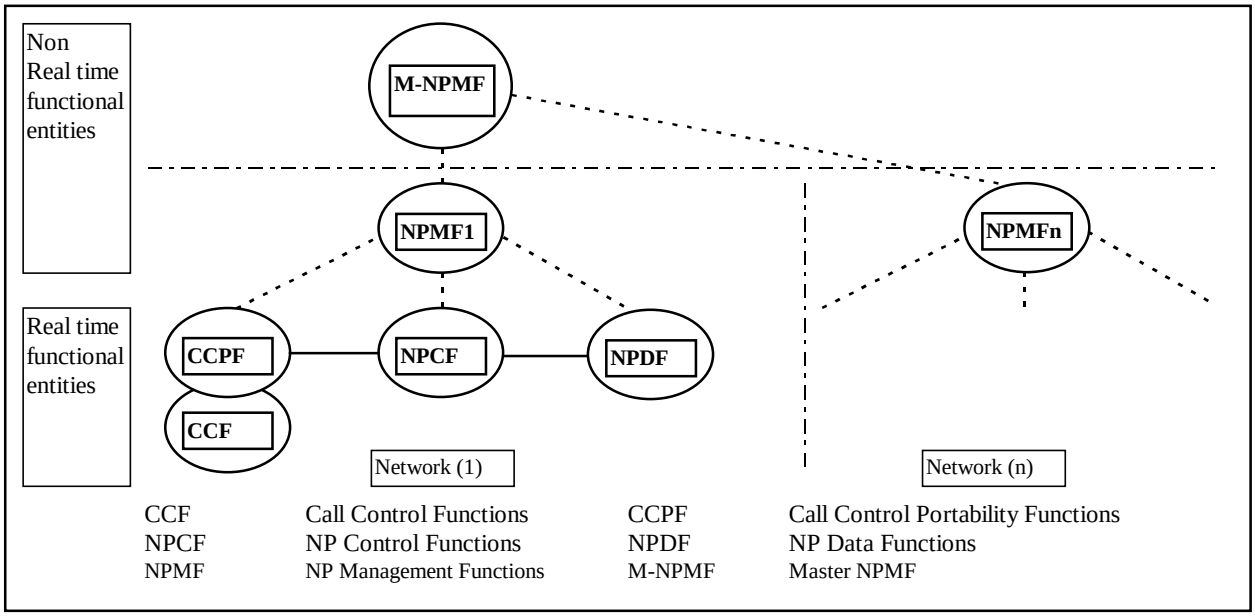

Figure 26: Functional entity model for number portability

The definition of the functional entities (CCF, Call Control Portability Functions (CCPF), Number Portability Control Functions (NPCF), Number Portability Data Functions (NPDF), Number Portability Management Functions (NPMF) and M-NPMF), with respect to Service Provider Portability (NP) for both Geographic (GNP) and Non Geographic Number Portability (NGNP) is found in the following subclauses.

Both Routeing and NP data management aspects of each functional entity is addressed, however no attempt is made to limit an individual Network Operators implementation of the functionality associated with each of the functional entities.

In the scenario of e.g. an exchange internal "onward Routeing" solution by Donor LE:

a) the CCF would have a trigger, e.g. a line category, on the ported-out number which would cause the CCPF interacting with NPCF;

b) the NPCF would then interact with the NPDF to obtain the Routeing Information and then instruct the CCPF to introduce it into CCF Routeing data;

c) the task of NPMF is then to:

   1) load the translation table in NPDF;

   2) set the triggering condition in CCF/CCPF;

   3) maintain the NP control logic in the NPCF (if manageable).

In the scenario of e.g. an "all call query" NP solution by Donor LE:

a) the CCF would have triggers on number blocks allowing NP, which would cause calls to numbers part of these blocks cause the CCPF interacting with NPCF;

b) the NPCF would then interact with the NPDF to obtain the Routeing Information and then instruct the CCPF to introduce it into CCF Routeing data;

c) the task of NPMF is then to:

   1) load the translation table in NPDF;

   2) set the triggering condition in CCF/CCPF;

   3) maintain the NP control logic in the NPCF (if manageable).

9.2 Call Control Functions (CCF)

Call Control Functions (CCF), provides the functions for processing and control of Routeing of calls and services according to definitions in ITU-T recommendation Q.71. In a Number Portability environment it also provides call trap and triggering functionality to access Number Portability Functionality for calls to portable/ported numbers, depending on type of trigger..

9.3 Call Control Portability Functions (CCPF)

CCPF which, associated with the CCF, provides a set of additional call control related functions that are required for the interaction between the CCF and the NPCF. It:

a) extends the logic of the CCF to include recognition of Number Portability control triggers;

b) extends the logic of the CCF to enable interaction with the NPCF;

c) modifies call processing data, i.e. the Routeing Information, under the control of NPCF;

d) interfaces and interacts with the NPCF;

e) interfaces and interacts with the CCF;

f) interfaces and interacts with the NPMF.

9.4 Number Portability Control Functions (NPCF)

NPCF provides functions that are required to command CCF, via CCPF, in the processing of a call to a ported number. It:

a) contains the Number Portability logic and processing capability to obtaining Routeing Information for calls to portable/ported numbers;

b) interfaces and interacts with the CCPF;

c) interfaces and interacts with the NPDF;

d) interfaces and interacts with the NPMF.

9.5 Number Portability Data Functions (NPDF)

NPDF contains a data mapping table, for real time access, giving Routeing Information for ported Numbers. The table is loaded and managed by NPMF.

Other functions that are required:

a) to ensure that only authorized access to NP data is given;

b) interfaces and interacts with the NPCF;

c) interfaces and interacts with the NPMF.

9.6 Number Portability Management Functions (NPMF)

NPMF controls the management of Number Portability Data within the domain of a Network. NPMF also possibly adds and or modifies some NP data before data is distributed to the different Network Elements (NPDF). NPMF also requires that possible NP data replicated into more than one NE is kept consistent.

In addition it also controls the setting of NP traps/triggers in CCPF and management of NP control logic in NPCF.

9.7 Master Number Portability Management Functions (M-NPMF)

Master Number Portability Management Functions (M-NPMF), controls the management of Number Portability Data within one or several Number Portability Domains. This management function may only be needed in case NP data is centrally managed on a national or European Telephony Numbering Space (ETNS) numbers level.

It also controls:

a) the down loading of NP data to concerned Networks;

b) that only authorized access to NP data is given;

c) authentication of users;

d) shadowing of stored data not to be distributed.

10 Service Provider Portability for Non-Geographic Numbers (NGNP)

In principle the same problems, architectures and solutions are valid/possible for NGNP as for Geographic Number Portability (GNP) but the main difference is that NP Routeing Number cannot indicate any Recipient Exchange instead only Recipient Network, this since the recipient Exchange is determined by the Non Geographic Service Number itself and by the Recipient Network. This means that NP related procedures, for non geographic numbers, ends when Recipient Network is reached.

11 Concatenation of service provider portability for Non-Geographic Numbers (NGNP) and Geographic Numbers (GNP)

It should be remembered that a Geographic Number might very well be the output after executing the NGN Service, this Geographic Number (GN) could in turn be ported, i.e. this means the concatenation of NGNP and GNP is a possible traffic case. This case is both applicable for call based Routeing and service (SCCP based) Routeing.

12 High Level examples for management of NP information

12.1 General Description

Management of Number Portability Data Base(-s) differ in complexity depending on Network solution, e.g. depending on if the NP data for a certain ported number only exists within the domain of Donor Network or if NP data is replicated over a number of Networks.

Number portability domains could e.g. be structured to:

a) all national Geographic Numbers;

b) national Geographic Numbers but per NDC;

c) all national non geographic numbers;

d) national non geographic numbers per type of service;

e) all national Mobile Station ISDN (MSISDN);

f) ETNS numbers.

NOTE: One should not forget that both call based Routeing and SCCP based Routeing need to be managed and that a least one of the managed network Elements stores the NP data that is accessed in real time.

12.2 NP data is donor network internal business

Despite the case that NP data is not distributed beyond Donor Network there still exists a number of Management options, i.e. one per type of NP DB distribution within the Donor Network.

See figure 27 for a principal Network layout for management of NP data when data maintained within Donor Network only.

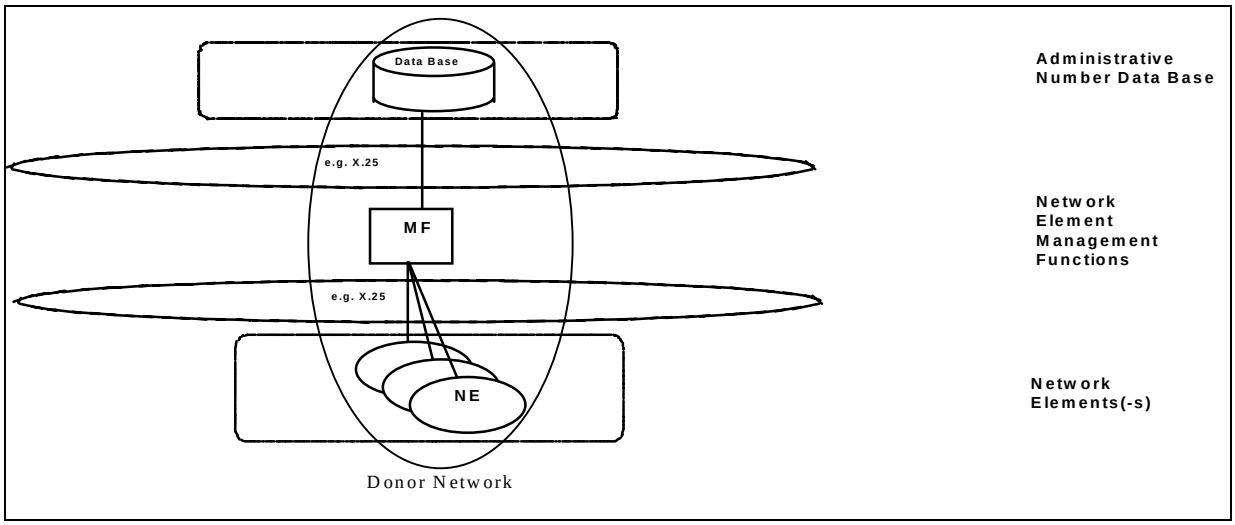

Figure 27: Principal network layout for management of np data when data is maintained within donor network only

From a management architecture point of view minor modifications are needed when introducing NP and NP data is stored within Donor LE but on the other hand more advanced solutions might be used as well e.g. that NP DB is located

Exchange external. Regardless location of NP DB, modifications are still needed to allow storage of the NP Routeing Information.

Despite NP data is maintained Donor network internally there are needs to have bilateral agreements on the content of NP DB e.g. the structure of Routeing Number. However no new interconnections to management systems are needed since down loading of NP information, from network external DB, is not needed in this case.

This NP management solution supports only the "onward Routeing" and "Drop-back" NP solutions.

This architecture supports the "Onward Routeing" case only.

12.3 NP data is centrally managed per portability domain

In the case that NP data is managed per e.g. NDC or charging zones and also that NP data is replicated in several different network data bases a management architecture according to figure 28 can be foreseen.

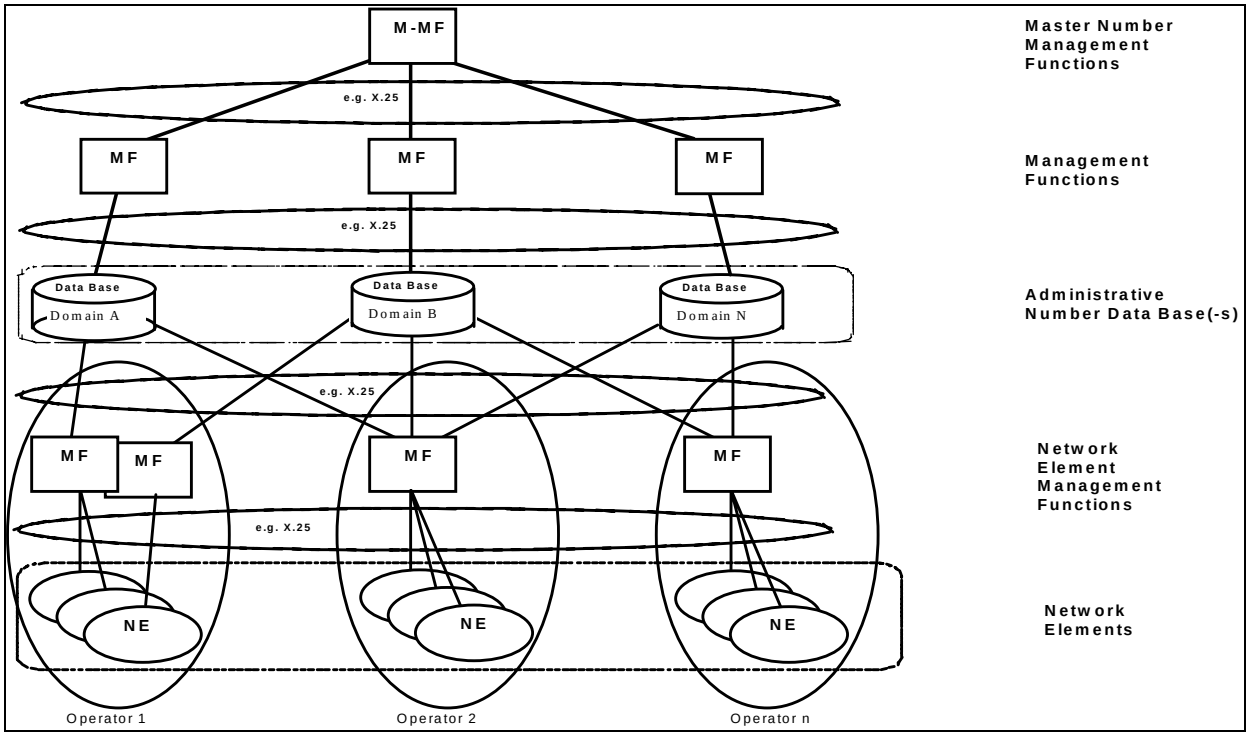

Figure 28: Network layout for management of NP data when data is maintained nationally, per portability domain and when NP data is replicated in each of involved operators network

From a management point of view this scenario brings in new interfaces/interconnections to networks for management of the Number portability data. This solution allows each of the Network providers to manage, e.g. distribute, data within their network.

This NP management solution supports all described NP solutions, but is not needed in case of "onward Routeing" and "Drop-back" solutions.

12.4 NP data is centrally managed on national level

In the case that Master NP data is managed centrally on national level, and distributed to networks according to figure 29, all networks have access to the same data regardless portability domains being part of. This means less interconnections for networks involved in many portability domains.

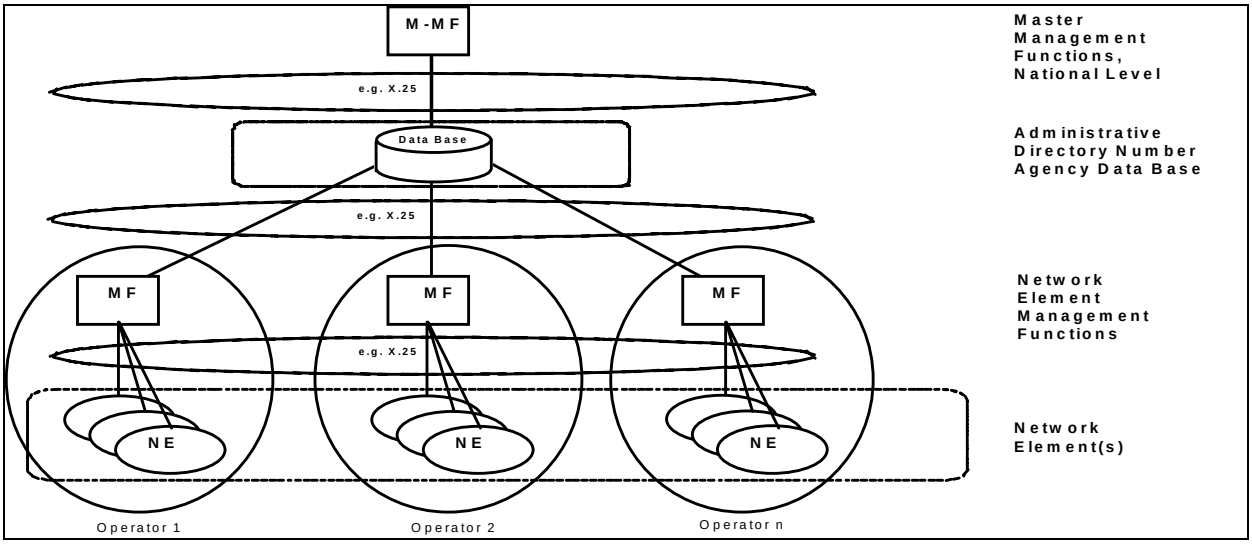

Figure 29: Network layout for management of NP data when data is maintained nationally, and when NP data is replicated in each of involved operators network

This NP management solution supports all described NP solutions, but is not needed in case of "onward Routeing" and "Drop-back" solutions.

12.5 NP data is centrally managed on European level

The ETNS is probably best management as an own NP domain, i.e. separated from national portable numbers, since data is managed on European level. For further information see TR "Number Portability for pan-European services".

Annex A

A.1 Current proposals on solutions for Number Portability

A.1.1 Introduction

There exist a number of different proposals for implementing number portability in the public switched telephony network (PSTN) and the Integrated Services Digital Network (ISDN).

Note, the vocabulary within this annex does not always follow the one used in the main report, instead the vocabulary used reflects the publicly discussed solution.

The proposals can be divided in the following main types:

- central Database;
- drop-back from donor;
- call Forwarding by donor;
- non-Geographic Number.

In the Central Database solutions the databases contain the relationship between the subscriber directory number and a routeing number used for routeing in the network. The actual routeing number can be the subscriber number prefixed with some kind of operator or even exchange identity or be a pure routeing number, like the Roaming Number used in the GSM network and in the ETSI CTM drafts.

The Drop-back solutions make use of the 'drop back' feature in the signalling network. When an exchange analyses the called number and detects that the number has been ported out from the exchange, the call is released with some information that can be used by a proceeding exchange that performs necessary re-routing.

The Call Forwarding solution makes use of the Call Forwarding Unconditional function in the exchange from where the number has been ported. The forwarded to number is the address to the current serving network or even exchange of the ported subscriber. This solution has the mayor drawback of impacting a lot of Supplementary Services.

The Non-Geographic Number solution requires that when a subscriber is ported for the first time he/she should change to a non Geographic (e.g. Personal) number. After this the subscriber can keep the number at any future porting. New subscribers can immediately receive a non-geographic number like e.g. an UPT number or PN. This solution then requires a number portability solution for non geographic numbers only. This solution has not been further elaborated in this report as it initially will force subscribers to change the directory number. This solution is used in Finland for nation wide NP.

Several solutions/methods have been proposed for providing number portability, the different methods can be grouped as follows:

Call Forwarding methods:

- Simple Call Forwarding Unconditional (CFU);
- Remote Call Forwarding (RCF).

Drop-back methods:

- Query on Release (QoR);
- Return to Pivot (RTP).

Central Database methods:

- Call Completion to Portable Number (CCPN);

- Local Area Number Portability (LANP);
- Carrier Portability Code (CPC);
- Network Routeing Prefix (NRP);
- Generic Routeing Method (GRM);
- Query on Release (QoR).

A.1.2 Simple Call Forwarding Unconditional (CFU)

In the described example the Call Forwarding Unconditional (CFU) function is used to reroute the call from the donor exchange to the recipient network or/and exchange.

The additional problem with this solution, compared to Remote Call Forwarding, is that the CLI as presented to called party might indicate the called party number since this is the number that caused the forwarding in the donor exchange. Depending on Call Forwarding parameters used also some Supplementary services (e.g. U-U-1) might not work, i.e. it is an option weather or not U-U-1 shall be transported at call forwarding.

Problem areas are otherwise similar as the ones for RCF.

This solution is only regarded as a very interim such.

A.1.3 Remote Call Forwarding (RCF)

In the Remote Call Forwarding differs from the Call Forwarding function in the way that it allow for correct presentation of CLI and does not restrict supplementary services being forwarded transparently to recipient exchange/network (it can be compared with Onward routeing in the main report).

The main drawbacks are that since the donor exchange is involved, the service level of the call is depending on the one available on the used interconnection protocols and the donor exchange. One should also consider services that normally do not work over operator borders are e.g. (Carrier Selection (CS), CUG, U-U. The CUG and U-U services might result in call being released at the interconnection point due to service requirements, e.g. CUG without outgoing access or U-U-1 essential. Regarding the CS we might have legal problems since CS decision might be wrong by the donor, it can also be questioned if the donor network is allowed to be routed through at all if CS tells else.

One can here consider the case that originating and destination network operators have agreements on transfer/inter-networking for CLIP, COLP, CUG, CS and U-U but the same agreements do not exist between donor and recipient network, i.e. the service level would differ for calls to ported subscribers compared to calls to non ported subscribers. One can also assume that cost effective routeing can not be performed with this type of solution, the call might in worst case be trombone back to originating network.

The solution is in service in UK and is planned for Germany. Both UK and Germany forward the call by using a prefix 5xxxxx and Dxxx respectively but without modifying the NOA. France intend to use x0xxx as identification of a routeing number.

A.1.4 Return To Pivot (RTP)

This is a method originally proposed by Pacific Bell but already exists as different variants in a number of markets, this is the method that usually is referred to as Drop-back.

RTP uses extended switching capabilities to accomplish portability. Calls using RTP will attempt to complete, as they presently do, to a switch that is assigned the dialled number serie. If the dialled number has been ported from the switch, the call will be released back to a previous switch (Pivot switch) in the call path for re-routing to its new location.

The re-routing information (RI), obtained from a central database or locally stored in the switch, are included in the release message sent back in the network to be able to reach the new location from the re-routing exchange. The Pivot switch indicates to succeeding exchanges with information (CI) sent in set-up message that it is Pivot capable and thus drop-back is possible.

This method is not seen as a long term solution for the introduction of service provider portability since it favours the incumbent service providers. Even though a subscriber has been ported to another service provider all calls will first be directed to the donor service provider which then will have control over the call. This also means that the donor service provider will be favoured since resources are used in its domain and accounts has to be settled which then favours the donor service provider.

The method also prohibits the service provider of the originating switch to perform optimal routeing in its own network before eventually breaking out to another service providers network. As a rule, a service provider would like to keep the call within its own network as long as possible to avoid unnecessary settlements of accounts between operators.

This method could though be used for location portability, but when the number of ported subscribers increases this will cause inefficient routeing and bad utilization of network resources.

A.1.5 Query on Release (QoR)

This is a method originally proposed by Nortel.

This feature is very similar as Return To Pivot. When using QoR the initiating switch sets a QoR attempt indicator and routes the call to the donor service providers switch. The switch determines whether it serves the called user. If it does not serve the called user and the call request contains the QoR attempt indicator, it releases the call back to the originating switch with an indication that the user is no longer served on the donors switch. The donors switch handles all other calls using existing procedures.

Based on the release information, the initiating switch obtains a network routeing number for the called user's terminating switch, clears the QoR attempt indicator, and completes the call. The network routeing number can be obtained by the originating switch by interrogating a database located either internally in the switch or external from the switch.

A.1.6 Call Completion to Portable Number (CCPN)

This is a method originally proposed by AT&T, and is in US considered the best long-term solution for the wireline networks in US. AT&T has also a proposal for wireless networks which uses the AT&T LRN scheme for call set-up.

As it seems now, US will go for the CCPN solution and work is already being done in ANSI T1S1 to include the CCPN method in the ANSI standard.

In this method, each portable number is associated with a Network Routeing Number (NRN) for this switch. When a number is dialled by a calling subscriber to reach the intended subscriber, the first switch that can query a number portability database will do so. The response will be the NRN which is the node address to the switch were the called subscriber is served.

The method proposes an modification of the ISUP signalling system, so that the NRN will be included as CdPN in the set up message to be sent off and used for further routeing in the network. The dialled digits will be included in Generic Number (in US called Generic Address Parameter, GAP) with a new number qualifier. A new field in Forward Call Indicator will be set to indicate if a database query has been performed, this to prevent several queries to be made.

The terminating switch will substitute the NRN included in CdPN with the actual dialled digits stored in Generic Number parameter and do a seizure attempt towards the called subscriber.

The Service Management aspects include both updates of the database as well as updating of GTT data. This means that there is a need for each ported subscriber to have an update in the Signalling Transfer Point (STP), translation data, for some subscriber services such as CCBS, CCNR and SMS services. This means that the updates to the database and the GTT data should be synchronized and handled within one transaction to maintain consistency. The subscriber line allocation/de-allocation is not taken into consideration. This is also valid for the next method described.

A proposal exists to also solve the SCCP using services by use of same database(-s), this by introducing a QoR procedure in the SCCP. SCCP shall then make the DB query in the case a SCCP message is rejected (by donor). The retrieved data is optionally also stored in the GTA, i.e. GTT will then be self provisioning. After this procedure the SCCP message is re-routed to recipient exchange.

The main drawbacks with this solution are that the SCCP tables will after a while be enormous and that donor exchange/network is loaded with failing SCCP messages a period after that a subscriber is ported out.

A.1.7 Local Area Number Portability (LANP)

This is a method originally proposed by U.S Intelco, Stratus Computer and Electric Lightwave Inc.

The LANP method is functionally a superset of LRN, the main difference between the CCPN and LANP methods is that the LANP only defines the inter-work interfaces in the network, but does not mandate or constrain the internal implementation in switches of the NP functionality amongst competing carriers.

The LANP method uses two "domains" of 10-digit numbers to route telephone calls to customer that have transferred the numbers to new carriers or new geographic locations. Specifically, LANP assigns a ten-digit customer number address (CNA) to each subscriber; this is the number that callers would dial to place telephone calls to the particular subscriber. It also assigns each customer a 10-digit network address (NNA) that identifies where in the telephone network to reach the particular subscriber. Both the CNA and NNA are stored in routeing databases so that carriers can determine from the dialled number where in the network to reach the called party.

The LANP method does not mandate how a specific NNA is interpreted in the terminating switch of a ported line, either the CNA or NNA values may be used to translate the incoming call to the intended subscriber facilities.

In other words, the LANP is functionally a superset of CCPN, as the NNA can be assigned the NRN value and CNA can be used to locate the subscribers facilities in the same way as in the CCPN method.

The method proposes the same modification of the signalling system as the CCPN method.

A.1.8 Carrier Portability Code (CPC)

This is a method originally proposed by MCImetro.

CPC is a method that uses a Number Portability database to obtain the routeing information necessary to terminate calls to subscribers that have been ported. Each service provider are assigned a unique three-digit Carrier Portability Code (CPC) in each number portability area (within a LATA). To be noticed is that CPCs and NPAs are not allowed to overlap which then also means that CPCs can be reused in another portability area i.e. LATA.

As can be seen from this method is that the called party number is destroyed since the NPA part of the NANP number is replaced with the CPC. One of the reasons for this is that the number length in US is always 7 or 10 digits. If the CPC just would be prefixed to the called party number this would most probably cause major impact on existing switching systems in US.

The CPC method does not require any updates of the signalling systems, both the Multi-Frequency (MF) and Signalling System 7 (SS7) can be used.

The CPC method is related to the Network Routeing Prefix (NRP) solution, the main difference is that in NRP solution a prefix is added to the called party number which means that the dialled number is not destroyed which is the case for CPC.

A.1.9 Network Routeing Prefix (NRP)

The main principle is the same as the LRN (the use of a central database) and CPC (routeing principle) methods, The NRP method is based on using a central database to administer all the addresses and have the relation between a subscriber directory number and the address to which node the subscriber resides on in form of a Network Routeing Prefix (NRP). No new signalling information is required compared to both LRN and NRA.

The NRP might either indicate the receiving operators network (gateway) or indicate the full address to the recipient exchange. An other difference is that it proposes using the Type Of Number (TON) to indicate that the CdPN contains NRP + Called Party Number, this saves digits in the CdPN, e.g. the starting 5 and 7 in the UK and German solutions can be omitted in transmissions. The method also allows for several TON values to be used, e.g. one value indicating NRP being a Network ID and an other telling Exchange ID.

When a call is made towards a subscriber, the dialled digits are analysed in the originating local exchange and a query is done towards a central database to get the NRP. The NRP is added as a prefix before the called subscriber number. NRP is then used for routeing the call to the called party network or to the recipient switch if the called party is within home network.

In the recipient LE the NRP is recognized as "own" and removed, thereafter the number is used for performing the call set up according to existing principles. The NRP can optionally be removed, in the gateway exchange prior leaving to other network, in case the other network uses an own DB for its network internal routeing. This then results in no extra information being sent on operator borders.

The method does not require any modifications of the signalling systems. A specific value of the TON is used to indicate the existence of NRP and implicitly also that a database query has been performed.

The Service Management aspects includes only SMS updates of the portability database. It is assumed that the number series are defined in the LE by ordinary LE management systems. This leaves the update of moved subscribers in the database to the SMS system.

The database Query could optionally be performed in the first transit exchange in the originating Network.

A.1.10 Generic Routeing Method (GRM)

This solution has originally been proposed by KPN.

The Generic Routeing Method is very similar to CCPN solution, the main difference is that the database query is only performed either prior to leaving the originating network or as a QoR procedure.

The NRN is not sent over operator borders.

This solution has some advantages since it does not involve the donor network. It requires similar modifications in the signalling protocols as the NRN solution.

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