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SERIES Q: SWITCHING AND SIGNALLING

Number portability – Scope and capability set 1 architecture

ITU-T Q-series Recommendations – Supplement 3

(Previously CCITT Recommendations)

ITU-T Q-SERIES RECOMMENDATIONS

SWITCHING AND SIGNALLING

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SUPPLEMENT 3 TO ITU Q-SERIES RECOMMENDATIONS

NUMBER PORTABILITY – SCOPE AND CAPABILITY SET 1 ARCHITECTURE

Summary

This Supplement describes number portability in terms of high-level service definitions and terminology and presents a set of high-level network architectures and generic routing methods for NP. These architectures and routing methods are not to be considered exhaustive; they just illustrate some of the options. Other alternatives do exist and may be covered by future capability sets.

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Supplement 3 to Q-series Recommendations

NUMBER PORTABILITY – SCOPE AND CAPABILITY SET 1 ARCHITECTURE

(Geneva, 1998)

1   Scope

This Supplement describes Number Portability in terms of high-level service definitions and terminology and presents a set of high-level network architectures and generic routing methods for NP. These architectures and routing methods are not to be considered exhaustive; they just illustrate some of the options. Other alternatives do exist and may be covered by future capability sets.

To support the routing methods identified, enhancements to signalling protocols are required (initially, not all the architectures and routing methods will be supported by the signalling protocols). These signalling enhancements will be phased in NP capability sets.

The following are included in this Supplement:

a)   number portability terminology;

b)   objectives for the study of number portability;

c)   classification of number portability;

d)   generic assumptions;

e)   a set of network architectures to support number portability;

f)   the exchange of NP-related information between networks per architecture;

g)   routing issues with relation to NP and the described architecture;

h)   generic Information flows for the described architectures;

i)   address types on routing towards ported/portable numbers.

NP architectures both for routing of ordinary calls (circuit-related signalling) and for routing of non-circuit-related supplementary services (e.g. CCBS) are included.

Only Service Provider Portability (SPP) of Geographic Numbers is considered in detail; however, some text is included on SPP of Non-Geographic Numbers, although this type of NP is still under study.

2   Normative references

[1]   ITU-T Recommendation E.164 (1997), *The international public telecommunication numbering plan*.

The normative references for supplementary services are covered in the Q.73x and Q.76x series of Recommendations.

3   Definitions

3.1   Entities

3.1.1   network operator: An entity that operates a network in order to route calls.

3.1.2   service provider: An entity that offers services to users involving the use of network resources.

The "Service Provider" is understood in this Supplement in a generic way and may have different status according to the service provided. 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.

3.2   service provider portability: The ability of an end user to retain the same E.164 international public telecommunication number when changing from one service provider to another.

3.2.1   donor service provider: The Service Provider from whom the number was initially ported.

3.2.2   recipient service provider: The Service Provider to whom the number is ported.

3.2.3   service provider portability for geographic numbers: The ability of an end user to retain the same geographic E.164 international public telecommunication number when changing from one service provider to another without changing their location, and without changing the nature of the service offered.

The service provider portability for geographic numbers is also known as Geographic Number Portability (GNP), also known as Local Number Portability (LNP).

3.2.4   service provider portability for Non-Geographic Numbers (NGNP): The ability of an end user to retain the same non-geographic E.164 international public telecommunications number when changing from one service provider to another without changing the nature of the service offered.

3.2.5   service provider portability for mobile numbers: The ability of an end user to retain the same mobile E.164 international public telecommunications number when changing from one service provider to another without changing the nature of the service offered.

3.3   location portability: The ability of an end user to retain the same E.164 international public telecommunication number when moving from one location to another.

Four variants of Location Portability can be seen to exist:

1)   within exchange area;
2)   within numbering area;
3)   within charge area;
4)   anywhere.

3.4   service portability: The ability of an end user to retain the same E.164 international public telecommunication number when changing from one type of service to another.

3.5 Numbers

Table 1 – Classification of directory number as geographic and non-geographic numbers

	Directory number
Geographic Number examples	• Mobile number • Other geographic number
Non-Geographic Number examples	• Mobile number • Service number • Other non-geographic number

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

3.5.2 end user's number: The E.164 number used by the calling party to establish a call to the end user. This number is also used for presentation services like Calling Line Identification Presentation (CLIP) and Connected Line Identification Presentation (COLP).

NOTE – The End User's Number is equivalent to a Directory Number.

3.5.3 Geographic Number (GN): An E.164 number which corresponds to a discrete geographic area.

3.5.4 mobile number: An End User's Number allocated to mobile service.

3.5.5 Non-Geographic Number (NGN): An E.164 number which has no geographic significance.

3.5.6 portable number: An entire E.164 number (identified by an appropriate authority) which is subject to number portability.

A Portable Number is also any number of a block of E.164 numbers.

3.5.7 ported number: An end user's E.164 number that has been subject to number portability.

3.5.8 routing number: A number that is derived and used by the network to route the call towards a Ported Number.

3.5.9 service number: A non-geographic E.164 number allocated to a specific category of services.

3.6 Networks

3.6.1 donor network: The initial network where a number was located before ever being ported.

3.6.2 initiating network: A network that requires and obtains the routing information for number portability.

3.6.3 originating network: The network serving a calling end user.

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 entry to the originating network for routing purposes.

3.6.4   recipient network: The network where a number is located after being ported.

3.6.5   transit network: A network between two networks, e.g. the Recipient Network and the Donor Network.

3.7   Exchanges

3.7.1   donor exchange: The initial exchange where a number was located before ever being ported.

3.7.2   initiating exchange: An exchange that requires and obtains the routing information for number portability.

3.7.3   originating exchange: The exchange serving a calling end user.

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

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

3.7.4   recipient exchange: The exchange where a number is located after being ported.

3.7.5   transit exchange: An exchange between two exchanges, e.g. the Recipient Exchange and the Donor Exchange.

3.8   Other definitions

3.8.1   geographic number portability: See "Service Provider Portability for Geographic Numbers".

3.8.2   non-geographic number portability: See "Service Provider Portability for Non-Geographic Numbers".

3.8.3   NP status indication: An indication sent in the call set-up message to indicate that the NP DB query has been done for the called number.

3.8.4   numbering plan: A Numbering Plan specifies the format and structure of the numbers used within that plan. It typically consists of decimal digits segmented into groups in order to identify specific elements used for identification, routing and charging capabilities, e.g. within E.164 [1] to identify countries, national destinations and subscribers.

A Numbering Plan does not include prefixes, suffixes and additional information required to complete a call.

The national Numbering Plan is the national implementation of the E.164 [1] Numbering Plan.

3.8.5   Numbering Plan Administration (NPA): Entity that is responsible for the administration and the assignment of numbers or number blocks, within a national Numbering Plan.

3.8.6   number range holder: An entity who is responsible for the administration and allocation of numbers within a particular range.

3.8.7   point of interconnection: An access point between two networks.

4 Abbreviations

CCBS   Completion of Calls to Busy Subscriber

CCNR   Completion of Calls on No Reply

CdPN   Called Party Number

CLIP   Calling Line Identification Presentation

COLP   Connected Line Identification Presentation

DB   Database

DDI   Direct-Dialling-In

DN   Directory Number

GN   Geographic Number

GNP   Geographic Number Portability

IN   Intelligent Network

INAP   IN Application Protocol

LE   Local Exchange

LNP   Local Number Portability

MSN   Multiple Subscriber Number

NGN   Non-Geographic Number

NGNP   Non-Geographic Number Portability

NP   Number Portability

NPA   Numbering Plan Administration

PRN   Partial Routing Number

RN   Routing Number

SCCP   Signalling Connection Control Part

SCP   Service Control Point

SP   Service Provider

SPP   Service Provider Portability

SPR   Signalling Point for Relay

SSCP   Service Switching and Control Point

SSP   Service Switching Point

5 Objectives

The technical descriptions on Number Portability should ensure:

1) Architectural flexibility: The set of architectures selected for support of number portability should allow network operators reasonable flexibility in the manner in which the architecture is implemented and the use of equipment from multi-vendors.

2) Transparency: The mechanism by which portability is provided should be transparent to the ported and non-ported customers.

3)   Performance: The mechanism by which portability is provided should subject the call to minimal (if any) performance degradation relative to that offered to non-ported numbers. This includes both post dial delay and transmission.

4)   Interconnection: All network operators offering portability within the same geographic area should interconnect, either directly, or via a transit, and complete calls. Direct or transit interconnection is a commercial decision.

The following objectives should be considered during the development of the signalling requirements within each of the NP capability sets (see Table 2).

Table 2 – List of objectives for the signalling support of number portability capability sets

Objective	Rationale
1) Seek and develop internationally standardized solutions as far as possible	• C7 signalling is based upon international standards and the objective is to evolve in line with standards (avoid proprietary solutions as far as possible). Number portability solutions therefore need to be established internationally in order to facilitate standards development. • To allow a multi-vendor environment.
2) Focus upon interconnection (inter-network) standards rather than intra-network solutions	• Operators need to be in control of their own network architectures and signalling systems. Solutions that "standardize" the inter-network relationship allow that freedom.
3) Seek and develop solutions that enable operators, as far as possible, to remain in control of their own network call control processes	• The network operator should not be required to be dependent upon another operator or organization for the real-time control of his network.
4) Number portability should concentrate on the information passed between networks. Solutions should be specified independent of specific technologies at the interface as far as possible	• Technology will advance rapidly whilst interconnection agreements will change at a slower pace. Solutions should not mandate the use of specific technologies at the interface.
5) Standardize basic building blocks and functions rather than monolithic solutions	• The solutions for number portability need to meet different regulatory and technical requirements. The solutions standardized should be capable of satisfying different network architectures and regulatory requirements. • In a multi-operator environment, solutions should allow operators to decide on a commercial basis if they wish to perform number portability functions. Clearly, there has to be a basic requirement which will have to be met by the set of operators involved.

**Table 2 – List of objectives for the signalling support of number portability
capability sets** *(concluded)*

Objective	Rationale
6) Co-existing phased solutions	• The network operator will require the rapid introduction of number portability based upon EXISTING infrastructure. Solutions should be capable of rapid deployment and be capable of evolving towards a long-term solution. Each phase must be capable of co-existing with previous ones. There must be no compulsion on an operator to upgrade.
7) Address solutions for the operation of both call-related and call-unrelated associated services	• Services like CCBS will need to operate across network boundaries and between networks in different regulatory domains where different overall solutions may exist for number portability

6   Classification of Number Portability

Generally, a Directory Number is considered to be ported when a major change occurs to the subscription of a customer, but the customer retains his assigned number(s). Depending on the kind of subscription change, the following types of Number Portability can be identified:

–   Service Portability;

–   Service Provider Portability;

–   Location Portability.

From the customer's point of view, all three types of Number Portability are desirable because a change of Directory Number(s) is usually linked with considerable inconvenience and expense.

In principle, the technical issues are the same for all types of Number Portability, but there are some differences. For example, Location Portability and Service Portability may be implemented within one operator's network domain – whereas Service Provider Portability requires inter-network specifications and agreements.

It is possible to combine the types of Number Portability, but this may be subject to regulatory approval and is outside the scope of the study of which this Supplement is part.

6.1   Location Portability

Location Portability is only applicable to geographic numbers, as by their nature, non-geographic numbers do not incorporate location information. Unless combined with other types of portability, Location Portability is an internal network operator matter.

Different scopes of Location Portability result in varying levels of complexity:

•   Porting within an exchange area and within a charging area impacts neither network routing nor billing.

•   Porting within an exchange area but outside the charging area has implications for billing but not for network routing.

- Porting outside the exchange area but within the charging area impacts network routing but not billing[1].

- Porting outside the exchange and charging area has implications for both routing and billing.

Geographic Numbers represent those numbers that imply the provision of a service to a specific geographic area and can be analysed by the calling party to determine the tariff. Operators generally allocate geographic numbers for PSTN/ISDN service (domestic and business) and according to the topology of their network. These numbers are generally allocated in blocks (e.g. 10 000 numbers) to individual local exchanges within a specific charge area. Thus, limited location portability may be possible within these constraints; there is a need, however, to consider the implications of subsequent porting.

Billing is impacted where the significant digits of the ported number no longer give an accurate reflection of the location of the terminal/customer for charging purposes. Routing can be impacted because the significant digits of the ported number can no longer be used to identify the exchange on which the number is hosted.

6.2 Service Portability

Service Portability is a network operator option to provide additional features of a network operator's service portfolio. Consideration should be given to charging implications; e.g. a freephone number should not be ported to a premium rate service, unless some warning is given to callers of additional charges.

6.3 Service Provider Portability

Service Provider Portability may be provided for geographic numbers and for non-geographic numbers, and allows customers to change Service Provider whilst retaining the same number.

6.4 Concatenation of types of Number Portability

Concatenation of types of portability can have implications if the customer wishes to revert to the original set-up; e.g. Service Provider Portability followed by Location Portability may make it impossible for the customer to revert to the original donor Service Provider, as the donor may not offer Location Portability to the extent of the domain of that offered by the recipient Service Provider (i.e. it is not possible to move so far in the donor provider hence it is impossible to revert service).

Table 3 shows the applicability (marked as √) of each type of portability to each type of number range.

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[1] This is only the case where operators have common charging areas; if they do not, the fourth bullet applies.

**Table 3 – Applicability (marked as √) of each type of portability
to geographic and non-geographic type of numbers**

Type of portability	Number ranges	
	Geographic	Non-Geographic
Operator or Service Provider	√	√
Location	√ (Notes 1 and 2)	Not applicable (Note 3)
Service	√ (Note 4)	√ (Note 4)
NOTE 1 – See previous text on Location Portability (i.e. Restricted, depending upon network configuration and tariffing). NOTE 2 – Location Portability can be provided by an operator as a service in its own right, e.g. call forwarding. NOTE 3 – Location Portability is not relevant to services that have no geographic significance. NOTE 4 – Allowed only if tariffing and regulatory constraints are met.		

6.5 Number Portability domains

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

In Figure 1, area "P" is the domain over which it is possible to port a number, area "R" is that part of the network that recognizes a number is ported, and carries out appropriate action (NOTE – For portability in the fixed network this routing domain could well include mobile networks). Domain "W" describes the rest of the telecommunications network that has no way of detecting a number is ported, and therefore must route using normal principles. For location and service portability, domain "R" is likely to be the extent of a single operator's network.
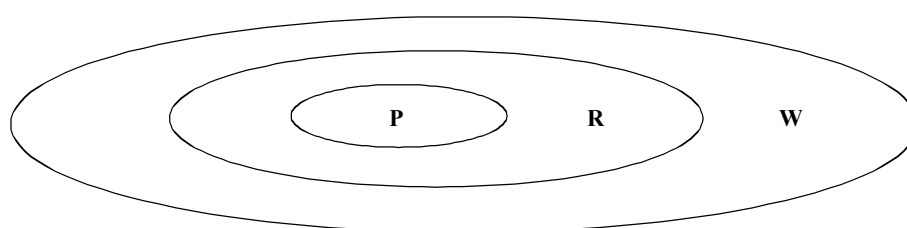
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Figure 1 – Domains

7 Generic assumptions for Number Portability

7.1 General

Solutions to support Number Portability should allow rapid deployment of Number Portability in such a manner that Service Providers can migrate between technical solutions. Solutions should be developed such that technology should not be presented as a barrier to implementing number portability.

This subclause lists some general assumptions and limitations related to Number Portability. In some cases (e.g. privacy) the requirements and the limitations are partially in conflict.

1) Initial routing arrangements have been defined and implemented prior to the introduction of routing based on a Routing Number.

2) Number Portability shall not influence functions in PBXs.

3) Number Portability shall allow 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.

4) Number Portability data distribution aspects shall allow evolution, continuity of service, safety and privacy.

5) Whilst it is not possible to port single numbers from a DDI range, dividing the range into blocks and porting the resultant sub block will have the same effect. Therefore, there is no need to support the portability of individual numbers within a DDI range.

7.2 How is Number Portability generically performed

A number of entities are involved when describing Number Portability. The information concerning Number Portability is transmitted between these entities by means of a Routing Number.
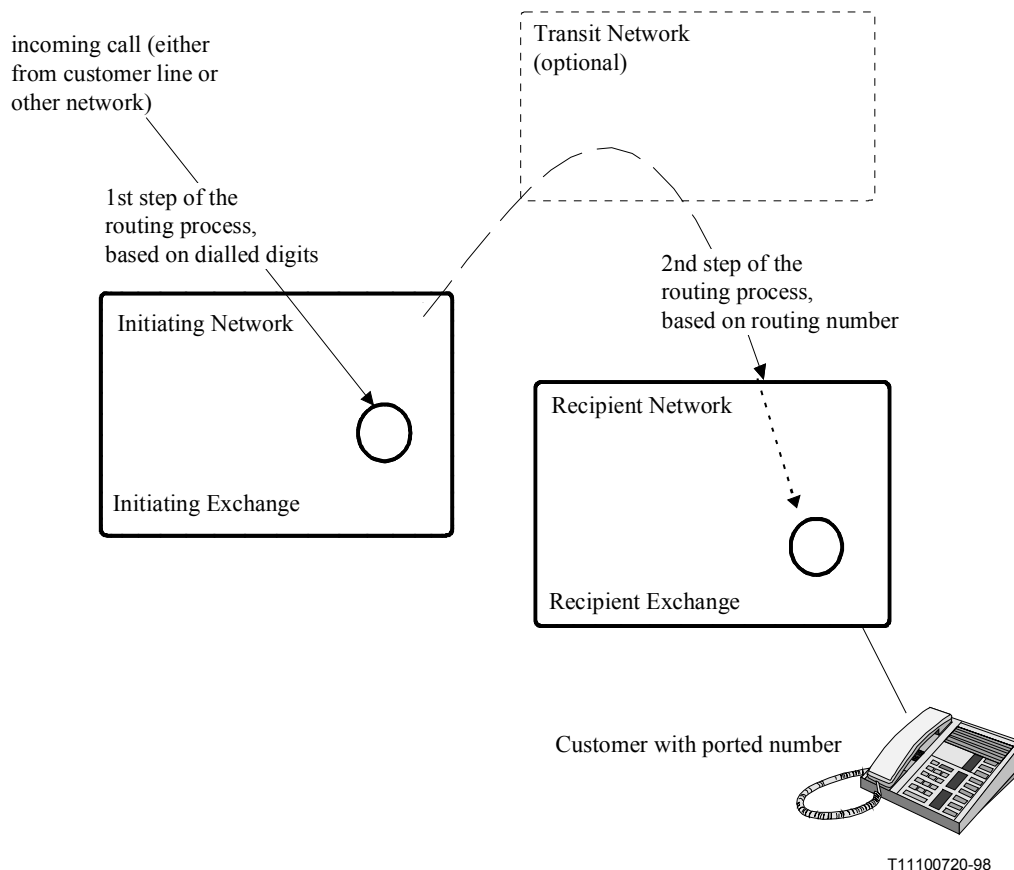
NOTE – The initiating Network may be the originating Network and/or the donor network, and/or a transit network.

Figure 2 – Conceptual framework for incoming calls

The Routing Number associated with a ported call has a structure associated with it.

Looking at the information contained in the Routing Number, two different cases can be identified: Complete Routing Number (CRN) and Partial Routing Number (PRN).

In case of portability for Geographic Numbers, Complete Routing Number means that the Routing Number obtained by the Initiating Exchange contains enough information to route the call to the Recipient Exchange. Likewise, Partial Routing Number means that the Routing Number obtained by the Initiating Exchange does not contain enough information to route the call to the Recipient Exchange. That implies the need of subsequent translations that may take place in the Transit Network or in the Recipient Network to get the routing information to complete the call.

In case of portability for Non-Geographic Numbers, the distinction between Complete Routing Number and Partial Routing Number is less important. In fact the Routing Number obtained by the Initiating Exchange has to identify not a specific exchange but only the Service Provider who is responsible for the provision of the service associated with the Non-Geographic Number. In this case, we can assume that the Routing Number is always a Complete Routing Number; that is, the Service Provider can be identified without subsequent translations.

7.3   Implications of Number Portability

The Numbering Plan Administration allocates numbers in blocks, and routing for the connection-oriented services and non-circuit-related services (e.g. CCBS) is based on these numbers. Number Portability breaks down this relationship based on these blocks.

When customers are allowed to port their Directory Number between operators, the number of customers per number series in a given exchange becomes much lower than previously since the total number of connected customers to a particular number series will then be shared by a number of exchanges and operators.

Another effect of Number Portability is that the same number series (e.g. 10 000 block of customer numbers) will now exist in many exchanges. With Location Portability this means that after a time all number series in the portability domain could exist in all local exchanges serving this domain.

A third effect of Number Portability is that one particular exchange will need to maintain many more number series than previously; this is to support the same number of customers connected, due to the lower number of customers per number series.

Service management and inter-operator procedures have been demonstrated to be the major area of difficulty when introducing Number Portability. Detailed considerations of these issues are outside the scope of this Supplement.

Implementing Number Portability has operation and maintenance implications for operators. Procedures are required to support operators that perform Number Portability. These procedures could include:

Process activity	Steps to be covered
Service establishment	Initial contact Planning stage Implementation planning Network implementation and testing
Service maintenance	Introduction of a new switch Introduction of a new number block Number change New routing number
Service ordering	Requests, validation, scheduling, contingency plans, hours, subsequent mobility, change of account name, reasons for rejection. Installation Cancellation
Fault and repair handling	
Directory number information	Directory entries, operator assistance. Emergency service
Billing	

The introduction of Number Portability will have implications for the administration of numbers by the NPA in order to support the procedures and process stated above.

The perceived implication will depend upon regulatory decisions and how the numbers are allocated i.e. *en bloc* or individually.

The impact of a ported Non-Geographic Number resolving to a Geographic Number has been raised as an issue, and is for further study.

8 High-level network models for Service Provider Portability of Geographic Numbers

8.1 Background information

To ease routing tables in the current public telecommunications networks (PSTN and ISDN), E.164 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 1000 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. Another 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 routing of a call to a PSTN/ISDN subscriber is normally done based on the 10 000 number block the called subscriber number is part of. This traditional principle for Routing 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 operator's network.

8.2 General introduction to described models

The following subclauses describe a high-level evolutionary model for Service Provider Portability for Geographic Numbers. Service Provider Portability for Non-Geographic Numbers is not explicitly within the scope of this Supplement, however, whilst this type of portability is subject for further study, some aspects of non-geographic portability are covered in the following subclauses.

The figures and the descriptions which follow focus 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 routing;

e) interconnection issues.

Note that the emphasis on the placement of the NP DB, as illustrated in the following figures, is from where the DB access is performed and triggering the DB access. Although the figures show the location of the DB being within the domain of a particular network, it shall be understood that the DB might 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.

With reference to the four types of networks listed above, a network that performs DB query is also designated as "Initiating Network". Depending on NP solution, one or several of the networks will act as Initiating Network.

Note that for most incoming international calls the Originating Network will be the network containing the incoming international gateway. The same principle is applied for an incoming call from a Public Land Mobile Network (PLMN), i.e. that the first incoming gateway exchange in the fixed network is regarded as Originating Exchange unless the PLMN has NP DB query capabilities for numbers belonging to the fixed network.

For reasons of simplicity, the management functions are not shown in the figures. The management functions for NP might, depending on choices of architectures, 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 provider's domain;

d)   management of NP within a network element (e.g. domain of a LE).

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

Although the messages in the figures, e.g. IAM and REL, give an association to the ISUP protocol, it shall be understood that signalling systems other than ISUP can be used.

The topic of loop and NP DB mismatch detection should be considered.

For each method described in this subclause, the initiating Service Provider may transport an indication, called an NP status indication, that the Number Portability query has been done. The NP status indication specifies that the NP database has been queried and that the call set-up message includes information necessary to route the call. The NP status indication may be included for both ported and non-ported numbers in a portable number block.

When the number is not ported and the NP status indication is received at the Transit or Donor Network, the Service Provider may use this indication as notification that the end user has not been ported and the call can be routed following existing methods. For ported Directory Numbers, the NP status indication may be used, in conjunction with the Routing Number, to route the call towards the Recipient Network/Exchange. A Transit Network that does not receive the NP status indication should not be forced to make a query. In such a case it will act as Initiating Network.

The receiving Service Provider may perform a NP query regardless of the encoding of the NP status indication. This decision to perform a query depends on network architecture or interconnection agreements. The use of the NP status indication can be applied to all the architectures proposed in this Supplement.

Below is an example flow to describe the interaction for a non-ported Directory Number (Figure 3):

CCF-A/B   CCF calling party/called party network
CCF-T/R   CCF Transit/Recipient query network
CCPF-T   CCPF Transit network
NPCF-T   NPCF Transit network
NPDF-T   NPDF Transit network
query   An event sent from SSF to SCF to obtain
           instructions on how to proceed
DN-B   Directory Number, called party

t.nbr   An event from CCF informing CCPF that a Called
                    Party Number being part of a "portable number block"
                    has been received
routing   An operation from NPCF providing routing information
                    to CCF
continue   An indicator that call can continue following existing
                    routing methods (not ported)
NP Status Indicator An indicator that the NP query function has
                    been done

Figure 3 – Non-ported Directory Number information flow

Other architectures may be possible. These are examples only and may need to be enhanced after further investigation.

8.3   Call re-routing initiated/performed by Donor Network

This subclause describes possible high-level NP architectures in a Donor Network.

8.3.1   Call re-routed from Donor Network by use of onward routing principles

8.3.1.1   General description

The first step/architecture 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 incoming calls to ported numbers, the Donor Network reroutes the call towards the Recipient Network according to onward routing principles outlined in Figure 4.
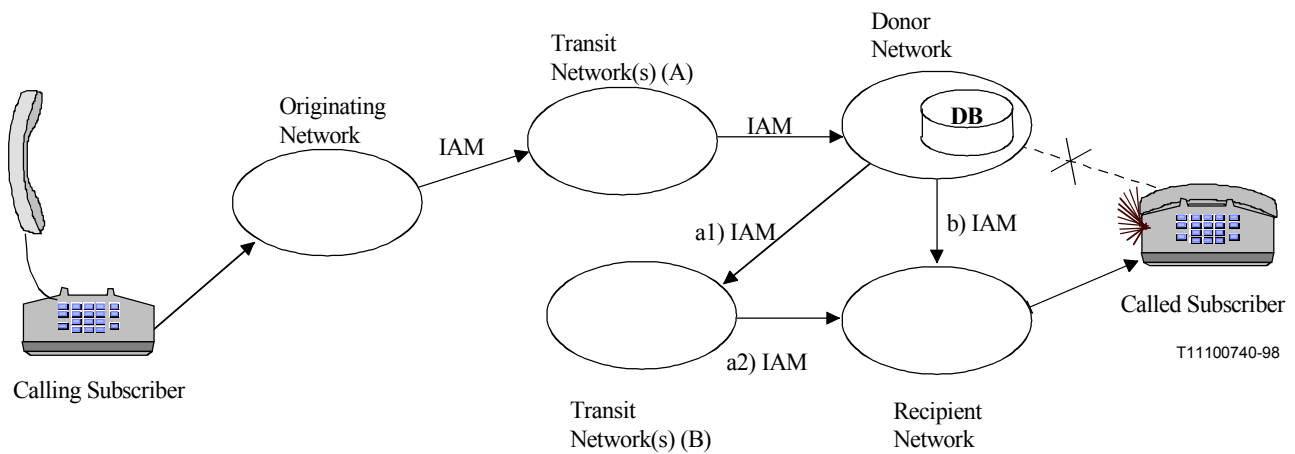
**Figure 4 – Call re-routing to Recipient Network by onward routing
principles from Donor Network**

In Figure 4, the Donor Network receives an Incoming call. It then detects that the called number has been ported to another network and makes a DB query to retrieve a Routing Number. It thereafter reroutes the call onward towards the Recipient Network using retrieved Routing Number.

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

Option b) is valid when direct interconnection exists between Donor Network and Recipient Network.

Though the Donor Network acts as an "onward routing" 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 interconnection between the 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.

8.3.1.2   Generic Information flows

In the Information flows in Figure 5, the Originating Network routes the call towards the Donor Network which detects that the number is being ported. It then makes a NP DB query to retrieve a Routing Number. The Routing Number is then used to route the call onward towards the Recipient Network and Exchange.
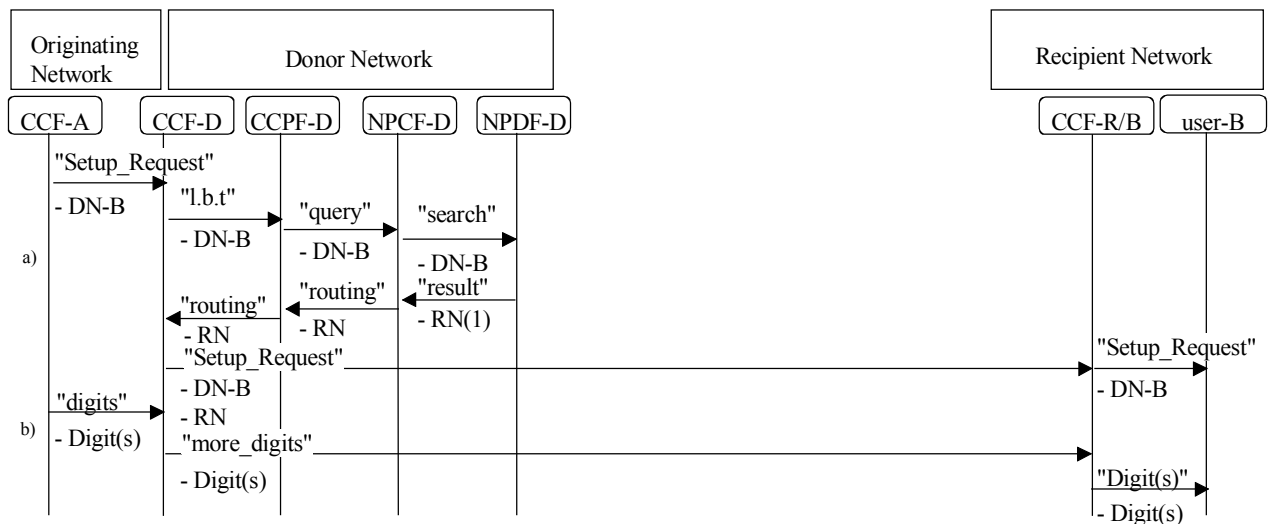
T11100750-98

CCF-A/B	CCF calling party/called party network	RN	Routing Number (e.g. Recipient Network and Exchange ID)
CCF-D/R	CCF Donor/Recipient query network	DN-B	Directory Number, called party
CCPF-D	CCPF Donor network	t.nbr	An event from CCF informing CCPF that a Called Party Number
NPCF-D	NPCF Donor network		being part of a "portable number block" has been received
NPDF-D	NPDF Donor network	routing	An operation from CCPF/NPCF storing a new routing number in CCF
query	An event sent from CCPF to NPCF to obtain instructions on how to proceed	req_dig	An operation from NPCF/CCPF to CCF requesting digits

a) Trigger on incomplete number is not applicable here since the Donor Exchange is reached prior to NP DB query.

b) The need for overlap sending of digits, after obtaining of RN, is only applicable where variable DDI ranges are used, i.e. is not necessary for fixed number length schemes.

Figure 5 – Information flows supporting Figure 4, i.e. a one-step "Onward Routing" solution

As can be read from the flows, the Donor Network is considered as the Initiating Network since it performs both NP trap functions and obtaining of RN towards Recipient Network. A second query in Recipient Network is not required in the case where the first step obtains the complete address to the Recipient Exchange. The sending of RN between networks is optional.

8.3.1.3   Interaction with supplementary services

The level of the service functionality between Originating and Transit Networks A and B might differ depending on the type of interconnection and bilateral agreements. Therefore, it should be noted that calls including end-to-end service request (e.g. UUS 1 essential) might be lost due to interworking. Calls including other type of service request (e.g. UUS 3) will still be delivered, but the requested service(s) are suppressed.

8.3.1.4   Interaction with IN-based services

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

8.3.1.5   Interaction with carrier selection

No interaction identified in the scope of this Supplement.

8.3.1.6   Interaction with statistical counters

No interaction identified.

8.3.1.7 Required forward information transfer between networks

Routing information (i.e. either by RN or DN) is mandatory in the forward direction, from Donor Network. The information is needed to inform Transit and Recipient Networks of the destinating Recipient Network and Recipient Exchange.

In addition to the above it might be of interest to have a separate indication that a database lookup, for NP Re-routing, has been performed, so that the Transit/Recipient Network(s) can easily recognize/trap incoming calls towards ported subscribers. On the other hand, the reception of Routing Number might be sufficient indication.

8.3.1.8 Required backward information transfer between networks

No new NP-related data is identified in the backward direction in the scope of this Supplement.

8.3.1.9 NP routing loop detection issues

No additional loop cases identified, since this architecture involves unique retrieval of Routing Number.

8.4 Call re-routing initiated/performed by Transit Network prior to Donor Network

This subclause describes possible high-level NP architectures in a Transit Network prior to a Donor Network.

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

8.4.1.1 General description

The following NP architecture outlines a Transit Network performing the principle of always querying a NP database prior to routing the call towards Donor/Recipient Network, i.e. re-routing according to "All call query one step" principles as outlined in Figure 6.
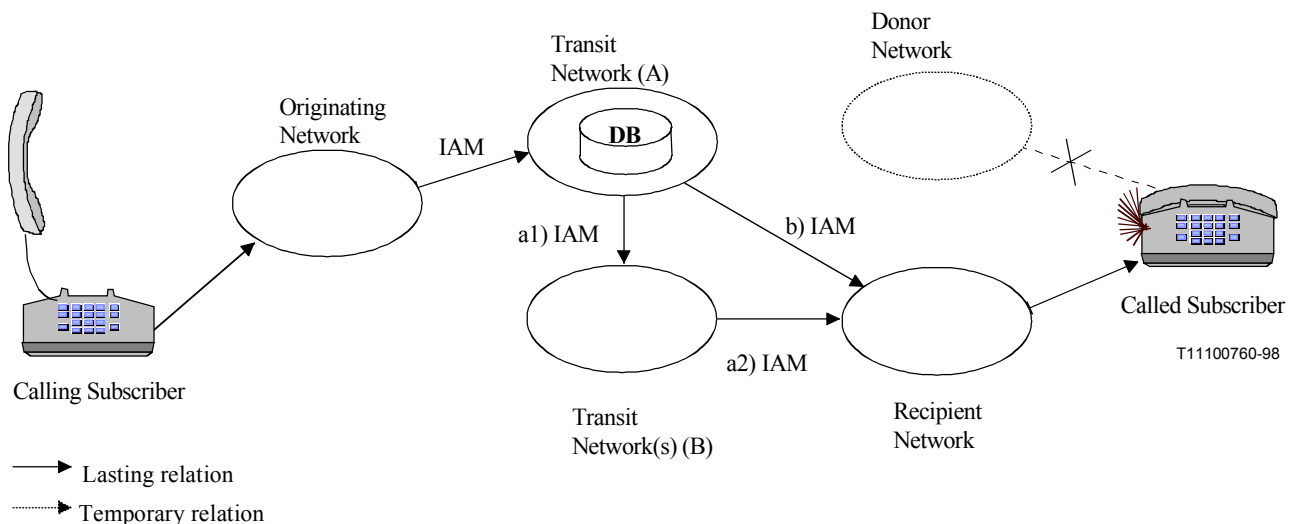

Figure 6 – "All call query" by Transit Network

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

As can be seen from Figure 6 the Donor Network is not involved at all in the call setup to the ported subscriber.

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

8.4.1.2   Generic Information flows

In the generic Information flows outlined in Figure 7, the Transit Network initiates a NP DB query on a "number block" basis; i.e. all outgoing calls with a called party number being part of certain number block(s) will lead to a NP DB query, to retrieve a Routing Number. The Routing Number is then used to redirect the call towards Recipient Network and Exchange.
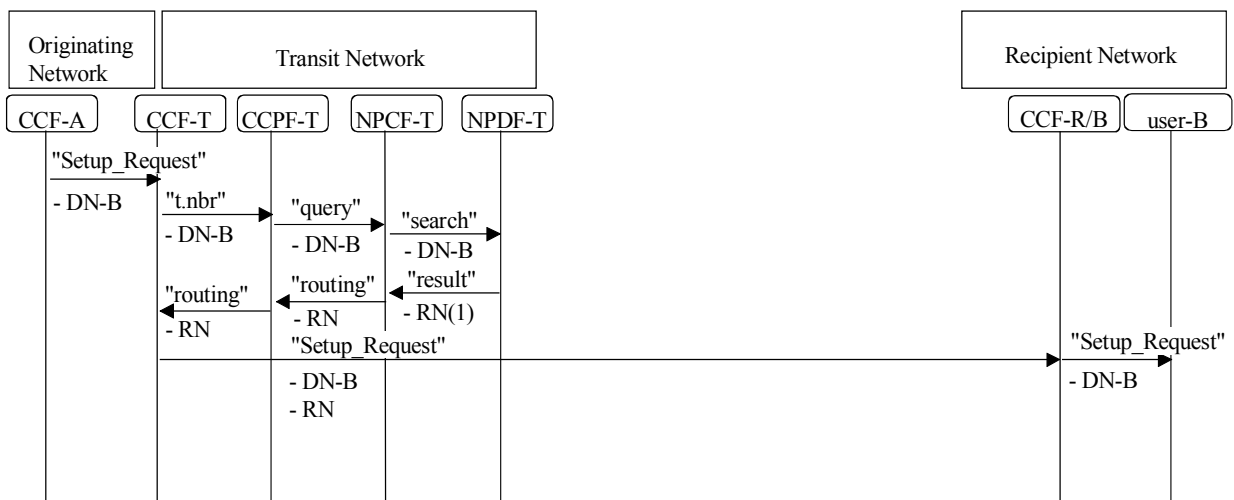
T11100770-98

CCF-A/B	CCF calling party/called party network	
CCF-T/R	CCF Transit/Recipient query network	
CCPF-T	CCPF Transit network	
NPCF-T	NPCF Transit network	
NPDF-T	NPDF Transit network	

RN	Routing Number (e.g. Recipient Network and Exchange ID)
DN-B	Directory Number, called party
t.nbr	An event from CCF informing CCPF that a Called Party Number being part of a "portable number block" has been received
routing	An operation from NPCF storing a new routing number in CCF
query	An event sent from CCPF to NPCF to obtain instructions on how to proceed

a) The shown NP DB query on incomplete number and the request for additional digits (from NPCF-O), is only needed in the case where variable number block length is applied and the CCF-O/CCPF-O do not "know" length for all number block(s) with portable numbers.

b) Overlap sending, after obtaining of RN, is an additional possible case if the called party is part of a variable DDI length, and DB mismatch detection are in the same way as in Figure 13.

**Figure 7 – Generic Information flows supporting of Figure 6,
i.e. a one-step "All call query" solution**

As can be read from the flows, the Originating Network is considered as the Initiating Network since it performs both NP trap functions and obtaining of RN towards Recipient Network.

The second query, in Recipient Network, is not required in the case where the first step obtains the complete address to the Recipient Exchange.

8.4.1.3 Interaction with supplementary services

The level of the service functionality between Originating and Transit Networks A and B might differ depending on the type of interconnection and bilateral agreements. Therefore, it should be noted that calls including end-to-end service request (e.g. UUS 1 essential) might be lost due to interworking. Calls including other type of service request (e.g. UUS 3) will still be delivered, but the requested service(s) are suppressed.

8.4.1.4 Interaction with IN-based services

No interference/impact identified.

8.4.1.5 Interaction with carrier selection

If calling party has requested carrier selection, then the interaction with carrier selection may indirectly determine which NP mechanism is invoked.

8.4.1.6 Interaction with statistical counters

No interference/impact identified.

8.4.1.7 Required forward information transfer between networks

What is described for "onward routing" is valid also here.

8.4.1.8 Required backward information transfer between networks

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

8.4.1.9 NP routing loop detection issues

No additional loop cases identified, since this architecture only involves retrieval of Routing Number once only, even for calls over operator borders.

8.5 Call re-routing performed by Originating Network

This subclause describes possible high-level NP architectures in an Originating Network.

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

8.5.1.1 General description

Same principles are valid as for Transit Network but for clarification the "All call query" principles are shown in Figure 8. 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.
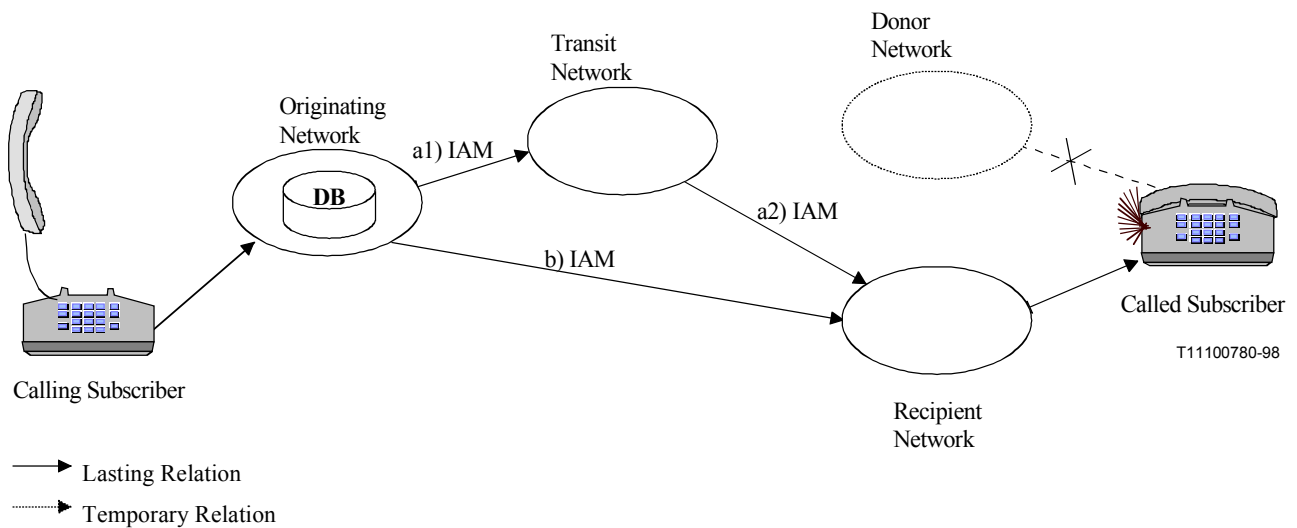
Figure 8 – "All call query" by Originating Network

As can be seen in Figure 8, 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.

8.5.1.2 Generic Information flows

In the generic information flows outlined in Figure 9, the Originating Network initiates a NP DB query on a "number block" basis, i.e. all outgoing calls with a called party number being part of certain number block(s) will lead to a NP DB query, to retrieve a Routing Number. The Routing Number is then used to redirect the call towards Recipient Network and Exchange.

Originating Network

| CCF-A | CCF-O | CCPF-O | NPCF-O | NPDF-O |

Recipient Network

| CCF-R | CCF-B | user-B |

```
"Setup_Request"
- DN-B        "t.nbr"      "query"      "search"
              - DN-B       - NP flag    - DN-B
                           - DN-B       "result"
                           "req_dig"    - incomplete
              "req_dig"
a)
"digits"      "digits"     "query"      "search"
- Digit(s)    - Digits(s)  - DN-B       - DN-B
                                        "result"
              "routing"    "routing"    - RN
              - RN         - RN
                                        "Setup_Request"         "Setup_Request"
                                        - DN-B                  - DN-B
                                        - RN
```
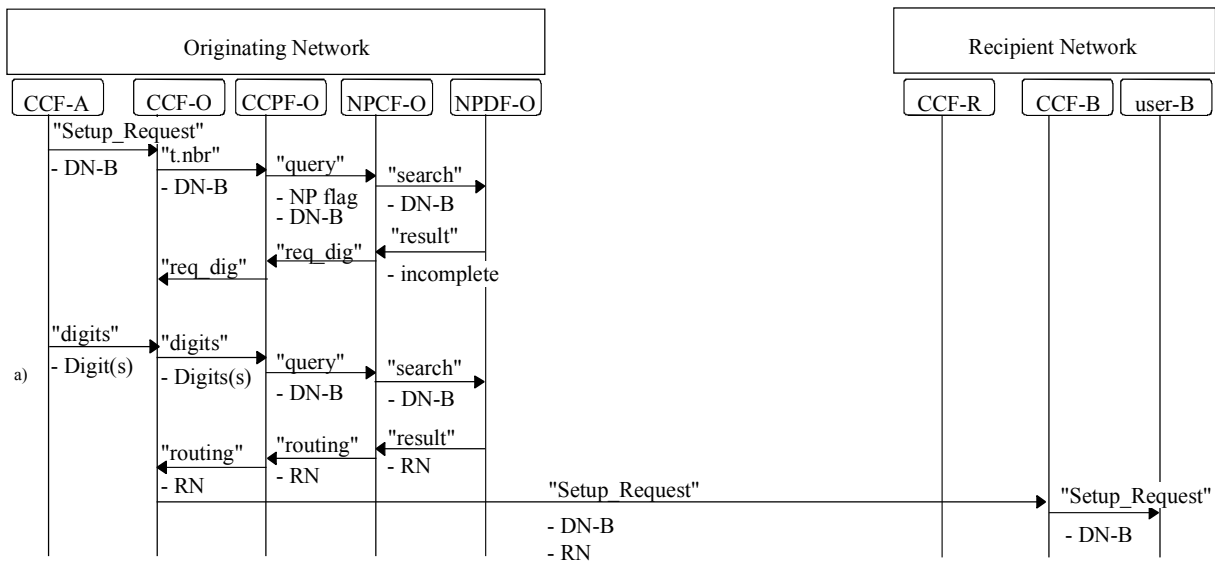
T11100790-98

CCF-A/B	CCF calling party/called party network	RN	Routing Number (e.g. Recipient Network and Exchange ID)
CCF-O/R	CCF Originating/Recipient query network	DN-B	Directory Number, called party
CCPF-O	CCPF Originating network	NP flag	A flag indicating requested service is NP number translation
NPCF-O	NPCF Originating network	t.nbr	An event from CCF informing CCPF that a Called Party Number
NPDF-O	NPDF Originating network		being part of a "portable number block" has been received
query	An event sent from CCPF to NPCF to	routing	An operation from NPCF/CCPF storing a new routing number in CCF
	obtain instructions on how to proceed	req_dig	An operation from NPCF/CCPF to CCF requesting digits

a) The shown NP DB query on incomplete number and the request for additional digits (from NPCF-O), is only needed in the case that variable number block length is applied and the CCF-O/CCPF-O do not "know" length for all number block(s) with portable numbers.

b) Overlap sending, after obtaining of RN, is an additonal possible case if the called party is part of a variable DDI length.

Figure 9 – Generic Information flows supporting of Figure 8,
i.e. a one-step "All call query" solution

As can be read from the flows, the Originating Network is considered as the Initiating Network since it performs both NP trap functions and obtaining of RN towards Recipient Network and Exchange.

8.5.1.3   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 interferences with, e.g. services having subscriber attribute(s) normally only available in the originating LE.

8.5.1.4   Interaction with IN-based services

No interference/impact identified.

8.5.1.5   Interaction with carrier selection

No interaction exists. If calling party has requested carrier selection, then the Originating Network would not need to do any NP DB query; instead, the call will be routed directly towards the requested Transit Network, which then is responsible for further routing towards recipient.

8.5.1.6   Interaction with statistical counters

No interference/impact identified.

8.5.1.7 Required forward information transfer between networks

Re-routing Number must be sent over network borders to inform about both the Recipient Network and Recipient Exchange.

8.5.1.8 Required backward information transfer between networks

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

8.5.1.9 NP routing loop detection issues

No additional loop cases identified, since this architecture only involves retrieval of Routing Number once only, even for calls over operator borders.

8.6 Call re-routing to Recipient performed by a two-step number translation principle

8.6.1 General description

This subclause describes a high-level NP architecture when a two-step number translation principle is used. The first step includes a number translation to obtain partial Routing Number indicating Recipient Network (optionally also point of Interconnection) and where the second step obtains the complete Routing Number indicating also the Recipient Exchange according to the following:

1) retrieval of partial Routing Number indicating Recipient Network only (optionally also point of interconnection).This step can either be initiated by:

   a) onward routing by Donor (only calls to ported-out numbers);

   b) "All call query" by Transit (all calls to portable numbers);

   c) "All call query" by Originating (all calls to portable numbers),

2) retrieval of complete Routing Number also indicating Recipient Exchange. Performed by Recipient Network either at reception of an incoming call with only partial Routing Number or for all incoming calls (to portable number blocks).

In all the above architectures the NP DB outside the Recipient Network contains Routing Number 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 databases need not be updated e.g. when the Recipient Network operator performs internal restructuring of its network.

For all architectures supporting two-step number translation, the Routing 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.

NOTE – DB mismatch means that the two NP DBs residing in different networks do not indicate the same Recipient Network.

8.6.2 Onward routing by Donor combined with query by Recipient Network

8.6.2.1 General information

Figure 10 shows a NP architecture 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 Routing Number to address the Recipient Network. It then routes the call onward towards the Recipient Network either directly or via Transit Network(s).

Figure 10 – Onward routing by donor combined with query by Recipient Network

In Figure 10, the Recipient Network either traps all incoming calls or only traps calls received with a special indication "ported call" or traps calls with a partial Routing Number. It then makes a query to "own" NP DB to obtain a complete Routing Number to address the Recipient Exchange.

8.6.2.2 Generic Information flows

In the generic Information flows in Figure 11, the Originating Network routes the call to the network being the owner of the number block that the called Directory Number (DN) is part of. The Donor Network has armed a "line-based" trigger, stating the number being ported out. It then makes a NP DB query, to retrieve a Routing Number. The Routing Number is then used to route the call onward towards the Recipient Network. When the call is received in the Recipient Network, a new query is performed, in similar way, to obtain a Routing Number to address the Recipient Exchange.

CCF-A | CCF-D | CCPF-D | NPCF-D | NPDF-D | CCF-R | CCPF-R | NPCF-R | NPDF-R | CCF-B | user-B

b)
"Setup_Request"
- DN-B
"l.b.t"
- DN-B
"query"
- NP flag
- DN-B
"search"
- DN-B
"routing"
- RN(1)
"routing"
- RN(1)
"result"
- RN(1)
"routing"
- RN(1)
"Setup_Request"
- DN-B
- RN(1)
"trigger"
- DN-B
- RN(1)
"query"
- NP flag
- DN-B
- RN(1)
"search"
- DN-B
"result"
- RN(2)

a) DB mismatch detection could be performed here

(ok) (nok)

"routing"
- RN(2)
"routing"
- RN(2)
"Setup_Request"
- DN-B
- RN(2)
"Setup_Request"
- DN-B

c)
"digits"
- Digit(s)
"more_digits"
- Digit(s)
"more_digits"
- Digit(s)
"digits"
- Digit(s)
"error"
- cause
"error"
- cause
"Setup_Reject"
- cause
"Setup_Reject"
- cause
"Setup_Reject"
- cause

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CCF-A/B/D	CCF calling party/called party/Donor exchange	
CCPF-O/R/D	CCPF Originating/Recipient/Donor	
NPCF-O/R/D	NPCF Originating/ Recipient/Donor	
NPDF-O/R/D	NPDF Originating/ Recipient/Donor	
query	An event sent from CCPF to NPCF to obtain instructions on how to proceed	

RN(1)   Routing Number (e.g. Recipient Network ID)
RN(2)   Routing Number (e.g. Recipient Network and Exchange ID)
DN-B   Directory Number, called party
l.b.t   Line Based Trigger, an event from CCF informing CCPF that a call to a number with an armed line based trigger is received
routing   An operation from CCPF storing a new routing number in CCF

a)   The DB mismatch detection principle in the figure shows one possible way of preventing loops to occur due to NP DB mismatch; this method is only possible if RN is sent between networks. Other ways of detecting database mismatch, e.g. use of ISUP hop counter, than the one shown in the figure do exist.

b)   Trigger on incomplete number is not applicable here since the Donor Exchange is reached prior to NP DB query.

c)   The need for overlap sending of digits is only applicable where variable DDI ranges are used, i.e. is not necessary for fixed number length schemes.

**Figure 11 – Generic Information flows for Figure 10,
i.e. a two-step "Onward Routing" architecture**

As can be read from the flows, the Donor Network is considered as the Initiating Network since it performs both NP trap functions and obtaining of RN towards Recipient Network. The second query, in Recipient Network, is not required in the case where the first step obtains the complete address to the Recipient Exchange. The sending of RN between networks is optional.

8.6.3   "All call query" by Transit Network combined with query by Recipient Network

8.6.3.1   General information

Figure 12 shows a NP architecture 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 Routing Number to address the Recipient Network. It then routes the call towards the Recipient Network either via another Transit Network(s) or directly.
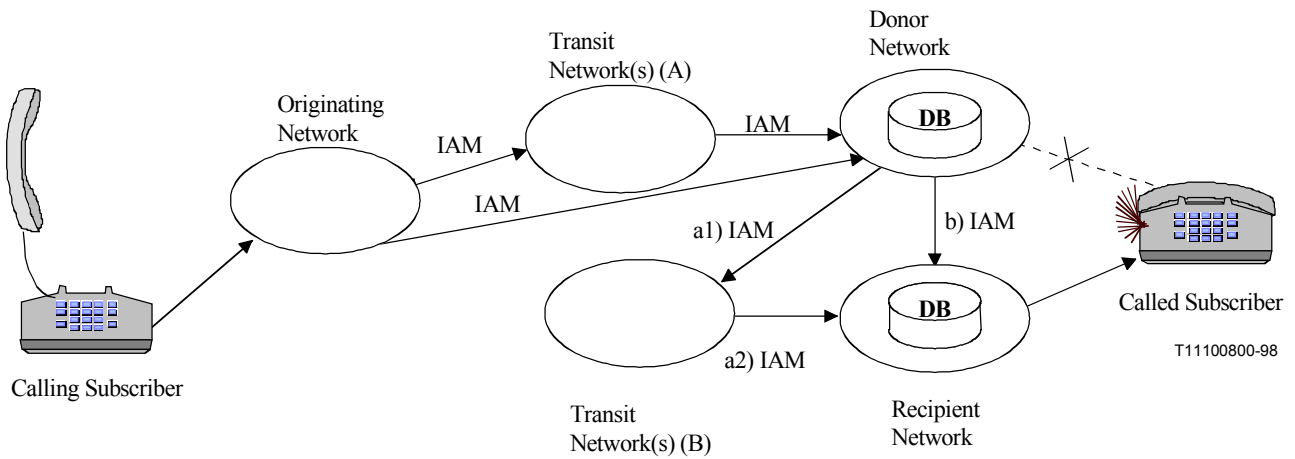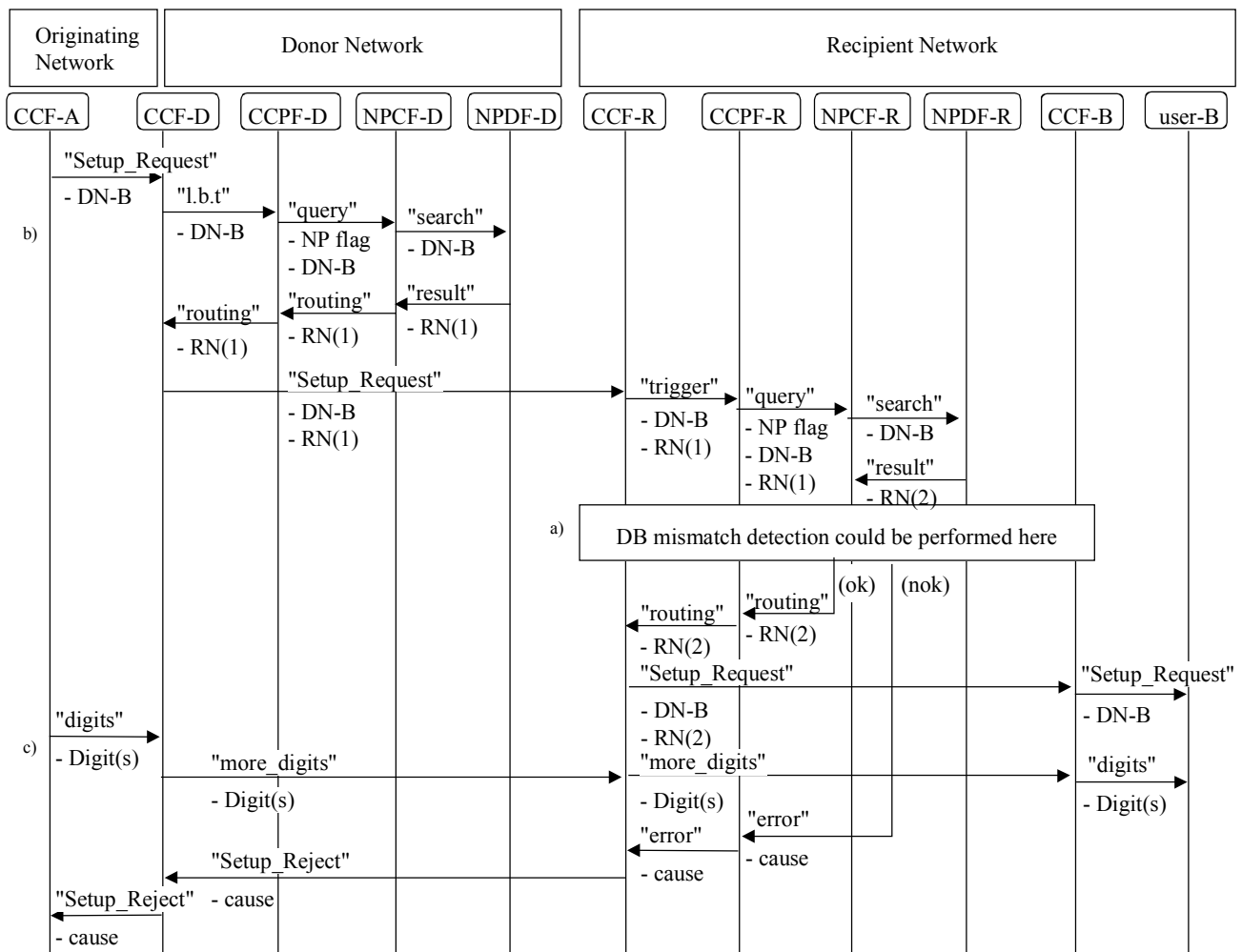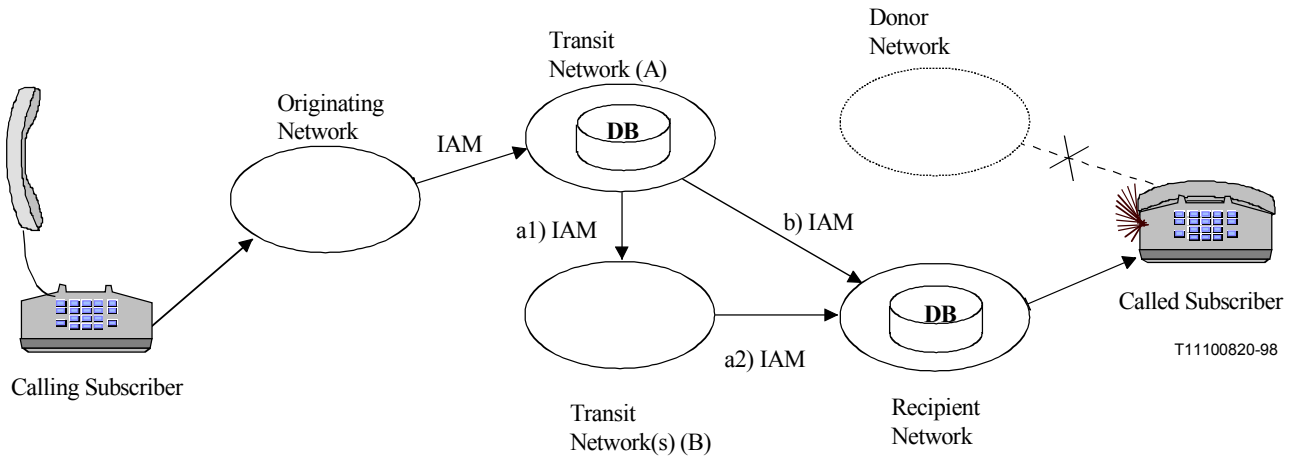

Figure 12 – "All call query" by Transit Network combined with query by Recipient Network

In Figure 12, the Recipient Network either traps all incoming calls or only traps calls received with a special indication "ported call" or traps calls with a partial Routing Number. It then makes a query to "own" NP DB to obtain a complete Routing Number to address the Recipient Exchange.

8.6.3.2   Generic Information flows

In the generic Information flows in Figure 13, the Originating Network routes the call towards the Donor Network. However, the Transit Network detects that the called Directory Number is within the armed "number block"-based trigger, indicating a block having portable numbers. It then makes a NP DB query to retrieve a Routing Number. The Routing Number is then used to route the call onward towards the Recipient Network. When the call is received in the Recipient Network, a new query is performed, in similar way, to obtain a Routing Number to address the Recipient Exchange.
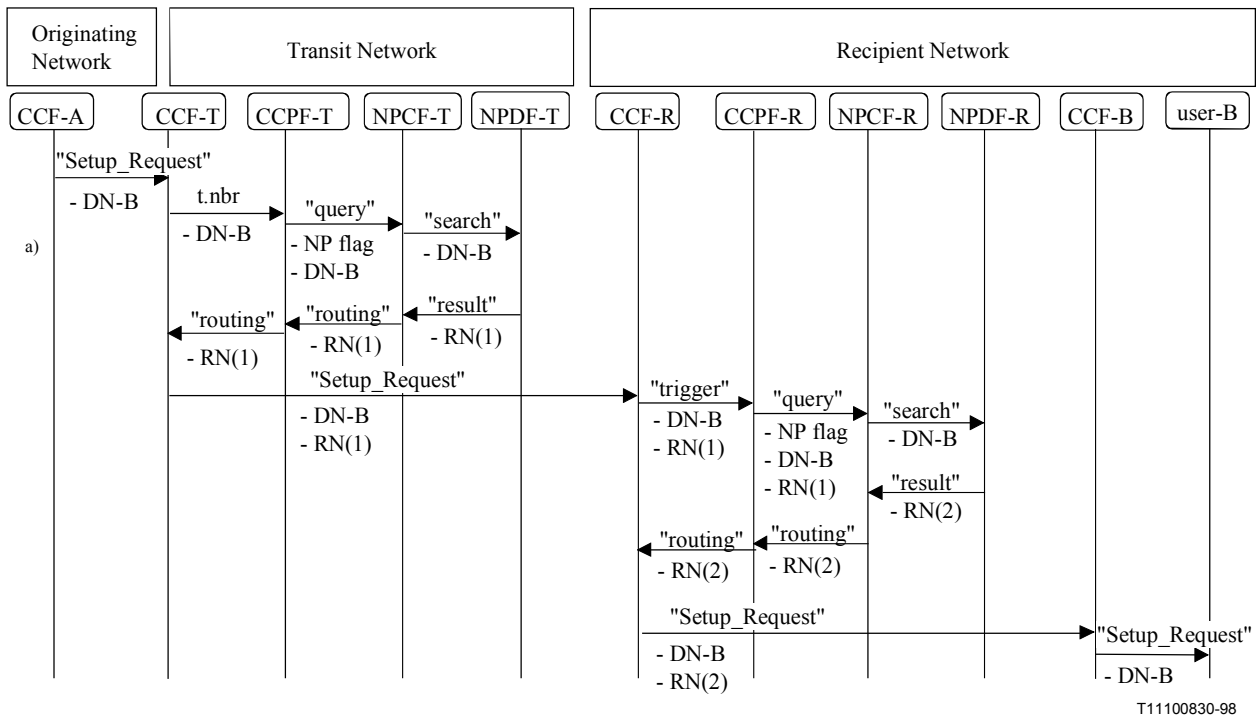
CCF-A/B/T	CCF calling party/called party/Transit exchange	
CCPF-O/R/T	CCPF Originating/Recipient/ Transit	
NPCF-O/R/T	NPCF Originating/ Recipient/ Transit	
NPDF-O/R/T	NPDF Originating/ Recipient/ Transit	
query	An event sent from CCPF to NPCF to obtain instructions on how to proceed	
RN(1)	Routing Number (e.g. Recipient Network ID)	
RN(2)	Routing Number (e.g. Recipient Network and Exchange ID)	
DN-B	Directory Number, called party	
t.nbr	An event from CCF informing CCPF that a call to a portable number with an armed trigger is received	
routing	An operation from NPCF storing a new routing number in CCF	

a) Overlap sending, after obtaining of RN and DB mismatch detection, are applicable options in this scenario in the same
     way as in Figure 11.

**Figure 13 – Generic Information flows for Figure 12,
i.e. a two-step "onward routing" architecture**

As can be read from the flows, the Originating Network is considered as the Initiating Network since it performs both NP trap functions and obtaining of RN towards Recipient Network.

The second query, in Recipient Network, is not required in the case where the first step obtains the complete address to the Recipient Exchange.

8.6.4   "All call query" by Originating Network combined with query by Recipient Network

8.6.4.1   General information

Figure 14 shows a NP architecture where first NP routing in the two-step number translation principle is that the Originating Network makes a DB query on the CdPN to retrieve a partial Routing Number to address the Recipient Network, routes the call towards the Recipient Network either via Transit Network(s) or directly (option b).
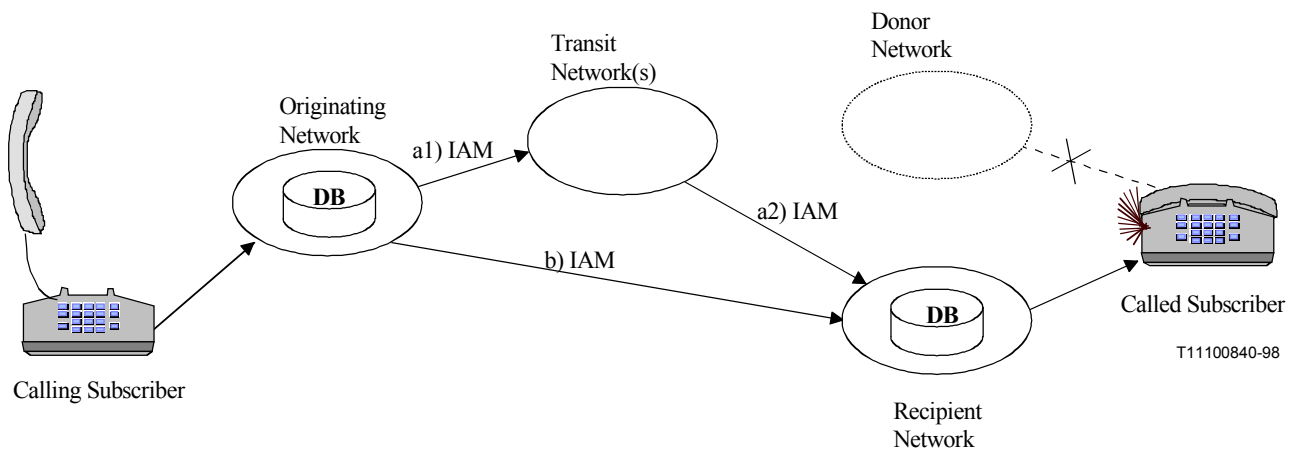
**Figure 14 – "All call query" by Originating Network combined with
query by Recipient Network**

In Figures 10, 12 and 14, the second NP routing in the two-step number translation principle is that the Recipient Network either traps all incoming calls or only traps calls received with a special indication "ported call" or traps calls with a partial Routing Number. It then makes a query to "own" NP DB to obtain a complete Routing Number to address the Recipient Exchange.

8.6.4.2 Generic Information flows

In the solution outlined in Figure 15, the Originating Network has armed a "number block"-based trigger, i.e. all outgoing calls with a called party number being part of this number block will lead to a NP DB query, to retrieve a Routing Number. The retrieved Routing Number is then used to redirect the call towards Recipient Network. The actions in Recipient Network are as in earlier solutions.

CCF-A/B	CCF calling party/called party exchange	RN(1)	Routing Number (e.g. Recipient Network ID)
CCF-O/R	CCF Originating/Recipient query exchange	RN(2)	Routing Number (e.g. Recipient Network and Exchange ID)
CCPF-O/R	CCPF Originating/Recipient	DN-B	Directory Number, called party
NPCF-O/R	NPCF Originating/ Recipient	NP flag	A flag indicating requested service is NP number translation
NPDF-O/R	NPDF Originating/ Recipient	t.nbr	An event from CCF informing CCPF that a Called Party Number being part of a "portable number block" has been received
query	An event sent from CCPF to NPCF to obtain instructions on how to proceed		
req_dig	An operation from NPCF/CCPF to CCF requesting digits	routing	An operation from NPCF/CCPF storing a new routing number in CCF

a) The shown NP DB query on incomplete number and the request for additional digits (from NPCF-O), is only needed in the case where variable number block length is applied and the CCF-O/CCPF-O do not "know" length for all number block(s) with portable numbers.

b) Overlap sending, after obtaining of RN and DB mismatch detection, are applicable options in this scenario in the same way as in Figure 11.

**Figure 15 – Information flows supporting Figure 14, i.e. a two-step
"All call query" architecture**

As can be read from the flows, the Originating Network is considered as the Initiating Network since it performs both NP trap functions and the obtaining of RN towards Recipient Network.

The second query, in Recipient Network, is not required in the case where the first step obtains the complete address to the Recipient Exchange.

8.6.5   Interaction with supplementary services

Interactions with supplementary services depend on the first NP routing in the two-step number translation principle and are described in previous subclauses.

8.6.6   Interaction with IN-based services

No interference/impact identified.

8.6.7 Interaction with carrier selection

Interactions with carrier selection depend on the first NP routing in the two-step number translation principle and are described in previous subclauses. The selected carrier takes the role of Originating/Initiating Network in case carrier selection is applied for the call. Figure 12 is the relevant figure for this case.

8.6.8 Interaction with statistical counters

Interactions with statistical counters depend on the first NP routing in the two-step number translation principle and are described in previous subclauses.

8.6.9 Required Forward information transfer between Networks

Forward Routing Number need to be sent over network borders.

8.6.10 Required backward information transfer between networks

NP-related backward information depends on the first NP routing in the two-step number translation principle and are described in previous subclauses.

8.6.11 NP routing loop detection issues

Some loop cases are identified, since this architecture involves retrieval of Routing Number two times, for a call over network borders. Only one retrieval is required if Initiating and Recipient Networks are the same.

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

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

8.7.1 General description

This subclause describes a high-level NP architecture when all involved networks, at call set-up, have access to a Number Portability database as outlined in Figure 16.
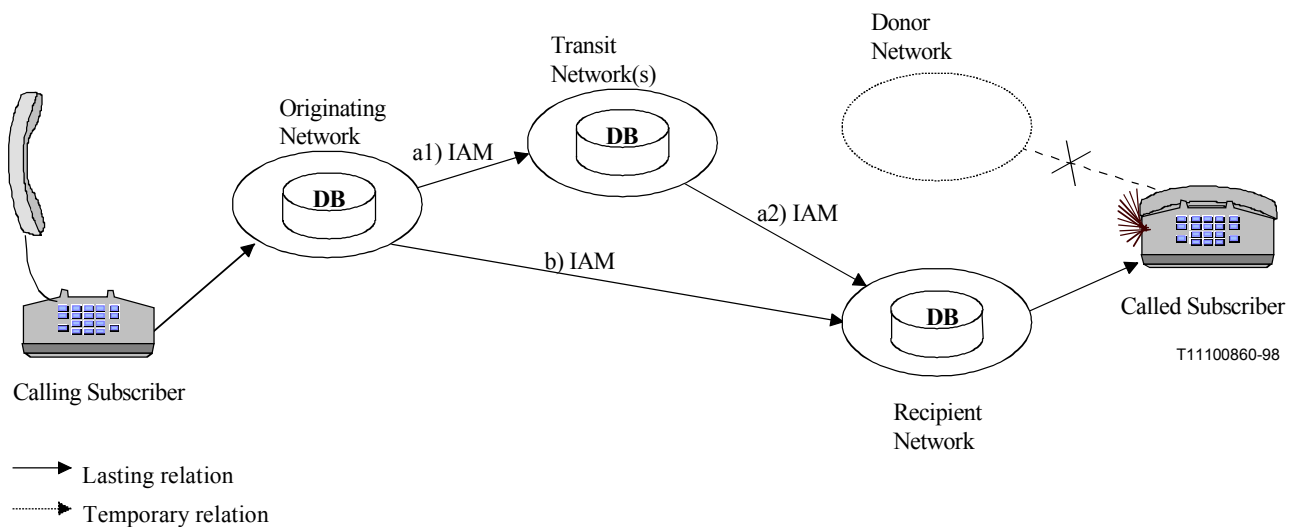

Figure 16 – "All call query" by all involved networks

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

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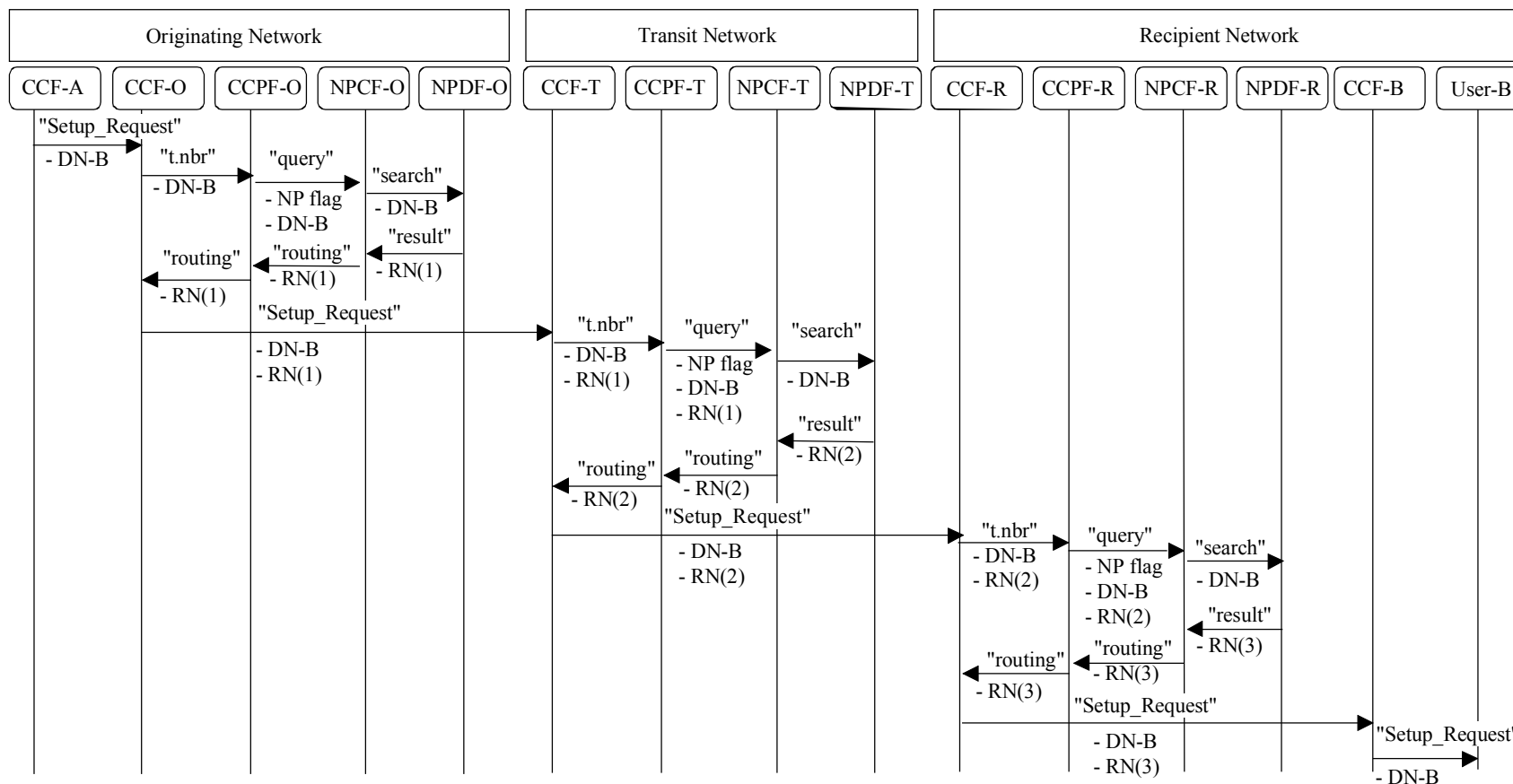
The Recipient Network receives the incoming call, makes a DB query again to retrieve a Routing Number to Recipient Exchange, then routes the call towards the Recipient Exchange.

As can be seen in Figure 16, all involved networks have access to a Number Portability database; this opens the possibility of not needing to transfer NP-related Routing Number between networks.

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

8.7.1.1 Generic Information flows

In the solution outlined in Figure 17, the Originating Network has armed a "number block"-based trigger, i.e. all outgoing calls with a called party number being part of this number block will be subject for NP DB query, to retrieve a Routing Number. The retrieved Routing Number is then used to redirect the call towards Recipient Network, via a Transit Network. The Transit Network receives the call without any Routing Number, traps the call and makes a NP DB query, to retrieve a Routing Number. The retrieved Routing Number is then used to redirect the call towards Recipient Network. The actions in Recipient Network are as in earlier solutions.

Figure 17 – Generic Information flows for Figure 16, i.e. "All call query all networks" architecture

The figure contains the following legend:

CCF-A/B	CCF calling party/called party network
CCF-O/T/R	CCF Originating/Transit/Recipient network
CCPF-O/T/R	CCPF Originating/Transit/Recipient network
NPCF-O/T/R	NPCF Originating/Transit/Recipient network
NPDF-O/T/R	NPDF Originating/Transit/Recipient network
query	An event sent from CCPF to NPCF to obtain instructions on how to proceed

RN	Routing Number (e.g. Recipient Network and Exchange ID)
DN-B	Directory Number, called party
NP flag	A flag indicating requested service is NP number translation
t.nbr	An event from CCF informing CCPF that a Called Party Number being part of a "portable number block" has been received
routing	An operation from NPCF/CCPF storing a new routing number in CCF

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As can be read from the flows, the Originating Network is considered as the Initiating Network since it performs both NP trap functions and obtaining of RN towards Recipient Network; the same is valid for both Transit and Recipient Networks since they also do NP DB queries.

8.7.2 Interaction with supplementary services

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

8.7.3 Interaction with IN-based services

No interference/impact identified.

8.7.4 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 routing towards recipient. Figure 12 is the relevant figure for this case.

8.7.5 Interaction with statistical counters

Interactions with statistical counters depend on the first NP routing in the two-step number translation principle and are described in previous subclauses.

8.7.6 Required forward information transfer between networks

Routing Number need not, but might optionally, be sent over network borders.

8.7.7 Required backward information transfer between networks

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

8.7.8 NP routing loop detection issues

Some loop cases are identified, since this architecture involves retrieval of Routing Number several times, for a call over network borders. Only one retrieval is required if Originating and Recipient Networks are the same.

9 Network architecture for non-circuit-related signalling support for ported Geographic Numbers

9.1 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 messages are always transported by the SCCP.

SCCP allows messages to be addressed with Global Titles (GT), which may contain E.164 numbers, including E.164 numbers which are subject to portability. For example, CCBS/CCNR uses the Called Party Number (CdPN), as dialled by the user, in the Global Title. Where a called GT in a SCCP message contains a ported number, the SCCP message must 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 routing functions and data, and have also sometimes only required a few hundred entries. With the advent of services which use E.164 numbers as GTs, and particularly with

the introduction of Number Portability, such GTT capability as implemented may be insufficient. Hence, solutions must be found which allow the correct delivery of SCCP messages addressed with E.164 numbers, including ported numbers.

9.2 Addressing requirements for routing of non-circuit-related messages

1) The routing of non-circuit-related messages must be achieved, 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.

2) The integrity of services provided by the SCCP layer should be maintained also in a NP environment.

3) Existing management procedures should ensure that the integrity of the addressing data is not affected by Number Portability. For example, inconsistency between GTT data and call routing data could lead to incomplete service being offered to customers with ported numbers or customers calling these numbers. Also, inconsistency between the GTT data held by different network operators may lead to circular routing of messages.

9.3 Network architecture models

In all architectures identified for circuit-related signalling, there exists one or more databases which assist the routing 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. These databases could also be used to assist the routing of non-circuit-related messages; however, there may be circumstances when it is not possible to use the same database.

For the case where the DB is internal to the exchange, the same NP DB for both circuit-related and non-circuit-related routing could be used. However, the retrieval is a NP function whereas Global Title translation is an SCCP function.

Where the DB is external to the exchange, then the procedures to retrieve the ported number address for the new Global Title would be a function supported by SCCP.

Regardless of the location of this NP DB, the result may be a modified GT which will be translated within the SCCP to determine how to subsequently route the non-circuit-related message.

The following subclauses describe a number of possible architectures. Three main approaches are identified, i.e. that a Global Title (GT) is retrieved and used:

a) by Donor Network that reroutes the non-circuit-related message to the correct destination;

b) by Originating LE that routes to the Recipient Network or destination;

c) by an SPR, e.g. an SPR that routes to the Recipient Network.

Note that combinations of a) and b) and of a) and c) are possible. Other architectures may be possible. These are examples only and may need to be enhanced after further investigation.

9.3.1 Non-circuit-related message re-routing by the Donor Network/Exchange

9.3.1.1 General description

In this architecture, the Donor Network/Exchange maintains all the data, e.g. a Global Title (GT), for ported-out numbers.

As outlined in Figure 18, the Originating Network/Exchange routes the non-circuit-related message according to the original location of the number series that the called party Directory Number is part of.
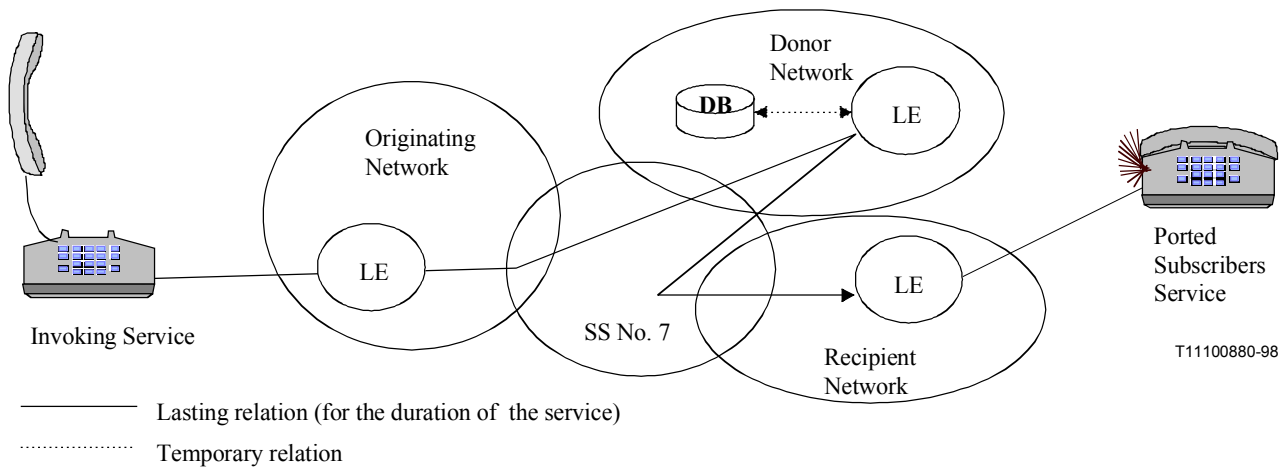
Figure 18 – DB query and SCCP message re-routing performed by Donor LE

The Donor Network (e.g. Local Exchange) detects that the called number has been ported out and retrieves the new Global Title replacing the received GT with this. Thereafter, the non-circuit-related message is onward routed towards the Recipient Exchange.

The Recipient Network need not make another NP query since the message is routed directly to the Recipient Exchange.

Figure 19 illustrates a further option where the Donor Network NP query retrieves a Global Title which is only sufficient to identify the Recipient Network. A further NP query, in the Recipient Network, retrieves a Global Title for onward routing to the Recipient Exchange.
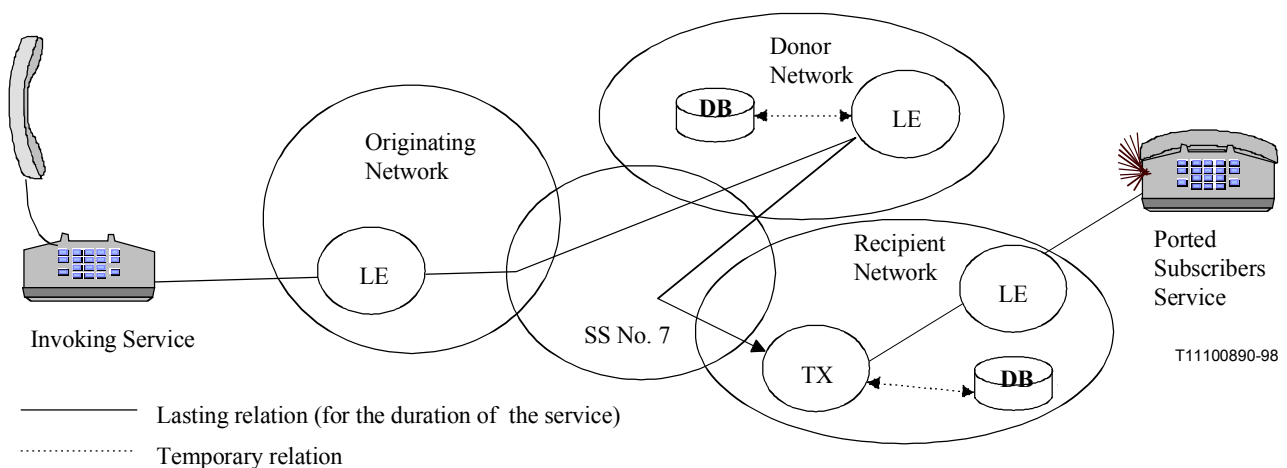
**Figure 19 – DB query and SCCP message re-routing performed by
Donor LE and Recipient Network**

9.3.2   Non-circuit-related message re-routing by the Originating Network/Exchange

9.3.2.1   General description

In this architecture, the Originating Network/Exchange has access to NP data to determine whether a number is ported or not (i.e. this model means that the NP data has to be accessed for all non-circuit-related messages, equivalent to the "All call query case").

As outlined in Figure 20, the Originating Network/Exchange retrieves a Global Title prior to routing the non-circuit-related message towards the Recipient Exchange. The Recipient Network need not make another NP query since the complete Routing Number is used.

Figure 20 – DB query and SCCP message re-routing performed by Originating LE

Retrieval of the ported Global Title (GT) is made by Originating LE prior to sending out the non-circuit-related message. This means that the Donor Network is not involved in the non-circuit-related message routing.

This principle is not backwards compatible to (Originating) Local Exchanges (e.g. outside NP domain) which are neither intended nor upgraded for Number Portability.

9.3.3 Non-circuit-related message re-routing at the SPR

9.3.3.1 General description

In this architecture (see Figure 21), the NP query is made first at the Signalling Gateway (SPR) in the Originating Network. The SCCP traps, by analysing the received Global Title, non-circuit-related messages directed towards a number block which is subject to Number Portability. The Originating Network retrieves the new Global Title [flow a)], modifies the Global Title and routes the non-circuit-related message onward to Recipient Network.

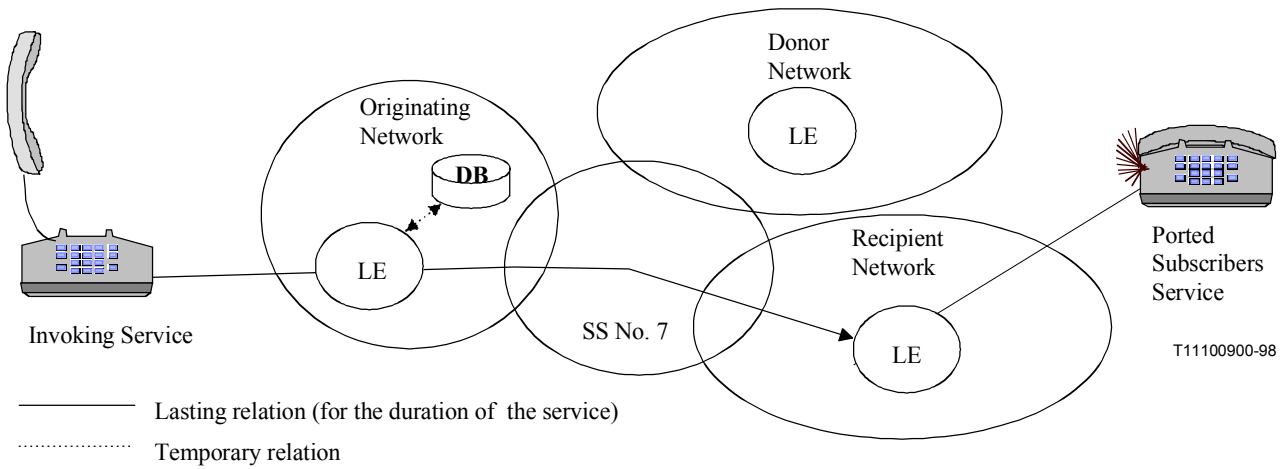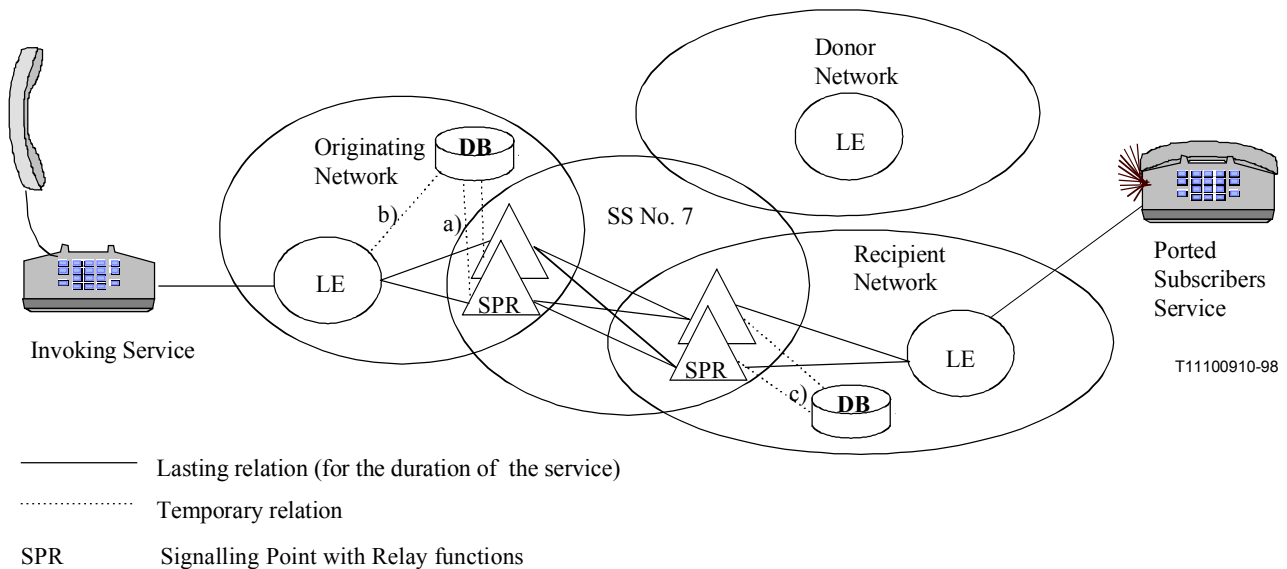**Figure 21 – DB query and SCCP message re-routing performed at SPR level**

The SPR of the Recipient Network traps the incoming non-circuit-related message by analysing the revised Global Title and makes a new DB query [flow c)], to obtain the Global Title of Recipient Exchange and routes the non-circuit-related message onward to Recipient Exchange. In this scenario, the Donor Network is not involved in the non-circuit-related message routing.

In order to allow load-sharing across SPRs when the Number Portability data is internal to the SPRs, the Number Portability data must be replicated in all SPRs.

The architecture above also shows the case where the originating Local Exchange [flow b)] may perform the NP DB query as described in the previous subclause.

A variation of this architecture is that the non-call-related NP triggering point (i.e. the SPR) could also be enhanced to be co-located with a SSP/SCP or SSCP which would allow IN techniques to be used to obtain the new Global Title. The same NP DB for both circuit-related and non-circuit-related routing could also be used. Further information concerning the IN physical entities can be found in the Q.12x5 series of Recommendations.

10 Generic Distributed Functional Entity Model for Number Portability

10.1 General information

A functional structure is needed to ease allocation of the different NP-related tasks required. Figure 22 shows a generic Distributed Functional Entity Model for Number Portability. This subclause addresses only routing-related aspects. The figure also depicts the functional entities and their relationship.
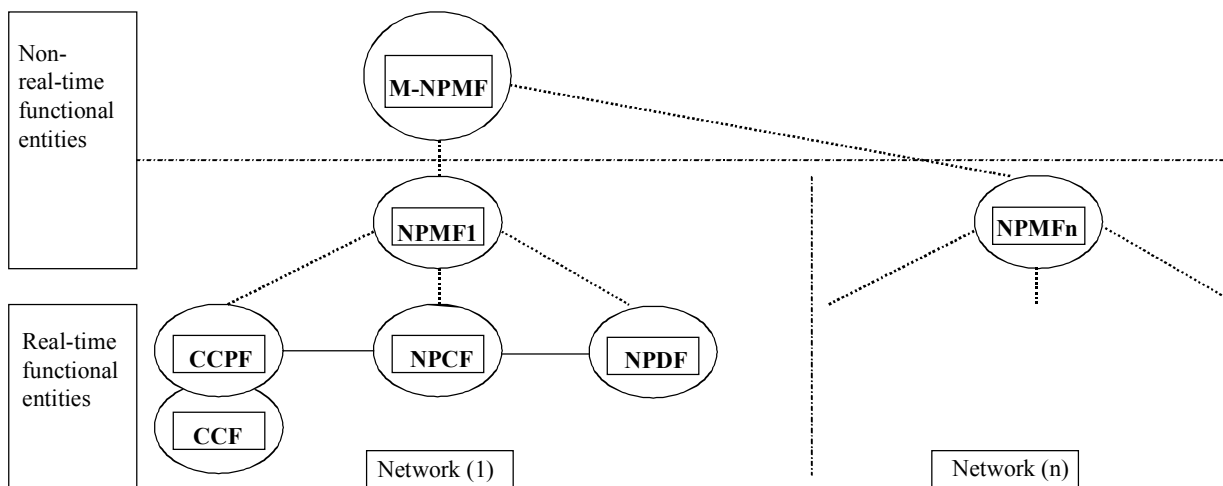
CCF   Call Control Functions
NPCF   NP Control Functions
NPMF   NP Management Functions
CCPF   Call Control Portability Functions
NPDF   NP Data Functions
M-NPMF   Master NPMF

Figure 22 – Functional Entity Model for Number Portability

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

Both routing and NP data management aspects of each functional entity is addressed; however, no attempt is made to limit an individual network operator's implementation of the functionality associated with each of the functional entities.

In the scenario of e.g. an exchange internal "onward routing" architecture 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 Routing Number and then instruct the CCPF to introduce it into CCF routing 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 possible).

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

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

b)   the NPCF would then interact with the NPDF to obtain the Routing Number and then instruct the CCPF to introduce it into CCF routing 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 possible).

10.2 Call Control Function (CCF)

Call Control Function (CCF) provides the functions for processing and control of routing of calls and services according to definitions in 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 the type of trigger.

10.3 Call Control Portability Function (CCPF)

Call Control Portability Function (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 Routing Number, 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.

10.4 Number Portability Control Function (NPCF)

Number Portability Control Function (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 routing 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.

10.5 Number Portability Data Function (NPDF)

Number Portability Data Function (NPDF) contains a data mapping table, for real-time access, giving Routing Number 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.

10.6 Number Portability Management Function (NPMF)

Number Portability Management Function (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 receives/retrieves data from M-NPMF. NPMF also ensures 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.

10.7 Master Number Portability Management Function (M-NPMF)

Master Number Portability Management Function (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 regional level.

It also controls:

a)   the downloading 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 which should not be distributed.

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

In principle, the same problems, architectures and architectures are valid/possible for Non-Geographic Number Portability (NGNP) as for Geographic Number Portability (GNP); the main difference is that NP Routing Number cannot indicate any Recipient Exchange but only the Recipient Network, 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.

12 Concatenation of Service Provider Portability for Non-Geographic Numbers (NGNP) and Geographic Numbers (GNP)

It must 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 (to reach NGN Service Provider) and GNP (to reach GN Service Provider) is a possible traffic case. This case is both applicable for call-based routing and service (SCCP-based) Routing.

13 Routing and addressing of calls towards portable numbers

The following types of addressable entities, for NP Routing purposes (to support the previously described NP architectures "Onward Routing" and "All call query" with one, two or multiple DB lookup methods) are identified:

a)   Recipient Network; or/and

b)   Point of Interconnection; or/and

c)   Recipient Exchange.

The following addressed types, when used for routing towards called party, have been identified:

d)   Concatenated Routing Number (RN) and Directory Number (DN), e.g. RN prefixing the DN in Called Party Number parameter;

e)   Separated RN and DN, RN and DN placed in separated parameters;

f)   Only DN, e.g. when no RN is sent between networks.

14 Routing and addressing for calls from portable numbers

Prior to Number Portability, the allocated numbers within a network had a geographic significance and implied that the number block, of the calling party number could be used to determine the

Originating Network (and Exchange). This capability was contained due to the fact that all numbers being part of a particular number block were always allocated to one particular operator who, in turn, applied the practice of connecting all users with these numbers to one and the same Exchange. But with Service Provider Portability (SPP), this is no longer possible.

Prior to SPP, the determining of calling origin (network and exchange) could, for example, be used to obtain input information for:

a)   routing, of calls to e.g. closest emergency office;

b)   charging, determining if own subscriber or not;

c)   accounting, determining the Originating Network.

The list above should not be considered exhaustive.

In addition to the list above the number block that the calling party number is part of is also used by e.g. Emergency Office and Malicious Call Identification (MCID) to identify, on a per call basis, which operator (database) to consult in retrieving calling party location information.

To continue support for the above, in an environment of Number Portability, calls from ported numbers must convey both logical and physical calling party information.

ANNEX A

IN support for Service Provider Portability of Geographic Numbers

A.1   General information

The requirement for Intelligent Network (IN) support of Service Provider Portability of Geographic Numbers incorporates: firstly, trapping (i.e. triggering of an IN NP DB query) of each call to a ported-out/portable number; secondly, obtaining a routing number; and finally; initiating call set-up towards the Recipient network and exchange. Management of NP data is elaborated in subclauses addressing management issues.

The IN architecture provides the basic relationship between the service control, service switching, connection control, database and specialized resources functions. There also are links with the management and service creation functions.

The interface between the switching network and the IN NP DB is provided by the INAP (Intelligent Network Application protocol).

Special requirements exists regarding support for cases where:

a)   number ranges have variable length: This might require multiple IN NP DB triggering, e.g. by request for more data, depending on knowledge of number length in SSP.

b)   DDI ranges have variable length (within a number range): This requires overlap signalling even after number translation all the way to the PBX, since the number length (per unique number) is controlled by the PBX owner.

The IN-triggering, to obtain a routing number, is applicable both for circuit-related signalling (call set-up) and for non-circuit-related signalling (TCAP-based services).

NOTE – Options a) and b) are only applicable for circuit-related signalling, since the complete destination must be reached (i.e. all digits received) before the calling subscriber is able to activate e.g. CCBS and CCNR services.

A.2 IN trigger conditions, circuit-related signalling to Geographic Numbers

A.2.1 General information

Triggering of an IN NP DB query, during call set-up, can in principle be due to:

a)   a subscriber number being identified as ported-out, i.e. a "ported or vacant number"-based trigger – to support high-level NP architecture "Onward routing".

b)   a received call to "portable number", i.e. a "number block"-based trigger – to support high-level NP architecture "All call query".

A.3 IN trigger conditions, non-circuit-related signalling to Geographic Numbers

Triggering of an IN DB query, during non-circuit-related signalling, can in principle be due to:

a)   a received non-circuit-related service request to a number being identified as ported-out, i.e. a "single number"-based trigger – to support high-level NP architecture "Onward routing" on SCCP messages.

b)   a received non-circuit-related service request to "portable number", i.e. a "number block"-based trigger – to support high-level NP architecture "All call query" on SCCP messages.

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