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Supplement 2

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SERIES E: OVERALL NETWORK OPERATION,
TELEPHONE SERVICE, SERVICE OPERATION AND
HUMAN FACTORS

Operation, numbering, routing and mobile services –
International operation – Numbering plan of the international
telephone service

The international public telecommunication
numbering plan

Supplement 2: Number Portability

ITU-T Recommendation E.164 – Supplement 2

(Previously CCITT Recommendation)

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ITU-T RECOMMENDATION E.164

THE INTERNATIONAL PUBLIC TELECOMMUNICATION NUMBERING PLAN

SUPPLEMENT 2

Number Portability

Source

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FOREWORD

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The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

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Recommendation E.164

THE INTERNATIONAL PUBLIC TELECOMMUNICATION NUMBERING PLAN

SUPPLEMENT 2

Number Portability

(Geneva, 1998)

1 Scope

This Supplement defines standard terminology for a common understanding of the different aspects of number portability within an E.164 numbering scheme. It identifies numbering and addressing formats, call flows, network architectures and routing approaches that will provide alternative methods of implementation. It also proposes some examples of the administrative and operational processes required for the successful implementation of number portability.

2 References

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

3 Definitions and abbreviations

3.1 Definitions

The following definitions and terms used in this Supplement are to be used within the context of number portability.

3.1.1 address (taken from E.164): A string or combination of decimal digits, symbols and additional information which identifies the specific termination point(s) of a connection in a public network(s) or, where applicable, in interconnected private network(s).

3.1.2 directory number: See end user's number.

3.1.3 donor network/exchange: The initial network/exchange where a number was located before ever being ported.

3.1.4 donor service provider: The service provider from whom the number was initially ported.

3.1.5 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 (CLI) and Connected Line Identification Presentation (COLP).

The end user's number is equivalent to a directory number.

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

3.1.7 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.

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

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

3.1.10 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 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 numbering plan.

3.1.11 originating network/exchange: The network/exchange serving a calling end user.

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

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

3.1.14 recipient network/exchange¹: The network/exchange where a number is located after being ported.

3.1.15 recipient service provider: The service provider to whom the number is ported.

3.1.16 routing number: A number that is derived and used by the network to route the call towards a ported number.

Four types of entities can be indicated by routing numbers as follows:

- *Recipient network:* The routing number identifies the network where the customer is now located. Therefore the routing process will need additional information (i.e. DN) to be completed.
- *Recipient exchange:* The routing number identifies the exchange where the customer is now located. Therefore the routing process within the recipient exchange will need additional information (i.e. DN) to be completed.
- *Point of interconnection:* The routing number identifies an interface to the next network in the routing process. Therefore the routing process will need additional information (i.e. DN) to be completed.
- *Network termination point:* The routing number identifies the subscriber/access line/service. The ported customer identified by the RN is unique. Therefore the routing process in terms of number portability can be completed without any additional information.

3.1.17 serving network(s)/exchange(s): The network(s)/exchange(s) that determines the status of a number in an environment capable of supporting number portability and, if necessary, obtains the routing information for ported numbers. The functionality to provide these capabilities may reside in either the originating, donor, recipient or transit network/exchange or in some combination.

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

3.1.19 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.

¹ The recipient exchange may consist of a central processor and both co-located and remote concentrator units. The routing number may identify either this whole ensemble or a specific concentrator (in which case the ensemble may use several different routing numbers).

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

3.1.21 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.

3.1.22 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.

3.1.23 service provider portability for non-geographic numbers: 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.

3.1.24 transit network(s)/exchange(s): A network/exchange between two networks.

3.2 Abbreviations

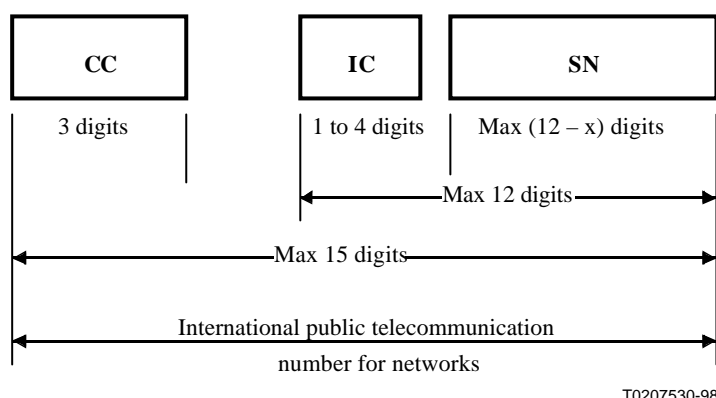
CCBS	Completion of Calls to Busy Subscriber
DDI	Direct-Dialling-In
DN	Directory Number
GNP	Geographic Number Portability
IN	Intelligent Network
MSN	Multiple Subscriber Number
NGNP	Non-Geographic Number Portability
RN	Routing Number
SP	Service Provider

4 E.164 number structures

This clause identifies three different structures for the international public telecommunication number:

- international public telecommunication number for geographic areas;
- international public telecommunication number for global services;
- international public telecommunication number for networks.

4.3 International public telecommunication number for networks



CC Country Code for networks
 IC Identification Code
 SN Subscriber Number
 x Number of digits in Identification Code (IC)

NOTE – National and international prefixes are not part of the international public telecommunication number for networks.

Figure 3 – International public telecommunication number structure for networks

5 Number portability types

An E.164 number is classified into the following three types of country codes:

- 1) beginning with CC for geographic areas;
- 2) beginning with CC for global services; and
- 3) beginning with CC for networks.

The following tables provide an overview of the applicability of each type of portability, when considered against the three number types.

Table 1 – Service provider portability

Scope	Between CC domains		Within CC domains	
CC type (Note 1)				
Geographic	Porting not applicable	Standards not required	Porting applicable	Standards not required (Note 4)
Global services	Porting not applicable	Standards not required	Porting applicable	Standards not required (Note 2)
Network (Note 3)	Porting not applicable	Standards not required	Network operator matter	Network operator matter

Table 2 – Service portability

Scope	Between CC domains		Within CC domains	
CC type (Note 1)				
Geographic	Porting not applicable	Standards not required	Porting applicable	Standards not required (Note 4)
Global services	Porting not applicable	Standards not required	Porting not applicable	Standards not required
Network (Note 3)	Porting not applicable	Standards not required	Network operator matter	Network operator matter

Table 3 – Location portability

Scope	Between CC domains		Within CC domains	
CC type (Note 1)				
Geographic	Porting not applicable	Standards not required	Porting applicable	Standards not required (Note 4)
Global services	Porting not applicable	Standards not required	Porting applicable (Note 5)	Standards not required
Network (Note 3)	Porting not applicable	Standards not required	Network operator matter	Network operator matter

Notes to Tables 1, 2 and 3:

NOTE 1 – Portability not supported between CC types.

NOTE 2 – Requires international agreement(s) and infrastructure to support number portability (e.g. UIFN).

NOTE 3 – Includes the CC + IC digits required to uniquely identify the network.

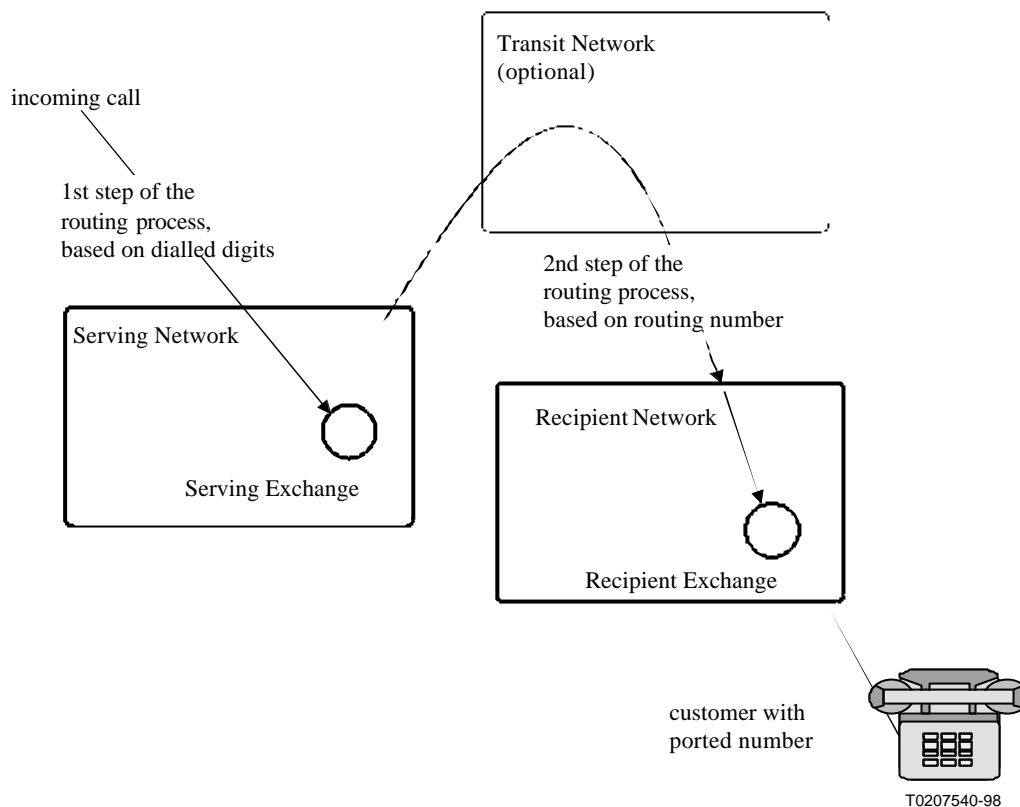
NOTE 4 – International standardization not required but could be of use.

NOTE 5 – These resources are "non-geographic" therefore location portability is inherent.

NOTE 6 – For purposes of Tables 1, 2 and 3, "Standards" means ITU-T Recommendations.

6 Generic implementation of number portability

The following general routing scheme is assumed as the routing model for calls routed to a ported customer.



NOTE – The serving network may be the originating network and/or the donor or a transit network.

Figure 4 – Conceptual framework for incoming calls

NOTE 1 – The caller sets up the call by dialling the end user's number which in this case is a ported number. The end user's number is enough to initiate the routing process. Furthermore, number portability, by definition, implies that the callers should continue to dial the same end user's number and nothing more to set up a call to a ported customer.

NOTE 2 – The routing process is split into two consecutive main steps:

- a) Normal routing based on end user's number towards a serving exchange:

As a 1st step in the routing process, the originating network routes the call up to a serving exchange clearly identified by the analysis of a certain number of leading digits of the end user's number.

- b) Routing to customer's interface based on routing number(s) obtained by this serving exchange:

It should be noted that this step might be subdivided into sub-steps (e.g. the serving exchange could provide information to route to a database – within the recipient network or accessed by the recipient network – which provides subsequent routing information identifying the recipient exchange, information used for a subsequent sub-step in the routing process).

NOTE 3 – If only the recipient network is identified, then it is the responsibility of the recipient network to terminate the call at the recipient exchange.

NOTE 4 – The internal routing process in the recipient exchange shall unambiguously determine the called customer's interface and complete the call taking into account the supplementary services activated.

NOTE 5 – If a number is ported subsequently from service provider No. 1 to service provider No. 2, then to service provider No. 3, etc. this will change the routing number but not the routing principles.

7 Entities addressed by routing

Entities which need to be addressed by a Routing Number (RN) in one or more routing solutions are identified in this clause.

According to the structure of the routing number, one or a combination of several of the following entities should be addressable:

- A recipient network: In this option, the routing number identifies the network where the customer is now located. Therefore the routing process will need additional information (i.e. DN) to be completed.
- A Point of Interconnection (POI): In this option, the routing number identifies an interface to the next network in the routing process. Therefore the routing process will need additional information (i.e. DN) to be completed.
- Recipient exchange: In this option, the routing number identifies the exchange where the customer is now located. Therefore the routing process within the recipient exchange will need an additional information (i.e. DN) to be completed.
- Network Termination Point (NTP): In this option, the routing number identifies the subscriber/access line/service. The ported customer identified by the RN is unique. Therefore the routing process, in terms of number portability, can be completed without any additional information.

8 Number portability mechanisms

8.1 Assumptions

The following document internal assumptions that have been made:

- a) that Calling Line Identification (CLI) is required to be transported, with display information, unchanged to recipient network;
- b) that Connected Line Identification (COLI) is required to be transported, with display information, unchanged to originating network;
- c) that initial routing arrangements have been defined and implemented prior to the introduction of routing based on a routing number;
- d) that number portability is not allowed to influence the carrier selection function;
- e) that an NP solution shall not influence functions in PBXs.

8.2 General description

8.2.1 Call rerouted from donor network by use of onward routing principles

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 reroutes incoming calls to ported-out numbers onward towards the recipient network according to onward routing principles outlined in Figure 5.

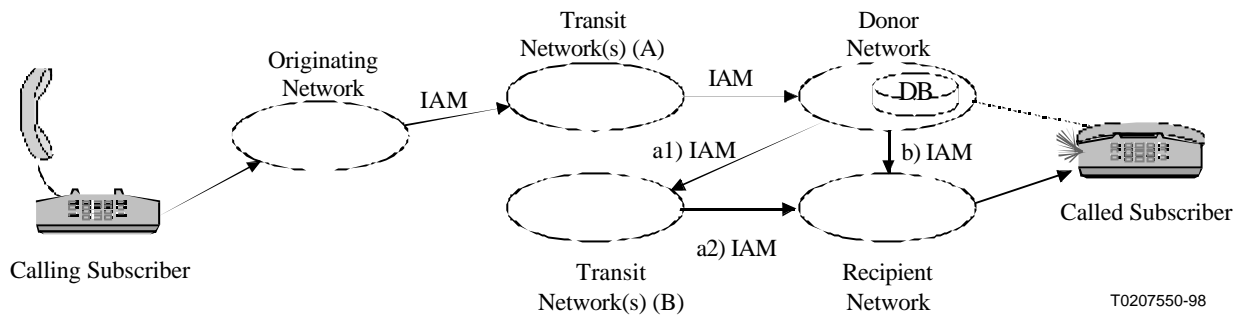


Figure 5 – Call rerouting to recipient network by onward routing principles from donor network

In Figure 5, the donor network receives an incoming call. It then detects that the called number has been ported-out 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 information.

Please note that the transit network(s) are optional, i.e. direct interconnections connections between originating network and donor network might 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.

8.2.2 Call rerouted by dropback principles from donor network

One possible enhancement of the previously described onward routing solution, is that the donor network initiates the rerouting of the call towards the recipient network according to "dropback" principles outlined in Figure 6. 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.

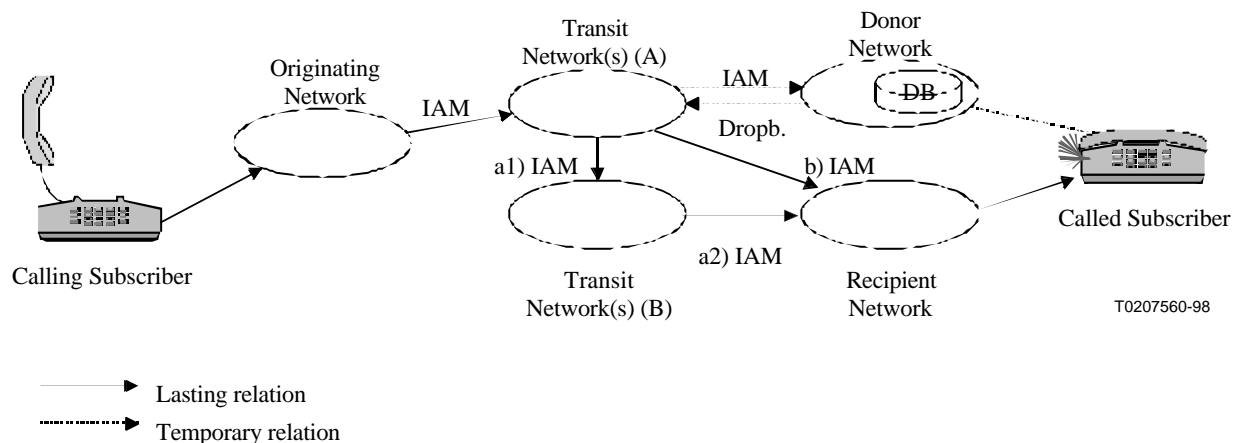


Figure 6 – Dropback with rerouting information and onward rerouting performed by a transit network

The option b) is valid when direct interconnection exists between transit network A and recipient network.

A further evolution is that the dropback indication is sent back to the originating network. This 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.

The dropback indication is also passed through to the originating network if either the transit network A has no "dropback" capability or determines that the preceding network has "dropback" capability. The originating network, at reception of the release, reroutes the call towards recipient network.

Please note that the transit networks are optional (i.e. direct connections between originating network and donor network might exist) but might exist [case a1) and a2)] between the onward routing (transit or originating) network and recipient network.

When carrier selection is valid for the call, the originating network reuses the carrier selection information after reception of dropback indication. It could be debated if a selected carrier (e.g. TN A) is allowed/recommended to transport the dropback to originating network, but it has no option if it has no redirect on "dropback" capability.

8.2.3 Call rerouting initiated by "Query on Release (QoR) " principles from donor network

A similar case as the previously described "dropback" principle is when the preceding network to donor initiates NP actions, i.e. an NP DB query, at reception of a release message. This case is often referred to as "Query on Release (QoR)".

In Figure 7, the donor network receives an incoming call. It then detects that the called number has been ported out to another 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 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 an NP database query and reroutes the call onward towards the recipient network. In this scenario the transit network has access to an NP DB with the complete address to the recipient network, at least for ported-out numbers.

Options a1) and a2), in Figure 7, are valid when transit network A either has no direct interconnection to recipient network or when overflow traffic is placed via transit network B.

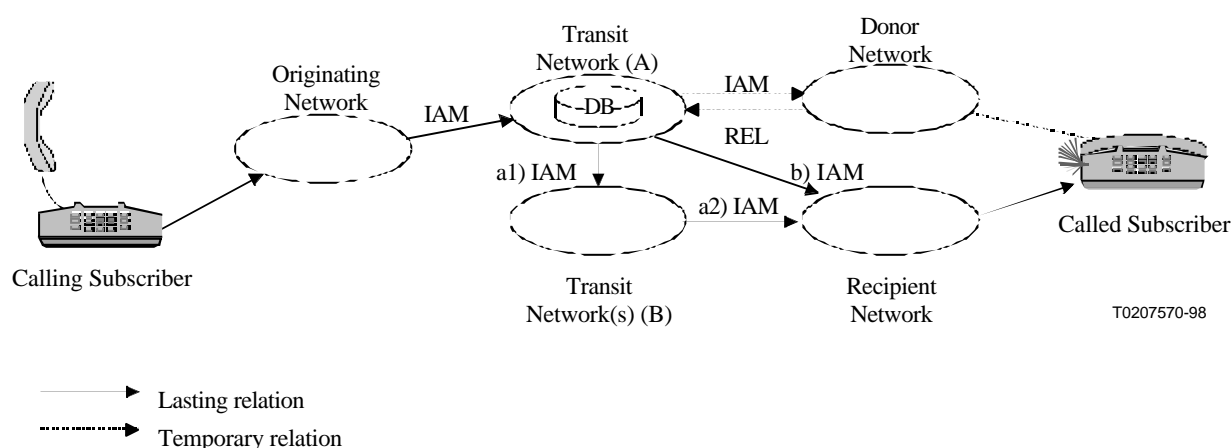


Figure 7 – Query on Release by transit network

The option b), in Figure 7, 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 originating network.

That is what may occur if 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 database and reroutes the call towards recipient network. In this scenario the originating network has access to an NP DB with the complete address to both recipient network and exchange, at least for ported-out numbers.

Sending back the release message to the originating network is also of interest if the originating network has direct connections to networks other than the transit network currently used.

When carrier selection is valid for the call, the originating network reuses the carrier selection information after querying NP DB. It could be debated if a selected carrier is allowed/recommended to transport the release message to originating network, but it has no option if it has no redirect on QoR capability.

8.2.4 Routing initiated by "All call query" principles

In the scenario shown in Figure 8, the originating network has access to an NP DB with the complete address to the recipient exchange, at least for ported-out numbers. This implies that only one NP DB look-up needs to be performed to complete the call.

Note however, that more than one DB look-up may be required if there is not sufficient information to route to the recipient exchange.

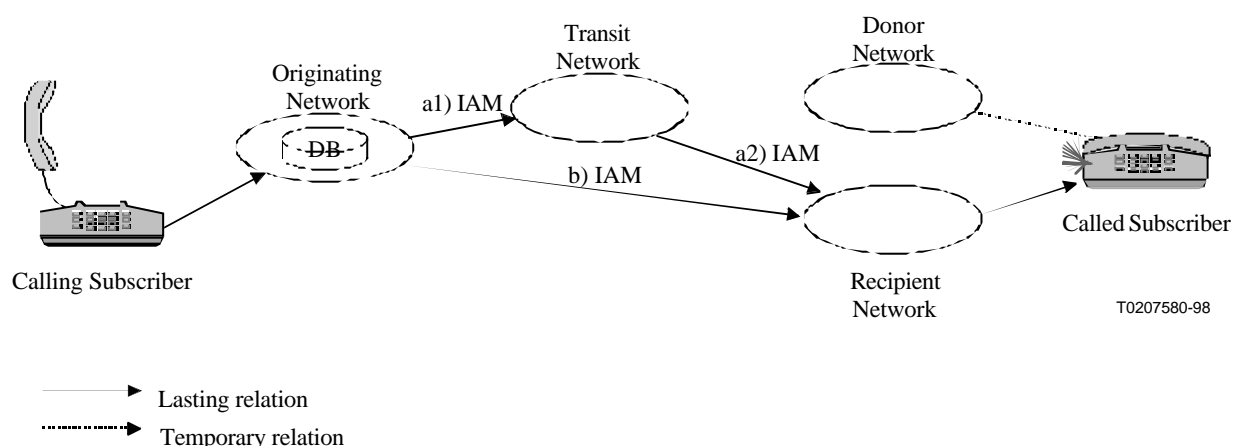


Figure 8 – All call query by originating network

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 cases a1) and a2) above] might be transiting the call to the recipient network.

Alternatively, a transit network, rather than the originating network, could perform the NP DB look-up.

9 Types of addresses and numbers – within networks and across network boundaries

With service provider portability it may no longer be possible to use an end user's number, dialled by the calling party, to route the call to the customer. If a customer changes service provider, a Routing

Number (RN) is needed to be able to route the call. The routing information may have one of the following:

- concatenated address (see 9.1);
- separated address (see 9.2);
- RN only, i.e. a plain network address, suppressed E.164 number (see 9.3);
- DN only, i.e. a plain E.164 number (see 9.4).

9.1 Concatenated address

9.1.1 Description

In this type of address, two numbers are concatenated in the same signalling field (the called party number) which is used to route the call (Figure 9).

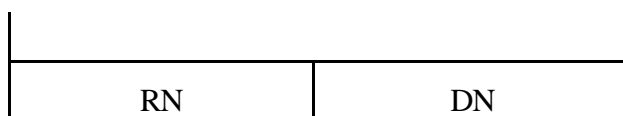


Figure 9 – Showing a concatenated address

RN is a routing number prefixed for a routing purpose. The length of RN may vary from country to country.

If some non-ported numbers have DN leading digits identical to the RN, this may imply a signalling field exists which indicates "Routing information for a ported number"; otherwise, the routing would be ambiguous.

The RN could take one of the following values:

- Case 1: RN represents the first digits of a number block usually handled by the addressed entity to which the call has to be routed. In this case, specific information carried by the signalling protocol is needed to indicate that it is a call to a ported number.
- Case 2: One or more of the first digits of the RN are digits not used as first digits in the national numbering plan used to indicate that the call is to a ported number. The value of the digits could be between 0 and 9 (spare in the national numbering plan). The rest of the RN identifies the addressed entity to which the call has to be routed and is used for this purpose.
- Case 3: This case is similar to case 2, but the first (or first two) digit(s) of the RN field is (are) one of the hexadecimal values nationally spare in the Signalling System No. 7. RN is used to route the call to the addressed entity.

9.1.2 Brief analysis

Case 1

Pros:

This solution does not waste any numbering resource since the RN value is formed by the first digits of the number block usually handled by the addressed entity.

This solution does not need a specific addressing scheme (for identifying the addressed exchange) and can be accommodated in the existing signalling.

Cons:

This solution requires the use of a specific identifier to qualify the routing number as an address used for a ported call which requires special treatment. The routing mechanisms in exchanges have to be adapted to be able to provide this special treatment. As there is a constraint on the maximum length of the complete concatenated address, the numbering space available for RN may be insufficient; limitations can be present on the maximum numbers of digits being supported by the signalling system and the exchanges in the different networks involved.

Case 2

Pros:

As for case 1, this solution can also be accommodated in the existing signalling. In opposition to case 1, this solution does not require any additional information to qualify the call as a ported call since one of the first digits of the routing number is dedicated to ported calls.

Cons:

This solution makes use of a part of the national numbering scheme. To be able to handle the prefix, routing mechanisms in the exchanges will have to be changed. As there is a constraint on the maximum length of the complete concatenated address, the numbering space available for RN may be insufficient.

Case 3

Pros:

This solution does not waste any resource from the national numbering plan since the first digit(s) is (are) hexadecimal². The advantages are similar to those already mentioned for case 2.

Cons:

The drawbacks are similar to those already mentioned for case 2. However, since this solution makes use of hexadecimal character(s), it requires changes (e.g. in signalling systems, switches and support systems). Although the solution does not require any resources from the national numbering plan, it does take up numbering resources (it uses a spare value from the Signalling System No. 7).

9.2 Separated addresses

9.2.1 Description

In this address type, the routing number and the directory number are carried in two different fields in the signalling messages (Figure 10). The address identifying the destination of the ported call, routing number, is used to route the call. The DN is carried transparently in a separate signalling parameter and is only used at the called side to complete the call.

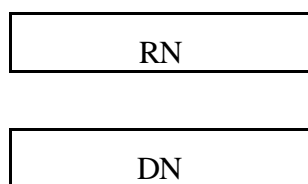


Figure 10 – Showing a separated address

² That is, one of the 6 values A, B, C, D, E or F.

9.2.2 Brief analysis

Pros:

The routing number can either be an E.164 number or a non-E.164 number. In either case the routing number should be in the same format as the national numbering plan. Since the called number and routing number are carried in separate signalling parameters, the possibility for mis-routing is minimized. If non-E.164 numbers are used, all numbers from the national numbering plan can be used as routing numbers. If E.164 numbers are used, numbers within the national numbering plans must be identified and assigned only for routing purposes. As opposed to prefix solutions, no special treatment of routing numbers need to be provided by the routing mechanisms of the exchange.

Cons:

Such a separated address solution requires, by definition, that signalling systems used are able to carry both RN and DN in separate signalling parameters.

9.3 RN only

9.3.1 Description

In this case the routing number is the only information being sent between exchanges/networks (Figure 11). The directory number, E.164 number, is not sent between exchanges but is translated into a routing number. The routing number must point out the access line to which the called party is connected as no other method is available.



Figure 11 – Showing a routing number only

9.3.2 Brief analysis

Pros:

The advantages of this addressing method are that it is internationally available today because the RNs are E.164 numbers and that it does not require any changes in the signalling systems.

Cons:

To be able to provide information regarding the DN, in services like COLP, a second query in the recipient exchange (or in the last transit exchange) is needed. This solution can waste numbering resources (depending on the solution).

9.4 Only DN (normally across network boundaries)

9.4.1 Description

In this case the directory number is the only information that is being sent between networks.



Figure 12 – Showing a directory number only

9.4.2 Brief analysis

Pros:

It is not mandatory to introduce RN transfer between networks, i.e. this solution does not affect existing network interfaces. It allows different addressing options of different operators to work together. Operators will have to transport routing information with ported calls inside their networks, regardless of which number portability solution is chosen. There are multiple options to transport this routing information. Separation or concatenation of routing information and directory number is the main characteristic.

Internal routing is not dependent on information given by other networks (no network interdependence).

Cons:

Use of this addressing method requires the use of "all call query all networks" architecture at the network interface.

10 Combinations of addressing types, addressed entities and mechanisms: general signalling requirements

The previous clauses above have identified that there are three components that must be determined in any implementation of service provider number portability:

- 1) the entity addressed by the routing number;
- 2) the method of transporting the routing number;
- 3) the architecture used to determine the routing number.

Addressed entity: Assuming a routing number is utilized (see below), there are four possible entities that can be identified by the routing number:

- 1) network termination point;
- 2) recipient exchange;
- 3) recipient network;
- 4) point of interconnection.

Transport of routing number: There are four transport methods described:

- 1) concatenated;
- 2) separated;
- 3) no routing number used;
- 4) routing number only.

Architectures: There are four architectures described:

- 1) onward routing;
- 2) dropback;
- 3) query on release;
- 4) all call query.

With the exception of the "No routing number used/routing number only" transport mechanisms, the three components are independent of one another, allowing a multitude of theoretically possible solutions by combining the components. For example, an implementation could consist of:

- Routing number identifies the recipient exchange, is transported concatenated with dialled digits and is derived using an onward routing architecture.

Or, an alternate implementation could be:

- Routing number identifies the recipient network, is transported in a separate field to the dialled digits and is derived using an all call query architecture.

The various combinations provide flexibility of implementation to take into account economical and technical parameters of each individual situation. For this reason this Supplement does not recommend one solution over another.

11 Examples of locations of number portability database(s) within networks

11.1 General description

Depending on the evolutionary level in a particular network, the NP database 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).

Regardless of data storing place, the exchange/network can act according to different NP principles, e.g. onward routing the call, dropping back the rerouting information or even acting as a database and responding a query with rerouting information.

12 Administrative processes

In establishing number portability, processes that underpin its introduction and management are a key requirement. The following list provides top level guidance on specific areas of activity and the steps that need to be covered.

Process activity	Steps to be covered
Service establishment	<i>Initial contact between operators</i> Planning stage Implementation planning Network implementation and testing
Service maintenance	Introduction of a new switch Introduction of a new numbering block Number change New routing number
Service ordering	<i>Request</i> Validation Scheduling Contingency plans Hours Subsequent portability Change of account name Reasons for rejection Installation Cancellation
Fault and repair handling	
Directory number information	Directory entries Operator assistance Emergency service Number plan administration Law enforcement agencies
Billing	

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