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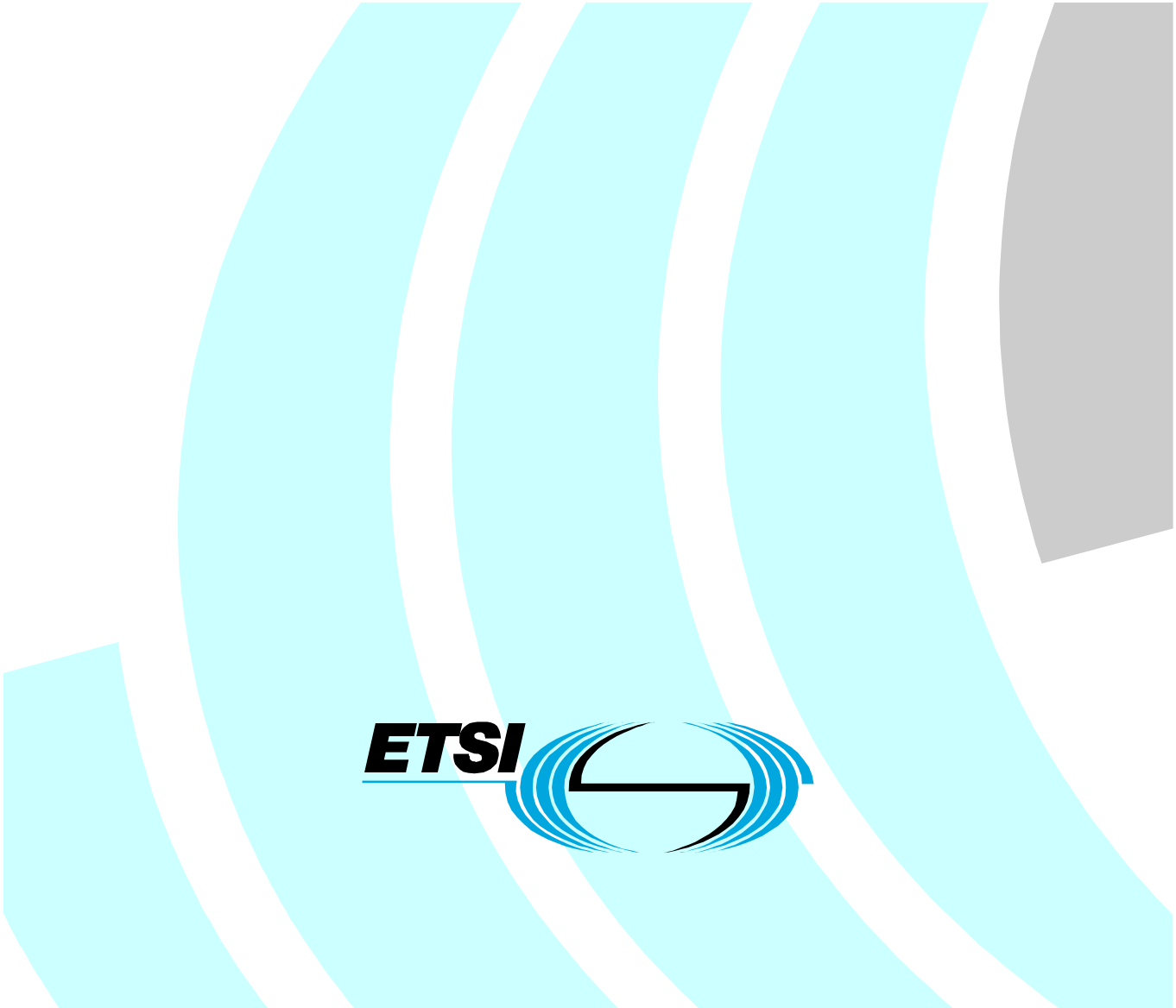
Technical Report

Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); Requirements Definition Study; Real time aspects of a resolution service



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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Foreword

This Technical Report (TR) has been produced by ETSI Project Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON).

TIPHON Resolution Capability (TRC) is a centralized resolution mechanism for inter-service provider call routing in TIPHON compliant networks. Its main function is to map an E.164 number to a unique service provider name called a Home Network Name (HNN). This HNN can be further resolved into network address(es) of the next-hop service provider network elements by the local resolution capability of the current service provider (which is outside of TRC). In this way, TRC allows call signalling to be routed hop-by-hop, through multiple service provider networks, to the terminating service provider network, where call signalling is routed to the destination terminal identified by the E.164 number.

At the heart of TRC is the database that stores the mapping from an E.164 number to an HNN of a service provider. There are two different parts of the TRC database operations: administrative and real-time. The administrative part deals with the required processes and procedures for administering E.164 numbers and service provider data, while the real-time part allows the originating service provider to query the database to determine the HNN of the home service provider serving the E.164 number.

It should be noted that although the TRC was originally developed to support an international UPT service, the concepts and technology infrastructure are equally applicable to other TIPHON applications, including national variants. The present document has been written to describe a generic resolution framework from which different scenarios can be derived. In some cases, specific features may need to be added to make it suitable for particular applications.

NOTE: For certain numbering ranges/types of service, a centralized resolution mechanism of the type offered by TRC is not a mandatory feature of TIPHON compliant networks. In those network scenarios, routing between originating and terminating networks may be carried out on a hop-by-hop basis, using a resolution function embedded in each of the networks traversed.

1 Scope

The present document describes the requirements and definitions for the administrative and real-time aspects of the TIPHON Resolution Capability (TRC).

TIPHON Resolution Capability (TRC) is a centralized resolution mechanism for inter-service provider call routing in TIPHON compliant networks. In terms of the general framework given in TR 101 326, the TRC is an objective service resolution. Its main function is to map an E.164 number to a unique service provider name called a Home Network Name (HNN). The administrative part deals with the required processes and procedures for administering E.164 numbers and service provider data, while the real-time part allows the originating service provider to query the database to determine the HNN of the home service provider serving the E.164 number. It should be noted that although the TRC was originally developed to support an International UPT service, the concepts and technology infrastructure are equally applicable to other TIPHON applications, including national variants.

The present document provides the basis for the Resolution Service capability in TS 101 878. At the same time, the present document can also be used as a stand-alone document.

2 References

For the purposes of this Technical Report (TR), the following references apply:

[1] ITU-T Recommendation E.164: "The international public telecommunication numbering plan".

[2] ITU-T Recommendation E.168: "Application of E.164 numbering plan for UPT".

[3] ITU-T Recommendation Q.1290: "Glossary of terms used in the definition of intelligent networks".

[4] ETSI TS 101 314: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); Network architecture and reference configurations; TIPHON Release 2".

[5] ETSI TR 101 326: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); the procedure for determining IP addresses for routeing packets on interconnected IP networks that support public telephony".

[6] ETSI TS 101 878: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON) Release 3; Service Capability Definition; Service Capabilities for a simple call".

3 Definitions and abbreviations

3.1 Definitions

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

Administrative Reference DataBase (ARDB): centralized database used for storing the master copy of E.164 number to HNN mapping that will be periodically downloaded to RTDBs for real-time query

NOTE: Service providers can create, update and delete records of E.164 number to HNN mapping in this database. It also contains the participating service provider profiles, which can be created, updated and deleted by the TRC administrators. There is logically exactly one ARDB per TRC.

availability: probability that a system can perform the required function at a given instant of time

NOTE: It is estimated by the ratio of actual service time to scheduled service time, and is expressed as percentage, or equivalently, as average downtime per year.

database sizing: storage capacity of a database system, usually measured as the number of records with respect to a specific record size

home network: network that supports the service to which a customer subscribes

Home Network Name (HNN): unique identifier/name for a service provider

NOTE: An HNN may be further resolved to a routable network address of the service provider by means outside of TRC.

home service provider of an E.164 number: service provider that provides the telephony services to the subscriber of the E.164 number

Number Allocation Authority (NAA): national or international organization being responsible for issuing telephone numbers to service providers and/or individual subscribers

query response time: between the last bit of query entering the database and the last bit of response going out of the database

NOTE: In other words, query response time only concerns the database query processing time, excluding the transmission delay incurred by the network between the querying entity and the database.

Real-Time DataBase (RTDB): database that contains a copy of the E.164 number to service provider HNN mapping from ARDB for real-time query by service providers

NOTE: RTDB is read-only by service providers, and its content is updated periodically by ARDB download. There can be more than one RTDB in a TRC, some of which may reside inside a service provider network.

resolution domain: group of service providers that agree to provide inter-carrier telephony services over a specific E.164 numbering range/type

NOTE: There shall be one TRC per resolution domain.

throughput: number of queries per second the database which is able to perform with respect to a certain load condition

TIPHON Resolution Capability (TRC): mapping function from E.164 numbers to HNNs

NOTE: Also refers to the set of network elements, protocols, and procedures necessary to provide such mapping.

Universal Personal Telecommunications (UPT): telecommunications service which enables uninterrupted access to telecommunications services while allowing personal mobility

UPT Number (UPTN): which uniquely and unambiguously identifies each UPT user

NOTE: It is used by a calling party to reach the UPT user. This number is independent of terminal, network or service used and shall conform to ITU-T Recommendation E.168 [2]. A UPT user may have more than one UPT number (for example, a business UPT number for business calls and a private UPT number for private calls), see ITU-T Recommendation E.168 [2].

3.2 Abbreviations

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

AD	Administrative Domain
AD-BES	Administrative Domain Back-End Service
ARDB	Administrative Reference DataBase
HNN	Home Network Name
IP	Internet Protocol
ITU-T	International Telecommunication Union - Telecommunications standardization sector
NAA	Number Allocation Authority
PIN	Personal Identification Number
PSTN	Public Switched Telephone Network
RTDB	Real-Time DataBase
SCN	Switched Circuit Network
SCP	Service Control Point

SOA	Service Order Activation
TRC	TIPHON Resolution Capability
UPT	Universal Personal Telecommunications
UPTN	UPT Number

4 Overview

The main purpose of the TIPHON Resolution Capability (TRC) is to provide a global, geographically independent service to telephony users in TIPHON compliant networks. Each user obtains a unique E.164 number during the provisioning process either from a Number Allocation Authority (NAA) or via the service provider where he/she first subscribes to the service. This globally unique E.164 number unambiguously identifies the subscriber. TRC enables personal mobility in that numbers are assigned to individuals and not to terminals; and they belong to individuals, not service providers. Hence, subscribers using TRC may change their service providers while keeping their E.164 numbers.

TRC is designed to operate within a resolution domain defined by the following characteristics:

- there is a group of service providers that agree to interconnect their networks together to provide cross-service provider telephony services to their subscribers. Each service provider constitutes an administrative domain, and is identified by one or more unique names called HNNs;
- each provider may have multiple networks and these networks may be heterogeneous, such as PSTN, wireless and IP networks. But all participating networks shall be TIPHON compliant;
- there is a specific E.164 numbering range/type that the group agrees to use for the intended telephony services. The numbering range/type is distributed among the service providers (this can be either in blocks of numbers or number by number like in International UPT). At any instant, an active E.164 number is served by exactly one service provider, called the home service provider of the subscriber. However, the association of an E.164 number and its home service provider cannot be derived directly from the number itself without querying the TRC.

A TRC is defined with respect to a resolution domain, which in turn is defined by the group of service providers and the E.164 numbering range/type for a specific telephony service. There is exactly one TRC for each resolution domain. In the case where the same group of service providers use different E.164 numbering ranges/types for different telephony services, they are considered as different resolution domains, and thus the corresponding TRCs are functionally different even though in some implementations they may be packaged together in one physical network element.

Unless otherwise stated explicitly, the present document only concerns requirements of TRC with respect to a single resolution domain. Requirements for services involving multiple TRCs are out of scope of the present document, but may be a subject for further study.

An example of a resolution domain is depicted by figure 1. For a given resolution domain, TRC serves as a centralized number resolution clearinghouse among all service providers for inter-domain call routing. Its main function is to map an E.164 number to the HNN of the home service provider of that number. However, since an HNN includes the identifier for a service provider, for call routing purposes another resolution function (routing resolution) may be needed to map the HNN to the network addresses of the service provider network. This is accomplished by the Administrative Domain-Back End System (AD-BES) of a service provider, which is outside the scope of TRC.

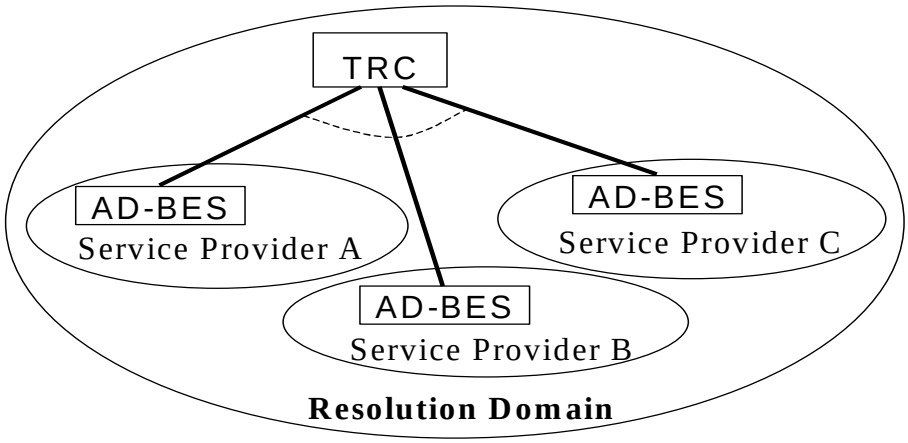


Figure 1: Resolution domain and TIPHON Resolution Capability (TRC)

Inter-provider call routing within a resolution domain follows the hop-by-hop paradigm using the two-level resolution hierarchy. The top-level resolution, called service resolution, is accomplished by querying the TRC, which returns the HNN of the home service provider of the called E.164 number. This is normally done once by the originating service provider since the HNN is passed along by the call signalling messages.

Note: Service resolution may occur at the originating network or the originating network can route the call to a network where service resolution takes place.

Once the home network has been identified by the objective service resolution, a second-level of resolution called routing resolution, which is subjective, takes place. This resolution may be repeated hop-by-hop by intermediate service provider (including the originating service provider) until the home network is reached. The home network signals to the terminating network. For the final stage of routing when call signalling finally reaches the terminating service provider network, the terminating service provider will resolve the called E.164 number to the destination terminal network address and route the call signalling to that terminal accordingly.

As is shown in figure 2, TRC is functionally divided into two parts: the administrative part and the real-time part. The administrative part is used to store and update the information about the association between subscribers E.164 numbers and the service providers while the real-time part is responsible for identifying the home service provider of the called user during the call setup process.

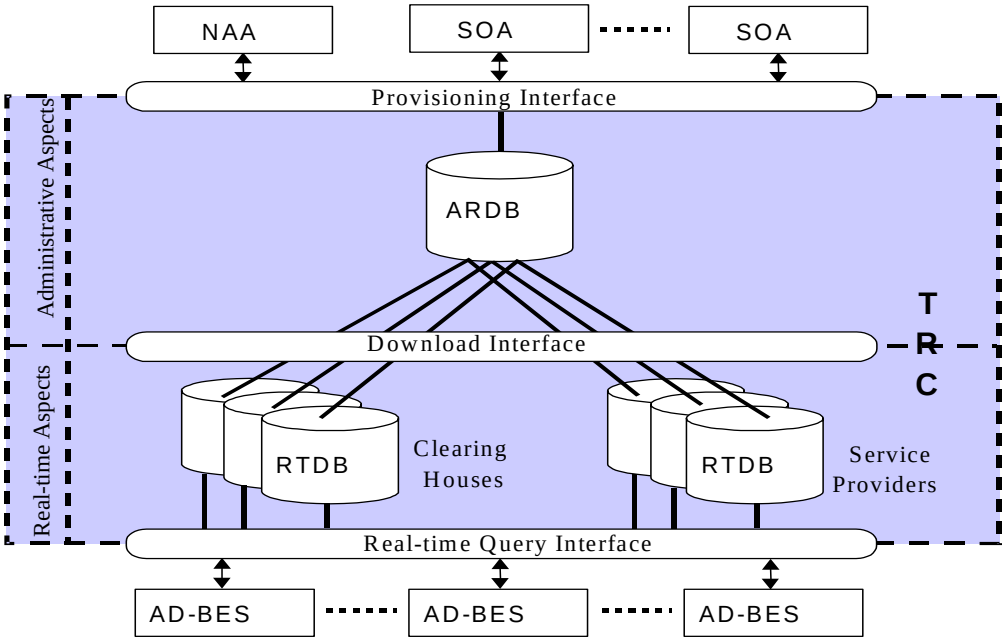


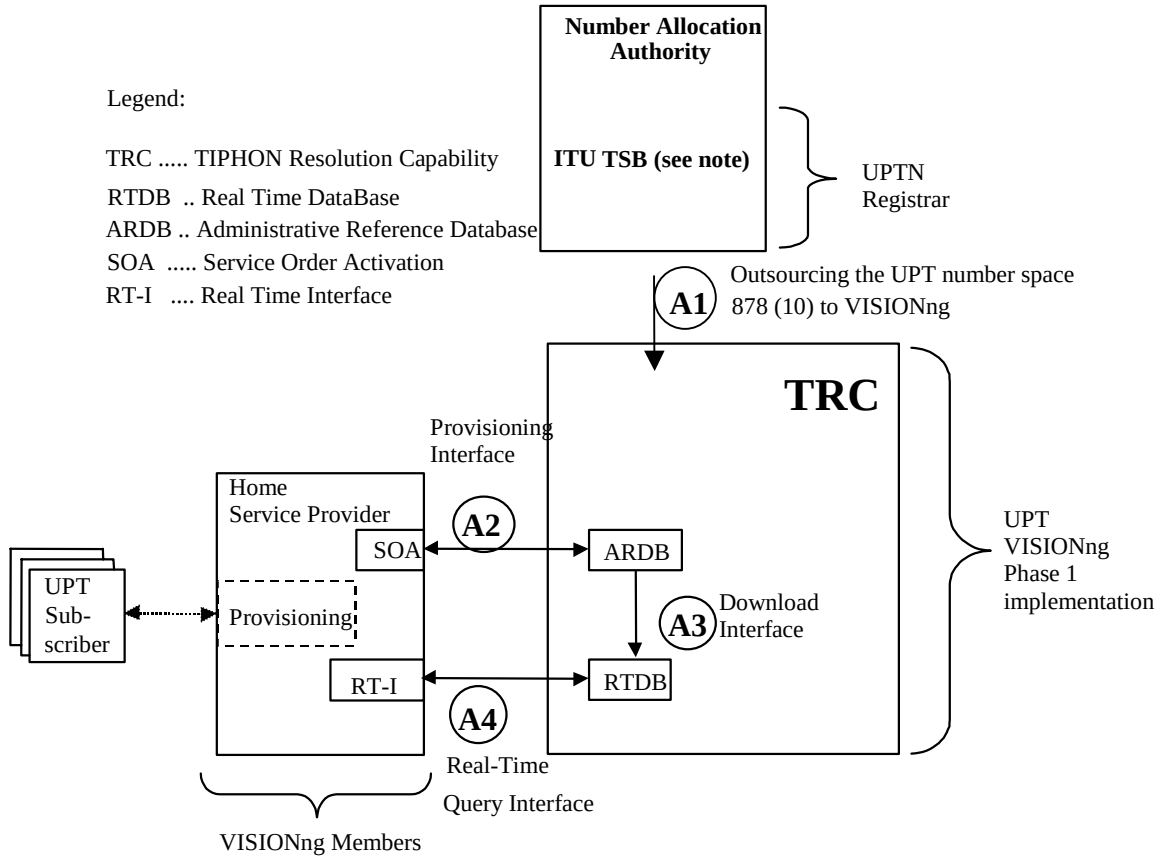
Figure 2: Functional separation of TRC: real-time and administrative aspects

The administrative part consists of a (logically) single Administrative Reference DataBase (ARDB), which contains the participating service provider profiles and the mapping for each active E.164 number to the HNN of its home service provider. A service provider performs number administration using its Service Order Activation (SOA) system, through the TRC provisioning interface, to create, update and delete records in ARDB for the subscribers E.164 numbers within its administrative domain. Each service provider should be only able to access and update E.164 number mapping information for its own subscribers in ARDB.

Note that all E.164 to HNN mapping records shall first be created and stored in the ARDB. Subsequent update and/or deletion of these records shall also be done through ARDB. However, during call setup, a service provider's AD-BES normally does not query the ARDB directly. Instead, it queries a TRC Real-Time DataBase (RTDB), which contains a copy of the mapping records of ARDB, through the real-time query interface of TRC. There can be (physically) more than one RTDB for a TRC, some of which may belong to competitive service providers such as resolution clearinghouses, while others may reside in participating service providers' networks. Changes made to ARDB, through the provisioning interface, are propagated to the RTDBs, through the download interface, by periodic database download from the ARDB to the RTDBs.

Note that the one-to-many arrangement between ARDB and RTDBs in TRC is aimed at improving query performance and service availability of the TRC. Logically, there should be exactly one ARDB for each TRC, though ARDB may be physically replicated to improve reliability and availability. On the other hand, the separation of ARDB and RTDB is a functional one. It is possible that ARDB and a RTDB may co-locate in the same physical network element, while other RTDBs reside in different physical network elements.

Hence a service provider has two ways to access TRC. One way is to use its own SOA to do number administration via the TRC provisioning interface. The other way is to use its AD-BES to request for E.164 number to HNN translation during call setup via the TRC real-time query interface. The requirements of administrative aspects of TRC apply to ARDB, the provisioning interface, and the download interface. The requirements of real-time aspects of TRC apply to RTDB and the real-time query interface. An example, specific to VISIONng, for International UPT is shown below in figure 3.



NOTE: The ITU-TSB is responsible for the allocation and assignment of international number resources that are under the purview of the ITU-T.

Figure 3: TRC functional components and interfaces in the context of subscribers and service providers

A subscriber can obtain an E.164 number from a service provider. However, the detailed number issuing process, though very important in its own right, is out of the scope of the present document. Hence, those interfaces are marked as a dotted line. The provisioning interface consists of the A2 interface with service providers' SOAs. The real-time interface consists of the A4 interface. The requirements on real-time aspects of TRC are concerned with the real-time query interface A4.

It should be noted that TRC is independent of the underlying network technologies. Hence the external interfaces A2 and A4 shall be made accessible to network elements from various network types within a service provider domain, including SCN, wireless, ATM, and IP networks.

4.1 Completing the call from home network to terminating network

The following describes how the call is completed. These steps are not part of TRC.

Once the home network has been identified by the objective service resolution, a second-level of resolution, called routing resolution, which is subjective takes place. This resolution may be repeated hop-by-hop by intermediate service providers (including the originating service provider) until the home network is reached. The home network signals to the terminating network. For the final stage of routing when call signalling finally reaches the terminating service provider network, the terminating service provider will resolve the called E.164 number to the destination terminal network address and route the call signalling to that terminal accordingly.

Two scenarios are depicted below, corresponding to whether service resolution occurs at the originating network or the originating network routes the call to a network where service resolution takes place.

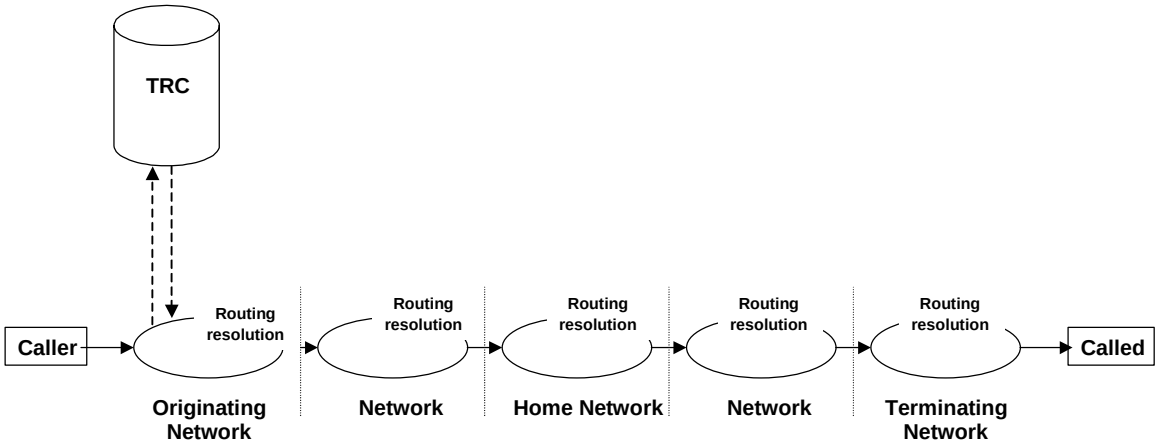


Figure 4: Completing the call where service resolution takes place at the originating network

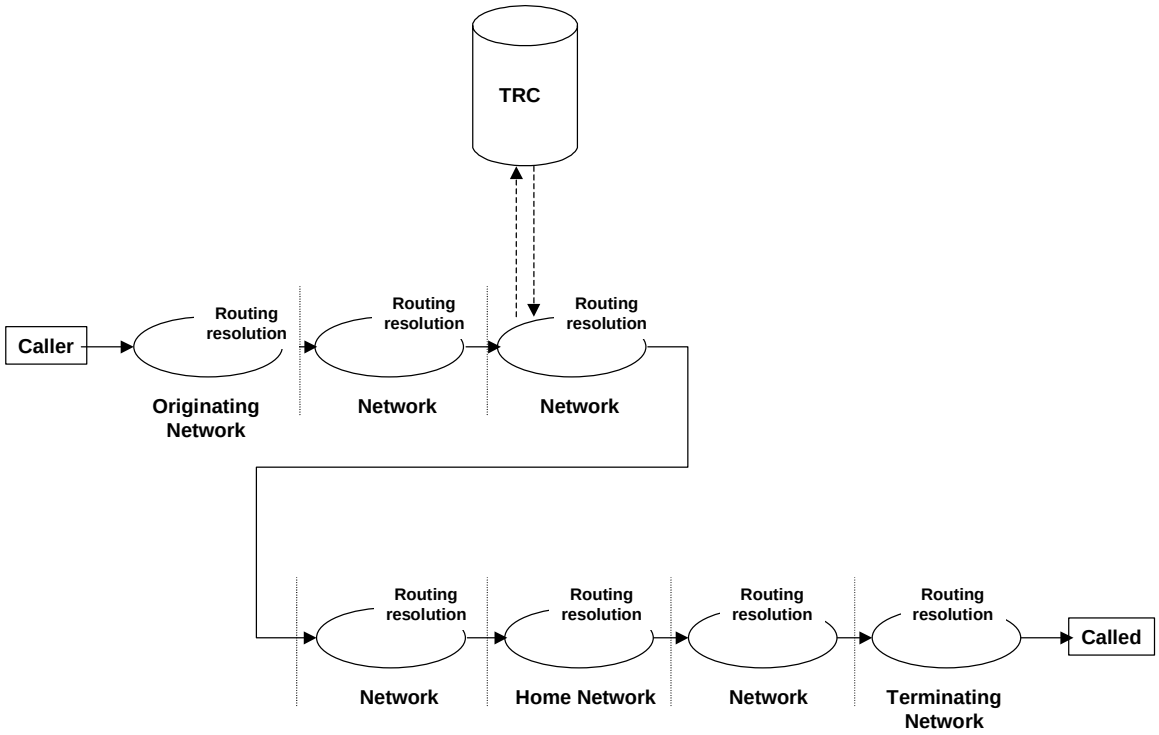


Figure 5: Completing the call where the originating network routes the call to another network where service resolution takes place

5 Functional requirements for the ARDB

This clause describes the requirements pertaining to the administrative aspects of ARDB. "SHALL" means mandatory, while "SHOULD" means recommendation, and "MAY" means optional.

5.1 Service provider management

5.1.1 Service provider profile

1) The ARDB SHALL maintain a profile for each participating service provider.

2) The profile of a service provider SHALL be created by the TRC administrator when the service provider is first granted access to the TRC.

3) The profile of a service provider SHALL be deleted by the TRC administrator when the service provider is no longer allowed to access the TRC.

4) Only those service providers with valid profiles are allowed to access the ARDB and RTDB.

5.1.2 Access control

1) The ARDB SHALL allow a service provider to query its own profile.

2) The ARDB MAY allow a service provider to provision certain parts of its profile.

3) The ARDB SHOULD accommodate multiple accounts for a service provider, which may access the RTDB simultaneously.

4) The ARDB SHALL disallow a service provider from accessing another service provider's profile.

5.1.3 Access methods

1) The ARDB SHALL allow interactive access by a service provider to its own profile.

2) The ARDB SHOULD allow non-interactive means by a service provider to update its own profile.

5.2 Subscriber record management

A subscriber record is associated with a specific service provider. If a subscriber has multiple numbers, each number constitutes a separate record. The TRC may consolidate common information among these numbers for a subscriber. If a subscriber has multiple numbers from different service providers, each number will have a record in the TRC associated with its respective service provider.

5.2.1 Subscriber record

1) A subscriber record SHALL contain the number to HNN translation information for each number assigned to the subscriber.

2) A subscriber record MAY contain other subscriber information such as contact address and billing.

3) The ARDB SHALL provide capabilities for a service provider to create, query, update and delete subscriber records of that service provider.

4) The ARDB MAY provide capabilities for a subscriber to query and update their own record.

5.2.2 Access control

1) A service provider SHALL be able to access all of its subscriber records.

2) A service provider SHALL be disallowed from accessing subscriber records of other service providers.

3) If an individual subscriber is allowed to access the ARDB, he/she SHALL be able to access only their record and nothing else. The operations allowed by an individual subscriber SHALL be limited to only query and update; and the update MAY be restricted to only certain part of the record.

5.2.3 Access methods

1) The ARDB SHALL provide both interactive and batch modes for a service provider.

2) If an individual subscriber is allowed to access their record(s), the ARDB SHALL provide interactive mode.

5.3 Number management

5.3.1 Number assignment

1) A number SHALL be assigned to no more than one subscriber.

2) A provider/subscriber SHALL be able to request for more than one number.

3) A provider/subscriber MAY be allowed to request for preferred (golden) number(s).

4) If a potential subscriber requests a specific number, the ARDB SHALL check for the availability of the number. The application of a particular selected number shall be rejected if it is not available.

5) The ARDB SHALL be able to pick an available number if the provider/subscriber has not specified a preference.

6) The ARDB SHALL be able to assign multiple numbers to a subscriber either in consecutive range or discretely.

5.3.2 Number recall

1) If a number is no longer associated with a subscriber, the number SHALL be marked as "hold" with a time stamp.

2) When the time expires, the number is marked as "free" and SHALL be returned to the available number pool for re-assignment.

5.3.3 States of a number

The states of each number SHALL include the following:

- Free – default entry state;
- Reserved – wait for routing provisioning to become complete;
- Assigned – finished registration and provisioning process;
- Hold – wait for time expiration in order to become available for assignment;
- Unusable; or
- Spare – not available for reservation or assignment at present.

5.3.4 Service disconnect

When a subscriber no longer wants to subscribe a number, he/she and the service provider will agree on a disconnect date/time. The service disconnect event SHOULD be logged. The ARDB SHALL remove the subscriber's record at the agreed upon disconnect date/time.

5.3.5 Problem solving

The TRC SHOULD aid in isolating problems associated with numbers that are not reachable. If an inaccuracy is found, the TRC SHALL take appropriate actions to fix the problems and inform or update any appropriate entities/parties.

5.3.6 Subscriber support

7x24 business support SHALL be provided by the TRC.

5.4 Number portability considerations

Number portability considerations are explained with an example using International UPT. The current number allocation for the UPT service of the VISIONng will be done through service providers. From the TRC database viewpoint, the porting of a number from one service provider to another is to change the HNN of the ported number in the TRC databases. The provisioning of HNNs takes place in the following cases:

- when a new UPT Number has been assigned;
- when a UPT Number has been withdrawn;
- when a UPT subscriber requests to port their UPTN between two Service Providers.

In response to a request for a UPT number port from either a subscriber or potential recipient, the old provider can request the ARDB to obtain a porting authorization pin number from the TRC system for one or more particular UPTN(s).

- A PIN number can only be requested by the old service provider of a UPTN.
- The old provider will give the PIN Number of the UPT to be ported to the new service provider via email, phone or FAX.
- The new service provider will use the PIN number given by the old service provider. The new service provider supplies the PIN to TRC for verification for the transfer of the ownership of the UPTN from the old service provider to the new service provider.
- Once the porting and related provisioning is completed by TRC, the new service provider will be reminded to inform the old service provider of the completion of the transfer via email/phone/FAX.

5.4.1 Verification of the provisioning request

Any provision request SHALL be verified against a set of rules defined by the TRC. Invalid provisioning requests SHALL be ignored. Both valid and invalid provision requests SHALL be logged.

5.4.2 Activation of the provisioning request

1) The new service provider SHALL be able to specify the time/date when a particular provisioning request becomes effective. The subscription data SHALL be made available at the effective time/date.
2) If the activation is to be done immediately, the activation SHALL be done in a timely manner.

5.4.3 Confirmation of the old service provider

If number porting is involved (e.g. a subscriber changes their service provider), the porting needs to be confirmed by the old service provider.

5.4.4 Conflict resolution

1) A process to resolve conflict SHALL be in place if the old and new service provider disagree on who will serve a particular subscriber. The TRC SHALL define the rules and process for conflict resolution.
2) Multiple provisioning requests for the same subscriber received before the subscription data becomes effective SHALL be detected and resolved.
3) The subscription data SHALL be downloaded to the RTDB only if the conflict is not resolved.

5.4.5 Order cancellation

After sending a provisioning request for a number but before the effective date/time, the service provider SHALL be able to cancel the provisioning request (e.g. the subscriber decides not to switch or subscribe before the effective date/time). The old service provider SHALL be informed about the order cancellation. The order cancellation event SHOULD be logged.

6 Requirements for the RTDB

This clause describes the requirements pertaining to the real-time aspects of TRC. "SHALL" means mandatory, while "SHOULD" means recommendation, and "MAY" means optional.

6.1 General

1) RTDB SHALL resolve an E.164 number to an HNN, which is the name of the home service provider for the queried E.164 number.

2) It is outside of the scope of TRC to resolve an HNN to a next-hop network address.

6.2 HNN

1) An HNN SHALL uniquely identify a service provider within a resolution domain. It MAY identify the call control function responsible for the E.164 number.

2) The format of an HNN SHALL is flexible and extensible to accommodate a wide range of naming conventions in both the SCN and the IP networks.

3) A service provider MAY have multiple HNNs within a specific resolution domain. For example, a large network may use more than one call control function, each of which may be identified with separate HNNs.

4) A particular HNN MAY be presented in more than one format.

5) A service provider SHALL be able to query the TRC for an E.164 number with a specific HNN format or ALL HNN format.

6) The RTDB SHALL respond to a query with the HNN(s) corresponding to the format specified, if any, in the query.

6.3 Scalability

An RTDB SHALL be scalable to the anticipated population of the resolution domain in discrete increments appropriate to the application in question. As a guide, an RTDB SHOULD be able to accommodate E.164 numbers in the order comparable to the size of various number translation databases of Service Control Point (SCP) in current Switched Circuit Network (SCN).

6.4 Availability

The availability of the real-time part of TRC depends on the availability of an RTDB, the number of RTDBs in the network, and the accessibility of those RTDBs to service providers. Availability of TRC will be dramatically improved if more than one RTDB is made accessible to each service provider within a resolution domain.

Availability of a single RTDB is defined as the probability that it can perform the resolution function at a given instant of time. It is estimated by the ratio of actual service time to scheduled service time, and is expressed as percentage, or equivalently, as average downtime per year. Availability of the real-time aspect of TRC, as seen by a service provider, is defined as the cumulative availability of all RTDBs that it has access to. The following requirements are generic in the sense that they are not meant to be exhaustive in covering all possible network configurations.

1) The scheduled service time of the real-time part of TRC SHALL be 24 hours per day, 7 days per week. I.e. there SHALL be NO scheduled downtime for the real-time part of TRC.

2) For the real time service of TRC with mated pair configuration, the average service downtime of the TRC SHOULD be no more than one minute per year for the whole service.

6.5 Session

A session is defined as a transaction between a service provider and the TRC that starts from the initial message from a network element of a service provider to TRC and ends with the final response from the TRC to the network element. In the case of number resolution, a session starts with a query from the AD-BES of a service provider containing an E.164 number, followed by the response from a RTDB of TRC containing the HNN of that E.164 number.

1) The transmission of query and response messages SHALL be made reliable.

2) The connection setup and teardown overhead for a session SHALL be made minimum. The life span of a connection SHOULD be limited to the corresponding session. (It is recommended that no persistent connection be used for multiple sessions between a TRC and a service provider.)

6.6 Performance

Performance of a database system is usually measured by three factors: query response time, throughput, and sizing. Query response time refers to the time between the last bit of query entering the database and the last bit of response going out of the database. In other words, query response time only concerns with the database query processing time, excluding the transmission delay incurred by the network between the querying entity and the database. Throughput refers to the number of queries the database is able to perform per second. Both query response time and throughput depend on the load of the system, and are usually quantified by mean value, say 95% of the time. Sizing, on the other hand, refers to the storage capacity a database system can handle, and is usually measured as the number of records with respect to a specific record size.

It should be noted that for simple number translation service (no service logic attached), such as freephone and LNP, there is little international/national/industry standards data available for performance. Most of the systems are built according to the Request For Proposals (RFPs) from service providers and thus their performances are platform dependent. The following requirements, when quoted as performance data, are derived from the limited information found and should only be used as guidelines, not as absolution conformance for a given implementation. Wherever possible, reference will be cited from which the data is obtained.

1) TRC RTDB SHALL be able to perform query processing at a rate (queries/second) that is comparable to its PSTN counterpart for number translation.

2) During normal load conditions, the mean query response time of TRC SHOULD NOT exceed 150 ms; 90% SHALL be less than or equal to 500 ms.

3) TRC RTDB SHALL be able to store data records with similar capacity as its PSTN counterpart for number translation.

6.7 Security

The following requirements apply to an RTDB that is accessible by service provider(s) via public networks:

1) It SHALL be possible for the querying service provider and the RTDB to mutually authenticate each other.

2) Each RTDB SHALL perform access control so that only the service provider(s) allowed to access the RTDB will be able to query the RTDB.

3) The RTDB SHALL be able to prevent denial-of-service attacks.

4) It SHOULD be possible to encrypt the content of a query and its corresponding response.

History

Document history		
V1.1.1	February 2002	Publication