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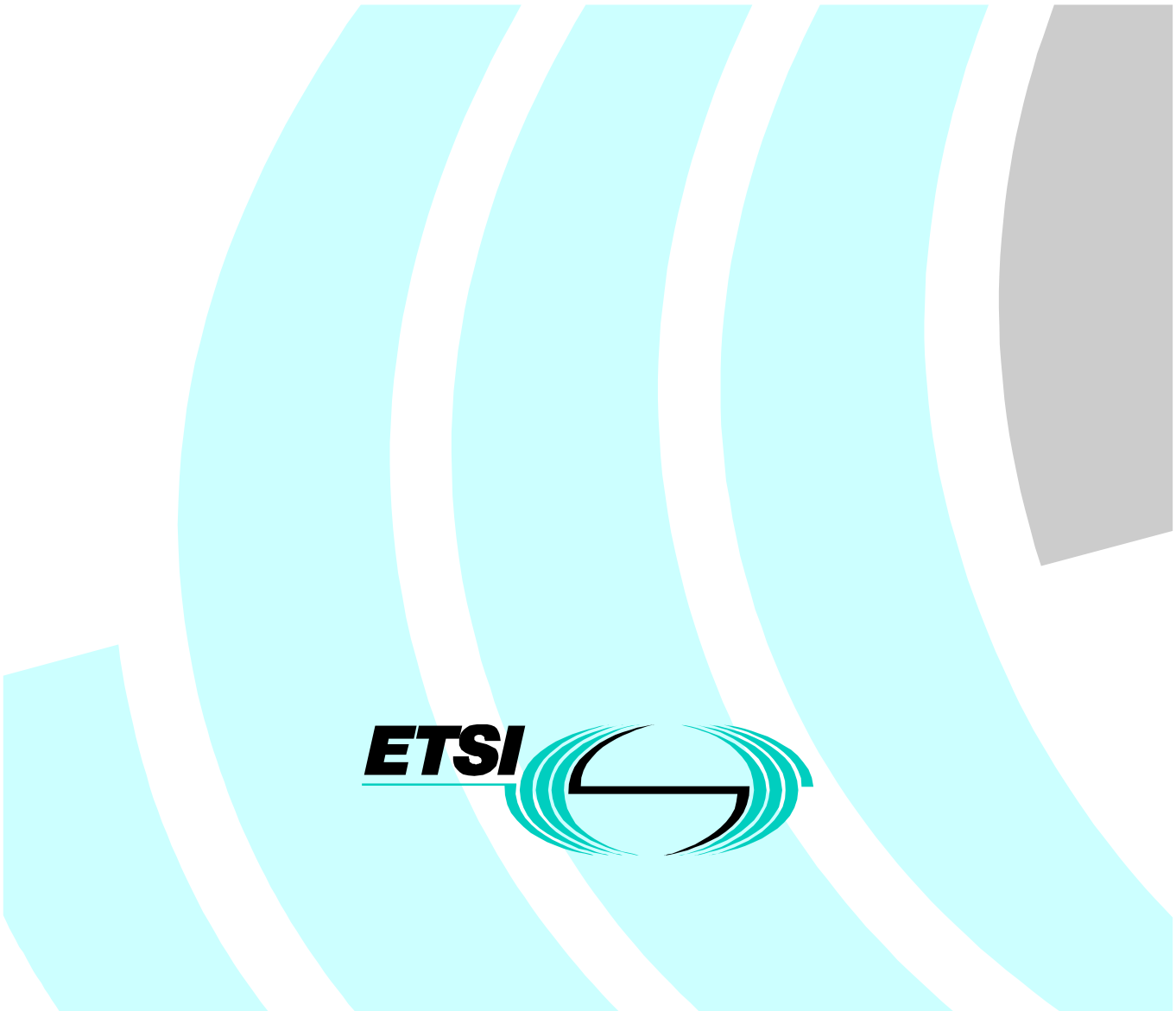
Technical Report

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



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Contents

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Foreword

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

Introduction

The present document explains the procedures for *routeing* of public telephony calls to an IP network. Starting point are the existing requirements in TS 101 314 [1] for addressing and *routeing* and in TS 101 324 [2] on numbering, and the numbering options for users on IP terminals as identified in TR 101 327 [3]. Additional general requirements for E.164/IP resolution are identified. These requirements may form the basis for a **service capability description** for call routeing.

The present document is based on the architecture developed in Tiphon WG2.

1 Scope

The present document explains the procedure for finding IP addresses for routeing signalling of public telephony calls to a terminating IP network or an IP network that supports a gateway back to an SCN. The calls may originate from or transit public IP based or SCN based networks.

The present document is applicable to all networks that support the public telephony service and is therefore written on the basis that the E.164 [13] numbering scheme is used for calling and called party identification. Nevertheless the underlying principles could also be applied with minor adaptation to private network numbering schemes.

The present document applies to calls to most types of number structures within E.164 [13], and includes the support of carrier selection and number portability. It does not specifically address the support of mobility or roaming, although it would apply to the routeing of a call to the home mobile network.

The present document covers only the routeing between networks. It does not include the routeing inside a terminating network.

NOTE: A further version of the present document may be produced for routeing inside a terminating network.

2 References

For the purposes of this Technical Report the following references apply:

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

[2] ETSI TS 101 324: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); Numbering; Scenarios 1, 2, 3 and 4".

[3] ETSI TR 101 327: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); Guide to numbering options for public networks based on VoIP technology".

[4] ETSI TR 101 287: "Network Aspects (NA); Terms and definitions".

[5] ETSI TR 102 081: "Network Aspects (NA); Number Portability Task Force (NPTF); Signalling requirements to support number portability".

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

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

[8] ETSI TR 101 118: "Network Aspects (NA); High Level Network Architecture and Solutions to support Number Portability".

[9] ETSI TR 101 122: "Network Aspects (NA); Numbering and Addressing for Number Portability".

[10] ETSI EG 201 367: "Intelligent Network (IN); Number Portability Task Force (NPTF); IN and Intelligence Support for Service Provider Number Portability".

[11] ITU-T Recommendation H.225.0, Annex G: "Call signalling protocols and media stream packetization for packet-based multimedia communication systems".

[12] ITU-T Recommendation Q.769.1: "Signalling system No. 7 - ISDN user part enhancements for the support of number portability".

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

[14] ITU-T Recommendation H.323: "Packet-based multimedia communications systems".

3 Definitions and abbreviations

3.1 Definitions

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

address: string or combination of digits and symbols which identifies the specific termination points of a connection/session and is used for routeing

called number: normally a name written as a numerical string identifying the called party or called terminal

contact ID: intermediate identifier for the destination of the next point of resolution (i.e. the destination of the next hop for the signalling messages). The form of the contact ID may vary and may or may not depend on the protocol and the technology used in the transport plane. (Contact IDs are used more in IP based networks than in SCNs)

E.164 [13**] number**: number allocated under ITU-T Recommendation E.164 [13] "International public telecommunication numbering plan"

name: combination of alpha, numeric or symbols that is used to identify end-users

Routeing Number (RN): a Routeing Number is, within the present document, a specific number that is used by the networks to route the call. The Routeing Number conveys information in a form more readily usable by the network (e.g. to route calls to a ported number)

routeing: set of instructions on how to reach a destination

transit network: network between two networks, e.g. between the initiating network and the recipient network

3.2 Abbreviations

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

ID	Identifier
IN	Intelligent Network
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISUP	ISDN User Part
PSTN	Public Switched Telephone Network
SCN	Switched Circuit Network
SIP	Session Initiation Protocol

4 Tutorial information on digit analysis and call routeing

4.1 Introduction to naming and addressing

Names and addresses are defined formally as follows:

- **address:** a string or combination of digits and symbols which identifies the specific termination points of a connection/session and is used for routeing
- **name:** a combination of alpha, numeric or symbols that is used to identify end-users

A name is a unique identifier of an entity that may be communicated with via a network. It does not normally indicate explicitly which network, or exactly where the entity is located. The name is used for identifying the calling and called parties within the service that is being provided.

An address is a specification of the location of the entity in terms of network structure. It includes the identity of the network to which it is connected and some information about the location within that network.

NOTE: Often the word "address" is used to mean "containing location information" but this is not sufficient for the purposes of the distinction between names and address in telecommunications. Here the critical issue is whether the location information is specified in terms of network structure. For example, an E.164 [13] number may contain location information if numbering is related to geographical areas, but such a number may be a name rather than an address if the structure that provides the location information does not relate explicitly to network structure. This would be the case for example if there is number portability between competing networks.

E.164 [13] defines the international public telecommunication numbering plan. It includes PSTN, ISDN and mobile networks and supports various services including public telephony, some special telephony services such as international freephone, fax, some data services and the GSM short message service. According to the ITU-T Recommendations, some telephony services such as national freephone do not use E.164 [13] numbers although their numbering is compatible with E.164 [13]. The E.164 [13] number is not necessarily identical to the dialled number as dialling prefixes and arrangements for local dialling are not part of E.164 [13].

For various historical reasons, E.164 [13] numbers are a mixture of names and addresses, but the trend is to reduce the degree of address information and make them more names than addresses (i.e. to reduce the network specific information). Various parts of E.164 [13] include structures related for example to geography. This structure may in the past have been related precisely to network architecture but the relationship to network architecture has reduced or been removed for example by operator and location portability.

When addresses are needed in switched circuit networks (i.e. when network information is needed for routeing), routeing numbers are used. A routeing number may be:

- a separate E.164 [13] number or E.164 [13] -like number (i.e. a number similar in format to E.164 [13] numbers and compatible with the E.164 [13] plan but not formally part of the plan) that contains the necessary network information,
- a non-E.164 [13] number that contains the necessary routeing information,
- or a routeing prefix added to the front of the E.164 [13] number.

Within IP based networks, there are separate naming and addressing schemes. Names normally have the form:

User@host

Where "host" is a domain name. IP addresses are completely separate binary strings and there are different forms depending on whether IPv4 or IPv6 is being used.

Table 1 shows some examples of the relationship between names and addresses for telephony and current web applications. It includes the differences between the Tiphon and SIP based solutions for telephony over IP.

Table 1: Examples of names and addresses

	Telephony on switched circuit network	Email	Tiphon solution for telephony on IP	SIP based solution for telephony on IP
Name	E.164 [13] number	user@host where host is described by a domain name	E.164 [13] number	user@host, possibly with an E.164 [13] alias for incoming calls from the switched circuit networks
Address	Routeing E.164 [13] number, or (routeing prefix +E.164 [13] number)	IP address	IP address	IP address

4.2 Routeing in the SCN - digit analysis

Within the SCN, **numbers** are used to identify (or to name) destinations. In many cases today, the address of the destination and the name are identical. The number is used to route the call to the terminating switch. It is therefore convenient for routeing, to attach numbering blocks (43 1 979 xxxx) or numbering ranges to switches (a numbering

range is consecutive blocks of numbers which follow the same routeing instructions e.g. 43 1 979 2xxx to 43 1 979 5xxx). Block sizes depend on national policy and differ from country to country and also within countries. The most common block size is 10 000 numbers. A disadvantage of this approach is the uneconomic use of the available numbering space, if the demand is less than the block size. Consequently in areas where there is a shortage of numbers and in rural areas smaller block sizes such as 1 000 are increasingly being used.

The mechanism that performs the analysis of numbers looks to see if a given number fits into a numbering block or numbering range and extracts the given set of routeing instructions for this numbering block, to be executed in call set-up. The information stored in switches that relates number blocks to routeing instructions is referred to as "routeing tables".

Because the analysis needed for the application of routeing tables is costly in terms of switch processor power and because of the problem of maintaining up-to-date routeing tables, the route to the final destination is evaluated in most cases step by step. The process of number analysis is distributed amongst switches, with each switch normally knowing only the route to the next switch (next hop). The next switch may repeat and refine the analysis process. Eventually the call is routed to the terminating switch that serves the called party. The terminating switch translates from the number (name) attached to the called party and the hardware address of the line card.

4.3 Routeing numbers in SCNs

Routeing numbers have been introduced to provide more flexibility and provide routeing control in cases where the called party is at a terminating switch that is not identified by the block that contains the called party number. This situation occurs either:

- where the number has been ported away from the switch identified by the number block, or
- where number blocks are not used (e.g. in mobile services or where numbers are allocated individually).

Routeing numbers may also be used to route calls to the correct termination point in the case where the same set of dialled digits is used for access to a particular service even though the service may be delivered from a number of different points in the network (e.g. 112 calls).

In these cases a routeing number is used instead of the called party number for the routeing of the call.

The routeing number is normally generated by either:

- a query to an IN database (e.g. a home location register in mobile networks to obtain the mobile station roaming number, which is the routeing number, or a number portability database in some number portability solutions)
- on-switch processing (e.g. in some onward routeing number portability solutions)

A routeing number is either:

a) added in front of the called party number in the field in the signalling system that carries the called party number, or

b) placed instead of the called party number in the field in the signalling system that carries the called party number, with the called party number being carried in a separate field, or

c) placed instead of the called party number in the field in the signalling system that carries the called party number, with the called party number no longer being carried.

With a), the routeing numbers are added to the routeing tables. With b) changes to the routeing tables in the switches may not be needed if the routeing number is chosen to match the number structure already stored in the routeing tables.

NOTE: Older signalling systems (e.g. early versions of ISUP) allow only one number to be transported, therefore the combined approach is used. New signalling systems (e.g. the latest version of ISUP) allow both numbers to be transported, but this opens another problem. Some networks use the called party number field for the routeing number, and put the called party number in the new field, others leave (for other compatibility reasons) the called party number in the old field and put the routeing number in the new field. (both approaches are conforming to ITU-T Q.series). Compatibility is achieved by giving additional information indicating what changes have been made possibly by using the nature of address parameter.

A routeing number may be a specific address for a destination (a network termination point, like an IP address), but in most cases it is the address of an entity who knows more details (next hop). The routeing number is therefore the equivalent to the "contact address" as defined in ITU-T Recommendation H.225.0, Annex G.

The addressed entity in the SCN may be subject to number portability (see TR 101 697 [6]).

If the routeing number is used for contacting the next hop, the destination number is normally also needed by the next switch to analyse the number further. Therefore the call signalling has to forward the destination number. The routeing number may not need to be forwarded in signalling if a new routeing number is generated at the next switch.

4.4 Call routeing in IP networks

IP networks that support public telephony have to support E.164 [13] numbers for caller and called party identification as a basic part of the public telephony service. They may support other naming schemes as well for other forms of telephony. Because E.164 [13] numbers in IP networks are names and are clearly distinct from IP addresses, there always has to be a translation from the E.164 [13] number to an IP address so that signalling can be routed.

Such translations are needed:

- for outgoing calls to enable packets to be routed from a terminal to an outgoing gateway
- for incoming calls to enable packets to be routed from an ingress gateway to the appropriate terminal
- for transit calls to enable packets to be routed from an ingress gateway to an outgoing gateway

Translations from name to address in IP networks are commonly called "resolutions".

There are two different possible aspects to these resolutions.

- a service related aspect, which may be present in only some cases, where the called E.164 [13] number needs to be translated to some form of contact information such as an E.164 [13] routeing number, before being finally translated to an IP address. Where this aspect is needed it may be combined with the basic translation in a single step
- a basic translation from an E.164 [13] number, or possibly some other contact information, to an IP address. This is always present and is the IP equivalent to digit translation (see 4.2 above)

5 Types of resolution in an SCN to IP call

5.1 Introduction

The purpose of this section is to distinguish the various different resolutions that may be encountered in an SCN to IP call. It is written for the public telephony service and so assumes that the E.164 [13] number is the principal identifier for a telephony correspondent whatever the technology used (SCN or IP), however the principles that would apply in a private domain would be similar.

The term "E.164 [13] number" is used loosely to mean the number that would be dialled or built up immediately from the dialled number (i.e. by expanding a local number).

This clause uses the terms gatekeeper and gateway because they are used extensively within H.323 [14] and H.225 and are useful for tutorial purposes. The latest Tiphon architecture uses the more abstract terms "call control", "service control" etc frequently in their place. The differences are not critical for the purpose of obtaining an overview of what is happening and they reflect the inevitable lack of synchronization in terminology.

Figure 1 gives an overview of the various resolutions. The position of the service resolution in the order of the resolutions is not fixed; it may be carried out within the SCN or within the IP domains depending on the technology used by the networks that support the service concerned. The figure shows the gatekeeper routed case (other cases are not covered at present in the present document).

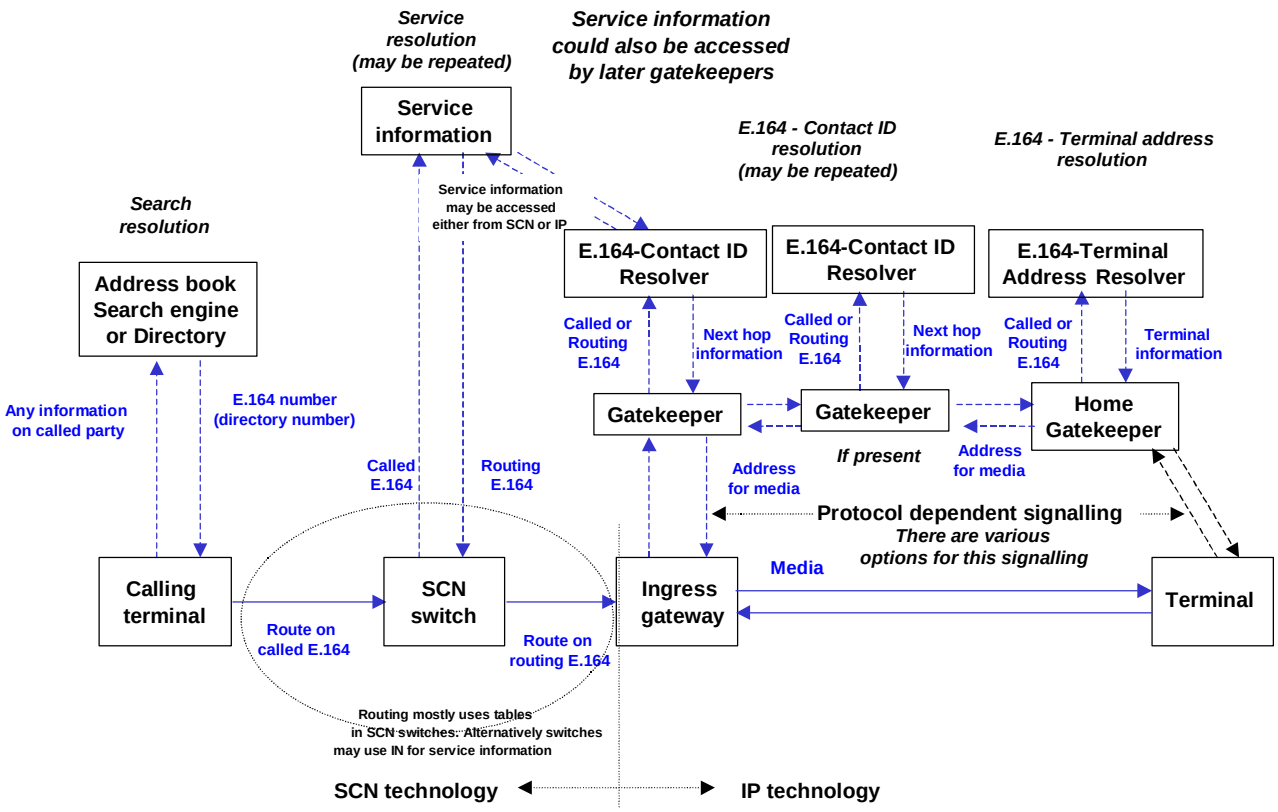

Figure 1: Resolution during a call from an SCN network to an IP network

5.2 Search resolution

The function of the first resolution is to find the E.164 [13] number (sometimes called the directory number) for the called party. This step may be skipped if this number is already known, or it may be carried out by:

- an address book or directory in the terminal
- an address book or directory in the calling network
- a public directory function
- a search engine

A search engine may be a successor to the current directory enquiry service to provide a user friendly public service interface for finding correspondents. There is likely also to be a user friendly customized terminal specific systems like an address book for commonly called numbers.

The search resolution will take some or any information and provide the E.164 [13] number. The query is made from the calling terminal and the response is returned to the calling terminal or calling party.

NOTE: The details of this resolution are out of scope of the present document.

5.3 E.164 service resolution

This resolution supports the particular service that is using E.164 [13] numbers. It resolves the called E.164 [13] number to a routeing E.164 [13] number whose main function is to give information on the identity of the network that is serving the called party. In some cases, additional information may be given such as the serving exchange within the serving network. This resolution may be needed:

- to support number portability
- to support personal numbering

- to support non-geographic services such as freephone

The routeing E.164 [13] number will direct the call towards the terminating network. If the query is made from an SCN switch (as shown in the diagram) then the response to the query will be an E.164 [13] routeing number. If the query is made from an IP gatekeeper (option in the diagram) then the response to the query may be:

- an E.164 [13] routing number
- a contact ID

Both will require subsequent resolution into an IP address.

This resolution may be local, regional or national and is not normally related to IP technology specifically because services are not normally technology specific. The resolution capability should be available to all operators that need to route calls into the domain that requires the resolution. The implementation may be a public service or each operator may use its own operational database. Any IP network that supports a service that requires this resolution will need access to the resolution system. We call this "E.164 [13] service resolution" because E.164 [13] is the numbering used for the service. The query for this resolution may be made from any point appropriate to the service concerned, e.g. for national number portability it would normally be made in the destination country, whereas for global personal numbering it could be made from any location with access to the appropriate database.

NOTE: There is as yet no standardization for queries to the service resolution, although there is a work item for standardizing a protocol for the resolution service.

It is possible that there may be more than one stage of the E.164 [13] service resolution. For example, with number portability the first stage may route the call to the home network and the second stage to the correct local area within that network.

If the E.164 [13] service function resolution function is provided as a public service, then it may be part of the resolution service.

It should be noted that in some cases the E.164 [13] service resolution will be a null function (e.g. where calls are routed on the digits as dialled without the need for a separate routeing number).

5.4 E.164 – Contact ID routeing resolution (for signalling)

This resolution is needed wherever the IP network that is handling the call needs to make a routeing decision. The first instance would be the routeing gatekeeper of the ingress IP network.

The diagram shows an E.164 [13] -contact ID resolver function that would be queried either by:

- the called E.164 [13] number
- the routeing number

NOTE 1: Additional information may be needed to indicate whether the input is the called E.164 [13] number or a routing number.

The resolution process provides the contact ID. The form of the contact ID may vary and may depend on the protocol and the technology used in the transport plane. The contact ID could be an IP address but is likely to be a more stable form of identification that will be resolved subsequently into an IP address.

NOTE 2: Further study is needed on the form of the contact ID.

The resolution process is time-critical as delays increase the call set-up time. It may be necessary to perform part or all of this process internally within a network under "controlled conditions" to achieve adequately low delays.

The architecture of the resolution system would reflect the structures of the E.164 [13] number.

The resolver function may access the service information and so include an E.164 [13] service resolution.

The next stage of the routeing may take the signalling to an interconnected transit network, in which case the E.164 [13] -contact ID routeing resolution process will be repeated by this next network.

The E.164 [13] -contact ID resolver may be:

- a local function within the network that is making the query (equivalent to a routeing table on a switch)
- a function shared for convenience by several networks
- an external public service

Various protocols could be used for interrogating the resolver and the choice of protocols is outside the scope of the present document.

Where the next stage of routeing will lead will depend on the where the location of the called party's home network relative to the resolver and the information available. This will determine the number of routeing hops needed to reach the home gatekeeper.

NOTE 3: Early drafts of documents have assumed that there will be a public resolution service that can resolve all E.164 [13] numbers to their home gateway, but this may not be available, and is certainly unlikely to be available for the earliest implementations.

If the network that is handling the call wants to route the call via a specific intermediate point such as another border element, or firewall, then this resolution arrangement would be internal to the network concerned and would return an appropriate address for this intermediate point.

In the case where the ingress gatekeeper is also the home gatekeeper for the called terminal, this stage (E.164 [13] - contact ID routeing resolution) is not needed.

If the E.164 [13] -contact ID resolution function is provided as a public service, then it will normally be part of the Resolution service.

In principle there is likely to be one contact ID address for each gatekeeper, different gatekeeper contact IDs are not used for each call.

5.5 Contact ID to transport address

In order to route the signalling, the contact ID may need to be resolved further into a technology and protocol specific form of address. This may be an IP address. This resolution is internal.

NOTE: Further discussion of the relationship of contact IDs to specific forms of address may be added into future versions of the present document after further development of the Tiphon architecture and protocol work.

5.6 E.164 – Terminal or outgoing gateway address resolution in the terminating network

This resolution is carried out by the gatekeeper of the terminating network (or the network that provides the outgoing gateway back to the SCN) and is local to that network. It provides the terminal address for signalling to the called terminal or outgoing gateway to the SCN. If the call needs to be routed on to another network then this resolution would identify a gateway as the endpoint. This resolution could also be a one or two stage process and is time critical. This resolution will depend on the protocol and the technology used in the transport plane.

This resolution may be more complex than that at earlier stages of the call because this resolution may take into account:

- the called user profile
- related services, e.g. call forwarding, announcements etc.

NOTE 1: Many terminating networks may use Network Address Translators (NATs) or firewalls. These devices present to external parties (e.g. the calling gateway) a public IP address but translate this into a private internal IP address for use within the terminating network.

NOTE 2: It is planned that a future version of the present document will provide more details about the resolution process in the terminating network.

5.7 Summary

The following table lists the types and key features.

Table 2: The stages of resolution

Resolution type	From	To	Carried out by	Status
E.164 [13] Search Resolution	Any information	Called E.164 [13]	Calling terminal or calling party	Address book, or Directory, or Search engine
E.164 [13] Service Resolution	Called E.164 [13]	Routeing information e.g. E.164 [13] for home network	SCN switch or gatekeeper	Specific to service or geographical area (Note: a service may be specific to a network) Not specific to IP technology
E.164 [13] - contact ID routeing Resolution	Called E.164 [13] or routeing number	Routeing information for next hop (contact ID)	Gatekeeper	Local or national or global Not specific to IP technology Process may be repeated as signalling progresses hop-by-hop
Contact ID Transport address	Contact ID	Transport address for next hop	Gatekeeper	Specific to the technology and the protocol used.
E.164 [13] - terminal address Resolution	Called E.164 [13] or routeing number	IP address of terminal (or outgoing gateway)	Gatekeeper	Local

5.8 IP addressing for the media packets

There are various possibilities for the IP addresses to be used in sending media packets from the gateway at the boundary between the technology domains to the called terminal. At one extreme, the signalling may provide a public IP address for media packets to be routed direct to a port on the called terminal. At the other extreme, at each boundary between IP networks, border element equipment may perform translations of IP addresses to be used for media packets. One of the issues is the extent to which the route of the media packets needs to be controlled. Control that ensures that the packets always pass through particular points may be needed for end-end quality (e.g. controlling time delay that affects speech quality) or for lawful interception.

History

Document history		
V1.1.1	September 2000	Publication