             Number Portability Parameters for the "tel" URI

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Abstract

   This document defines five parameters in the "tel" Uniform Resource
   Identifier (URI) to carry the number portability (NP)-related
   information. Those parameters can be passed to the next-hop network
   node after an NP database dip has been performed.

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1. Introduction

   Number portability (NP) [RFC3482] allows telephony subscribers to
   keep their telephone numbers when they change service provider
   (service provider portability), move to a new location (location
   portability), or change the subscribed services (service
   portability). The telephone numbers can be the geographical
   telephone numbers, mobile telephone numbers, freephone numbers, or
   other types of non-geographical telephone numbers. Some mobile
   telephone numbers are like geographical telephone numbers (e.g.,
   those in North America) and others are of non-geographical nature but
   their routing is similar to the routing of geographical telephone
   numbers so they are not specifically mentioned in this document. The
   freephone numbers are also known as toll-free phone numbers. The
   called party who is assigned the freephone number pays the call
   charge when the caller dials the freephone number.

   NP impacts call signaling and routing. One impact is the need to
   carry the NP-related information in the "tel" Uniform Resource
   Identifier (URI) [RFC3966] for protocols such as the Session
   Initiation Protocol (SIP) [RFC3261] and H.323 [H323] after the NP
   database dip has been performed. Another impact is for a Voice over
   IP (VoIP) server to use the NP-related information in a received
   "tel" URI to determine routing.

   A routing number is associated with a geographical or mobile
   telephone number that has been ported out from a donor carrier to
   another carrier. A donor carrier is the initial carrier where a
   geographical telephone number was allocated before ever being ported.
   A "non-ported" geographical or mobile telephone number does not have
   any routing number associated with it because the first N digits of
   the geographical or mobile telephone number can be used for routing.
   A routing number can also be used to indicate the switch or network
   node that originates a call or service similar to the Jurisdiction
   Information Parameter in Signaling System Number 7 (SS7) Integrated
   Services Digital Network User Part (ISUP). The "rn" parameter
   carries the routing number information. The "rn-context" parameter
   describes how the "rn" parameter value should be interpreted when the
   value is not a "global-rn" as is discussed in Section 4.

   The NP database dip indicator is used to inform the downstream
   servers or switches during call setup that there is no need to
   perform the NP database dip for a geographical telephone number
   again. The "npdi" parameter carries such an indicator.

A Carrier Identification Code (CIC) identifies the current freephone
service provider for a freephone number. This parameter can also be
used to carry the pre-subscribed or dialed long-distance carrier
information; however, that is outside the scope of this document.
The "cic" parameter carries the CIC information. The "cic-context"
parameter describes how the "cic" parameter value should be
interpreted when the value is not a "global-cic" as is discussed in
Section 4.

2. Conventions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
document are to be interpreted as described in RFC 2119 [RFC2119].

3. Abbreviations

    ABNF   Augmented Backus-Naur Form
    ANSI   American National Standards Institute
    CIC   Carrier Identification Code (also cic)
    CIP   Carrier Identification Parameter
    FCI   Forward Call Indicator
    GAP   Generic Address Parameter
    GSTN   Global Switched Telephone Network
    HTML   HyperText Markup Language
    IC   Identification Code
    ISUP   Integrated Services Digital Network User Part
    JIP   Jurisdiction Information Parameter
    NP   Number Portability
    NPDB   Number Portability Database
    npdi   NP Database Dip Indicator
    rn   Routing Number
    PNTI   Ported Number Translation Indicator
    SIP   Session Initiation Protocol
    SS7   Signaling System Number 7
    URI   Uniform Resource Identifier
    VoIP   Voice over IP

4. Formal Syntax

The following syntax specification uses the Augmented Backus-Naur
Form (ABNF) as described in RFC 4234 [RFC4234] and defines the five
parameters, rn, npdi, cic, rn-context and cic-context, by extending
the "parameter" production rule of the "tel" URI defined in
[RFC3966].

```
parameter               =/ rn / cic / npdi
rn                      = ";rn=" (global-rn / local-rn)
npdi                    = ";npdi"
cic                     = ";cic=" (global-cic / local-cic)
global-rn               = global-hex-digits
local-rn                = 1*hex-phonedigit rn-context
rn-context              = ";rn-context=" rn-descriptor
rn-descriptor           = domainname / global-hex-digits
global-hex-digits       = "+" 1*3(DIGIT) *hex-phonedigit
hex-phonedigit          = HEXDIG / visual-separator
visual-separator        = "-" / "." / "(" / ")"
domainname              = *( domainlabel "." ) toplabel ["."]
domainlabel             = alphanum
                           / alphanum *( alphanum / "-" ) alphanum
toplabel                = ALPHA / ALPHA *( alphanum / "-" ) alphanum
alphanum                = ALPHA / DIGIT
global-cic              = global-hex-digits
local-cic               = 1*hex-phonedigit cic-context
cic-context             = ";cic-context=" rn-descriptor
```

The "rn", "npdi", or "cic" parameter each can appear in the "tel" URI
at most once.

The first "hex-phonedigit" value in "local-rn" or "local-cic" MUST be
a hex-decimal digit.

For a "global-rn", the routing number information after "+" MUST
begin with a valid E.164 [E164] country code. Hexadecimal digit is
allowed after the country code in the "global-rn".

For a "local-rn", the routing number in the "rn" parameter MUST be
interpreted according to the "rn-context". For example, if a
national routing number is in the "rn" parameter, the "rn-context"
MUST contain a valid E.164 country code after "+" if it is in the
"global-hex-digits" format. Hexadecimal digit is allowed in the
"local-rn".

For a "global-cic", the CIC information after "+" MUST begin with a
valid E.164 country code.

For a "local-cic", the CIC value in the "cic" parameter MUST be
interpreted according to the "cic-context". For example, if the
national CIC value is in the "cic" parameter, the "cic-context" MUST
contain a valid E.164 country code after "+" if it is in the
"global-hex-digits" format.

The inclusion of the visual separator in the "rn" or "cic" is
optional.

5. Normative Rules

   There are two distinct uses for the "tel" URI. In one use, the "tel"
   URI appears in a piece of static content. For example, it might
   appear in a HyperText Markup Language (HTML) page or a presence
   document. In another use, the "tel" URI appears in call signaling
   protocols, such as SIP and H.323, where it is used to guide routing
   of the call setup messages. The "tel" URI extensions defined in this
   document are targeted at call signaling protocols. When a "tel" URI
   is placed in static content, the parameters defined here SHOULD NOT
   be present, and any entity receiving them SHOULD remove them prior to
   using the tel URI.

   Within the context of signaling protocols, these parameters are meant
   for usage between call signaling entities, called network nodes,
   among which there is a trust relationship. Since parameters inserted
   by one network node can impact the routing of a request at a
   downstream node, processing of these parameters depends on trusting
   that the upstream element properly followed the rules defined here.
   A call signaling protocol can verify that an upstream element is part
   of its circle of trust through hop-by-hop integrity mechanisms. See
   Section 7, Security Considerations, for more information. If a
   network node receives a call signaling message from an element it
   does not trust, it SHOULD ignore the parameters.

   This section discusses how a network node handles a received "tel"
   URI that contains one or more of the parameters defined in this
   document or has accessed an NP database for a freephone number or
   geographical telephone number and needs to add some of the parameters
   defined in this document to a "tel" URI.

   In countries where there is no freephone number portability or
   geographical telephone number portability, the call routing can be
   based on the leading digits of the freephone number or geographical
   telephone number. This document does not describe those scenarios.

   Please note that two accesses to the freephone databases are normally
   done for routing a call to a freephone number. The first one is done
   by the originating network that queries a freephone database for the
   CIC information so that the call can be routed to the serving
   freephone service provider of the called freephone number. When the
   call reaches the serving freephone provider, the second database
   access is performed to map the freephone number to a geographical
   telephone number and/or internal routing information. This document
   does not address the case where internal routing information is
   returned.

   The first freephone database contains the CIC information for all the
   active freephone numbers, whereas the second one usually contains
   mapping information only for those freephone numbers served by a
   freephone service provider. Because the originating carrier may
   provide freephone service, its freephone database would contain the
   CIC information for all the active freephone numbers plus the mapping
   information for those freephone numbers it serves. This document
   refers to the two database accesses as "the first freephone database
   access" and "the second freephone database access".

   When handling the "rn" and "cic" parameters and the phone numbers in
   the "tel" URI for purposes such as database access and routing, the
   visual separators in them are removed before using the information in
   them.

   When a network node handles a "tel" URI that contains invalid "rn" or
   "cic" information, it may release the call or drop the invalid
   parameter and access the appropriate NP database or freephone
   database to see whether it can retrieve a valid routing number for a
   geographical telephone number or valid CIC for the freephone number.

   When a "tel" URI is received from an untrusted source, a network node
   MAY redo the NPDB query.

   SIP [RFC3261] has mechanisms in place to detect routing loops due to
   URI re-writing, and the new parameters added here work within these
   established contexts. The "npdi" parameter in the URI that indicates
   a NPDB query has already been done can also prevent routing loop.
   Other protocols considering using these "tel" URI parameters SHOULD
   ensure that they have mechanisms in place to detect loops when re-
   writing the "tel" URI.

5.1. Handling "tel" URI with NP Parameter or Parameters

   If the "tel" URI contains the "npdi" parameter, the network node MUST
   NOT retrieve the NP-related information for geographical telephone
   numbers even if it is set to do so.

   If the "tel" URI contains the "cic" parameter whose CIC value is
   different from the one this network node is associated with, this
   network node MUST NOT retrieve the NP-related information for the
   geographical telephone number or perform the first freephone database
   access for the freephone number in the "tel" URI.

   For the "cic" and "rn" parameters and either a freephone number or
   geographical telephone number, the order of processing is to look for
   the "cic" parameter first for call routing. If the CIC information
   is not useful or the "cic" parameter does not exist, then the next

step is to look for the "rn" parameter. If the information in the
"rn" parameter is not useful or the "rn" parameter does not exist,
then the freephone number or geographical telephone number is used.

If the network node does not know how to route based on the "cic" or
"rn" parameter, the local policies MUST decide whether to stop the
call processing or continue the call processing by ignoring the
invalid/unknown information.

When looking for the "cic" parameter and that parameter exists in the
"tel" URI:

- The network node MUST ignore the "cic" parameter if the CIC
  identifies a carrier or service provider associated with that node
  and look for the "rn" parameter for making the routing decision.
  It MUST remove the "cic" parameter when it routes the call to the
  next-hop network node that belongs to another carrier or service
  provider.

- The network node MUST invoke special handling process if the "cic"
  parameter contains a code that requires such a treatment. For
  example, a CIC value of "0110" in the response to a freephone DB
  query in North America indicates "local, translated geographical
  telephone number provided". In this particular example, the "cic"
  parameter is ignored. Please note that this particular CIC value
  of "+1-0110" normally will not appear in the call setup message.
  It is given as an example to show that such special CIC values may
  exist. The exact code values and the handling of them are outside
  the scope of this document.

- Otherwise, the network node MUST make the routing decision based on
  the CIC. The network node MUST NOT remove the "cic" parameter
  unless it is handing over the call to the carrier or service
  provider identified by the CIC and the local policies require it to
  remove the "cic" parameter. How the call is actually routed based
  on the CIC value in the "cic" parameter is outside the scope of
  this document.

When looking for the "rn" parameter and that parameter exists in the
"tel" URI:

- If the routing number in the "rn" parameter points to this network
  node (e.g., the call has reached the intended network node), this
  network node MUST look for the freephone number or geographical
  telephone number for making the routing decision. It MUST remove
  the "rn" parameter when setting up the call to the next-hop network
  node regardless if that next-hop network node is in the same or
  different network.

   - If the routing number in the "rn" parameter points to a network
     this network node is in (e.g., in some countries the routing number
     gets the call to the serving carrier network where another NP
     database access is required to locate the serving switch), this
     network node MUST look for the freephone number or geographical
     telephone number for making the routing decision. The network node
     MAY access the NP database for routing information if it is set to
     do so. It MUST remove the "rn" parameter if the next-hop network
     node belongs to another carrier or service provider.

   - Otherwise, the network node MUST make the routing decision based on
     the routing number in the "rn" parameter. How the call is actually
     routed based on the routing number in the "rn" parameter is outside
     the scope of this document.

   When the "cic" or "rn" parameter is not used for routing, the network
   node uses the freephone number or geographical telephone number for
   making routing decisions. It may access the NP database if it is set
   to do so, or it may route the call to a designated network node that
   will access the NP database, or it may route the call based on the
   local routing table. How the call is handled at this stage is
   outside the scope of this document. See Section 5.2 for rules in
   adding the parameter or parameters defined in this document to the
   "tel" URI if the network node is set to access the NP database.

5.2. Adding NP Parameter or Parameters to the "tel" URI

   There are two cases in terms of NP database access. One is for a
   geographical telephone number and the other is for a freephone
   number. They are discussed in Sections 5.2.1 and 5.2.2 for a "tel"
   URI that is used for routing.

   Section 5.2.3 discusses a special case where the "rn" parameter is
   added to a "tel" URI that is associated with the first network node
   that handles the call request from the caller. Section 5.2.4
   discusses the addition of the parameter or parameters defined in this
   document to the "tel" URI due to protocol conversion.

5.2.1. Retrieving NP-related Information for a Geographical Telephone
        Number

   When a network node accesses an NP database for a geographical
   telephone number:

   - If the network node retrieves a routing number, it MUST add the
     "rn" parameter to the "tel" URI to carry the routing number
     information in the "global-rn" or "local-rn" format. It MUST also
     add the "npdi" parameter.

   - If the network node does not retrieve a routing number (e.g., for a
     non-ported geographical telephone number), it MUST add the "npdi"
     parameter to the "tel" URI.

   The network node MUST follow the rules described in Section 5.1 for
   using the information in the "tel" URI to make the routing decision.

5.2.2. Retrieving NP-related Information for a Freephone Number

   When a network node performs the first or second freephone database
   access for a freephone number:

   - If the network node retrieves a CIC that identifies a carrier or
     service provider associated with that network node, or indicates
     that a geographic number is supplied (e.g., "+1-0110" means "local,
     translated geographical telephone number provided"), it would have
     retrieved a geographical telephone number. The network node MUST
     NOT add the "cic" parameter and MUST replace the freephone number
     in the "tel" URI with the retrieved geographical telephone number
     in either the "global-number" or "local-number" format.

     Some freephone databases may not return the geographical telephone
     number but internal routing information in a proprietary format
     (e.g., switch ID and trunk group ID). That case is outside the
     scope of this document.

   - If the network node retrieves a CIC that belongs to another
     freephone service provider, the network node MUST add the "cic"
     parameter to the "tel" URI that contains the CIC in the "global-
     cic" or "local-cic" format.

     The originating carrier may have business agreements with a
     freephone service provider to return the geographical telephone
     number in addition to the CIC. When a geographical telephone
     number is returned, the network node MUST replace the freephone
     number in the "tel" URI with the returned geographical telephone
     number in either the "global-number" or "local-number" format.

   - If the network node retrieves a geographical telephone number
     (which is the typical case for the second freephone database
     access), the network node MUST replace the freephone number in the
     "tel" URI with the retrieved geographical telephone number in
     either the "global-number" or "local-number" format.

     When a geographical telephone number is returned in the response,
     it is possible that the NP-related information for that
     geographical telephone number could also be returned. In that
     case, the network node MUST add the "npdi" parameter and MUST add

   the "rn" parameter to contain the routing number in either the
   "global-rn" or "local-rn" format only when the routing number is
   available.

The network node MUST follow the rules described in Section 5.1 for
using the information in the "tel" URI to make the routing decision.

5.2.3. Adding Location Information about the Caller

In SS7 ISUP, the JIP identifies the switch that originates the call,
and the information in it may be used by the serving carrier to
determine the call charge to the caller or by the involved carriers
to determine the settlement amount between them.

A network node that is the first to handle the call request from the
caller MAY include the "rn" parameter to the "tel" URI associated
with the caller, if one exists. For example, if the network node is
a Global Switched Telephone Network (GSTN) gateway that receives an
ISUP message that contains the JIP, the correct location information
in the JIP can be placed in the "rn" parameter of the "tel" URI that
is associated with the caller.

Please note that the information in the "rn" parameter may not be
authenticated; therefore, the use of the information by the recipient
of the "tel" URI for anything related to charging is done at its own
risk.

5.2.4. Adding NP Parameter or Parameters Due to Protocol Conversion

A GSTN gateway needs to convert between SS7 ISUP and the VoIP
protocol such as SIP or H.323. This type of network node MUST map
between the corresponding ISUP parameters and the parameters defined
in this document associated with the "tel" URI for routing and MAY
map between the corresponding ISUP parameters and the parameters
defined in this document that are in the "tel" URI associated with
the caller.

Since ISUP support for NP depends on the individual country, the
following discussion applies to a situation when a network node is to
map between the NP information in the American National Standards
Institute (ANSI) ISUP and the NP-related parameters in the "tel" URI.

For a ported geographical telephone number, the network node MUST
convert the routing number in the ISUP Called Party Number parameter
to a routing number in either the "global-rn" or "local-rn" format
and carry it in the "rn" parameter for a "tel" URI that is used for
routing. The network node MUST convert the phone number that is
marked as the "ported number" in the ISUP Generic Address Parameter

(GAP) to a phone number in either the "global-number" or "local-
number" format [RFC3966] and put it in the global-number-digits or
local-number-digits (see [RFC3966]) part of the "tel" URI that is
used for routing.

For a non-ported geographical telephone number, the network node MUST
convert the phone number in the ISUP Called Party Number parameter to
a phone number in either the "global-number" or "local-number" format
and put it in the global-number-digits or local-number-digits (see
[RFC3966]) part of the "tel" URI that is used for routing. The "rn"
parameter MUST NOT appear in the "tel" URI unless the local policies
require the network node to include it. It is outside the scope of
this document how to include the "rn" parameter if the local policies
require the network node to do so.

The network node MUST include the "npdi" parameter in the "tel" URI
that is used for routing when the Ported Number Translation Indicator
(PNTI) bit in the Forward Call Indicator (FCI) parameter is set to
"1".

The network node MUST include the "cic" parameter in either the
"global-cic" or "local-cic" format in the "tel" URI that is used for
routing when the ISUP Carrier Identification Parameter (CIP) is
present.

The network node MAY include the "rn" parameter in the "tel" URI
associated with the caller information when the ISUP JIP is present.
This may be subject to the network node's local policy and/or the
signaling protocol that carries the "tel" URI.

Mapping NP-related parameters in a "tel" URI to the NP-related
information in the ISUP message depends on the national ISUP
implementation and is outside the scope of this document.

6. Examples

   A. A "tel" URI, tel:+1-800-123-4567, contains a freephone number
      "+1-800-123-4567". Assume that this freephone number is served by
      a freephone service provider with a CIC "+1-6789". After
      retrieving the NP-related information, the "tel" URI would be set
      to

         tel:+1-800-123-4567;cic=+1-6789

   B. A "tel" URI, tel:+1-800-123-4567;cic=+1-6789, is handled by a
      network node in the serving freephone service provider's network.
      Assume that the freephone number is mapped to a geographical
      telephone number "+1-202-533-1234". After retrieving the NP-
      related information, the "tel" URI would be set to

         tel:+1-202-533-1234

   C. A "tel" URI, tel:+1-202-533-1234, contains a geographical
      telephone number "+1-202-533-1234". Assume that this geographical
      telephone number is ported and is associated with a routing number
      "1-202-544-0000". After retrieving the NP-related information,
      the "tel" URI would be set to

         tel:+1-202-533-1234;npdi;rn=+1-202-544-0000

   D. A "tel" URI, tel:+1-202-533-6789, contains a geographical
      telephone number "+1-202-533-6789". Assume that this geographical
      telephone number is not ported. After accessing the NP database,
      the "tel" URI would be set to

         tel:+1-202-533-6789;npdi

   E. A "tel" URI, tel:+1-202-533-1234;npdi;rn=+1-202-000-0000, contains
      an invalid routing number (e.g., no routing information on "+1-
      202-000-0000"); the network node may drop the "rn" parameter and
      access the NP database again.

   F. A "tel" URI, tel:+1-800-123-456, contains a freephone number
      "+1-800-123-456" that is one digit short. When accessing the
      freephone database, there will not be any "cic" information for
      this freephone number. The call would be released.

   G. A "tel" URI, tel:+1-800-123-4567;cic=+1-56789, is handled by a
      network node in an originating or a transit network. The "cic"
      information is invalid. The network node may drop the "cic"
      parameter and access the freephone database again. If the same
      wrong CIC information is received, the network node would release
      the call because it does not know how to route the call with an
      invalid CIC. If valid information is received, the network node
      will use the received CIC in the "cic" and route the call based on
      the "cic".

7. Security Considerations

   In addition to those security implications discussed in the revised
   "tel" URI [RFC3966], there are new security implications associated
   with the parameters defined in this document.

   If the value of the "rn" or "cic" in the "tel" URI is changed
   illegally when the signaling message carrying the "tel" URI is en
   route to the destination entity, the signaling message or call may be
   routed to the wrong network or network node causing the call setup to
   be rejected.

   If the "npdi" is illegally inserted into the "tel" URI when the
   signaling message carrying the "tel" URI is en route to the
   destination entity, the call may be routed to the wrong network or
   network node causing the call setup to be rejected. It is less a
   problem if the "npdi" is illegally removed. An additional NPDB query
   may be performed to retrieve the routing number information and have
   the "npdi" included again.

   If the "rn" in the "tel" URI that is associated with the caller is
   illegally changed or inserted, the call charge based on that "rn"
   would be incorrect.

   Because of these considerations, these "tel" URI extensions are only
   applicable within a set of network nodes among which there is mutual
   trust. If a node receives a call signaling request from an upstream
   node that it does not trust, it SHOULD remove these parameters. This
   will generally cause it to redo any DB queries.

   To verify that an upstream neighbor is trusted, and to prevent man-
   in-the-middle attacks whereby an attacker inserts or modifies these
   parameters, call signaling protocols carrying these parameters SHOULD
   provide hop-by-hop message integrity. In the case of SIP, this is
   accomplished with the Session Initiation Protocol Secure (SIPS) URI
   mechanism.

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9. IANA Considerations

   This document defines five parameters for the "tel" URI. Further
   information on a registry for those parameters is covered in
   [TELREG]. This document requires no IANA actions.

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10.1. Normative References

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