

# ENUM and VoIP

## Numbering and Dialing Plans

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**RIPE 46**

**VoIP and ENUM Tutorial**

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# Today's Roadmap on Numbering

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1. POTS – from Comfort to Numbering
  - Why are the numbers in the PSTN in the way they are?
  - A History
2. ENUM and VoIP – Numbering and Dialing Plans
  - ENUM Mapping of E.164 Numbers to Internet Names and Addresses
  - E.164 Numbers for VoIP and Routing on the PSTN
  - Why Numbering and Dialing Plans for VoIP?
  - An Overview and a Proposal
3. VoIP and CLI – Trusted Identification
  - Calling Line Identification on VoIP
  - A Proposal

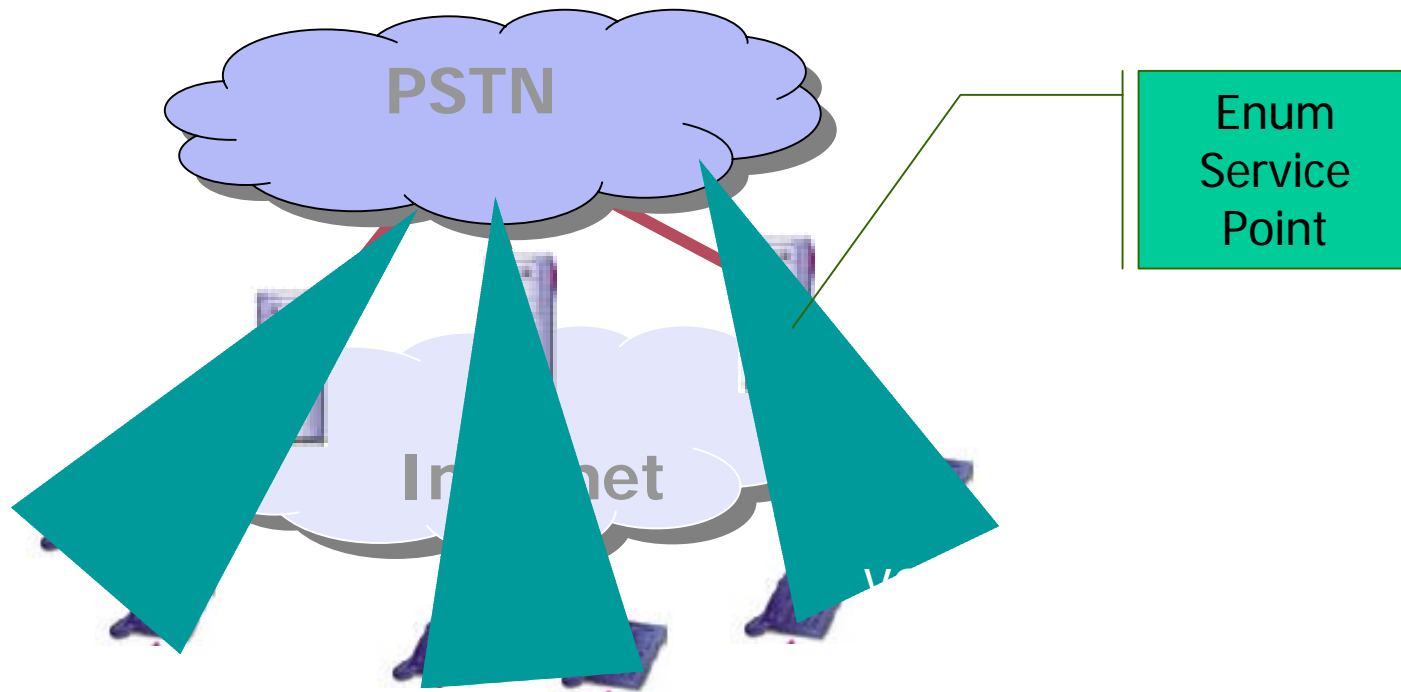
# What is ENUM?

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- ENUM is part of the convergence of Circuit Switched and Packet Networks
  - ENUM is defined by the Internet Engineering Task Force (IETF) and translates an E164 phone number into Internet Domain Names; RFC 2916 - September 2000; RFC2816bis – June 2003
- ENUM is about new service creation
  - Allows the use of a traditional telephone number in the context of different communication media, e.g., e-mail, VoIP, etc. and therefore could facilitate the penetration of new applications into the mass market easily
- Defines the use of Domain Name System (DNS) resource records to find:
  - E-mail addresses
  - Voice over IP SIP / H.323 servers
  - Voice Mail servers
  - Fax Machines
  - etc.

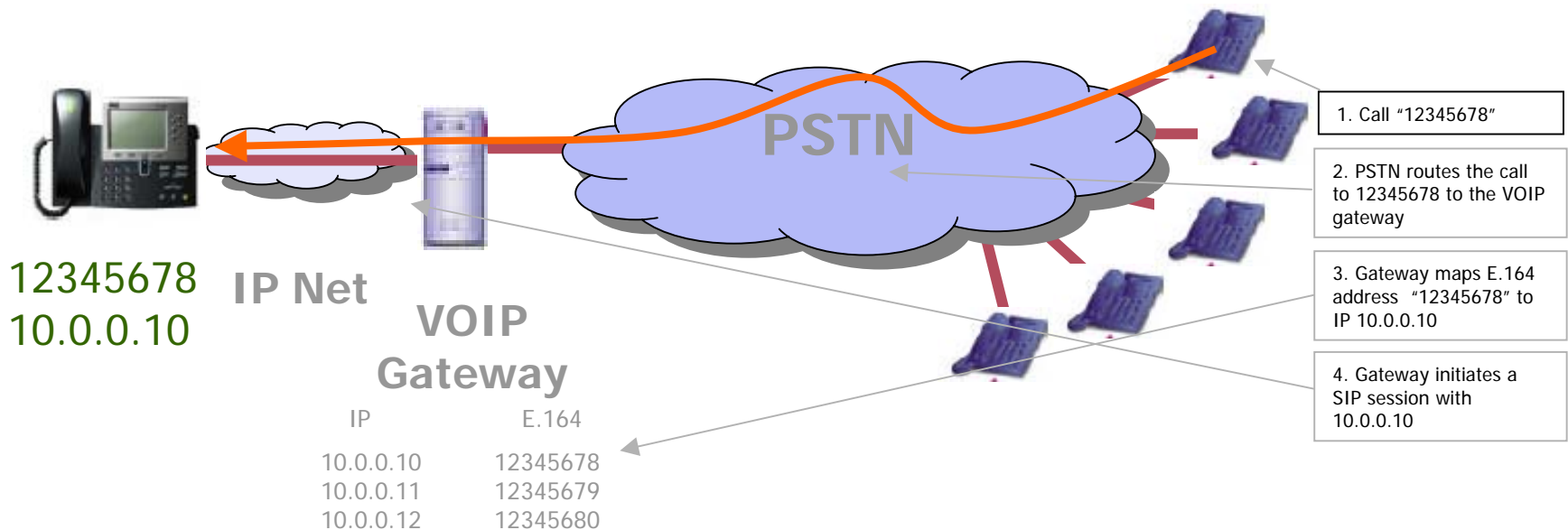
# The VOIP Gateway Model for ENUM

- Most IETF work these days assumes a 'reference architecture'
- ENUM's core reference architecture is VoIP-to-VoIP



# The VoIP Gateway Model

- The single gateway model is simple:
  - A PSTN / IP gateway maintains a mapping between IP and E.164 addresses



# The multi-Gateway VoIP World

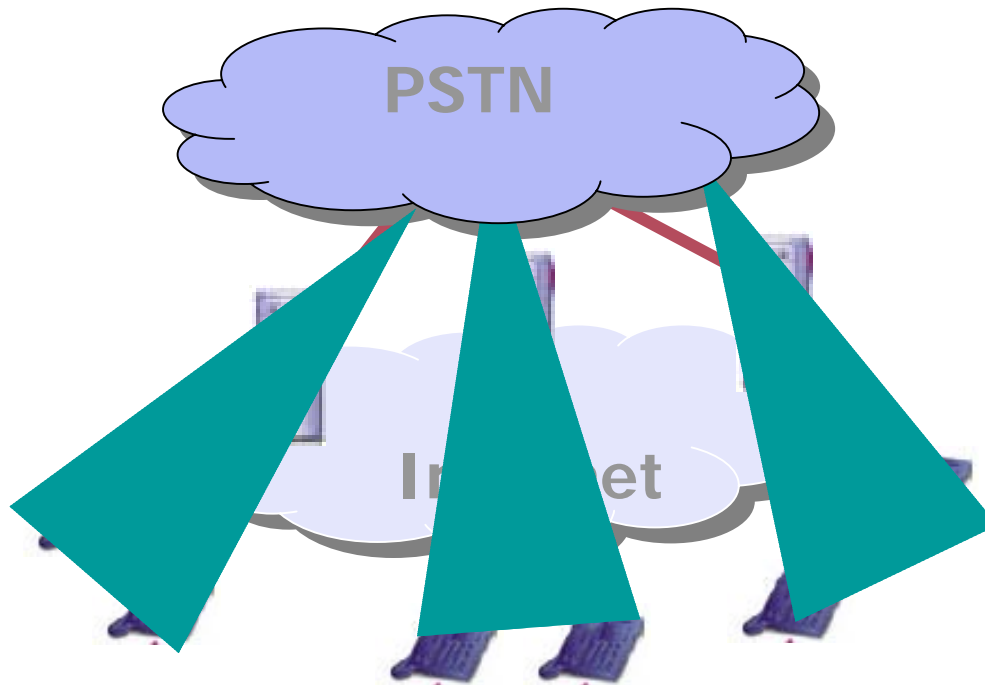
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- Use PSTN / VOIP Gateways
  - Each Gateway maps a set of telephone numbers to a set of served IP service addresses
  - Each Gateway knows only about locally served devices
  - Gateway-to-Gateway calls need to be explicitly configured in each gateway to use IP or some private connection, or use the default of the PSTN
  - The PSTN currently is the glue that allows the VOIP islands to interconnect with each other

# The multi-Gateway VOIP World

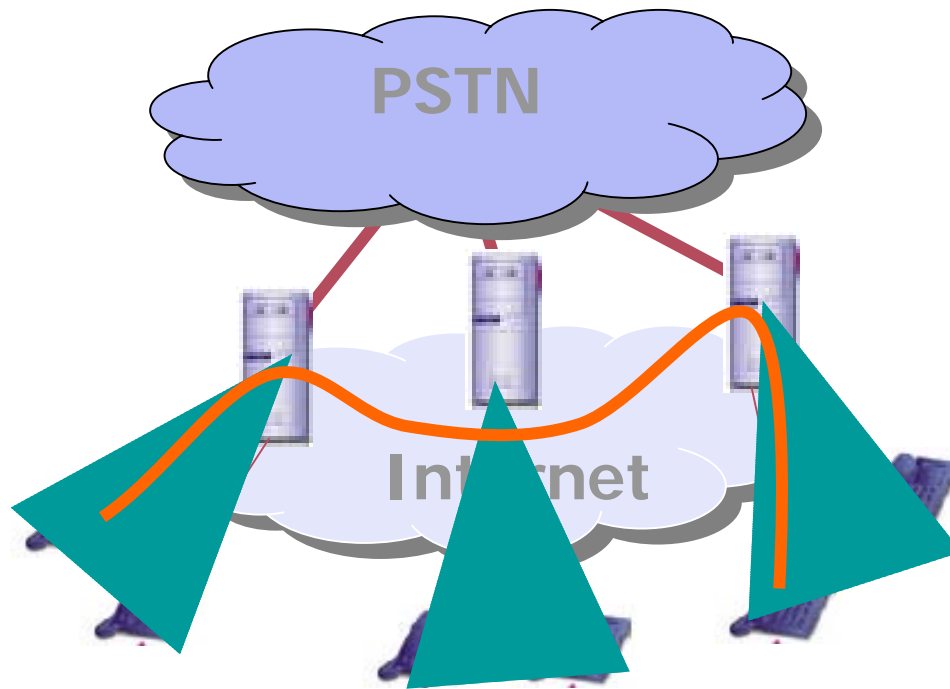
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- VOIP Islands
  - E.164 numbers are only routable over the PSTN
  - Enterprise or carrier VOIP dialing plans cannot be remotely accessed by other VOIP network segments



# The Core ENUM Problem

- How can a VOIP gateway find out dynamically:
  - If a telephone number is reachable as an Internet device?
  - And if so, what's its Internet service address?





# Problem statements for ENUM

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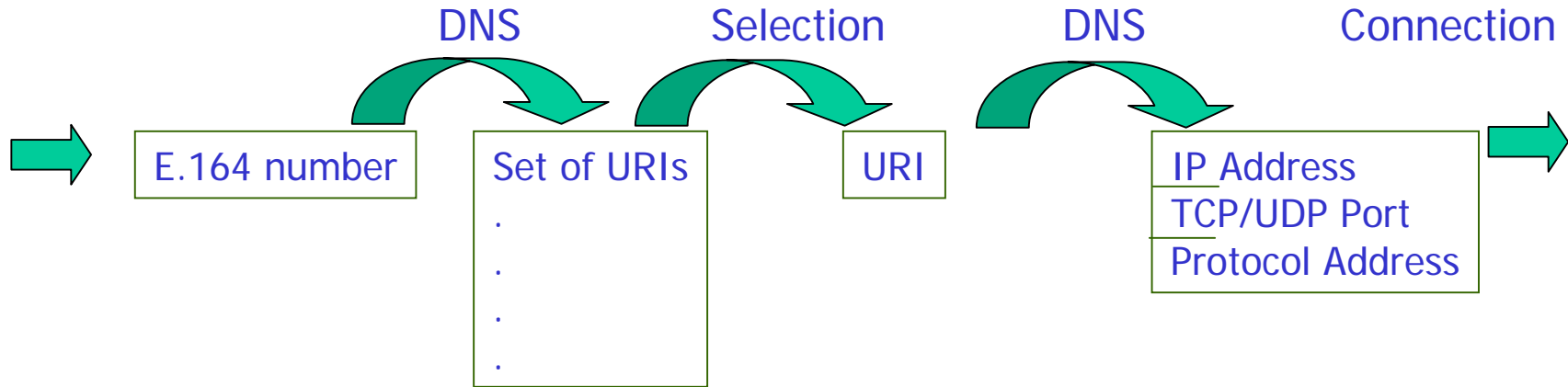
1. How do network elements (gateways, SIP servers, etc.) find services on the Internet if you only have an E.164 telephone number?
2. How can subscribers define their preferences for nominating particular services and servers to respond to incoming communication requests?
3. How can this be generalized to be open for all future applications?

# The ENUM Objective

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- Allow any IP and PSTN/ISDN device to establish a communication if an E.164 telephone address is reachable as an Internet-described Service
  - And ... what the preferred Service Point actually is
  - And if its an Internet-reachable Service Point... what IP address, protocol address, port address and application address should be used to contact the preferred Service Point

# ENUM Resolution

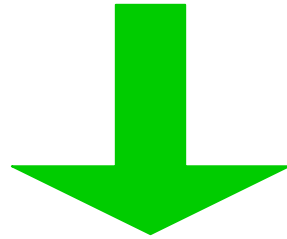


- IP services associated with a single E.164 may be provided on a collection of different IP service points
- An ENUM DNS request should return the entire set of service points and the associated service.

# How to put an E.164 number in DNS

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+43 1 979 33 21



1.2.3.3.9.7.9.1.3.4.e164.arpa

# ENUM Resolution (RFC2916bis)

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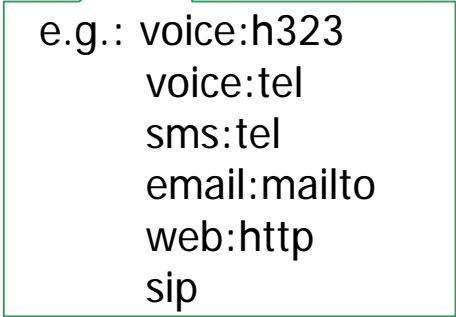
This domain-name is used to request NAPTR records from the DNS Database which may contain the end result (or, if the flags field is blank, produces new keys in the form of domain-names from the DNS).

```
$ORIGIN 0.8.7.9.7.1.3.4.e164.arpa.
```

```
;      type order pref flag      enumservice      regular expression      replacement
2.3 IN NAPTR 10 100 "u" "E2U+voice:sip" "!^.*$!sip:32@iphone.at!" .
```

or

```
* IN NAPTR 10 100 "u" "E2U+voice:sip" " "!^\\+43179780(.*)$!sip:\\1@iphone.at!".
```



e.g.: voice:h323  
voice:tel  
sms:tel  
email:mailto  
web:http  
sip

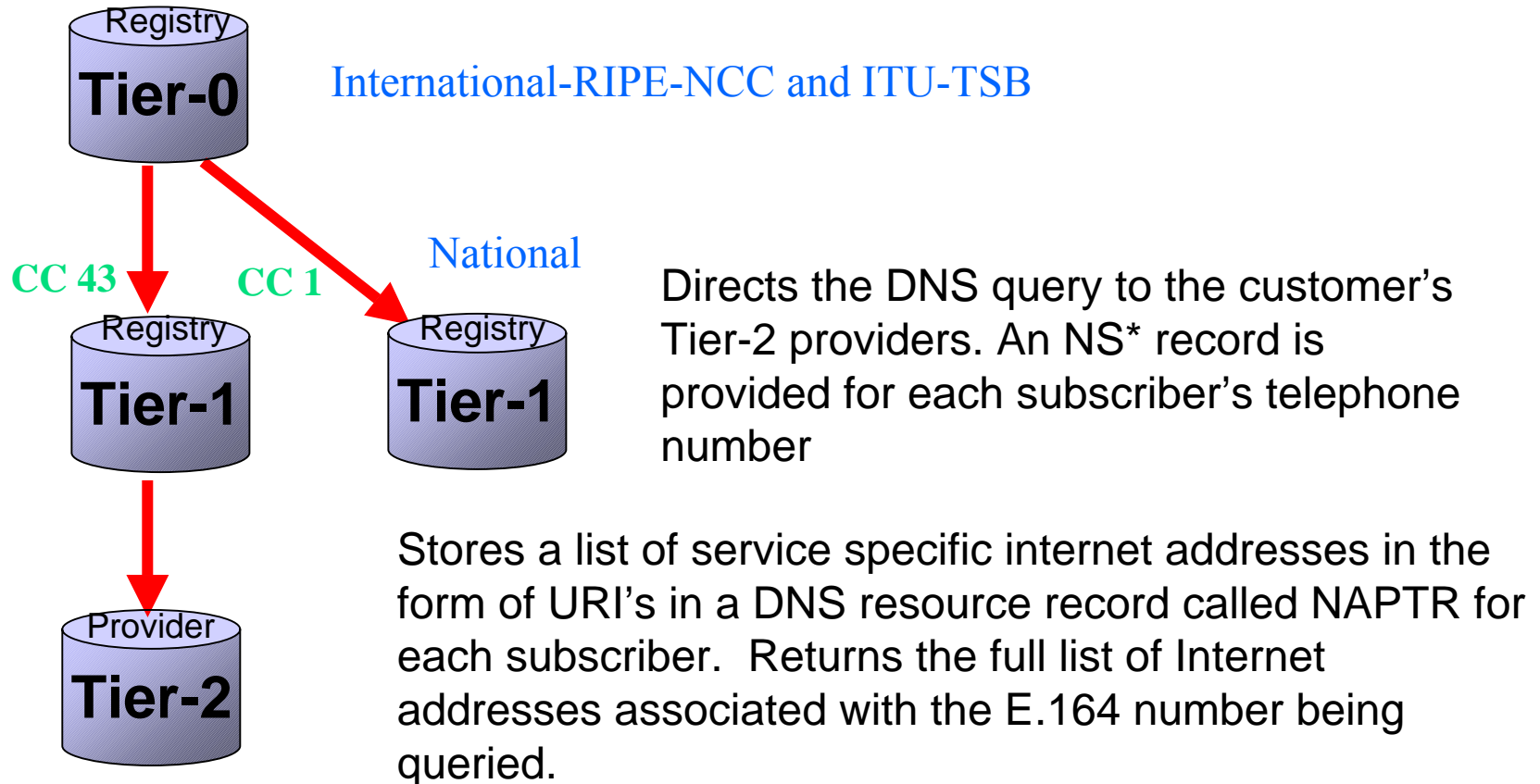
Defined in  
ETSI TS 102 172

# Why URIs?

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- URIs represent a generic naming scheme to describe IP service points
  - Generic format of
  - service:service-specific-address
- A URI in IP context is ultimately resolvable to
  - transport protocol (TCP/UDP) selection
  - IP address
  - Port address
  - Address selector within the application session

# The ENUM "Tiers"



\*An NS record is an authoritative Name Server DNS record used to delegate to subordinates

# ENUM Delegations

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## Delegations in e164.arpa as of 1. September 2003

- 31 Netherlands
- 33 France
- 358 Finland
- 36 Hungary
- 374 Armenia
- 40 Romania
- 420 Czech
- 421 Slovakia
- 43 Austria
- 44 UK
- 46 Sweden
- 48 Poland
- 49 Germany
- 55 Brazil
- 86 China
- 246 Diego Garcia
- 247 Ascension
- 290 Saint Helena
- 971 UAE
- 87810 VISIONng UPT

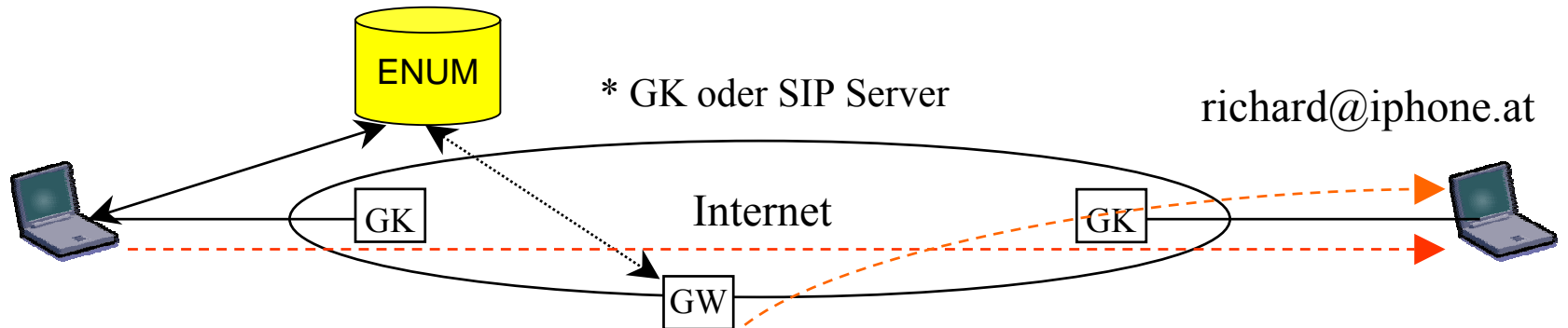
<http://www.ripe.net/enum/request-archives/>



# ENUM as second line service

## USER ENUM

+4319793321 ➔ richard@iphone.at



richard@iphone.at

e.g. dialing an ENUM access code  
10xx 4319793321

problem: the access code is  
different in every country

+4319793321



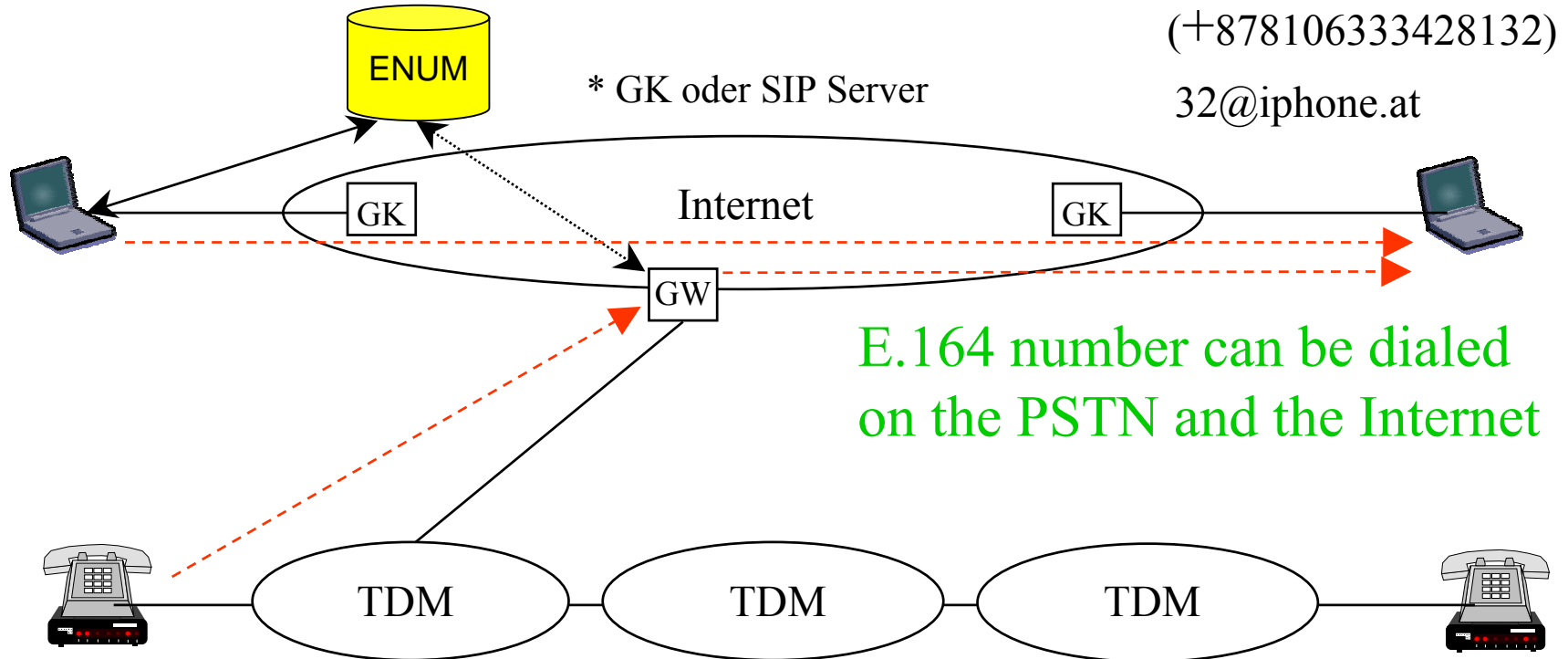
e.g. dialing 00 43 1 9793321

# E.164 Numbers for VoIP

## INFRASTRUCTURE ENUM

32@iphone.at is alias of richard@iphone.at

+878106333428132 ➔ 32@iphone.at



dialing 00 87810 6333428132

# So why should we use numbers in SIP servers directly?

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- VoIP has its own naming and addressing scheme, based on URIs, the DNS and IP-Addresses
  - e.g.: sip:user@acme.com
- So why use numbers?
  - As a courtesy to users having only keypads or terminal adapters
  - People are used to dial numbers
  - the numbers can be mapped to E.164 numbers as partial numbers
- This would allow to define a numbering plan from scratch
- But:
  - to keep existing numbering plans if migrating from the PSTN
  - To be reachable from the PSTN
  - To be able to reach the PSTN
- a compatibility with the PSTN numbering plans is required

# Numbering and Dialing Plans

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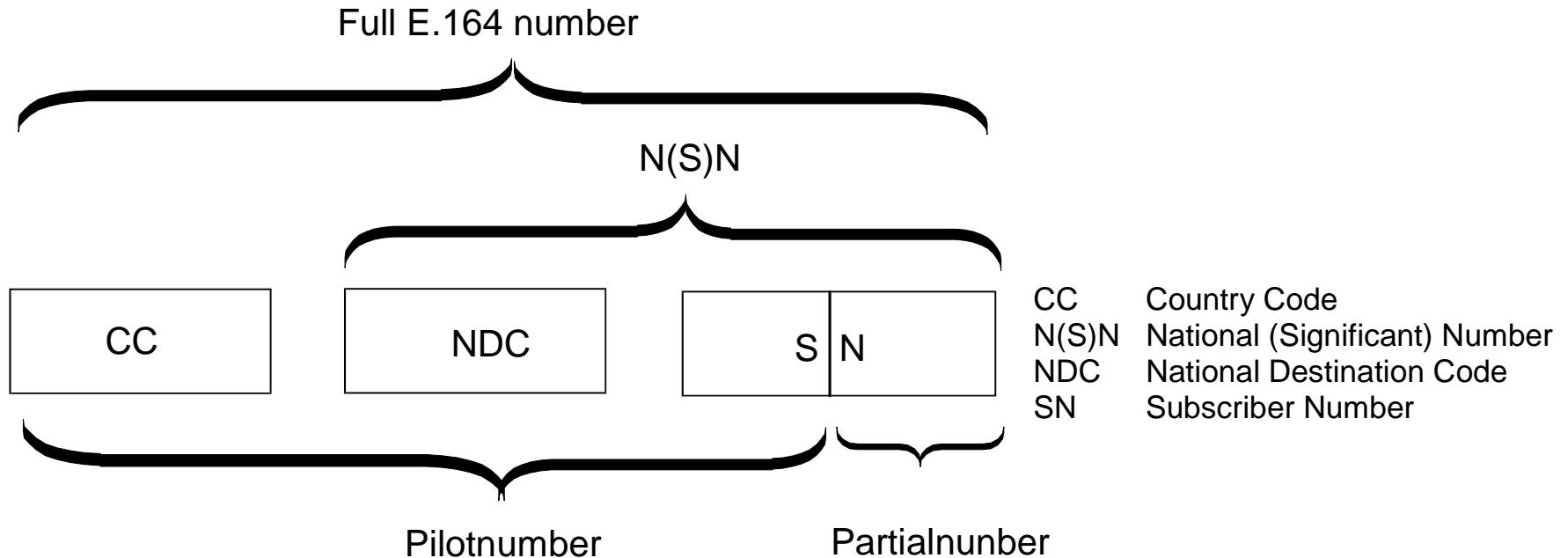
- What is the difference?
- Numbering Plan
  - is a name space defining the called endpoints
- Dialing Plan
  - defines the method by which a defined numbering plan is accessed by the calling user (by entering a dialing string)

# Numbering Plans

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- A numbering plan is an inverted tree
  - e.g. for +4317978032 the '+' is the root and each digit is a label
- Types of numbering plans:
  - The Public International Telecommunication Numbering Plan (E.164)
  - National numbering plans
  - Local or network specific numbering plans
  - Private numbering plans
- Each numbering plan has a structure
  - open numbering plan = variable length of digits
  - closed numbering plan = fixed length of digits
- Numbering plans can be mapped into each other

# Mapping of Numbering Plans



- Mapping of a private numbering plan as partial number to a local pilot number, both together are a subscriber number which is mapped to a national numbering plan, which is in turn mapped to the E.164 numbering plan

# Types of Numbers

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- International E.164 country codes (CC)
  - CC for Global Services – CC GSN – e.g. 800 for global freephone
  - CC for Networks – 882 IC SN – for global networks
  - CC for Groups of Countries – 388 3 for Europe
  - CC for geographic areas 1, 43, 49, 421 N(S)N
- National (significant) Numbers mapped to E.164
  - geographic numbers
  - non-geographic numbers for private networks
  - non-geographic numbers for networks (e.g. mobile numbers)
  - non-geographic numbers for personal services
  - non-geographic for services (tariff related) –free phone, premium rate, ..
- National non-E.164 numbers
  - Service numbers, emergency numbers, ...

# This grouping is not consistent

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- The grouping is not consistent and a national matter
  - geographic numbers are used for mobile terminals
  - geographic numbers are used for mobile VoIP
  - personal numbers are defined as service numbers, but could also count as mobile numbers
  - Mobile numbers could count as personal numbers
  - etc.
- Specific number ranges for VoIP?
  - some NRAs claim numbering is technology independent
  - but provide number ranges for mobile terminals
  - some provide special number ranges for VoIP (Japan)
  - non-geographic numbers for personal services



# Proposed new grouping

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- National pure geographic numbers
- National non-geographic numbers for private networks
- National non-geographic numbers for networks and personal numbers
  - or better: mobile personal services
- National non-geographic numbers for tariff related services
- International numbers for networks
- International numbers for personal services
- International numbers for tariff related services

# E.164 Numbers for VoIP only

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- VoIP is already used in carrier and also in local networks
  - Any number may terminate on VoIP now already because
    - Numbering IS technology independent
  - So anybody may set up an IP-based network
    - but these networks are not connected directly to the Internet
  - they use conventional Points-of-Interconnect (PoI)
- So what about VoIP on the Internet?
  - ENUM is currently a second line service
  - PSTN originating calls are routed on the PSTN to the primary line
- E.164 numbers for VoIP users on the Internet
  - may also be routed on the Internet with ENUM
  - but need proper routing on the PSTN to ENUM-enabled gateways

# What is the advantage?

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- What is the advantage of using the Internet vs. IP-based closed networks (the NGN approach)?
- Calls originating on the Internet stay on the Internet
  - this is now and especially in the future not so much a cost benefit
  - it is a Quality-of-Service benefit
  - NGNs need either to connect via the PSTN or define bilateral PoI or create a new international network
- Users may connect to the Internet anywhere, at any time, with any device
  - global, mobile, device independent personal services
- All other Internet applications are available
  - Multimedia services

# Which numbers to use for VoIP?

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- Pure geographic numbers
  - yes, but only from a defined location
  - for residential subscribers and "PBX" on one location
- Non-geographic numbers for private networks (enterprises)
  - yes, for "PBX" with more than one location within a country
- Non-geographic numbers for networks and personal numbers
  - yes, for all mobile VoIP subscribers
- Non-geographic numbers for tariff related services (not applicable)
- International numbers for networks
  - yes, for all "PBX" with more than one location in different countries
- International numbers for personal services
  - yes, for all mobile VoIP subscribers
- International Numbers for tariff related services (not applicable)

# Routing to these numbers on the PSTN

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- Pure geographic numbers
  - are always routed to the geographic area
- Non-geographic numbers for private networks
  - are always routed to the country
- Non-geographic numbers for networks and personal numbers
  - are by default routed to the country, but may be recognized in originating networks with (7) digit analysis.
- International numbers for networks
  - can be recognized in originating networks
- International numbers for personal services
  - can be recognized in originating networks
- Numbers for tariff related services are always translated first to one of the other numbers and then routed.

# Dialing Plans

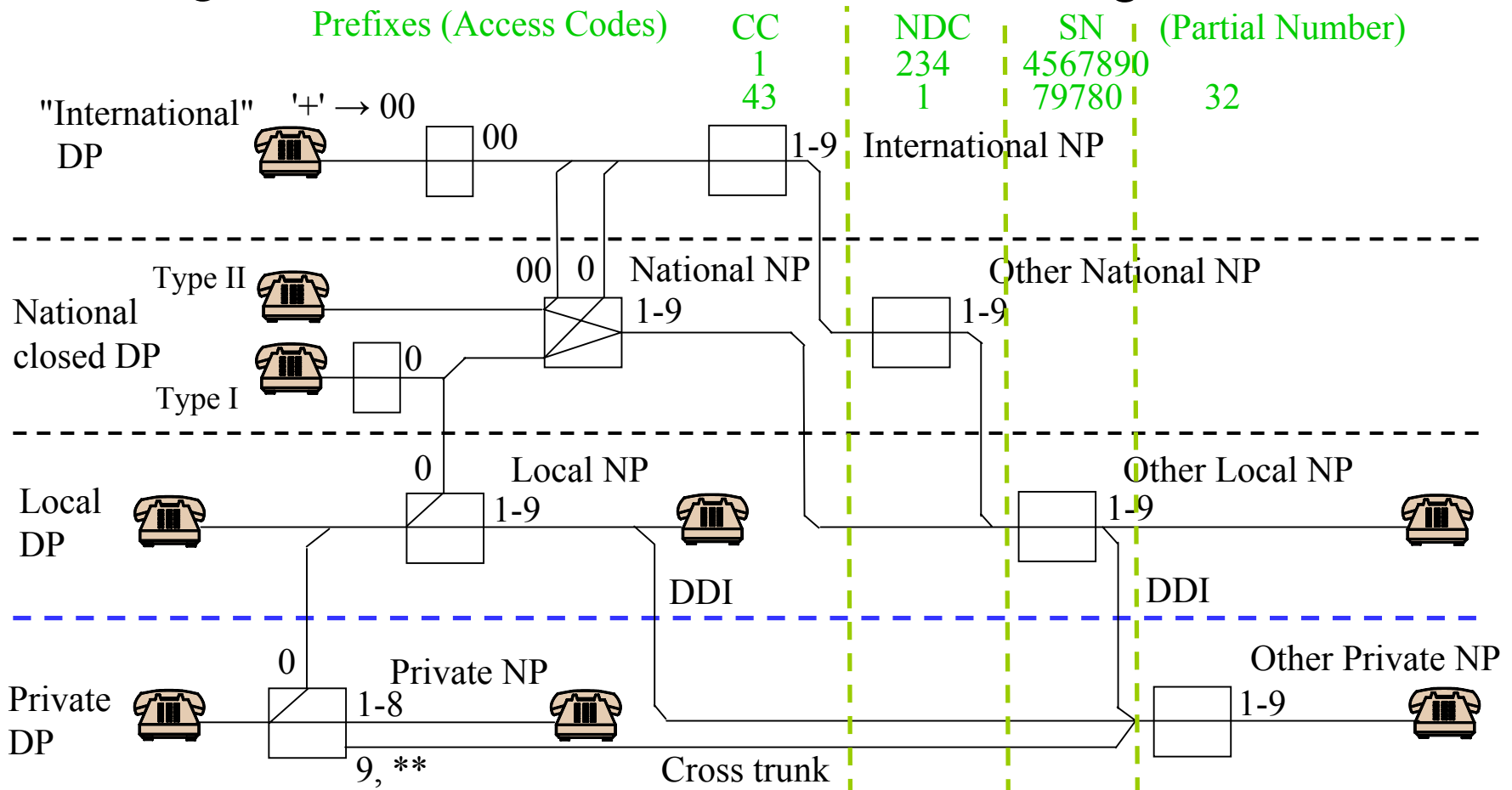
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- Numbering plans do not contain prefixes and suffixes
- A user is not entering simply a number in his device
  - he is entering a dialing string, depending on his local context
- Dialing Plans are normally set up in such a way
  - that numbers in the local context can be entered directly
  - and other numbering or dialing plans can be accessed via "prefixes"
  - Prefixes may also used for other purposes e.g. for carrier selection
- PSTN lines normally assume local (or private) context
  - prefix '0' or '9' is used to acces the local dialing plan
  - prefix '0' or '1' is used to access the national numbering or dialing plan
  - prefix '00' or '011' is used to access the international numbering plan
- Closed dialing plans:
  - Type I: the national prefix has to be dialed always (also for local calls)
  - Type II: national numbers are dialed without prefix directly
  - Mixed: in the NANP depending on NPA if you dial 1+10D, 10D and/or 7D

# Mapping of Dialing and Numbering Plans

## Dialing Plans DP

## Numbering Plans NP



Note: For simplicity access code '0' is assumed always

# Examples: same PBX

## Dialing Plans DP

## Numbering Plans NP

Prefixes (Access Codes)

CC

NDC

SN

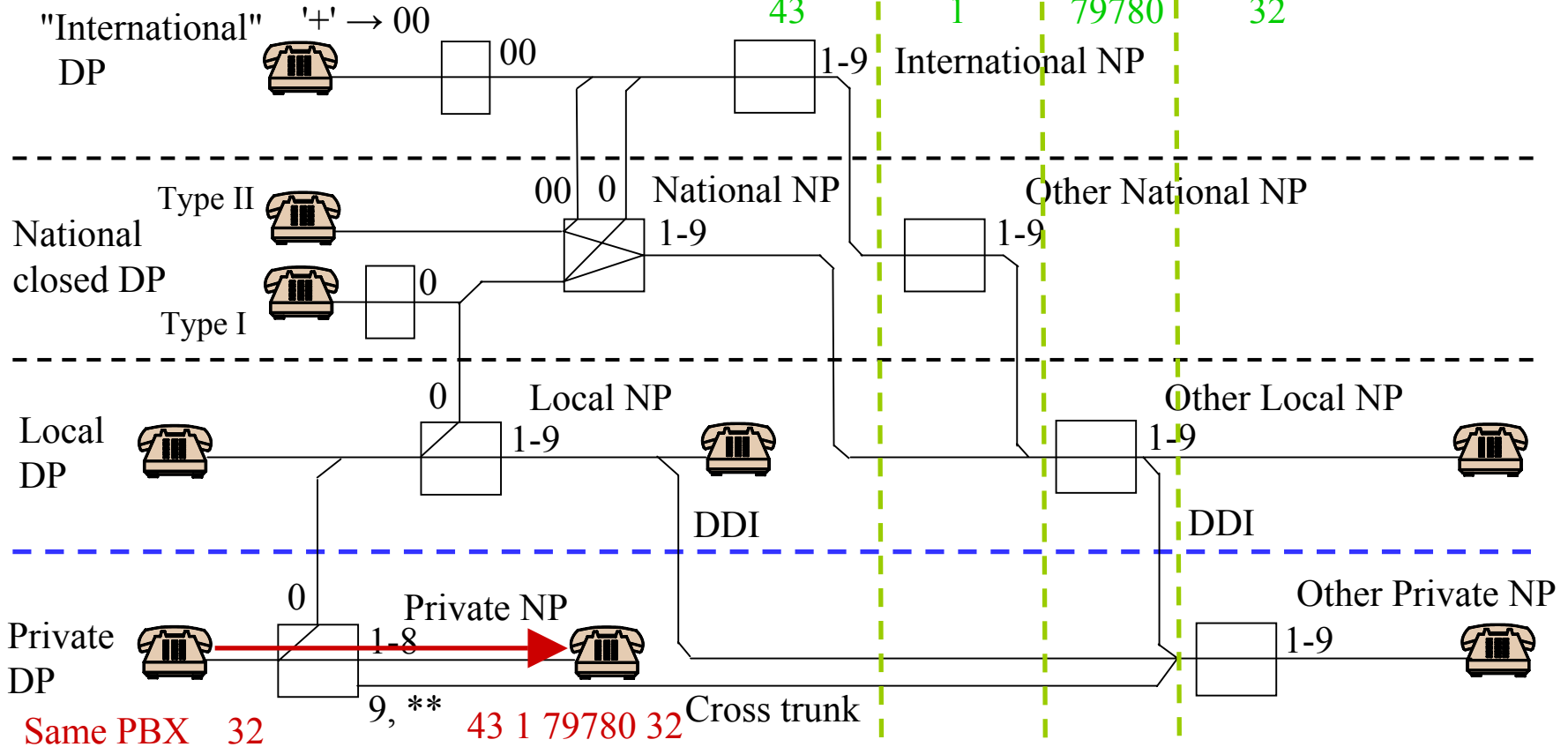
(Partial Number)

1  
43

234  
1

4567890  
79780

32  
32





# Examples: Cross Trunk

## Dialing Plans DP

## Numbering Plans NP

Prefixes (Access Codes)

CC

NDC

SN

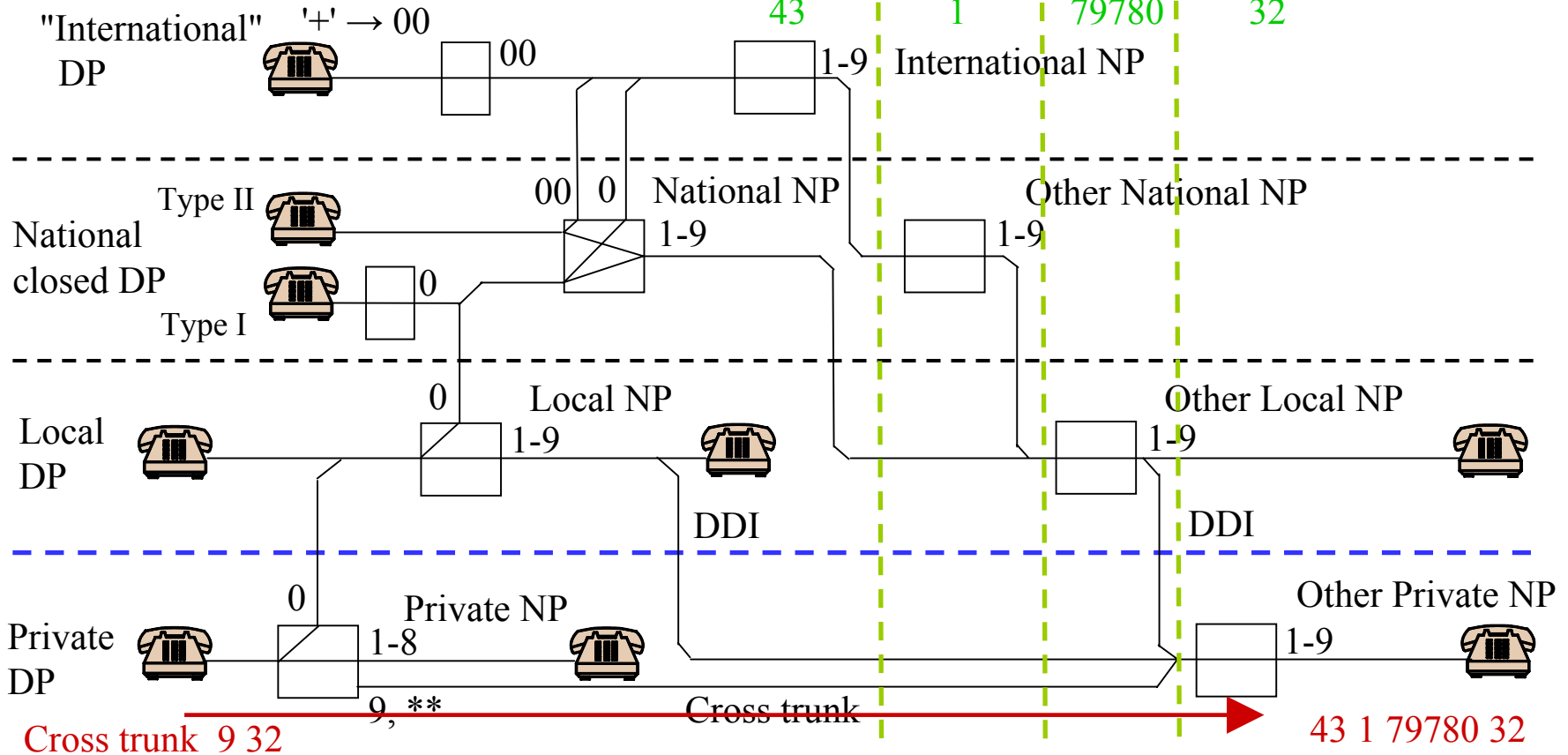
(Partial Number)

1  
43

234  
1

4567890  
79780

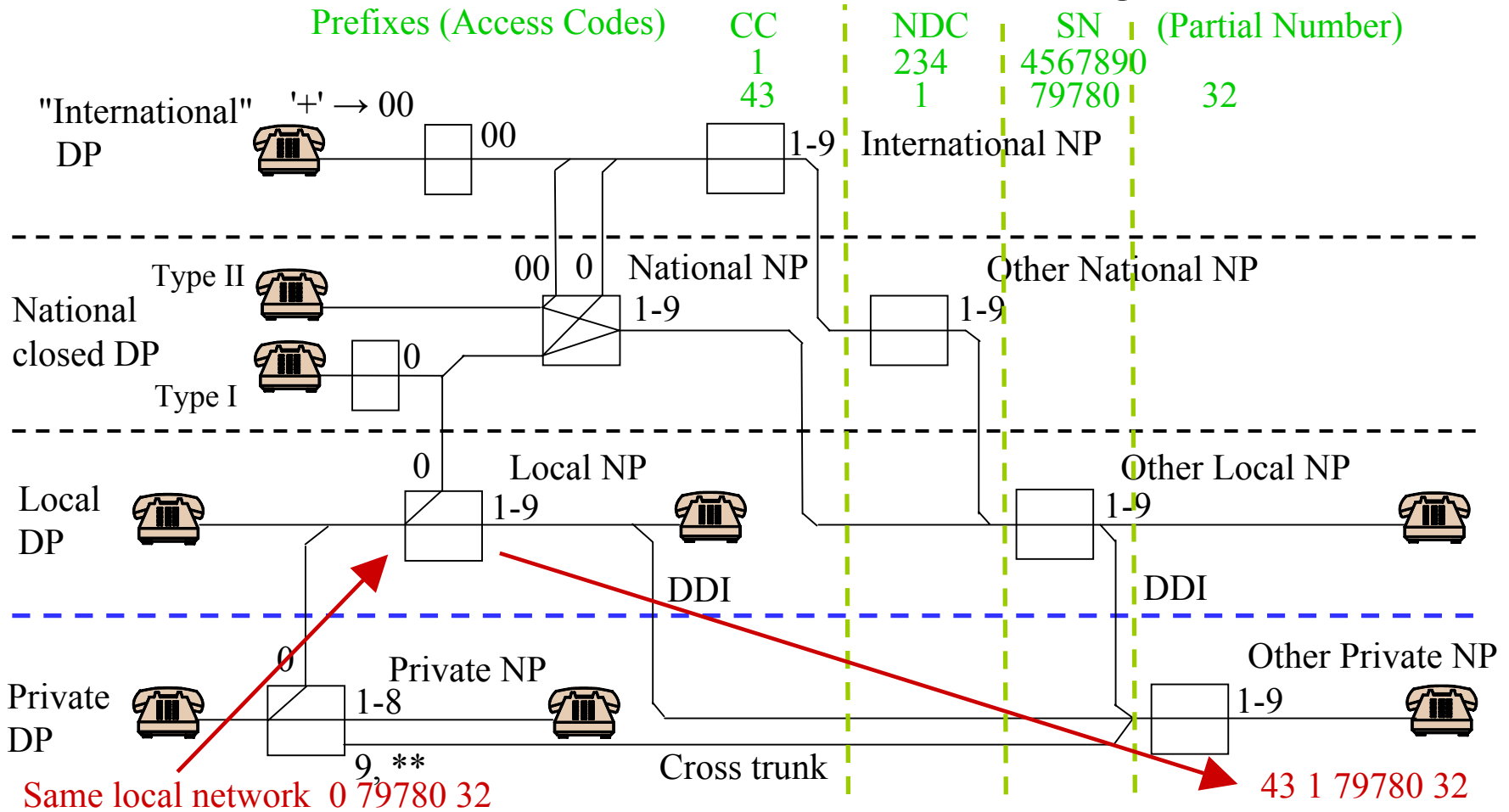
32



# Examples: Same local network

## Dialing Plans DP

## Numbering Plans NP



# Examples: same national network

## Dialing Plans DP

## Numbering Plans NP

Prefixes (Access Codes)

CC

NDC

SN

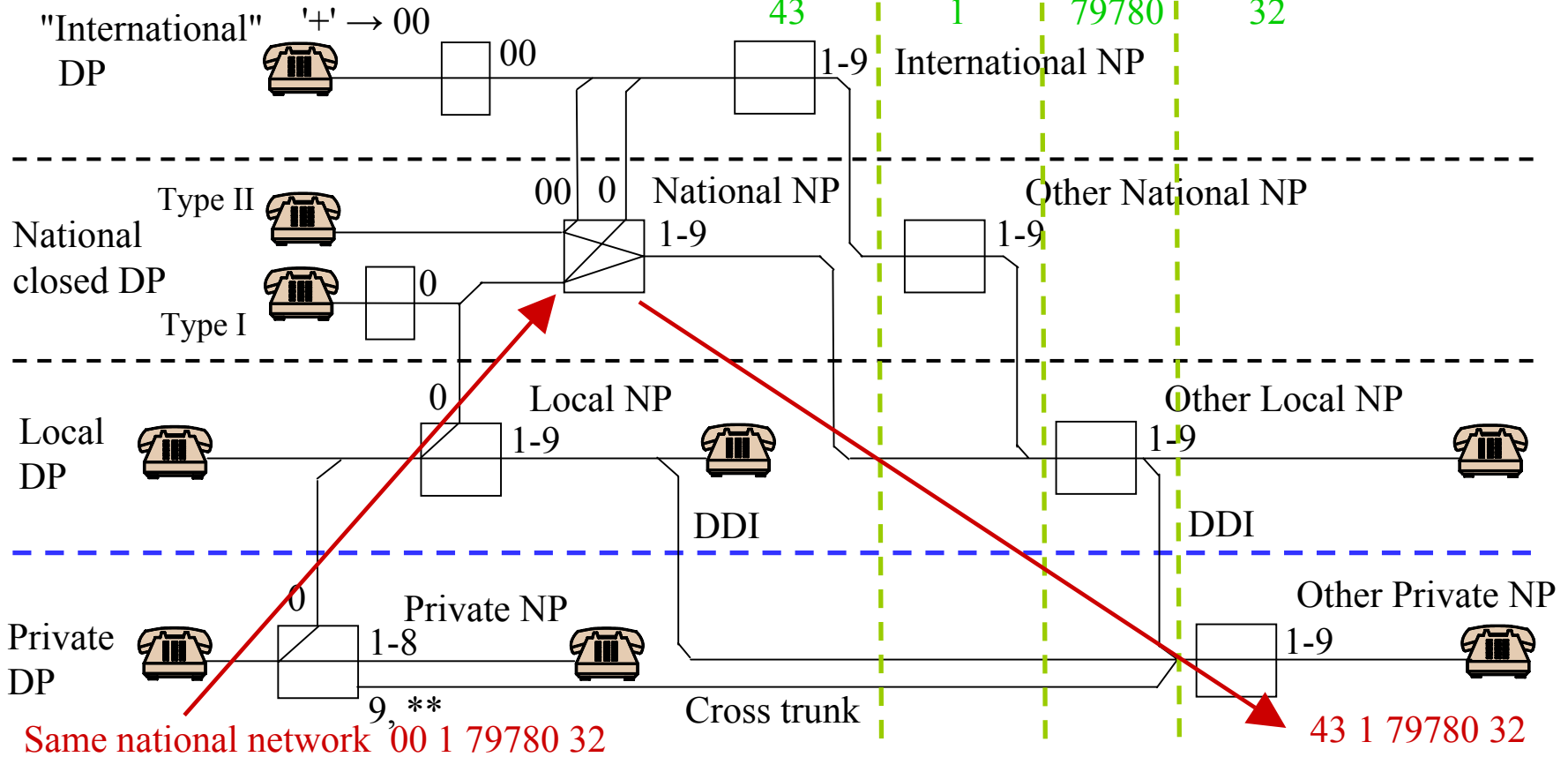
(Partial Number)

1  
43

234  
1

4567890  
79780

32



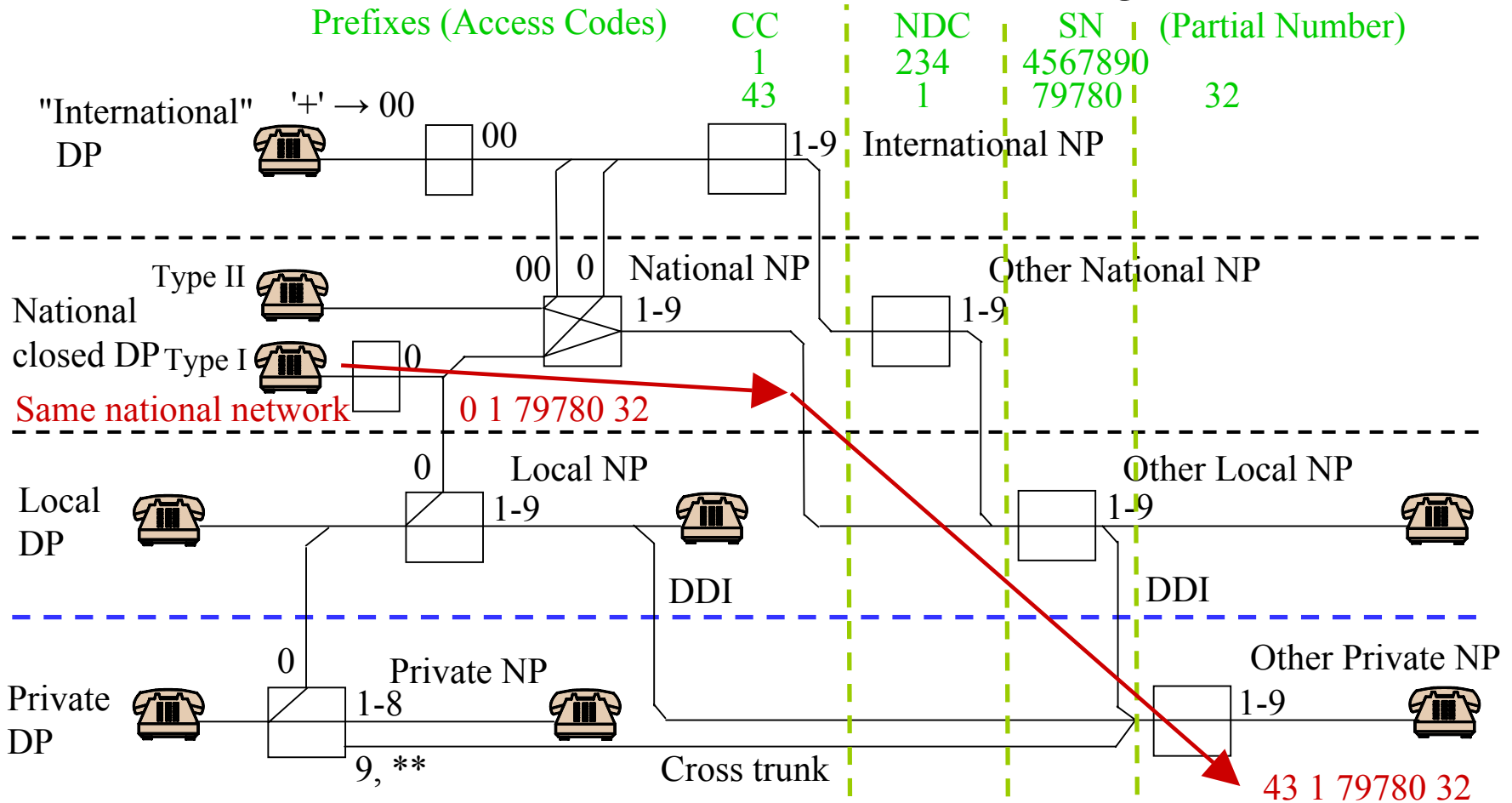




# Examples: same national network

## Dialing Plans DP

## Numbering Plans NP



# Examples: same national network

## Dialing Plans DP

## Numbering Plans NP

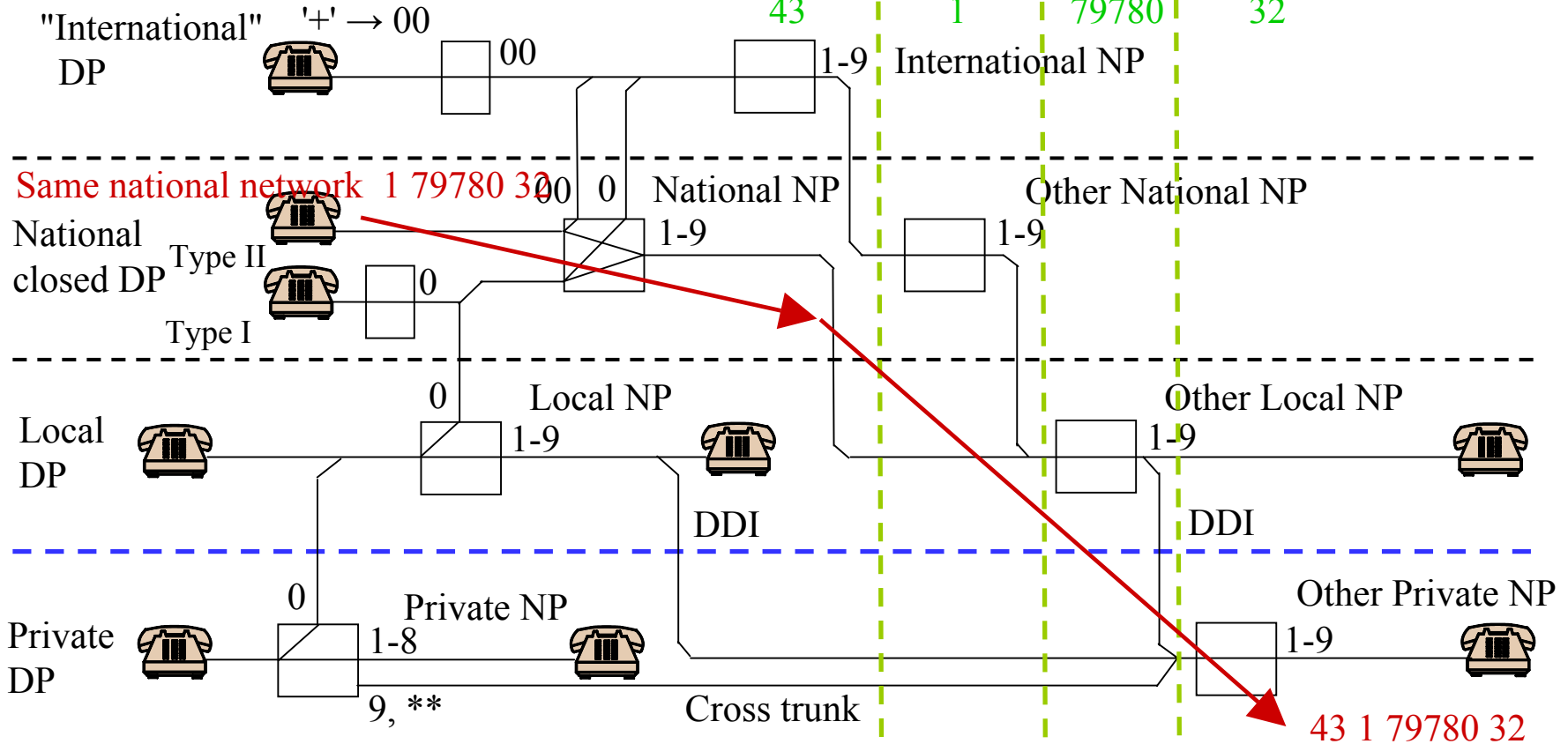
Prefixes (Access Codes)

CC  
1  
43

NDC  
234  
1

SN  
4567890  
79780

(Partial Number)  
32







# How to ...

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- ... create a numbering and dialing plan for an ITAD?
  - IP Telephony Administrative Domain
- Note: This is only valid if a numbering and dialing plan is created from scratch
  - If a network (public or private) is migrated to VoIP and the existing dialing plan has to be kept for regulatory (e.g. number portability) or customer convenience (PBX migration) there is no choice
- Basic requirements:
  - User shall be able to access other ITADs and the PSTN with E.164 numbers
  - Users of the ITAD shall be able to be accessed from other ITADs and from the PSTN with E.164 numbers

# How to proceed?

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1. Select the E.164 number range (pilot number) where the numbering plan should be mapped to as partial number
  - You should have an idea of the number of users expected especially if you are mapping to a closed numbering plan
  - You should also try to define a closed numbering plan with a fixed digit length (this is also recommended because of end-of-dial)
  - Some number ranges may not be available because you do not get a short enough number.
2. Set up the dialing plan
  - Define the access codes and service codes
  - this restricts the number ranges available for the numbering plan
3. Finally set up the numbering plan

# Select the E.164 number range

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- The following number ranges may be available
  - National Geographic numbers
  - Non-geographic numbers for private networks
  - Non-geographic numbers for (mobile or personal) networks
  - International numbers for networks
- The choice may depend on
  - availability of numbers (also in ENUM)
  - location or mix of subscribers
- The private numbering plan may also be mapped to more than one number range as partial number

# Set up the dialing plan (I)

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- For outside access, all dialing plans SHALL recognize:
  - a global number in the format '+4317978032'
  - the international access code either in the format '00' or '011'. ITADs with global access only SHALL recognize both formats  
**Note: this is not valid for private dialing plans with local access**
- all dialing plans MAY recognize:
  - For customer convenience, the '\*' as replacement for '+'
  - '\*\*' for the selection of cross trunks in the format '\*\*yyyxxxxx' where yyy ist the access to another numbering plan and xxxxx is a number of the local numbering plan
  - If it is planned to use '\*' for access to supplementary services, a digit MAY be used for selection of cross trunks. In this case the digit '9' is recommended.

# Set up the dialing plan (II)

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- Now select one of the 4 available contexts:
  1. only global access
    - recommended for ITADs with international numbering ranges and for subscribers from various nationalities
    - all previous requirements apply
    - network specific numbers may be introduced in number ranges '1' and '9'
  2. national access
    - recommended for ITADs with national non-geographic number ranges
    - the international and national access code should be the one used in the national environment (e.g. '00' OR '011', '0' OR '1')
    - the network administrator may select a type I or II dialing plan
    - network specific numbers are dependent on the type used
  3. in local dialing plan (use as is)
  4. private dialing plan with local access
    - recommended for ITADs with national geographic number ranges
    - access to only ONE specific local dialing plan either with '0' or '9'
    - the further prefixes depend on the local dialing plan

# Set up the numbering plan

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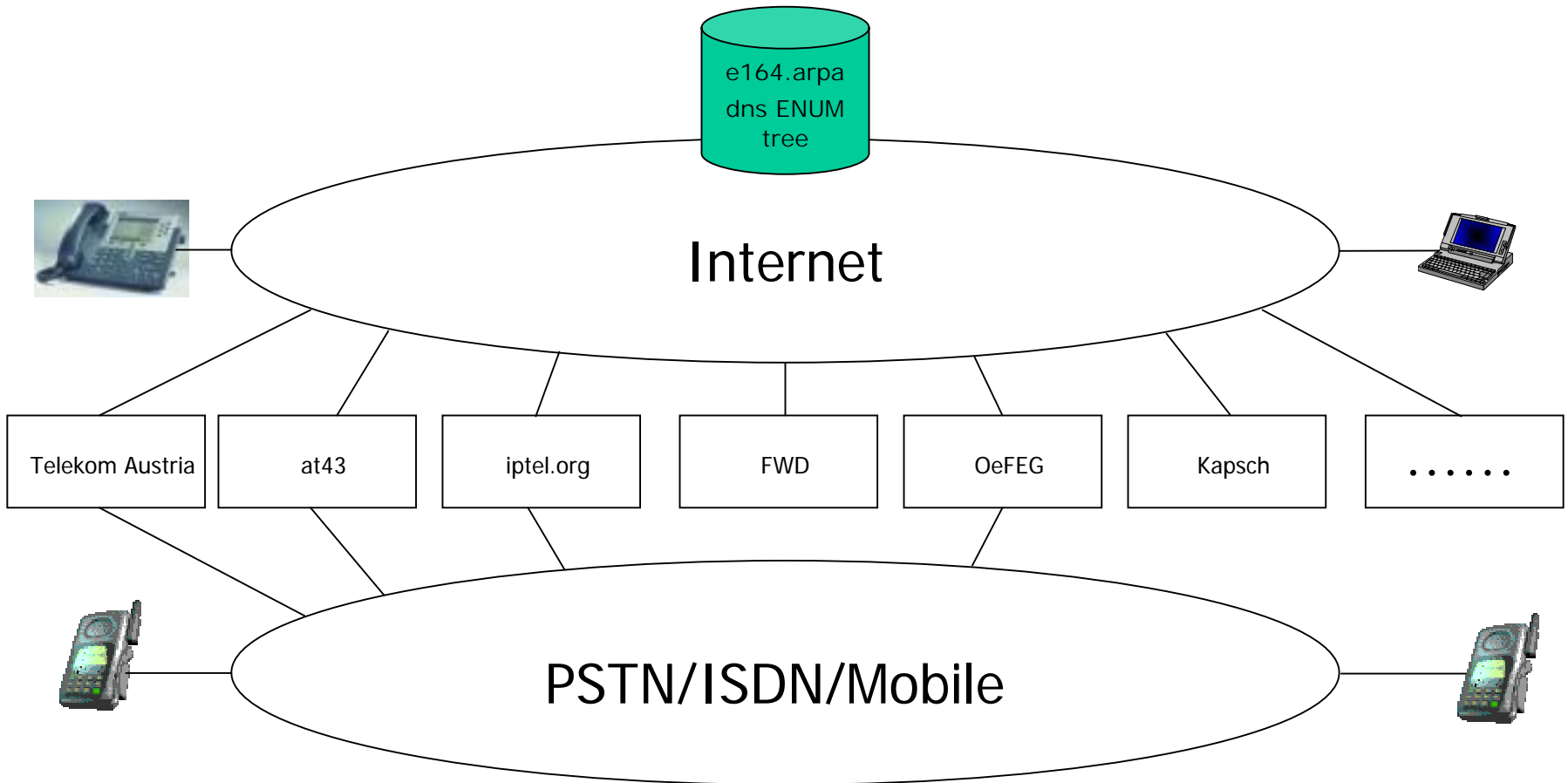
- Define the number of digits  $N$  of the local number
  - This has already be done in step one if a number range from a closed numbering plan has been selected
  - If mapped to a open numbering plan, also a fixed length is recommended
  - The maximum length of pilot and partial number SHALL never exceed 15 digits.
- Now select the number ranges available for subscriber numbers
  - No private number SHALL start with '0'
  - it is recommended to leave number range '1' and '9' for services, network specific numbers, cross trunks and future extensions
  - it is therefore recommended to use number ranges '2' to '8' for private numbers, so private numbers should start with 2xxxx

# A simple alternative ...

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- ... to all this hassle with dialing and numbering plans
  1. Define a dialing plan you want to use
  2. Program this dialing plan into your UAC to convert any number dialed into an E.164 Number in the international format
    - Example: Local Vienna Dialing Plan
    - any number starting with XNNN is converted to +431XNNN (where X is 1-9)
    - any number starting with 0XNNN is converted to +43XNNN
    - any number starting with 00NNN is converted to +NNN
  3. Go query ENUM for this E.164 Number
    - If an ENUM entry exists (e.g. a sip: URI) forward it to your UAS
    - IF no ENUM entry exists forward the number as tel:+NNNN
- Advantage:
  - Users may decide on their own which dialing plan to use
  - Popular dialing plans may be preloaded
  - User may switch dialing plans and service providers at their discretion

# VoIP and ENUM





# The End

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**Thank you for  
your attention**