# ENUM & DNS Roles in Modern Telecommunications Networks

*A NETNUMBER WHITE PAPER*

NetNumber

The importance of the Electronic Number Mapping (ENUM) function is increasing in signaling core networks while they are modernizing, and it goes beyond the traditional IMS core function for which it was initially conceived. This whitepaper explains why ENUM routing and flexibility is becoming more and more important and why it is critical in helping Service Providers to transition to a full IP-based network.

## ENUM and DNS Technology Brief

When Service Providers are offering IP telephony services to their subscribers, it's transparent to the caller and accessible using traditional telephone numbers (E.164 numbers). While traditional telephony networks (SS7/C7 in particular) have been designed for reaching destinations using E.164 telephone numbers, IP networks have been designed using IP v4 or IP v6 as destination addresses. Therefore, ENUM was created in order to allow routing of IP-based services towards telephone numbers in modern networks.

The ENUM Registry provides a mapping of IP routable information, and a list of services/ platforms against telephone numbers. This information is provided in the form of a Uniform Request Information (URI). The URI is not directly routable in the IP network and will require additional resolutions that are provided by the Domain Name Service (DNS). DNS allows the translation of the URI into a server name, that is providing services to the user. The server name is then translated into routable IP v4 or IP v6 addresses by a new DNS query. This is depicted in Figure 1.

As a summary, ENUM allows the conversion of an E.164 number into URI. The DNS allows the conversion of a URI into server names and then into IP addresses.

## ENUM and Interconnect

The success of telephony and in particular of mobile services was mainly due to its global reach. By just knowing the phone number of a destination, anyone was able to communicate remotely and at distance. This was possible and independent of underlying technology (fixed/mobile/VoLTE/NGN), of the country of origin, and of the provider serving the destination.

Example for routing tel URI 33672130541 to its serving network:

1. **ENUM** query 1.4.5.0.3.1.2.7.6.3.3.e164enum.net
   - Provides the SIP URI to use in the form of "E2U+sip"
     "!^.*$!sip:+33672130541@ims.mnc001.mcc208.3gppnetwork.org!"
2. **NAPTR** query in order to retrieve the transport protocols supported by the destination network for the sip service:
   - Provides _sip._ucp.ims.mnc001.mcc208.3gppnetwork.org
     _sip._tcp.ims.mnc001.mcc208.3gppnetwork.org
3. **SRV** query in order to retrieve the server hostnames and ports associated to SIP service on tcp.
   - Provides 5060 ibcf1.ims.mnc001.mcc208.3gppnetwork.org
     5070 ibcf2.ims.mnc001.mcc208.3gppnetwork.org
4. **SRV** query in order to retrieve the server hostnames and ports associated to SIP service on udp.
   - Provides 5050 ibcf1.ims.mnc001.mcc208.3gppnetwork.org
5. **A or AAA** query in order to retrieve the IPv4 address for ibcf1.ims.mnc001.mcc208.3gppnetwork.org
   - Provides A record 10.35.56.2

*Figure 1. Using ENUM and DNS in IMS Network*

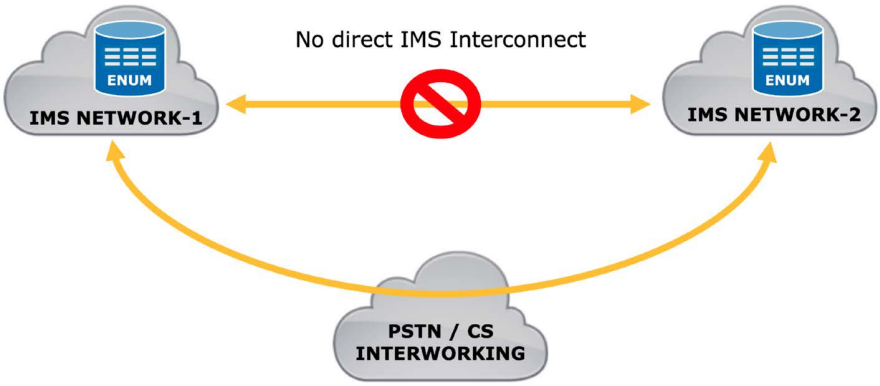


*Figure 2. Circuit-switched Break-out for IMS Interworking*

With the introduction of IMS networks, and in order to maintain the levels of telephony service ubiquity, it was decided to perform interconnect using circuit-switched (CS) based networks, therefore breaking-out into the CS domain.

Whilst the number of interconnects (roaming, IMS and VoIP) are increasing, with services expanding beyond voice - such as in Rich Communications Services (RCS), and while IP costs are decreasing, this strategy must continue to evolve. As far as possible, Service Providers should now try to avoid breaking-out to the CS domain.

ENUM is a key component in this strategy since it allows service providers to know when calls/ sessions can be routed directly between IMS networks. Considering interconnects, breaking out to the CS domain between two VoLTE networks is introducing excessive transcoding, voice quality degradation, latency and unnecessary CS network resource usage. In addition, when breaking-out into the CS domain, it's worth bearing in mind that end-to-end service features such as on-line presence, will no longer be available.

For direct interconnect between IMS networks, the GSMA is providing guidelines in Official Document NG.105 - ENUM Guidelines for Service Providers and IPX Providers. Those guidelines are introducing the concept of a hierarchical ENUM architecture with zone delegation and iterative queries. In this model, as displayed in Figure 3, the ENUM Tier 1 is delegating top-level domains to ENUM Tier 2. It can also be extended with zone forwarding and recursive queries.

With such model, and if authorized by national regulation rules, it is now possible to directly interconnect and to directly route calls/sessions between IP IMS networks.

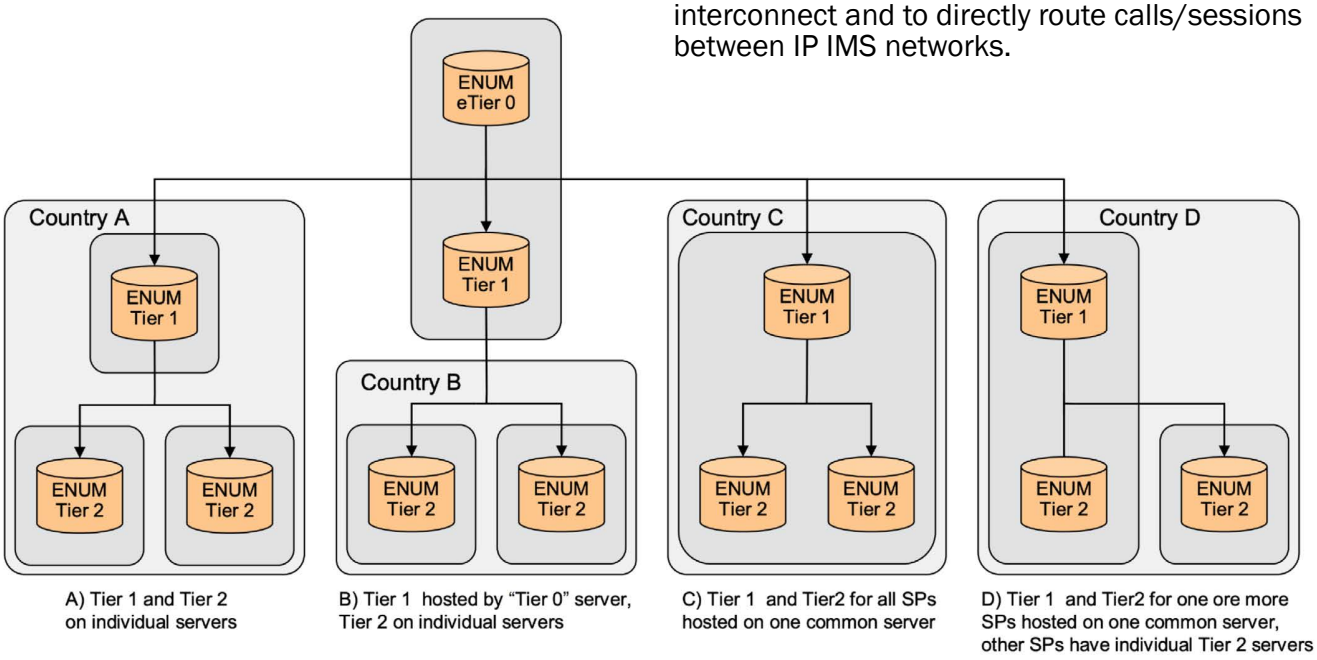


*Figure 3. GSMA NG105: Logical architecture for Carrier ENUM on the IPX*

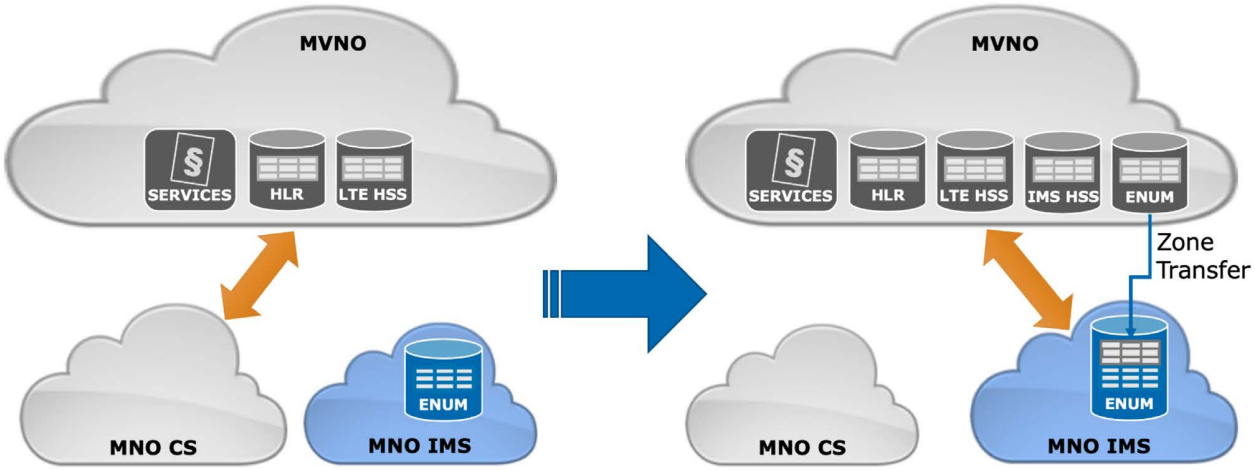


*Figure 4. MVNO Hosting*

## ENUM and MVNO Hosting

While the Mobile Network Operator (MNO) network is evolving to IMS, operators are looking to move hosted MVNOs towards those services. For this, the hosting MNO may simply require the full MVNOs (Mobile Virtual Network Operators) to upgrade their HLR into IMS HSS/LTE HSS and to provide direct interconnect using ENUM. ENUM will be used by the hosting MNO in order to know how to route calls/ sessions to the MVNO subscribers using the IMS network as highlighted in Figure 4.

For this, ENUM is offering useful zone transfer mechanisms with AXFR (RFC1995) and IXFR (RFC5936). It would allow the hosting MNO to use information populated by their MVNOs on their own ENUM registries, which are synchronized but isolated from the MNO ENUM. The zone transfer import mechanisms provide the following benefits to the MNO:

- The MVNOs do not have to provision in the MNO ENUM (security).
- The MVNOs do not have access to the MNO ENUM (privacy).
- The MNO ENUM can be configured with zone transfer, with multiple MVNOs.

## ENUM and Number Portability

For many years, almost all countries worldwide have implemented number portability for fixed and mobile networks. This introduces a new level of complexity in routing voice services to the destination, because with number portability, the service provider of the destination may no longer be the one that was initially allocated the number ranges.

In order to provide a number portability service, fixed and mobile networks have introduced databases that contain number portability information in the form of E.164 numbers and a corresponding service provider routing ID. For historical reasons, this information is very often provided using different technology for fixed and for mobile networks. Even worse, within the same mobile network, this information is very often delivered differently between voice, messaging and value-added services.

In modern and future networks, ENUM routing must also consider number portability correction. Using an ENUM query for portability is providing much more flexibility at a fraction of the cost of the TCAP based query (CAMEL, INAP or MAP). Instead of performing a portability query for finding the destination service provider, and then an ENUM query in order to find the IP domain and server

name within this service provider, it would be much more efficient to perform a single query using ENUM, and then let the ENUM routing engine retrieve the number portability information based on the available technologies.

As indicated, the available technologies for retrieving Number Portability Information are numerous and depend on the destination network and type of interconnect.

For example, number portability information can be retrieved using the following type of queries:

- MAP AnyTimeInterrogation
- MAP SendRoutingInformation
- MAP SendRoutingInformationForShortMessage
- MAP SendIMSI
- INAP InitialDP
- Camel InitialDP
- SIP INVITE
- ENUM
- Diameter SRR/SRA S6c
- Diameter UDR/UDA Sh
- HTTP Rest
- ...

The diagram in Figure 5. is depicting an ENUM solution providing Number Portability correction using 4 different types of queries.

It illustrates how a flexible and advanced ENUM with an NP correction routing engine, will allow the NP complexity to remain hidden from the interrogating network, and will allow smooth evolution of the number portability databases to newer and more modern technologies, transparently from the interrogating network.

## ENUM and Network Evolution

Telephony Networks have been in constant change and evolution since being deployed, more recently experiencing an acceleration in the speed at which

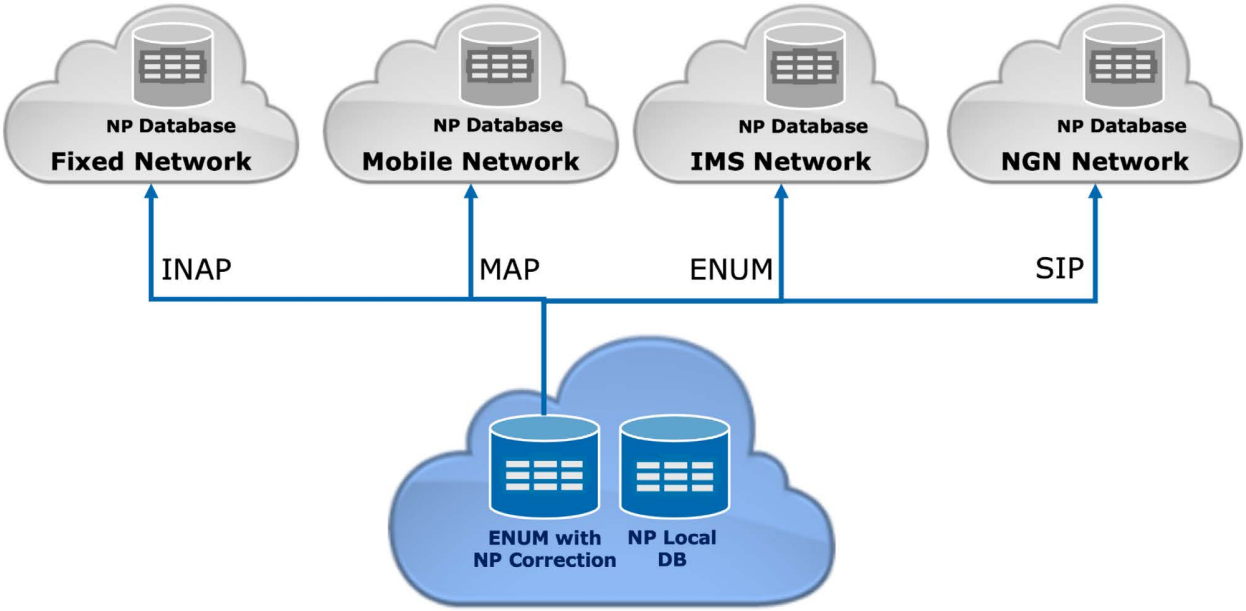


*Figure 5. ENUM and Number Portability*

they must evolve. As an illustration, 5G is being introduced while LTE (wrongly named "Long Term Evolution") is not yet fully deployed, not reached its full potential and is not yet reaching the radio coverage of older 2G and 3G networks.

While operators are transforming themselves to offer 5G services, their existing networks must evolve in order to provide:

- Network simplification and harmonization.
- Database reduction (consolidating ENUM databases and the NP databases from different domains).
- R4 shutdown.
- Operational and engineering cost reduction.

By allowing network selection and routing, ENUM serves as a key component allowing support for such an evolution.

As indicated previously, ENUM is only the first query allowing resolution of an E.164 number into a URI, that must be translated into IP addresses using subsequent DNS queries. DNS is also used in order to avoid having to statically configure the IP addresses of destinations. This allows a network to dynamically scale, and to be instantiated on-the-fly, supporting upcoming 5G slicing technology. DNS will also be heavily used by new 5G networks where all the network functions are addressed by using the 'fully qualified domain name' that needs to be resolved.

## Conclusion

NetNumber is a leader in multi-protocol software development, research, integration, and security with 20 years of expertise in delivering high-performance, high-volume solutions to network operators around the world.

As mentioned in this white paper, the role of ENUM/DNS function is extending and is getting more and more important. It's critical for Service Providers to deploy a very flexible solution that goes beyond the IMS use cases, such as the one proposed by NetNumber - displayed in Figure 6.

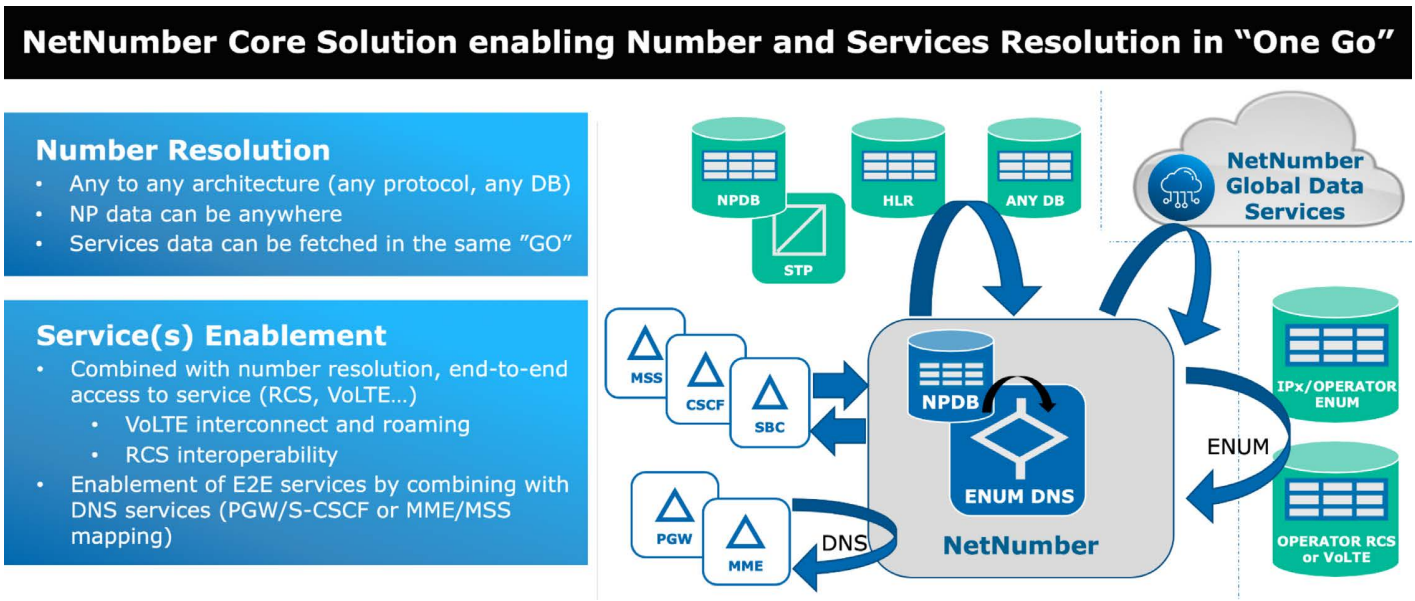


*Figure 6. NetNumber Number Resolution and E2E Services*

The NetNumber ENUM/DNS/NP solution not only addresses the IMS use cases, it additionally provides the following features:

- ENUM query resolution
- DNS query resolution with glue inclusion
- Zone delegation, zone chaining, zone splitting, zone forwarding and zone transfer
- Configurable zone matching algorithm
- Iterative and recursive queries
- NP retrieval using MAP SRI, ATI, INAP/CAMEL IDP, SIP, ENUM
- Large databases
- Combined with NetNumber Global Number Portability solution
- Flexible telephone number translations and routing number translations
- Flexible southbound queries using SS7 (SCCP and any TCAP based variants), SIP or ENUM

# About NetNumber

*NetNumber, Inc. brings almost two decades of experience delivering platforms that power global telecom and enterprise networks. Our software-based signaling-control solutions accelerate delivery of new services like Private LTE and IoT/M2M solutions across multi-generation networks, dramatically simplifying the core and reducing opex. These solutions span a range of network types from 2G-3G-4G-5G to future G delivered on the industry's first InterGENerational signaling platform - TITAN. NetNumber Data Services are essential for global inter-carrier routing, roaming, voice and messaging. The data powers fraud detection and prevention solutions and enables enterprise B2B and B2C communications platforms. NetNumber's award-winning multi-protocol signaling firewall, fraud-detection, and robocalling solutions secure networks against current/emerging threats.*

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