INTERNATIONAL INTERCONNECTION FORUM

FOR SERVICES OVER IP

(i3 FORUM)

(www.i3forum.org)

Workstream "Services Aspects"

Global SPID Whitepaper

(Release 1.0) May 2011

Table of Contents

1 Introduction

This document discusses the reasons for the introduction of a Global Service Provider Identifier (SPID) for use in routing between service providers, carriers and other telecommunications entities. It then goes on to discuss the i3 Forum recommendations for what the identifier should look like as well as the policies that should be associated with the assignment of the identifier. Finally it reviews the currently available identifier schemes and evaluates them against the Global SPID recommendations.

2 Acronyms

AS	Autonomous System
BGP	Border Gateway Protocol
DB	Database
DN	Dialed Number
DNS	Domain Name System
ENUM	E.164 Number Mapping
FTP	File Transfer Protocol
GSM	Global System for Mobile Communications
GSMA	GSM Association
HD	High Definition
HTTP	Hypertext Transfer Protocol
IANA	Internet Assigned Numbers Authority
ICANN	Internet Corporation for Assigned Names and Numbers
IEEE	Institute of Electrical and Electronic Engineers
INAP	Intelligent Network Application Part
IPv4	Internet Protocol Version 4
IPv6	Internet Protocol Version 6
IPX	IP Exchange
IMSI	Internation Mobile Subscriber Identity
ITSP	Internet Telephony Service Provider
ITU	International Telecommunications Union
ITU-T	ITU Telecommunication Standardization Sector
LCR	Least Cost Routing
LNP	Local Number Portability
MAC	Media Access Control
MAP	Mobile Application Part
MCC	Mobile Country Code
MNC	Mobile Network Code
MNP	Mobile Number Portability
MVNO	Mobile Virtual Network Operator
NANP	North American Numbering Plan
NPAC	Number Portability Administration Center
OID	Object Identifier
PEN	Private Enterprise Numbers
RN	Routing Number
SG2	Study Group 2
SIP	Session Initiation Protocol
SNMP	Simple Network Management Protocol
SPID	Service Provider Identification
SPN	Service Provider Number
SRV	Service Record
SS7	Signaling System 7
URI	Uniform Resource Identifiers
VoIP	Voice over IP

3 References

[1] I3 Services Work Stream – Routing and Addressing Services for International Interconnections over IP (v 1.0) June 2010

[2] IETF RFC 5526 The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application for Infrastructure ENUM - April 2009

[3] IETF RFC 6116 The E.164 to Uniform Resource Identifiers (URI) Dynamic Delegation Discovery System (DDDS) Application (ENUM) – March 2011.

[4] IETF RFC 5067 Infrastructure ENUM Requirements – November 2007.

[5] GSMA PRD IR.67 - DNS/ENUM Guidelines for Service Providers & GRX/IPX Providers – August 2010

[6] ITU-T E.212 The international identification plan for public networks and subscription – May 2008

[7] ITU-T M.1400 Designations For Interconnections Among Network Operators – November 2002

[8] IETF RFC 1157 A Simple Network Management Protocol (SNMP) – May 1990

[9] IETF RFC 1213 Management Information Base for Network Management of TCP/IP-based internets: MIB-II – March 1991

4 Arguments for Global SPID

The following section looks at arguments for the creation of a Global SPID identifier and discusses its potential use solving different problems within current and future routing and addressing models. The need for a Global SPID was also discussed in the i3 Forum Services WS Whitepaper “Routing and Addressing services for International Interconnections over IP (V 1) May 2010” [1].

4.1 Problems with direct URI routing

The original conception of ENUM [3] was that it was designed to map directly from an E.164 number to a Uniform Resource Identifier (URI). The URI would then contain a domain name that would then be used to find the IP address of the Border Function belonging to the network responsible for the subscriber associated with the E.164 number or even the end user equipment directly.

This direct resolution approach was necessary to support the User or Public ENUM model that was proposed during the conception of the ENUM protocol. In this model end user equipment would resolve E.164 numbers, using hierarchical ENUM DNS queries, to a distant end IP address; calls would then flow directly from the originating end user equipment to the terminating end user equipment without intervening infrastructure other than routers. This model entailed the Public Internet and unrestricted access from each piece of end user equipment to all other end user equipment within the User ENUM model.

The direct URI return type for an ENUM query was also used in the original conception of Carrier or Infrastructure ENUM [2] [4]. In this model service providers would create entries in an ENUM database for their subscribers. Routing would again occur by querying an ENUM database to return a URI which would then be resolved to the IP of the destination carrier Border Functions system via ENUM DNS records. Similarly this model depends on the idea that carrier routing systems would have unrestricted access to each other across a layer that presents no intervening infrastructure other than routers. In most deployment scenarios the transport infrastructure would be the Public Internet.

The critical element in making use of a direct URI, and therefore IP addresses, is the use of an unrestricted IP forwarding layer between the systems owned by interconnecting carriers. The most unrestricted IP forwarding layer is typically the Public Internet, but may also be a separate shared private forwarding layer between operators. The problem with this conception is that it does not necessarily match the layout of service provider networks, security concerns or business requirements. However the discussion below should not be construed as advocating for the abandonment of direct URI return in ENUM queries, but to advocate the addition of a Global SPID identifier in query response.

The most obvious difficulty is that interconnects between networks over the Public Internet are usually secured by firewall and filtering schemes and are not open to connection from unknown IP addresses; the Border Functions system behind the firewall and filtering only being open to connections from IP addresses that are associated with a pre-existing business relationship between the terminating network and an originating network. This means that an originating provider who performs an ENUM query and resolves a direct URI/IP address may not have IP reachability to the IP address of the terminating provider or a business agreement with the terminating provider. A similar lack of IP reachability may arise in cases where the terminating provider is only available via a direct private interconnect that the originating provider does not have, the terminating provider is connected to an IPX which is operating in transit or hubbing mode or the originating provider and terminating provider may be connected to separate peering federations that do not interconnect. In these cases where IP reachability does not exist, calls to E.164 numbers that are associated with the unreachable terminating party may be required to be sent to a different IP address other than that resolved in the query. This may be the IP address of a ‘transit’ provider who has a business relationship with the terminating provider and therefore IP reachability or the address of the IPX operating in transit or hubbing mode. Converting from one IP address to another, or using specialized DNS views to return the correct IP i.e. split horizon DNS, adds an extra layer of complexity to configuration and network operation.

A related difficulty is that the point at which a routing query is performed within the service provider network is not necessarily the egress Border Functions. In the normal case of a Border Functions system if an IP address is returned the Border Functions would have to have IP reachability to directly forward the call and may be expected to for a particular set of IP addresses. However if a system at a mid point in the network completes a routing query and receives back a URI and resolves that to an IP address, or receives the IP address directly, it may not have IP reachability to the resolved IP address to successfully terminate the call. This might be due to the structure and configuration of the service provider internal IP routing architecture and it may be very common in the case if the call has to reach Border Functions operated by an external party. Again IP address conversion, or split horizon DNS, at a particular point may be required.

Further, the direct URI model is not easily integrated into the Least Cost Routing (LCR) used by most service providers and carriers. The direct URI model assumes that carriers will be able to reach the terminating service provider directly and assumes that this is most desirable path. Of course this may not be the case based on the costs, products and business relationships of the originating service provider. For a more detailed discussion on business requirements please see the i3 Forum Services WS Whitepaper “Routing and Addressing services for International Interconnections over IP (V 1) May 2010” [1].

Finally, the resolution of E.164 numbers directly to a URI and then appropriate IP addresses is not actually necessary in the structure of most carrier networks. Business relationships and interconnects associated with them are well defined entities that go through processes involving interconnect configuration, interconnect testing and billing and settlement. The IP addresses associated with interconnects are usually defined at configuration time. They do not require in most cases to be dynamically discovered at resolution time. Though the dynamic discovery of IP addresses may in some cases be useful for load balancing and network management, both these activities typically require co-ordination between the originating and terminating networks and can be achieved through other platform specific mechanisms such as percentage routing.

It follows from these problems that direct URI scheme is not always appropriate for service providers and carriers. What is really needed is an additional label for traffic routing in the service provider network which can be processed by LCR systems to correctly identify the appropriate interconnect to use for forwarding a particular call. The Global SPID is intended to be this identifier.

4.2 Number Portability Implementations

Number portability has been launched in over 40 countries for either fixed or mobile numbers, usually described as Local Number Portability (LNP) and Mobile Number Portability (MNP) respectively. Usually the trigger for the introduction of number portability in a particular country is the decision of the country’s national regulator to mandate number portability to be available for end subscribers. Once the regulator has mandated number portability the regulator and national service providers then decide on the mechanism for provision of number portability.

There are several different architectures and models that are commonly chosen: there are schemes which do not have a centralized number portability database, for example in the UK, and there are those that have a central database. Within those that provide a central database, update periods, database structure and procedures all may differ. More importantly for the purposes of this discussion, the identifiers chosen by the number portability database for use in routing are also completely different from database to database. Some databases, such as the US and Canadian NPAC, use a provider ID for identification as well as a routing number (RN) which identifies not the carrier but the switch the terminating service provider uses to serve that customer. Other databases do not include a routing number and only provide a carrier identity. When a routing number is provided the format of that number is chosen based on the currently national routing scheme and therefore varies significantly between countries.

International service providers and carriers may wish to make use of this information for voice calls or other traffic types, to enhance termination in order to lower costs or improve quality. However, in order to make use of each number portability database for the purposes of correctly routing, the service provider has to adapt the information received from the number portability database for use in their network. Due to the fact that number portability databases and identifiers used for routing are so different between countries this places a significant burden in terms of cost and complexity on the service provider.

The Global SPID provides a potential solution to this problem even if it is clear that the adoption of the Global SPID concept by number portability databases would be a long term project. By using Global SPID as an adaption layer between the national number portability database and the carrier LCR and routing architecture the service provider, or number portability data provider, can assist with the process of introducing number portability into the routing of international traffic.

4.3 LCR Integration

An important aspect of making advanced routing and addressing schemes be of benefit to service providers and carriers is to easily integrate with existing routing schemes and equipment and in particular Least Cost Routing (LCR) systems. This lowers the cost and the time taken to perform implementation of schemes using ENUM or other query based routing.

A potential solution is to integrate via the mechanism of prefixing rather than by trying to use a completely new identifier scheme such as that employed by the direct URI model that is discussed in section 4.1. Prefixing schemes are already a normal part service provider routing systems, for example being used to directly route to a particular interconnect. In a case where it is possible to route over several alternatives to reach a destination referred to by the same prefix then the LCR system is designed to use the lowest cost or best performing route based on the service provider's particular criteria.

Unlike URIs, domain names or IP addresses, Global SPID identifiers could be considered as prefixes by an LCR system. This provides the benefits of easy implementation with the LCR system and therefore the routing structure used by the provider. It should be noted that the Global SPID concept is not limited to this particular mechanism of integration.

4.4 Interconnection Routing

The Global SPID concept can be used in various interconnection scenarios as an enabling identifier to make interconnection between networks easier to configure and manage in cases where routing needs to be more sophisticated than simple dialed number prefix routing. This is important in cases where direct routing is important such as the introduction of HD voice and video. There are two routing cases where Global SPID can be used in this way: bilateral interconnection and multilateral interconnection.

4.4.1 Bilateral Interconnection

A bilateral interconnection arrangement where Global SPID is useful is where a carrier/service provider directly interconnects with another carrier/service provider for the purposes of exchange of calls or other traffic to the other carrier/service provider's direct or directly associated subscribers and downstream customers. The relationships could be bidirectional and reciprocal with each carrier/service provider allowing access to their subscribers or customers. The use of Global SPID may change the billing arrangements between the two parties but does not have to, i.e. traffic between the two will most likely be subject to normal billing and settlement.. There may be other restrictions placed on the interconnection arrangement depending on the commercial policy of each carrier/service provider.

Considering the additional functionality required to implement the use of Global SPID for a bilateral arrangement may be burdensome, some service providers may prefer to establish arrangements with carriers or hubbing providers for multilateral interconnection arrangements for international traffic.Figure 1 below shows a bilateral interconnection arrangement between two service providers for this purpose:

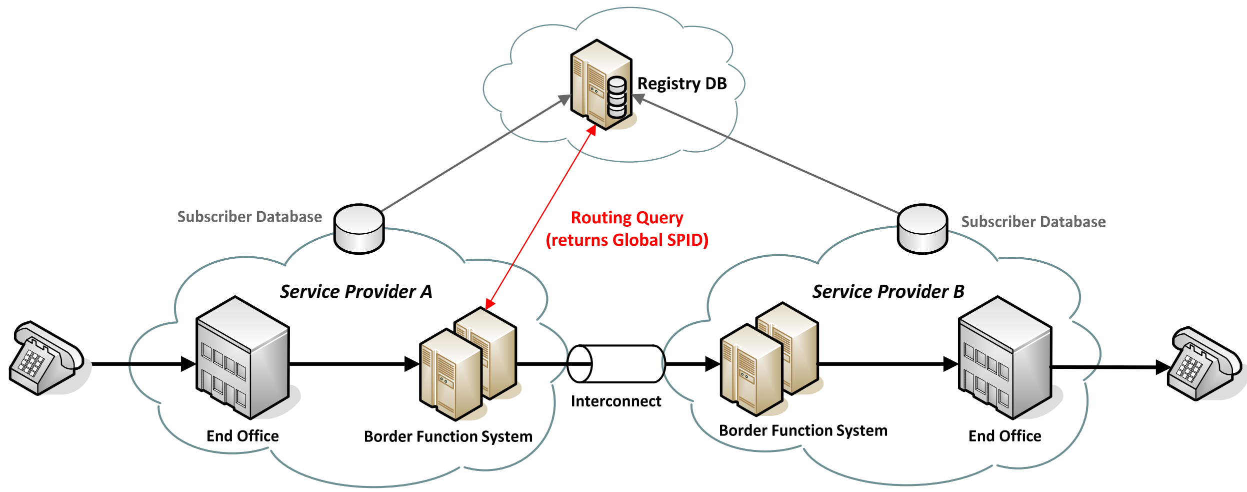

Figure 1 - Bilateral Interconnection

In this case Service Provider A is sending a call to a subscriber belonging to Service Provider B. In order to know whether the call is being sent to a subscriber of Service Provider B, the Border Function system in Service Provider A queries a registry database via a routing query. The registry database then returns a Global SPID corresponding to the identity of Service Provider B. Please note in this case the query is being originated from the Border Functions systems, however other network elements may also perform the query.

The advantage of using a Global SPID identifier in this scenario is that if Service Provider A or B need to vary the configuration of the interconnection, with respect to IP addresses or other technical parameters, they can do so without requiring to change or alter large amounts of data in the registry database. It is possible to achieve the same flexibility by use of SRV records in direct URI routing however that would require extra queries to resolve SRV records as part of the call flow.

Another potential advantage is a case where there are multiple interconnections between service provider A and service provider B; the extra layer of indirection provided by the use of Global SPID would allow a mechanism for choosing which interconnection is used between the service providers depending on where the call originates in the network. Though it may be possible to replicate this functionality in direct URI routing using IP routing protocols, for example anycast BGP, this would require co-ordination of the IP routing layer and the voice switching layer which may be difficult to achieve.

The use of a Global SPID identifier for referring to a service provider within a number portability database, as discussed in section 4.2, also allows interconnection based on number portability records to be configured, while being easily integrated with routing that is not based on number portability information.

4.4.2 Multilateral Hubbing Interconnection

A multilateral hubbing arrangement is where a service provider interconnects to an intermediary hubbing provider, such as an international carrier, for the purposes of interconnecting to multiple partner service providers without the requirement to setup individual interconnection relationships with partner service providers. In this situation the service provider may only have to create a contractual relationship with the hubbing provider rather than with each individual service provider.

The GSMA IPX Hubbing Model is an example of this arrangement.

Figure 2 below shows a multilateral hubbing arrangement:

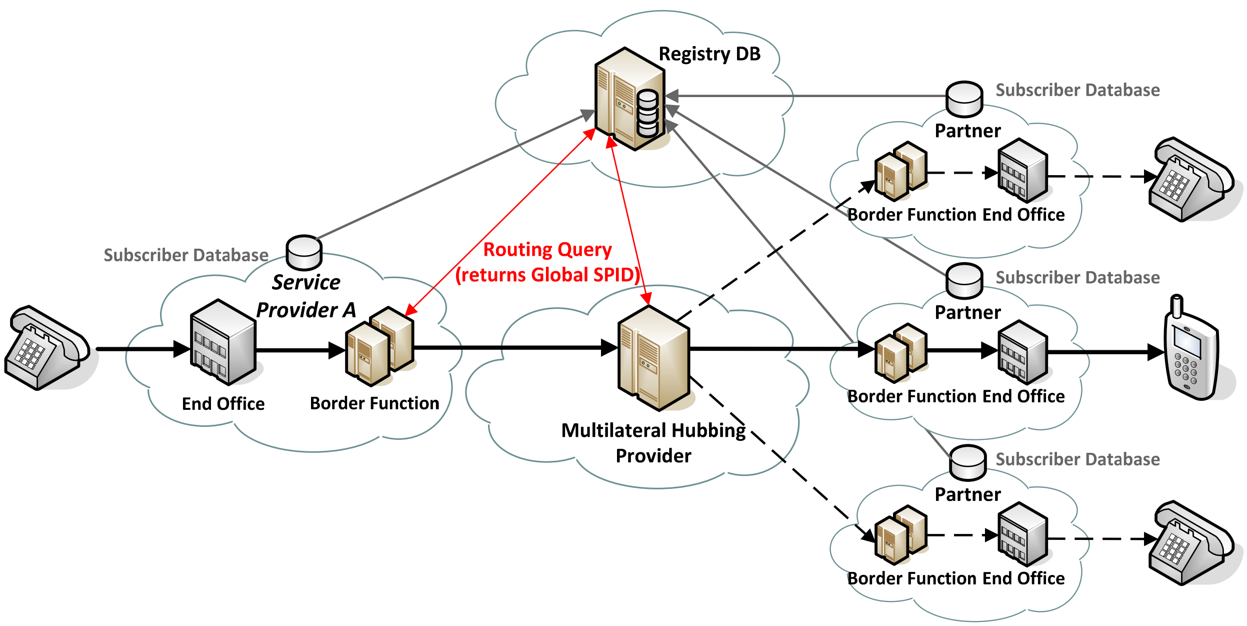

Figure 2 - Multilateral Hubbing

In the multilateral arrangement shown in Figure 2, service provider A has joined a multilateral hubbing system to reach several distant partners. The incoming call into service provider A causes a query to the registry database which returns a Global SPID identifier which service provider A's routing recognizes as being available via the multilateral hubbing provider. The call is then routed to the multilateral hubbing provider who then performs another query to establish the particular interconnect to the destination service provider. The use of a Global SPID identifier simplifies matters considerably versus direct URI routing. Service provider A can route all traffic associated with the Global SPID identifiers belonging to its partners available via the multilateral hubbing provider, without regard to the technical interconnection details required to reach those service providers, by routing the traffic to the interconnection with the multilateral hubbing provider. Without the use of Global SPID identifiers service provider A would need to remap the URIs returned from the registry database, to replace the domain name or IP address of the end service provider, or would require a different set of registry database data containing the corrected URIs with the correct information.

Service providers without the capability or desire to establish the functionality for Global SPID lookup may prefer to route traffic towards the multilateral hubbing provider or carrier. The multilateral hubbing provider or carrier would then use Global SPID to determine routing to the terminating service provider.

4.5 Internal Routing

Global SPID identifiers may also be used inside a network to facilitate query based routing similar to that used for interconnection but for internal purposes. The exact purposes would be beyond the scope of this document, but may involve the use of SPID identifiers for separate geographic pieces of network, different service classes or different pieces of equipment within network architecture.

Global SPID identifiers would be particularly useful for this purpose when networks are merging or migrations need to be conducted from one set of infrastructure to another.

5 Global SPID Specifications

This section discusses the recommendations for the essential properties, format and assignment policy for Global SPID.

5.1 Global Uniqueness

In order for the Global SPID to function correctly as an identifier in internal, interconnection and number portability routing use cases without fear of overlapping numbers, the global SPID should be globally unique and therefore assigned by a central numbering authority that can ensure this property.

5.1.1 Recommendation

Global SPID identifiers must be globally unique.

5.2 Hierarchical or Flat

The Global SPID identifier could be either a code or number without any structure or a hierarchical identifier with rules surrounding the layout of the identifier.

5.2.1 Hierarchical

A hierarchical identifier is an identifier which contains a definite structure such that sections of the identifier, with or without a separator character, each express a level of aggregation within the identifier scheme. A simple example of this sort of scheme is the E.164 numbering plan where the first few digits of the number represent the country code of country within which the number belongs and further digits may express areas within the country.

Hierarchical identifiers are most commonly associated in telecommunications with a geographical aggregation scheme, where the sections of the identifier refer to smaller units of geographical area such as with the example of E.164 above. However they can also be used to indicate other aggregation properties such as entity type as seen in the US domain name scheme; www.i3forum.org, the .org indicating the entity type of as a non commercial organization. Further, multiple aggregation properties can be mixed in a scheme. An example would be the use of both geographical identifiers and type identifiers in the domain name scheme used internationally by many countries.

Hierarchical identifiers are often used with delegation of sub assignment, so that an organization can be allocated a particular set of identifier numbering space by a parent organization, and the delegated organization can then further sub assign identifiers, or blocks of identifiers, to other organizations. Examples of this are the E.164 numbering plan or E.212 MCC/MNC codes [6].

There are two advantages to a hierarchical scheme for Global SPID. The first is that it is easier to construct complex processing rules for the use of such identifiers provided that the user wishes to make use of the aggregation expressed by the hierarchy. The second is that is easier for debugging purposes to recognize the identifiers and understand their meaning when the identifiers display a definite structure.

5.2.2 Flat

A flat identifier is one that has no structure associated with its contents; it is typically assigned sequentially or randomly. Examples of flat identifiers are IEEE MAC addresses (00:18:8B:15:2A:B7) or IP addresses (192.168.1.1).

Flat identifiers, in a similar way to hierarchical identifiers, can be delegated for sub assignment by a controlling organization to another organization and so on. Again IP address space and IEEE MAC addresses are good examples of this process being applied. However with flat identifiers there is no obvious way to understand the boundaries of the sub assignment and information regarding this must be looked up externally rather than being immediately apparent.

The advantage of a flat identifier being used for Global SPID is that processing is very simple due to the lack of structure and limited to simple entry lookup schemes. A related advantage is relative efficiency of number space utilization, when using sequential assignment, for a given length of identifier.

5.2.3 Recommendation

Though it is possible to make use of the structure of the Global SPID in hierarchical scheme, this is only useful if the aggregation hierarchy is itself of some use to the user. If for example the Global SPID is allocated in a geographical hierarchy it is not clear that this is useful, as most routing relationships in a direct traffic exchange scenario, such as envisaged by the GSMA IPX, are between commercial entities rather than at a country by country level. It is not clear that other forms of aggregation by entity type would be useful either due to the varying requirements of service providers and carriers.

Another difficulty associated with the use of a hierarchical scheme is that is more complex to setup and administer than a simple flat scheme for the assignment body.

It is recommended therefore that the Global SPID identifier be flat in structure.

5.3 Numeric or Alphanumeric

There are three useful options for the allowed character syntax within the Global SPID identifier, a syntax allowing only digits (0-9), allowing hexadecimal digits (0-F) or a syntax that allows use of additional alphanumeric characters. A further syntactical option is whether to allow the use of separator characters within the Global SPID and the choice of the separator characters.

5.3.1 Numeric

Purely numeric identifiers have the advantage of being simple to handle and work well across all query types including SS7 Intelligent Network Application Part (INAP) and Mobile Application Part (MAP) as well as ENUM and SIP protocols. Crucially, numeric identifiers alone support prefixing as discussed in section 4.3

They also integrate well with existing routing tools and systems allowing a simpler migration to utilization of the number portability database and advanced interconnection scenarios.

A disadvantage is the length of the identifier may be have to relatively long to allow a sufficient amount of Global SPID numbering space to be available for future use.

5.3.2 Alphanumeric

The advantage of an alphanumeric syntax is that is can be used to express a symbolic name which can refer to the numbers associated with the Global SPID. An example of this might the service provider company name who owns the end subscribers numbers referred to by the Global SPID. This would aid recognition and debugging by being human readable

A further advantage is the ability to have relatively short Global SPID identifiers due to the larger range of characters having a greater amount of numbering space than a purely numeric or hexadecimal identifier.

The disadvantage of an alphanumeric identifier is that it cannot be easily returned or processed by equipment using SS7 query mechanisms such as Intelligent Network Application Part (INAP) or Mobile Application Part (MAP). The query response in those protocols is returned by the mechanism of prefixing. ENUM and SIP query types can handle alphanumeric identifiers being returned.

A further disadvantage is the difficulty of using and integrating these identifiers in LCR style routing schemes which are designed to process digit based prefixes.

5.3.3 Hexadecimal

Hexadecimal identifiers use the extended hex character set of digits (0-9) and letters (A-F). There usage is common in systems that can represent digits in 4 bit groups (nibbles).

Hexadecimal identifiers, like purely numeric identifiers would also integrate well with existing SS7 query types (INAP and MAP) which can handle the use of hex characters in their query responses. However they are not easy to handle in routing tools and systems as they are generally not designed to be able to cope with these characters. Also Hex identifiers can't support prefixing.

5.3.4 Separator Characters

The use of separator characters, such as '.' or '-', is useful to delineate sections of an identifier. For example this can be seen within a domain name e.g. www.i3forum.org. Normally the use of separator characters implies the use of structured and hierarchical identifiers as discussed in section 5.2.

5.3.5 Recommendation

One of the goals of Global SPID is to provide the widest possible applicability to encourage usage. So in order to maintain the maximum level of compatibility with existing SS7 query mechanisms such as MAP and INAP, as well as ENUM and SIP, numerical or hexadecimal identifiers are clearly preferable. Additionally to facilitate easy integration with legacy routing tools and systems such as LCR tools purely numeric identifiers have the advantage.

Separators are not required within the Global SPID due to the recommendation made in section 5.2.3.

It is recommended that the Global SPID make use of only numeric digits (0-9).

5.4 Fixed or Variable Length

The Global SPID identifier can be either a fixed number of characters or a variable number of characters.

5.4.1 Fixed

Fixed length identifiers have the advantage of being easier to process by switch software, routing tools and other associated tools; the production of software for each of these is greatly simplified in the case of fixed length identifiers. In addition configuration of routing tools and switches within the network is also made significantly easier by the use of fixed length identifiers.

For query systems that return a prefix to an existing number such as those used in SS7 Intelligent Network Application Part (INAP) queries a fixed length identifier is essential to allow operation due to the boundary between the Dialed Number (DN) and the prefix not being delineated by a separator character.

5.4.2 Variable

The advantage of variable length identifiers is the ability to be extended as required to increase numbering space as discussed in section 5.5. This allows a degree of future proofing to be added to the identifier scheme. A further advantage is that a variable length identifier can economically express a name without the use of unnecessary characters, e.g. the I3 forum can just be expressed as ‘I3’; though any scheme has to be careful about identifiers being substrings of others which can complicate processing.

5.4.3 Recommendation

As the purpose of the Global SPID is to make routing scenarios easier, the advantages of a fixed length identifier within equipment and software are essential.

It is recommended that the Global SPID be of a fixed length.

5.5 Size of Numbering Space

It is important that the numbering space that the Global SPID is assigned from be of sufficient size to handle the existing numbers of entities, such as Service Providers and Carriers, who wish to use them for routing purposes. However, it is also important to give the Global SPID a long useful life and to provide sufficient flexibility to the users of the Global SPID.

5.5.1 Identifier Useful Life

There have been many identifiers used in telecommunications that have been specified by their creators as being sufficient for current and future scenarios only to be revealed as to have been too short for the expansion that has occurred in global telecommunications.

An excellent example of this is provided by the Autonomous System (AS) number used to identify service provider networks in the global BGP routing system used for Internet routing. This identifier was specified as being 16 bits in length when it was originally specified. This meant that there were a maximum of 2^16 entities or 65536 entities possible in the global BGP routing system. This has since proved to be insufficient by the rapid expansion of the Internet. The identifier has been re-specified to be expanded to 32 bits in length (2^32 or 4 billion possible numbers). However this has created significant pain for service providers and carriers globally requiring software and hardware to be upgraded to facilitate the expanded identifier.

For a Global SPID to be useful it requires to have a reasonable useful life and to avoid any consequences related to the Global SPID having to be re-specified purely for the purposes of length expansion. This means the numbering space provided by the identifier must be sufficient for future requirements in the twenty year and over time period.

5.5.2 Flexibility

It is not possible to foresee at this time all the potential use cases for the Global SPID identifier that may be required by entities involved in telecommunications and the routing environment. However it is clear that there should be sufficient numbering space within the identifier scheme to allow flexibility of application. This may include the use of multiple Global SPIDs by a single entity which would require sufficient numbering space to be available for this purpose.

Example uses might include referring to separate geographical areas or network structures by the use of multiple Global SPID identifiers, or to referring to different service types or grades. Further, when networks are split, combined or require migrations, which are common within the industry due to changes in the commercial entities that own them, more identifiers may be required.

5.5.3 Recommendation

The Global SPID is recommended to be fixed length as discussed in section 5.4.3 and should contain only numbers as specified in section 5.3.5. This will require a sufficient length of identifier to be available for flexibility and future expansion.

The length of the Global SPID should be at least 8 digits, giving 100 million possible identifiers (and over 4 billion possibilities if hex digits are used).

5.6 Assignment Policy

The Global SPID requires a flexible and simple assignment process in order to encourage adoption amongst service providers, carriers and other potential users. The following are important recommendations surrounding assignment policy.

5.6.1 Entities

Global SPID identifiers should be available to the widest possible set of entities to encourage adoption and to promote common use in the routing environment. This is important if the benefits of the adoption a Global SPID standard on decreasing costs are to be realized.

Global SPID identifiers should be available to all entities that require them for the purposes of routing without justification of status as a licensed operator, carrier or any particular type of corporate entity. This will allow Global SPID to be used by VoIP Internet Telephony Service Providers (ITSP), Enterprises, Mobile Virtual Network Operator (MVNO) and so on, who are not necessarily the so called 'Carrier of Record' for the E.164 numbers allocated to their subscribers for the purposes of call routing. The 'Carrier of Record' is conventionally defined as the underlying entity to which the E.164 numbers have been assigned to by the in country regulator within the rules of the ITU-T E.164 specification; this entity may not be the entity that owns the subscribers by having a service relationship, but may provide the other entity with network and other services on a wholesale basis.

If the Global SPID is not available to such entities its usefulness will decrease as solutions will still require to be constructed inside carrier routing systems, software and configurations to be able to route to such entities as cannot apply for and receive a Global SPID. This will directly increase costs and lower the ability for carriers and other entities to interwork successfully.

5.6.2 Reassignment & Reuse

In order to allow Global SPID identifiers to be able to adapt to the changes in the commercial entities that own them when entities are merged, split-up or sold the Global SPID identifiers must be able to be reassigned from one entity to another.

The process for reassignment should be simple for an entity to conduct by direct application to the assignment body with the submission of an appropriate proof of ownership and a desired entity reassignment. This process should however guarantee that entities may not hijack or takeover Global SPID identifiers belonging to other entities without the original entities permission to do so.

Within an organization that has been assigned a Global SPID, that entity should be free to reassign and reuse internally for their own purposes without discussion or justification being required between the entity and the assignment body for Global SPID. This will allow users of Global SPID to adapt and change where they use them as required by dictates of new technologies, new services and the different geographical areas.

An additional question is to whether the assignment body should reclaim Global SPID identifiers that belong to entities that no longer exist or that are no longer in use. This presents some difficulties as the use of Global SPID identifiers will not be easy to detect, so it is desirable that the assignment body should not reuse Global SPID identifiers upon assignment. This would be possible provided sufficient numbering space has been allocated for Global SPID as discussed in section 5.5.3.

5.6.3 Multiple SPIDs

While it would be possible to limit the assignment of a Global SPID to one per entity this would severely limit the applicability of Global SPID to very simple routing relationships and scenarios. Allowing users to be able to apply for multiple Global SPID identifiers as needed for routing purposes will enhance the flexibility and applicability of the Global SPID.

There are a wide variety of service provider and carrier use cases that might require the use of multiple Global SPIDs to refer to different sets of subscribers within one entity. For example a network might be divided into separate geographical coverage areas which are not directly interconnected in such a way as to allow for easy communication with another entity through a single interconnect. A service provider may also have different networks for different services or subscriber service definitions which require a separate Global SPID identifier to be used for each and selectively wish to route differently to each as part of an interconnect relationship.

When entities are merged or acquired by other entities, the controlling entity will own the Global SPID identifiers of the other entity. There should be no requirement to have to migrate to a single identifier owned by the controlling entity or otherwise reduce the use of Global SPID identifiers owned by either entity.

5.6.4 Private SPIDs

In order to facilitate scenarios where a service provider uses Global SPIDs for reference to external service providers and carriers and wishes to make use of Global SPID like identifiers for internal routing purposes it is recommended that a range of the Global SPID numbering space be set aside for this purpose.

These Global SPID identifiers would be available for use only within a particular service provider network and would not be available for use outside that network for the purposes of interconnection. The numbering space allocated to private Global SPIDs would therefore not be unique and the same set of Global SPID numbering space would be used by each service provider for this purpose. This is equivalent to use of RFC1918 private IPv4 address space within the global IP address space e.g. 192.168.0.0/16 or NANP Carrier Identification Codes 9000-9199.

The provision of this private numbering space would make the Global SPID identifier more useful to service provider users who wish to deploy query based routing technology within their network.

5.6.5 Compatibility with ITU-T E.212

To make interworking with the existing ITU-T standard [6] for identifying mobile operators by the use of the combination of Mobile Country Code (MCC) and Mobile Network Code (MNC) in identifiers such as International Mobile Subscriber Identity (IMSI) it is recommended that the numbering space allocated for Global SPID include the MCC/MNC space within its structure.

The MCC is 3 digits long and the MNC is either 2 or 3 digits, with 2 digits in use in all countries except North America which uses 3 digit MNC identifiers. The simplest approach to providing compatibility would be to ‘0’ pad the 6 or 5 digit MCC/MNC combinations to the 8 digits recommended for the Global SPID in section 5.5.3. An example MCC/MNC combination expressed as a Global SPID would be ‘00310150’ which in this case is the MCC/MNC combination for AT&T Mobility in the USA with the MCC and MNC preceded by “00” to indicate that what follows in an E.212-based assignment.

By making Global SPID compatible with the E.212 standard, interworking with the GSMA recommendation IR.67 [5] will be simplified.

5.6.6 Publically available SPID Database

To allow all users of Global SPID to understand who owns a particular SPID and the purpose of the SPID, the assignment body should keep a database of all assignments that have been made and make this database publically accessible.

The database should store the name of the entity the SPID has been assigned to and a text field which allows the entity to specify a description of the purpose of the SPID, these fields should free text to allow the users flexibility in the naming of the entity and the SPID description.

The database should be available for download using HTTP or FTP to allow SPID users to identify SPIDs for the purposes of designing routing policy and troubleshooting the use of SPID identifiers in their networks.

5.6.7 Assignment Policy Recommendations

The following assignment policy requirements are recommended:

Global SPID identifiers should be available to all entities that require them and not limited to licensed operators or ‘Carriers of Record’.

Global SPID identifiers should be able to be reassigned and reused by the entity they have been assigned to. The assignment body should not reuse them however.

Entities should be able to apply for multiple Global SPID identifiers as required for their routing purposes.

There should be a range of Global SPIDs provided for the use within a network for internal purposes. These Global SPIDs should be private to the user’s network.

The Global SPID identifier numberings space should include the ability to encode MCC/MNC combinations as specified in ITU-T E.212 by reserving the Global SPID identifiers beginning ‘00’ as E.212 identifiers. The translation should be performed by ‘0’ padding.

The assigning entity should maintain a database of Global SPID identifiers along with the assigned entity name and a description of the SPID purpose. This database should be publically accessible.

6 Current Proposed Solutions

6.1 IANA

The Internet Assigned Number Authority (IANA) is the assignment body responsible for the administration of number and identifier assignment for the global Internet. It is the central organization responsible for administering the Domain Name System (DNS), the allocation of protocol numbers within IPv4 and IPv6, the assignment of BGP Autonomous System (AS) numbers and the allocation and assignment of IPv4 and IPv6 addresses. The IANA Mission Statement is:

The IANA team is responsible for the operational aspects of coordinating the Internet's unique identifiers and maintaining the trust of the community to provide these services in an unbiased, responsible and effective manner.

More information on the IANA itself can be found at www.iana.org/about.

The IANA itself is operated by the Internet Corporation for Assigned Names and Numbers (ICANN) which is a not for profit, public benefit international corporation which works with the Internet Engineering Task Force (IETF), Internet Architecture Board (IAB) and Internet Engineering Steering Group (IESG) to manage assignment of numbering and naming resources. More information on ICANN can be found at www.icann.org/about.

The IANA is the central organization that allocates IP Addresses and AS Numbers to Regional Internet Registries: ARIN, RIPE, APNIC, LATNIC and AFRNIC. These registries are then responsible for assignment to individual entities. For certain other resources the IANA is the directly responsible assignment body.

6.1.1 Private Enterprise Numbers (PEN)

The IANA Private Enterprise Numbers (PEN) are designed for use in the Simple Network Management Protocol (SNMP) which is detailed in RFC1157 'A Simple Network Management Protocol (SNMP)' [8] and RFC1213 'Management Information Base for Network Management of TCP/IP-based internets: MIB-II' [9]. They are part of the SNMP Object Identifier (OID) used to refer to keys and values in SNMP. The PENs are handed out so that entities can create proprietary extensions to SNMP as required for their needs.

The PEN is a variable length, numeric only identifier which is assigned sequentially to any organization that requests one without restrictions. Currently approximately 37,000 PENs have been assigned which are listed publically at: www.iana.org/assignments/enterprise-numbers. There is no charge made by the IANA for the application for a PEN. Multiple PENs at not available for a single organization as SNMP OID strings are hierarchical by nature and further sub-division of the identifier is possible by providing digits after the identifier and a '.' separator. Reassignment between entities is possible though and large entities may have more than one PEN. Additionally the IANA does not seem to reuse PENs.

As it stands today the IANA PEN does not meet all the requirements listed in section 5 for a Global SPID, particularly the fixed length and the multiple identifier requirements. The variable length requirement could however be solved by number padding and multiple identifiers for an organization can be created provided the separator '.' is allowed within the Global SPID syntax. However, the use of the '.' separator would not be compatible with legacy routing systems and SS7 query protocols.

6.1.2 The assignment structure of the IANA and the PEN is a good fit for i3 recommendations on Global SPID assignment policy. Future IANA Identifier

Though the IANA PEN identifier is not an exact fit for use as a Global SPID it may be possible to use the framework provided by IANA to provide a new identifier specifically for use as a Global SPID. This possibility will require an new effort to be made through the IETF and IANA to create such an identifier and associated assignment structure. In order for an IANA identifier to be effective it would be best if there was a consensus regarding this approach among industry organizations such as the GSMA, see section 6.2.

6.2 GSMA

The GSM Association (GSMA) represents the interests of the world's GSM mobile service providers. It is responsible for identifying standards and assisting with interworking for the advancement of GSM technology and its member base. i3 Forum members will be familiar with the work of the GSMA with respect to the IPX initiative and in particular i3 Forum work on Voice over IPX (VoIPX).

The GSMA discusses the use of Global SPID like identifiers within the structure of the GPRS Roaming Exchange (GRX) and IP Packet Exchange (IPX). This is documented in the GSMA document IR.67 DNS/ENUM Guidelines for Service Providers & GRX/IPX Providers [5].

The document is discusses the use of full Uniform Resource Identifier (URI) identifiers being returned by the ENUM DNS protocol in the GRX and IPX environments and extends this approach from the GRX environment to IPX, including the concept of resolving numbers in a future IMS environment.

Mobile operators within IR.67 are commonly referred to using their identifiers from the ITU-T E.212 'The international identification plan for mobile terminals and mobile users' specification [6]. These are the Mobile Country Code (MCC) and Mobile Network Code (MNC). In the context of IR.67 these are combined together in different combinations to create domain names that are the service provider identifying part of the URI. For example for IPX use between IMS systems, the identifier would be as described in the table below extracted from IR.67:

Domain Name	Sub-domain(s)	Explanation	Rules of Usage	Resolvability
`.3gppnetwork.org`	`ims.mnc<MNC>.mcc<MCC.3ggpnetwork.org` Where <MNC> and <MCC> are the MNC and MCC of the Service Provider represented in decimal (base 10) form, with any 2 digit MNC padded out to 3 digits by inserting a zero ("0") on the beginning e.g. 15 becomes 015.	Used in IMS in SIP addressing; specifically in the Private and Public Identities used in SIP registration. See section 4.5 and 3GPP TS 23.003 [8], section 13, for more information.	Each Service Provider is allowed to use only sub domains consisting of MNC(s) and MCC(s) that are allocated to them by ITU T and their local national numbering authority.	Domain needs to be resolvable by at least all SIP/IMS based service inter working partners/Service Providers, as well as roaming partners where a visited P-CSCF is used.

The intent of the IR.67 specifications for identifiers is that mobile operators should be identified by their MCC/MNC combinations as indicated in the table; for communication between mobile operators only the GSMA does not need another Global SPID like identifier.

However, in IR.67 the GSMA does anticipate that they will require to be able to identify and communicate with other types of service providers within the across the IPX. To do this they specify another identifier format for non mobile service providers or carriers under the ipxsp.org domain name. This is the table extract from IR.67 which specifies this:

Domain Name	Sub-domain(s)	Explanation	Rules of Usage	Resolvability
.ipxsp.org	spn<SPN>.ipxsp.org Where <SPN> is the Service Provider Number (as defined in ITU-T E.xxx [41]) of the Service Provider. An example is: "spn001.ipxsp.org". Further sub-domains under this are the responsibility of the owning Service Provider. However, it is recommended to use/reserve the sub-domains defined above for the domain "mnc<MNC>.mcc<MCC>.3gppnetwork.org".	Not used in any particular service, however, can be used by any Service Provider for any service they see fit. The main intention is to provide a domain name that Service Providers without an E.212 number range allocation can use when connecting to the IPX network.	Each Service Provider is allowed to use only SPNs that are allocated to them by ITU T.	Domain needs to be resolvable by at least all roaming/interworking partners for the services used by this domain name.

This table indicates that they expect the results of ITU SG2, discussed below in section 6.3 to be used to provide the SPN portion of the identifier used in IPX. However the important point here is that there is nothing in this identifier specification that precludes or is incompatible with the definition of a Global SPID as specified in this document; for example based on the recommendations in section 5, the service provider identifier within GSMA IPX would be spn12345678.ipxsp.org, with a Global SPID of 12345678. The GSMA does not suggest anything in terms of assignment policy i.e. entity applicability, regulatory hierarchy etc. beyond the statement that 'each service provider is allowed to use only the SPNs that are allocated to them by ITU-T'.

In conclusion the GSMA position is neutral with respect to the specification of Global SPID, though clearly they expect MCC/MNC to be the dominant way of identifying mobile operators. By providing compatibility within the Global SPID scheme, as discussed in section 5.6.6, the Global SPID scheme can interoperate with identification of provider based on MCC/MNC.

6.3 ITU

The ITU has a pre-existing standard ITU-T M.1400 [7] carrier codes that could serve as a Global SPID type identifier, however an identifier more suited to this purpose is under study by ITU-T Study Group 2 (SG2).

6.3.1 M.1400 Carrier Codes

ITU Carrier Codes are documented in ITU-T Recommendation M.1400 'Designations For Interconnections Among Network Operators' [7]. The document presents specifications for the naming of trunk groups etc. and includes methods of identifying entities for this purpose. The codes themselves are handed out by appropriate regulator in each country. The exact format of the codes is the responsibility of each regulator, but are generally alphanumeric, less than 6 characters and variable length. An example of the carrier codes are the US Operating Company Number (OCN) assigned by the National Exchange Carrier Association. A full list of worldwide carrier codes can be found here: http://www.itu.int/oth/T0201.

The M.1400 carrier codes do not match well to the Global SPID recommendations as discussed in section 5. They are alphanumeric, variable length and are not actually guaranteed on their own to be globally unique. Additionally they are only available to entities licensed by a regulator within a country. They are not suitable for use as a Global SPID and this is recognized by the tasking of SG2 to look at alternatives.

6.3.2 Study Group 2

The ITU-T Study Group 2 is a working group which looks at 'Operational aspects of service provision and telecommunications management'. This group is currently responsible for the E.164 numbering plan and ITU work on ENUM. It is also responsible for the E.212 standard [6] that defines the Mobile Country Code (MCC) and Mobile Network Code (MNC) as discussed in section 6.2.

The study group is looking at further identifiers for use in routing under the general question 1 – 'Application of numbering, naming, addressing and identifications plans for fixed and mobile telecommunications services'. Contributions on the SPID topic have been made by several ITU members and a correspondence group established to work the issue. The ITU SG2 last discussed this topic in November 2010 and the next meeting is due to discuss this topic in Switzerland from the 1st June 2011 to the 10th June 2011. The understanding is that at this point there is no definite conclusion on a specification for a Global SPID identifier.

7 i3 Forum Position

The current i3 Forum position on Global SPID is to encourage the adoption of a specification for Global SPID and to make a recommendation as to that specification. Both a new IANA or ITU-T SG2 solution could potentially be used and the i3 Forum will provide information and support about what is considered by the carriers' community as important requirements for a Global SPID. The i3 Forum members also believe that the specification should be compatible with the approach chosen by the GSMA, as discussed in section 6.2 of this document.