Federal Communications Commission (FCC)

North American Numbering Council (NANC)

Nationwide Number Portability Working Group

(NNP WG)

Report on Nationwide Number Portability

Final Report to the NANC

July 28, 2020

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Executive Summary

In response to the Federal Communications Commission ("FCC") Wireline Competition Bureau directive to the North American Numbering Council ("NANC") to further analyze the Internet Protocol Local Routing Number ("IPLRN") solution, we hereby submit the following considerations.

- The greatest impacts will be to non-IP Service Providers for both cost and level of changes required to comply
- Service Providers who may rely on transit providers to reach outside NPAs may not require network updates
- Other Service Providers with legacy TDM networks may be impacted as internal software system and network updates to the network would likely need to take place
- Consumer's will be impacted regarding changes to long distance calling costs and services; potential customer confusion if not all Service Providers implement NNP
- Applicable Tariffs may need to be revised
- The timeline for implementation should take into consideration all impacts

In summary, with the goal of advancing progress towards nationwide number portability ("NNP"), there are several impacts related to the IPLRN solution noted within this document that should be carefully considered and seeking public comment as well as soliciting advice from other industry standards groups would be advantageous. Existing legacy TDM networks were not designed with IPLRN or more generally with NNP in mind. Thus, although the IPLRN proposed alternative generally relies upon established capabilities of TDM networks to originate NNP calls to IP networks, it is extraordinarily difficult to contemplate all unintended consequences that could result from such a proposal.

Introduction and Background

The NANC Nationwide Number Portability Issues Working Group (in the June 2018 report), defined Nationwide Number Portability as:

"The ability of users of telecommunications services to retain existing telecommunications numbers without impairment of quality, reliability; or convenience when switching from one telecommunications carrier to another or when moving from one physical location to another."

The LNP architecture relies upon the use of location routing numbers ("LRNs") which identify the Service Provider's switch that serves the ported number. The Number Portability Administration Center (NPAC) feeds downstream databases to support queries associated with the dialed numbers. The query returns the LRN for the dialed number. The FCC currently limits the geographic scope of an LRN to a Local Access and Transport Area ("LATA"), thereby

restricting the ability of consumers to port a telephone number to a LATA other than its own. (The United States is covered by about 200 LATAs.)

Description of NNP

The FCC released the NNP Notice of Proposed Rulemaking/Notice of Inquiry ("Notice"), on October 26, 2017, which also sought comment on "how best to move toward complete nationwide number portability to promote competition between all Service Providers, regardless of size or type of service."[1] Specifically, the FCC requested input from industry stakeholders regarding prior work of the NANC, ATIS and other organizations.

In addition to issuing the NNP NPRM, the FCC's Wireline Competition Bureau ("Bureau") sent a letter to the Chairman of the NANC, dated December 7, 2017[2], directing its NNP WG to:

- Determine whether any of the four models discussed in the NNP Notice are preferable in terms of feasibility, cost, and adaptability to changing markets and technologies;
- Specify in detail the potential costs, benefits and barriers to implementing these proposals;
- Identify any likely consequences of these proposals for routing, interconnection, or public safety;
- Recommend next steps to advance full nationwide number portability; and make any other recommendations deemed necessary to achieve this goal

The Bureau further directed the NANC to approve a written report of its findings on those issues, and to transmit that report to the Bureau. The NANC approved this report, which is publicly available at http://www.nanc-chair.org, at its May 29, 2018 meeting.

On July 3, 2018, the Wireline Competition Bureau further directed[3] the NANC to investigate the technical requirements necessary to support NNP and provide more detailed cost/benefit analysis of proposed lasting solutions to:

1. Provide an analysis of the technical requirements for adopting an Internet Protocol Local Routing Number (IPLRN) solution (previously referred to as NGLRN – Non-Geographic LRN), including which entities will need to make changes if this solution is adopted
2. Provide an analysis of the technical requirements for adopting a National Location Routing Number (NLRN) alternative, including which entities will need to make changes if this solution is adopted

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[1] *Id.*¶ 2; With publication of the NNP Notice in the Federal Register, the FCC received initial comments in the matter on December 27, 2017 and reply comments on January 26, 2018.

[2] *See*, Letter from Kris Monteith, Chief, Wireline Competition Bureau, FCC, to North American Numbering Council Chair (Dec. 7, 2017), ("Wireline Bureau Letter"), http://www.nanc-chair.org/docs/mtg_docs/Dec17_NANC_Referral_NNP.pdf

[3] See, http://nanc-chair.org/docs/mtg_docs/NNP-Ltr-frm-WCB-to-NANC-Chair-7-2018.pdf

3. Specify in detail the potential costs and benefits of the NLRN and IPLRN proposals, including which parties could bear which costs and reap which benefits; and
4. Recommend next steps the Commission and industry should take to achieve full nationwide number portability

The initial interim report was requested for the December NANC meeting 2018. The final report was requested for the first NANC meeting in 2019. An extension was given (due to the Government Shutdown) moving the final report's due date to February 29, 2019.

A second interim report was presented at the NANC's March 2019 meeting and the additional findings report was submitted to the NANC on May 13, 2019. An NNP recommendation was not reached by the NANC NNP Technical Committee. The Technical Committee recommended the impacts on interconnection, compensation, tariffs, and access charges be further investigated for the NLRN and IPLRN solutions.

On December 16th, the Bureau directed the NANC to develop more specific recommendations regarding what the NANC described in the May 13, 2019, Report as the Internet Protocol Local Routing Number (IPLRN) solution. The bureau specifically directed the NANC to:

1. Analyze the likely effects of the IPLRN solution, including as to:
    a. Interconnection
    b. Carrier expenses relating to database dip costs and to transport costs;
    c. Consumer expectations regarding toll charges; and
    d. State and federal tariffs for retail and wholesale services

2. Recommend a path forward to implement the IPLRN solution, including specifically providing recommendations as to:
    a. The necessary series of steps, including the estimated time each step would take,
    b. in implementing the IPLRN solution; and
    c. The extent to which commercial solutions can serve as a substitute for the IPLRN solution for smaller carriers, including the cost of such solutions

3. Whether the IPLRN solution should be modified in light of any developments since the Report was issued and the conclusions reached with regard to #1

4. How to address the objections and concerns raised in the Minority Report accompanying the Report

<u>Description of Internet Protocol Location Routing Number (IPLRN)</u>

The IPLRN solution assumes to keep the current Local Number Portability architecture, including the role and responsibilities of the Number Portability Administration Center (NPAC). However, a new process would be implemented using IP-enabled switches or third-party IP networks that act as gateways. Service providers could use these gateways to assist in routing

NNP calls. IPLRN would not discriminate between wireless and wireline TNs, and the solution may work for both.

The IPLRN proposed alternative has two main elements:

- One or more new non-geographic area codes and an administrative process to provide Service Providers with their own unique IPLRNs specifically and uniquely for NNP;
- VoIP nodes, functioning as IP Network Entry Points, that host IPLRNs and provide connectivity to Service Providers that port in NNP TNs.

To enable NNP for a geographic telephone number ("TN"), the TN would be associated with a Service Provider specific IPLRN within the TNs current NPAC region. This is contrary to currently how a traditional geographic Service Provider specific LRN is associated to a TN within the same LATA. When a Service Provider acquires an IPLRN from the new administration function, the Service Provider would associate a Session Initiation Protocol (SIP) URI to that IPLRN, identifying the specific IP Network to be used for call processing on the VoIP network. Each IP Network entry point would deliver calls to one or more networks that terminate calls.

When an LNP query is performed on the dialed TN, the IPLRN would be returned. Calls on the TDM network may query the local copy of the NPAC database and route based on the IPLRN's 3-digit area code to a VoIP network whether directly over a VoIP interconnect or over a TDM interconnect via a media gateway that would provide the TDM-to-IP protocol conversion that enables the call to continue in IP on a VoIP network. However, based on the routing of such 3-digit area code, each originating network would need to establish its own unique connection with a TDM interconnect via a media gateway that would provide the TDM-to-IP protocol conversion that enables the call to continue on an IP network. The IP network would query the full 6/10-digit IPLRN to obtain the terminating IP Network address, i.e., a SIP URI. Once on the IP Network, the call would be routed to the terminating network. This gateway functionality allows the TDM network to coexist and interoperate with the VoIP network. (*See*, Figure 1 – IPLRN TDM to IP call flow, below).

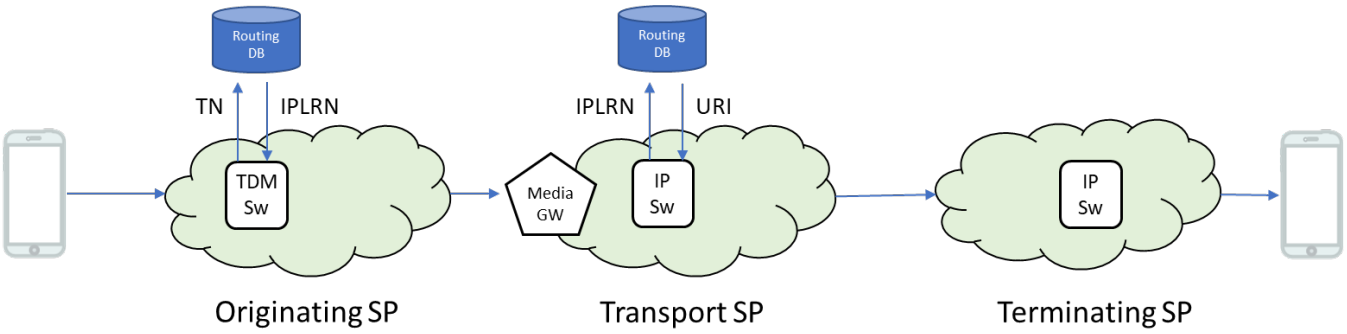


Figure 1 – IPLRN TDM to IP call flow

Calls that originate on a VoIP network may retrieve the 6/10-digit IPLRN from the local copy of the NPAC database and either receive the SIP URI in the same query or alternatively, may trigger on the IPLRN 3-digit area code to query a routing database with the full 6/10-digit

IPLRN to obtain the IP Network's SIP URI. The call would be routed to the correct terminating IP Network using the SIP URI. (*See*, Figure 2 – IPLRN IP to IP call flow, below).

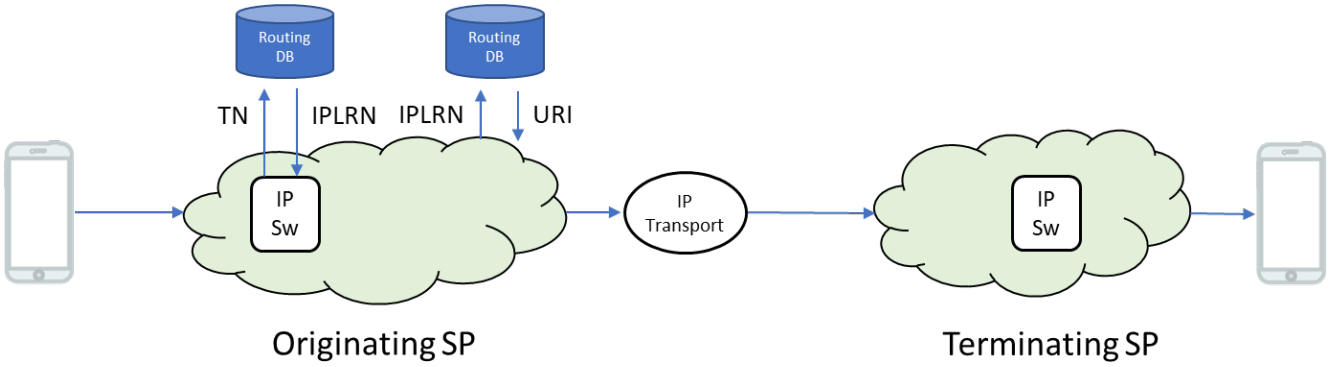


Figure 2 – IPLRN IP to IP call flow

To summarize, the IPLRN solution uses an IP network consisting of VoIP nodes, which will terminate calls to NNP TNs. Service providers have multiple options as to how they update their routing (e.g., NPAC, commercial agreement, internal routing tables). However, there may be an option to update the SIP URI field via SOA and to retrieve IP routing information for each number via LSMS. In addition to SOA, there may be an opportunity to include IP information via the LERG™ Routing Guide or other databases. The IP Network may then route calls toward the terminating network based upon SIP URI and depending upon the terminating provider; the call may be terminated to a VoIP network or terminated to a media gateway that converts the protocol from IP to TDM. Thus, any time an NNP call is placed on the PSTN, it must route the call to an IP Network entry point so that the IP Network can route the call to the terminating network. For text messaging in an LNP environment, the NPAC could record locally cached SPIDs that are used rather than LRNs to allow routing to the correct recipient Service Provider.

Assumptions

1. This report is informed by the 2 previous NANC NNP Working Group reports
2. We assume central offices which do not currently support LNP will not support NNP either
3. This report assumes that NNP calls are non-jurisdictional.
4. This report is focused on the IPLRN solution for NNP and the assumption remains that TDM end office switches are not able to support serving customers with NNP numbers.
5. All switches that are currently LNP-capable need to support the porting out of their customers. If the Service Provider is not able to provision an NNP subscriber, they would not be required to accept that customer's request.
6. All Service Providers must allow customers to port out their telephone number using NNP, except those exempted from porting out.
7. Originating Service Providers may bear the consequence for routing and transit to an NNP number.
8. All Call Query (ACQ) facilitates NNP and should be supported for all portable NPA-NXX. With ACQ, the originating Service Provider performs the number portability query

on all originating calls. Where ACQ is not technically feasible or where ACQ is not performed, the Service Provider network should route the NNP call on dialed digits to a downstream carrier to perform the query. Routing will continue to be based on 6 digits.

9. ACQ, including the exceptions that may be performed downstream, would require LSMS access to all NPAC regions.
10. NNP ports will be processed in the code holder's NPAC region. Thus, the NNP recipient Service Provider would require SOA access to all NPAC regions where providers plan to support such porting.
11. Wireless Service Providers who have the appropriate agreements for roaming may continue to use national roaming if they choose to do so. Permanent roaming is also expected to continue if Wireless Service Providers choose to continue to provide it.
12. If an IP call cannot be completed fully in IP and processes across a TDM interconnection or uses TDM transport in order to get to a NNP destination, it is assumed that the costs associated with doing so would be similar to what they are today, except for calls with the local routing option on IPLRN. For example, if a number was ported from New York to an IPLRN with a subscriber in California and the call at some point crosses a TDM interconnection or uses TDM transport, then the infrastructure cost of that call from the original LATA is potentially the equivalent to the cost currently for a long distance call from New York to California.
13. In alignment with the previous NANC NNP WG Technical Committee report, costs are stated as orders of magnitude using the following convention:

    - Small (S) - $10K-$90K
    - Medium (M) - $100-$999K
    - Large (L) - $1M-$9.9M
    - Extra-large (XL) - $10M+

Effects of IPLRN

This section will analyze the likely effects of IPLRN as it relates to interconnection, numbering, carrier expenses related to database query costs and transport costs, consumer expectations regarding toll charges and state and federal tariffs for retail and wholesale services.

A. Interconnection

Agreements will be required to govern the IP connectivity between carriers. One hurdle that will be faced by IP-enabled providers in an IPLRN enabled environment is the general lack of desired terms of available IP Interconnection for smaller IP-enabled providers, as also mentioned in the May 2018 NANC NNP report. IPLRN could

facilitate direct IP interconnection with large players in the industry. This also could make it easier for non-IP providers to leverage existing interconnections for TDM-to-IP translation services.

IPLRN enabled NNP can be facilitated via the Service Provider's own network or an existing transport provider that transports calls for the Service Provider (such as out of region calls).

The creation of a new IPLRN prefix would be similar to the creation of a new area code, which is a process that is well established across different Service Provider types. The vast majority of providers should be able to leverage existing methodologies and commercial agreements to terminate traffic to these destinations (e.g., LCR, tandem transit, IXC).

There will be no obligation to require carriers to support calls with IPLRNs that would terminate to their networks. Instead, Service Providers would have to demonstrate a capability of being able to support calls destined to IPLRN destinations not on their network. The IPLRN's sole purpose on a legacy switch is to identify that a number is NNP and therefore the call should egress the TDM network at the earliest opportunity. To assist with NNP routing via IPLRN, ACQ should be supported for all portable NPA-NNXs. ACQ should happen as early in the call path as possible in order to 1) know that the call is destined to an IPLRN, and where possible 2) obtain the URI's associated with the IPLRNs in IP networks. To perform ACQ within an NNP environment, access to porting records in all 7 NPAC regions would be required. With ACQ, the originating Service Provider typically performs the number portability query on all originating calls if the capability exists. Where ACQ is not technically capable in a Service Provider network, the Service Provider should route the NNP call on dialed digits to a downstream carrier to perform the query. If a non-IP provider performs the query to the local copy of the NPAC database, the IPLRN would indicate the call needs to be routed to a third-party provider. This third-party provider would also need to perform an additional query via a local copy of the NPAC to receive the voice URI value and properly terminate the call. The IP provider would transit that call to the IP network serving the subscriber. For Service Providers who do not subscribe to the NPAC URI fields in their LSMS streams, then the Fully Qualified Domain Name (FQDN)s may be obtained via the updated LERG records or alternate data source for that IPLRN. This presumes the network domain is the same as provisioned in the voice URI field of the NPAC. Similar companies offering PSTN hosting to VoIP providers today should be able to provide transport to the IP network indicated by the IPLRN.

B. Numbering

A single NPA-NXX per NNP Service Provider could be created and solely used for IPLRNs. The creation of a new IPLRN prefix would be similar to the creation of a new area code, which is a process that is well established across different Service Provider types. This allows for the industry to easily identify IPLRNs and may simplify switch programming for determining how to properly route NNP calls. Seeing an LRN with the IPLRN NPA would alert IP-enabled Service Providers to query a local copy of the NPAC

to receive the SIP URI and continue to route over IP. It is anticipated that most legacy switches can be programmed to recognize the NPA of an IPLRN and route to a designated IP provider to terminate over IP.

The creation of new dedicated NPAs for IPLRNs would remove millions of numbers from possible assignment. The IPLRN may provide national coverage allowing for some VoIP and mobile providers to potentially forgo requesting multiple codes for IPLRNs in each serviceable LATA. IPLRNs would be managed and assigned by the North American Numbering Plan Administrator ("NANPA") chosen by the FCC.

Once the NANPA assigns an IPLRN to a Service Provider, that Service Provider has the responsibility to establish the IPLRN in the NPAC and LERG.

Service providers should also add the assigned IPLRN to the LERG or appropriate data source to properly associate a routing FQDN. It is assumed that the FQDN shown for a given IPLRN will match the URI for the same IPLRN in NPAC. This will allow for alternative routing data in case URI data is not available within the local copy of the NPAC.[4]

C. Transport

Interconnection

This section attempts to address transport costs as the cost required to transport a call to the terminating network, which benefits the Service Provider to which the number is ported and not the Service Provider that originated the calls or subsequent Service Providers that transport the calls.

IPLRN has a dependency on VoIP, which requires the use of IP and SIP for successful delivery of numbers that use an IPLRN. While IP has been deployed heavily in North American networks and interworking between networks is generally regarded to be a solved problem[5], calling between networks require connectivity between the originating network (or that of its intermediary partner) and the destination network.

From a physical network standpoint, IP relies on a nationwide fiber network that is physically interconnected. This fiber is offered through Service Providers that sell services, namely internet transit, point-to-point, and mesh networks. These Service Providers interconnect with one another and with content providers in carrier-neutral meet-me rooms around North America.[6]

The densest points of interconnection are in Los Angeles, the Bay Area, Chicago, Dallas, New York City, and Atlanta.[7] They are serviced by thousands of Service Providers.

There are three mechanisms of achieving this connectivity: Internet Transit, Network-to-Network Interface (NNI), or Exchange.

[4] ATIS's Testbed Focus Group completed test calls via FQDN routing found in LERG test files. ATIS-I-0000067 contains the full summary.
[5] NNI Profile, Joint Taskforce IP-NNI, SIP Forum
[6] https://en.wikipedia.org/wiki/Meet-me_room
[7] https://cloudscene.com/market/data-centers-in-united-states/all

Internet Transit

Video conferencing services such as like Zoom, Skype, and Google Meet have demonstrated the general efficacy of the internet for transport of Real Time Communications.

At 80 kbit/s with overhead, the G711u (equivalent to TDM's PCMU) uses a fraction of the bandwidth required by major video calling platforms.[8] The average price per megabit has fallen 90% in the past 10 years, with an average cost below $1.00 per Megabit per second.[9] It is evident that the market-based transport services are generally more efficient than those offered under a tariff construct. This can be seen by the migration of consumers from tariffed services to market-based transport services. Rural Service Providers serving remote, rural areas are likely to face substantially higher costs and further investigation of internet transit costs for rural carriers is necessary.

More importantly, Internet transit does not offer an equivalent service to dedicated TDM circuits, as call quality could be severely diminished as compared to that available today due to packet loss and jitter. The risk of failure or degradation increases as the number of "hops" between the originating and destination network increases.

While this can be mitigated through multi-homing (using multiple intermediary ISPs) that have implemented diverse network paths, public interconnection is still not an equivalent to current means of transport via TDM.

Network-to-Network Interface (NNI)

Ethernet NNIs in some respects can be characterized as the IP equivalent of TDM interconnection. They involve physically interconnecting two networks -- typically via fiber. This interconnection can happen at the originating network, terminating network, or some mutually agreed upon Point of Interconnection (POI) (i.e., meet-me room). Once the two networks are physically connected, Ethernet is established, and interworking can be established in a manner similar to the Internet Transit case.

When using a meet-me rooms as a POI, a fiber cross-connect supporting up to 100 Gb/s) is typically $250-400/month.[10] However, in the case where two networks do not share a POI, there will be additional costs associated with bringing transport to these locations.

One challenge with NNI interconnection is which operators bear what costs to interconnect. Rural and other Service Providers are concerned that if they are made to bear the costs of interconnecting at distant points from their service area – an arrangement that upends existing practices as these carriers typically exchange voice traffic at or near their "network edges" – they will be unduly burdened with substantial transport costs that they do not bear today. These costs will, for the first time ever, be

[8] https://www.cisco.com/c/en/us/support/docs/voice/voice-quality/7934-bwidth-consume.html
https://support.zoom.us/hc/en-us/articles/201362023-System-requirements-for-Windows-macOS-and-Linux
[9] https://www.ncta.com/whats-new/the-price-per-megabit-per-second-has-gone-down-90-percent
[10] https://www.datacenterhawk.com/blog/connectivity-perspectives-low-cost-amenity-or-high-margin-business

foisted on Rural Service Providers and their small customer bases and will then need to be applied on top of the already higher costs of serving a rural area.

Exchange Point

An exchange point is the physical infrastructure by which carriers can exchange traffic between their networks. Generally, these are located at regional data interconnect points, also known as carrier-hotels. It is possible that exchange points can be implemented to deal with the costs associated with establishing NNIs between every network in the United States. This is a concept commonly used to exchange internet traffic. Exchange points provide a single physical location conveniently located to service providers that allow them to exchange traffic with one another. Exchange points offer the benefits of NNIs without the cost overhead costs associated with interconnecting with every service provider.

Most ISPs, including most RLECs use similar exchanges for exchanging internet traffic. It is possible that these facilities can be repurposed to serve this use case.

Additional Interconnection Considerations

Although the above mechanisms for interconnection address current commercially available methodologies, the current regulatory construct for interconnection must also be addressed.

Thus, the IPLRN proposal introduces issues around interconnection that should properly be addressed in the FCC Technology Transitions proceeding[11] or other appropriate regulatory proceeding where the regulatory obstacles may be considered. For example, costs to Service Providers may be reduced – and IP voice interconnection with Service Providers can be made possible – by the adoption of rules that appropriately allocate the costs associated with the NNP transport responsibilities.

Additionally, IPLRN and more generally an NNP requirement further implicates POI location obligations associated with calls that originate on TDM networks. Without addressing such regulatory policy changes, the voluntary nature of negotiated commercial agreements is likely the only path for IPLRN and NNP in general that would avoid conflict with the existing interconnection policy.

The issue of how to facilitate ubiquitous IP Interconnection for Real Time Voice Communications using NANP numbering has been well documented. IP interconnection relies fundamentally on telephone number to URI translations. The ATIS/SIP Forum IP-NNI Task Force delivered a report entitled ATIS-1000062 IP Interconnection Routing; however, consensus on a single registry architecture was not achieved.[12] Should there be a future opportunity to technically access IP interconnection routing as networks evolve and regulatory policies change, IPLRN should be considered.

[11] GN Docket No. 13-5

[12] https://www.sipforum.org/download/joint-atissip-forum-technical-report-ip-interconnection-routing-atis-1000062-sipforum_twg-6/?wpdmdl=2780

D. NPAC Dependencies

The NNP proposal below based on an IPLRN does not require changes to the NPAC SMS data model or to the local system interfaces (i.e., SOA or LSMS). The expected changes are focused on configuration and business processes at the SOA and LSMS edge which are local to Service Providers as well as internal business logic updates within the NPAC regarding current edits performed on the LRN attribute and possibly new reporting requirements.

The NPAC SMS would need to update its edits for the LRN when the ported TN record (subscription version) is created or modified.

When an IPLRN is detected by the NPA prefix, the LRN edit constraining ports to be intra-LATA will not be performed.

For all other NPAs, the LRN edit constraining ports to be intra-LATA will remain as-is.

It is assumed that the subscription version will be maintained in the Region the number is assigned for identification purposes. That is, subsequent ports would be easily identified given the telephone number is uniquely assigned to a known location which is the code holder's NPAC region. There would be two general impacts to the Service Providers and others in the NPAC SMS ecosystem given this NNP architecture:

1. ACQ would require that the originating switch when digits are dialed will have access in its Number Portability Data Base (NPDB) for all LSMS records across the U.S. given the dialed number may terminate outside the local NPAC SMS Region.[13]
2. Service Providers that plan to port an NNP number into their location would need to have their SOA System connected to the NPAC SMS Region or select the applicable region via the Low Tech Interface (LTI) for which the new subscriber's number is geographically assigned (i.e., the code holder region).[14]

Currently, Service Providers that port local numbers are connected to the NPAC SMS Region where that number is assigned. In the NNP model, a number that is geographically assigned, for example, to the Northeast Region, can be updated to reflect a port to a location for which facilities are on the west coast.

If the New Service Provider (NSP) only provides facilities in a territory on the West Coast currently, they would not need to have a SOA connection to the Northeast NPAC SMS Region for local number porting. With NNP, any Service Provider offering NNP for any subscriber would require a SOA that supports all NPAC regions.

[13] Today all national carriers receive downloads from all the NPAC SMS Regions. In the future, carriers that have presence in a single or limited number of Regions would need to have the ported data for all of the NPAC SMS Regions. In other words, their NPDB would need to be provisioned with all of the NPAC SMS LSMS regional download data.

[14] Furthermore, NNP Service Providers would need to provision (i.e., create) an LRN with their assigned IPLRN value in all regions where it would be applicable, which is likely to include all the regions. Once created, their IPLRN may be assigned to as many TN records as required based on the subscribers requesting NNP.

Please see Figures A and B for the change in the LSMS and SOA connection management required to support ACQ and NNP provisioning.

Figure A – Current Local Number Portability

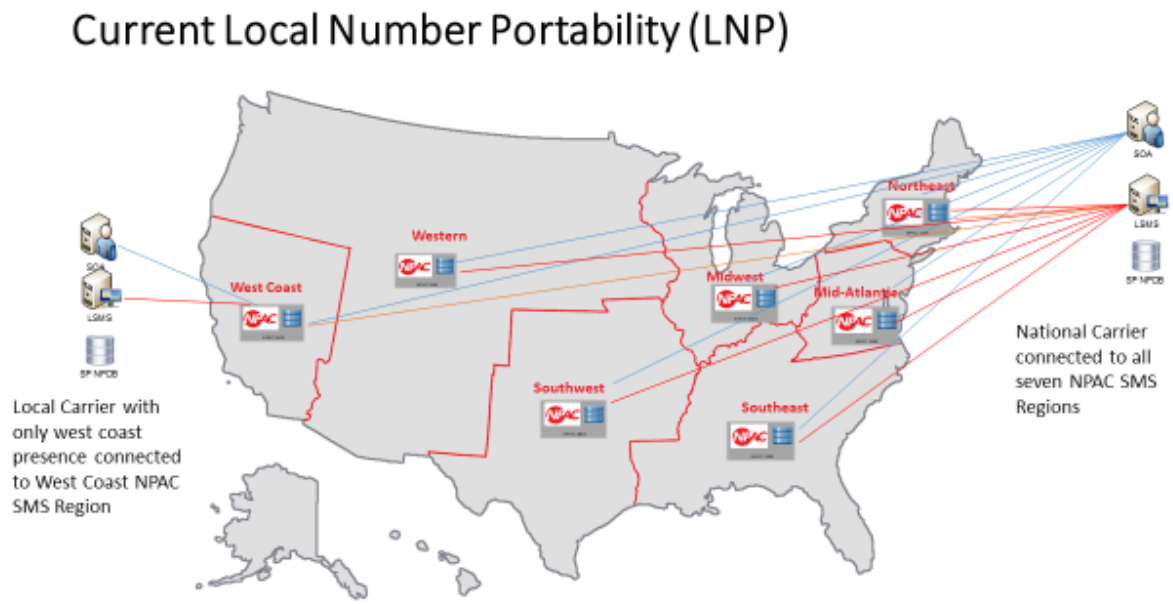
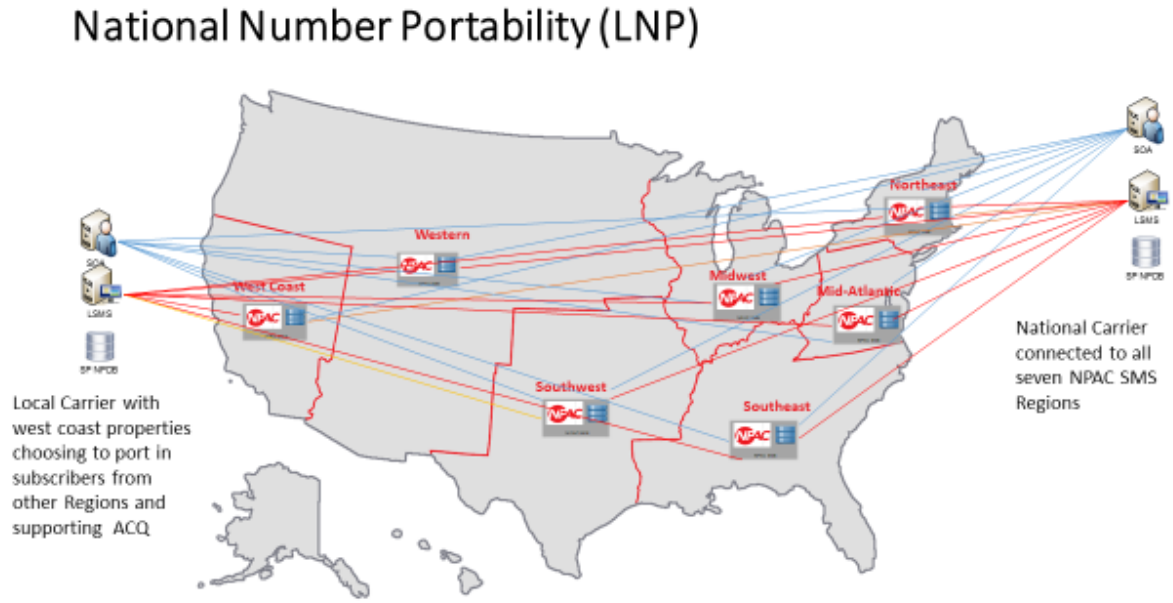


Figure B - Nationwide Number Portability



E. 9-1-1 Connectivity

Public safety (E9-1-1 or NG 9-1-1) is a concern that must be considered in implementing NNP with IPLRN using IP-enabled switches or third-party IP networks that act as gateways. Accurate originating location information of all E9-1-1 calls is vital to providing emergency services in a timely manner.

9-1-1 calls originating from NNP TNs may utilize the p-ANI solution to provide accurate location information for the originating TN.

NNP calls to 9-1-1 will likely require p-ANI services to route to the correct PSAP. This may not be feasible in some wireline TDM networks but could potentially be offered by third parties.

Calls to 9-1-1 initiated by NNP TNs could use the existing p-ANI solutions deployed for wireless and VoIP Service Providers. Today, there are multiple vendors who provide a p-ANI-based solution via commercial agreements. Notably, current implementations for Wireless and VoIP providers (e.g., p-ANI) used to route 9-1-1 calls today can be and are used for NNP.

9-1-1 Costs

Commercial agreements /p-ANI solutions will have their own cost. Service providers choosing to offer NNP will likely incur expenses associated with the negotiation of interconnection with third parties to provide a POI in the donor LATA. Service providers choosing to offer NNP may also have to pay for upgrades to billing systems, number inventory systems, caring for "out of rate center" numbers, as well as 9-1-1 solutions. For example, Service Providers with traditional fixed-line connections to the local PSAP, would need to support p-ANIs or use third-party solutions.

9-1-1 (p-ANI) IPLRN alternative costs

For originating 9-1-1 calls, the Service Provider would need to consider the following capabilities and charges:

- Provisioning and data services:
    - Collection and maintenance of Geographic Information System (GIS) based 9-1-1 Authority jurisdiction data to include roads, structures, and emergency response boundaries
    - Establishment or use of existing p-ANI records per jurisdictional boundary to support a routing path through legacy 9-1-1 selective routers to a specific PSAPs
    - Establishment or use of dedicated 9-1-1 trunking to the jurisdiction's 9-1-1 Service Provider to transport 9-1-1 traffic from the p-ANI contracted commercial provider to the PSAP
    - Establishment or use of dedicated data services for real time delivery of location data at the time of the emergency call
    - Customer record preparation, validation and storage services for pre-call validation, which may include GIS data (latitude/longitude) confirmation services

- Staffing for error research and clearance

- Emergency Call Processing
  - Compliant, dedicated trunking between originating carrier and contracted commercial provider.
  - Real time location determination services and conversion to GIS data if not available prior to the emergency call. This is only needed if the end user is not in a fixed location (e.g., a soft-phone or over-the-top VoIP application).
  - Staffing and operation of a dedicated call center structured to manage emergency calls not properly provisioned prior to an emergency call.

Service pricing varies by the size of the originating carrier and the size of the jurisdictional footprint the carrier intends to cover. Typical agreements would include a non-recurring set up charge to establish services, and a monthly charge per customer record for validation and storage that would be volume based.

F. End User Billing

It should be assumed that local calling would remain under the same regulatory jurisdictions as it is currently, and the IPLRN solution offering to the calling party would likely be set based on the originating provider's agreement with their customers. It can also be assumed that for a majority of calls routing over IP, the VoIP rate would be in accordance with the originating provider's agreement with their customer, and the originating provider's agreement with the interconnecting partners and may vary from the local tariffed rate.[15] Given these assumptions, the calling party may experience a change in their billing when routing over IPLRNs rather than local LRNs.

G. Query Costs

Service Provider expenses relating to database query costs and to transport costs

As indicated in the assumptions above it is expected that IPLRN would require LNP queries for all calls (ACQ). Unless there is an exemption for certain geographic areas or network operators, NNP allows for numbers to be ported from locations where LNP porting does not currently exist. This would require numbers that are currently excluded from the need to perform LNP queries to potentially become eligible for porting. Thus, this would drive queries where local competition does not exist and that otherwise would not require LNP queries. Currently, there are 6,147 Geographic NPA NXX's that are identified as codes that are not subject to porting; these are in addition to the NXXs associated with providers that have obtained waivers for intermodal porting.

N-1 is the current backstop on an unqueried call LNP query policy.[16] For NNP, it may be most efficient to determine the NNP nature of calls as close to the point of origination to

[15] See: https://prodnet.www.neca.org/publicationsdocs/wwpdf/6911google.pdf

[16] See FCC 18-95

prevent unnecessary routing. This query policy would shift the volume and costs of LNP queries from them being performed by both the originating Local Exchange Carrier (LEC) for local calls and Interexchange carriers for long distance calls to the originating Service Provider for both local and long-distance calls. Some Service Providers may already perform ACQ on all originating calls as they do not differentiate on jurisdiction (routing local vs. routing long distance via IXC).

The cost allocation for ACQ by the originating Service Provider will need to be addressed as is reflected in previous reports. Although the benefit of ACQ resides with the Service Provider that acquires customers using IPLRN and benefits from NNP capability, the originating Service Providers under ACQ would be burdened with performing originating queries and potentially the transport of calls to the terminating network. In the event that ACQ is not performed and calls are subject to default routing (i.e., calls that route to the Service Provider originally allocated the numbering resource without being queried), cost allocation must also be addressed.

As explained in the minority report of the previous working group's effort, the overall economic impact of ACQ on legacy network Service Providers is not well understood, especially the costs of equipment upgrade to enable a localized cache of the full NPAC.

H. Consumer Expectations Regarding Toll Charges

There is a difference in how customers are charged for calls to TNs in geographically distant locations, dependent on their Service Provider's regulatory construct, for example:

- Wireline – Local and toll charges, possibly some packages
- Wireless – Package billing
- VoIP – Package billing

As a result, some customers may be more aware of toll charges than other customers.

The expectation:

This example is for where a customer is aware of toll charges – Customer A, who dials a TN to their neighbor, customer B, may assume it is a local call; however, if NNP is implemented, their neighbor may have moved to a geographically distant location. From an end user billing perspective, customer A expects that the call will have no additional charge because they dialed a local TN to reach customer B.

The reality:

The infrastructure used by customer A's Service Provider to get that call to customer B via their IP SP may vary from the infrastructure used when customer B was previously physically located in the same geography as customer A. However, customer A is unaware of that variance, and may not even know that customer B has moved to a geographically distant location. Customer B's IP-based SP may require customer B to register with a geographically based SBC for other reasons, yet customer A and their SP have no insight to this information.

The regulation:

Future regulatory action could make a change related to local and toll charge applications. IP telephony does not have a long-haul carriage distinction as is present in current TDM SS7 geographic jurisdiction-based call rating. IP SPs may base their charges to their customers on the same structure as their IP commercial interconnection agreements, or some other package-based charging.

I. Nationwide 10-Digit Dialing

Dialing plan consistency (e.g., national 1+10-digit dialing) may be needed. For example, variations exist across the country with how calls can/should be dialed, i.e., 1+10-digits, 10-digits, and/or 7-digits. These are often related to intelligence in the dialed number relative to routing. For example, local calls originating and terminating within the same NPA, if only one NPA today serves the area, are usually dialed on a 7-digit basis. Areas where NPA overlays have occurred are dialed as 1+10-digits or only 10-digits depending on the dial plan approved by the state. NNP impacts on the varying dialing plans need to be assessed.

10-digit dialing may not be required where switches are capable of amending the dialed number with the 3-digits of the default NPA associated with the 7-digit dialed digits. This would facilitate the 10-digits required for ACQ. However, it is not clear of the TDM switch types that may allow for such switch logic programing if ACQ is a capability of the switch. Amending dial digits to facilitate ACQ may have implications for call authentication efforts.

Depending upon the consistency of the application of call jurisdiction, i.e., local vs toll, in areas where NNP is available, consumer confusion may be a factor where 7-digit dialing for local calls exist. This may materialize in several ways. Where Service Providers vary their application of call jurisdiction, consumers may become confused from provider to provider as to what calls may be dialed with 7-digits (local) vs 10-digits (toll). Additionally, consumers that are used to dialing 7-digits for local calls may become confused when a 7-digit dialed NNP call is toll or a local call that requires 10-digits is local. Although the 10-digit dialing requirement in most US NPAs will be necessary to implement the 988-suicide hotline and may address much of this issue across the country and to resolve any difficulties with call authentication, it may make sense for the nation to adopt 10-digit dialing nationwide.

J. State and Federal Tariffs for Retail and Wholesale Services

In the current environment, services that Service Providers offer are filed in tariffs in the state jurisdictions where applicable. These rely on the ability to determine the general geographic location, such as the LATA, of the initiating and/or called party, particularly for distinguishing between local and toll calls. In an IPLRN environment, where the initiating party may not know whether a call being placed is local or to a geographically ported number, Service Providers that offer these tariffed services would need to either replace or remove those services or revise definitions. The amount of time required to modify, file, and have tariffs approved at the state level vary by state; therefore, a transitional period may be necessary as carriers move to the IPLRN environment.

- Federal tariffs filed with the FCC, by definition, cover interstate services. Calls made in an IPLRN environment that are interstate in nature could be conceivably covered by existing tariffs.

Recommended Path Forward to Implement IPLRN

The following section provides recommended steps and a timeline to implement IPLRN. The recommendation takes into consideration the type of carrier, switching equipment and capabilities.

The following chart reflects IPLRN network changes required for NNP implementation, who benefits, and who incurs the associated costs, and the order of magnitude of those costs:

Switch	Telephony Function	Switch Type	NNP Changes Required	Who incurs Cost	Magnitude S/M/L/XL	Who Benefits
Originating	Routing	Legacy Wireline (LD)	ACQ[3] if feasible or downstream commercial arrangement; transport costs associated with reaching the IP network; adding IPLRN to all switch translations	All orig SPs who do not have ACQ already; all orig SPs; all orig SPs	M-L per switch; depending on IP capability and/or commercial agreements; S per switch	NNP SPs
Originating	Routing	Legacy Wireline (Local)	ACQ[3] if feasible or downstream commercial arrangement; adding IPLRN to all switch translations; ACQ requires LSMS data for all NPAC regions;	All orig SPs who do not have ACQ already; all orig SPs; all orig SPs	L per switch; S per switch; M per switch depending upon IP capability or commercial agreement; M per switch	NNP SPs

Switch	Telephony Function	Switch Type	NNP Changes Required	Who incurs Cost	Magnitude S/M/L/XL	Who Benefits
			trunking between TDM and IP switches			
Originating	Routing	Legacy Wireline (2-PIC)	ACQ[3] if feasible or downstream commercial arrangement; transport costs associated with reaching the IP network; adding IPLRN to all switch translations; CIC routing based on LRN; ACQ requires LSMS data for all NPAC regions	All orig SPs who do not have ACQ already; all orig SPs; all orig SPs	L per switch; depending on IP capability and/or commercial agreements; S per switch	NNP SPs
Originating	Routing	VoIP	ACQ[3] if not already in use; Requires LSMS data for all NPAC regions	All orig SPs who do not have ACQ already	M per network	NNP SPs
Originating	Routing	Mobile	ACQ[3] if not already in use; Requires LSMS data for all NPAC regions	All orig SPs who do not have ACQ already	M per network segment	NNP SPs

Switch	Telephony Function	Switch Type	NNP Changes Required	Who incurs Cost	Magnitude S/M/L/XL	Who Benefits
Originating	Routing	LNPA	Remove LATA edit prohibiting NNP	LNPA	S for the LNPA	NNP SPs
Originating	Rating	Legacy Wireline (LD Option)	LRN based rating[2];	Orig SPs with LD plans would enhance rating for NNP calls	L per network as calls that were previously rated as local now need to be rated as LD and Form 499[4] reporting	NNP SPs; Orig SPs might recover some costs for their NNP LD calls via the rate plan
Originating	Rating	Legacy Wireline (Local Option)	N/A	N/A	N/A	NNP SPs;
Originating	Rating	Legacy Wireline (2-PIC Option)	LRN based rating;	Orig SPs with LD plans for rating of all calls	XL per network for rating and Form 499[4] reporting	NNP SPs; Orig SPs might recover some costs for their NNP LD calls via the rate plan
Originating	Rating	VoIP	LRN based rating if LD rate plan	All Orig SPs who do not currently do this	L per network for rating changes	NNP SPs

Switch	Telephony Function	Switch Type	NNP Changes Required	Who incurs Cost	Magnitude S/M/L/XL	Who Benefits
Originating	Billing	All types	No Change	N/A	N/A	NNP SPs; Originating switch only on NNP LD calls
Transit	Routing	RBOC Tandem	Routing changes to egress the TDM Network via IP. If not supported, IP-capable tandem Service Providers can be leveraged to translate TDM to IP. An additional query for NNP calls would be required to identify the destination SIP URI as well as LSMS access to all NPAC regions	Transit Carriers	M per tandem switch if RBOC tandem is responsible for TDM to IP translation. No change if IXC has the obligation to support IP calls.	NNP SPs; Originating switch only on NNP LD calls
Transit	Routing	VoIP Transit	A query for NNP calls would be required to identify the destination SIP URI as well as	N/A	M per network.	N/A

Switch	Telephony Function	Switch Type	NNP Changes Required	Who incurs Cost	Magnitude S/M/L/XL	Who Benefits
			LSMS access to all NPAC regions. Routing would need to be modified to support sending calls via this method including codec negotiation or other SIP required attributes.			
Transit	Routing	IXC LD Tandem	A query for NNP calls would be required to identify the destination SIP URI as well as LSMS access to all NPAC regions.	N/A	M per network.	NNP SPs; Originating switch only on NNP LD calls
Transit	Routing	MSC Gateway	N/A	N/A	N/A	N/A
Transit	Rating	RBOC Tandem	The ability to rate calls routing on IPLRNs.	RBOC Tandem	L per network.	NNP Service Providers.
Transit	Rating	VoIP Transit	N/A	N/A	N/A	N/A

Switch	Telephony Function	Switch Type	NNP Changes Required	Who incurs Cost	Magnitude S/M/L/XL	Who Benefits
Transit	Rating	IXC LD Tandem	The ability to rate calls routing on IPLRNs.	IXC LD Tandem	L per network	NNP Service Providers.
Transit	Rating	MSC Gateway	N/A	N/A	N/A	N/A
Transit	Billing	RBOC Tandem	N/A	N/A	N/A	N/A
Transit	Billing	VoIP Transit	N/A	N/A	N/A	N/A
Transit	Billing	IXC LD Tandem	N/A	N/A	N/A	N/A
Transit	Billing	MSC Gateway	N/A	N/A	N/A	N/A
Terminating	Provisioning	Legacy Wireline	Assumed not possible	N/A	N/A	N/A
Terminating	Provisioning	VoIP	SOA support for the IPLRN and access to all NPAC regions	NNP SPs	S for SOA change; M for TN admin changes	NNP SPs
Terminating	Provisioning	Mobile	SOA support for the IPLRN and access to all NPAC regions	NNP SPs	S for SOA change; M for TN admin changes	NNP SPs

Switch	Telephony Function	Switch Type	NNP Changes Required	Who incurs Cost	Magnitude S/M/L/XL	Who Benefits
Terminating	Provisioning	Mobile permanent roading	No Change	N/A	N/A	N/A
Terminating	Routing & Termination	Legacy Wireline	Assumed not possible	N/A	N/A	N/A
Terminating	Routing & Termination	VoIP	N/A	N/A	N/A	N/A
Terminating	Routing & Termination	Mobile	N/A	N/A	N/A	N/A
Terminating	Rating	Legacy Wireline	Assumed not possible if NNP TN not provisionable; Support rating for onward routing to NNP provider	Term SP (Code Holder[1])	M per network	NNP SP; Term SP if billing for onward routing
Terminating	Rating	VoIP	Support rating for onward routing to NNP provider	Term SP (Code Holder[1])	M per network	NNP SP: Term SP if billing for onward routing
Terminating	Rating	Mobile	Support rating for onward routing to NNP provider	Term SP (Code Holder[1])	M per network	NNP SP; Term SP if billing for onward routing
Terminating	Billing & Settlement	Legacy Wireline	Support billing upstream SP not using ACQ	Term SP (Code Holder[1])	M per network	NNP SP; Term SP if billing for

Switch	Telephony Function	Switch Type	NNP Changes Required	Who incurs Cost	Magnitude S/M/L/XL	Who Benefits
			for NP query and NNP onward routing			onward routing
Terminating	Billing & Settlement	VoIP	Support billing upstream SP not using ACQ for NP query and NNP onward routing	Term SP (Code Holder[1])	M per network	Term SP if billing for onward routing
Terminating	Billing & Settlement	Mobile	Support billing upstream SP not using ACQ for NP query and NNP onward routing	Term SP (Code Holder[1])	M per network	Term SP if billing for onward routing

Commercial Solutions as A Substitute For IPLRN

This section details how commercial solutions can serve as a substitute for rural carriers to implement NNP.

The use of commercial agreements by a provider is considered by both the wireless industry and by the assessment of NNP options conducted by ATIS, as an interim solution. Twenty-six (26) various organizations, notably LNPA WG, ATIS, CCA/CTIA and the NANC FON WG, have all previously identified and evaluated the use of commercial agreements to accommodate a Service Provider's ability to provide NNP for its end users.

The commercial agreement solution, as stated in the 2016 ATIS NNP Technical Report[17], includes the use of third-party facilities to provide a POI in the donor LATA and to deliver traffic from that POI to the network of the recipient provider in a distant LATA.

[17] https://www.atis.org/01_strat_init/nnp/docs/ATIS-1000071.pdf.

IP Connectivity Arrangements

SIP connection

A lack of IP connectivity options also may limit effective use of commercial agreements by certain kinds of providers and in certain areas, such as VoIP providers that need to find a third-party provider to convert calls from IP to TDM for purposes of interconnection and traffic exchange.

IP connectivity agreements directly with ILECs may be unavailable due to the lack of IP capability within some ILEC networks. In some commercial agreements, there may also be provisions that prevent the efficient and economic interconnection with other Service Providers, such as terms that stipulate that the non-national or non-facilities-based Service Provider may not pursue IP interconnection with originating networks, and that any traffic destined for that Service Provider must route through its Service Provider partner's network. In addition, some existing interconnection agreements ("ICAs") may contain language which restricts porting to within the rate center boundaries.

Numbering & Routing

- There are no changes to existing routing requirements that would prevent NNP.
- There are no changes to numbering (administration & guidelines) with the use of commercial agreements.
- Although not a full barrier to implementation, the use of third parties to provide a POI in the donor LATA and to deliver traffic from that POI to the network of the recipient can increase the complexity of the routing, sometimes resulting in confusion to Service Providers when troubleshooting issues with multiple Service Providers involved. However, such confusion may be reduced by standardizing the processes that facilitate efficient troubleshooting.
- N11 dialing could require changes by the provider to reflect the geographic location, not basing the translation on the NPA NXX.
- Service providers local calling scopes could require changes as a result of NNP.

Costs

- Estimated costs for 3rd party.

Service providers choosing to offer NNP would likely incur expenses associated with the negotiation of interconnection with third parties to provide a POI. Service providers choosing to offer NNP may also have to pay for upgrades to billing systems, number inventory systems, caring for "out of rate center" numbers, as well as 9-1-1 solutions. For example, Service Providers with traditional fixed-line connections to the local PSAP would need to support p-ANIs or use third-party solutions.

- IP Connectivity estimated costs

  - IP connectivity pricing varies by carrier location, and there may be additional requirements for leased facilities where connectivity is not present. Typical agreements would include a non-recurring set up charge for installation and a monthly reoccurring charge for maintaining the facilities and connection.
- Service provider systems estimated costs
- Upgrades to a provider's internal systems (e.g., billing, number management, etc.) would vary. Factors include a carrier's internal versus external development, level of development (e.g., code or patch, etc).
- Service provider 9-1-1 (p-ANI) solution costs
  - In a commercial agreement for originating 9-1-1 calls, the Service Provider would need to consider the capabilities and charges.
  - Service pricing varies by the size of the originating carrier and the size of the jurisdictional footprint the carrier intends to cover. Typical agreements would include a non-recurring set up charge to establish services, and a monthly charge per customer record for validation and storage and would be volume based.

Suggested Modifications/Considerations to The IPLRN NNP Model

The current NNP WG was asked to consider whether the IPLRN solution should be modified in light of any developments since the June 2018 Report was issued and the conclusions reached with regard to #1;

#1 Analyze the likely effects of the IPLRN solution, including as to:

a. Interconnection;

b. Carrier expenses relating to database dip costs and to transport costs;

c. Consumer expectations regarding toll charges; and

d. State and federal tariffs for retail and wholesale services.

The NNP WG has carried forward many assumptions from previous NNP WG efforts. It is unlikely that the IPLRN model would need to be modified or reconsidered unless these assumptions change or policy decisions are made regarding traffic jurisdiction, intercarrier compensation, POI location and interconnection requirements.

Minority Report Concerns and Response

The minority report[18] identified valid issues associated with the implementation of NNP. These elements are included in this report.

[18] See Appendix D

The issues, as identified in the Minority Report response to the NNP Technical Sub-Committee report that must be addressed by the Commission are Intercarrier Compensation, IP Interconnection, and industry routing database accommodations to support proposed interim and long-term solutions. The very nature of NNP breaks the association of the TN to a specific geographic area on which many policies in U.S communications are based. These impacts are not unique to any one particular NNP technical alternative, be it IPLRN or the NGLRN or NLRN approaches explored in previous reports. Before an NNP solution is implemented, these issues will need to be addressed, whether in the Technologies Transition docket or in another regulatory proceeding.

Intercarrier Compensation

Current FCC rules on Intercarrier Compensation, CC Docket No. 01-92, favor TDM interconnection - Intercarrier Access reform would have to be addressed to incentivize IP interconnection. The Commission has appropriately declined to classify Interconnected VoIP as a Title II service and has used its plenary numbering authority under Section 252(e) 1 of the Act to expand 9-1-1 and LNP obligations to VoIP Service Providers. Originating access reform remains to be addressed and should be resolved to avoid the complication by an NNP mandate and implementation prior to such reform. This becomes more challenging as originating access would be difficult to expand to include the addition of transport outside of the LATA and therefore should be eliminated. If the issues around intercarrier compensation are not resolved, then this would further challenge the legacy network operator's capability to allocate appropriate charges associated with existing and additional costs and may divert funds that could otherwise be used for transitioning to IP.

The IPLRN proposal has been significantly modified from its original NGLRN form to remove the NGGW function. While it is assumed, that this will result in fewer points of interconnect due to the unresolved regulatory construct issues it may result with IP Gateways and/or transport in/to potentially every rate center. Although the Commission's policy has been to incent the industry away from rate centers and LATAs, as the Intercarrier Compensation reform effort has proved, there is still significant cost pressures against that effort. As this relies upon federal policy, the FCC's Technology Transition proceeding or other appropriate regulatory proceedings appear to be the appropriate way to address these issues prior to an NNP mandate.

Other Considerations

This has raised the question in the NNP WG of whether it is technically feasible to permit some elements and Service Providers of the industry to enable NNP and allow others a delay or optional implementations such as areas where there is no demand for porting.

Pursuant to the minority report, the combination of STIR/SHAKEN, IVC, 988, NNP and all IP Interconnection should be addressed from a goal-based policy approach prior to an NNP mandate.

Alternatives that require changes to TDM-based networks divert resources and are a distraction from addressing the broader issues of Intercarrier Compensation and Technology Transition. Any interim regulatory focus should concentrate on the dependencies that would place the technological options on equal footing, including encouraging the existing commercial agreements alternative discussed in previous reports.

Conclusion/Next Steps

The IPLRN alternative provides an opt-in NNP solution that would allow non-IP enabled service providers to continue migration to IP technology. The NNP Issues Working Group performed an in-depth analysis to determine the effects of IPLRN on interconnection, carrier expenses, consumer expectations and tariffs.

Carrier expenses related to database queries and transport costs will vary greatly based on the type of Service Provider. The group determined that non-IP Service Providers will be greatly impacted in both costs and the level of changes required to support NNP. Service Providers with legacy TDM networks will incur the highest costs to support NNP via an IPLRN solution due to the need to update networks, internal software systems and entering into commercial agreements with an IP provider to transport NNP calls.

The Working Group recommends the impacts on access charges be further investigated for the NNP alternatives.

Service Providers that offer long distance calling services at a cost to consumers may need to educate their customers or change their service offerings. Some Service Providers may elect to not offer NNP which may cause consumer confusion.

Applicable tariffs would be impacted by any NNP solution implemented and may need to be revised or redefined to support NNP.

The impacts to each Service Provider to implement an IPLRN solution will vary greatly based upon the type of service provided, the age of existing network elements and internal system development to upgrade billing and numbering software. For routing of NNP calls to function correctly, changes required to networks and software for an IPLRN implementation must be coordinated across all Service Providers. Therefore, the timeline for implementation must allow for the various changes required by different service providers.

Existing legacy TDM networks were not designed with IPLRN or more generally with NNP in mind. Thus, although the IPLRN proposed alternative generally relies upon established capabilities of TDM networks to originate NNP calls to IP networks, it is extraordinarily difficult to contemplate all unintended consequences that could result from such a proposal. Although some evaluations could be more thoroughly evaluated through standards development, some unintended consequences may not be fully understood until implementation.

The FCC should seek comment on the impacts and costs identified in this report in implementing an IPLRN solution to support NNP. Additionally, the related techniques described in this report

should be reviewed by the appropriate subject matter experts in the industry forums that govern changes for those products. Specifically, the Common Interest Group for Rating and Routing (CIGRR) for LERG and the informal LNP Working Group (previously the NANC TOSC) for NPAC SMS.

APPENDIX A:

Nationwide Number Portability Working Group Membership

Chairs:
USConnect
Bridget Alexander White, Staff Director, Business Development

CenturyLink
Philip Linse, Director for Public Policy

Members:
Alliance for Telecommunications Industry Solutions
Jackie Wohlgemuth, Senior Manager of Global Standards Development

AT&T Services, Inc.
Teresa Patton, Principal -Technology Solutions Manager

Bandwidth Inc.
Robert Brezina, Director, Number Management

Charter Communications, Inc.
Glenn Clepper, Director – Regulatory

Comcast Corporation
Beau Jordan, Director, Compliance Legal/Regulatory

Competitive Carrier Association
Alexi Maltas, SVP & General Counsel

Cox Communications
Jennifer Hutton, Bill Application Process and Support Specialist

Inteliquent

Bryan Bethea, Senior Director

National Association of Regulatory Utility Commissioners
Rebecca Beaton, Infrastructure Manager, Washington Utilities and Transportation Commission

NTCA – The Rural Broadband Association
Brian Ford, Director of Industry Affairs

Peerless Network, Inc.
Julie Oost, Vice President of Regulatory Affairs and Contracts

Public Service Commission of Nebraska
Cullen Robbins, Director of Communications

SIP Forum
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T-Mobile USA, Inc.
Rosemary Leist, Senior Numbering Policy Manager, State Government Affairs, Legal Affairs

Telnyx Inc.
David Casem, CEO

TDS Telecommunications LLC
Paul Nejedlo, Senior Administrator – Number Management

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Mark Desterdick, Distinguished Member of Technical Staff

Non-Voting Members:
iconectiv, LLC
Chris Drake, Chief Technology Officer

Somos, Inc.

Mary Retka, Senior Director for Industry Relations

APPENDIX B:

Nationwide Number Portability Technical Subcommittee Membership

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Somos
Mary Retka, Vice President for Industry Relations

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Teresa Patton, Principal, Technology Solutions Manager

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Philip Linse, Director for Public Policy

Charter Communications, Inc.
Glenn Clepper, Director - Telephone Regulatory

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Beau Jordan, Director, Compliance Legal/Regulatory

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Telcordia Technologies, Inc. dba iconectiv
Chris Drake, Chief Technology Officer

T-Mobile USA, Inc.
Rosemary Leist, Sr. Numbering Policy Manager

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David Casem, CEO

Appendix C: Glossary

Abbreviations:

ACQ	All Call Query
ATIS	Alliance for Telecommunications Industry Solutions
CCA	Competitive Carrier Association
CdPN	Called Party Number
C4	Class 4 Switch
C5	Class 5 Switch
CSCF	Call Session Controller Function
I-CSCF	Interrogating - Call Session Controller Function
P-CSCF	Proxy - Call Session Controller Function
S-CSCF	Serving - Call Session Controller Function
CTIA	CTIA – The Wireless Association
DNS	Domain Name System
ENUM	Electronic Numbering
FCC	Federal Communication Commission
FQDN	Fully Qualified Domain Name
GIS	Geographic Information System
HSS	Home subscriber server
IP	Internet Protocol
IPLRN	Internet Protocol Location Routing Number
IP-NNI	Internet Protocol-Network to Network Interface
ISUP	Integrated Services Digital Network User Part
ISP	Internet Service Provider
IXC	Inter Exchange Company
LATA	Local Access and Transport Area
LCR	Least Cost Routing
LD	Long Distance
LERG	Local Exchange Routing Guide
LRN	Location Routing Number

LNP	Local Number Portability
LSMS	Local Service Management System
MSC	Mobile Switching Center
NANC	North American Numbering Council
NANC FON WG	North American Numbering Council Future of Numbering Working Group
NGGW	Non-geographic Gateway
NGLRN	Non-geographic Location Routing Number
NLRN	National Location Routing Number
NNI	Network to Network Interface
NNP	Nationwide Number Portability
NNP WG	Nationwide Number Portability Working Group
NP	Number Portability
NPA	Numbering Plan Area
NPAC	Number Portability Administration Center
NPDB	Number Portability Data Base
NPRM	Notice of Proposed Rule Making
NSP	Network Service Provider
NXX	Exchange
RBOC	Regional Bell Operating Company
PCMU	Pulse Code Modulation u-law
POI	Point of Interconnection
p-ANI	Pseudo-Automatic Number Identification
PSAP	Public Safety Answering Type
PSTN	Public Switched Telephone Network
RS	Route Server
SBC	Session Border Controller
SIP	Session Initiation Protocol
SP	Service Provider
SOA	Service Order Administration
SS7	Signaling System 7

TDM	Time-Division Multiplexing
TN	Telephone Number
UAC	User-Agent Client
UAS	User Agent Server
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
VoIP	Voice over Internet Protocol

Definition of Terms:

A

All Call Query (ACQ) is the requirement or function of originating Service Providers querying the called party telephone number in the routing database, on every call to determine LRN.

Alliance for Telecommunications Industry Solutions (ATIS) is a standards body where companies in the information and communications technology (ICT) industry come together to address common, critical priorities. ATIS is accredited by the American National Standards Institute (ANSI).

C

Called Party Number (CPN) is a telephone number that has been dialed to reach a destination.

Call Session Controller Function (CSCF) represents a series of SIP servers or proxies, collectively called Call Session Control Function (CSCF), are used to process SIP signaling packets in IP call flows.

Interrogating - Call Session Controller Function (I-CSCF) is a proxy server retrieves information from IMS core elements for purposes of SIP registration and call set up.

Proxy - Call Session Controller Function (P-CSCF) is the first point of contact for the IMS core network. End-user devices connect to the proxy, and it forwards all messaging request to the applicable IMS Core elements registration, security, routing, etc.

Serving - Call Session Controller Function (S-CSCF) is the central node of the signaling plane. It is a SIP server but performs session control too. It is always located in the home network. It interfaces to the HSS to download user profiles and upload user to S-CSCF associations.

Class 4 Switch or tandem, telephone switch is a U.S. telephone company central office telephone exchange used to interconnect local exchange carrier offices for long distance communications in the public switched telephone network. It doesn't connect directly to any telephones; instead, it connects to other class-4 switches and to class-5 telephone switches.

Class 5 Switch is a telephone switch or telephone exchange in the public switched telephone network located at the local telephone company's central office, directly serving subscribers. Class-5 switch services include basic dial-tone, calling features, and additional digital and data services to subscribers.

Competitive Carrier Association (CCA) trade association representing rural wireless communications industry.

CTIA – The Wireless Association is a trade association representing wireless communications.

D

Domain Name System (DNS) a hierarchical and decentralized naming system for computers, services, or other resources connected to the Internet or a private network. It associates various information with domain names assigned to each of the participating entities.

E

Electronic Numbering (ENUM) is a data type that consists of predefined values, being able to map the same phone number no matter where you are.

Exchange (NXX) is the three-digit code that forms the second part of a 10-digit telephone number. The NXX is also known as the "central office code" or "exchange".

F

Federal Communication Commission (FCC) The FCC regulates interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Columbia and U.S. territories. An independent U.S. government agency overseen by Congress, the commission is the United States' primary authority for communications law, regulation and technological innovation.

Fully Qualified Domain Name (FQDN) refers to the hostname component of a URI and whose value is determined by a service provider.

G

Geographic Information System (GIS) An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.

H

Home Subscriber Server (HSS) is a master user database that supports the IMS network entities that handle calls. It contains the subscription-related information, performs authentication and authorization of the user, and can provide information about the subscriber's location and IP information.

I

Internet Protocol (IP) is a packet-based protocol used to exchange data over computer networks. IP handles addressing, fragmentation, reassembly, and protocol demultiplexing. It is the foundation on which all other IP protocols (collectively referred to as the IP Protocol suite) are built.

Internet Protocol Location Routing Number (IPLRN) is a location routing number that is used to port numbers to and route non-geographically assigned telephone numbers to the IP enabled carriers.

IP-Network to Network Interface (IP-NNI) is an interface that specifies signaling and management functions between two networks. An NNI circuit can be used for interconnection of signaling (e.g., SS7), Internet Protocol (IP). It is also the name of a joint ATIS and SIP Forum Task Force.

Inter Exchange Carrier (IXC) is a telephone company providing connections between local exchanges in different geographic areas. They also provide local access and transport area services as per the Telecommunication Act of 1996. They are commonly referred to as long-distance carriers.

Integrated Services Digital Network User Part (ISUP) is part of Signaling System No. 7 (SS7), which is used to set up telephone calls in the public switched telephone network (PSTN). Link to additional info.

Internet Service Provider (ISP) an organization that provides services for accessing, using, or participating in the Internet.

L

Local Exchange Routing Guide (LERG) The iconectiv® LERG™ Routing Guide is an output from the BIRRDS database. It is used by Service Providers (SP) and other carriers as a common means to reflect and exchange current and planned Central Office (CO) Code (NPA-NXX) and Thousands-Block (NPA-NXX-X) assignments along with associated routing data. Data is provided for all SPs in the North American Numbering Plan (NANP). It is generated monthly in its entirety, with daily change activity also available. See “Telecom Routing Administration (TRA)” definition.

Least Cost Routing (LCR) the process of selecting the path of outbound communications traffic based on cost.

Local Access Transport Area (LATA) is a geographical area designated as a LATA in the National Exchange Carrier Association. It often defines an area where a Regional Bell Operating Company is permitted to offer exchange telecommunications and exchange access services. Currently, the geographic scope of a local routing number is limited to a LATA, meaning numbers can only be ported within a LATA assignment.

Long Distance (LD) is a telephone call made to a location outside a defined local calling area or those calls that cross LATA boundaries.

Local Routing Number (LRN) is a ten-digit number in a database called a Service Control Point (SCP) that identifies a switch for a local telephone exchange. The assignment of a location routing number to telephone numbers allows for local number portability.

Local Number Portability (LNP) refers to the ability of a "customer of record" of an existing fixed-line, VoIP or mobile telephone number assigned by a carrier to reassign the telephone number to another carrier.

Local Service Management System (LSMS) is a system used by a Service Provider which receives data broadcast from the Number Portability Admiration Center (NPAC). The LSMS provisions the Service Provider's downstream systems, such as its call routing database.

Legacy Wireline Switch (LWS) is a telephone switch or telephone exchange in the public switched telephone network, directly serving subscribers. Also called a Class 5 Switch or TDM switch, an LWS is a computer specialized for TDM-based, circuit-switched telephone calls. Services include basic dial-tone, calling features, and additional digital and data services to subscribers connected to a local loop.

M

Mobile Switching Center (MSC) is the primary service delivery node for Global System for Mobile Communications (GSM), responsible for routing voice calls and SMS as well as other services. It also enables mobile devices to communicate with other mobile devices and telephones in the Public Switched Telephone Network (PSTN).

N

North American Numbering Council (NANC) is a Federal Advisory Committee that was created to advise the Commission on numbering issues and to make recommendations that foster efficient and impartial number administration.

NANC Future of Numbering Working Group (NANC FON WG) a working group that was once formed by the NANC to discuss a wide array of Numbering issues and is no longer operational.

Non-geographic Gateway (NGGW) are VoIP nodes, that host NGLRNs and provide connectivity to Service Providers that port in NNP TNs.

Non-geographic Location Routing Number (NGLRN) is a model supporting nationwide number portability by establishing a new numbering admiration network gateway function for the assignment and porting of telephone numbers to NGLRN vs. a traditional local routing number.

National Location Routing Number (NLRN) is model supporting nationwide number portability using existing LRNs. The approach allows TNs to be ported beyond the current LATA boundaries, thereby allowing TNs to be made available to customers in any geographic location across the nation.

Nationwide Number Portability (NNP) is the ability of users of telecommunications services to retain existing telecommunications numbers without impairment of quality, reliability; or convenience when switching from one telecommunications carrier to another or when moving from one physical location to another.

Nationwide Number Portability Working Group (NNP WG) is a working group formed by the NANC to discuss the process of moving from geographic number portability to national number portability.

Network to Network Interface (NNI) an interface that specifies signaling and management functions between two networks.

Network Service Provider (NSP) a business or organization that sells bandwidth or network access by providing direct Internet backbone access to internet service providers and usually access to its network access points.

Notice of Proposed Rule Making (NPRM) a public notice that is issued by law when an independent agency of the US government wishes to add, remove, or change a rule or regulation as part of the rulemaking process.

Number Portability (NP) allows the customer of record to reassign the number to another carrier ("Service Provider portability"), move it to another location ("geographic portability"), or change the type of service ("service portability").

Number Portability Data Base (NPDB) see Number Portability Administration Center (NPAC).

Numbering Plan Area (NPA) divides territories into Numbering Plan Areas (NPAs), each identified by a three-digit code commonly called area code. The NPA is the first three digits of a ten-digit telephone number (**NPA**)-NXX-XXXX or **303**-372-1000.

Number Portability Administration Center (NPAC) The database that contains routing information on ported Telephone Numbers (TN) and Thousands-Block Number Pooled Thousands-Blocks (NPA-NXX-X) and facilitates the updating of the routing databases of all subtending Service Providers (SP) in the portability area. Also called the Number Portability Administration Center (NPAC) Service Management System (SMS)

P

Pseudo-Automatic Number Identification (p-ANI) A 10-digit number used for the purpose of routing an E9-1-1 call to the appropriate Public Service Answering Point (PSAP). P-ANIs include but are not limited to: ESRD, ESRK, and ESQK numbers. If a North American Numbering Plan (NANP) Telephone Number (TN) is used as a p-ANI, this number cannot be Assigned to a customer. See "Administrative Numbers" definition.

Public Switch Telephone Network (PSTN) is the aggregate of the world's circuit-switched telephone networks that are operated by national, regional, or local telephony operators, providing infrastructure and services for public telecommunication. The PSTN consists of telephone lines, fiber optic cables, microwave transmission links, cellular networks, communications satellites, and undersea telephone cables, all interconnected by switching centers. Thus, allowing most telephones to communicate with each other. Originally a network of fixed-line analog telephone systems, the PSTN is now almost entirely digital in its core network and includes mobile and other networks, as well as fixed telephones.

Post Code Modulation u-law (PCMU) a method used to digitally represent sampled analog signals.

Point of Interconnection (POI) The physical location where a Service Provider's (SP) connecting circuits interconnect for the purpose of interchanging traffic on the Public Switched Telephone Network (PSTN).

Public Safety Answering Point (PSAP) a call center where emergency calls initiated by any mobile or landline subscriber are terminated.

R

Route Server (RS) is a routing server for a SIP network. Route Server can be deployed as a routing server for Local Number Portability queries.

S

Session Border Controller (SBC) is a network element deployed to protect SIP based Voice over Internet Protocol (VoIP) networks. The functions include security, connectivity between networks, quality of services policy, and media (voice, video, and other) services.

Session Initiation Protocol (SIP) is a signaling protocol used for initiating, maintaining, modifying, and terminating real-time sessions that involve video, voice, messaging and other communications applications and services between two or more endpoints on IP networks.

Service Provider (SP) is a company that has traditionally provided telephone and similar services allowing users to send and receive telephone calls and faxes.

Service Order Administration (SOA) is a hosted or managed service that automates the process of updating the Number Portability Administration Center (NPAC) during the number porting process.

Signaling System 7 (SS7) is an architecture for performing out-of-band signaling in support of the call-establishment, billing, routing, and information exchange functions of the public switched telephone network (PSTN). Link to Wikipedia.

Subscription Version A reference to the subscriber's TN information and the current service provider porting info to facilitate data downloads to the Network.

T

Time-Division Multiplexing (TDM) is a method of putting multiple data streams in a single signal by separating the signal into many segments, each having a very short duration. Each individual data stream is reassembled at the receiving end based on the timing.

Telephone Number (TN) is a sequence of digits assigned to a fixed-line telephone subscriber station connected to a telephone line or to a wireless electronic telephony device, such as a radio telephone or a mobile telephone, or to other devices for data transmission via the public switched telephone network (PSTN) or other public and private networks.

U

User Agent (UA) collectively the **User Agent Client** (UAC) and **User Agent Server** (UAS) is used to establish connections and enable sessions between users and the IMS network.

Uniform Resource Identifier (URI) is a string of characters that unambiguously identifies a logical or physical resource on a network, of which the best-known type is the web address or URL.

Uniform Resource Locator (URL) colloquially termed a web address, is a reference to a web resource that specifies its location on a computer network and a mechanism for retrieving it.

V

Voice over Internet Protocol (VoIP), also called IP telephony, is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks.

Appendix D: Minority Report

North American Numbering Council National Number Portability Technical Working Group
Minority Report

Richard Shockey

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I wish to congratulate the members of the technical sub-working group for their efforts under extremely difficult circumstances. The challenges they face were not of their own making but reflected difficult time lines and challenging policy and economic choices that were beyond the scope of the referral made to the NANC by the Wireline Competition Bureau.

Regretfully I cannot support the report for the principal reason that includes references to IP-LRN (formally NG-LRN) which, in my opinion, should not have been included for consideration as a possible technical solution to the National Number Portability issue.

In my judgement the working group should have focused its limited resources on the N-LRN solution as the only viable option.

In the previous report to the NANC we rejected out of hand the GR-2982 Core (GUBB) solution as in appropriate since it relied on modification to SS7 to implement. It has been apparent for years that SS7 or the entire TDM network architecture cannot and should not be modified as we continue down the road of the all IP Transition of the Voice Communications network of the United States.

The principal issue in IP-LRN's is to facilitate interconnected SIP/IMS networks and tangentially proports to solve the problem of National Number Portability. IP-LRN's are attempting to solve a business model problem for IP centric service providers that should properly be addressed in the Technology Transitions proceeding which has been ongoing for many years now.

The issue of how to facilitate all IP Interconnection for Real Time Voice Communications using NANP numbering has been understood for nearly 20 years and has been well documented. I have been directly involved in many of those efforts.

I would point out several relevant items.

First. For nearly 9 years I was the co-chair of the IETF ENUM working group that produced RFC 6116. ENUM relies on the use of Domain Name System (DNS) technology to perform a number to URI translations. This technology is in use today and is the basis of the ITRS database maintained by the FCC to facilitate the Telephone Relay Service and may be used to help facilitate Video Relay services in the future. ENUM works, its fast, highly saleable though it does have some shortcomings that I will not elaborate on here.

Second. The NANC many years approved a variety of URI fields in the NPAC that could be used for phone number to URI translations at a service layer granularity. Voice Video Text etc. These are collectively the NANC 400 fields. I was directly involved in the design of those fields. Since the introduction of those fields. NOT ONE SERVICE PROVIDER IN THE US HAS EVER PROVISIONED A SINGLE NANC 400 NPAC FIELD.

Third. ATIS and the SIP Forum Network to Network TF tried to deliver to the industry a consensus report on IP interconnection and we concluded there was NO CONSENSUS. ENUM was studied as an option. For now, the elements of the industry are satisfied with negotiated bi-lateral agreements. This may have to change in the future but IP-LRN's are not the optimal technical solution.

https://www.sipforum.org/download/joint-atissip-forum-technical-report-ip-interconnection-routing-atis-1000062-sipforum_twg-6/?wpdmdl=2780

Fourth. It should be pointed out that the Commission has steadfastly refused to classify Interconnected VoIP as a Title II service. The Commission has used its plenary numbering authority under Section 252(e) 1 of the Act to impose mandatory 911 and LNP obligations on VoIP service providers. In my judgement the Commission would have to revisit that decision if it choose to take the IP-LRN solution seriously.

Fifth. The IP-LRN proposal has been significantly modified from its original NG-LRN form that would have potentially mandated IP Gateways in every rate center and LATA's. The Commission has been trying to nudge the industry away from rate centers and LATA's but as the Intercarrier Compensation reform effort proved there is still significant resistance to that effort.

Other Consideration

The Technical subcommittee correctly concluded that there are several issues beyond the scope of the technical working group that will have to be considered if there is to be progress on implementing National Number Portability.

First. It is not clear to me Commission is prepared to address the forest of issues surrounding ratings and tariffs especially on the problem of Originating Access charges. I have serious doubts NNP can proceed without forcefully addressing this challenge.

Second. It is not clear whether IP-NNP or a national system of IP Interconnection will require service providers, especially smaller rural carriers would be forced into accepting the burden of Bi-Directional transport costs to new all IP points of interconnection.

Third. It is not entirely clear whether NNP requires the imposition of National 10 Digit Dialing which would have not just economic impacts but political impacts on states that still permit 7-digit local dialing such as Montana, North Dakota South Dakota, Maine, Vermont, Delaware, Alaska etc.

Fourth . The economic impact of All Call Query on smaller service providers is not well understood. Especially the significant costs of equipment upgrade to enable a localized full cache of the NPAC which NNP would probably require. This is an industry with very very thin margins and some networks are more advanced than others.

This begs the question raised in the NNP WG of whether it is technically feasible to permit some elements of the industry to enable NNP and establish a timeline for others to follow.

Some observers have noted that the impending STIR/SHAKEN Call Authentication Mandate outlined by Chairman Pai and now pending before Congress may result in a mandate to all IP interconnection since the Call Authentication data can only survive carrier to carrier if the call signaling remains SIP/IMS in the call path. There is merit to this argument. Only time will tell if this is the case. It should be noted that STIR/SHAKEN imposes real and significant costs to the industry. In any event the combination of STIR/SHAKEN and NNP and all IP Interconnection may be a “Bridge to Far” for the industry.