LNP

Future-Proofing LNP Architecture

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Understanding the current Local Number Portability (LNP) architecture is an essential step in grasping the complexities associated with LNP implementation and ongoing operations. However, a more important issue is how service providers will address the challenges LNP, or more generically Number Portability (NP), will introduce as the network evolves. This paper discusses these challenges and suggests solutions that will ensure network integrity, solutions which will so-call "future-proof" the evolving network. The discussion begins with brief coverage of inter-company communications and troubleshooting associated with NP services, followed by number pooling and wireless NP. Network routing issues that arise because of database services such as Calling Name (CNAM) and Line Information Database (LIDB) are then addressed. An explanation of multiple dip requirements and the impact on the other network services follows. A brief consideration of geographic number portability and the evolution of service transfer point (STP) and service control point (SCP) technologies will conclude our look at the future of NP.

+ Inter-Company Communications and Troubleshooting

Communications

As other essays have shown, the basic LNP dip—implementing the capability for the switch to retrieve the Location Routing Number (LRN) from the NP database—is an important and well understood requirement of local number portability. This LRN approach was adopted by the industry in 1995 and 1996, and today it has been successfully implemented in over 100 Metropolitan Statistical Areas (MSAs), and it works! It is in the operations support system (OSS) area where complications arise. For example, when a telephone exchange (NPA-NXX) is marked as portable, the LERG needs to be notified. This is required so that carriers introduce the appropriate translations in their switches to begin dipping the LRN database so that calls can be successfully routed. If the NPA-NXX is not marked as portable in the LERG, the infrastructure will route the call as if NP were not introduced, and if the number is ported, the call will nor be completed correctly. Similar call completion examples reside in the Service Order Administration (SOA) process and other OSSs required to implement successful NP services. The majority of problems experienced to-date with number portability basically can be traced to inter-company communications which do not adhere to agreed upon requirements, starting with the contractual inter-connect agreements that define escalation points and going through the agreed-upon LNP process flows. Number portability is well documented, as are the requirements carriers have to operate under to successfully implement this complex service. Thus providers must gather the appropriate information and participate in operations groups to understand their responsibilities necessary for inter-company NP.

Troubleshooting and Repair

Troubleshooting and repair is another critical area in successfully porting a customer from one carrier to another. With NP, carrier identification vie the NPA-NXX has been lost: the routing information for the call has been separated from the switch translation tables and placed in NP databases. This can cause confusion among carriers. For example, if a ported subscriber on a competitive local-exchange carrier (CLEC) places a 10-digit long distance call, the long distance carrier may not be able to latter identify the CLEC as the originating carrier but will instead bill the incumbent local-exchange carrier (ILEC) for the call. In a resale environment where the NPA-NXX still resides on the ILEC switch, opportunities for fraud clearly exist. Another difficulty for troubleshooting and repair involves the multiple global title translations (GTTs) required for proper routing for CNAM, LIDB, Inter-Switch Voice Mail (ISVM), and CLASS. GTTs are covered more completely later in this paper, but basically the distributed database architecture of a number portability environment includes several different points in the SS7 network in which global title translations must occur. If the global titles are not administered correctly, CNAM, LIDB, ISVM, and CLASS services will not work resulting in degraded service and possible call failure.

Inter-connected Signaling System No. 7 (SS7) networks introduce additional challenges in managing the network to ensure correct network routing in an NP environment. In non-NP environments that call for a simple database dip for CNAM and LIDB, it is easy to trace the SS7 call path. With LNP, on the other hand, calls can potentially leave and return to a network several times, making it very difficult to follow the call path to isolate problem areas. Thus the provider must be very careful to implement call-trace capabilities. Then, when a problem arises, the call path within the complexity of LNP can be followed.

+ Number Pooling

When a carrier enters a market, the carrier is assigned a 10,000 block of numbers (and NPANXX) to identify itself for routing and billing considerations. A 10,000 block is required for every rate center in which the carrier operates. Given the number of carriers competing in the market, the number of NPA-NXXs implemented has far exceeded anyone’s expectations, resulting in a severe number exhaust problem. The number portability infrastructure can offer a solution by allowing 10,000 blocks to be shared across carriers on a 1,000 block basis.

Local Service Management System and Database Capacity Concerns Associated with Number Pooling

The way that number pooling is implemented has implications for the database record size. Recent estimates show that the database record size could increase by a factor of five or even more, depending upon how the number pooling capability is implemented within the number portability infrastructure. One number pooling option is to "port on demand", in which blocks of 1,000 are assigned to carriers, but telephone numbers are ported as they are used. Another option which is currently being implemented in several states is "pre-porting", in which a carrier ports a 1,000-block pool from another carrier in the same serving area at the time the block is assigned.

In pre-porting, all 1,000 blocks are ported upon assignment, which impacts the size of the NP database. A coding method called Efficient Data Representation (EDR) can help alleviate the problem by storing all the numbers as one record. For example, in a database environment, EDR would be used in two places. First, the NPAC (Number Portability Administration Center) would use EDR to download data to the local service management system (LSMS). EDR would also be used by the database provider to store data efficiently.

Figure 1 shows how EDR can help aid efficiency. In number pooling, the current guideline is that there can only be up to 100 contaminated numbers, which are numbers that have already been used by customers on that switch. If there are 100 contaminated records, as in the middle column, and they are all consecutive, 1,000 entries would be necessary without EDR but only 101 with EDR: 100 for the numbers that have already been allocated and one for the block of the rest of the numbers. If there are no contaminated records, the entire block can be stored as a single block, as in the third column in *Figure 1*. Therefore, EDR is an efficient coding mechanism, and a combination of pre-port and EDR is the current implementation.

+ *Used by NPAC to download data to LSMS*
+ *Used by LNP database to efficiently store LNP/GTT data*
+ *Example:*

# of DB Records Required
Ported 1,000 Block

	100 CRs	100 CRs	0 CRs
Record Format	9c9c9c…9c	900ccc…c	1,000
w/o EDR	1,000	1,000	1,000
w/ EDR	200	101	1

CRs: Contaminated Records

Figure 1
NUMBER OF DATABASE RECORDS REQUIRED

+ Wireless Issues

Wireless NP involves two sets of issues: rate center issues and the separation of Mobile Station Identifier (MSID) and Mobile Directory Number (MDN). A typical wireless switch and base station implementation covers many, many rate centers, leading to a disparity in the definition of the rate center for the wireline incumbent as opposed to the wireless provider. That disparity has an impact on who can port where, which makes operations cumbersome.

Regarding the second issue, the separation of the MIN and MSID, when a customer ports from a carrier to another, the MDN will remain the same (the customer's dialed phone number), but the MSID changes to the MSID of the new carrier. This separation of the MSID and MDN has a significant impact on handsets, home location registers (HLRs), and SS7 signaling. Portability and roaming require significant changes in the wireless environment; indeed, without roaming wireless number portability would be relatively simple. The roaming component combined with number portability makes wireless NP an interesting challenge.

+ GTT Challenges

Global title translations (GTT) allow the SS7 network to direct queries to the proper database. For all the database services—800 service, Line Information Database (LIDB), calling name (CNAM), inter-switch voice mail—and for enhanced services such as class services, the SS7 network uses the NPA-NXX of the calling/called party to determine where to route the query, i.e., the NPA-NXX points to a database. GTT translates the NPA-NXX of either the calling party or the called party, depending upon the service, into the destination point. When a customer ports from one carrier to another, the database where the information is stored will change. Hence, routing on the NPA-NXX will no longer work since this will route the query to the old database. What is required is to map the old NPA-NXX-XXXX to the new database provider's address. Thus the STP network must be first be able to recognize if a number has been ported. If the NPA-NXX is portable, the query must be sent to the LNP database, which contains not only the LRN for routing but also the information that points ported numbers to the appropriate database (so-called 10-digit GTT information). This is an extensive change to the network for ported numbers, and it requires careful administration and ongoing attention from the network operator.

This SS7 network change has national routing and hubbing impacts. When the change is implemented incorrectly, looping problems internal or external to the SS7 network can cause the utilization of the SS7 network to skyrocket in a matter of seconds. A network carrier must make sure that the SS7 provider has call-trace capabilities and linked-monitoring capability to find out what is happening when utilization jumps so dramatically. Looping associated with NP is a critical issue for network integrity.

+ Multiple Dip Requirements

In the long run, every call will require a NP dip. In the case of an 800 call to a ported-in which the terminating customer subscribes to CNAM, the call will actually require three dips. As porting becomes normal, multiple dips on each call will become more and more common with some call scenarios requiring as many as five different SS7 dips. This evolving multiple SS7 dip environment will create new alternative dip approaches, such as an SS7 mediation device that creates packages of multiple little dips into one big dip, resulting in network efficiencies.

+ Geographic Number Portability

Geographic number portability extends NP beyond the rate center, the mobile switching area (MSA), and the LATA. Geographic portability will occur faster than most people anticipate for several factors including the mismatch between the mobile switching center (MSC) and the wireline rate center as well as competitive factors. Indeed, some CLECs today are offering geographic number portability within their own network. With geographic number portability, several issues must be addressed. Recall the role of the NPACs who are a significant part of the NP infrastructure. Currently, carriers interface to one NPAC for both SOA (Service Order Administration) and the Local Service Management System (LSMS). With geographic number portability, the carrier must provide an interface to multiple NPACs. Doing so, however, will increase the carrier's database requirements by a factor of seven. Another issue involves routing—the current N-1 carrier scheme is inefficient for geographic number portability.

Figure 2 [P. 8]shows the implementation of a typical number port for a region. It has a single SOA interface to a single NPAC, and the local service management system (LSMS) interfaces to a single NPAC as well. Implementation with geographic number portability can be accomplished in two ways. In the first option, as shown in *Figure 3*, [p. 8], the number of NPACs increases to seven or eight, which in turn increases the load on the SOA and local service management system (LSMS). The SOA and LSMS must be much more complicated because they must be able to route a call to the appropriate NPAC.

The next question that arises is which carrier responsible for performing the dip? The N-1 carrier has been defined as the carrier responsible for performing the dip for the current LNP implementation. Case 1 in *Figure 5* [p.9] shows this current implementation, which involves an intra-LATA port with the N-1 carrier performing the dips. In this example, we see that customer 913-111-1234 has ported from carrier 913-111 to carrier 913-222. When the call is placed by someone on the ILEC's switch to this ported customer, the ILEC is the N-1 carrier, so it dips the NP database to determine the LRN of the terminating carrier and then routes the call to the CLEC. This is a very efficient arrangement.

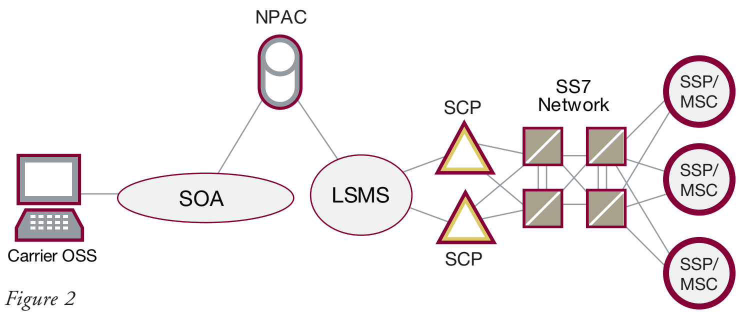

Figure 2

LOCAL NUMBER PORTABILITY

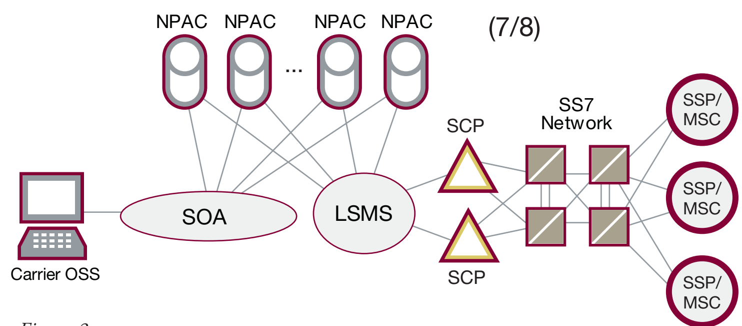

Figure 3

GEOGRAPHIC NUMBER PORTABILITY OPTION 1: DIRECT CONNECT TO ALL NPAGS

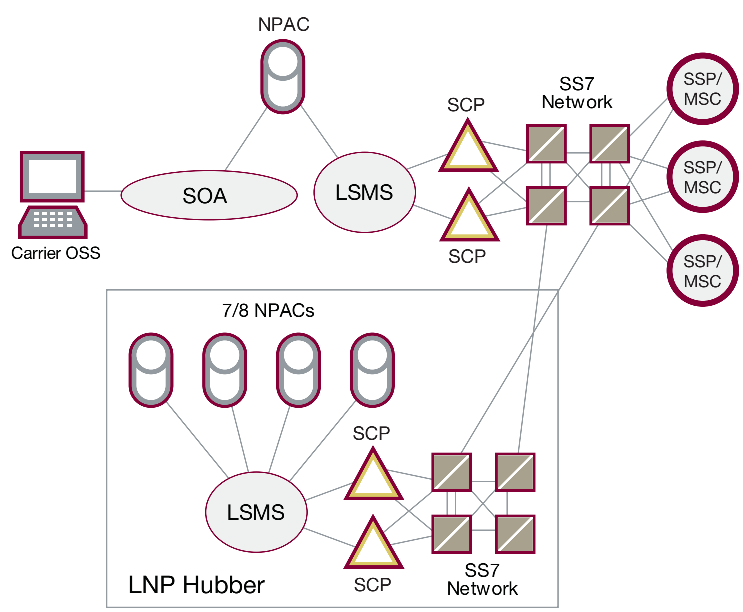

Figure 4

GEOGRAPHIC NUMBER PORTABILITY OPTION 2: LPN HUBBER

In case 2, the 913-111-5678 customer is ported to the CLEC in LATA 2. When a call is placed by a customer of the ILEC in LATA 2 to this ported number; however, the ILEC, under current implementations, will view this as a call destined for the 913 LATA and the call will be routed to the IXC, which becomes the N-1 carrier. The IXC performs the dip and the LRN points the call to the 212-444 CLEC. In this case, transmission and switching facilities are used inefficiently because the N-1 dip approach is geared toward an intra-LATA porting environment. The system will have to evolve to the method shown in stage 3, in which the originating carrier dips for all ported exchanges. In this scenario, the originating carrier, the ILEC 212-333 exchange, will dip the appropriate NP database and send the call to the CLEC without sending the call to the IXC. This is the most efficient routing technique for geographic NP.

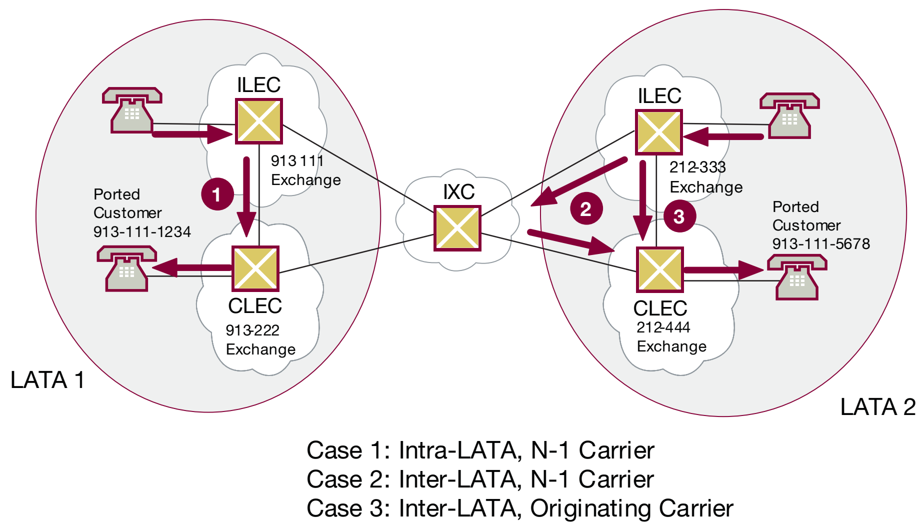

Figure 5
WHO IS THE N-1 CARRIER?

+ Advances in STP and SCP Technologies

There has been some debate over the architecture of NP in terms of how the NP database is implemented. Some argue that the NP database should be a stand-alone SCP, and others argue for integrating the database into the STP. At a very high level, one could argue that STPs are much more efficient for the LRN and GTT functions associated with LNP than are SCPs. SCPs, however, are more flexible for providing additional advanced intelligent network (AIN) services. The STP and SCP technologies continue to develop and, as a result, STPs are incorporating more and more AIN services, and SCPs are increasing in capacity. Therefore, these two technology platforms are basically merging, and within the next few years the differences between them will no longer matter.

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+ Conclusions

The easy part of implementing LNP has been done. What comes next? Many challenges remain. In the next year the industry must focus on developing iron-clad, inter-company communication and troubleshooting capabilities to eliminate the problems that have been caused by not following the rules that have been established to ensure network integrity. This is the most important step in addressing the issues that are emerging with number pooling, wireless, GTT requirements, multiple dip requirements, geographic number portability, and the advances in STP and SCP technologies.