Detailed call flows associated with specific architectural proposals are described, along with those architectures, in Section 13. The following brief high level description is intended to provide a broad understanding of the manner in which calls to a ported number will progress through the networks which are involved in the call path.

A network switch, located in either the originating, terminating, or (n-1)st network in the call path will (1) recognize a potential ported number, and (2) launch a query to the appropriate number portability routing database. If the called number is ported, a record in that database will contain the information to properly route the call, and that information will be forwarded to the network switch in the form of a database response . This information will be used by the network switch to route the call. Additional information within signaling messages may be necessary to provide other network switches in the call path not only the network address required to route the call, but also the original dialed called number and possibly an indication that the database query has been performed. The original dialed number will be used -- depending upon the particular call processing methodology employed -- to properly complete the call in the end office which serves the called party and to effect proper use of calling number based services such as caller ID. A database query indicator will prevent unnecessary, redundant queries.

8.0 Numbering Administration

Number administration typically refers to the assignment and general oversight of both central office codes (code adminstration) and line numbers (line number administration) within those codes. The introduction of number portability demands changes in the manner in which dialable NANP numbers are assigned and administered. In today's non-portable environment, NPA-NXXs, which serve both as customer numbers as well as network addresses, are assigned to local service providers by the local code administrator, typically the dominant LEC, consistent with industry guidelines. Line number assignments within those NXX codes are the responsibility of the assigned service provider. Today, in the United States, the Local Exchange Routing Guide (LERG) provides information on which NPA/NXXs are assigned to which wireline and, in many cases, wireless switches or Points of Interconnection (POI).

8.1 Administration of Portable NPA-NXXs

In a number portable environment, there will exist two types of numbers; dialable, customer numbers, and numbers used exclusively for the routing of calls (i.e., network addresses or switch IDs). Accordingly, the administration of both these types of numbers must be considered, including whether the administrator for these two types of numbers should be the same or different entities. It is generally agreed that with the introduction of number portability, central office code (NPA-NXX) administration should be the responsibility of a neutral, third party, rather than a local service provider. Further, it is understood that line number assignments to end users will continue to be the responsibility of local service providers, but the manner in which those assignments are made will be dependent upon which number administration scenario is chosen.

Two general number administration scenarios can be considered. In the long term, it is possible that customer numbers (NPA-NXXs) will no longer be assigned to specific service providers, but will be assigned by the administrator to a "pool" for use in a given geographic area and accessible for use by all carriers who provide service in that area. Assignment of numbers in this manner offers the benefit of improved utilization of numbers with the potential for reduced demand for additional NXXs and the associated area code relief. This scenario, however, demands that all potentially portable numbers be associated with database records in the SMS, and that all requests for service, whether they involve the porting of an existing number or a request for new service, make use of the SMS for service provisioning (see Section 9). Moreover, with this scenario, there exists no default carrier to which the call could be routed if database information is unavailable, which may prove problematic if the originating or intermediate carrier network cannot launch a query. Furthermore, with no default carrier, announcements necessary for disconnected or vacant numbers must be provided via the switch that launched the query (based upon information obtained from the routing database) rather than via the terminating switch.

Yet another consideration would involve a hybrid scenario which supports the pooling of numbers but still assigns each NPA/NXX to a given service provider. This arrangement offers the benefit of improved utilization of numbering resources derived from pooling, but provides default routing to accommodate those situations where database information may not be available to an originating or intermediate (N-1) carrier. In addition, a hybrid scenario would allow the continued provisioning of vacant code treatment in the terminating switch. This hybrid scenario would require determination of how to assign NPA/NXXs to service providers.

Alternatively, it is possible that existing NPA-NXXs, as well as new NPA-NXXs will continue to be associated with (assigned to) specific local service providers. Customer requests for new service will, therefore, continue to be accommodated as they are today, with line number assignments made by service providers from the specific NPA-NXXs which they are assigned. Porting of numbers will require communication between the service provider assigned the NPA-NXX and the service provider to which a customer chooses to port their number. This communication will lead to the creation of a customer record in the SMS with the information necessary to properly route the call. In this administrative scenario, only numbers which have been ported need to have records in the SMS. Furthermore, default routing to the carrier "assigned" the NPA-NXX can easily be accommodated and announcements for disconnects and vacant numbers can be provided by the default carrier.

It may be advantageous to consider an evolutionary scenario, in which, initially, NPA-NXXs are assigned to service providers with the transfer of the code to the "pool" only after some percentage of numbers have been ported. In this way, the introduction of portability might be effected with an optimum trade-off between the desire to limit the complexities of implementation and the desire to realize the full benefits of portability as quickly as possible.

Finally, it should be understood that the administration of numbers assigned for routing purposes, (e.g., network addresses or service provider IDs) will be the responsibility of the neutral, third party, and that these assignments will continue to be documented in the LERG. Further discusssion of the role of the LERG in a number portable environment is described in Section 8.2, below.

8.2 Industry Notification

Industry notification will be required when an existing NPA/NXX becomes portable, or when a new NPA/NXX that is immediately deemed portable is first introduced. It is expected that existing industry guidelines and notification methods will be modified to accommodate this need. Further study is required in this area.

The Routing Database System (RDBS) is administered by the Traffic Routing Administration (TRA) of Bellcore. The RDBS processes LEC routing and rate center data to produce both on-line and off-line reports for the administration of routing within the NANP (excluding Canada). Results of processing data obtained from the RDBS include:

- The Local Exchange Routing Guide (LERG)
- The NPA-NXX Activity Guide (NNAG)
- The NPA-NXX V & H Coordinates
- The LIDB Access Routing Guide (LARG)

The Bellcore Rating Input Database System (BRIDS) data forms the input for the Industry Number Plan Guide (INPG) and the Telephone Area Code Directory (TACD).

It is anticipated that the entity responsible for CO code administration will continue to enter and maintain the databases from which these documents are produced.

In a portable number environment, the LERG is expected to indicate which NPA/NXXs are designated as portable. The LERG is further expected to document network addresses and their association with service providers (e.g., switch Ids or Network Node Addresses). The LERG might also provide information indicating the service provider to which the NPA/NXX was initially assigned, the geographic area it serves, and the identity of the regional SMS in which information on numbers within the NPA/NXX reside. The actual impact of number portability on the LERG and other industry routing guides (e.g., Seamless Roaming Implementation Guide (SRIG)) requires further study.

9.0 Service Provisioning

Service provisioning in a portable number environment is closely related to the method employed for number administration. It should be recognized that service provisioning should be examined for two distinct activities, the provisioning of service to new customers (i.e., customers who have no existing service in the area) and the porting of service from one service provider to another.

If NPA/NXXs are assigned directly to a pool by the neutral third party **administrator**, control of an existing number might pass to the new service provider upon entry of a change record into the SMS and notification to the previous service provider. Activation of new (previously-unassigned) numbers might be performed by the service provider entering a new record in the SMS

after first scanning the pool of available numbers and making a selection. Alternatively, service providers may be assigned blocks of telephone numbers from the SMS in order to speed the process.

If NPA/NXXs continue to be assigned to service providers, the provisioning process for existing and new numbers could be similar to that described above, with the exception that there is no need to scan the SMS before assigning a new number.

Regardless of whether number pooling or traditional NXX assignment methodologies are employed, transfer of existing numbers will require close coordination between both the new and previous service providers.

Although the considerations reflected in 9.1 and 9.2 generally apply to both wireline and wireless networks, there may be additional considerations unique to wireless services that need further study. For example, most wireless customers are able to enjoy an FCC-endorsed form of mobility known as roaming. Wireless carriers have established a number of distinct and individual partnerships, also known as roaming agreements, with other wireless carriers. These partners carry each other's customer calls when those customers "roam" in a partner's system. At this time, inherent to the functionality of most roaming arrangements is the presence of a Mobile Identification Number (MIN) in each wireless unit. This MIN, which includes the NPA/NXX of the home system, not only facilitates call processing, including rating and routing, but also identifies the home system of the caller to the visiting system. Number pooling, if applied to wireless carriers, may render such agreements unmanageable since identification of the home system might not be possible.

9.1 Number "Pools" for Geographic Areas

Consider one of the number assignment scenarios described above, where numbers are assigned to geographic areas (rather than specific central offices) and are available to all service providers[2]. With this arrangement, all numbers will be identified as working or spare, and those numbers that are assigned will identify the service provider or the responsible organization (RESPORG). As is the case with the SMS used to support the portability of 800 numbers, records will be accessible for modification only to the RESPORG assigned to that number. Porting of service will proceed in a manner identical to the procedures currently in place for 800 service.

9.1.1 Provisioning of Ported Service

Upon receipt of an order from a customer wishing to transfer service, the selected provider must generate a service order and input information into its network and administrative systems. The new service provider must also contact that customer's current provider and indicate the customer's order for the change. The current provider will them transfer RESPORG responsibility for the number, allowing the new provider to access the record. The new provider can then

---

[2] Note that not all service providers' serving areas conform to the same geographic boundaries.

modify the record as necessary, establishing an effective date at which the record will be downloaded to the appropriate routing database(s).

The exchange of Inter-Service Provider Maintenance, Administration and Provisioning (ISPMAP) information between the current and new service providers will require some form of standard data format for ensuring that such information is transmitted and received properly. To develop this standard format, the use of existing information exchange formats, such as the Customer Account Record Exchange (CARE) format, can be expanded to provide a wider functionality satisfying the needs of all service providers. The use of a currently standardized data format, such as the expanded CARE format, will facilitate a timely and efficient means of data exchange between service providers and the SMS.

9.1.2 Provisioning of New Service

The provisioning of new service should be straight-forward. Upon receipt of a customer order, the selected service provider will scan the SMS for available numbers and select a number for assignment to the customer. The service provider will then create the necessary record with the appropriate service date.

9.2 Service Provider-Specific Number Assignments

An alternative number assignment scenario is one in which NPA/NXXs continue to be initially assigned to service providers and the SMS contains records only for numbers actually ported.

9.2.1 Provisioning of Ported Service

Porting of service is similar to that described in Section 9.1.1. That is, the selected carrier will inform the customer's current service provider of the customer's order to change, and if the record exists in the SMS, the current provider will transfer RESPORG responsibility. Because, under this method of number assignment/administration, records exist in SMS only for previously ported numbers, it is possible that no record is in place. If this is the case, the current carrier must first create a record for this number, as it is assumed that only the carrier initially assigned the NPA/NXX will be allowed to create this initial record. After the record is created, the current carrier can then transfer RESPORG responsibility to the new service provider.

9.2.2 Provisioning of New Service

New service may be provisioned without the use of the SMS, in the same manner service is provisioned today, prior to the introduction of portability. Specifically, service providers will provide new customers with service only from the NPA/NXXs they have been assigned.

10. Rating and Recording

Today, call rating is based on information associated with end office location as specified by NPA-NXX. This information is listed in the LERG and related documentation, and specifically provides the V&H coordinates of a given switch or (wireless) Point of Interconnection (identified by NPA-NXX) and the associated rate center. Downstream processing uses Automatic Message Accounting (AMA)[3] data recorded during call processing which identifies the calling and called party location, again as specified by NPA-NXX. This AMA data together with the LERG-based information to determine calling and called party rate centers is used to calculate the distance of the call, and ultimately establish the corresponding rate. The introduction of local competition, and subsequently, number portability, impacts both call recording and rating, for both the end user and access charges billing.

As indicated previously, most call rating is currently performed in a downstream process using call detail information from AMA recordings, which identifies the calling and called (dialed) numbers, and the associated location information provided in the LERG. In a number portability environment, the AMA information may not explicitly provide the necessary location information for call rating. Rather, the downstream rating process will need to determine the appropriate location routing numbers or network node addresses associated with call origination and termination. Accordingly, this process could include a query to a database, either one specifically deployed to provide rating information or perhaps the same as that used to route calls. If both calling and called numbers were ported, two queries and the associated responses would be necessary. Alternatively, the network address of the calling party switch may be identified in the SS7 call setup (signaling) message. Once the location routing numbers (NPA-NXX) or network node addresses were obtained, the specific V&H and rate center data could be determined from tables derived from the LERG. On the other hand, it may be more efficient to include the V&H and rate center data in the database record itself, thereby eliminating any subsequent table look-up. It is possible that within the interval between the time of call processing and the time at which the rating process takes place, a customer may have switched carriers causing the database record to be updated accordingly. In this situation, a database query and response during the rating process would provide inaccurate information and an improper rate. This difficulty would be avoided if, at a minimum, the location routing numbers or network node addresses of ported calling and called party are included in the AMA record. Including the V&H and rate center data as well would preclude the need for additional database queries or table look ups during the downstream rating process.

Moreover, if V&H and rate center data are part of the database record, those data could be associated with the customers premises rather than with the customers serving wire center. Association of rating data with the customers premises would resolve any potential rating problems that might otherwise arrise. This association has not been done previously, and may lead to significant development and administrative issues, possibly depending on the number of additional data points involved. Another potential solution is the use of distance insensitive, postalized rates.

10.1 Impact on Billing Information

[3] Similar considerations apply to other billing formats such as CIBER and CDR.

Billing information systems may be heavily affected by Location Portability and Service Provider Portability. Traditionally, there are extensive edits within the systems to control the validity of numbers. These edits will require modifications to allow numbers which were formerly outside the scope of the entity to be stored in CRIS accounts and Message Processing Systems. These systems will also need modifications to control these non-standard numbers and ensure that they are used properly. The systems will need to be able to identify numbers which were formerly assigned to one entity, but were transferred to another entity.

Treatment processes will need to react to the new scenarios. Accounts (identified by Telephone number) are often retained for extended periods subsequent to disconnect to permit collection of unpaid amounts. When a customer transfers to another service provider and retains her TN, information about the transfer may need to be stored for this purpose.

Sent Collect Messages, i.e., billing detail for calls originated in one service provider's area but billed in another, will also be impacted by number portability. Within the settlements processes, these messages are transmitted (and proccessing charges billed) to the proper billing carrier based upon the NPA/NXX of the charged telephone number. Changes will be required to message processing systems to ensure that the appropriate billing carrier can be identified in a portable number environment.

10.2 Impact on Telephone Call Accounting Systems

It has been suggested that number portability, in particular location portability, will impact existing telephone call accounting systems such as those used by universities, hotels/motels, some payphone providers and other entities. These call accounting systems use their own call rating databases based on the NPA-NXX association with unique V&H coordinates. Suggested solutions include the use of postalized rates, or allowing call accounting systems access to the information stored in the appropriate SMSs.

10.3 The Impact of Regulation

The method used for call rating in a competitive, number portability environment will likely be controlled by regulatory directive. If a state commission[4] accepts the fact that different charges may be incurred on calls made to a given party after that party has changed service provider, the process of call rating could remain the same. That is, call rating could continue to be based upon the V&H and/or rate center of the calling and called party serving offices. In such a case, the end user may experience the problem of unexpected toll charges as detailed in section 11.2.

If, however, a commission considers the prospect of such price variation, and especially the possibility of unexpected toll charges to be unacceptable, it may

---

[4] It is important to note that in Docket PR 94-103-109 the FCC preempted the states from regulating CMRS rates and entry conditions. Also, CMRS providers have been granted calling areas that do not conform to wireline calling areas. Both of these factors differentiate CMRS providers from wireline entities and could influence number portability initiatives.

direct the industry to adopt consistent rate center boundaries or to perform call rating based upon the location of the customers premises, rather than the location of that customer's serving central office. In either situation, whether calls are rated based upon the location of a serving end office, or rated based upon the location of a customers premises, changes in the rating process will be necessary.

Finally, one other solution which would mitigate any added complexity which might otherwise be encountered with call rating, in a number portability environment, would be the use of flat, distance insensitive (e.g., postalized) rates. The use of such a rating and charging scheme would again be subject to regulatory approval.

11.0 End User Impacts

Solutions developed for number portability should, to the extent possible, be transparent to both called and calling customers in respect to call setup delay, use of existing features, toll charges, transmission and service quality and blocking. Concerns have been expressed regarding the ability of any solution identified thusfar to fully meet this objective. The following section details a number of these concerns.

11.1 Impact upon Portability Subscriber

The focus of the Workshop thus far has been on terminating calls to a ported number customer. It is generally acknowledged, however, that calls originated by a ported number customer should allow both the calling and called customer full use of their subscribed features. In addition, number portability must allow customers use of their (ported) number for both receiving and placing calls. Solutions that utilize a different (calling) number associated with the placement of outgoing calls may prove problematic because of their potential to cause customer confusion for both called and calling customers. For example, called customers with Caller ID terminals may see a different number displayed from that which was expected from the calling party. A similar situation may be encountered if the ported number customer dials the Operator, business office, customer care center or a 911 service provider. The calling or called customer may also see that his calls are billed to, or received from a number that is different from the number that was expected.

Existing and planned services that provide unique routing based upon the calling number assume that the originating location can be determined by screening the NPA/NXX of that number. For example, some national retail chains may advertise a single 800 number for callers to dial from any area of the country. Callers are routed to the closest outlet, based upon the NPA/NXX of the originating number. In addition, wireless carriers are able to determine which numbers are home versus roamer in any particular system via NPA/NXX or a similar form of screening. Misdirected calls may result if the network cannot screen all 10-digits to determine the originating location. Access to the LNP database may need to be provisioned for such services, and the database may need to contain some indicator of the serving location.

Another concern is that with number portability, ported number callers attempting to transmit or receive packet or circuit-switched data over ISDN lines may be unable to do so, due to the lack of portability between data networks.

11.2 Impact upon Party Calling Ported Number Customer

For individuals calling a ported number customer, the dialed number may no longer be sufficient in identifying the physical location of the called party. There is also some concern that certain calling features, e.g., CLASS features, such as Repeat Dialing and Automatic Callback Calling[5] may be compromised. These features rely on signaling messages passed between the originating and terminating switches to monitor the status of the called line. A problem may arise because the type of signaling messages employed today cannot access a database to determine if the serving switch is different from that assigned the NPA/NXX of the called number. Without this determination, these features may not function properly. Expanded translations within the STPs could be employed to solve this problem, but are viewed by many as overly burdensome and otherwise limiting.

Another concern is that the calling party may incur charges not expected when placing calls to a ported number. For example, under a location portability environment, an end user may be allowed to retain his number when moving to a distant city. Callers served by the same NXX may be unaware of the move, assume that the call they are making is still local in nature, and be surprised when they receive a toll bill. A similar situation may occur if there is no consistency in rates between competing providers serving the same area, e.g., calls to ported numbers served by one carrier may be billed differently than calls to other numbers within the same NXX, or if the serving switch and its network address (NPA/NXX) is outside the rate center of the calling/called customer. In addition, numbers within NPA/NXXs used to uniquely identify a type of service (e.g., Calling Party Pays), if ported, may result in improper or unexpected charges to the calling or called customer, if the new service provider does not conform to the service in question.

Some have suggested the need for a special announcement or "toll warning tone" to precede the establishment of ported number calls to advise callers that a toll charge may apply. Such tones or announcements may quickly become obtrusive on subsequent calls to the same number, however, and be considered as discriminatory if only applied on calls to ported numbers.

11.3 Post Dial Delay

Since, in a number portability environment the dialed number will no longer identify the actual terminating location of the called party, the network will need to employ some other means (e.g., number retranslation or external database access) to identify and terminate the call to the proper destination. Such mechanisms will add some delay to the actual time required to connect the called and calling parties. The amount of additional post dial delay will vary depending on the actual methodology, implementation and architecture used to provide the

---

[5] Repeat Dialing allows the user to activate a feature which repeatedly checks the status of a busy line and notifies the caller if the line becomes idle within a given period of time. Automatic Callback Calling allows the user to return the last call received.

capability. The potential for noticeable (additional) delays by the calling party must be closely scrutinized for any solution under consideration.

12.0 Technical Considerations

Besides the potential impacts of number portability on end users, there are a number of concerns regarding its impact on service providers' networks and support systems.

12.1. Impact on SS7 Signaling

It has been suggested that number portability could have a significant impact on service providers' SS7 signaling networks. Several INC contributions have suggested that although the existing links between the end offices and the STPs may be sufficient to handle the additional traffic generated by number portability, the number of new links provisioned between the STPs and routing databases could be substantial, as described in section 12.5.

In addition to the number of SS7 messages required, some alternatives for number portability suggest new uses of existing parameters such as the Generic Address Parameter (GAP). The suggested uses of these new parameters may increase the length of SS7 messages used for NP. Some of these issues are presently under consideration by Committee T1.

12.2 Interworking/MF Signaling.

Some alternatives proposed for number portability require that SS7 signaling links be employed end to end in the call path. This may not accommodate current network configurations which involve a mix of both SS7 and inband signaling trunks. Accordingly, SS7/MF interworking impacts must be considered.

12.3 Impact on Switches/Service Switching Points

It has been an assumption of this workshop that switches cannot perform translations past the NXX for more than a minority of calls. The call processing and administrative burdens are considered too great for switches to perform 10-digit translations on all calls.

To accommodate number portability on a wide scale, switches and access tandems equipped with SSP functionality must be programmed to recognize portable NXXs and launch queries to the appropriate network databases. If a switch lacks SSP functionality, the switch must hand the call off to another switch (or Access Tandem) that has SSP functionality. The switch or Access Tandem with SSP functionality must be able to act upon the instructions from the routing database. These routing instructions may require the switch/SSP to interpret SS7 messages or fields in these messages in a manner different from what is done currently, thus dictating the possible need for hardware and/or software modifications. Standards efforts may be required for these proposed modifications as well. Furthermore, it has been suggested that some alternatives for number portability identified thus far require new or significantly-modified routing tables within the switch.

The use of external databases to support number portability may dictate the need for the development of new AIN or IN triggers to launch queries from various switching nodes within the call path. Some of the triggers currently available may be unsuitable for number portability because they were developed for a specific purpose, have already been assigned for other service applications, or if used for number portability, may negatively impact some existing services. Proper sequencing of events associated with any new trigger(s) also becomes critical to ensure that certain attributes of the call (e.g., carrier preselection) are maintained.

The proper sequencing of translation changes in the donor and recipient switches, in coordination with updates to the routing databases, will also be essential to prevent misroutes and "looping" conditions, whereby the recipient switch does not recognize the dialed number as resident within and attempts to reroute the call back to the donor switch.

12.4 Signal Transfer Points

Service provider portability will cause increased SS7 traffic due primarily to increases in the number of non call-associated (TCAP) messages and due secondarily to increases in the length of SS7 messages. This may increase the number of links required at the STP. Specifically, the number of links to the routing database(s) will depend upon the penetration of number portability, the method used to provide it within a given area, and the use of services associated with ported numbers that require non call-associated messages.

At the STP, Global Title Translations (GTTs) examine the called and/or calling number to determine the proper signaling end point to which the message should be routed. The identity of the signaling end point is generally associated with a Destination Point Code (DPC). Currently, most GTTs are 3 or 6 digits - that is, routing is determined by examining only the NPA or NPA/NXX. In the event the STP is required to perform this function to support number portability, the size and administration of GTT tables becomes a concern. Furthermore, GTTs are processing-intensive, and some STPs have upper limits on their processing capacity.

Specific areas of concern with respect to GTTs include:

- GTT Changes for Existing Services

  As described elsewhere in this document (Sections 12.7.3 & 12.8.3), some existing services that currently use 6-digit GTTs would require 10-digit GTTs for ported NPA/NXXs. 10-digit GTTs would be necessary to route the TCAP message to the proper SSP or SCP. Two such examples are services such as Automatic Callback/Repeat Dialing and Calling Card Validation.

- Routing Portability Queries to the Routing Databases

  For a given network, as long as all portability queries for all called numbers within a given NPA/NXX are routed to the same SCP(s), 6-digit GTTs are sufficient. If number portability expands

beyond a limited geographical area, however (e.g., state or nationwide portability), 10-digit GTTs may be required to determine which SCP(s) contains the necessary routing information for a particular number. In addition, some have suggested that a new SS7 Translation Type may be required to route the query to the SCP(s) dedicated to number portability.

Several potential solutions to the 10-digit GTT concern have been proposed, but may involve various economic and administrative tradeoffs. They include upgrades to existing STPs (e.g., larger GTT tables), STP adjuncts to perform the GTTs, or use of other signaling components (e.g., SCPs) to perform this function. The impacts of each on current signaling functionality must be fully assessed.

12.5 Routing Databases

As mentioned in section 7.1.2 the routing databases will contain information allowing for the routing and rating of calls to portable numbers. The queries must be received and responses formulated and transmitted so as not to significantly increase call set-up time. The database responses must be able to be interpreted by the SSPs setting up the call. Databases may be deployed in mated pairs, should be sized to accommodate the anticipated transaction requirements, and should be designed for appropriate levels of reliability.

An INC presentation has suggested that if portability were widely deployed, a LEC's network may only be able to handle data base queries generated locally, not those launched from other areas. The significance of this discovery is that calls to ported numbers that originate from outside of the specific area in which portability is deployed may have to access data bases other than those handling traffic originating within the area. This implies that unlike the LIDB (Line Interface Data Base, used for calling card service) model, multiple sets of redundant data bases may need to be deployed to accommodate number portability signaling traffic.

12.6 Impact on Operations Systems

The structure of the existing embedded base of legacy systems used by most regional telephone companies was designed around the idea that a telephone number has a specific, non-mobile, geographic relationship that exists from the time the number is placed into service until that number is removed from service. Provisions were made for movement of the telephone number from one location to another, but with restrictions within certain geographic areas (i.e., within the area served by the wire center).

Current operations systems use either a seven or ten digit identification of the telephone number. Those systems that use only a seven digit number identification cannot support a number portability scheme and would require modification to their database structure to permit the identification of lines with a ten digit identifying telephone number. In the cases where the operations systems support a ten digit number the impacts become administrative.

Most operations systems are deployed with specific administrative boundaries and areas of responsibility. The introduction of number portability will tend to conflict with the administrative boundary scheme used with the operations systems. Many operations systems use geographic specific databases, an example being the Service Order Administrative and Control System (SOAC).

The NPA-NXX code is used internally by service providers for customer contact, provisioning, maintenance, installation, and planning functions. The operations systems that support these functions are highly automated and may require significant modification or replacement as number portability is introduced. For example, wireline provisioning systems generally include a "flow-through" capability which automatically assigns the outside plant facilities, telephone number, and central office equipment to a new service order. They also provide mechanized updates to repair bureau and directory listing databases. NXX sharing or the association of more than one number with an individual customer will compromise this process.

12.7 Impact on Switch Features

Of special concern to service providers is the impact of number portability on existing features and services, especially those that rely on the transmittal of the proper calling number or the association of a (called or calling number) NPA/NXX with a specific serving switch. A partial listing of potentially-affected features follows.

12.7.1 Call Forwarding

Some solutions employ the use of certain call forwarding triggers and/or signaling parameters to launch database queries and transmit routing information to other switches in the call path. It is essential that, when invoked, the call forwarding feature continues to function properly and that both the original called and calling numbers are received and properly interpreted by the terminating switch.

12.7.2 Caller ID/ Calling Number Delivery Blocking

When a call is placed by a calling party who has a portable number, the called party expects to receive a recognizable, dialable number of the caller on the display unit. Similarly, customers that build call blocking or screening lists will populate them with dialable numbers of parties they wish to deny or allow. Solutions that transmit special routing or non-dialable numbers in the calling number field of the signaling message may disable or otherwise compromise such services.

12.7.3 Automatic Callback/Automatic Recall

Use of currently available originating triggers for AIN Release 0.1 (e.g., PODP) for number portability will result in the denial of these two features. This may dictate the need for a unique, AIN trigger or an upgrade to a newer AIN release. Furthermore, these features may require the use of 10-digit GTTs in order to function properly.

12.7.4 Network Voice Messaging

Some voice messaging services employ the use of TCAP messaging to provide a message waiting indicator to the called line after treatment of the incoming call is rendered at a centralized location. As indicated in section 12.4, current TCAP messages rely on the association of the NPA/NXX with a particular switch for identifying the proper destination.

12.8 Impact on Operator Services

The Operator Services (OS) networks deployed by most OS providers use inband, multifrequency (MF) signaling. These OS systems rely on NPA/NXX screening for most functions, including call routing and rating. Although data base queries are performed for certain billing validation purposes, (e.g., credit card, collect, and third number billed calls), there is currently no provision for performing a separate data base query to a Number Portability Data Base (NPDB) to determine the actual terminating location. The following represents several concerns identified thusfar regarding the potential impact of number portability on certain operator functions.

12.8.1 Busy Line Verification

One concern is the impact of number portability on the provisioning of busy line verification/barge-in services. To verify a busy line on an intraLATA call, today the operator keys in the number to be monitored. The operator switch (e.g., TOPS, OSPS) seizes a no-test trunk to the terminating office based upon the keyed NPA/NXX. If the monitored line is within the LATA but served by another Operator Services provider, the operator can establish a connection directly to that provider if Inward Operator trunks have been provisioned between both. Similarly, for interLATA busy line verification traffic, the operator may be able to transfer the request to the operator of the customer's choice if Operator Transfer trunks exist. There is currently no means for temporarily suspending the action to perform a data base query to determine if the desired number is now served from a different end office,carrier or LATA.

12.8.2 Emergency Calls

Another issue involves emergency situations whereby an end user dials the operator (0-), reports an emergency, and either hangs up or is unable to provide location information. One issue is what information the Operator is given for the end users number.

If location portability is allowed, the operator may not be able to determine which police or fire department to contact by examining the Calling Party Number. Although such situations are encountered today where an NPA/NXX is served by multiple fire/police districts, the problem could be exacerbated by the introduction of location portability.

12.8.3 0+, 0- Calls Made by the Ported Number User

When placing a 0+ or 0- call using a calling card, the Operator switch will attempt to validate the calling card number by launching a query to the LIDB that serves the billing number group (e.g., NPA/NXX) of the calling card number. The call will be denied if the new service provider does not have that calling card number loaded in the same LIDB as that used by the previous service provider. A 10-digit Global Title Translation (GTT) may be performed at the STP, which is used to properly route the query to another LIDB, but the number of GTT slots available in a STP are limited, and performing the necessary translations changes for all ported numbers could become extremely burdensome.

12.8.4 0+, 0- Calls Made to Ported Numbers

In the direct-dialed (1+) environment, the originating end office will perform the database dip on an intraLATA call to determine the actual terminating service provider and/or location. For 0+ calls, however, this method cannot be employed today, because the Operator switch trunks employ MF signaling, which precludes the ability to forward information on the actual terminating service provider from the originating end office to the Operator switch.

Today, the Operator switch does perform a database dip to LIDB to validate the calling card number or special billing arrangement (e.g., collect, 3rd number billing). In order to identify the proper terminating provider/location for subsequently routing the call to its final destination, a second database dip would need to be performed to the NPDB. If SS7 trunking is available, that information can be forwarded either direct to the terminating provider or via an access tandem. For Operator switches, however, this may create a problem because they may only be equipped with MF trunking.

Additional software would need to be provisioned at the OPERATOR switch to perform the second database dip and undesirable call set-up delays may be encountered. If the calling party is dialing his/her own number, it may be possible to include terminating service provider information in the LIDB response (similar to Billed Party Preference information) but this would also require additional software and would only address the "calling home" scenario. Another alternative may be to implement OSS7 in all OPERATOR switches so that SS7 signaling can be employed for all OPERATOR trunking, thereby allowing the database dip to take place at the originating end office. This will be essential if location portability across LATA and NPA boundaries is allowed, in order to initially determine which operator should handle the call.

12.8.5 Directory Assistance

End users may have choices on which and how many white pages directories carry their listings. The impacts of number portability on Directory Assistance do not appear to be distinct from those impacts caused by local competition.

12.8.6 Impacts on Directory Assistance/Call Completion

A concern exists as to how to complete a call to a portable number, from a DA position, since a database query is necessary to determine correct routing information.

12.8.7 Impact on Public Telephones/Customer-Owned Coin-Operated Telephones (COCOTS)

For local, coin sent-paid calls, the totalizer within the paystation itself (for most LEC-provided phones) notifies the originating end office when sufficient money has been deposited to allow the call to be completed. For the more distant coin zone or intraLATA toll calls, the call is forwarded to the Operator switch for rating and routing. In both situation, the determination of whether local (end office) or Operator switch treatment is required is based upon an examination of the dialed prefix (i.e., NPA/NXX). If the call appears to be local but is actually toll in nature, or vice-versa, due to location portability, the call will be incorrectly handled. Even if the call is correctly identified as coin zone or toll, the Operator switch equipment may incorrectly determine the amount of money to deposit because its rating tables are based upon the NPA/NXX of the called and calling numbers. One remedy may be to initially route all coin traffic to the Operator switch where, under a scenario previously described, a NP database dip could be performed to determine proper rating and treatment, based upon the response received. Again, this assumes that the Operator switch has the capability to access the NP database. This may also require massive additions to the Operator trunk groups, because the majority of coin calls in many metropolitan areas are local and today only one coin call in ten needs to be forwarded to Operator.

Other types of paystations in use by independent pay phone providers and some LECs utilize programmed intelligence within the instrument itself to properly rate and route the call. These "smart phones" rely solely on the dialed NPA/NXX to determine appropriate charges for each call. Direct access to a database to determine the actual destination may not be feasible. This situation requires further analysis and identification of a solution to accommodate location portability beyond a rate center boundary.

12.9 Impacts on 911/E911

There will be some administrative issues in ensuring that all local service providers have all end users' telephone numbers entered into the appropriate E911 database, and that changes in service providers do not adversely impact E911 for end users. It is essential that the calling number transmitted to the Public Safety Answering Point (PSAP) is a dialable number (rather than a network routing number) to allow PSAP operators to return the call of the calling party under certain circumstances. In addition, to help ensure that calls can be transferred from one PSAP to another during periods of network congestion or disruption, PSAP numbers should probably not be ported.

Procedures will need to be developed that involve all local service providers and the E911 provider. E911 has an audit procedure in which DNs are checked to ensure that calls from those DNs are routed to the correct PSAP. If an NXX is made service provider portable, and the end user location does not change, then the PSAP should remain the same, but the new service provider's switch must be able to route calls to the aforementioned PSAP. Business arrangements may be possible wherein an alternative (new) local service provider could elect to obtain E911 service through an existing local service provider, rather than providing his/her own routing hub and E911 database. Such arrangements will result from the introduction of local exchange competition in general and are not unique to number portability.

E911 could accommodate location portability, with appropriate administrative procedures, provided the customer location is fixed. The interaction of E911 with mobile (e.g., wireless) services is not covered in this document. With location portability, the end user changes physical location (e.g., business address) but retains the previously assigned telephone number. In the E911 Automatic Line Identification (ALI) database, the telephone number is associated with an end user's street address, with an indication of serving switch address, in case ANI is not available. In the ALI database an end user's street address can be changed with the telephone number remaining the same. However, since the end user changed physical address, their PSAP may change, causing confusion with the audit process. New procedures must be developed so that entities offering location portability can ensure that ALI databases are updated appropriately and that E911 audit processes can accommodate location portability.

12.10 Impacts on (Advanced) Intelligent Network Features

A call to an 800/888 number or a 500 number that is translated to a portable number may result in one 800/888 number database query or 500 number database query followed by an NP query. The two queries may be performed in the same or different networks. The particular procedure used may impact overall call setup time. This area is for further study.

12.11 Impact On Wireless Networks And Services

12.11.1 Impacts On Wireless Mobile Station Registration and Call Delivery

The introduction of number portability may cause modifications to current registration and call delivery procedures on calls involving wireless customers that have ported their number.

For example, in the case of IS-41 based registration procedures, the service provider associated with a specific Mobile Identification Number (MIN) or its equivalent would have to be determined via an additional or modified set of procedures in order to establish a dialogue between the serving and home systems. This would likely include identification of the MIN as belonging to a portable number block and performance of a 10-digit Global Title Translation (GTT) on the MIN.

In the case of call delivery (set up of the call from the home system to the system serving the roaming subscriber) additional procedures may be required in order to minimize the number of subsequent database dips involving routing a call from the home Mobile Switching Center (MSC) to the serving MSC. For example, call delivery procedures may have to be modified in order to include the pertinent parameters or fields in the ISUP Initial Address Message (IAM) in order to indicate that the Temporary Local Directory Number (TLDN) is the true destination address and no further database dips are required in order to determine the terminating service provider or terminating SSP.

At this point, the impact of number portability on registration and call delivery procedures in the case where a given wireless system serves two or more

geographic regions which may have deployed different number portability solutions is unclear. It is possible that the serving MSC may have to accommodate all of the number portability solutions which have been deployed in the operating regions served by the home wireless system with which the serving MSC has a roaming agreement.

12.11.2 Impacts On Wireless Switches For Call Origination

Several proposed number portability architectures require an IN or AIN trigger capability. The wireless industry does not generally have an equivalent IN/AIN trigger capability of the landline networks. For IS-41, standards are actively being developed for the Wireless Intelligent Network (WIN) architecture and call models. It is presently unclear as to exactly when the WIN trigger capabilities will be available and deployed within the wireless industry. Until such time as this trigger is available, the use of a default routing option (see Section 7.2.1) may be necessary.

The impact on call origination in wireless switches serving multiple geographic regions with different number portability solutions is unclear at this point in time and requires further analysis.

It is anticipated that the wireless system will have to accommodate all of the number portability solutions which have been deployed within the geographic regions served by a given wireless system.

12.11.3 Impact On Wireless Anti-Fraud Mechanisms

Wireless carriers employ several anti-fraud techniques. The impact of a service provider environment on wireless anti-fraud mechanisms is unclear at this time and requires further study.

12.11.4 Impact On Wireless Call Detail Recording Mechanisms

Wireless call detail recording procedures required to accommodate the terminal mobility environment are relatively complex. Specifically, in addition to recording "air time" and "interconnect time," call detail recording is also invoked in order to provide for a complete audit of the facilities utilized in a given call. This includes details to identify the trunk facility used for the inter-switch handoff and cell site facilities utilized for cell site to cell site or sector to sector handoffs. The impact of a service provider portability environment on this wireless call detail recording is unclear and requires further analysis.

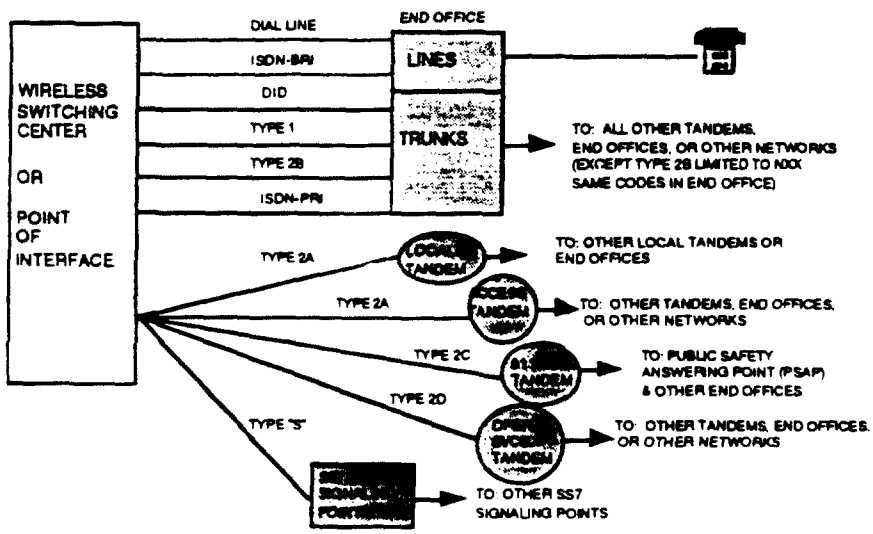
12.11.5 Impact On Wireless/Wireline Interconnection Arrangements

As a fundamental principle, existing technical interconnection arrangements for non-participants should not be affected by the implementation of number portability. These interconnection arrangements for carriers have evolved over several decades from various regulatory decisions and industry negotiations.

Bellcore's Technical Reference TR-NPL-000-145 (TR-145) describes the most common types of interconnection arrangements.

It is possible that the implementation of number portability could adversely affect the existing interconnection arrangements between wireless carriers and the LECs even if the wireless carriers are not required to provide number portability. For example, if a wireless carrier chooses to employ a large degree of direct trunking (Type 2B) connections (See Figure 12.11.1) and the LEC implements number portability, but only equips their tandem offices to perform the query function, the wireless carrier may be forced to change their fundamental network architecture. The result would nullify an existing arrangement that had previously been negotiated by the parties involved.

Figure 12.11.1: Wireless/Wireline Interconnection Overview



13.0 Architectural Alternatives

Several proposals have been offered thusfar as a means of achieving number portability. Many of these proposals differ not so much in the network components utilized to provide the capability, but rather in the call processing methodologies employed to ensure that the call is delivered to the proper terminating location. This section provides a detailed description of each of these proposals.

The documentation contained within is that furnished by various advocates of each alternative. As such, any and all claims as to the ability of a given alternative to fully accommodate or comply with the issues/concerns identified in Sections 8 through 12 are offered only from the perspective of the proponent and do not represent consensus by INC.

The proposals detailed within this section are as follows:

13.1 LRN Proposal page 45
13.2 LANP Proposal page 59
13.3 CPC Proposal page 80
13.4 RTP Proposal page 98
13.5 Non-Geographic Number Proposal page 104

13.1 THE LRN PROPOSAL

Section 13.1, following, describes AT&T's proposal for the provision of the network capability necessary to support local number portability (LNP). The proposal is presented in nine subsections. Included are (1), a General Description, highlighting the key characteristics; (2) an Architecture Description, explaining the necessary network infrastructure; (3) the Method of Operation, describing call flows and associated call processing; (4) the Network Impacts, identifying necessary network changes; (5) Service Impacts, describing the accommodation of exisitng services; (6) End User Impacts, illustrating the transparency to the end user; (7) Number Administration considerations, addressing potential adminstration scenarios; (8) Call Rating issues, suggesting treatment of rating matters; and (9) Timing and Availability projections, estimating the general availability of the proposal.

13.1.1 GENERAL DESCRIPTION

AT&T's proposal for the permanent implementation of local number portability assigns a unique number to each end office switch to which a call could be routed. This unique number serves as a network address and is labeled a Location Routing Number or LRN. An LRN is associated with each ported number in network routing databases, and identifies the end office switch which serves the called party. The LRN is obtained by network switches during call processing through database queries and the associated response.

The LRN is in the form of a 10 digit North American Numbering Plan (NANP) number and can therefore be used by all network switches without the need to change existing routing algorithms. Although network routing is typically and properly performed with the analysis of only six digits (NPA-NXX), the LRN is built out to 10 digits to eliminate any impact on network switches present in the call path which would be expecting a 10 digit number in signaling messages used for call set-up. Because the LRN uniquely identifies the end office from which the called party is served, and to which the call must be terminated, efficient routing -- via either direct or tandem connections -- can be easily provided.

13.1.1.2 A Single Number Solution

The LRN proposal is a "single number solution". That is, the customer is identified in the serving switch by a single number -- the number that is dialed by the calling party to reach that subscriber -- and there is no need to provide a unique, customer specific network address to effect call routing. Rather, all ported customer numbers served by a given switch can be associated with a single network address (the LRN) that identifies that switch. To effect call completion, the original dialed number is carried along in signaling messages and is used by the called party's serving switch to route the call to the appropriate subscriber loop.

The single number solution inherently makes available the customer number for proper presentation of caller ID and can be used by switches, along with the necessary processing, to support other (CLASS type) signaling services. In addition, the one number approach simplifies the billing process, providing both calling and called party numbers for call detail recording and, therefore,

allowing bills to be easily rendered using customer numbers to identify both the calling and called parties. Furthermore, the single number solution easily allows the porting of blocks of numbers served by PBXs, a capability not easily realized if each customer is assigned two numbers, an individual network address as well as a customer number.

It is recognized that this type (single number) implementation of number portability demands that end office switches recognize and complete calls associated with the large number of central office codes (NXXs) that might be included in a number portable area, and must, therefore, "open" a potentially large number of codes on the switch. Many switches can already accommodate several hundred (NXX) codes and AT&T believes that the alternative dual number solution, which assigns a unique network address to each customer, is wasteful of numbering resources, creates the need to extensively modify many operations support systems, and could create confusion in all processes which involve intereaction between the customer and network functions (e.g., customer trouble reporting).

13.1.1.3 Use of Numbering Resources

The LRN proposal is especially effective in conserving numbering resources. It requires only one (10 digit) number to identify each switch and that number can be associated with all customer numbers served by that switch. The additional numbers that would be required if network addresses were associated with each customer (the dual number solution) are not needed. Moreover, this proposal does not use numbering resources which are primarily designed for other purposes (e.g., area codes or NPAs) or require additional network intelligence that might be required to distinguish the use of such a common numbering resource as a routing code for the support of number portability.

13.1.1.4 Types of Number Portability Supported

The LRN proposal can effectively support location portability and service portability as well as service provider portability, as any dialed number can theoretically be mapped to any LRN and routed accordingly. Although implementation of widespread location portability adds to the complexity of call rating and originating call processing, the LRN solution does not preclude its introduction and deployment.

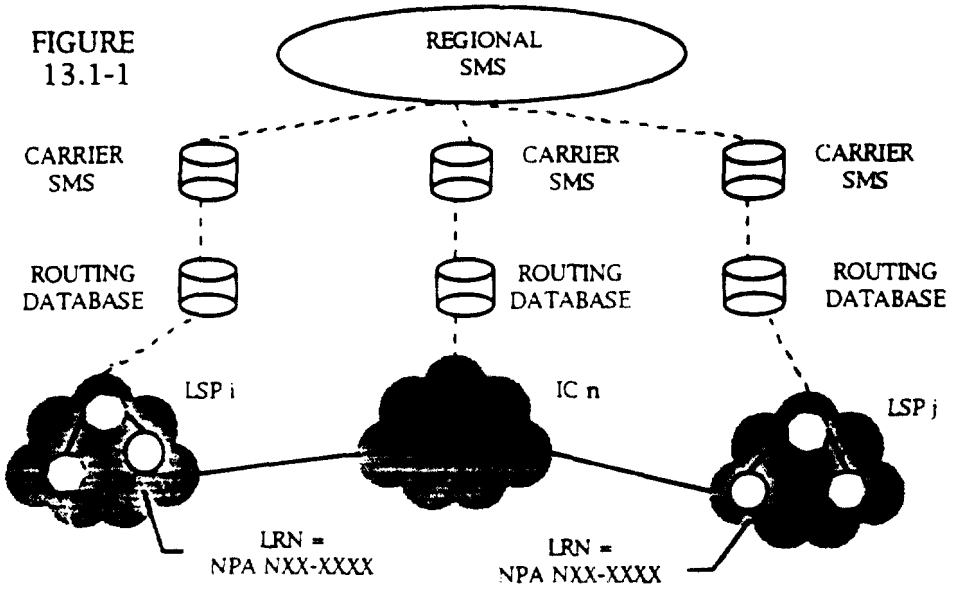
13.1.2 ARCHITECTURE DESCRIPTION

This section describes the network infrastructure necessary to support the LRN proposal. In addition, the format of the location routing number itself, and the manner it will be assigned for a given switch is explained.

13.1.2.1 Functional Diagram

Figure 13.1 -1 represents a typical network configuration in a number portability environment where the LRN architecture is used. Consistent with the general architecture described in Section 7, the LRN proposal involves network switches, network routing databases, both centralized and carrier specific SMSs, and the signaling network which supports these elements. Three distinct networks are represented, two local service provider networks (LSP i and LSP j) and and Interexchange carrier network (IC n).

FIGURE 13.1-1



Network switches are shown (as circles) within each LSP network. Although an LRN would necessarily be assigned to every network switch which serves customer lines, the diagram – for simplicity -- identifies the LRN and illustrates its format for a single switch in each network. Further, although not essential to the LRN architecture, it is assumed that the SMS will be regional and that the network routing databases will likely be located within each major carrier's network. Alternatively, carriers may choose not to deploy routing databases in their own networks, but obtain access to routing data through business arrangements with other carriers or third party vendors. Finally, the use of carrier specific SMSs should provide a given network provider greater flexibility and control over data which is downloaded into that carrier's routing databases. Such carrier specific SMSs are not required however, as routing information could be downloaded directly from the regional SMS to network routing databases.

Key to the functionality required in a number portable environment is the use of the LRN, which provides a unique identification for each network switch terminating subscriber lines. For existing switches the LRN will be selected from within one of the existing NXXs currently assigned to that switch. For example, if a large central office switch currently employed several NXXs, one of those codes would be selected as the NPA-NXX for use as part of the LRN. A given line number would be assigned within that NPA-NXX as the LRN itself. Although it would be convenient if the same line number could be assigned in every end office to identify the LRN (e.g., "0000"), it is recognized that this is unlikely, as their exist no line numbers that have been set aside for non-customer use in every end office.

The single 10 digit number assigned as the LRN will not typically be used for customer service. This number, however, is the only number within the NXX code which is not readily available for customer assignment.* In addition, the NPA-NXX selected for use for the LRN in a given office cannot be an NPA-NXX associated with (i.e., assigned to) any other office. Accordingly, a new central office must receive, as the NPA-NXX from which the LRN will be assigned, an NPA-NXX which is unique. This assignment rule is consistent with the manner that central office codes are assigned today and eliminates the possibility that routing would have to be performed in two "domains", one for the routing of LRNs and another for routing of NPA-NXXs assigned to offices where portability was not yet implemented.

13.1.3 METHOD OF OPERATION

The method of operation associated with the LRN proposal is best understood by examining typical call flows. Basic to an understanding of these call flows is an appreciation of the modifications in signaling necessary to effect call completion in a number portable environment.

13.1.3.1 Signaling Assumptions

As previously described, the LRN proposal will use a 10 digit network address (the LRN) to properly route the call, and will carry, in signaling, the original dialed number. It is specifically proposed that within the SS7 call set-up message, the LRN be contained in the called party number (CdPN) parameter and the original dialied number be placed in the generic address parameter (GAP).** It is further proposed that an indication that the database query has been performed be included in the signaling message and that this indicator be provided within the existing forward call indicator (FCI) parameter. The indication that the query to the number portability routing database has already been performed will eliminate the possibility that switches in the call path will launch redundant, unnecessary queries.

13.1.3.2 Terminating Switch Processing

The use of a single number solution as part of the LRN architecture requires terminating switch processing for call completion. Specifically, the terminating switch, upon receipt of the signaling message and recognition that a database query has been performed must examine the contents of the CdPN parameter to verify that the LRN indicates the call is to terminate in this switch, and retrieve the contents of the GAP (the dialed number) to identify the specific customer served by the switch to which the call must be routed.

13.1.3.3 Query Point

---

* Although not recommended, it is technically possible to assign the LRN as a customer number and to properly distinguish this number, either as the LRN or a customer number, for appropriate and proper call completion.

** A specific type GAP entry is required for LNP as multiple types of GAPs are allowed by standards.

The LRN proposal supports the previously described policy (Section 7.2) that the database query be launched from the "next-to-last" or (n-1)st network in the call path. Accordingly, for local calls the query is made by the orignating LSP; for interLATA calls by the interexchange carrier; and for intraLATA toll calls by the carrier selected to handle the call. Moreover, the LRN solution can be used with default routing. That is, in those situations where the originating LSP cannot provide the database query on a local call, or where an interLATA call is handled by an IC who cannot support the query function, the call will be forwarded to the terminating LSP originally assigned the NPA-NXX of the dialed number. That carrier would perform the query, retrieve the LRN and appropriately route the call to the specific switch in the network of the LSP which now serves the called party.

13.1.3.3 Call Flows

Consider the network configuration shown in Figure 13.1-2. The Figure describes a local network and indicates the manner in which a call to a ported number would flow. The end offices (EO) of two different local service providers (LSPs), LSP1 and LSP2 are shown. LSP1 is assigned two NXXs, (679) 887 and (679) 386, while LSP2 is assigned (679) 267 and (201) 540. Moreover, the LRNs of each of these switches is identified (within the ovals) as (679) 887-0000 and (679) 267-0000 respectively. It is further assumed that the customer, previously served by LSP1 with the line number (679) 887-1234 from the LSP1 EO has ported his/her number to LSP2 and is now, therefore, served from the LSP2 EO.