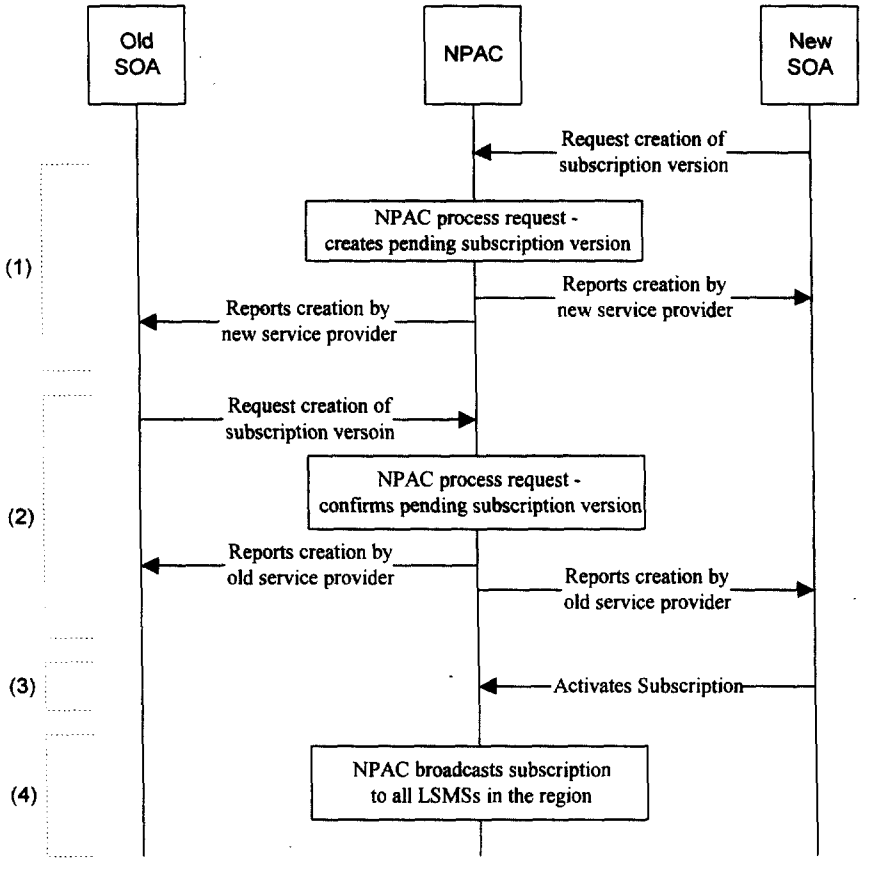
4.3 Overview of Flows between NPAC and Facility Providers

4.3.1 Provisioning

The facility based providers communicate with the NPAC to affect the porting of a subscriber. The following information further describes the communication between the facility provider and the NPAC. The information flows shown in Figure 4-5 are a high level summary based on the NANC specification of the NPAC interface as documented in NPAC SMS Interoperable Interface Specification. For complete details, the reader is referred to that document.

Flexibility is afforded regarding the order in which some of the information can be exchanged, and this section only illustrates one example. As described previously, the it is assumed that the new service provider initiates the communications to the NPAC.

Figure 4-5 NPAC—SOA Message Flows



The steps involved can be divided into four groups.

(a) *New Service Provider Requests Create*: Since the new service provider is in contact with the subscriber, it follows that the new service provider is likely to initiate the creation of the subscription to the NPAC. The request must include:

- Ported Telephone Number
- New Service Provider
- Old Service Provider
- Due Date

Assuming the NPAC successfully processes the request, the NPAC responds to the new and then the old service provider with a confirmation that the subscription is in the "pending" state. The confirmation includes the above listed information so that the old service provider is aware of the new service provider and telephone number involved.

(b) *Old Service Provider Requests Create:* The old service provider can explicitly confirm or deny the porting of the subscriber. If the old service provider does not respond at all within a time period, the NPAC assumes concurrence. For expediency, it is suggested that if the old service provider accepts the port, it do so explicitly and immediately.

It is possible that the old service provider can initiate the create request. In this case, the flows are very similar except that the order is reversed. However, if the new service provider does not respond with a create within a set time period, concurrence is not assumed and the process is cancelled.

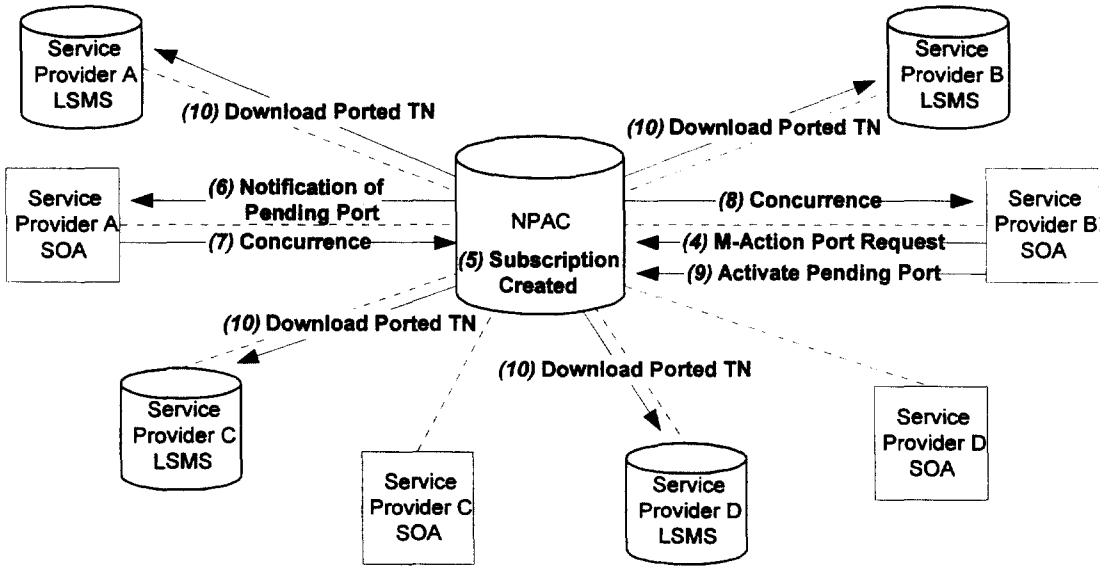
(c) *New Service Provider Activates Subscription:* Any time after the requested due date, the new service provider can send an activate request to the NPAC This request signals to the NPAC to download the data. . If the activate is sent prior to the agreed to due date, the activate request is ignored.

(d) *Downloading of Data:* The NPAC then broadcasts the associated ported number information to the various LSMSs. This step is not explicitly shown on the figure.

There above message flow shows a typical example. In reality, many variations and error handling procedures are possible. In addition, each of the above messages is confirmed under normal conditions, but these are not shown.

As a summary, the figure below illustrates an example of the porting process.

Figure 4-6 Summary of the Porting Processing



Subscriber of Service Provider A requests transfer to Service Provider B:

(1) Service Provider B completes an LSR and transmits it to Service Provider A.

(2) Service Provider A responds to the LSR with an FOC.

(3) Service Providers process the order internally and make ready switch, HLR, and internal systems.

(4) Service Provider B initiates an 'M-Action' placing the porting order to the NPAC.

(5) The order of 'subscription' is created in the NPAC database thereupon establishing a pending port.

(6) A notification of the pending port is transmitted to the Service Provider A SOA.

(7) Service Provider A can execute the following:

- Transmit a concurrence via its SOA
- Transmit a conflict notice via its SOA.
- Transmit a cancel notice via its SOA.
- Do nothing.

(8) This example assumes that Service Provider A concurs and transmits a concurrence notification to the NPAC SMS.

(9) On or after the effective due date/time, Service Provider B transmits an activate message for the pending subscription.

(10) Notification and subscription data is downloaded to all Service Providers' LSMSs which are connected to the NPAC network.

(11) The download is acknowledged by teach service provider.

(12) Once each service provider has acknowledged, the subscription is considered active and all service providers had updated their network elements (SCPs, STPs, etc).

4.3.2 Other Functions

The NPAC-SOA interface is used to provide a variety of other functions. These include:

- *Service Disconnect* -- this allows disconnected ported numbers to be returned to the original code holder for future reassignment.
- *Service Repair* -- the ability to receive indications of problems and perform audit functions.
- *Conflict Notification/Resolution* -- the ability for one of the parties to refuse the porting of a subscriber.
- *Disaster Recover and Backup* -- the ability to recover from disasters and outages.
- *Service Order Cancellation* -- the ability to cancel a subscription.
- *Audit Request* -- the ability to audit data contained in a service provider's NP-DB.
- *Data Administration* -- the ability of service providers to request data/reports from the NPAC.

For complete information regarding the NPAC functionality and operation, the reader is referred to the NANC NAPC-SMS Functional Reference Specification and the Interoperable Interface Specification.

4.4 Number Administration

Three numbering resources are involved in WNP: Mobile Identification Numbers (MIN), Mobile Directory Numbers (MDN), and International Mobile Subscriber Identifiers (IMSI)

4.4.1 MIN Administration

Prior to number portability, the MIN was the same value as the MDN and there was no need for a separate MIN administrator. Since the values are now separate, MIN administration is a vital new function.

Currently, draft MIN administration guidelines are being developed by CTIA for adoption by the wireless industry. That document describes the process and functions of the administrator. On the date that number portability officially starts, all the MIN values that a service provider are currently using are automatically "grandfathered", i.e. programmed MIN values in mobile sets are automatically assigned to that service provider. No mass reprogramming of mobile sets is planned. However, once the MIN and MDN are separated, any subsequent MIN values programmed into a mobile set will have to be obtained from the MIN Administrator.

It is envisioned that the MIN Administrator will allocate blocks of 10,000 values which corresponds to the number of telephone numbers in a central office code block. This allows the first 6 digits of the MIN to uniquely identify a service provider and minimizes SS7 routing procedures for registration. Mobile sets will be programmed with a MIN, but it may not be the same value as the associated MDN.

It is possible that whenever a NPA-NXX block of telephone numbers is allocated to a wireless carrier, the MIN administrator will attempt to assign the corresponding block of MINs. However, the details of this have not yet been finalized.

4.4.2 MDN Administration

4.4.2.1 Current Administration

The administration of telephone numbers was historically done at three levels:

- Number Plan Administration (NPA) - administered by Bellcore on a national basis
- Central Office Code (NXX) - administered by the dominate LEC in each area
- Line Level (XXXX) - administered by the service provider

Effective January 19, 1998, the administration of NPAs is performed by Lockheed Martin, as the new North American Numbering Plan Administration (NANPA), and during 1998 and 1999 the transition of Central Office Code Administration, including NPA Relief Planning, will migrate as well. During this period, wireless carriers will continue to administer line level numbers. The change of numbering administrators by itself does not impact wireless number portability.

4.4.2.2 Number Pooling

With the implementation of number portability, specifically the support of routing via an LRN, the communications industry is migrating towards the implementation of number pooling. The intent is to provide more efficient utilization of numbering resources. Whereas number portability is the capability of porting assigned telephone numbers, number pooling can be described as the porting of unassigned telephone numbers.

Under this scheme, service providers will be allocated blocks of numbers on a 1000-number basis, effectively sharing a central office code other service providers. Number pooling also requires the separation of the MIN and MDN. With number pooling, wireless carriers would be required to obtain MIN resources to program into the mobile sets in order to preserve 6 digit routing within the SS7 network.

4.4.2.3 Disconnecting Ported Numbers

When a ported wireless subscriber terminates service (i.e. does not port but rather drops service altogether), the WSP must provide appropriate call termination treatment (e.g., intercept). Intercept treatment is usually indicated by removing the profile of the subscriber in the HLR. When the mobile switch queries the HLR, the absence of a customer profile triggers the intercept message. During this period, no changes are indicated to the NPAC-SMS and calls will continue to be routed to the WSP via the LRN in the NP-DB.

After the period of providing intercept expires, the serving WSP then notifies the NPAC-SMS that the portable number entry should be removed. The NPAC then effectively removes any association of the number to an LRN and broadcasts this to all the LSMSs and routing to that number reverts to the service provider that was allocated the NPA-NXX associated with the disconnected number. Once this occurs, the original service provider may then reassign the number to a new subscriber. This process of releasing the disconnected ported number has been referred to as "snap back to the code holder."

4.4.3 Location Routing Number Assignment

As number portability routing to an MSC is based on the LRN, each MSC shall be assigned at least one LRN. A WSP may designate a single MSC in the serving area as a single point of entry for incoming calls for ported subscriber (e.g., a gateway MSC). In this case, the gateway MSC would require at least one LRN value for other networks to route calls. Once the MSC receives the call; it may invoke existing wireless procedures for obtaining a temporary routing number to complete the call. The MSCs behind the gateway do not require LRNs.

Alternatively, a WSP may choose to allocate at least one LRN for every MSC in the serving area which would result in routing calls to various MSCs and eliminating the concept of a gateway MSC. If multiple MSCs share the same code block (i.e., NPA-NXX), then a unique LRN is needed to identify each MSC.

Specifically, the Industry Numbering Committee[47] advises assigning one LRN per LATA boundary to preserve routing and rating across LATA boundaries. As wireless MSCs span multiple LATAs in some cases, it may also make sense to assign LRNs per Point of Interconnect (POI) to also preserve the unique routing and associated rating for call connection and completion. Such an assignment may be based upon interconnection agreements with the LECs. Additionally, there may exist some services (e.g., NPA-NXX based services) for which assigning an LRN specific to routing for that mobility service may make sense.

The WSP must select LRNs for a particular switch from those NPA-NXX codes already assigned to that switch. If multiple NPA-NXXs exist, then LRNs may be selected from any of these values. Furthermore, as the LRN must be a 10 digit number, the service provider may select any line number value.

[47] Industry Numbering Committee *Location Routing Number Assignment Practices*, Issue No. 102.

4.4.4 Steps for opening an NPA-NXX for Portability

Various steps are necessary prior to a WSP being able to participate in number portability. Although not all the details are described, three key steps are necessary:

- Initiate a formal request to other carriers for portability
- Open an NPA-NXX for portability
- Activate the query trigger

4.4.4.1 Initiating a Request for Portability

This process involves a formal notification to the carrier (either wireline or wireless) serving the MSA in question to provide number portability in their switch(es) serving the MSA. The FCC has described timetables by which the designated switches must be provisioned for number portability. The agreement in the wireline industry is on a switch requested to be made LNP capable, all NPA-NXXs should be made available or opened for number portability. This will not hold true for wireless, given that a wireless switch likely serves NPA-NXXs outside the MSA in question. This will lead to a need for WSPs to identify beyond the switch level, the NPA-NXXs subject to portability it the specified area.

The wireless industry is investigating options to facilitate the logistical process of requesting portability. One option recommended is to employ the services of a "clearinghouse." At a high level, the function of the clearinghouse would be to accept the request from a WSP and forward the request to the appropriate carrier. Its anticipated function is to facilitate the logistical process, such as the sending of certified letters of notification, maintaining the appropriate name and address contact for each carrier, tracking and logging responses, etc. Alternatively, this function could be handled one-on-one between carriers. In any case, the TCC LNP order specifies that cellular, broadband PCS, and covered SMR providers must make available lists of their switches for which deployment has and has not been requested.

4.4.4.2 Opening an NPA-NXX for Portability

Once a number block is identified for portability, it must be opened for portability. Population of the NPA-NXX in the NPAC SMS as described in the FCC approved NANC flows is the process to accomplish this. This process and the associated flows are documented in the LNPA WG Report to the NANC, dated April 25, 1997 and forwarded to the FCC on May 1. The population of the NPAC SMS can be done in real time. Although the FCC approved flows do not specify population of the LERG with the NPA-NXX portability identification, the LERG is currently being updated for this purpose by carriers participating in number portability. Given the initial carrier request for portability (step 1) should be made 9 months in advance of the FCC directed implementation date. This allows adequate time for industry notification of LNP targeted NPA-NXXs.

4.4.4.3 Activating the Query Trigger

The third step in the process is to activate the query trigger for that NPA-NXX. This process is driven by the FCC approved NANC flows described as the "First TN ported in NPA-NXX"

process. The industry decided to separate the activation of the query form the opening of the NPA-NXX for portability. This was to avoid forcing carriers to query on calls to NPA-NXXs where there are no ported customers. The industry agreed on this process based on the first ported number in the NPA-NXX, allowing 5 days for all carriers to activate the triggers for that NPA-NXX in their switches.

This is a separate and distinguishable step from designating an NPA-NXX as ready-for-porting or, equivalently, opening an NPA-NXX for portability. A carrier may choose to activate the triggers in their own switches prior to a first port notification (e.g., based on data published in the LERG); however, carriers are under no obligation to do so. It will be at the discretion of the WSP as to when to provision their network to query the NPA-NXX designated for portability. The activation process and query cost recovery approach of the interconnecting LEC may impact the WSPs decision.

4.5 Billing Aspects

The billing function is comprised of three distinct systems: a Service Order System, a Message Processing System, and a Billing System. This section discusses the impacts of Wireless Local Number Portability on each of these systems.

4.5.1 Service Order Systems

Within a typical Service Order System, an inventory of directory numbers is maintained and constantly updated due to the addition of new directory numbers, assignment of existing numbers for new activations and the release of existing numbers for deactivations. With the split of the MSID and MDN, two inventories will need to be maintained instead of just one and two separate requests for number resources will have to be generated when either additional MSIDs or MDNs are needed.

Provision will also need to be made for assignment of both an MSID and MDN for new, non-porting subscribers and assignment of just an MSID for new, porting subscribers. Also, for new, porting subscribers, the directory number that they bring with them may need to be added to the MDN inventory prior to completion of the service order depending on the edits in place in the system. Provision must also be made for "snap-back" functionality if a subscriber discontinues service with a ported number.

Generation of CARE records is typically initiated by service order activity. The CARE record format, which is maintained by OBF, has been updated to include specific fields for wireless carriers and for number portability. The Local Service Request (LSR) form, also maintained by OBF, could also be generated from information gathered for service order processing.

4.5.2 Message Processing Systems (MPS)

Message Processing Systems generally process all usage generated by home and Roaming customers. This includes inputs from such sources as switches, the roaming clearinghouse, any adjunct systems such as Short Message Service Centers, LECs, and IXCs. Outputs may be generated for a number of users such as LECs, IXCs, the roaming clearinghouse, fraud systems,

alternate billing systems, etc. Changes to support LNP will affect most, if not all, of the data passed from and to these systems.

Specifically, changes have already been identified for switch records (changes will vary depending on switch vendor), Cellular Inter-Carrier Billing Exchange Roamer records, maintained by CIBERNET (see Section 3.3.5), and EMR/EMI records, maintained by OBF. New edits will be required to validate the data in the new fields and/or modules in these records.. New data from modified inputs may need to be included in the proprietary internal billing records which will cause major changes to many of the MPS programs. In addition, a number of new reports may be required to support changes to the business due to Local Number Portability.

Another function of MPS, in some designs, is to "guide" usage to the correct billing number. Changes will be required to this process to be able to guide based on either MDN or MSID to allow for usage (such as roaming usage from switches that are not MSID/MDN split capable).

4.5.3 Billing Systems

If the guiding function discussed above is performed in the Billing System, then the changes required for guiding would need to be implemented in billing and not MPS. Actual invoicing should be based on the dialable directory number (MDN) as it is today and not the MSID. The MDN, not the MSID, is the number that should appear on the customer's bill. By the time the proprietary billing records get through Message Processing to Billing, they should have the same information as they do prior to LNP (they may have additional LNP related information which was used in MPS, but this would not impact billing). The greatest changes will most likely be due to the generation of LNP specific reports if necessary. With the vast number of proprietary systems and business practices, it would not be within the scope of this report to completely document the impact of LNP on billing. Therefore, each company should examine every aspect of their systems to determine how billing is accomplished, especially with regard to the MSID and MDN separation.

4.5.4 Call Detail Record

The switch creates a call detail record (CDR) for every call recorded. With number portability, the CDR will have to explicitly record the MDN separate from the MIN. This requires an additional field to the CDR record which must be processed by the service provider's operation systems.

In addition, the CDR should contain an indication whether the number portability query was performed by the switch for that call. Indication of the result of the dip, i.e. the LRN received should be recorded. If the query does not succeed for some reason, the CDR should indicate the error (time out encountered due to no response, incorrect LRN received, et cetera).

4.5.5 CIBER Records

In order to support Wireless Local Number Portability, CIBERNET held an open forum in January, 1998 to review and discuss industry comments on three proposed new CIBER (Cellular Inter-Carrier Billing Exchange Roamer) records: Type 22, Type 42, and Type 52. During the course of this meeting, it was determined that an additional Type 32 record was required. The

new Type 22 corresponds to a combination of the Type 10 and Type 20. The new Types 32, 42, and 52 correspond to the Types 30, 11 and 50, respectively. With respect to WNP, the format of the new records differ from that of the existing records in that the required fields of MSID, MDN, and LRN have been added. If the MDN is unknown, it is assumed that the MSID would either be duplicated within the MDN field or the MDN field will be populated with zeros. Additional fields were added to the new CIBER record types beyond the three mentioned above. Readers should contact CIBERNET for details.

The existing CIBER Type 10, Type 20, Type 11, Type 30, and Type 50 records will remain available for use for exchanging data recorded either by systems not required to support WNP or on switches that have not been upgraded for the MSID/MDN separation. Carriers will need to be able to send and receive both sets of records.

In addition, an existing table, the NPA-NXX LINE RANGE Table will be renamed. This table lists all NPA-NXXs / Line Ranges assigned to wireless carriers as well as the corresponding SID/BID, Market name, and CIBERNET Carrier Code. In the past, these NPA-NXXs have been used to identify directory numbers assigned to carriers. CIBERNET will rename this table to the MSID TABLE to ensure that the NPA-NXXs only refer to the MSIDs and not the MDNs.

The IS-124 Standard, also known as Data Message Handler (DMH) was developed to facilitate faster exchange of roaming usage between carriers and replace the CIBER records. All record types within the IS-124 Standard also need to be reviewed and revised where necessary so that, at a minimum, they support the separation of the MSID and MIN as well as the ability to pass the LRN when appropriate.

The impact on North American GSM operators, including possible changes to the North American TAP 2 (Transfer Account Procedures Version 2) to support WNP, has not been formally addressed at this time. However, the current structure does appear to support the required elements.

4.5.6 Subscriber Billing

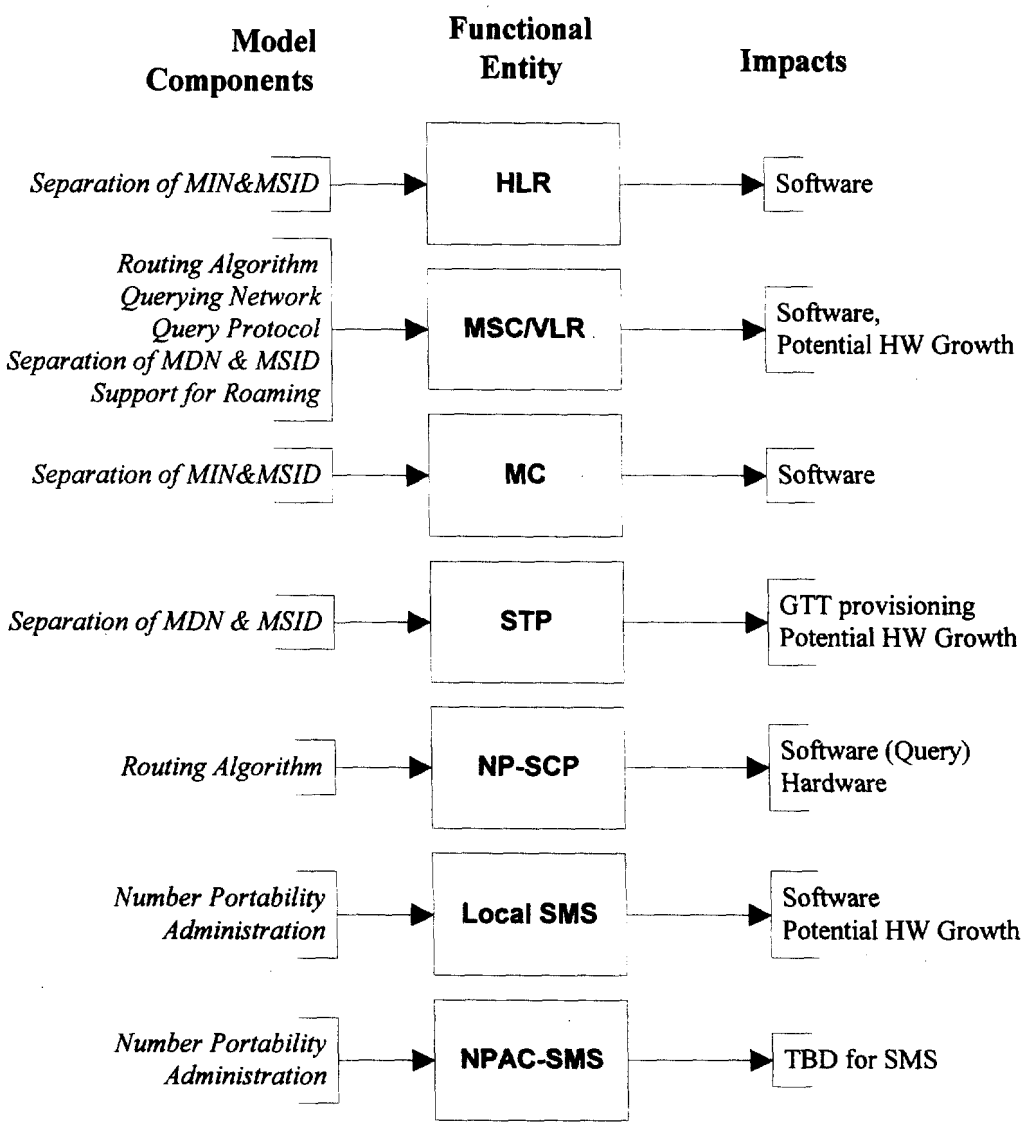
Service providers should be able to bill ported subscribers. This will require separate administration of the MIN and MDN with respect to identification of the account.

5. WIRELESS NUMBER PORTABILITY SYSTEM IMPACTS

This section summarized the anticipated WNP architecture impacts to each of the entities in the network architecture.

Figure 5-1 maps the components of the wireless number portability building blocks in Figure 2-1 to the wireless NP functional entities (e.g., network elements, operations systems). Most entities map to only one building block; the exception is the MSC as it maps to multiple. The figure also illustrates the recommended impacts related to each functional entity.

Figure 5-1 Mapping of Platforms to Wireless Number Portability Model



5.1 Impacts to the Mobile Station

The following impacts are anticipated on the mobile stations:

- The mobile station will, at a minimum, need to contain a MSID. Specifically, the mobile station will need a MIN to register on MIN-capable networks and, if applicable, an IMSI to register on IMSI-capable networks.
- The MS will register with the IMSI on an IMSI capable network or with the MIN on MIN-capable networks. If the mobile is not IMSI-capable, it will register with MIN on IMSI or MIN networks.
- Mobile stations typically have the capability to display the telephone number to the subscriber. Therefore, it may be desirable to program the MDN into the mobile station to display the telephone number to the subscriber. However, the mobile station need not have the MDN for service or call completion. The MDN will not be transmitted over the air interface during registration. The communication with the MSC and base station will be via the MSID, only.
- If the MDN is not programmed into the mobile station, it is more desirable to display nothing than the MSID as the telephone number. Existing mobile stations may display the MIN; this may add an impact to Customer Care and subscriber education.
- Porting from one facility provider to another will require that the mobile station be reprogrammed with a new MSID, MIN or IMSI or both, as appropriate, to the recipient provider.

5.2 Impacts to the Air Interfaces

No impacts have been identified for the following air interface protocols: IS-136, IS-95 and GSM.

However, if a provider chooses to implement an IMSI network, the following impacts should be known (and is being worked on by the IS-136 standards committees):

- In the IS-136A standards, if both an IMSI and a MIN are programmed in the mobile, the MIN takes precedence over the IMSI while in the mobile's home country. Therefore, modifications to the standard are required in order to reverse the precedence, allowing IMSI to be the primary identifier in an IMSI-capable network.

5.3 Impacts to IS-41 Signaling

The following impacts to the IS-41 signaling standards are anticipated:

- All IS-41 messages which contain MIN (e.g., Registration Notification) will need to be enhanced to support the MSID parameter *if, and only if,* the IMSI parameter is introduced. The MIN parameter is already defined and encoded in IS-41 Revision C.
- All IS-41 transactions which are based on identifying the subscriber based on their telephone number (as opposed to mobile station identification) should use the MDN where MIN was used prior to number portability.

- All IS-41 transactions which are based on mobile station identification should use the MSID (or MIN as appropriate) where MIN was used prior to number portability.
- The contents of the *Digits(Dialed)* parameter in the IS-41 messages (e.g., LocationRequest) should be interpreted as the MDN, not the MIN.
- IS-41 will need to be enhanced to support Automatic Code Gap (ACG).
- Incorporate a new message for querying a LNP database. TR45.2 has standardized[48] the NumberPortabilityRequest query and response message set.
- MIN is currently a mandatory parameter in the SMSRequest and SMSNotification messages. For SMS in WNP, the appropriate value (for what is a MIN today) will be the MDN. The SMSREQ message should be modified to require the MDN.

5.4 Impacts to GSM-based PCS 1900

GSM-based PCS 1900 is a mixture of ANSI protocols and international SS7 protocols to provide service in North America. For example, GSM-based PC 1900 uses the international SS7 Mobile Application Part (MAP) but interfaces it with the ANSI versions of TCAP and ISUP.

The GSM-based PCS 1900 signaling modifications to support WNP involve two areas. The first area involves ISUP which is based on the same modifications adopted for wireline portability. These include the following[49]:

- new FCI bit indication for translated number
- new GAP code point to indicate Called Party Number

The other change involves the MAP. The changes include the following:

- a definition of a query message and response (T1.708)
- incorporation of ACG protocol and procedures

As recommended in Short Message Service §3.3.4, GSM network will need the following Short Message Service support:

- A new DN-to-MC translation type that is used jointly with IS-41
- Administration of a service SS7 subsystem number and point code each ported number via the NPAC-SMS

Note that the GSM Subscriber Identify Module (SIM) card provides a DN for connection to the Home MC for that subscriber.

In the case of special of temporary numbers used for GSM-based PCS 1900, the following the numbers should not be portable:

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[48] ANSI-41 Addendum for Wireless Number Portability, PN-3980A.

[49] ANSI T1.xxx – 1998, *American National Standards for Telecommunications – Signaling System Number 7 – Number Portability Call Completion to a Portable Number.*

- Hand-over numbers (HON) used to hand over calls between service providers during a call as it cross RF boundaries
- Mobile Station Routing Numbers (MSRN) used to delivery calls to the serving network.

5.5 Impacts to the Home Location Register

The WNP architecture notes the following impacts on the HLR:

- Mapping between MSID and MDN

  The HLR must provide a mapping between the MSID and the MDN for subscribers. For example, the HLR must map the MDN received in the LocationRequest to an MSID. The MSID is then sent to the Serving MSC/VLR requesting a TLDN.

  The NPAC-SMS will not provide the HLR provisioning information for the assignment of a porting MDN to a network owned MSID. Existing systems will need to make this assignment upon notification/validation that a subscriber is porting into the wireless network. The assignment can be made prior to the NPAC-SMS broadcast provisioning window.
- The MDN should be made available to the MSC/VLR at the time of registration in the RegistrationNotification Return Result (or equivalent); this is an absolute requirement for subscriber's whose MSID and MDN are not equal.
- If multiple MDNs are used for the same MSID, the HLR must designate one MDN as the preferred MDN for the domestic network.
- The HLR must support any enhancements to the IS-41 (or equivalent) messages required to accommodate MSID, MIN, MDN, and IMSI, as appropriate.
- The HLR should indicate to the MSC whether the destination digits in the Location Request Return Result are a TLDN or another type of digits (e.g. Call Forwarding digits).
- Querying the NP DB Before the HLR

  Querying the NP DB before the HLR alleviates the need for the MSC to query the HLR for calls to ported numbers not resident on the querying MSC and for calls to wireline subscribers within a portable NPA-NXX. That is, if the response returns an LRN not associated with the MSC, or it returns no LRN and the NPA-NXX is a portable NPA-NXX not associated with this network, then there is no need to query the HLR. The amount of required HLR capacity is therefore significantly reduced in high call volume areas by eliminating this unnecessary HLR query volume.

5.6 Impacts to the Mobile Switching Center

The MSC is impacted in multiple areas including registration/validation, call origination, call delivery, roamer tables, digit screening, query capabilities, and others. Some of these items are detailed below.

To ensure the Calling Number Identification Presentation (CNIP) service continues to deliver the appropriate number to the called party the MSC must populate the calling party number parameter with the MDN in the ISUP IAM.

5.6.1 Registration/Validation

The impacts on the MSC due to the proposed WNP architecture, pertaining to the MS registration and validation, are the following:

- The MSC must support (or at least portions of) IS-41 Revision C (or equivalent) protocol for the Mobile Application Part if the MSC is to perform NP functions.
- The MSC must send the registration request to the HLR requiring GTT of the MSID digits at the STPs.
  - IMSI will use a TT of 9, and MIN will use a TT of 3.
  - IS-41 Revision C must be modified to include the MSID in place of the MIN as a mandatory parameter in the RegistrationNotification message.
- The MSC will receive an HLR response to the registration/validation message which is MTP routed from the HLR. The profile macro in the response message must include the DN of the MS.
- The MSC must be able to differentiate between MSID and MDN and to store them in the call register.

5.6.2 Call Origination

The impacts on the MSC due to the proposed WNP architecture, pertaining to the MS call origination, are the following:

- The originating MSC must populate the CgPN in the ISUP IAM with the MDN. This MDN is obtained from MS's HLR in the response to the registration response.
- The originating MSC must populate the Charge Party Number in the ISUP IAM with the MDN. This DN is obtained from MS's HLR in the response to the registration response.
- If the CdPN belongs to a ported NPA-NXX block in the MSC's serving area, then the following must hold true:
  - The MSC will query the NP DB using the WNP Query message to obtain the LRN of the entry switch of the ported number.
  - The MSC must be able to interpret the response received from the NP DB. The response contains the LRN for ported DNs and the dialed DN for non-ported DNs.
  - Upon receiving the LRN, the MSC must send an ISUP IAM message, to the next switch with the "m" bit set in the FCI, the CdPN set to the retrieved LRN, the CgPN set to the MDN of the calling party, and the GAP parameters set to the dialed DN.

- If the dialed number is not ported, the NP DB will respond with an indication in the response message as dictated by the protocol to route on the dialed DN. The MSC must be able to process this message. No GAP parameter is required in this circumstance.

- If MSC determines that it is an inter-LATA call, it must route the call to the appropriate IXC for further processing using ISUP or Multi-Frequency (MF) trunk set up messages. The IXC may then perform the query to the NP DB.

5.6.3 Call Delivery

The impacts on the MSC due to the proposed WNP architecture, pertaining to the MS call delivery, are the following:

- The MSC must be able to process the IAM parameters, including the FCI *m*th bit and the GAP.
- The MSC pointed to by the LRN (i.e., entry MSC) must recognize the LRN in the CdPN as its own. It must then replace the CdPN value with the GAP value. This new CdPN will then be processed by the MSC as usual.
- The MSC will send a query to its HLR based on the MDN received from the ISUP message. Since the MDN is different from MSID and since multiple HLRs may support be supported at the MSC (for some networks), a special translation of the DN may be needed to locate the HLR.
- When setting up the trunk to the Serving network, the MSC must populate the IAM message with the CdPN equal to the TLDN, the ANI or CHN (if any) equal to the MDN, the GAP equal to the MDN, and the FCI indicator as set (no query is necessary during this leg of the call).
- If the call is forwarded to another number, the entry MSC must treat the forwarded number as a new dialed number and follow the LRN solution. Thus, if the forwarded number is within a ported range, the MSC will query the NP DB to get the LRN of the destination switch.

5.7 Impacts to Interconnection Types

There are two basic types of interconnection used by wireless carriers for interconnecting with the PSTN[50] [51], Type 1 and Type 2. Type 1 and Type 2 trunks can be used for interchanging traffic in both directions, i.e. wireless-to-wireline and wireline-to-wireless. A description of these interconnection types and the impacts of WNP follows.

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[50] EIA/TIA IS-93 *Cellular Radio Telecommunications A_i-D_i Interfaces Standard*

[51] Bellcore GR-145 *Compatibility Information for WSP-LEC Interconnection*

5.7.1 Type 1

Type 1 interconnection is a trunk interconnection between an MSC and a wireline End Office switch and can support interchange of traffic between the MSC and the PSTN. This includes traffic to and from customers served by that Type 1 office, traffic to and from other end offices and MSCs in the local network, and traffic to and from long distance carriers. Type 1 trunks also support interchange of other types of traffic (i.e., ancillary traffic) such as operator services, directory assistance, and emergency service access (i.e., 911).

Since Type 1 trunks are configured as trunks with line treatment (TWLT) at the Type 1 end office, they can only support MF or ISDN access signaling and not SS7 ISUP signaling. Therefore, the substitution of the LRN in the CdPN, and the use of the FCI and GAP parameters proposed in the SS7 ISUP IAM for NP cannot be supported by Type 1 trunks. Consequently, providers using Type 1 trunks for wireless-to-wireline calls following an NP DB query by an MSC will lose the benefit of the query.

Type 1 trunks can continue to be used for wireless-to-wireline calls (including wireless-to-wireless via the wireline) in an NP environment in the following instances:

(a) where a WSP establishes a business agreement with the Type 1 service provider to perform the NP queries,

(b) for calls to non-ported NPA-NXXs,

(c) for long distance calls where the IXC, and not the Type 1 service provider, would perform the NP query, and

(d) for ancillary services such as operator services, directory assistance, and emergency service access.

Type 1 trunks can also continue to be used for wireline-to-wireless calls (including wireless-to-wireless via the wireline) in an NP environment where there exist no ported numbers within the entire NPA-NXX in the WSP's Type 1 number range.

If type 1 interconnects are to be replaced with an interconnection type such as type 2A-SS7 to support the LRN call routing method, the MSC will need to be re-homed from the end office to an access tandem.

5.7.2 Type 2

There are multiple Type 2 interconnections, i.e. Type 2A, 2B, 2C & 2D.

- Type 2A interconnection is a trunk interconnection between an MSC and a wireline tandem switch, and can support interchange of traffic between the MSC and the PSTN. This can include traffic to and from end offices and other MSCs served by that Type 2A tandem switch, and traffic to and from long distance carriers if the Type 2A tandem also serves as an access tandem. Type 2A trunks can operate with MF or SS7 ISUP signaling. To support NP, Type 2A trunks must be converted to SS7 ISUP in order to be

able to send and receive the LRN in the CdPN, and the FCI and GAP parameters in the SS7 ISUP IAM.

- Type 2B interconnection is a trunk interconnection between an MSC and a wireline end office switch, and can support interchange of traffic between the MSC and only customers served by that Type 2B office. Type 2B trunks can operate with MF or SS7 ISUP signaling and are usually provisioned to allow overflow traffic to route to an associated Type 2A trunk group. To support NP, Type 2B trunks can remain MF as long as none of the NPA-NXXs served by the Type 2B end office or MSC contain any ported numbers. Further, the Type 2B end office and MSC can perform an NP DB query with the result indicating that the call should be routed to a Type 2B trunk group. Again, MF signaling can still be used in such cases as long as the Type 2B end office and MSC can retain the LRN for use with the associated Type 2A overflow trunk group, should all of the Type 2B trunks be found busy. Type 2B trunks can be converted to SS7 ISUP and optionally arranged for sending and receiving the LRN in the CdPN, and the FCI and GAP parameters in the SS7 ISUP IAM.

  WSPs can make business arrangements for another provider to query and properly route the call to the ported-to network.

- Type 2C interconnection is a trunk interconnection between an MSC and an E911 tandem for Emergency Service calls. Signaling over Type 2C trunks is not impacted by WNP. Emergency Services feature interactions with WNP are covered in section 3.3.2.

- Type 2D interconnection is a trunk interconnection between an MSC and an Operator Tandem. Signaling over Type 2D trunks is not impacted by WNP. Operator Service feature interactions with WNP are covered in section 3.3.1.

5.8 Impacts to the Signaling Transfer Point

Note: It is recommended that all service providers utilize the GTT capability at their STPs for routing SS7 queries. Although MTP routing capability can be used, it will not be able to utilize all of the performance and administrative benefits of GTT.

The proposed NP architecture will have the following impacts on the STPs in the SS7 backbone network:

- If LRN GTT is used, STPs must support the new TT value (11) for routing WNP query messages to the NP DB.

- The STPs shall perform appropriate SS7 route and SCCP management for routing queries.

- If IMSI is implemented, the STPs must support GTT of IMSI for the new IMSI TT. Although IMSI has 15 digits, the STPs may need to perform GTT only 6-digit GTT on IMSI to locate the home service provider's network. If the home network supports multiple HLRs for the same mobile network code of the IMSI, it may have to perform GTT on greater than 6-digits of the IMSI in order to locate the HLR for the MS. Only the IMSI digits needed to perform GTT are required in the SCCP CdPA. The complete IMSI value used by the end application should be provided in the TCAP.

- STPs must have route-sets defined for every possible destination network with which the service provider has a roaming agreement.
- STPs should be able to support DN-to-HLR routing translation based on a new intra-network TT yet to be defined.
- STPs will perform Intermediate GTT (IGTT) for messages to remote network nodes and Final GTT (FGTT) for routing to the local network nodes.

5.9 Impacts to Global Title Translation

The impacts below apply to the location of GTT databases within a network. These impacts only apply to networks that plan to use GTT for the routing and management of query messages.

- The LRN GTT database is a six-digit GTT database located on the STP.
- It is perceived that MSID GTTs are STP based and are not impacted by number portability.
- MDN GTTs for inter-network service and capabilities are the most impacted in a number portability environment. The MDN GTT database may be provided on either an STP or on an SCP. Regardless of location, MDN-GTTs may require interrogation of the TCAP portion of the message to complete the GTT lookup.
- Service providers need to ensure correct and timely provisioning to avoid circular routing conditions between network elements performing GTT.
- The NP DB should provide load sharing of queries to application SCPs and Gateway STPs as necessary. The NP DB should also provide SCCP management in the case of application failures.
- MDN-GTTs on the SCP require a six-digit GTT database on the STP for each GTT database located on the SCP. This service provider managed database is used by the STP to locate the SCP performing the ten-digit GTT.
- A local SMS interface may be beneficial depending on the volume of updates received. The local SMS would provide updates for ported numbers. It is up to each service provider to update their default GTT databases for each inter-network service via existing service provider procedures.

5.10 Impacts to the Number Portability Database

The WNP solution will have the following impacts on the NP DB (some of which are already known in the LRN solution):

- The NP DB must support WNP query messages from wireless network and a response message including the LRN of the ported subscriber's MSC.
- NP DBs should be deployed with redundant replicates for total availability. This will require synchronization of the data in all replicated units to be provided by a centralized service management system.
- NP DBs should comply with Bellcore GR-1280-CORE, AIN SCP Generic Requirements, Section 11. Requirement 11-4 demands that the Mean Response Time at

the rated transaction load be 100 ms or less, and the 95% response time be 120 ms or less.

- The NP DB should implement congestion control and indicate such a condition to MSCs via ACG as to defined by IS-41 and/or GSM standards.

5.11 Impacts to Customer Care and Provisioning

The following list describes the potential impact of NP on customer care and provisioning systems, depending upon a service provider's infrastructure:

- Some system in the Customer Acquisition/Care provisioning stream must interface to the regional SMS for negotiating/announcing ported numbers with the other service provider(s) and for querying existing subscriber records.
- Any system which interfaces with the regional SMS system must do so with the enhanced format of the Customer Account Record Exchange (CARE), also known as the Inter-Service Provider Maintenance, Administration, and Provisioning (ISPMAP) information.

5.12 Impacts to Billing

The following list describes the potential impact of NP on billing and fraud management systems.

- Roaming tables may need to be modified to support both IMSI and MIN MSID formats. If the billing systems store IMSI, standard call records will also need to be modified and expanded. Additionally, telephone inventory records must be modified.
- Billing systems will most likely need to support more than one identifier for a subscriber: MSID(s) and/or MDN.
- Any system or process which is built on MIN must be modified to support another ID - rating, cycle changes, splits, et al.
- Fraud Management will also be impacted for the same reason as above. Call Detail Records from the visited service providers are currently extracted on the basis of NPA-NXX translation of the billed number.
- A billing module may have to be added to the existing AMA records for calls involving ported numbers. The details are for future study.
- A billing identifier may be added to the call setup or AMA records. Future study is required.
- Call data message handling (e.g., IS-124) needs must be addressed.

5.13 Impacts to Maintenance

The following list describes the potential impact of NP on the maintenance operations:

- Performance and measurements
- Fault Detection, isolation and recovery

- Alarm detection and alarm reporting
- Maintenance and administration position
- Test procedures of the non-ported number, ported number and disconnected ported number

5.14 Impacts to Number Portability Data Administration

The following list describes the potential impact of NP on customer and network data administration.

- Service providers need to have an EDI interface for exchanging ported subscriber's data.
- WSPs must provide for an LSMS function to mediate the data sent from the NPAC-SMS to the NP DB, including the CMIP interface to the NPAC-SMS.
- WSPs must provide for an SOA function to mediate the data sent from the WSP's service order entry systems to the NPAC-SMS, including the CMIP interface to the NPAC-SMS.
- The CTIA Cellular Operations Record Distribution (CORD) and the LERG data distribution procedure must be updated to provide rapid exchange of PC/SSN, MSID, and other pertinent routing and subscription information.
- WSPs must provide for a means (e.g., an Operations Support System, manual) with which to provision network data, including
  - portable NPA-NXX block indicator for the MSCs,
  - new TT and new GTTs in the STPs,
  - HLR updates to include ported numbers, and
  - translation data in NP DB.

5.15 Impacts to Service and Network Reliability

The porting of a customer from one service provider to another requires provisioning changes that are both accurate, timely, and precisely coordinated between all service providers in a portable area. This provisioning is especially critical with respect to GTT databases. Incorrectly provisioned GTT databases can result in SCCP circular routing conditions that may utilize all of a link set's capacity within seconds. A circular routing mechanism is therefore needed that eliminates SCCP circular routed messages from occurring.

ANSI T1.112 provides procedures for SCCP message looping in the form of the SCCP Hop Counter. This hop counter is available in SCCP X-Unitdata (XUDT) messages only. Network elements will require upgrades to support XUDT message formats. Due to economics and desired dates of implementation, the UDT message will be used for number portability and existing applications. The XUDT message has been flagged as the desired long term solution.

5.16 Human Factors Impacts

Today, mobile subscribers may dial seven digits for calls within their home NPA. An NPA is pre-pended to the dialed digits for some mobile originated calls. In a Number Portability environment, 10 digits must be sent in the query to the NP DB. Wireless Number Portability is driving the separation of MSID and MDN, with the possibility that the MSID (as MIN) will not reflect the NPA of the subscriber's MDN.

The question then is how will the MSC determine what NPA to pre-pend to a 7 digit dialed number. The call might be misrouted, or the wrong information sent to the NP DB, if the MSC relies on the MIN MSID or the NPA of the MSC to determine the NPA of the called number.

There are 3 possible solutions:

(a) Require 10 digit local dialing for all mobile subscribers. This would treated all mobile subscribers equally (whether ported or non-ported) but may put the wireless carrier that implements 10 digit local dialing at a competitive disadvantage if the other local carriers, wireless or wireline, still support 7 digit local dialing. (A variation would be to have only the ported subscriber dial 10 digits. But that disadvantages that subscriber, would not meet dialing parity criteria, and would require the carrier to maintain multiple dialing plans for different classes of subscriber.)

(b) Assign the ported subscriber an MSID in MIN format with the same NPA as the ported MDN. It is not clear if this would always be possible, and this practice may affect MSID administration and may lead to inefficient use of the MSID. (MIN administration is for further study.) If the mobile subscriber has an IMSI as MSID, and no MIN, the MSID provides no value for this process since an IMSI does not contain an NPA.

(c) Use the NPA of the MDN of the calling mobile subscriber. This solution assumes that the calling party's MDN is available at the time of this substitution.

5.17 NPA-NXX BASED SERVICES

There are a number of services for wireless customers that are based on dedicated blocks of NPA-NXXs for directory numbers. These services include Calling Party Pays, reverse toll billing, and wide area calling among others. Some require agreement and interaction with a wireline carrier and apply specifically to wireline originated calls; others do not. Due to the fact that these services are based on directory numbers and directory numbers will be portable from one service provider to another, there are problems with maintaining service and billing integrity with LNP.

5.17.1 Service Descriptions

There are two applications of reverse toll billing. In one scenario, the wireline carrier bills a toll charge to customers calling wireless numbers unless the wireless numbers fall within specific ranges of NPA-NXXs. In those cases the wireless subscriber has agreed to pay the wireline toll charges. The second scenario is similar except that the wireless company pays the toll charges instead to the wireless subscriber.

Wide area calling is similar to, but just the opposite of, reverse toll billing. In this case, wireless subscribers who are assigned directory numbers within specific dedicated NPA-NXXs are allowed a larger local, toll free calling scope than other subscribers. One or more local exchange carriers has agreed., or has been ordered, to provide the larger toll-free calling scope for wireless customers with directory numbers within the dedicated NPA-NXX ranges.

Calling Party Pays is a service offered by some wireless providers which provides no airtime is charged to the wireless subscriber for incoming calls. The wireline providers identify CPP directory numbers based on dedicated NPA-NXXs and bill their customers additional charges for CPP terminated calls.

5.17.2 Possible Resolution

In the examples given, the specific wireline service providers need to determine whether or not to bill air-time or toll charges based on either an originating or terminating directory number and agreements with wireless carriers. But with LNP, the customer's directory number can remain the same while he ports to other service providers that may not participate in the agreements, or he may port into a wireless carrier with a foreign NPA-NXX which may need to be recognized as participating in a service of this type. One resolution proposed by a CTIA sponsored workshop is to assign dedicated LRNs for each of these services. The billing would then be based on the number to which the call was routed and the first six digits of the dedicated LRN would be added to the list of dedicated NPA-NXXs for that specific service.

5.18 Other Service Impacts

The following impacts to services, as known today, are anticipated with the introduction of number portability as proposed in this document:

- Over the Air Activation must support the delivery of a MDN to the MS.

  The User Initiated Over The Air Function (OTAF) will not have impact with Call Origination on Wireless Number Portability. The Network Initiated OTAF with Call Termination will have some impact on Wireless Number Portability.

- CNIP must support the delivery of the MDN and not the MIN as the call party number for mobile originated calls.
- Emergency services must ensure that the subscriber is known to the operator by the MDN and not the MSID. Refer to section 3.3.2 for further discussion.
- Delivery of an SMS message to the Destination MC and ultimately the mobile station is based upon the MIN. In WNP, the delivery network only has the MDN of the mobile station. Therefore, the service is impacted in routing to the Destination MC. Refer to section 3.3.5 for presented solutions.

Impacts to CLASS type services are similar to those outlined in the ICCF document "INC Report on Number Portability," section 13.1.5.1.

There may also exist impacts to proprietary service implementations not appropriate for this document.

6. RELATED DOCUMENTS

The following documents can provide additional information regarding Number Portability:

- *Industry Numbering Committee (INC) Report on Number portability, Industry Service providers Compatibility Forum (ICCF)*, INC 96-0607-013, July 11, 1996.
- *FCC First Report and Order and Further Notice of Proposed Rulemaking*, CC Docket 96-116, July 2, 1996.
- *FCC First Memorandum Opinion and Order on Reconsideration,* CC Docket No. 95-116, March 11, 1997.
- *FCC Second Order and Report,* CC Docket No. 95-116, August 18, 1997.
- *Federal Communications Commission (FCC) Notice of Proposed Rulemaking (NPRM) for the Local Number Portability*, Docket Number 95-116, July 13, 1995.
- *Generic Requirements for SCP Application and GTT Function for Number Portability*, Illinois Number Portability Workshop, Issue 0.95, September 4, 1996.
- *Generic Switching and Signaling Requirements for Number Portability*, Illinois Number Portability Workshop, Issue 1.02, June 17, 1996.
- *IMSI Assignment Guidelines and Procedures*, Version 1, February 12, 1996.
- *North American Numbering Council LNP Architecture and Administrative Plan,* Issue 5, March 4, 1997.
- ANSI T1.660 – 1998, *American National Standards for Telecommunications – Signaling System Number 7 – Number Portability Call Completion to a Portable Number.*
- ANSI T1.708. – 1998, American National Standards for Telecommunications – PCS 1900 Service Provider Portability.
- *The Number Portability Administration Center (NPAC) Interoperable Interface Specification*, www.npac.com
- *The North American Numbering Council Functional Requirements Specification*, www.npac.com.
- *The North American Numbering Council Local Number Portability Administration Working Group (LNPA WG) Report on Wireless/Wireline Integration*, May 8, 1998.
- *The North American Numbering Council (NANC) Local Number Portability Administration Working Group (LNPA WG) Report to the NANC*, April 25, 1997.
- *TIA/EIA-IS-756 TIA/EIA-41 D Modifications to Support Wireless Number Portability*, February, 1998.
- *TIA/EIA-IS-756A TIA/EIA-41 D Modifications to Support Wireless Number Portability, Phase II*, release date TBD.
- *CTIA Mobile Identification Number (MIN) Assignment Guidelines and Procedures,* Version TBD, release date TBD.

- Industry Number Committee *Location Routing Number Assignment Practices*, Issue No. 102, www.atis.org/atis/clc/inc/incwdocs.htm.

Information is available via the World Wide Web regarding number portability. In some cases, the above mentioned document may be found at these web sites.

- www.fcc.gov -- information regarding the NANC LNP activities, FCC orders, meetings, etc.
- www.wow-com.com – CTIA's web site containing copies of this document.
- www.ported.com -- this site contains various documents and information related to wireline portability.
- www.t1.org/index/0701.htm -- this site contains, among many other things, the CCPN document
- www.npac.com – Lockheed Martin's NPAC site.
- www.atis.org/atis/clc/inc/inchom.htm – INC Working Documents.