EXHIBIT 10

RESPONSE MATRIX
Request for Information

Number Portability

Company Name:

AT&T Wireless Services, et al.

Section	Question/Subject	Response Included	No Response
5.1	Proposed Architecture Overview	Yes	
	Network Elements	Yes	
	Triggering	Yes	
	Gateway Requirements	Yes	
	Network Routing Number Entity	Yes	
	Central Database	Yes	
	SS7 Global Titles	Yes	
	System Performances	Yes	
5.2	Network Functionality	Yes	
5.2.1	Registration	Yes	
5.2.2	Authentication	Yes	
5.2.3	Call Handling	Yes	
5.2.3.1	Call Origination on MSC	Yes	
5.2.3.1.1	To Wireline	Yes	
5.2.3.1.2	To Wireless	Yes	
5.2.3.2	Call Delivery to Mobile Station	Yes	
5.3	Roaming Issues	Yes	
5.4	Database Issues	Yes	
5.5	Mobile Station Identification Issues	Yes	

RESPONSE MATRIX
Request for Information

Number Portability

Company Name:

AT&T Wireless Services, et al.

Section	Question/Subject	Response Included	No Response
5.6	Service Interactions	Yes	
5.6.1	Over the Air Activation (OTA)	Yes	
5.6.2	Short Message Services	Yes	
5.6.3	Data Services	Yes	
5.6.4	Emergency Services	Yes	
5.6.5	Operator Services	Yes	
5.6.6	Other impacts on Existing Services and Features	Yes	
5.7	Operational Support Systems	Yes	
5.7.1	Service Management System (SMS)	Yes	
5.7.2	Billing	Yes	
5.7.3	Maintenance Systems	Yes	
5.7.4	Customer Care	Yes	
5.8	Timing	Yes	
6.1	Fraud Management	Yes	
6.2	LAES (Lawfully Authorized Electronic Surveillance)	Yes	

1. INTRODUCTION

1.1 INTRODUCTION AND ADMINISTRATIVE PROVISIONS

This document is being provided in response to the Cellular Telecommunications Industry Association (CTIA) Request for Information (RFI) regarding Number Portability (NP). Specifically, this document provides a recommended solution known hereafter as Wireless Number Portability (WNP). In responding to the request, this document answers each question posed in the RFI as well as includes a standalone attachment describing the WNP solution in detail. Readers of this response can choose the read either or both depending upon the need for information.

This WNP solution has been endorsed by the following corporations:

AG Communication Systems
AT&T Wireless Services
Ericsson Inc.
Lucent Technologies
Tandem Computers

For questions regarding this response, please contact the following person(s):

Carol H. Peters
Senior Member of Technical Team
AT&T Wireless Services
5000 Carillon Point
Kirkland, Washington 98033
(206) 803-1263
carol.peters@attws.com

The respondent(s) of this RFI agree to the terms and responsibilities presented in the RFI and will be prepared to present this solution at the schedule NP Forum in Las Vegas on October 9-11, 1996.

1.2 BACKGROUND AND DEFINITIONS

The recent Federal Communications Commission (FCC) *Number Portability Report and Order, CC Docket 95-116,* mandates that all

telecommunications service providers (cellular, broadband Personal Communications Services, and covered Specialized Mobile Radio) provide the capability to deliver calls from their network to ported numbers anywhere in the United States by December 31, 1998. Furthermore, the order mandates that these providers offer service provider portability, including support for roaming, by June 30, 1999. The definition for service provider portability as mandated by the FCC can be found below. However, in simplistic terms, one can view a ported number under service provider portability as a number is retained by the subscriber in the event that the subscriber changes service providers.

Because the FCC mandate also addresses the wireless industry, a number portability solution must be adapted to encompass wireless special needs. The wireless number portability solution must strive for the following goals:

- make minimal impact on the existing networks;
- continue to support roaming as it exists today;
- do not impact the existing defined service and feature set;
- do not inhibit the future growth of wireless technology; and
- do not unduly deplete the North American Numbering Plan (NANP) numbering resources.

1.3 ASSUMPTIONS AND DEFINITIONS

This response makes the following assumptions in finding a solution to number portability for the wireless environment:

- *Service Provider Portability* is defined as "the ability of end users to retain the same telephone numbers as they change from one service provider to another." [1]
- *Service Portability* is defined as "the ability of users of telecommunications services to retain existing telecommunications numbers without impairment of quality, reliability, or convenience when switching from one

[1] Federal Communications Commission order in the matter of Telephone Number Portability, CC Docket No. 95-116, order FCC 96-26 released July 2, 1996, pg. 98, paragraph 172.

telecommunications service to another service provided by the same telecommunications service provider." [2]

- *Location Portability* is defined as "the ability of users of telecommunications services to retain existing telecommunications numbers without impairment of quality, reliability, or convenience when moving from one physical location to another." [3]
- The FCC states that "... requiring service or location portability now would not be in the public interest. ... service provider portability is critical to the development of competition, but service and location portability have not been demonstrated to be as important to the development of competition." [4] For this reason, this proposal addresses only service provider portability. It does not ignore the future complexities of location or service portability but it does not directly attempt to solve these problems at this time.
- Location number portability includes service provider portability and any associated location portability so long as that location portability is confined to the same rate center. [5]
- Roaming agreements with more than one service provider in any serving area will be allowed.
- Any proposed solution should not have a significant impact on the wireline solution for number portability.
- There is no impact on the Electronic Serial Number (ESN).
- The number portability database will contain a record for each ported number in the area it serves for both wireline and wireless.

[2] CC Docket No. 95-116, paragraph 172.

[3] CC Docket No. 95-116, paragraph 174.

[4] CC Docket No. 95-116, paragraph 182.

[5] Wireless may not conform to the wireline definition of a rate center.

- There will exist one or more regional Service Management Systems (SMS) controlled by a neutral third party to provision the routing data for ported numbers into the number portability database.

1.4 SCOPE

The solution presented in this document is written based on TDMA technology, including IS-41 Rev C and IS-136 standards. This is done for ease of presentation but is not meant to preclude other technologies. This document does not include potential impacts to the other standards (e.g., IS-652).

1.5 ACRONYMS

The following acronyms are used throughout the proposal

Acronym	*Acronym Expansion*
ACG	Automatic Code Gapping
CdPA	Called Party Address
CdPN	Called Party Number
CLASS	Custom Local Area Signaling Services
CgPA	Calling Party Address
CgPN	Calling Party Number
CTIA	Cellular Telecommunications Industry Association
DN	Directory Number
EOs	End Offices
ESN	Electronic Serial Number
FCC	Federal Communications Commission
FCI	Forward Call Indicator
FGTT	Final Global Title Translation
GAP	Generic Address Parameter
GT	Global Title
GTT	Global Title Translation
HLR	Home Location Register
IAM	Initial Address Message
IGTT	Intermediate Global Title Translation
IMSI	International Mobile Station Identifier (E.212)
IN	Intelligent Network
IS-41	Interim Standard - 41 Signaling Protocol for

Acronym	*Acronym Expansion*
	cellular Mobility Management
ISUP	ISDN User Part
LATA	Local Access Transport Area
LRN	Location Routing Number
MCC	Mobile Country Code
MDN	Mobile Directory Number
MIN	Mobile Identification Number
MNC	Mobile Network Code
MS	Mobile Station
MSC	Mobile Switching Center
MSID	Mobile Station Identifier
MTP	Message Transfer Part
NANP	North American Numbering Plan
NE	Network Element
NP	Number Portability
NP-SCP	Number Portability Service Control Point
NPRM	Notice of Proposed Rulemaking
OMSC	Originating Mobile Switching Center
OAM&P	Operations, Administration, Maintenance, and Provisioning
OEO	Originating End Office
OSS	Operations Support System
PC	Point Code
PODP	3/6/10 Digit Public Office Dialing Plan
PSTN	Public Switched Telecommunications Network
SCCP	Signaling Connection Control Part
SCPs	Service Control Points
SMR	Specialized Mobile Radio
SMS	Service Management System
SS7	Signaling System 7
SSN	Sub-System Number
STP	Signal Transfer Point
TEO	Terminating End Office
TLDN	Temporary Local Directory Number
TT	Translation Type
VLR	Visiting Location Register
VMSC	Visited Mobile Switching Center

Acronym	*Acronym Expansion*
WNP	Wireless Number Portability
TDMA	Time Division Multiple Access
WIN	Wireless Intelligent Network

1.6 DOCUMENT ORGANIZATION

This RFI response is organized into two major portions: first, each RFI question is responded to directly on the immediate following pages; also, attached is a stand-alone detailed description of the WNP proposal. The response to the questions are numbered just as the RFI; therefore, the next section will start with (5) and follow that of the RFI.

5. RESPONSE

This section contains the response to each of the RFI questions. The section contains each question, in italics, for the benefit of the reader, followed by the response in ordinary font.

5.1 PROPOSED ARCHITECTURE OVERVIEW

Note: In order to best described the overall architecture proposed by this response and to answer all of the questions asked in this section, a summary has been written and included. This summary is included to answer all of the questions presented in this section. Where the reader may want more detail, please refer to the attached document or the additional question responses.

CTIA: Network Elements - Does the architecture use any one or a combination of the following: STP, SCP, ISCP, IP, MSC, etc. If so, what information and process needs to be available at each element? Is more than one database required?

CTIA: Triggering - Identify any trigger mechanisms and protocols used, and at which points in the network for this architecture? (ITU IN CS IR, ANSI IN, AIN, WIN?)

CTIA: Gateway Requirements - Are there requirements for a new gateway function for wireless networks?

CTIA: Network Routing Number Entity - Under the LRN process to which network element does the network routing number point? (MSC-Home, HLR, MSC-Gateway, mobile network gateway.)

CTIA: Central Database - Is a central database for wireless use required for identification of HLRs or are there other methods available?

CTIA: SS7 GTs - Identify any impacts on current SS7 Global Title processes. (MIN to MSC, MIN to HLR, IMSI to MSC, IMSI to HLR?)

CTIA: System Performance - Identify any expected performance implications/impacts on: normal call processing, post dial delay, registration, authentication, roaming?

The WNP solution can be summarized with the following major modifications to today's wireless network architecture in order to best support number portability:

- Build upon the Location Routing Number (LRN) solution generally adopted by the wireline industry. The LRN has many merits:
  - It has been generally accepted as the wireline solution to number portability.
  - It does not require one unique network address for each ported number. The network address for a ported number is tied to the ported-to switch address, instead.
  - Call routing will follow the current switch processing with only minor ISUP modifications.
  - The DN is passed to the terminating switch without modification. This is important in order to preserve Custom Local Area Signaling Services (CLASS) processing.
- Separate the Mobile Direction Number (MDN) from the Mobile Station Identifier (MSID).

  If, instead, the MSID and the MDN were the same for all MSs, a 10-digit translation of the MSID belonging to a portable NPA-NXX block would be needed in order to locate the Home Location Register (HLR) of the Mobile Station (MS). Although it is possible to provide such a translation in the Mobile Switching Center (MSC) or an Signaling Transfer Point (STP), it is impractical to consider administering such a large volume of numbers or the penalty that would be imposed on the switch and STP performance under their current configurations. Additionally, billing and provisioning systems, including roaming tables, which work today on NPA-NXX number blocks would also be required to store and map on all 10+ digits of the identifier.

- Make the MDN the portable number; keep the MSID as a non-portable number controlled by the wireless service provider. This is essential in order to avoid 10+ digit translations in call routing and, similarly and equally important, in support system processing (e.g., billing tables).
- Target the ITU E.212 International Mobile Station Identify (IMSI) as the principal MSID.

  The advantages of IMSI over MIN are many:

  - Because of the arrangement of the IMSI number (as illustrated in section 5.2.1 of this response) 6-digit translation of the number can easily identify the service provider of the MS.
  - Because IMSI is an international standard, the use of IMSI makes international roaming more feasible and easy.
  - There already exists guidelines for IMSI numbering as well as a committee for IMSI assignment.
  - The 15-digit IMSI numbering plan will not deplete the numbering resources in the foreseeable future.
- Identify a well-defined interim period for which the MSID could be a MIN-style number (still non-portable) until networks support IMSI as a widespread standard.

  Having a well understood direction for the industry is critical to roaming and minimizing the impact on subscribers.

Please note that proposing such changes to the wireless network architecture is not done with ease but is backed by much thought and discussion. Overall, there will exist no number portability solution which does not have impact. Therefore, one underlying philosophy of this response is that if a solution is to be implemented for number portability in the wireless industry, it

should be done so efficiently and in-line with the long-term goals of the wireless industry.

Also, please note that this is a summary of the overall architecture. The details can be found in the attachment as well as in the responses to the RFI questions below.

To summarize this response, the architecture for the WNP solution includes the following network elements:

Network Elements in WNP

NE	*New Functionality or Enhanced Functionality*
HLR	As it exists today plus the enhanced to support separation of DN and MSID, to support MSID as IMSI and/or MIN.
MSC	Enhanced to support the separation of DN & MSID, to support MSID as IMSI and/or MIN in registration, call origination, and call delivery. Enhanced call delivery to support LRN addressing
NP-SCP	New database providing the DN to LRN address mapping for a mobile call routing.
STP	Enhanced to support the new translation types.

The impact of number portability on MS registration is primarily in routing the registration request query for an MS with a ported number to its HLR, and doing so with an MSID which is not the MDN. In an IMSI-capable network, the MS would register with the IMSI; in a non IMSI-capable network, the MS must still register with a MIN. The registration message is sent to the subscriber's HLR using an STP Global Title Translation (GTT) on the MSID based upon a Translation Type of 3 for MIN or 9 for IMSI. The HLR responds to the originating MSC with an appropriate registration response, including the DN of the subscriber. As proposed in this response, if the MSID is managed in number blocks (ideally, under the ITU E.212 IMSI standard), then 10-digit translation is not require to locate the subscriber's home network nor the subscriber's HLR.

The impact of number portability on mobile call origination is in using the MDN of the cellular subscriber as the calling party number in the ISUP message as opposed to the MIN in today's environment. Additionally, an Originating MSC (if *N-1*) must be capable of making the determination as to whether the number is a

ported block and thus query the Number Portability Service Control Point (NP-SCP) using a dialed number based trigger. This solution proposes that an MSC access the NP-SCP using an IS-41 OriginationRequest (or equivalent message). This will have minimal impact on the MSCs in terms of protocol development.

The impact of number portability on mobile call delivery is in using the LRN to deliver the call to some MSC in the subscriber's home network based on the MDN of the called mobile subscriber. (Occasionally, this response will refer to this MSC as an entry MSC.) The *N-1* network in the call path will query the NP-SCP for the LRN of the subscriber's home network MSC using the DN as input. Continuing, the entry MSC will query the MS's HLR database to locate the MSC serving the subscriber.

As mentioned above, this proposal refers to an entry MSC as to which the LRN points to in the subscriber's home network. The layout of such an arrangement can be left to each wireless service provider's discretion. That is, this solution does not impose the concept of a Gateway MSC in the traditional sense that a gateway function does nothing more than provide a single entry point into a network. The entry MSC can be any chosen MSC in the provider's network. It can differ per ported number block, and it does not necessarily need to be the Home MSC.

Another item worth noting is that this solution does not propose a separate database solution for wireless than for wireline. This solution assumes using an NP-SCP in the same fashion as the wireline LRN solution. In fact, this solution does not impose any restrictions that every wireless service provider must own an NP-SCP; it is conceivable that a provider could enlist a third-party to provider the database or the query.

Any call to a ported number, fixed or mobile, needs to query an NP database to determine the current service provider. This database dip will increase the post dial delay with an estimated 200 - 500 ms per call set up.

The introduction of IMSI is not expected to pose any performance degradation to the signaling network. Any other development and implementation changes to the wireless infrastructure could

possibility have minor impacts on memory consumption and CPU utilization, but is not to have any significant impact on the service perception by the end user.

5.2 NETWORK FUNCTIONALITY

Please include a detailed description of each network functionality with the associated call flows and involved network elements.

5.2.1 Registration

Note: If the reader requires a more detailed explanation regarding registration under number portability than is directly included below, please refer to section 2 of the attached document.

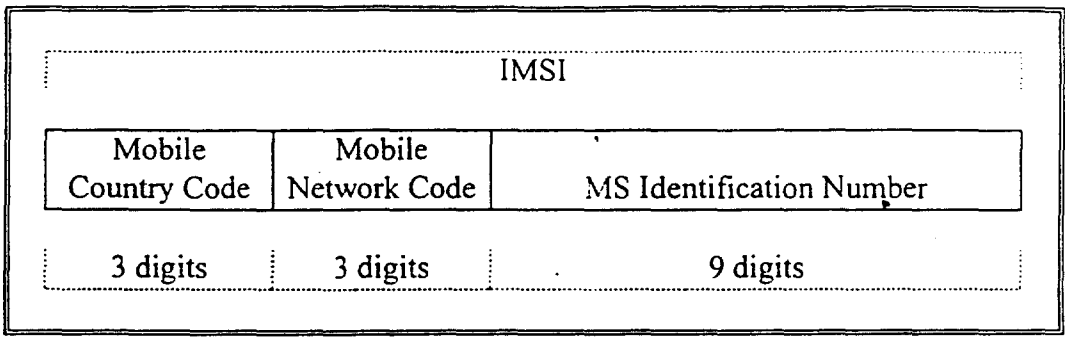
CTIA: How should mobile registration be accomplished under number portability?

Mobile registration should be accomplished in the same fashion as today but using the MSID to obtain the subscriber's profile. Furthermore, the MSID should be separated from the MDN. This separation allows the industry to assign numbers to the wireless service providers in blocks. This makes it easy to identify the subscriber's service provider within the first several digits of the number.

CTIA: Given that today we use the MIN which is currently the Mobile Directory Number (MDN) and that we have agreed to move to the use of IMSI with the new digital technology, what process should be used to register mobiles under number portability?

In an IMSI-capable network, the IMSI should take precedence and be the identifier in the registration process. ITU E.212 has designated the IMSI to be in the format on the following page:

ITU E.212 IMSI Standard



The first three digits of an IMSI identify the country code of the MS's home network; the next three digits identify the home network itself. Simply, 6-digit translation on the IMSI (with a new translation type) will route the registration request message to the proper HLR.

Note: 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.

CTIA: Now that the DN (and consequently the MIN based on today's use) could be ported to or from another provider including wireline, is there a solution to avoid changing the imbedded base of analog phones?

In an ideal world, changing out an analog phone for an IMSI-capable phone when a subscriber ports would alleviate much overhead on the wireless solution. However, it is recognized that this is not entirely realistic to expect all service providers, large and small, to quickly convert to IMSI capable network infrastructure.

Therefore, the solution to number portability will require an interim period in which the wireless network will recognize a mobile station by either IMSI or MIN separate from the MDN.

MIN would be treated in the same fashion as an IMSI; it would remain behind as the property of the service provider when a subscriber ports. The subscriber can be assigned a MIN from the MIN block already owned by the wireless service provider. Additionally, the same DN can appear as a MIN in another network. This dual assignment does not unduly deplete the NANP number pool. It requires, nonetheless, independent administration of MINs, IMSIs, and DNs.

In summary, with this MSID identification including an MIN and/or an IMSI, the mobile station can register in both digital and analog networks on a 6-, 7-, or 8-digit analysis basis. For IS-553 (AMPS) and IS-54B (D-AMPS) phones, the MIN will be the only MSID used.

CTIA: Could a process separating MIN and DN be used?

The response to this question assumes that (a) the DN will be separated from the MSID when a subscriber ports, (b) the MSID is the MIN, and (c) the DN is portable whereas the MIN is not.

If a subscriber has not ported to a new network, the MIN as one knows it today is both the MDN and the MSID. For example, the MIN for subscriber *A* today is (123) 555-7890 . After June, 1999, when subscriber *A* ports to a new service provider, (123) 555-7890 ports with the subscriber as his/her MDN. Subscriber *A* receives a new MSID from his/her new service provider; and the MIN=1235557890 is left behind in the donor network for re-use as an MSID (but not an MDN) for another subscriber. The service provider will maintain a mapping of MSID to MDN in their own mobility management databases.

CTIA: Could we use a process based on Mobile Station Identification (MSID) e.g., IMSI plus pseudo-IMSI for the DN as MIN based phones?

The opinion expressed in the WNP proposal states that IMSIs must follow the strict format as defined in the ITU E.212 IMSI standard. Because the Mobile Country Code (MCC) and the Mobile Network Code (MNC) are located in the first six digits of the format, a registration process only need translate the first six digits of the identifier in order to locate the home network. If another arrangement of the numbers were employed, the advantage of the

MCC and the MNC would be lost. Strict adherence to the E.212 standard is more efficient.

CTIA: Is there a solution that avoids extensive ten digit Global Title Translations (GTT) for routing Mobile Application Part messages?

The WNP solution proposes a means by which 10-digit GTT can be avoided

a) either at the STPs or the MSCs;

b) either when completing the call delivery or when locating the profile of the subscriber.

To address point (a), separating the MSID from the DN and assigning MSIDs in number blocks to the wireless service providers allows these providers to perform translation on only 7 or 8-digits on the MSID as opposed to 10 or more digits.

To address point (b), translation on the MDN is first encountered at the MSC to which the LRN routes. This entry MSC must translate the MDN in order to find the HLR in which the subscriber's profile is located. The WNP solution proposes several alternatives (there may be more) to routing a location request query to the HLR with 10-digit GTT. These alternatives are described below:

a) The STP would maintain a table mapping of all its MDN number blocks within its regional network to the corresponding HLR Point Code (PC) and Subsystem Number (SSN). By appropriately assigning number blocks to HLRs, a 6-digit GTT will suffice. A new intra-network Translation Type (TT) must be defined for accessing this table. The MSC sends the STP the IS-41 LocationRequest (or equivalent) message with the SCCP CdPA equal to the MDN and the TT equal to the TT for MDN-to-HLR mapping. After appropriate translations, the STP sends the message to the HLR.

b) The MSC would maintain the table mapping of all its MDN to the HLR addresses. The MSC (as opposed to the STP) can

route the message to the HLR using the PC-SSN of the HLR as obtained from this translation table. This alternative is not based on the use of any GTT.

c) The above method can be refined by mapping the MDN to the appropriate MSID number blocks supported by an HLR (as opposed to mapping to its point code). Then the MSC GTT routes the LocationRequest (or equivalent) message using STP GTT on the MSID number blocks (using existing TT=3 for MIN or existing TT=9 for IMSI).

Each service provider can choose to implement the routing method (those above or another) which best serves that provider's needs.

CTIA: What are the international implications?

Beyond what implications exists today, the use of IMSI will make international roaming much easier since the first 6-digits of the IMSI can be uniquely associated with any network in the world.

CTIA: Describe the process flow and protocol implications. Describe the impacts on all network elements. Include the implications on current standards, i.e., IS-41, IS-136, TDMA, CDMA, GSM.

The attached WNP solution details the registration process using the North American TDMA (e.g., IS-136) and AMPS air-interface and IS-41 protocol. This response does not attempt to embody the expertise of other protocols and standards (e.g., IS-652); however, parallel impacts are anticipated. In general, all networks must use IS-41 Rev-C (or equivalent). The use of IMSI as the MSID in the registration process requires digital control channel as with IS-136 or fully digital GSM.

Process is only implicated in that the systems in the process must be aware that the MSID is no longer a DN but a separate identifier which will map to the DN in the call flow process. For example, the Registration response must include MSID and MDN.

5.2.2 Authentication

Note: If the reader requires a more detailed explanation regarding authentication under number portability than is directly included below, please refer to section 2 of the attached document.

CTIA: How will authentication be supported in a Service Provider Number Portability environment?

Authentication will continue to be supported in a number portability environment and must do so using either MIN or IMSI. In fact, IS-136 Rev A covers the choice of MIN or IMSI today (refer to IS-136 Rev A section 8.1.4.2). However, IS-41C must be brought up-to-date with IS-136A in order to process the authentication messages with either MIN or IMSI, as appropriate.

5.2.3 Call Handling

5.2.3.1. Call Origination on MSC

Note: If the reader requires a more detailed explanation regarding call origination under number portability than is directly included below, please refer to section 2 of the attached document.

CTIA: Can a determination be made that the call is to another mobile for potential services and call routing efficiencies?

Calls to a wireless subscriber can in the *N-1* case be handled more efficiently if the MSC were to first query its own HLR normally associated with the dialed block. (This is efficient only so long as the service provider is supplying service to the majority of DNs defined in the block.) The HLR would respond with either (a) an indication that the number is ported, or (b) normal call delivery. If the number is ported, the MSC would then query the NP-SCP and route the call according to the LRN.

CTIA: Will the MSC use the SS7 Call Completion to Portable Number (CCPN) network capability?

Yes, the MSC will use the SS7 CCPN network capability. However, this response strongly recommends only the LRN solution within the CCPN.

CTIA: How is the appropriate subscriber information - ANI (charge number) and calling party number - correctly populated?

Inasmuch as the calling party DN and MSID are different, the originating MSC will populate the ISUP IAM CgPN with the calling party DN. The originating MSC will obtain the DN from the registration notification response.

The ANI, on the other hand, could be populated with the DN or with the DMH billing digits from the registration notification response message.

CTIA: Any other options are encouraged to address the following questions.

Please refer to the attached document for a complete understanding of all options considered along with associated arguments and investigations.

5.2.3.1.1. To Wireline

CTIA: What changes need to be made to allow the MSC to do the NP query for a local call?

The following changes, if not available in a service provider's MSC today, are anticipated under number portability:

- The MSC must support 3- or 6-to-10-digit originating triggers. Specifically, the MSC must first check the NPA of the dialed number to identify the call as local or long-distance. If a local call and if the NPA-NXX belongs to the MSC, it can check its own VLR. If the VLR is not found but there is an NP trigger, the MSC will query the local NP-SCP. Existing office triggers will take precedence over NP triggers.
- The MSC must be capable of sending an OriginationRequest (or equivalent) query to the NP-SCP.
- The MSC must be capable of receiving the respective response message in return with the LRN.
- The MSC must be capable of re-translating the CdPN using a new NP routing table.

CTIA: How will the MSC interact with the routing databases when defined?

Note: The response to this question assumes the routing database to be the Number Portability SCP.

In that context, the WNP proposal recommends using an IS-41 Rev C OriginationRequest (or equivalent) message to interact with the NP-SCP. Wireline End Offices could use the modified AIN Info_Analyzed query (modified for LRN) or the IN Instruction_Start query.

CTIA: How is the call processed if the call is beyond the local area?

If the call is beyond the local area (zone of portability) for the originating network, the call should be delivered to the PSTN as it is today - via an access tandem or to an IXC directly based on the outcome of the 3 or 6-digit translation.

CTIA: What types of triggers are used?

A dialed number trigger will need to be implemented in the MSC to launch the Origination Request (or equivalent) query to the NP-SCP for number portability. This dialed number trigger will be a conditional trigger based upon 3 to 10 digits of the dialed number and will be administered on an MSC basis. This dialed number trigger should be the lowest priority of all of the dialed number triggers. For example, in an Intelligent Network (IN) type of call model, this dialed number trigger could be an office-based trigger from the Analyzed_Information Detection Point.

CTIA: What are the protocol impacts - IS-41, IS-652, etc.?

This response does not address impacts to CDMA or GSM specific protocols. The following impacts are anticipated surrounding TDMA and IS-41:

- The WNP solution recommends using an IS-41 Rev C OriginationRequest message to query the NP-SCP. Therefore, wireless NP-capable networks must use IS-41 Rev C (or equivalent) protocols in order to query the NP-SCP.

  (Note: Wireline EOs will use AIN or IN queries.)

- IS-41 Rev C must support the introduction of IMSI as an MSID.
- IS-41 Rev C will need to be enhanced to support Automatic Code Gapping (ACG), particularly to the NP-SCP.
- The IS-41 LocationRequest message needs to be modified in order to identify whether the destination digits are a TLDN or another type of digits. It will also need to provide a method to indicate the DN is ported.

CTIA: Are there efficiencies that can be applied?

Calls to wireline will always be routed to the terminating end office where the wireline subscriber's line is located. In the local NP environment, the ported number translation should be performed in the *N-1* network.

5.2.3.1.2. To Wireless

CTIA: Are there efficiencies which can be developed for delivery to a wireless user or must the procedure be the same as for wireline delivery?

Because of the wireless infrastructure, originated calls from an MSC to a wireless subscriber can in the *N-1* case be handled more efficiently if the MSC were to first query its own HLR normally associated with the dialed block. (This is efficient only so long as the service provider is supplying service to the majority of DNs defined in the block.) The HLR would respond with either (a) an indication that the number is ported, or (b) normal call delivery. If the number is ported, the MSC would then query the NP-SCP and route the call according to the LRN.

CTIA: What are the protocol impacts and performance implications? Can efficiencies be implemented?

Although not mandatory, call delivery requires support of ISUP at the entry MSC of the home network for the called mobile subscriber. This will avoid having to query the NP-SCP at the entry MSC. The ISUP IAM will include new parameters such as GAP and TCPN bit in the FCI, as described in the WNP solution. By utilizing the LRN solution, multiple queries to the NP-SCP can be avoided.

The network performance, when querying the HLR before the NP-SCP, improves so long as the service provider is supplying service to the majority of the DNs defined in the number block associated with the HLR. This is analogous to the wireline service provider process of first checking its own serving switch before querying the NP-SCP if the DN is ported before

CTIA: Can we avoid the trunking to the home location and then trunking to the visited location?

Wireless service providers today that avoid first trunking to the home location before the visited location can continue to do so under number portability. This solution will not impose any restrictions in that regard.

CTIA: How is the location request message routing handled? (e.g., GTT at STPs, GTT to the HLR...)

The location request message routing requires a DN to HLR address translation before the message can be sent to the correct HLR. In a previous question, this response posed several alternatives to accomplish this routing. The key points to this routing are (a) that each service provider can route the message internally to the appropriate HLR independent of the NP solution, and (b) that 10-digit GTT can be avoided as previously indicated.

5.2.3.2. Call Delivery to Mobile Station

Note: If the reader requires a more detailed explanation regarding call delivery under number portability than is directly included below, please refer to section 2 of the attached document.

CTIA: How will call delivery to a mobile station be accomplished?

The basic procedure is as follows: The *N-1* network will query the NP-SCP for a ported number and receive the LRN of the home MSC of the mobile subscriber in return. The LRN will be used as the CdPN in the ISUP IAM parameters in order to set up the call to the entry MSC in the home network. The IAM will also include the dialed DN in the GAP and FCI with the TCPN bit set. After analyzing the IAM, the entry MSC will recognize the LRN as one

of its own or its neighbors. The entry MSC may or may not be the home MSC of the MS. In either case, it will launch a LocationRequest (or equivalent) message with the DN to the HLR and will receive a response with subsequent routing information in order to deliver the call to the mobile.

CTIA: Will a network routing number be assigned to each MSC?

Yes, an LRN will be assigned to each MSC as each MSC may be connected to the PSTN directly.

CTIA: If efficiencies are applied, can we avoid triggering the NP processes in routing to the termination location?

If the HLR returns a TLDN efficiency can be achieved in the subsequent call routing by informing the downstream switches that no more NP-SCP dips are necessary by setting the TCPN bit in the FCI parameter of the ISUP IAM.

CTIA: How is the location request message routing handled? (e.g., GTT at STPs, GTT to the HLR, ...)

The location request message routing requires a DN to HLR address translation before the message can be sent to the correct HLR. In a previous question, this response posed several alternatives to accomplish this routing. The key points to this routing are (a) that each service provider can route the message internally to the appropriate HLR independent of the NP solution, and (b) that 10-digit GTT can be avoided as previously indicated.

5.3 ROAMING ISSUES

Note: If the reader requires a more detailed explanation regarding roaming under number portability than is directly included below, please refer to section 2 of the attached document.

CTIA: How will the roamer tables be handled with number portability?

The proposed solution assumes that the MSID is non-portable and can be assigned to wireless service provides in blocks of numbers. IMSI, for example, easily identifies the home service provider network and thus is ideal for the roaming tables. Having a number

block assignment is essential in order to preserve the search in the roamer tables on 6-digits as opposed to the full 10-digits of a DN.

CTIA: What are the implications to performance, protocols, and architectures?

Roamer registration will be based on the MSID. Both MIN and IMSI can be used for MSID; however, IMSI will be supported only by those networks that have deployed digital control channel in the air interface. Since an IMSI, for example, would be assigned in number blocks with unique first 6-digits, GTT on the first 6 digits will locate the home network of the roamer. Translation Type (TT) of 3 for MIN to HLR or TT of 9 for IMSI to HLR could be used as suggested above. Although MTP routing can also be employed, it should be avoided because of data administration overhead. Use of IMSI as an MSID will require modifications to several IS-41 messages (e.g., RegistrationNotification) to support IMSI. The registration notification response must return the MDN of the roamer along with their service profile.

Additionally, modifications to the appropriate digital air interface protocols might be required to ensure that IMSI takes a higher precedence than MIN in the mobile registration process.

CTIA: How will roaming with Mexico and Canada be accomplished.

To maintain a truly seamless roaming network with Mexico and Canada, it is envisioned that these network will eventually be compatible with the North American wireless number portability solution. In the meantime NP subscribers roaming in these countries will be supported with the following process and additional challenges (assuming no modifications to their existing roaming capable network):

- The roamer will register as today with the MIN as the pointer back to its home service providers HLR.
- The MDN will not be known to the serving network.
- Equal access, if applicable, will not include the subscribers billing number in the feature group D signaling message.

The ANI field would include the MIN and not the DN as expected.

- Class services based on the MDN such as Calling Name identification will not be easily supported.
- The billing record generated by the visiting MSC will include the MIN and not the MDN in the calling party number. The home carrier will need to map the MIN to the actual subscriber number for correct billing.

CTIA: How would roaming with other countries using the same technology work?

Considering the benefits with IMSI for international roaming, it is envisioned that the carriers in other countries would adopt the separation of MDN and MSID and support of IMSI.

The IMSI allows for identifying the country as well as the home network while roaming.

5.4 DATABASE ISSUES

Note: If the reader requires a more detailed explanation regarding the NP-SCP database under number portability than is directly included below, please refer to section 2 and 3 of the attached document.

CTIA: What are the implications of databases to our networks?

Please note that this response assumes the question is asking about the implications of adding a new database to our existing networks.

The implications of databases in the network are as follows:

- There will be additional database queries which will result in call setup delays. However, to minimize the impact of these additional databases, the protocols should be enhanced so that only one dip to the database is performed per call instance.
- There will be more administration and coordination of these new databases. It is proposed that the regional SMS

be used for the administration and coordination of these databases.

- An interface to this database must be defined.

CTIA: What wireless information should be added to the currently proposed SMS and SCP databases?

Potentially miscellaneous wireless information might be added to the SMS database; however, the only elements identified as essential to the solution are the subscriber's DN and the associated LRN - the same data as wireline.

CTIA: Should wireless develop their own database for each HLR location?

Under the proposed LRN solution, it is not necessary to develop databases for each HLR location. Calls only need to be delivered to an MSC within a wireless service provider's network. The service provider can then route the call internally as necessary. Each service provider may elect to develop their own NP database, may elect to use a third party NP database, or may elect to develop a NP database in conjunction with other service providers.

Use of a non-portable number, such as IMSI, would provide for the proper routing of non-call related events such as mobile registration. HLRs may need to be modified to provide a mapping between the subscriber's directory number and the terminal identification.

CTIA: Is the development of mobile station identification database an issue? Does it address administration?

The industry should assign mobile station identifiers on a per block basis, allowing each service provider to administrator their own individual number assignments. The mapping between the subscriber directory number and the terminal identifier would then be provided by the HLR for all subscribers.

It is not necessary to develop separate mobile station identification database.

CTIA: What are the implications of using another service provider's database or query process?

Some of the wireless service providers, especially the smaller service providers, may not have their own NP databases and, therefore, may be using another service provider's or third party NP database or query process.

Implications of using another provider's database are as follows:

- Charging and billing as well as OAM&P procedures among the wireless service providers and any third party providers must be defined.
- Interfaces to another provider's database may require a wireline-type message (e.g., AIN) as opposed to an IS-41 message (or wireless equivalent).

Implications of using another provider's query process are as follows:

- There exists a risk for a wireless service provider that handing off a call to another party in order to perform the query will result in the call being routed back to the same provider (i.e. mobile-to-mobile might result in a loop-around trunk connection through the querying switch).
- Routing would have to be defined and coordinated among all wireless service providers or third party NP provider;

5.5 MOBILE STATION IDENTIFICATION ISSUES

Note: If the reader requires a more detailed explanation regarding mobile station identification under number portability than is directly included below, please refer to section 2 of the attached document.

CTIA: What should our long term identification method be?
CTIA: Should we focus on IMSI as the identification?

Please note that this reply chooses to answer these two questions with a single response.

The long term identification for the mobile terminal should solely be IMSI and should be based on the separation of the MSID from

the DN. IMSI instead of MIN should be the long term identifier for the following reasons:

- Use of IMSI will greatly enhance international roaming as IMSI is already an international numbering plan.
- GSM has already established the precedence of separate directory and terminal numbers.
- Both IS-136 and the equivalent CDMA standard has already defined IMSI as the mobile terminal identification number.
- International and United States organizations already exist for the management and allocation of IMSI numbers up through the first six digits (mobile country code plus mobile network code).
- Because IMSI is not of the same length as MDN, use of IMSI will help eliminate any confusion (especially for operations trouble shooting and traces) between directory numbers and terminal numbers.
- Depletion of the existing sets of numbers is not an issue since a new and completely different set of number ranges will be assigned.

CTIA: Can we transition from MIN to IMSI gracefully?

During the transition, both MINs and IMSI numbers must be used. Newer phones, such as IS-136 based phones, would have both MIN and IMSI numbers to support roaming in markets which do not support IMSI. Older phones which are not capable of supporting IMSI would have only MIN numbers. As the older phones become obsolete, they would be replaced by new phones which would support IMSI.

This assumes that all the necessary modifications are made such that each network type is able to register with the appropriate identifier (e.g., IMSI in IS-136, MIN in AMPS and IS-54B).

This transition period should be finite and well-defined by the industry.

CTIA: Would it be possible to use a pseudo-IMSI based on MIN?

In order to support international roaming, the implementation of IMSI should be based upon ITU E.212. Additionally, in order to avoid 10 or more digit translations, the E.212 format of the IMSI is crucial as it indicates the service provider network within the first 6 digits.

CTIA: Could a process separating MIN and DN be used?

Yes. The MSID should be separate from the DN whether the MSID is an IMSI or a MIN. This has been discussed in above question responses. However, it is recognized that there will be additional administration required to administer MINs as well as DNs and IMSIs. The use of MIN should be viewed as an interim solution only in order to provide backward capability into non-IMSI-capable networks.

CTIA: Can IMSI be used for other processes rather than MIN?

Beyond being an terminal identifier, IMSI can provide home network identification and country identification when roaming internationally.

5.6 SERVICE INTERACTIONS

Note: If the reader requires a more detailed explanation regarding registration under number portability than is directly included below, please refer to section 3 of the attached document.

5.6.1 Over the Air Activation (OTA)

CTIA: How will OTA work given number portability?

Following the IS-136 Rev A standards, OTA will still function as designed to program the terminal for both new activation and change of service. By separating the MSID from the MDN, the terminal retains the associated MDN and OTA assigns a new MSID.

CTIA: If we change to IMSI, can an IMSI be changed via OTA if the customer changes providers or wants another provider upon activation?

IS-136 Rev A allows OTA of an MSID in the format of MIN or IMSI. In addition, the IS-136 Rev A specification allows the programming of both a MIN and an IMSI into the terminal. The OTA message will need to be capable of programming the MDN in the mobile phone as well.

5.6.2 Short Message Services

CTIA: How will short message service operate under number portability?

Following IS-136 Rev A, Short Message Service will still operate as defined, that being routing messages based on the MSID. IS-136 Rev A includes both MIN and IMSI for Short Message Service delivery.

Because operators may have proprietary network architectures, all functional components are not mentioned in this section.

CTIA: Are there implications for short message service protocols?

No, the protocols will remain unchanged.

5.6.3 Data Services

CTIA: How will data services operate under number portability?

All data services will function as they do today.

CTIA: Are there implications for the protocols?

No, the process for data calls to and from the terminal will be based on the MSID.

5.6.4 Emergency Services

CTIA: How will emergency services be impacted by number portability?

The MSC impact for emergency services is to ensure that the subscribers is referred to as a mobile DN, not MSID.

CTIA: Can Enhanced-911 be supported in a Service Provider Number Portability environment? What are the impacts?

Enhanced-911 is supported with impacts only as mentioned in the previous response.

5.6.5 Operator Services

CTIA: What are the impacts on Operator Services?

Impacts are similar to those outlined in ICCF document "INC REPORT ON NUMBER PORTABILITY," section 13.1.5.2. In addition, some cellular service providers do not allow collect calls to mobile terminals. This requires the operators to validate all charge negotiations on either the 10-digit DN, or to inquire with the NP / SCP and validate the service provider via the LRN.

5.6.6 Other impacts on Existing Services and Features

CTIA: What are the impacts on IS-52 services, e.g. CLASS type services?

Impacts are similar to those outlined in ICCF document "INC REPORT ON NUMBER PORTABILITY," section 13.1.5.1.

CTIA: Are there any existing or planned services/features which are impacted by number portability not covered above? Please describe.

There are currently no additional planned services known to be impacted by number portability. Service impact will also need to be addressed on a network level for any proprietary features or services.

5.7 OPERATIONAL SUPPORT SYSTEMS

Note: If the reader requires a more detailed explanation regarding registration under number portability than is directly included below, please refer to section 3 of the attached document.

5.7.1 Service Management System (SMS)

CTIA: Please identify any wireless requirements for the SMS. Also, identify any needed interfaces with the SMS or its databases. Please identify any unique needs of the wireless networks over wireline.

The wireless impacts on provisioning for number portability are similar to the wireline impacts. In order for the Regional SMS to communicate with a service provider's NP-SCP, there most likely will exist a connection from the Regional SMS to the service provider's local SMS.

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.

This interface might be more complex if a service provider does not choose to deploy their own NP-SCP but borrow another service provider's database.

5.7.2 Billing

CTIA: Please identify the proposed methods for billing under number portability. What should the identifier be? How will call detail records change? What will be used for V and H coordinates.

The following impacts to billing are expected with the introduction of number portability:

- Roaming tables may need to be modified to support IMSI. 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: MIN, IMSI, and/or DN. Call Detail Records will also need to carry all of these identifiers.
- Understand issues regarding rate center differences.
- V and H coordinates will be used as today.

5.7.3 Maintenance Systems

CTIA: How will existing maintenance systems be impacted by number portability and its proposed architecture, performance and protocol changes?

Number portability introduces an external NP database that need to be monitored and maintained as any other network based SCP.

If the wireless service provider decide to deploy and maintain its own NP database the impact on the maintenance system is equivalent to the introduction of a new network element. Alarms, operation and maintenance procedures need to be introduced. Training and possibly additional staff to operate the new network element will also be required.

If the wireless service provider does not deploy and operate its own NP database but contracts with a third party, detail operation and maintenance procedures and contracts need to be established to acquire the desired level of service.

With the introduction of IMSI and its separation from DN the operation personnel need to have clear understanding when the system is using DN versus IMSI for the different traffic cases and signaling. Successful trouble investigation of any traffic cases will require the knowledge of both the DN and the IMSI. The technician need an easy access to the HLR database or similar to query the relationship between DN and IMSI.

5.7.4 Customer Care

CTIA: How will our customer care systems interact with number portability impacts? (e.g., 611 routing) Will they interact with the SMS, other databases, billing systems effectively?

Number portability effects customer acquisition and care systems as follows:

- Depending upon an individual service provider's infrastructure, the Care system, if not a downstream provisioning system, could connect with the industry NP SMS databases for the purpose of negotiating the ported subscriber as well as auditing the subscriber routing information.
- Most front-end systems (care, billing, et al.) do work based on the NPA-NXX of a subscriber; thus, it will be necessary to have a similar basis for decisions, the 1st 6 plus digits of an IMSI, for example, where the number is separate from the ported DN.
- Managing a subscriber with multiple identifiers will be an administrative overhead to both the Care systems and Care personnel. Care systems must be able to store and query on all identifiers (i.e., IMSI, MIN, and DN).
- The phone will need to display the DN and not the MSID so as not to confuse the subscriber and to improve communications between the subscriber and care personnel.

5.8 TIMING

*CTIA: **Respondents are asked to comment on times required to complete the standards as well as develop, test, and implement the solutions proposed in order to meet these dates.***

The respondents are making efforts to meet the FCC mandated dates. The large scope of activity required may best be handled if work efforts are broken down into stages. The first efforts, target December 31, 1998, can be focused on testing and implementing the MSC solutions identified for supporting a query to an NP

routing database. The next 6 months can then be focused on final implementation and testing of care, provisioning, operations, maintenance systems, billing and roaming solutions to meet the June 30, 1999, date for offering Service Provider Portability.

Wireless will have the benefit of utilizing the test plans and service order administration and provisioning procedures that are being developed for wireline number portability. These products can be adopted or adapted to meet our needs, with the outcome of more efficiently using our time and resources in an effort to meet the FCC timeline for number portability in our networks.

6. FRAUD ISSUES

6.1 FRAUD MANAGEMENT

CTIA: How will number portability impact fraud management systems? Can these systems interact with the new environment in real time? What are the performance impacts?

As changes in the billing systems look at the DN field will mean that the fraud systems must need to make the same changes.

6.2 LAES (LAWFULLY AUTHORIZED ELECTRONIC SURVEILLANCE)

CTIA: Are changes needed to support LAES requirements?

There are no anticipated changes to the LAES requirements.

Attachment

Wireless Number Portability Architecture

PREFACE

The recent Federal Communications Commission (FCC) *Number Portability Report and Order, CC Docket 95-116,* mandates that all telecommunications service providers (cellular, broadband Personal Communications Services (PCS), and covered Specialized Mobile Radio (SMR)) provide the capability to deliver calls from their network to ported numbers anywhere in the United States by December 31, 1998. Furthermore, the order mandates that these providers offer service provider portability, including support for roaming, by June 30, 1999.

The telecommunications industry launched several initiatives to finding a long-term number portability solution in the context of service provider portability. Several solutions have been proposed for the wireline environment. Location Routing Number is one such solution that has achieved general acceptance by the wireline service providers. It does not, however, address the portability issues faced by the wireless service providers. The solution must be adapted to encompass the wireless environment. The proposal in this document urges the wireless industry to push for a suitable portability proposal that has minimal impact on the existing networks, continues to support roaming as it exists today, and does not unduly deplete the NANP numbering resources.

This document proposes the Wireless Number Portability (WNP) solution, built on the LRN solution with appropriate modifications to accommodate wireless call processing and mobility management. This solution is aimed at accomplishing all of the above goals.

This document encompasses the following:

- Proposed functional specifications for the wireless network to support the portability of telecommunication subscriber Directory Numbers (DN) among Local Service Providers (LSPs) within the NP area. Number portability between wireless and wireline LSPs is also included.
- A network architecture to support the above specifications.
- A discussion of the impacts to each of the network entities, including network elements, billing systems, and the mobile itself.

The solution presented in this document is written assuming IS-41 Rev C standards. It is done so for ease of presentation but is not meant to preclude other technologies.

Table of Contents

1. INTRODUCTION

This section presents the necessary background information to establish a foundation for the number portability solution for the wireless telecommunications industry, including

- a discussion of the Number Portability (NP) history and why NP is a necessity,
- a definition of Number Portability (NP);
- a list of definitions and assumptions made throughout the document;
- an overview of the accepted wireline solution - the Location Routing Number (LRN) solution; and
- a list of keys points in summary of the proposed solution.

1.1 THE DEFINITION AND NEED FOR NUMBER PORTABILITY

The recent Federal Communications Commission (FCC) *Number Portability Report and Order, CC Docket 95-116,* mandates that all telecommunications service providers (cellular, broadband Personal Communications Services (PCS), and covered Specialized Mobile Radio (SMR)) provide the capability to deliver calls from their network to ported numbers anywhere in the United States by December 31, 1998. Furthermore, the order mandates that these providers offer service provider portability, including support for roaming, by June 30, 1999. The definition for service provider portability as dictated by the FCC can be found below. However, in simplistic terms, one can view a ported number under service provider portability as a number is retained by the subscriber in the event that the subscriber changes service providers.

The telecommunications industry launched several initiatives to finding a long-term number portability solution in the context of service provider portability. Several solutions have been proposed for the wireline environment. Location Routing Number (LRN) is one such solution that has achieved general acceptance by the wireline service providers. It does not, however, address the portability issues faced by the wireless service providers. The solution must be adapted to encompass the wireless environment. Supporters of this document urge the wireless industry to push for a suitable portability solution that aims for the following goals:

- has as minimal impact on the existing networks;

1. INTRODUCTION

This section presents the necessary background information to establish a foundation for the number portability solution for the wireless telecommunications industry, including

- a discussion of the Number Portability (NP) history and why NP is a necessity.
- a definition of Number Portability (NP);
- a list of definitions and assumptions made throughout the document;
- an overview of the accepted wireline solution - the Location Routing Number (LRN) solution; and
- a list of keys points in summary of the proposed solution.

1.1 THE DEFINITION AND NEED FOR NUMBER PORTABILITY

The recent Federal Communications Commission (FCC) *Number Portability Report and Order. CC Docket 95-116,* mandates that all telecommunications service providers (cellular, broadband Personal Communications Services (PCS), and covered Specialized Mobile Radio (SMR)) provide the capability to deliver calls from their network to ported numbers anywhere in the United States by December 31, 1998. Furthermore, the order mandates that these providers offer service provider portability, including support for roaming, by June 30, 1999. The definition for service provider portability as dictated by the FCC can be found below. However, in simplistic terms, one can view a ported number under service provider portability as a number is retained by the subscriber in the event that the subscriber changes service providers.

The telecommunications industry launched several initiatives to finding a long-term number portability solution in the context of service provider portability. Several solutions have been proposed for the wireline environment. Location Routing Number (LRN) is one such solution that has achieved general acceptance by the wireline service providers. It does not, however, address the portability issues faced by the wireless service providers. The solution must be adapted to encompass the wireless environment. Supporters of this document urge the wireless industry to push for a suitable portability solution that aims for the following goals:

- has as minimal impact on the existing networks;

- continues to support roaming as it exists today;
- does not inhibit the future growth of wireless technology; and
- does not unduly deplete the NANP numbering resources.

This document proposes the Wireless Number Portability (WNP) solution, built on the LRN solution with appropriate modifications to accommodate wireless call processing and mobility management. This solution is aimed at accomplishing all of the above goals.

1.2 DEFINITIONS

Readers should use the following definitions when reading this document:

- *Service Provider Portability* - "the ability of end users to retain the same telephone numbers as they change from one service provider to another." [6]
- *Service Portability* - "the ability of users of telecommunications services to retain existing telecommunications numbers without impairment of quality, reliability, or convenience when switching from one telecommunications service to another service provided by the same telecommunications service provider." [7]
- *Location Portability* - "the ability of users of telecommunications services to retain existing telecommunications numbers without impairment of quality, reliability, or convenience when moving from one physical location to another." [8]
- *Regional Service Management System* - a Service Management System (SMS) controlled by a neutral third party to provision the LRN data for ported DNs into the NP-SCPs.
- *Mobile Station (MS)* - "is the interface equipment used to terminate the radio path at the user side. It provides the capabilities to access network services by the user." [9]

[6] Federal Communications Commission order in the matter of Telephone Number Portability, CC Docket No. 95-116, order FCC 96-26 released July 2, 1996, paragraph 172.

[7] CC Docket No. 95-116, paragraph 172.

[8] CC Docket No. 95-116, paragraph 174.

[9] IS-41.1 Rev C

- *Mobile Station Identifier (MSID)* - is a 15-digit E.212 formatted International Station Mobile Identification (IMSI) and/or 10-digit North American Numbering Plan (NANP) Mobile Identification Number (MIN).
- *International Mobile Station Identifier (IMSI)* - is a 15-digit network address as defined in ITU (formally CCITT) E.212.
- *Mobile Identification Number (MIN)* - is a 10-digit NANP network addresses used in world zone 1 as defined by annex A of ITU (formerly CCITT) E.163.

1.3 ASSUMPTIONS

The following general assumptions are made regarding wireless number portability:

- The FCC states that "... requiring service or location portability now would not be in the public interest. ... service provider portability is critical to the development of competition, but service and location portability have not been demonstrated to be as important to the development of competition." [10] For this reason, this proposal addresses only service provider portability. It does not ignore the future complexities of location or service portability but it does not directly attempt to solve these problems at this time.
- Location number portability includes service provider portability and any associated location portability so long as that location portability is confined to the same rate center.
- Roaming agreements with more than one service provider in any serving area will be allowed.
- Efforts will be made to minimize the impact on existing networks.
- Any proposed solution should not have a significant impact on the wireline solution for number portability.
- There is no impact on the Equipment Serial Number (ESN).
- The number portability database, the NP-SCP, will contain a record for each ported DN in the area it serves for both wireline and wireless DNs.

[10] CC Docket No. 95-116, page 103, paragraph 182.

- This document makes no assumptions regarding the number nor distribution of the Regional SMS systems; it assumes that one or more neutral third party NP-SMSs exist for the purpose of provisioning the NP-SCPs and maintaining a master copy of the NP data.

1.4 SUMMARY OF THE LOCATION ROUTING NUMBER SOLUTION

In the LRN solution, a single 10-digit number is associated with each switch as the network address of that switch. Of these 10 digits, primarily the first 6 digits (i.e., the NPA-NXX of the 10-digit number) are significant to the Public Switched Telephone Network (PSTN) for routing a call. For an existing switch, this code could be the NPA-NXX code block that the switch already serves. This 10-digit Network Routing Address (NRA) of a switch is referred to as the *Location Routing Number*.

There exists, in the LRN proposal, a number portability Service Control Point (NP-SCP) which maps every ported number to its serving switch's LRN. If *N* denotes the network sequence number of the terminating network in the call route, the *N-1* network will identify the NPA-NXX of the dialed number as a ported block and will make the dip into the NP-SCP to retrieve the LRN mapping to the ported number. The *N-1* network switch will then locate the next switch based on NPA-NXX translation of the LRN and will set up the subsequent leg of the call by sending an ISUP Initial Address Message (IAM) including the following parameters:

- Forward Call Indicator (FCI) - indicates whether the NP-SCP dip has been made by using the *M* bit (also known as the Translated Called Party Number (TCPN) indicator)
- Called Party Number (CdPN) - denotes the LRN from the NP-SCP
- Generic Address Parameter (GAP) - holds the dialed Directory Number (DN) with a "Ported Number" indication

The terminating network does not need to perform any additional dips to the NP-SCP if the TCPN flag is received in the ISUP call set up message. The terminating switch can identify the CdPN as its own serving address and can replace the CdPN value with the GAP value in order to route the call to the subscriber's phone.

The LRN solution has many merits:

- It does not require one unique network address for each ported number. The network address for ported number is tied to the ported-to switch address.

- Call routing follows the normal processing in the switches with minor ISUP modifications.
- The DN is passed to the terminating switch without modification. A DN is required for providing Custom Local Area Signaling Services (CLASS), including Automatic Callback Automatic Recall, and Screen List Editing

The solution, however, requires changes in the PSTN:

- Although not mandated on all Local Service Providers (LSPs), the NP participant LSPs will require ISUP signaling between switches for an efficient use of this method.
- Some standards modification to ISUP will be required to incorporate
  - the new NP-SCP dip indicator in the M-bit of the FCI parameter; and
  - a new code point for the existing GAP in order to indicate "Ported Number."
- Special call processing procedures are needed in the intermediate and terminating exchange including identifying the ported DN in the recipient switch.

1.5 KEY POINTS OF THE WIRELESS NUMBER PORTABILITY SOLUTION

The WNP solution can be summarized with the following major modifications to today's wireless network architecture in order to best support number portability:

- Build upon the Location Routing Number (LRN) solution generally adopted by the wireline industry.
- Separate the Mobile Direction Number (MDN) from the Mobile Station Identifier (MSID).
- Make the MDN the portable number; keep the MSID as a non-portable number controlled by the wireless service provider. This is essential in order to avoid 10+ digit translations in call routing and, similarly and equally important, in support system processing (e.g., billing tables).
- Target the ITU E.212 International Mobile Station Identify (IMSI) as the principal MSID.
- Identify a well-defined interim period for which the MSID could be a MIN-style number (still non-portable) until networks support IMSI as a

widespread standard. Having a well understood direction for the industry is critical to roaming and minimizing the impact on subscribers.

Each of these points are discussed in more detail in Section 2 of this document. Supporters of the WNP solution believe that these particular ideas will attain the goals stated in this introduction.

1.6 SCOPE

The solution presented in this document is written based on TDMA technology, including IS-41 Rev C and IS-136 standards. This is done for ease of presentation but is not meant to preclude other technologies. This document does not include potential impacts to the other standards (e.g., IS-652).

1.7 RELATED DOCUMENTS

The following documents have been used as references:

- *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*, FCC 96-286, June 27, 1996.
- *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.

2. NETWORK ARCHITECTURE TO SUPPORT NUMBER PORTABILITY

This section describes in detail the proposed architecture for the WNP solution. First, this section will list the needs of any number portability solution for the wireless industry. Next, it will describe the architecture, followed by illustrating call flows. Lastly, this section will summarize the impacts anticipated to each of the components in the network.

2.1 NUMBER PORTABILITY SOLUTION METHODOLOGY FOR A WIRELESS ENVIRONMENT

Any NP solution must embody the following components in order to meet the goals stated in the introduction:

a) Numbering

- Each subscriber is identified with a single, unique North American Numbering Plan (NANP) number which will port with the subscriber from service provider to service provider.
- Each subscriber's mobile station is associated with a corresponding network node address (the LRN)which is also a NANP number but does not necessarily need to be unique.
- The network node address for the subscriber must be assigned in such a way as to not unnecessarily deplete the NANP number pool.
- Many of the telephony systems are developed on the assumption that customer identifiers are administered in blocks of numbers by the service providers. Because of this, mobile station identifiers in number portability need still be controlled by service providers in blocks of numbers. Otherwise such items as Global Title Translations, roaming tables, provisioning and billing tables, and more will be forced to maintain tables on the full 10-plus digits of the subscriber identifier.

b) NP-SCP Query Triggering

- Call criteria in the switch must be defined for launching database dips such as dipping the number portability database.

- There must exist a means to recognize which NPA-NXX number blocks require a query.

- If there are *N* networks involved in the call route, the *N-1* network should perform the database dip. As a guideline, for an inter-LATA call, the inter-exchange service provider is the *N-1* network; and for an intra-LATA call, the originating network is the *N-1* network.

- Redundant and extraneous dips should not be performed. This means that after the dip is made for mapping the dialed number to network node address, the *N-1* network will set a "dip" flag to the downstream nodes. This statement, in and of itself, does not imply that only one dip will always be requirement; it merely states that efficient database dipping is essential to the solution.

c) Signaling and Routing

- SS7 links are used for the query.

- If the mobile DN is a ported number, a method of finding the HLR address of the MS must be established.

- Both wireless MSCs and wireline End Offices (EO) can query the NP-SCP. These different types of switches may use different query messages. The NP-SCP must be able to differentiate among these applications based on SS7 SCCP Called Party Address Translation Type or Subsystem Number (SSN) via STPs.

- MSCs will use SCCP routing to send IS-41 (or equivalent) queries to databases such as HLR and NP-SCP.

- The LRN translation at the switch will be used as input to normal routing schemes to determine the outgoing trunks from a switch.

d) NP-SCP Database Structure

- Each database must support number portability data for at least one rate center.

e) Data Administration

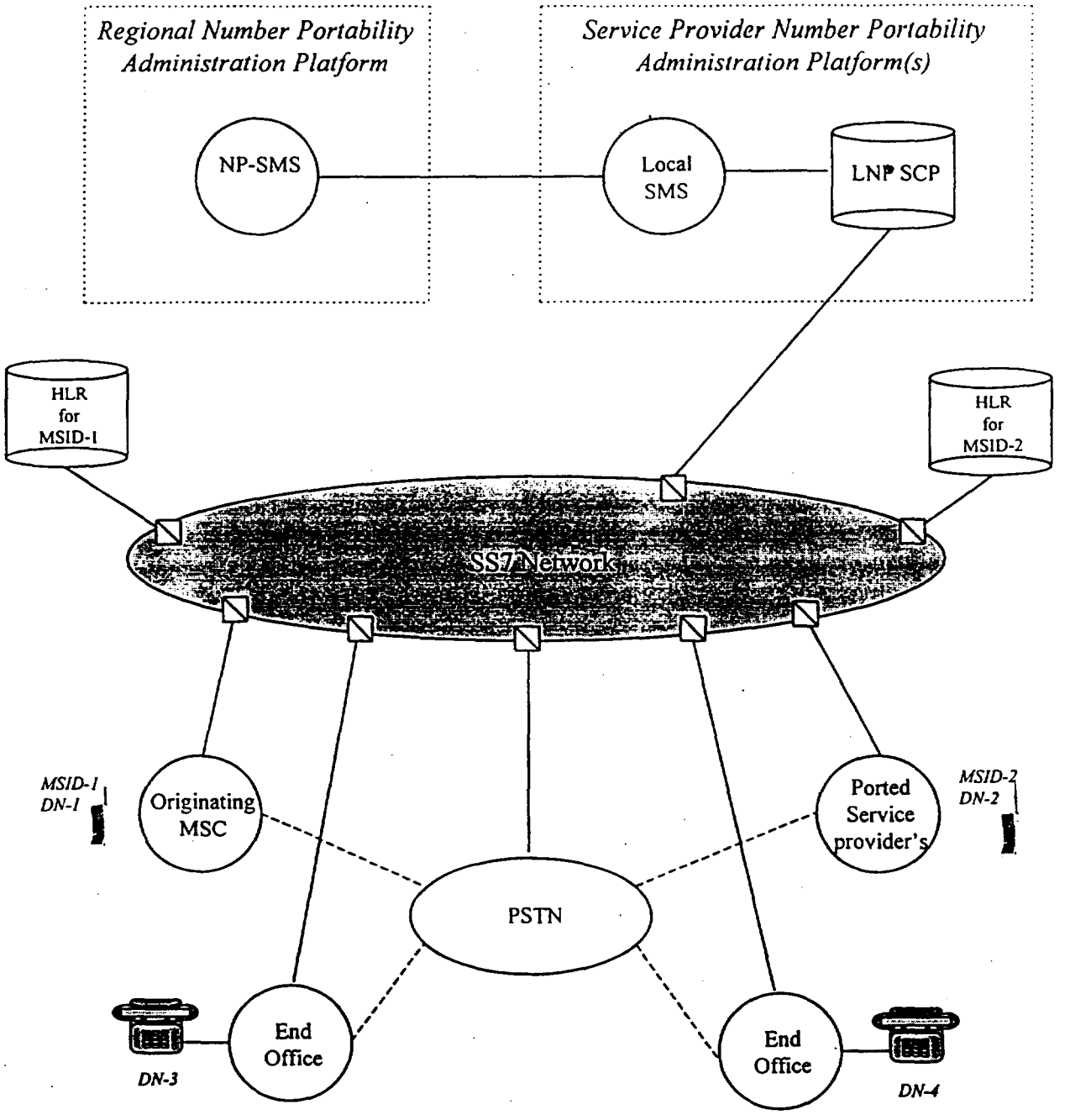
- The master database is in the regional Service Management System (SMS), administered by a neutral third party.
- Service providers are responsible for maintaining the integrity of the SMS data on behalf of their customers
- The SMS will update service provider's NP-SCPs with an appropriate subset of the information available in the SMS, potentially via the provider's internal provisioning system(s).
- The number portability solution cannot be implemented without the Regional SMS in place.

2.2 WIRELESS NUMBER PORTABILITY NETWORK ARCHITECTURE

2.2.1 Network Configuration Illustration

Figure 2.2 on the following page illustrates the network entities involved in number portability.

Figure 2.2 Network Configuration to Support Number Portability



Each service provider will either own or have access to an NP-SCP that will include the mapping of ported DNs to their associated LRNs. The NP-SCP provisioning data will be provided through a regional SMS deployed. The regional SMS could include portability information covering at least one rate center. The real provisioning of the NP-SCP will be done by the service provider SMS, which interfaces with the regional SMS. The service providers update the regional SMS with their ported subscriber information.

The MSCs have SS7 signaling connection to their local NP-SCPs. They also require SS7 connection to the HLRs of all service providers with whom they have roaming agreements.

This picture illustrates that completing calls for ported numbers involves the wireless and wireline networks alike. The call flows throughout the next few pages illustrate this in more detail.

It is important to define the *Ported Service provider's MSC* in the context of the WNP solution. Namely, this proposal assumes that every MSC could be assigned an LRN. The path by which the call takes once received by the service provider's network is to the discretion of each individual service provider. This proposal, therefore, thinks only of the MSC as an entry point into the service provider's network as indicated by LRN input by the service provider in the NP-SCP.

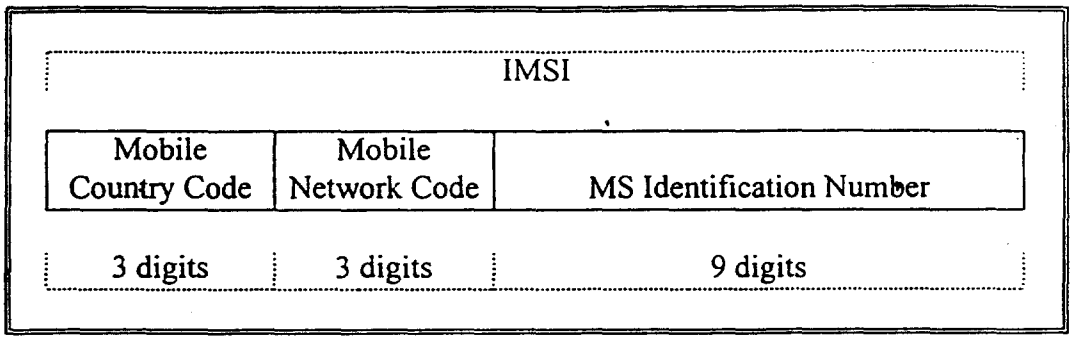
2.2.2 Identifying the Mobile Station

Cellular telephony requires that a subscriber be registered, and authenticated if applicable, in the switch before making a call. The fact that the registration may now involve a cellular subscriber with a ported number necessitates some modifications in the existing cellular call processing. Cellular call delivery also brings in some new issues which are unique to the cellular telephony.

In wireless number portability, Mobile Stations (MS) will require both an MSID and DN. These two numbers will need to be different. The mobile DN will be the corresponding dial-able directory number, in the NANP format and will be the portable number. The MSID will be an E.212 IMSI and/or a NANP number MIN and will not be portable. When the DN is ported from one Local Service Provider (LSP) to another, a new MSID will assigned to the MS by the new LSP. The MIN and IMSIs are assigned in such a way that the existing network STPs can locate the network supporting the MS's HLR after a 6 digit translation of the MS's MSID.

As mentioned above, the MSID could be the E.212 IMSI numbering format is illustrated in Figure 2.1 below.

Figure 2.1: E.212 IMSI Format



The supporters of this document urge the wireless industry to work toward IMSI only identification as a long term goal. However, it is recognized, that this is not the feasible short-term solution and thus, in the interim, MIN will also be required to handle calls roaming on non-IMSI-capable networks.

The advantages, however, to working toward IMSI as the only MSID are many:

- Because of the arrangement of the IMSI number as illustrated above, a 6-digit translation of the number can easily identify the service provider of the MS.
- Because IMSI is defined as an international standard, the use of IMSI brings each service provider closer to international roaming capabilities.
- There exists, already, an industry committee for the purpose of administering IMSI numbers; there exist no such committee for the administration of MINs when MINs are no longer DNs.
- The 15-digit IMSI numbering plan will not deplete the numbering resources in the foreseeable future.

It is envisioned that service providers, in the interim period, will be able to administer MINs within their own environment, reusing MINs when freed from a ported subscriber. The freed MIN can be assigned to any new subscriber in the donor network, making it possible to have the same 10 digit number as a MIN in one network and a DN in another. This interim solution does pose an additional administrative overhead in needing to administer both MINs and IMSIs in networks supporting IMSI.

If, instead, the MSID and the mobile DN were the same for all MSs, a 10-digit translation of the MSID belonging to a portable NPA-NXX block would be needed in order to locate the HLR of the MS. Although it is possible to provide such a translation in the MSC or STP, it is impractical to consider administering such a large volume of numbers or the penalty that would be imposed on the switch and STP performance under their current configurations. Additionally, billing and provisioning systems, including roaming tables, which work today on NPA-NXX number blocks would also be required to store and map on all 10+ digits of the identifier. Therefore, this solution proposes separating the MSID from the DN instead and managing the non-portable MSID similar to NPA-NXX administration today.

2.2.3 Queries and Triggers to the NP-SCP

Trigger in the MSC to query the NP-SCP

A dialed number trigger will need to be implemented in the MSC to launch the Origination Request (or equivalent) query to the NP-SCP for number portability. This dialed number trigger will be a conditional trigger based upon 3 to 10 digits of the dialed number and will be administered on an MSC basis. This dialed number trigger should be the lowest priority of all of the dialed number triggers. For example, in an Intelligent Network (IN) type of call model, this dialed number trigger could be an office-based trigger from the Analyzed_Information Detection Point.

Wireline Queries

If the *N-1* network switch is a landline switch, it can use an AIN or an IN query to the NP-SCP, specifically

- the AIN *Info_Analyzed* message for the 3/6/10-digit Public Office Dialing Plan (PODP) based trigger, or
- the IN *Instruction_Start* message, for the IN trigger.

The NP-SCP will respond with either the *Analyze_Route* (response to *Info_Analyzed*) or *Control_Connect* (response to *Instruction_Start*) response message.

Wireless Queries

If the *N-1* network switch is an MSC, then it is expected to send an OriginationRequest (or equivalent) message to the NP-SCP; the NP-SCP will respond with the OriginationRequest response message including the LRN for the DN.

Query Routing

The query will be routed using either the GTT capability at the STPs with a new NP Translation Type or MTP routing. The NP-SCP must be able to differentiate among these applications based on the SS7 SCCP Called Party Address Translation Type (TT) or Subsystem Number (SSN) used for routing via STPs.

2.2.4 Directory Number to HLR Mapping

The LocationRequest message routing requires a DN to HLR address translation before the message can be sent to the correct HLR. This routing translation could be done in one of the following ways:

a) The STP would maintain a table mapping of all its MDN number blocks within its regional network to the corresponding HLR Point Code (PC) and Subsystem Number (SSN). By appropriately assigning number blocks to HLRs, a 6-digit GTT will suffice. A new intra-network Translation Type (TT) must be defined for accessing this table. The MSC sends the STP the IS-41 LocationRequest (or equivalent) message with the SCCP CdPA equal to the MDN and the TT equal to the TT for MDN-to-HLR mapping. After appropriate translations, the STP sends the message to the HLR.

b) The MSC would maintain the table mapping of all its MDN to the HLR addresses. The MSC (as opposed to the STP) can route the message to the HLR using the PC-SSN of the HLR as obtained from this translation table. This alternative is not based on the use of any GTT.

c) The above method can be refined by mapping the MDN to the appropriate MSID number blocks supported by an HLR (as opposed to mapping to its point code). Then the MSC GTT routes the LocationRequest (or equivalent) message using STP GTT on the MSID number blocks (using existing TT=3 for MIN or existing TT=9 for IMSI).

It is important to note that each service provider can implement a Location Request routing method that is effective in the service provider's internal network.

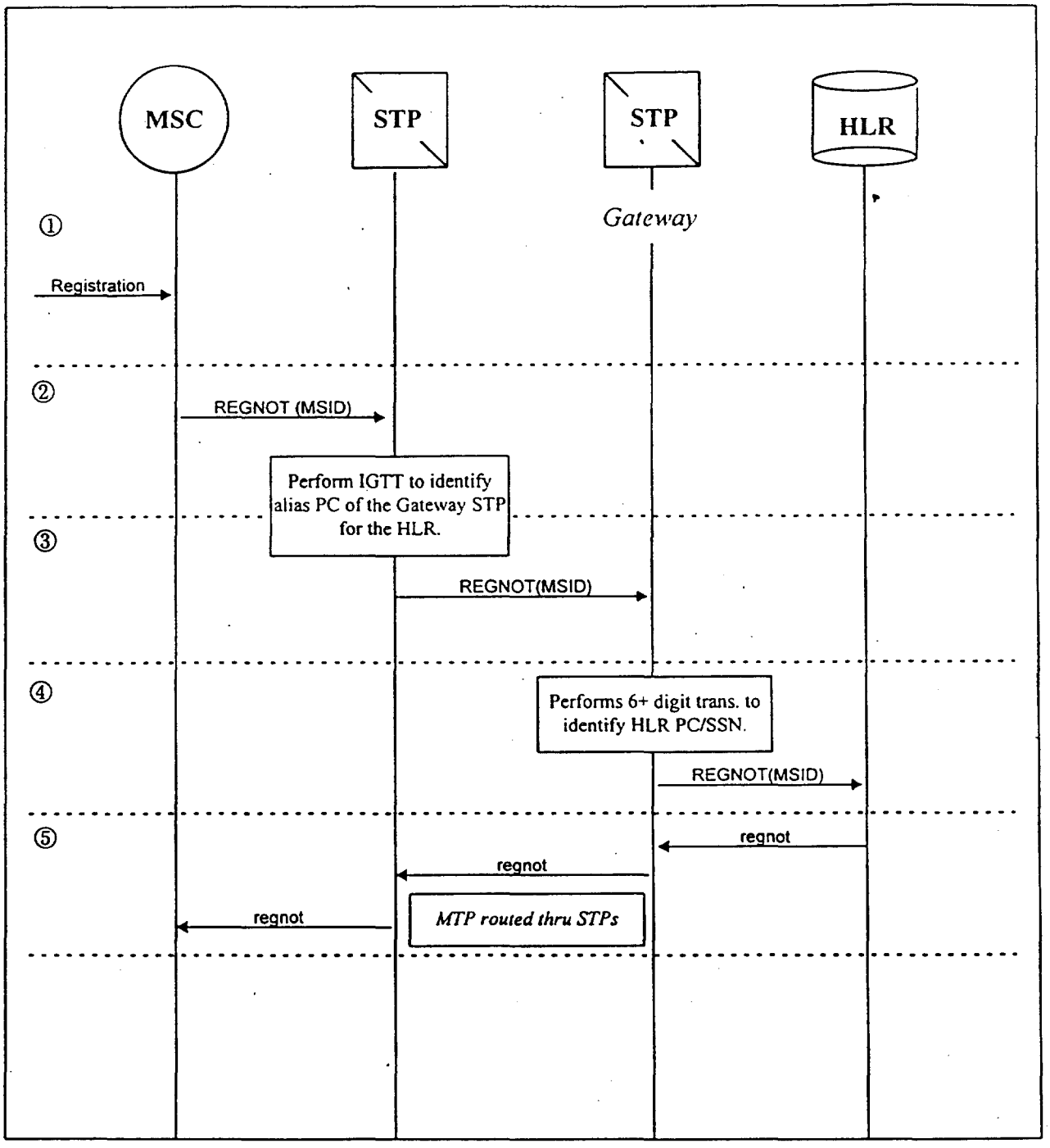
2.3 CALL FLOWS

The call flows in this subsection are included to illustrate the inter-workings of the above network architecture.

2.3.1 Registration and Validation

The registration message is sent to the roamer's HLR using an STP GTT on the MSID based on the TT defined for the type of MSID (TT=3 for MIN, TT=9 for IMSI). The HLR responds directly to the originating MSC with an appropriate result, including the mobile DN of the MS. Figure 2.3 and subsequent text illustrate this scenario.

Figure 2.3: WNP Information Flow for MSC Registration[11]



[11] These call flows display IS-41 messaging; however, it is recognized that alternative and equivalent messages can be substituted as appropriate.

Refer to Figure 2.3 for a diagram of the following information flow.

① The MS powers on, secures a control channel, and sends a Registration Request with its MSID and ESN.

② The MSC sends a RegistrationNotification query to the network STP for GTT with the MSID of the MS and the appropriate TT (TT=3 or 9 for MIN or IMSI, respectively). The message is sent to the STP, which translates the MSID to the associated HLR address and routes the query to it.

Networks that do not support GTT at STPs will need to perform this MSID to HLR address mapping at the MSC and send the query to the HLR using the Message Transfer Part (MTP) routing capability of the SS7 network.

③ The STPs perform routing on the query per the capabilities described above. If the STP performs GTT in order to route the query to the appropriate HLR, either alternative (a) or (b) is executed; Figure 2.2 illustrates the latter case:

a) If the MSID belongs to the serving service provider, the STP may perform FGTT on 6 or more digits of the MSID (depending on the number of digits that must be analyzed in order to locate HLR) to identify the HLR PC/SSN. The message is then MTP routed directly to the HLR.

b) If the MSID belongs to another service provider's network, the STP performs IGTT to identify the Alias PC of a gateway STP in the supporting network. The message is then routed to the Gateway STP.

④ The gateway STP at the destination network (i.e., the network where the HLR of the MS resides) performs either MTP or GTT routing on the query, depending on the type of SS7 routing requested in steps 2 and 3.

If GTT routing is requested, the gateway STP performs FGTT on the digits of the MSID to locate the HLR PC/SSN. The message is then routed to the HLR.

⑤ The HLR finds a match for the MSID and sends RegistrationNotification response message back to the MSC.

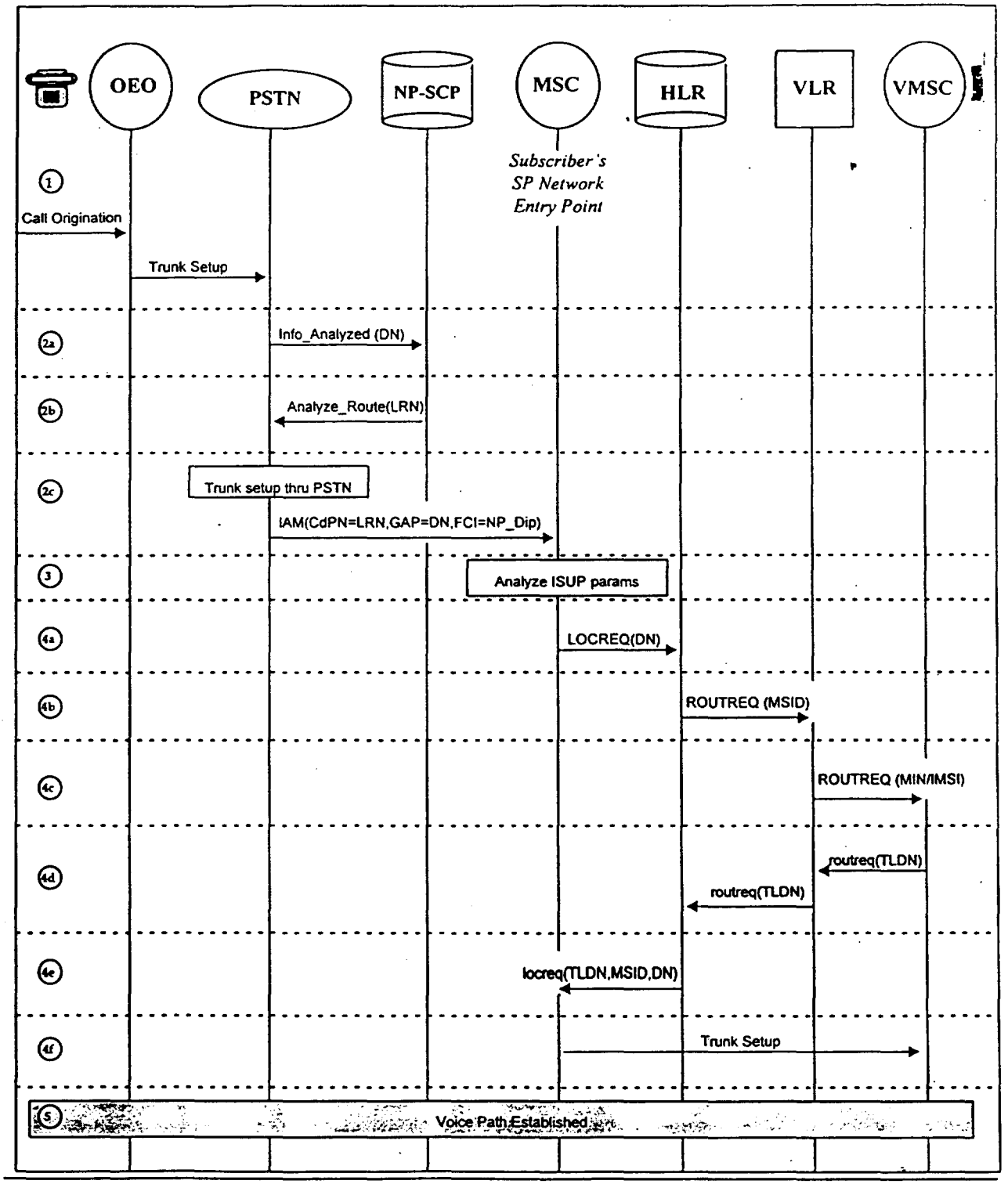
2.3.2 Call Routing To a Ported Directory Number

Cellular call routing can be divided into three scenarios: Land-to-Mobile, Mobile-to-Land, and Mobile-to-Mobile.

The Land-to-Mobile Call

Figure 2.4 and its associated text illustrates a Land-to-Mobile call scenario.

Figure 2.4: WNP Call Flow for a Land-To-Mobile Call[11]



① A landline phone originates a call. The dialed DN is analyzed in the Originating End Office (OEO) to determine if it is an intra-LATA or inter-LATA call.

- If it is intra-LATA call, the OEO will be the *N-1* network switch.
- If, on the other hand, it is an inter-LATA call, the OEO will send the call to the preferred IXC for the mobile subscriber, and the IXC will be the *N-1* network. Figure 2.3 illustrates this case.

② The *N-1* network switch processes the call to the ported number via the following steps:

a) The switch checks the porting status of the DN NPA-NXX from the associated NP trigger table. This table contains all NPA-NXXs that have been opened for portability. (In the case of service provider portability, this table need only include the local NPA-NXXs.)

- If the DN does not belong to a ported number block, the call is routed to the service provider MSC of the dialed subscriber using existing signaling methods (skip to 2d).
- If the DN belongs to a ported NPA-NXX block, the *N-1* network switch sends a query to the NP-SCP to obtain the LRN of the DN (as illustrated in Figure 2.3)

b) The NP-SCP responds with the LRN of one of the service provider's MSC (per the provider's designation). If the response carries the same dialed number as in the query message, it indicates that the specific number is not ported and routing continues as normal.

c) The querying *N-1* network switch translates the LRN to find the next switch in the call path, It then sends this switch an ISDN User Part (ISUP) Initial Address Message (IAM) with the following parameters:

CdPN	=	LRN or DN depending if DN is ported
GAP	=	DN (included only if DN is ported)
FCI	=	TCPN indicator(to indicate NP-SCP dip has been made)

d) Before the call is received by the service provider's MSC, the intermediate switches cannot modify the CdPN as well as the optional GAP parameter

and TCPN in the FCI of the IAM. These parameters are to be passed to the next switch.

③ Upon receipt of the message, the MSC performs the following analysis on the ISUP parameters:

The MSC confirms that the CdPN belongs to its network. It checks the FCI in the IAM for any NP-SCP dip indication in the TCPN.

- If the TCPN is not set, then the call flow skips to step 4.
- If the TCPN is set, but no GAP is included, the call flow skips to step 4.
- If the TCPN is set and the GAP is included, the MSC first replaces the CdPN with the DN value in the GAP parameter and then proceeds to the next.

④ The MSC now attempts to locate and deliver the call to the mobile.

a) The MSC sends a LocationRequest query to an HLR within its network based on the DN received in the ISUP message. Because there may exist multiple HLRs for a single MSC, a translation from the DN to the appropriate HLR address is required. Various alternatives were presented above; this flow assumes that one of these or some other alternative can be successfully applied.

b) If the MS's HLR record indicates that the MS is registered in a Visited MSC (V-MSC), as is the case in this example, the HLR sends a RouteRequest to the V-MSC's VLR for the MSID.

c) The V-MSC's VLR receives the RouteRequest query from the HLR and, in turn, routes the message to the V-MSC.

d) The V-MSC responds to the VLR, and the VLR responds to the HLR via a RouteRequest response message with a Temporary Local Directory Number (TLDN) identifying the V-MSC serving the roaming subscriber. The V-MSC also keeps a record of the MSID to the assigned TLDN.

e) The HLR sends this TLDN to the service provider's MSC through the LocationRequest return result message.

f) The MSC receives the TLDN and routes the call through the cellular/PSTN network based on the TLDN.

⑤ The serving V-MSC receives the call and directs it to the MS located in the serving area. The MS answers, and the call is completed.

The Mobile-to-Land Call

The following general procedure will be used to process a Mobile-to-Land call. Figure 2.5 and Figure 2.6 illustrate Mobile-to-Land call scenarios for inter-LATA and intra-LATA calls, respectively.

Figure 2.5: WNP Call Flow for a Mobile-To-Land Inter-LATA Call [11]

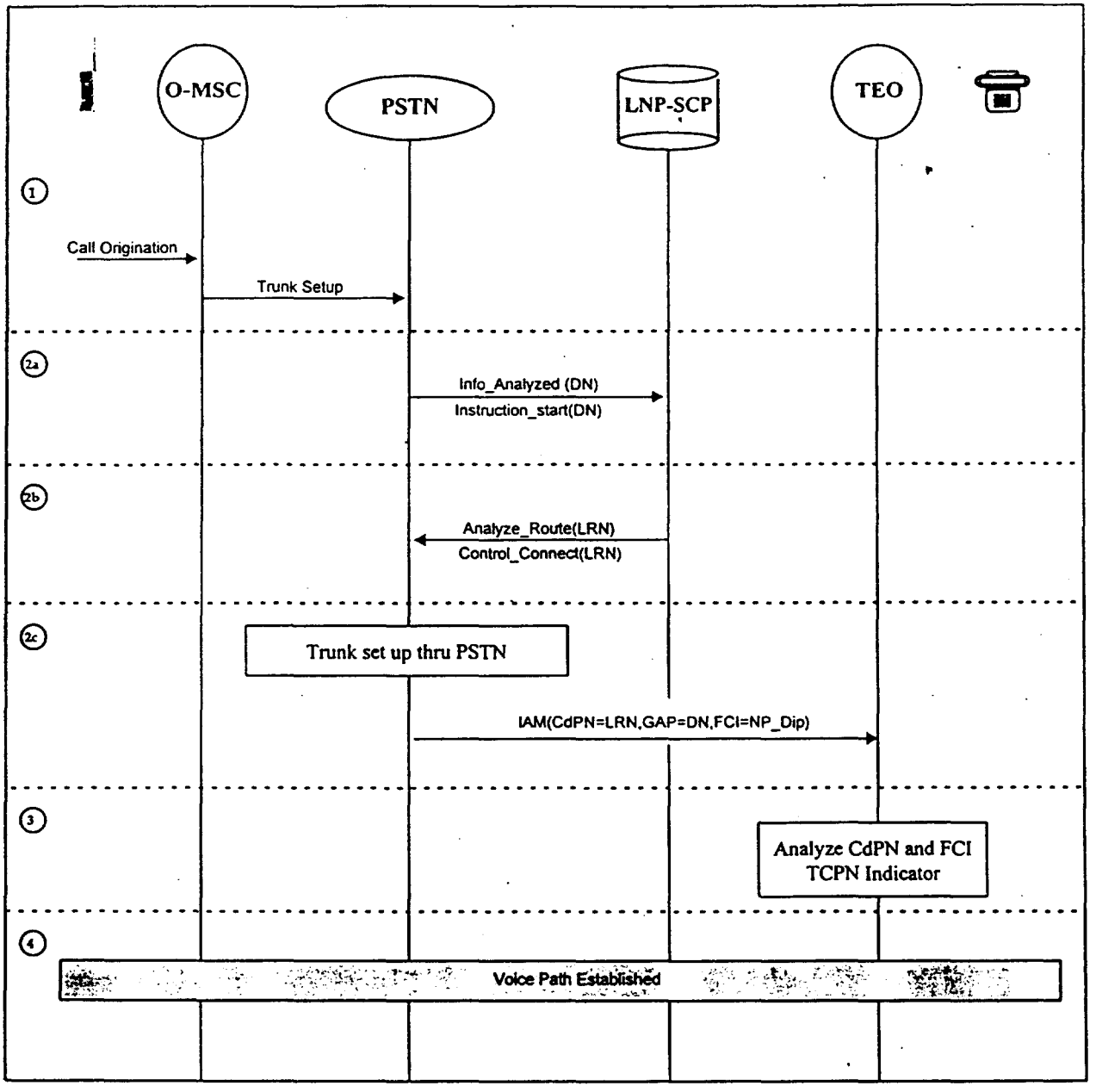
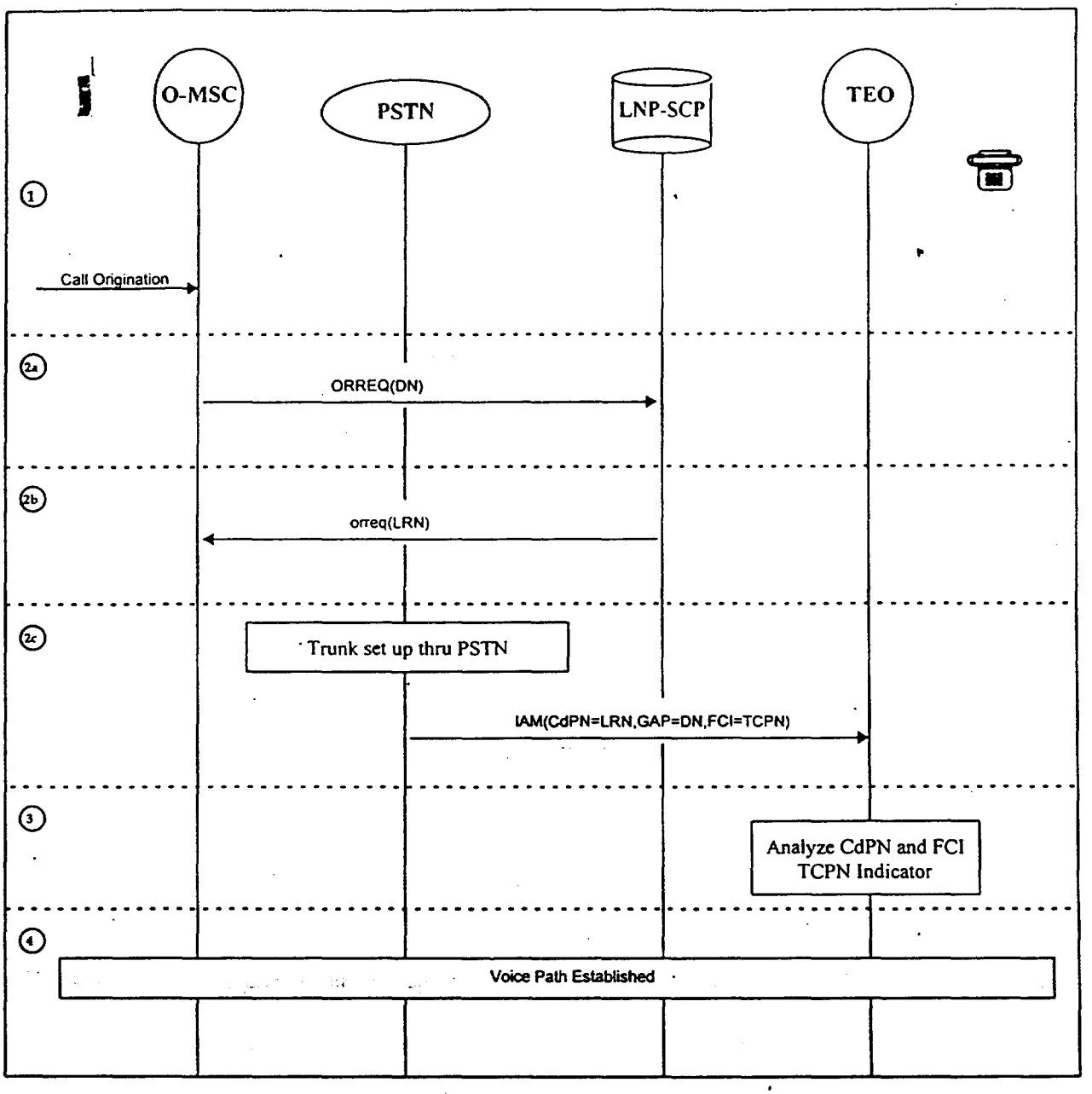


Figure 2.6: WNP Call Flow for a Mobile-To-Land Inter-LATA Call [11]



Refer to both Figure 2.5 and Figure 2.6 when following this information flow.

① A mobile phone registers and places a call. The dialed DN is analyzed in the Originating Mobile Switching Center (O-MSC) to determine if it is an intra-LATA or inter-LATA call.

- If it is an intra-LATA call (Figure 2.6), the O-MSC will be the *N-1* network switch.
- If it is an inter-LATA call (Figure 2.5), the OEO will send the call to the preferred IXC, and the IXC will be the *N-1* network.

② The *N-1* network switch will process the call to the dialed number.

a) The switch checks the porting status of the NPA-NXX of the DN from the associated flag in the dialed number translation table.

- If the DN does not belong to a ported number block, the call is routed to the Terminating End Office (TEO) of the dialed subscriber using the existing signaling method.
- If the DN belongs to a ported NPA-NXX block, the *N-1* network switch (the O-MSC for intra-LATA call, or IXC switch for inter-LATA call) sends a query to the NP-SCP through the STPs to identify the LRN of the DN (as in the illustrations).

  An O-MSC will use the IS-41 OriginationRequest message to query the NP-SCP. The IXC will use either the AIN *Info_Analyzed* message for the 3/6/10-digit Public Office Dialing Plan (PODP) based trigger or the IN *Instruction_Start* message, for the IN trigger.

b) The NP-SCP will respond to the query with an OriginationRequest response message to the O-MSC or an *Analyze_Route* (response to *Info_Analyzed*) or *Control_Connect* (response to *Instruction_Start*) response message to the IXC switch.

   If the response carries the same dialed DN in the CdPN as in the query message, it indicates that the specific number is not ported. For ported numbers, the response will include the LRN of the TEO along with the DN.

If LRN is received from the NP-SCP, the querying N-1 network switch will check the LRN against its own. For non-ported DNs, the NP-SCP response will not include the LRN. In this example, the LRN belongs to a wireline EO.

c) The querying switch sends an ISUP IAM message to the next switch with the following parameters:

CdPN = LRN or DN depending if DN is ported
GAP = DN (included only if DN is ported)
FCI = TCPN indicator(to indicate NP-SCP dip has been made)

Before the call is received by the TEO, the intermediate switches will not change the CdPN and the optional GAP parameter and the TCPN indicator in the FCI of the IAM. These parameters are to be passed to the next switch.

③ The TEO analyzes the CdPN to find it belongs to the TEO. Then it checks the FCI TCPN indicator in the IAM for any NP-SCP dip indication.

- If an NP-SCP dip has been made but no gap is included, the TEO call processing jumps to step 4.
- If the dip indicator is set and the GAP is included in the IAM, the TEO will replace CdPN with the DN value in the GAP parameter. DN translation will find a match in the switch database.

④ The TEO will complete the call to the loop to the assigned to the DN. The call is then connected.

The Mobile-to-Mobile Call

The following general procedure will be used to process a Mobile-to-Mobile call. Figures 2.7 and 2.8, along with the subsequent text, below illustrate Mobile-to-Mobile call scenarios for Inter-LATA and Intra-LATA calls.

Figure 2.7 WNP Call Flow for Mobile-To-Mobile Inter-LATA Call [11]

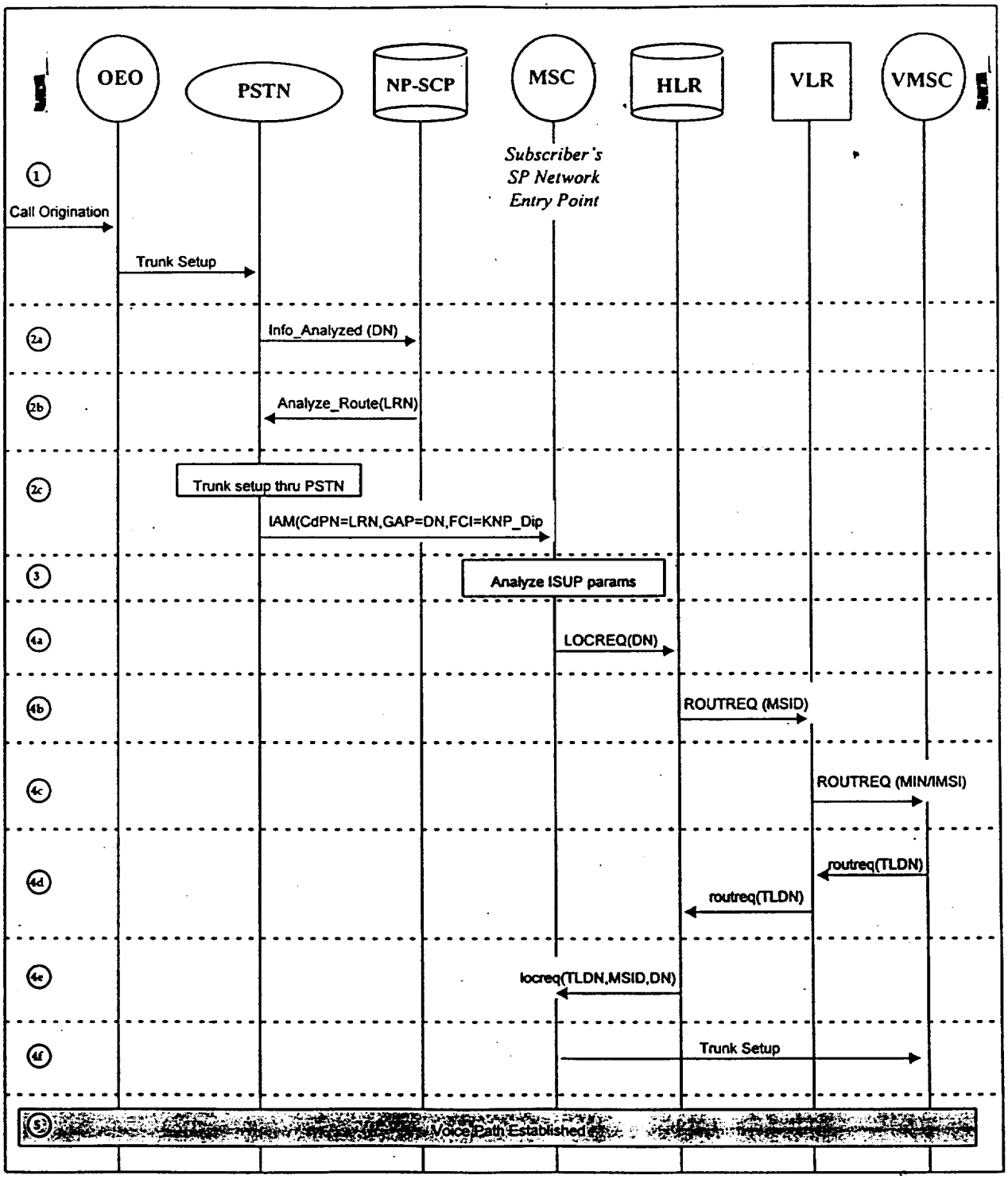
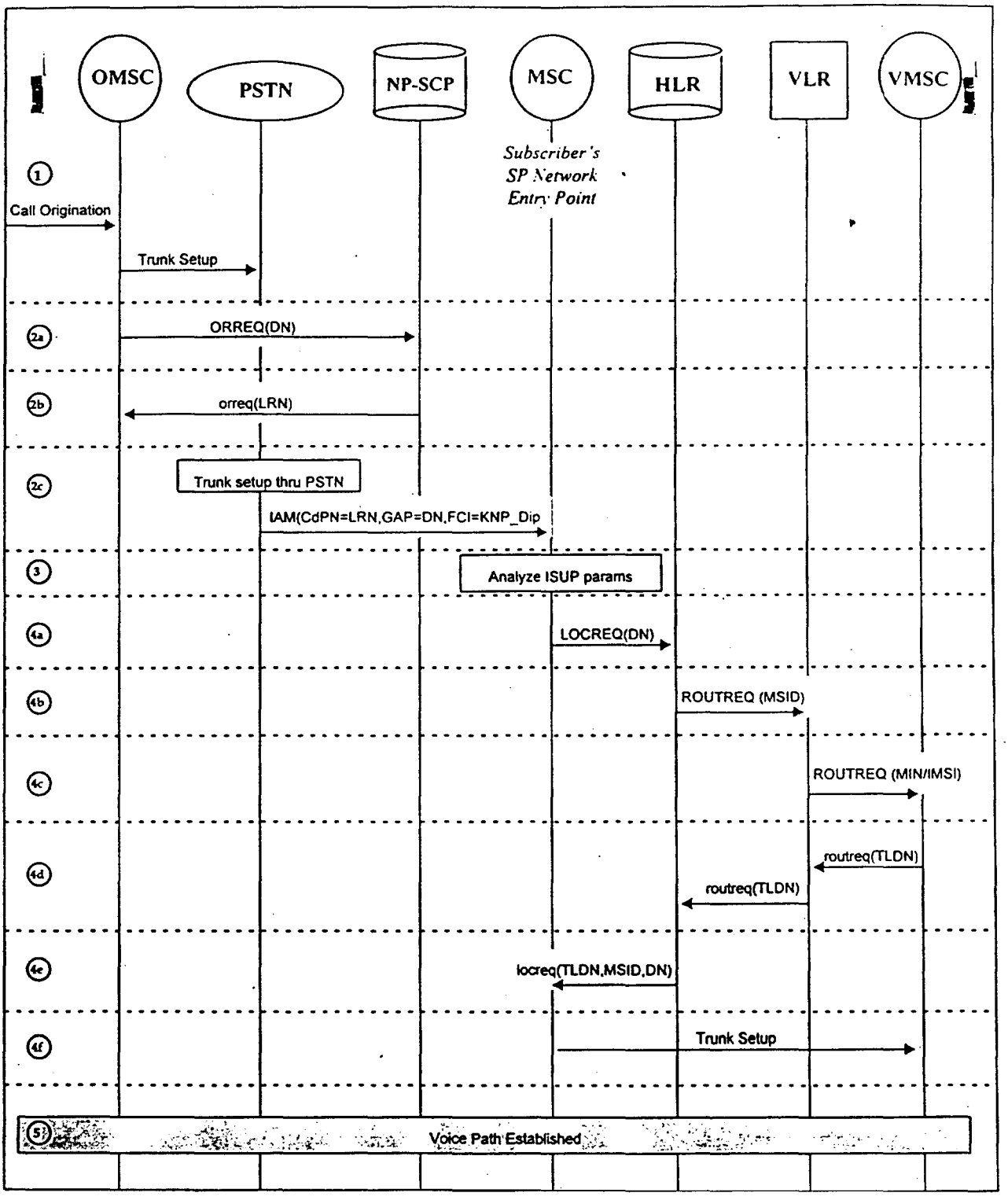


Figure 2.8: WNP Call Flow for Mobile-To-Mobile Intra-LATA Call [11]



Refer to Figures 2.7 and 2.8 when reading through this call flow text.

① A mobile registers and originates a call. The dialed DN is analyzed in the O-MSC to determine if it is an intra-MSC, intra-LATA or inter-LATA call.

- If it is an intra-MSC call, the O-MSC is also the service provider's entry MSC for the dialed mobile subscriber.
- If it is an intra-LATA call (Figure 2.7), the O-MSC will be the *N-1* network switch (skip to step 2).
- If it is an inter-LATA call (Figure 2.8), the OEO will send the call to the preferred IXC, and the IXC will be the *N-1* network.

② The *N-1* network switch will process the call to the ported number.

a) The switch checks the porting status of the DN NPA-NXX from the associated NP trigger table. This table contains all NPA-NXXs that have been opened for portability. (In the case of service provider portability, this table need only include the local NPA-NXXs.)

- If the DN does not belong to a ported number block, the call is routed to the service provider MSC of the dialed subscriber using existing signaling methods.
- If the DN belongs to a ported NPA-NXX block, the *N-1* network switch (the O-MSC for intra-LATA call, or IXC switch for inter-LATA call) sends a query to the NP-SCP through the STPs to identify the LRN of the DN (as in the illustrations).

  An O-MSC will use the IS-41 OriginationRequest message to query the NP-SCP. The IXC will use either the AIN *Info_Analyzed* message for the 3/6/10-digit Public Office Dialing Plan (PODP) based trigger or the IN *Instruction_Start* message, for the IN trigger.

b) The NP-SCP responds to the query with the OriginationRequest response message to the O-MSC (or with *Analyze_Route* in response to *Info_Analyzed* or *Control_Connect* in response to *Instruction_Start* response message to the IXC switch).

For ported number, the response will include the LRN of the subscriber's service provider entry point MSC along with the DN. If the response carries the same dialed DN in the CdPN as in the query message, it indicates that the specific number is not ported.

c) The querying *N-1* network switch translates the LRN to find the next switch in the call path, It then sends this switch an ISDN User Part (ISUP) Initial Address Message (IAM) with the following parameters:

CdPN	=	LRN or DN depending if DN is ported
GAP	=	DN (included only if DN is ported)
FCI	=	TCPN indicator(to indicate NP-SCP dip has been made)

d) Before the call is received by the service provider's MSC, the intermediate switches cannot modify the CdPN as well as the optional GAP parameter and TCPN in the FCI of the IAM. These parameters are to be passed to the next switch.

③ Upon receipt of the message, the MSC performs the following analysis on the ISUP parameters:

The MSC confirms that the CdPN belongs to its network. It checks the FCI in the IAM for any NP-SCP dip indication. If dip has been made, but no GAP is included, the MSC proceeds directly to the next step. If the TCPN is set and GAP is included in the IAM, the MSC first replaces the CdPN with the DN value in the GAP parameter and then proceeds to the next.

④ The MSC now attempts to deliver the call to the mobile.

a) The MSC sends a LocationRequest query to an HLR within its network based on the DN received in the ISUP message. Because there may exist multiple HLRs for a single MSC, a translation from the DN to the appropriate HLR address is required. Various alternatives were presented above; this flow assumes that one of these or some other alternative can be successfully applied.

b) If the MS's HLR record indicates that the MS is registered in a Visited MSC (V-MSC), as is the case in this example, the HLR sends a *RouteRequest* to the V-MSC's VLR for the MSID.

c) The V-MSC's VLR receives the *RouteRequest* query from the HLR and, in turn, routes the message to the V-MSC.

d) The V-MSC responds to the VLR, and the VLR responds to the HLR via a *RouteRequest* response message with a Temporary Local Directory Number (TLDN) identifying the V-MSC serving the roaming subscriber. The V-MSC also keeps a record of the MSID to the assigned TLDN.

e) The HLR sends this TLDN to the service provider's MSC through the *LocationRequest* return result message.

f) The MSC receives the TLDN and routes the call through the cellular/PSTN network based on the TLDN.

⑤ The serving V-MSC receives the call and directs it to the MS located in the serving area. The MS answers, and the call is completed.

3. WIRELESS NUMBER PORTABILITY SYSTEM IMPACTS

This section summarized the WNP solution by detailing the impacts to each of the entities in the network architecture.

3.1 IMPACTS TO THE MOBILE STATION

The following impacts are anticipated on the MSs:

- Because the solution splits the MSID from the DN, the MS will need to contain the DN and the MSID. This implies both IMSI as well as the MIN in the interim period for as long as MIN is part of the interim solution.
- The MS will register with an IMSI and/or a MIN depending on the capability of the network (IMSI for an IMSI-capable network, MIN for a non-IMSI-capable network).
- It will be desirable for the phones to display the DN instead of the MSID when the subscriber powers on his/her phone.

3.2 IMPACTS TO THE AIR INTERFACE

The following impacts to the air interface specifications are envisioned:

- 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.

3.3 IMPACTS TO SIGNALING (IS-41)

The following impacts to the signaling standards, namely IS-41 in the case of this proposal, are anticipated:

- All IS-41 messages which contain MIN (e.g., Registration Notification) will need to be enhanced to support MSID.
- The contents of the dialed digits parameter in the IS-41 messages (e.g., LocationRequest) will be the MDN instead of the MIN.
- IS-41 will need to be enhanced to support Automatic Code Gapping (ACG), particularly to the NP-SCP.
- The OriginationRequest (or equivalent) message will need to be enhanced to support queries to the NP-SCP.

- The IS-41 LocationRequest message needs to be modified in order to identify whether the destination digits are a TLDN or another type of digits. It will also need to provide a method to indicate the DN is ported.

3.4 IMPACTS TO THE HOME LOCATION REGISTER

The proposed WNP architecture has noted the following impacts on the HLR:

- The HLR must provide a mapping between the MSID and the DN of the MS for all subscribers regardless if the subscriber has been ported. The DN should be made available to the MSC/VLR at the time of registration for all subscribers.
- If multiple DNs are used for the same MSID, the HLR must designate one DN as the preferred DN for the domestic network.
- The HLR must support any IS-41 Rev C message for, at a minimum, MS authentication, registration, and call delivery.
- The HLR must support any enhancements to the IS-41 Rev C messages required to accommodate MSID, MIN, MDN, and IMSI.

3.5 IMPACTS TO THE MOBILE SWITCHING CENTER

MSs with ported numbers will have their MSID and DN as different numbers. The MSID is a 15-digit IMSI and/or a 10-digit MIN, and the DN is a 10-digit NANP number. In the transition period, before IMSI is universally supported in every wireless network, the MSID has to carry MIN as one of the identifiers.

3.5.1 Registration/Validation

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

a) The MSC must support (or at least portions of) IS-41 Rev-C protocol for the Mobile Application Part if the MSC is to perform NP functions.

b) The MSC must launch a query 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 Rev C must be modified to include the MSID in place of the MIN as a mandatory parameter in the RegistrationNotification message.

c) 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.

d) The MSC must be able to differentiate between MSID and DN and to store them in the call register.

3.5.2 Call Origination

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

a) The originating MSC must populate the CgPN in the call setup message with the mobile DN. This DN is obtained from MS's HLR in the response to the registration response.

b) If the CdPN belongs to a ported NPA-NXX block, then the following must hold true:

- The MSC must have a new trigger for the NP-SCP dip when the MSC determines that the call is intra-LATA and non-local. The MSC will query the NP-SCP using an IS-41 Rev-C OriginationRequest (or equivalent) 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-SCP. 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 TCPN being set in FCI, the CdPN set to the retrieved LRN, the CgPN set to the DN of the calling party, and the GAP parameters set to the dialed DN.

- If the DN is not ported, the NP-SCP will respond with the CdPN set to the dialed DN in the response message. The MSC must be able to process this message.

- 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-SCP.

3.5.3 Call Delivery

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

a) The MSC must be able to process the IAM parameters, including the FCI TCPN and the GAP.

b) 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 LocationRequest query to its HLR based on the DN received from the ISUP message. Since the DN is different from MIN and since multiple HLRs may support the arrived at MSC, a special translation of the DN will be needed to locate the HLR. It is important to note that GTT routing to HLR is more robust than MTP routing as well as it provides efficiency in routing data administration. Also, since the number distribution among HLRs is unique to the individual service providers, the DN to HLR translation should be provided internally in the LSP network. This routing translation was described in section 2.2.4 of this document.

c) 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 a ported number, the MSC will query the NP-SCP to get the LRN of the destination switch.

3.6 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:

a) Today's STPs must handle a higher traffic volume.

b) If STP GT is used, STPs must support a new TT for routing messages to the NP-SCP. The STPs shall perform appropriate SS7 route management for routing queries to the active NP-SCP when the database has a redundant configuration.

c) 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 a few more than 6-digits of the IMSI in order to locate the HLR for the MS.

d) STPs must have route-sets defined for every possible destination network with which the service provider has a roaming agreement.

e) STPs should be able to support DN-to-HLR routing translation based on a new intra-network TT yet to be defined.

f) STPs will perform Intermediate GTT (IGTT) for messages to remote network nodes and Final GTT (FGTT) for routing to the local network nodes.

3.7 IMPACTS TO THE NUMBER PORTABILITY SERVICE CONTROL POINT

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

a) The NP-SCP should have sufficient memory to store ported numbers for at least one rate center (both wireline and wireless)

b) Transaction loads should be optimized through careful trigger strategies.

c) The NP-SCP must support IS-41 query messages from wireless network and a response message including the LRN of the MSC.

d) The NP-SCP should comply with Bellcore GR-1280-CORE, AIN SCP Generic Requirements, Section 13. The individual downtime should not be more than 12 cumulative hours per year (99.98% availability).

e) NP-SCPs are assumed to be segmented to an LSP level and must require no more than 6-digit GTT of the DN at the STPs to locate each SCP.

f) NP-SCPs 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.

g) NP-SCPs 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.

3.8 IMPACTS TO CUSTOMER ACQUISITION, CUSTOMER CARE AND PROVISIONING SYSTEMS

The following list describes the impact of NP on customer care and customer acquisition systems.

a) 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.

b) 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.

3.9 IMPACTS TO BILLING AND FRAUD MANAGEMENT SYSTEMS

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

a) Roaming tables may need to be modified to support both IMSI and MIN. If the billing systems store IMSI, standard call records will also need to be modified and expanded. Additionally, telephone inventory records must be modified.

b) Billing systems will most likely need to support more than one identifier for a subscriber: MIN, IMSI, and/or DN.

c) Any system or process which is built on MIN must be modified to support another ID - rating, cycle changes, splits, et al.

d) 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.

e) A billing module may have to be added to the existing AMA records for calls involving ported numbers. The details are for future study.

3.10 IMPACTS TO DATA ADMINISTRATION

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

a) There will exist one or more regional Service Management Systems (SMS) that will be administered by a neutral third party. Each NP-SCP will be provisioned by this regional Service Management System (SMS)

b) Each service provider must have direct terminal access to the appropriate regional SMS(s).

c) Service providers need to have an electronic interface for exchanging ported customer's data.

d) The NP-SCPs will be administered with their own SMSs.

e) Each Regional SMS will store the database of record. Service provider systems will interface with the regional SMS to download records to be provisioned into their own NP-SCPs.

f) The CTIA Cellular Operations Record Distribution (CORD) and the LERG data distribution procedure must be updated to provide rapid exchange of PC/SSN, MIN, and other pertinent routing and subscription information.

g) Service provider systems, with the help of network Operations Support Systems (OSS), will update all NEs with portability information as appropriate to service provider operations. The information might include

- portable NPA-NXX block indicator for the MSCs,
- new TT and new GTs in the STPs,
- HLR updates to include ported numbers, and
- translation data in NP-SCP.

3.11 IMPACTS TO STANDARD SERVICES

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.
- Emergency services must ensure that the subscriber is known to the operator by the MDN and not the MSID.
- 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.

4. FUTURE ENHANCEMENTS

Some of the future evolution of the wireless network will have direct impact on number portability solution. These impacts are discussed in this section.

4.1.1 Envisioned Evolution to Geographic Portability

The proposed WNP solution for service provider portability described in this document does not impose any foreseeable limitations on a possible a future location number portability mandate.

5. LIST OF ACRONYMS

The acronyms in the table below have been used throughout this document.

Acronym	*Expansion*
ACG	Automated Code Gapping
AIN	Advanced Intelligent Network
AWS	AT&T Wireless Services
CARE	Customer Account Record Exchange
CC	Customer Care
CdPA	Called Party Address
CdPN	Called Party Number
CLASS	Custom Local Area Signaling Services
CORD	Cellular Operations Record Distribution
CgPA	Calling Party Address
CgPN	Calling Party Number
CTIA	Cellular Telecommunications Industry Association
DN	Directory Number
EOs	End Offices
ESN	Electronic Serial Number
FCC	Federal Communications Commission
FCI	Forward Call Indicator
FGTT	Final Global Title Translation
GAP	Generic Address Parameter
GT	Global Title
GTT	Global Title Translation
HLR	Home Location Register
HLR-NRA	HLR Network Routing Address (Supported MSID number block to identify HLR)
IAM	Initial Address Message
IGTT	Intermediate Global Title Translation
IMSI	International Mobile Station Identifier (E.212)
IN	Intelligent Network
IS-41	Interim Standard - 41 Signaling Protocol for cellular Mobility Management
ISDN	Integrated Services Digital Network

Acronym	*Expansion*
ISPMAP	Inter-Service Provider Maintenance, Administration, and Provisioning
ISUP	ISDN User Part
LATA	Local Access Transport Area
LERG	Local Exchange Routing Guide
LRN	Location Routing Number
LSP	Local Service Provider
MCC	Mobile Country Code
LEC	Local Exchange Carrier
IXC	Inter Exchange Carrier
MDN	Mobile Directory Number
MIN	Mobile Identification Number
MNC	Mobile Network Code
MS	Mobile Station
MSC	Mobile Switching Center
MSID	Mobile Station Identifier
MTP	Message Transfer Part
NANP	North American Numbering Plan
NE	Network Element
NP	Number Portability
NP-SCP	Number Portability Service Control Point
NPRM	Notice of Proposed Rulemaking
O-MSC	Originating Mobile Switching Center
OAM&P	Operations, Administration, Maintenance, and Provisioning
OEO	Originating End Office
OSS	Operations Support System
PC	Point Code
PODP	3/6/10 Digit Public Office Dialing Plan
PSTN	Public Switched Telecommunications Network
SCCP	Signaling Connection Control Part
SCPs	Service Control Points
SMR	Specialized Mobile Radio
SMS	Service Management System
SS7	Signaling System 7
SSN	Sub-System Number
STP	Signal Transfer Point
TCAP	Transaction Capabilities Application Part
TCPN	Translated Called Party Number

Acronym	*Expansion*
	(a.k.a. NP-SCP dip indicator)
TEO	Terminating End Office
TLDN	Temporary Local Directory Number
TT	Translation Type
VLR	Visiting Location Register
V-MSC	Visited Mobile Switching Center
WNP	Wireless Number Portability
TDMA	Time Division Multiple Access
WIN	Wireless Intelligent Network