

# Cellular Networking Perspectives

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The ESN is an important mobile identifier yet, within a decade, there may be none left for new manufacturers to allocate.

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Local Number Portability (LNP) Phase I provides the ability for wireless switches to terminate calls to ported landline numbers. The query mechanism that is provided to identify the system to which the number has been ported is described, and the impact on wireless switches.

*TIA TR-45.5 CDMA Digital Air Interface Standards*..... p. 5

The TIA standards subcommittee responsible for CDMA digital air interface standards is moving fast to claim that they have a standard conformant with most 3G/IMT-2000 requirements. This new standard has cleverly been named IS-2000.

**Next Issue: June 2, 1999**

## **Telecom Trivia Trading Card Series 2: Hints**

The quiz associated with our second issue of trading cards ([www.cnp-wireless.com/cardquiz2.html](http://www.cnp-wireless.com/cardquiz2.html)) is based on the photographs of US locations that adorn one side of each card. Since this quiz has proved to be very challenging, here are some additional hints, one for each card:

1. A famous line.
2. A hidden hi-tech company.
3. Not Corn...Rice.
4. You stand a slim chance of guessing this location, baby.
5. If you live near here, sometimes it's rainy, sometimes...
6. A famous American erection in memory of a famous American president.
7. Science and religion being monitored.
8. Bet you think this one is easy!
9. Bring a trowel here at midnight.

Now that we have just about given the prize away, we expect you to claim it real soon now.

If you do not have a set of trading cards yet, simply email [cnpaccounts@compuserve.com](mailto:cnpaccounts@compuserve.com) quoting offer #CNP9905.

### **Get Your Inches of Fame!**

If you disagree with one of our opinions, think that we have our facts wrong, or have important information to add to an article, send an email to us ([crowed@cnp-wireless.com](mailto:crowed@cnp-wireless.com)). We may very well publish your letter!

## **Erratum: Nortel Implementation of IS-41 Rev. C, TIA/EIA-41 Rev. D**

The status of IS-41 Rev. C and TIA/EIA-41 Rev. D inter-systems operations implementation was reported in the March 1999 issue. The following information for Nortel was omitted:

- a. Local Number Portability (LNP; IS-765) Phase II for analog (AMPS), CDMA and TDMA is under development,
- b. Over-the-Air Activation (OTA; IS-725) for CDMA and TDMA digital systems is in field trial or commercial service, and
- c. Wireless Intelligent Network (WIN; IS-771) Phase I for analog (AMPS), CDMA and TDMA is in field trial or commercial service.

Our thanks to Brett Stewart of Nortel Networks for pointing out this omission.

## **ESN Exhaustion**

Out of 254 ESN (Electronic Serial Number) manufacturer codes available for assignment, over half have been used. At the current rate of allocation, the remaining 124 are expected to be allocated by 2007, unless manufacturer code expansion occurs. The TIA and CTIA are currently considering whether this expansion should be within the current 32 bit ESN structure (by reducing the bits assigned to individual serial numbers) or within a new 56 bit structure.

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## Local Number Portability Phase I: Terminations to Ported Landline Numbers

The first requirement for local number portability (LNP) in wireless systems, known as LNP Phase I, is to correctly terminate calls to ported landline numbers. This situation arises when, for example, a business chooses to transfer its local telephone service from an ILEC (Incumbent Local Exchange Carrier) to a CLEC (Competitive LEC) while keeping its phone numbers the same.

Future articles will discuss Phase II LNP (also known as WNP or Wireless Number Portability) which supports the ability of wireless phones to be ported, and Phase III which supports advanced services, such as SMS (Short Message Service).

The February, 1999 issue of *Cellular Networking Perspectives* summarizes the regulatory and political background to the LNP requirements. Acronyms related to LNP are defined as they are first used in this article, and also at:

[www.cnp-wireless.com/glossary.html](http://www.cnp-wireless.com/glossary.html)

### IS-756: The Phase I Standard

TIA/EIA/IS-756 provides a standard Phase I LNP solution for wireless systems. It is a modular add-on to TIA/EIA-41 Revision D intersystem operations. It was published in April 1998. This interim standard has already been revised once to incorporate Phase II requirements, and this revised version (IS-756-A) will be incorporated in Revision E of TIA/EIA-41.

### The LRN Method

Several methods have been proposed to support local number portability, but the US and Canada have chosen the LRN (Location Routing Number) method. A benefit of this method is that switches that previously served a ported number (known as the *Donor* switch) are not involved in the call. Also, the LRN method does not require the assignment of two phone numbers to each ported subscriber.

The LRN is obtained by querying a Number Portability Database (NPDB) using a directory number as input, and is returned for ported numbers only. The first 6 digits of this 10 digit North American directory number are used to route the call to the *Recipient* switch, with the directory number being used by that switch to identify the specific subscriber. The LRN must identify the Recipient switch, because the directory number would cause routing to the Donor switch that the customer previously subscribed to with the same number. For numbers that have not been ported, no LRN is provided, and the original directory number is used both for routing and for identifying the subscriber, just as is done when number portability is not implemented.

### Number Pooling

Number pooling is a method of number conservation that uses the LNP infrastructure, although its benefits for number conservation may be minimal (see the January, 1999 and February, 1999 issues for more information on number pooling and other proposed number conservation methods).

Number pooling allows carriers to share numbers within a block of 10,000 numbers, but consequently requires number portability queries for the entire block, even for numbers retained by the original carrier. From a wireless perspective, a landline block that has been pooled will be treated the same as a block that is portable. Some blocks may contain both pooled and ported numbers.

### Looping and Other Dangers

LNP and number pooling do pose some dangers for switches. One is that a call that has already resulted in an NPDB query might be routed back to the switch that performed the query, resulting in the call looping until one of the switches involved runs out of trunks. The risk of this happening has been reduced by adding a one-bit flag to the ISUP interconnection protocol to indicate that a query has been performed (*PortedNumber-TranslationIndicator* field in the *ForwardCallIndicators* parameter in the *InitialAddressMessage* (IAM)). This

solution works unless software (or, less likely, hardware) errors cause this flag to be cleared, or unless MF interworking is encountered. In these cases, an LNP database error could cause the call to be rerouted, and looping could occur.

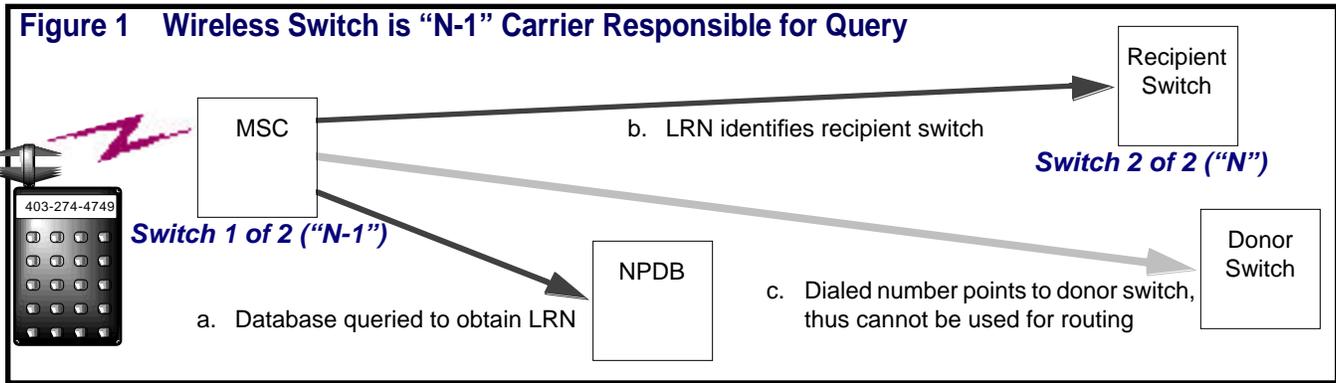
Another danger is that the additional load of LNP queries could cause switches to become overloaded. This is less of a concern with wireless switches, which already have a heavy load of messaging due to TIA/EIA-41 intersystem operations, than it is for landline switches. But, even with wireless switches, LNP could easily add an additional database query to most local calls. Even if only 1 out of every 10,000 landline customers choose to port their phone number, the majority of landline terminations will require a number portability query.

### Other Features

Phase I LNP does not affect most wireless features, because wireless numbers cannot be ported. However, some features are affected. Calling Name Display, for example, requires that a wireless system query a landline database using the calling party's number. If the landline party has ported, their number would lead to the database of the wrong carrier (the Donor, and not the Recipient). This problem is solved transparently to the querying system, based on modifications to the global title based SS7 routing. An STP in the SS7 network near the originating system has to recognize that a Calling Name global title is from a portable block of numbers, and either maintain number portability tables itself (for an internal query) or route the message to an SCP for this purpose. In this case routing is not based on an LRN, but on an SS7 point code that identifies the calling name database of the Recipient system.

### Who Does the Query?

In many calls, particularly long distance calls, multiple switches are involved, but the "N-1" switch in the call path is generally responsible for querying the NPDB. "N-1" is a reference to it being the last but one switch in the call path. Earlier switches in the call path are not,



in general, able to perform the query as they may be outside the local number portability region (e.g. a switch in San Francisco does not have access to the number portability database for New York City) or even outside the country. Furthermore, these switches could not be expected to maintain the tables of number blocks that are required to minimize the number of database queries that are performed.

The "N-1" switch is the wireless switch for local mobile-to-land calls (see Figure 1). When a wireless phone makes a long distance call, it is usually an inter-exchange carrier switch that is "N-1" in the call path (see Figure 2) and the wireless switch is not responsible for the query.

### When is a Query Required?

The "N-1" switch only has to perform a number portability query when the destination directory number is in a *Portable Block* – a block of 10,000 numbers that

contains at least one ported number. This requires all switches in the local area, including wireless switches (that are not yet fully within the number portability mandate), to maintain tables that identify which local number blocks are portable, and which are non-portable (i.e. that do not contain even a single ported number). To ensure correct routing these tables have to be updated soon after the first number in a block is ported (or the recently ported number will still be routed to the donor switch). An alternative to maintaining these tables is to perform a number portability query on all local number blocks, which may become a viable alternative after the majority of number blocks in a local area become portable (due to either LNP or number pooling).

### The NPREQ Query Message

An NPDB query message known as *NumberPortabilityRequest* (NPREQ) has been defined in IS-756 by TIA stan-

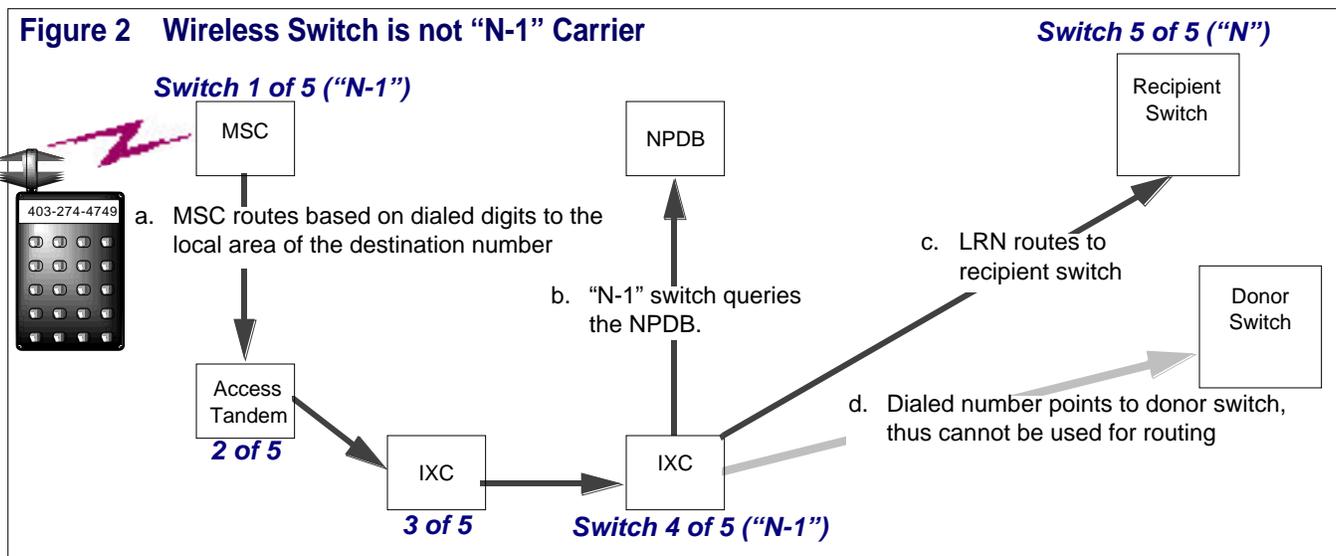
dards subcommittee TR-45.2 (see Table 1). The INVOKE for this message is sent from a wireless switch (MSC) to the NPDB and the response (RETURN RESULT) either contains no parameters, indicating that the destination number is not ported, or an LRN (disguised as the *RoutingDigits* parameter) if the destination number is ported.

The NPREQ message is only used by wireless systems to query the NPDB. Landline switches will use other query messages (e.g. based on IN or AIN).

### An Example

Figure 3 details the setup of a mobile to landline call that requires an LNP query.

- a. A mobile dials a landline number that is ported (although this is not yet known).
- b. The MSC queries an internal table of local number blocks that identifies the blocks that are portable (i.e. that con-



**Table 1: NumberPortabilityRequest (NPREQ) Operation**

INVOKE Parameters	
Digits (Dialed)	The destination directory number (e.g. dialed number). The only mandatory parameter.
CallingPartyNumberDigits1	The identity of the party initiating the call. The purpose of this parameter is not specified. It may find some use in traffic statistics and flow control (e.g. automatic code gapping).
MSCID	The identity of the MSC (composed of SID and a switch number). Not required to process the message, but may be used to allocate transaction charges.
MSID (Originating)	The MIN or IMSI of the mobile originating the call. The purpose of this parameter is not specified.
RETURN RESULT Parameters	
RoutingDigits	The LRN (Location Routing Number). This parameter is only included if the number is portable. Otherwise the destination directory number can be used for routing.

- tain ported numbers, pooled sub-blocks or both).
- c. The MSC queries the NPDB using the IS-756 NumberPortabilityRequest INVOKE (NPREQ) message containing the directory number (DN) derived from the dialed digits (403-274-4749 in this example).
- d. Since the dialed number is ported, the LRN identifying the Recipient switch is returned in the NumberPortabilityRequest RETURN RESULT (npreq).
- e. The MSC selects a trunk group based on the LRN (not based on the DN, as

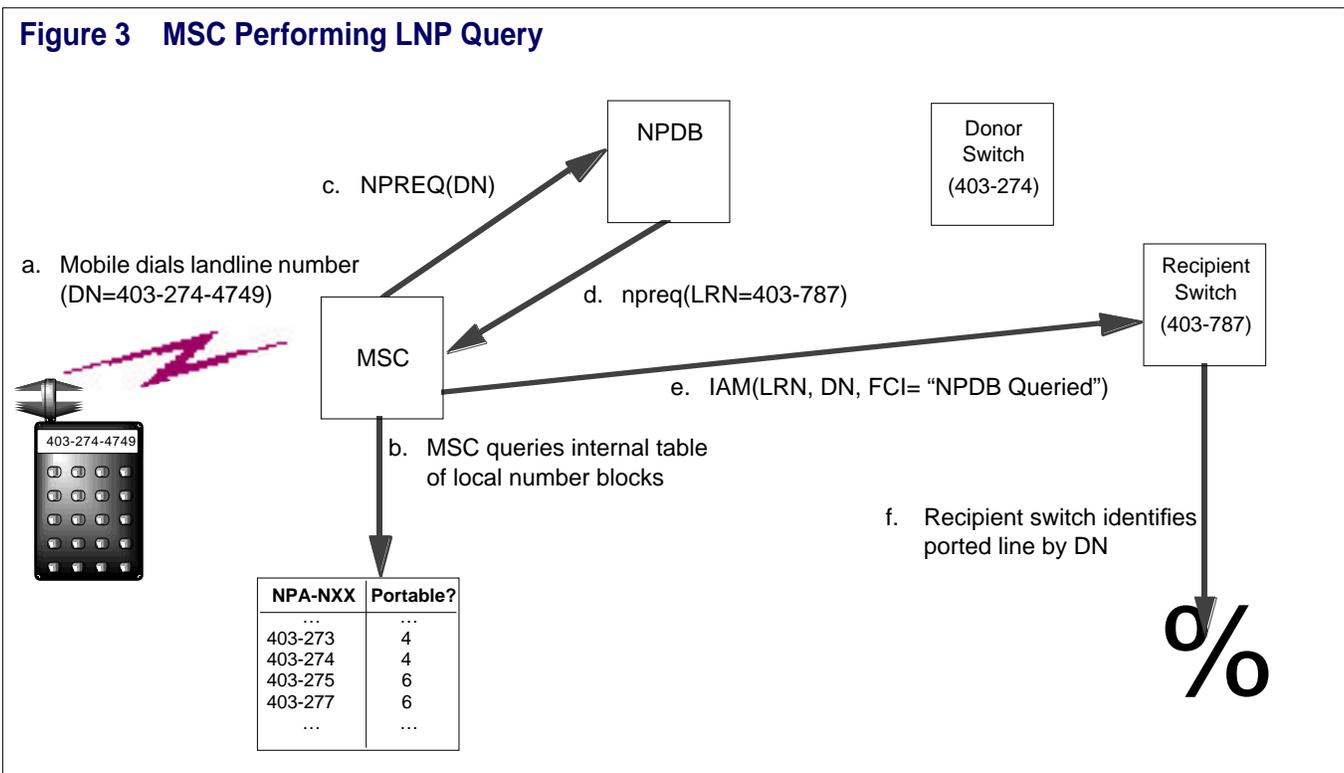
is done without LNP). If there are any intermediate switches, they will also route based on the LRN. Note that, in these cases, the MSC would not technically be the “N-1” switch.

The message that is used is the ISUP IAM (Initial Address Message). It contains the LRN, the DN, and an indication that an LNP query has been performed, in the Forward Call Indicators, to minimize the probability of looping.

f. The Recipient switch routes to the destination line based on the DN.

**To be continued...**

In the continuation of this article, we will discuss LNP Phase II, which supports the ability to port mobile numbers, requiring separation of the MIN and mobile directory number (MDN). We will also discuss LNP Phase III, which will extend number portability to enhanced services, most notably Short Message Service (SMS), and which raises some issues with SS7 global title routing.



# TIA TR-45.5 CDMA Digital Air Interface Standards

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### CDMA Digital Air Interface Standards - First Wave (Cellular)

Standard	Description	Publication
IS-95	CDMA Dual-Mode Air Interface Standard (Authentication Appendix pub. 11/92)	Published 07/93
IS-96	CDMA Option 1: Voice Coder	04/94
IS-97	Base Station minimum performance standards	12/94
IS-98	Mobile Station minimum performance standards	12/94
IS-126	Service option 2: Loopback	12/94

### CDMA Digital Air Interface Standards - Second Wave (Cellular & PCS)

Standard	PN/SP	Description	Publication
IS-95-A		IS-95 Revised (Authentication Appendix "A" Nov. 1994)	05/95
IS-96-A		CDMA Voice Coder	12/94
IS-97-A		Base Station minimum performance standards for IS-95-A	07/96
IS-98-A		Mobile minimum performance standards for IS-95-A	07/96
IS-98-A-1	PN-3867	Errata and additional tests for IS-95 mobile stations	09/97
IS-99		Data Services (9.6kbps Fax and Circuit Switched Data)	07/95
IS-125		Voice coder minimum performance standards	05/95
IS-126-A		Mobile station loopback service option	07/96
IS-637		Short message service (rate set 1)	12/95
<b>J-STD-019</b>	<b>SP-3383</b>	<b>Base station minimum performance standards. (note: publication date is 1996, but the document was not released by the TIA until</b>	<b>07/96</b>
<b>J-STD-008</b>	<b>SP-3384</b>	<b>IS-95 adapted for 1800 MHz frequency band. (note: publication date is 1996, but the document was not released by</b>	<b>07/96</b>
<b>J-STD-018</b>	<b>SP-3385</b>	<b>Mobile minimum performance standards (for J-STD-008). (note: publication date is 1996, but the document was not</b>	<b>07/96</b>
TSB-58		Parameter value assignments	12/95

## CDMA Digital Air Interface Standards - Third Wave (Integrated Cellular/PCS)

Standard	PN/SP	Description	Publication
IS-96-B		CDMA variable rate voice coder (max. 8 kbps)	07/96
IS-127		Option 3: enhanced variable rate (max. 8kbps) voice coder (EVRC)	01/97
<b>IS-127-1</b>	<b>PN-4146</b>	<b>Addendum to IS-127 (EVRC)</b>	<b>08/98</b>
<b>TIA/EIA-637</b>	<b>SP-4391</b>	<b>Short message service</b>	<b>development</b>
IS-657		Packet data services (Internet, CDPD)	07/96
IS-658		Data inter-working function interface (e.g. modem pool)	07/96
<b>IS-658.1</b>	<b>PN-4385</b>	<b>IS-658 revision to support mid-call interface status queries</b>	<b>development</b>
IS-683	PN-3569	Over the air activation and service provisioning	02/97
<b>IS-683-A</b>	<b>PN-3889</b>	<b>OTA update: Roaming system selection and programming lock</b>	<b>06/98</b>
IS-683.A		Authentication/Encryption Annex "A" for IS-683	03/96
IS-707	PN-3676	14.4 kbps data services (including async data, fax, STU-III and packet	02/98
<b>IS-707-A</b>	<b>PN-4145</b>	<b>Revision to IS-707 to be consistent with TIA/EIA-95 capabilities</b>	<b>In press</b>
<b>IS-718</b>	<b>PN-3648</b>	<b>Minimum performance standards for EVRC voice coder</b>	<b>07/98</b>
IS-733	PN-3972	High rate CDMA voice coder (max. 13 kbps)	03/98
<b>IS-736</b>	<b>PN-3973</b>	<b>Minimum performance specification for IS-733</b>	<b>11/98</b>
<b>TIA/EIA-95-B</b>	<b>SP-3693</b>	<b>IS-95 for 800 MHz and 1800 MHz frequencies (including J-STD-00</b>	<b>In press</b>
<b>TIA/EIA-96-C</b>	<b>SP-4138</b>	<b>CDMA variable rate voice coder (max. 8 kbps)</b>	<b>08/98</b>
<b>TIA/EIA-97-B</b>	<b>SP-3814</b>	<b>Minimum performance standards for base stations</b>	<b>08/98</b>
<b>TIA/EIA-97-C</b>	<b>SP-4384</b>	<b>Revision of TIA/EIA-97-B</b>	<b>Ballot</b>
<b>TIA/EIA-98-B</b>	<b>SP-3815</b>	<b>Minimum performance standards for mobile stations</b>	<b>08/98</b>
<b>TIA/EIA-98-C</b>	<b>SP-4383</b>	<b>Merges TIA/EIA-98-B and J-STD-018</b>	<b>Ballot</b>
<b>TIA/EIA-126-B</b>	<b>SP-4136</b>	<b>ANSI version of IS-126 (MS loopback option)</b>	<b>08/98</b>
<b>TIA/EIA-637-A</b>	<b>PN-4391</b>	<b>ANSI version of IS-637 (short message service, including TSB-7</b>	<b>Ballot</b>
<b>TSB-58-A</b>	<b>PN-4158</b>	<b>Parameter value assignments</b>	<b>Ballot</b>
TSB-74		14.4 kbps radio link protocol and inter-band operations	12/95
TSB-79	PN-3823	IS-637 update for 14.4kbps SMS, service negotiation and Y2K	02/97

## CDMA Digital Air Interface Standards - 3G Version (cdma2000)

Standard	PN/SP	Description	Status
<b>IS-2000</b>		<b>cdma2000</b>	<b>Ballot</b>
<b>.1</b>	<b>PN-4427</b>	<b>cdma2000 Introduction and Overview</b>	<b>Ballot</b>
<b>.2</b>	<b>PN-4428</b>	<b>cdma2000 Physical Layer</b>	<b>Ballot</b>
<b>.3</b>	<b>PN-4429</b>	<b>cdma2000 Media Access Control (MAC) layer</b>	<b>Ballot</b>
<b>.4</b>	<b>PN-4430</b>	<b>cdma2000 Signaling Layer 2 Link Access Control (LAC)</b>	<b>Ballot</b>
<b>.5</b>	<b>PN-4431</b>	<b>cdma2000 Signaling Layer 3</b>	<b>Ballot</b>
<b>.6</b>	<b>PN-4432</b>	<b>cdma2000 Analog Operation</b>	<b>Ballot</b>
<b>IS-xxx</b>	<b>PN-4535</b>	<b>Location services</b>	<b>Development</b>
<b>TSB-xxx</b>	<b>PN-4534</b>	<b>Capabilities requirements mapping</b>	<b>Development</b>

- Note:
1. IS- TIA Interim Standard, PN- TIA Project Number, SP- ANSI Standards Proposal, TIA/EIA- ANSI approved TIA standard, TSB- TIA Telecommunications Systems Bulletin.
  2. **Bold Type** indicates modification since the previous publication of this report.

Thanks to David Ott and Jack Nasielski (Qualcomm) for providing information for this table