Cellular Networking Perspectives

Editor: David Crowe • Phone +1-403-289-6609 • Email crowed@cnp-wireless.com Vol. 9, No. 11 November, 2000

*In This Issue...*



### *Price Increase!*

Our prices will be increasing in 2001! All renewals received before January 1, 2001 will be honored at the current prices. For more information, please email:

cnpaccts@cnp-wireless.com

***Next Issue: December 4th, 2000***

## New Chairman for TIA TR-45.6

TIA subcommittee TR-45.6, responsible for packet data standards, has a new chairman - Ed Campbell of 3Com Corporation. He can be reached via email at:

ed_campbell@3com.com

## Optimal Routing, Part I

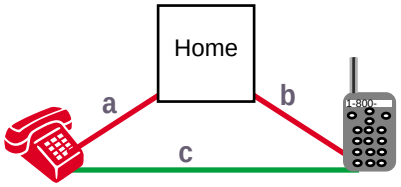
Routing calls to a roaming mobile can be very inefficient in utilization of trunks and switching resources. In the worst case, a Brazilian calling a Canadian mobile roaming in Brazil could invoke two international long distance calls (from Brazil to Canada and back), just to call across Rio.

Rectifying this situation involves 'thinking before doing', determining the whereabouts of the destination mobile before routing a call blindly towards its home system, where the mobile may very well not be. However, solutions stumble because it is difficult to examine a phone number and determine whether it is a mobile or not, especially if it is homed in another country. And, it is even more difficult to determine whether the phone is accessible using the same Mobile Application Part (e.g. GSM MAP or TIA/EIA-41).

### Basic Concept

Optimal Routing allows a call to be routed directly from the Originating Switch to the MSC currently serving a mobile (leg 'c' in Figure 1), which replaces both the leg from the Originating Switch to the home MSC (leg 'a') and from the home MSC to the Serving MSC (leg 'b').

**Figure 1: Optimal Routing**




Optimal Routing is not applicable (or at least, has no benefit) when a mobile is within its home system (scenario i in Figure 4). It is most useful when the roaming mobile being called is within the local calling area of the calling mobile. Currently, such a situation may require two long distance calls even if the two parties are within spitting distance (see Figure 2). Optimal Routing can reduce this to a single local call (see Figure 3).

### Using a MAP

The *Mobile Application Protocol* or *MAP* that allows cellular or PCS systems to interconnect at a high level of intelligence. The two that are most commonly used are GSM MAP and TIA/EIA-41, although in the near future 3G systems will likely develop new MAPs.

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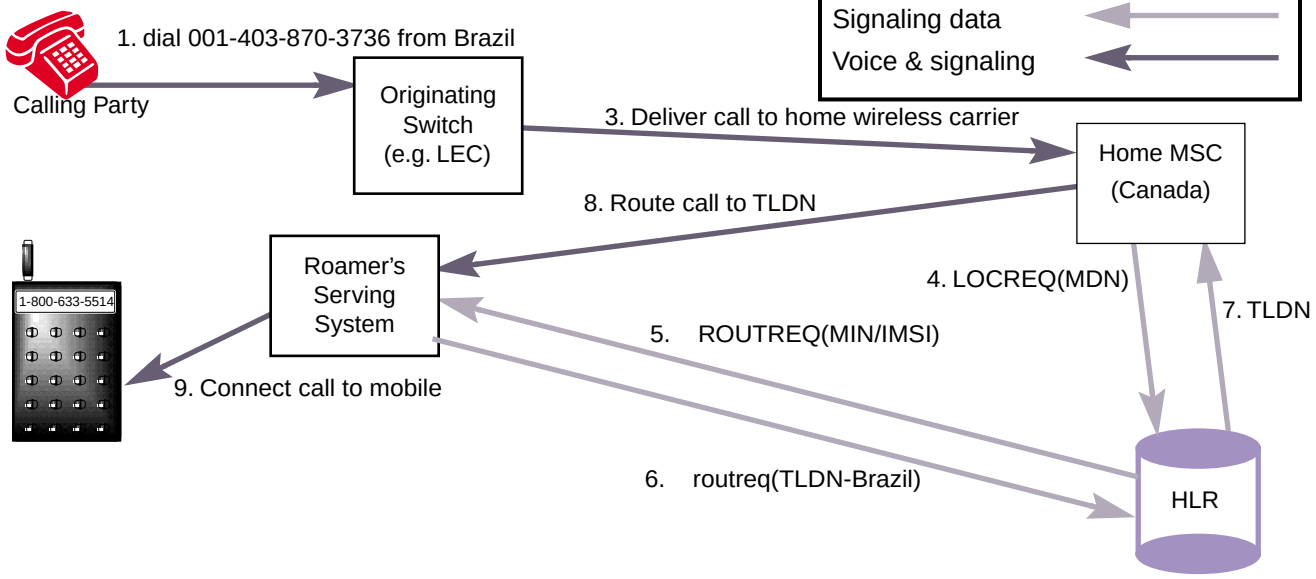
**Figure 2: Routing to Roamer: Worst Case Routing**




Both GSM MAP and TIA/EIA-41 have the ability to perform optimal routing once the dialed digits have been identified as a compatible number (i.e. served by a network conforming to the same MAP). There are several major reasons why this is, however, rarely done:

- Billing Complications
- Recognizing Digits
- Number Portability Concerns

### *Billing Complications*

Billing for a call to a roamer without optimal routing is quite simple. The calling party pays for the leg to the home system and the called mobile pays (if it is roaming) for the leg to the current serving system. Airtime charges may be paid by the calling party (Calling Party Pays) or the called mobile (Terminating Party Pays).

With Optimal Routing new billing scenarios are possible, as shown in Figure 4. When the mobile is at home (scenario i), optimal routing has no effect, so there are no billing complications.

When the mobile is roaming near the calling party (scenario ii), two long distance calls may be avoided, so the toll charges for both parties can be reduced or eliminated.

When the mobile is roaming further away from the calling party than the home system (scenario iii), charges must be split because the charge from the calling party to the mobile's actual location (c) may be greater than either the leg to the home system (a) or the leg from the home system to the current serving system (b), but will almost certainly be less than the sum of charges for legs a and b.

There are several solutions to the billing problems raised by optimal routing. One is to leave the charges paid by the calling party unchanged. This means that they will sometimes pay toll charges for a call with no toll leg (not likely to upset carriers, but possibly regulators and consumers). Another solution is to apportion the charges, ensuring that neither party ever pays more than they would in a non-optimal routing case. This may require wire-

**Figure 3: Optimal Routing using MAP (e.g. TIA/EIA-41)**

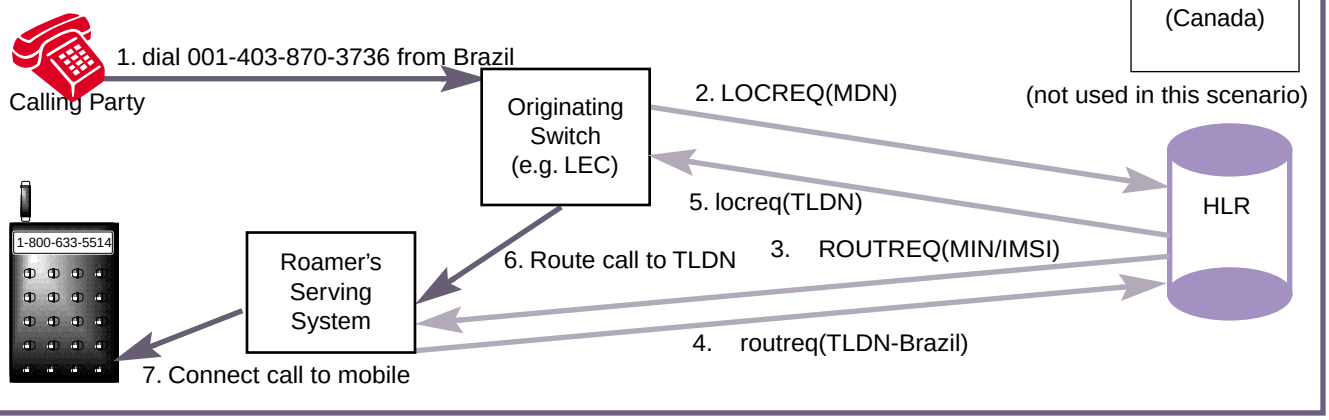
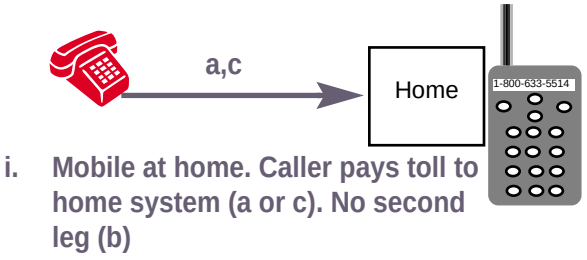
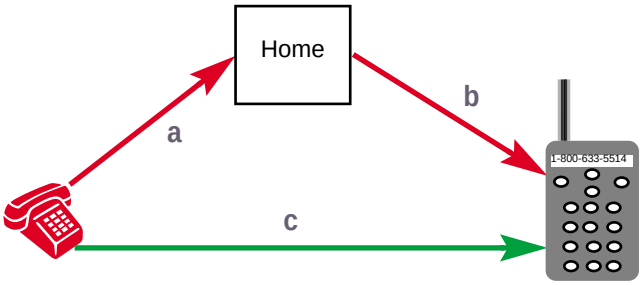


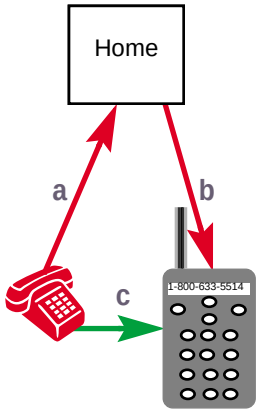
**Figure 4: Optimal Routing Billing Cases**




i. Mobile at home. Caller pays toll to home system (a or c). No second leg (b)




iii. Mobile roaming away from caller. Toll charges must be split (c > a+b but a > c and b > c)




ii. Mobile roaming near caller. No toll (c = 0).

| Notes | |
|---|---|
| a | Leg from calling party to Home |
| b | Leg from Home to Roamer |
| c | Optimal Routing Leg (replaces a and b) |

less–landline billing record exchange, something that is avoided today.

With the trend towards fixed rate calling plans from both wireless and long distance companies, a simple solution is probably the best. The calling party can be charged their standard long distance calling rate, and the called mobile their standard combined airtime/long distance rate, with the carrier pocketing the savings.

### *Recognizing Digits*

In many countries wireless carriers are assigned unique numbering prefixes, so it is possible to recognize that a call is to a wireless carrier by analyzing only the first 2 to 3 digits of the number (requiring a table of 100 or 1,000 entries, at most). Some wireless carriers make this easily recognizable number an essential part of their marketing image (e.g. Shinsegi 017 in Korea). However, it is difficult to extend this ability to international dialing because it would require maintaining much larger tables, as well as tracking numbering plan changes in other countries. In North America the problem is even worse because wireless carriers are assigned blocks of 10,000 numbers (and sometimes even smaller!). A table to examine the first 6 digits of every dialed number would have 1,000,000 entries, and because it would change frequently, would be virtually impossible to manage.

### *Number Portability Concerns*

Number portability makes it risky to identify a carrier based on analysis of dialed digits. A switch may determine that dialed digits are for a mobile, only to discover later that they have been ported to a wireless carrier that uses a different MAP or, even worse, ported to a landline carrier. In the opposite direction, a lesser problem occurs when a carrier determines that dialed digits are not for a wireless carrier, and does not initiate optimal routing when it is actually possible.

Solutions to this problem depend on the method being used, and will be discussed separately with each approach.

## When is it Feasible?

Optimal Routing is feasible under a number of situations:

- Within a single carrier network, digit translations can route intra-carrier calls as mobile-to-mobile calls, initiating the TIA/EIA-41 LocationRequest INVOKE (LOCREQ), for example.
- In countries where wireless carriers are assigned entire region or area codes, all carriers can maintain lists of the directory number prefixes for other carriers.
- Number Portability is not only a potential problem for optimal routing, but also a potential solution. If it is extended nationwide (and that is a big if), queries will need to be moved to the originating switch and the LNP database could include information about the type of MAP supported, facilitating optimal routing.
- Enhanced Roamer Agreement Tables. These existing tables can be enhanced to support optimal routing for mobile-to-mobile calls.
- ISUP *Release to Pivot*. This SS7 ISUP protocol has promise for allowing optimal routing for all types of calls, without number portability problems, although current protocols are not yet flexible enough.

## To be continued…

The continuation of this article will discuss *Number Portability, Enhanced Roamer Agreement Tables* and ISUP *Release to Pivot* as potential methods for implementing Optimal Routing.

# Status of IS-41 Rev. C & TIA/EIA-41-D (ANSI-41) Implementations

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| Intersystem Operations Capability | Vendor and Radio Technology | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ericsson (MSC/BS) | | GTE (HLR) | LG | Lucent (MSC/BS) | | | Motorola (MSC/BS) | | Nortel (MSC/BS) | | |
| | Analog | TDMA | all | CDMA | Analog | CDMA | TDMA | Analog | CDMA | Analog | CDMA | TDMA |
| **Authentication (CAVE)** | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **IS-778 Authentication Enhancements** | | | | 🕐 | | | | | | | | |
| **CNAP/CNAR** | | ✔ | ✔ | 🧪 | | 🧪 | 🧪 | | | 🕐 | 🕐 | 🕐 |
| **CNIP/CNIR** | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Data (IS-737)** | | ✔ | | ✔ | | | | | ✔ | | 🕐 | 🕐 |
| **Inter-MSC handoff: Analog to…** | ✔ | ✔ | | | ✔ | | ✔ | ✔ | | ✔ | | ✔ |
| **Inter-MSC handoff: CDMA to…** | | | | ✔ | ✔ | ✔ | | ✔ | ✔ | ✔ | ✔ | |
| **Inter-MSC handoff: TDMA to…** | ✔ | ✔ | | | ✔ | | ✔ | ✔ | | ✔ | | ✔ |
| **International (IS-751 IMSI and IS-807)** | | ✔ | | 🧪 | | 🧪 | 🧪 | | | | 🕐 | 🕐 |
| **Hyperband handoff (TSB-76)** | | ✔ | | | | ✔ | ✔ | | ✔ | | ✔ | ✔ |
| **LNP Phase I (IS-756)** | ✔ | ✔ | 🕐 | | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **LNP Phase II (IS-756-A)** | ✔ | ✔ | | | | | | 🕐 | 🕐 | 🕐 | 🕐 | 🕐 |
| **MWN** | ✔ | ✔ | ✔ | ✔ | | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Origination Triggers** | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Over-the-air Activation (IS-725)** | | 🧪 | | ✔ | | ✔ | 🕐 | | ✔ | | ✔ | ✔ |
| **SMS Origination** | | ✔ | ✔ | ✔ | | 🧪 | ✔ | | 4Q'00 | | ✔ | ✔ |
| **SMS Termination** | | ✔ | ✔ | ✔ | | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Termination Triggers** | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| **Voice Privacy - basic** | | ✔ | | ✔ | | ✔ | ✔ | | ✔ | | | |
| **Voice Privacy - EPE** | | | | | | | | | | | | 🕐 |
| **WIN Phase I (IS-771)** | ✔ | ✔ | | 🧪 | 🕐 | 🕐 | 🕐 | 🕐 | 🕐 | ✔ | ✔ | ✔ |
| **WIN Phase II (Prepaid)** | | | | 🕐 | | | | 🕐 | 🕐 | 🕐 | 🕐 | 🕐 |

# Status of IS-41 Rev. C & TIA/EIA-41-D (ANSI-41) Implementations

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| Intersystem Operations Capability | Vendor and Radio Technology — Telos | | |
|---|---|---|---|
| | Analog | CDMA | TDMA |
| **Authentication (CAVE)** | ✔ | ✔ | ✔ |
| **IS-778 Authentication Enhancements** | | | |
| **CNAP/CNAR** | | | |
| **CNIP/CNIR** | ✔ | ✔ | ✔ |
| **Data (IS-737)** | | 🕓 | |
| **Inter-MSC handoff: Analog to…** | ✔ | | |
| **Inter-MSC handoff: CDMA to…** | ✔ | ✔ | |
| **Inter-MSC handoff: TDMA to…** | ✔ | | ✔ |
| **International (IS-751 IMSI and IS-807)** | | 🕓 | |
| **Hyperband handoff (TSB-76)** | | | |
| **LNP Phase I (IS-756)** | ✔ | ✔ | ✔ |
| **LNP Phase II (IS-756-A)** | 4Q'00 | 4Q'00 | 4Q'00 |
| **MWN** | | ✔ | ✔ |
| **Origination Triggers** | ✔ | ✔ | ✔ |
| **Over-the-air Activation (IS-725)** | | 4Q'00 | ✔ |
| **SMS Origination** | | ✔ | 4Q'00 |
| **SMS Termination** | | ✔ | ✔ |
| **Termination Triggers** | ✔ | ✔ | ✔ |
| **Voice Privacy - basic** | | | |
| **Voice Privacy - EPE** | | | |
| **WIN Phase I (IS-771)** | ✔ | ✔ | ✔ |
| **WIN Phase II (Prepaid)** | | | 🕓 |

**Notes**

Terms: www.cnp-wireless.com/glossary.html.

Symbols:

| | |
|---|---|
| ✔ | In field trial or commercial service. |
| XQ'XX | Specifies the quarter during which commercial availability is expected (e.g. 4Q'01). |
| ⚗ | In lab trial. |
| 🕓 | Under Development |
| | Shading indicates a capability that is not technically feasible at present, or for which no standard yet exists. |
| **Bold type** | Company names in **bold type** have indicated a change in status since the last report. |
| Red | Text and figures in red indicate specific changes since the last report (visible only in electronic edition of newsletter). |

# TIA TR-45.5 CDMA Digital Air Interface Standards

Cellular Networking Perspectives

Editor: David Crowe • Phone +1-403-289-6609 • Email crowed@cnp-wireless.com

*Last published May, 2000*

Note: 1. IS- Interim Standard, TSB- Telecommunications Systems Bulletin, PN- Project Number, SP- ANSI Standards Proposal.
2. Bold Type indicates a modification since the previous publication of this information.
3. Published TIA standards can be obtained from Global Engineering Documents at 1-800-854-7179.

Thanks to Jack Nasielski for his assistance compiling the information in this table.

## First Wave - Cellular

| Standard | Description | Status |
|---|---|---|
| IS-95 | CDMA Dual-Mode Air Interface Standard (Authentication Appendix Nov. 1992) | Published 07/93 |
| IS-96 | CDMA Option 1: Voice Coder (Speech Service Option) | Published 04/94 |
| IS-97 | Base Station minimum performance standards for IS-95-A | Published 12/94 |
| IS-98 | Mobile Station minimum performance standards | Published 12/94 |
| IS-126 | Service option 2: Loopback | Published 12/94<br>Rescinded 04/99 |

## Second Wave - Cellular and PCS

| Standard | Description | Status |
|---|---|---|
| J-STD-008 | IS-95 adapted for 1.8-2.0 Ghz frequency band. Note: published in 1996, but not released until 1998. | Published 07/96<br>Rescinded 04/99 |
| J-STD-018 | Mobile minimum performance standards (for J-STD-008). Note: published in 1996, but not released until 1998. | Published 07/96<br>Rescinded 04/99 |
| J-STD-019 | Base station minimum performance standards. Note: published in 1996, but not released until 1998. | Published 07/96 |
| IS-95-A | IS-95 Revised (Authentication Appendix "A" Nov. 1994) | Published 05/95 |
| IS-96-A | CDMA Voice Coder | Published 05/95 |
| IS-97-A | Base Station minimum performance standards for IS-95-A | Published 07/96 |
| IS-98-A | Mobile minimum performance standards for IS-95-A | Published 07/96 |
| IS-98-A-1 | Additional tests for IS-95 mobile stations | Published 09/97 |
| IS-99 | Data Services (9.6 kbps Fax and Circuit Switched Data) | Published 07/95<br>Being rescinded |
| IS-125 | Voice coder minimum performance standards | Published 05/95<br>Rescinded 10/00 |
| IS-126-A | Mobile station loopback service option | Published 07/96<br>Rescinded 04/99 |
| IS-637 | Short message service (rate set 1) | Published 12/95 |
| TSB-58 | Parameter value assignments | Published 12/95 |

## Third Wave - Integrated Cellular and PCS

| Standard | Project | Description | Status |
|---|---|---|---|
| TIA/EIA-95-B | SP-3693 | IS-95 for 800 MHz and 1800 MHz frequencies (including J-STD-008) | Published 03/99 |
| TIA/EIA-96-C | SP-4138 | CDMA Voice Coder (8 kbps) | Published 08/98 |

| | | | |
|---|---|---|---|
| TIA/EIA-97-B | SP-3814 | Minimum performance standards for base stations | Published 08/98 |
| TIA/EIA-97-C | SP-4384 | Minimum performance standards for base stations (merges TIA/EIA-97-B and J-STD-019) | Published 09/99 |
| TIA/EIA-98-B | SP-3815 | Minimum performance standards for mobile stations | Published 08/98 |
| TIA/EIA-98-C | SP-4383 | Merges TIA/EIA-98-B and J-STD-018 | Published 06/99 |
| **TIA/EIA-125-A** | **SP-4682** | **Correction of errors in speech service option 1** | **Published 02/00** |
| TIA/EIA-126-B | SP-4136 | ANSI version of IS-126 (MS loopback option) | Published 08/98 |
| **TIA/EIA-126-C** | **SP-4578** | **Mobile Station loopback test** | **Published 04/00** |
| TIA/EIA-637-A | SP-4391 | Short message service (including service negotiation, 14.4 kbps transmission, PCS and TIA/EIA-95 support) | Published 09/99 |
| IS-96-B | | CDMA Voice Coder (8 kbps) | Published 07/96 |
| IS-127 | | Option 3: enhanced variable rate voice coder (EVRC) | Published 01/97 |
| IS-127-1 | PN-4146 | Addendum #1 to IS-127 | Published 08/98 |
| IS-127-2 | | Addendum #2 to IS-127: TTY/TDD capabilities | Published 09/99 |
| **IS-127-3** | | **Addendum #3 to IS-127** | **Development** |
| IS-657 | | Packet data services (Internet, CDPD) | Published 07/96<br>Being rescinded |
| **IS-658** | **PN-4374** | **Data Services Interworking Function Interface (e.g. modem pool)** | **Published 07/96** |
| **IS-658-1** | | **Addendum 1 to IS-658. Extends the ability to perform interface status exchange at times other than call setup** | **Published 05/99** |
| IS-683 | PN-3569 | Over the air activation (OTA) and service provisioning (Authentication Appendix A published 03/96) | Published 02/97 |
| IS-683-A | PN-3889 | OTA update: Roaming system selection and programming lock | Published 06/98 |
| IS-707 | PN-3676 | 14.4 kbps data services (including asynch. data, fax, STU-III and packet data) | Published 02/98 |
| IS-707-A | PN-4145 | Revision to IS-707 to be consistent with TIA/EIA-95 capabilities | Published 04/99 |
| IS-718 | PN-3648 | Minimum performance standards for EVRC voice coder | Published 07/98 |
| IS-733 | PN-3972 | High rate CDMA voice coder (13 kbps) | Published 02/98 |
| IS-733-1 | | Addendum #1 to IS-733: TTY/TDD capabilities | Published 09/99 |
| **IS-733-3** | **PN-3972-AD2** | **Addendum #2 to IS-733** | **Development** |
| IS-736 | PN-3973 | Minimum performance specification for IS-733 (13 kbps voice coder) | Published 11/98 |
| **IS-736-A** | **PN-4653** | **Corrections to testing procedures in IS-736** | **Published 08/00** |
| TSB-58-A | PN-4158 | Parameter value assignments for TIA/EIA-95-B | Published 04/99 |
| TSB-74 | | 14.4 kbps radio link protocol and inter-band operations | Published 12/95<br>Rescinded 04/99 |
| TSB-79 | PN-3823 | IS-637 update for 14.4 kbps SMS, service negotiation and Year 2000 | Published 02/97 |

## 3G Version (cdma2000, IS-2000, 1xRTT, 1xEVDO)

| Standard | Project | Description | Status |
|---|---|---|---|
| **TIA/EIA-97-D** | | **Minimum performance standards for IS-2000 base stations** | **Ballot** |
| **TIA/EIA-98-D** | | **Minimum performance standards for IS-2000 mobiles** | **Development** |
| **TIA/EIA-99** | **PN-4617** | **9.6 kbps data service option for IS-2000** | **Rescinded 10/00** |
| | | | **Rescinded 10/00** |
| IS-2000.1 | PN-4427 | cdma2000 Introduction and Overview | Published 08/99 |
| IS-2000.2 | PN-4428 | cdma2000 Physical Layer | Published 08/99 |
| IS-2000.3 | PN-4429 | cdma2000 Media Access Control (MAC) layer | Published 08/99 |
| IS-2000.4 | PN-4430 | cdma2000 Signaling Layer 2 Link Access Control (LAC) | Published 08/99 |
| IS-2000.5 | PN-4431 | cdma2000 Signaling Layer 3 | Published 08/99 |
| IS-2000.6 | PN-4432 | cdma2000 Analog Operation | Published 08/99 |
| **IS-2000-A** | **PN-4693-8** | **cdma2000 (all 6 parts to be revised)** | **Published 03/00** |
| **IS-2000-A-1** | | **Addendum for IS-2000-A** | **Published** |
| IS-707-A-1 | PN-4541 | Adds cdma2000 radio link protocol 3E support to 14.4kbps data | Published 12/99 |
| IS-707-A-2 | PN-4692 | Data support for IS-2000-A | Ballot |
| IS-801 | PN-4535 | Position determination services (e.g. for E911 Phase II) | Published 10/99 |
| **IS-801-1** | | **Addendum to position determination** | **Ballot** |
| **IS-834** | **PN-4707** | **Direct Spread Specification for Spread Spectrum Systems on ANSI/TIA/EIA-41 (DS41) Upper Layers Air Interface** | **Published 03/00** |
| **IS-856** | **PN-4875** | **cdma2000 High Rate Packet Data Air Interface Specification (1XEV DO)** | **Published 10/00** |
| **TSB-58-B** | **PN-4691** | **Parameter value assignments for IS-2000** | **Published 11/99** |
| **TSB-58-C** | | **Parameter value assignments for IS-2000-A** | **Published 05/00** |
| TSB-2000 | PN-4534 | Capabilities requirements mapping for cdma2000 standards | Published 09/99 |
| | PN-4575 | Speech and capacity-sensitive voice coder (formerly EVRC) | Development |
| | **PN-4650** | **13k voice coder simulation (TTY/TDD update)** | **Ballot** |
| | PN-4651 | EVRC simulation (TTY/TDD update) | Development |
| | **PN-4876** | **Markov Service Option (MSO) for cdma2000 spread spectrum systems** | **Development** |
| | **PN-4877** | **Test Data Service Option (TDSO) for cdma2000 spread spectrum systems** | **Development** |

## GSM MAP and Smart Card Support

| Standard | Project | Description | Status |
|---|---|---|---|
| **IS-820** | **PN-4690** | **R-UIM (Removable "Smart Card")** | **Published 09/00** |
| **IS-820-1** | | **R-UIM Addendum** | **Ballot** |
| **IS-833** | **PN-4706** | **Multi-carrier Specification for Spread Spectrum Systems on GSM MAP (MC-MAP) Lower Layers Air Interface** | **Published 03/00** |
| | PN-4859 | Minimum performance standards for TTY signal detector and regenerator | Development |