Cellular Networking Perspectives

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In This Issue...

Next Issue: December 2, 1998

CNP Index Beta Test

The email version of *Cellular Networking Perspectives* is prepared in Adobe Acrobat™ format, which has powerful indexing capabilities. We have created a full text index, which allows Acrobat Reader or Exchange to perform an almost instantaneous full text search of all back issues, identifying those that may have the information that you need (even those that you have not purchased). If you would like to participate in a Beta test of this index, and provide feedback on its benefits, please contact the editor at crowed@cnp-wireless.com.

If we didn't answer the phone…

There were some problems with our Local Exchange Carrier's voice mail system over the past month. If you were unable to leave a message when phoning our 1-800 number, please try again or, better yet, send us email at cnpsales@cnp–wireless.com. Please accept our apologies for any inconvenience this may have caused you.

Quote of the Month

"A single cellular phone transmitting from the surface of the moon would be perceived on Earth as one of the strongest radio signals in the universe."

David Malakoff

Letter to the Editor

This issue contains our first ever *Letter to the Editor*. If we ever publish something you disagree with, or can comment on further, do not hesitate to write to us, and express your opinion. We reserve the right to select letters for publication, and may edit for brevity.

TDMA Capabilities Slighted?

"I would like to offer a comment on your description of wireless data (October,1998 issue). It was well written…up until your comment that [CMDA] IS-95 is more flexible than TMDA IS-136, which is unfounded and warrants a retraction."

"The fact is, [IS–136 TDMA is] already able to operate in packet data mode, using one or more time slots and one or more 30 khz channels, as traffic requires (end to end digital….with software modems that are downloaded over the air); up to 9.6kbps net per two timeslots or 19.2 kbps net per full 30khz channel [6 timeslots]. These data slots can interoperate with voice slots...even on the same 30 khz channel. In our [HNS's] Prague fixed wireless system for example, there are approximately 40,000 subscribers operating any mix of voice, fax, modem data and packet data (for wireless Internet), generating up to 4600 erlangs of traffic in the peak busy hour, with only 4+4Mhz of spectrum in the 800MHz

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band…a net spectral efficiency of over 8 erlangs per 30khz channel!"

"An added advantage: each subscriber unit while on an internet session can be interrupted with an incoming voice call (same phone number); after completion of the voice call, the internet session resumes where it left off. You would need two phone lines to do this…neither CDMA nor GSM have this capability in commercial service. By the way, each voice call only requires one slot; we are operating with a half rate vocoder(4.8kbps) along with digital speech interpolation. Even though this has not yet been "standardized" (largely because the process is slow and bureaucratic), it has all been implemented within the air channel and DCCH rules of IS-136…indeed a testament to TDMA's flexibility and future proof evolution. Next step is to introduce 8PSK modulation (early 1999),which will yield 64kbps (net 43.2kbps) for data calls, still interoperable with existing voice calls.And able to be implemented on existing base station hardware, with only software upgrades. By 2000,look for TDMA and GSM to merge on the EDGE path (multiple 200khz channels, still interoperable with 30khz channels) and with QAM modulation, yielding the promised 2Mbps."

Dr. Arunas Slekys
Vice-President
Hughes Network Systems

The Editor Responds…

There is much that TDMA can do outside the bounds of the current 6 slot architecture. But, within that architecture it cannot squeeze out more bits than are allocated for voice in one 30 khz channel (currently about 30 kbps). In future standards, more will be possible, but that will not be today's TDMA.

The use of 4.8 kbps voice coders and digital speech interpolation is proof that spectrum is still considered a scarce resource, worth conserving. If spectrum is being conserved to squeeze in ever more voice users, why would carriers then throw spectrum at data users in significantly greater amounts?

The fact that CDMA is currently more flexible in allocating bandwidth is a two edged sword. With voice coders running at 8-13 kbps (or even as low as 4.8 kbps, as Dr. Slekys points out), there is an exponential divergence between the slow decrease in the bitrate needed for one voice user and the increasingly high bitrates expected by data users. The bigger question is not whether 64 kbps to 2Mbps data can be made available, but how carriers will price it. Will it be 8 to 250 times the per-minute charge for voice? If not, why will carriers accept a lower profit margin on data than on voice?

Digital Circuit Switched Data, Part II: IS-737 Call Processing

The October, 1998 issue of *Cellular Networking Perspectives* introduced the major challenges with the transmission of data from digital wireless phones. While radio interface standards (IS-99/ IS-707 for CDMA mobiles and IS-130/ IS-135 for TDMA) are sufficient for mobiles in their home system, TIA/EIA/ IS-737 is required if roamers are to originate or terminate data calls, and to permit inter-MSC handoff and mid-call modifications.

Network Reference Model

Data Services for digital wireless phones introduce new network elements and interfaces. Figure 1 shows a simplified version of the network reference model:

- IWF Interworking function (e.g. specialized modem pool)
- MT0 An integrated data terminal (e.g. including user interface)
- MT2 A modular data termination (connected to TE2)
- TE2 A standard terminal device (e.g. laptop computer)
- Rm Interface between MT2 and TE2 (e.g. cable between laptop and mobile phone)

As with any network reference model, the network elements only represent log-

Figure 1: Data Services Network Reference Model (Simplified)

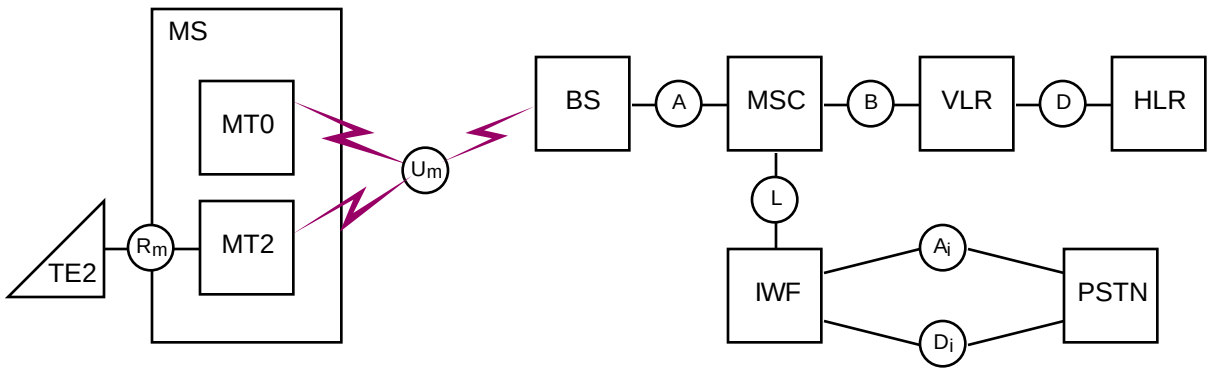
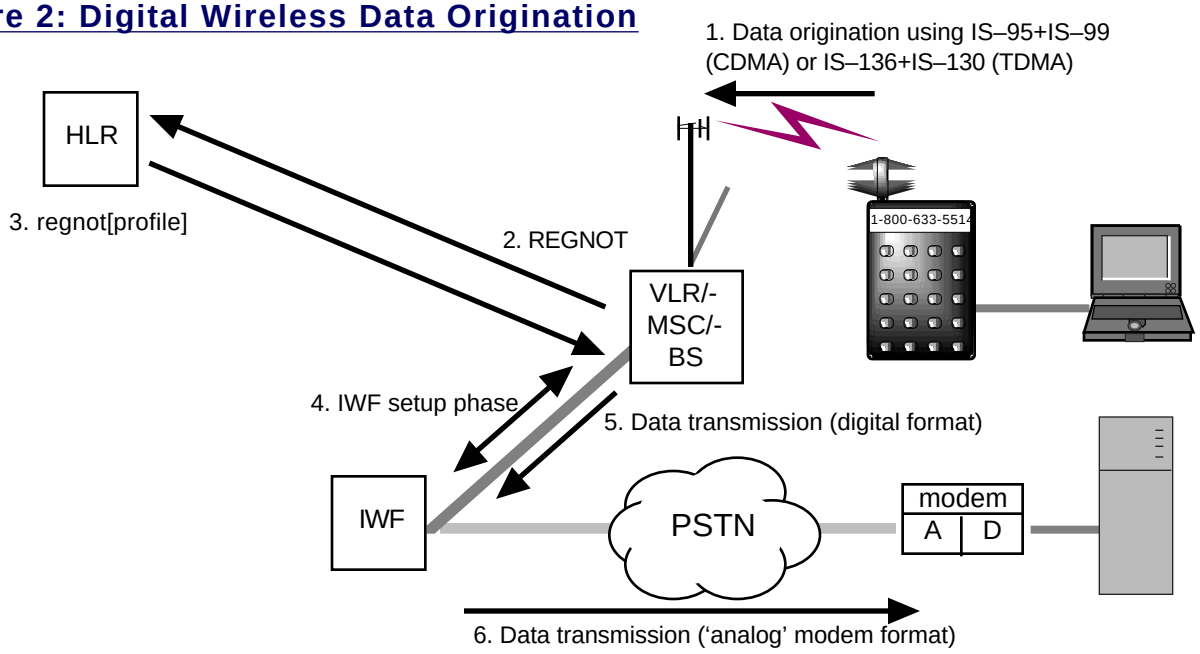


Figure 2: Digital Wireless Data Origination



ical concepts, between which standard interfaces are supported. The data terminations (MT0 and MT2) will, for example, usually not be implemented physically, but as software within a wireless phone. The IWF, on the other hand, may will more likely be realized as separate hardware and software (i.e. a specialized modem pool) at the MSC site.

Mobile Data Originations

Mobile originated data calls are relatively simple, because it is known from the very beginning of the call that the traffic is data and not voice. The HLR has to support an enhanced profile to prescribe the data services that the mobile is subscribed to, but no new TIA/EIA–41 transactions are required. Figure 2 illustrates this case.

Mobile Data Terminations

Terminating a data call is significantly more challenging (as was discussed in the October, 1998 issue) because it is difficult to tell that an arbitrary incoming call is data and not voice. There are three different points in call processing where the call can be recognized as data, depending on the number dialed to reach the mobile. Figure 3 illustrates the flavors of data call termination to a roaming mobile.

If a call is made to a common 'data port' (case A in Figure 3), the TIA/EIA–41 LocationRequest INVOKE (LOCREQ) message indicates the type of data service (which therefore requires either a data port number per service, or a dialog to establish the type of service), information which is forwarded in the RoutingRequest INVOKE (ROUTREQ). Calls to a separate mobile directory number (case B) have the data service determined by the HLR, and thus only affect the ROUTREQ message (requiring a separate directory number per service). Calls that start as voice and are later switched to data (case C) do not result in modifications to either the LOCREQ or ROUTREQ messages, but do require extensive modifications to the call path (e.g. removing voice coders and inserting an inter-working function).

Inter-MSC Handoff

Inter-system handoff for a data call has special challenges (described in the October, 1998 issue). The TIA/EIA-728 Inter-System Link Protocol (ISLP) provides for the transmission of data on the inter-MSC facility, allowing the inter-working function ("modem pool") to be retained at the Anchor MSC. The sequence of TIA/EIA–41 messages for handoff-forward, handoff-back and path minimization ("handoff-to-third") remains the same, although new parameters are required to describe the type of data service, the ISLP circuit and the data encryption key.

Figure 4 illustrates an inter-MSC handoff-forward, including a change in service from voice to data after the handoff (see below).

Mid-Call Service Changes

A new data service can be invoked during a call. A likely reason for this is to switch from voice to data during a call (see Figure 4). Alternatively, calls can be switched from data to fax, or from one data speed to another. CDMA even allows service negotiation, where a suite of services can be presented, with the Serving System picking the best service that it is willing and able to support for the mobile. TDMA proponents apparently feel that this is overkill.

For a mobile that has not handed off to a new MSC, service changes involve only radio interface transactions and BS/MSC internal call processing actions. However, following inter-MSC handoff two new TIA/EIA41 transactions are required to support this capability:

ChangeService

When the new service can be supported on the same inter-MSC facility as the old.

ChangeFacilities

When the new service requires a new inter-MSC facility.

Figure 4 illustrates a service change from voice to data following an inter-MSC handoff.

To be concluded…

This article will conclude in the December, 1998 issue with a summary of the TIA/EIA/IS-737 transactions and parameters required to support data calls for digital wireless phones and a list of radio interface and network standards that are required to support various aspects of digital cellular and PCS circuit switched data communications.

Figure 3: Digital Wireless Data Termination

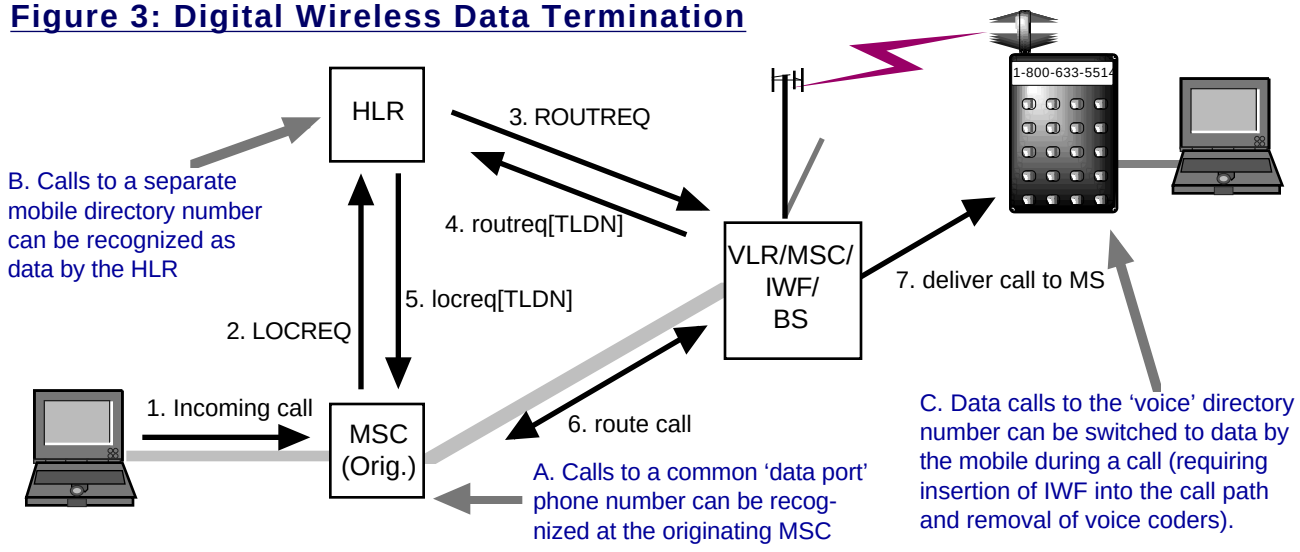
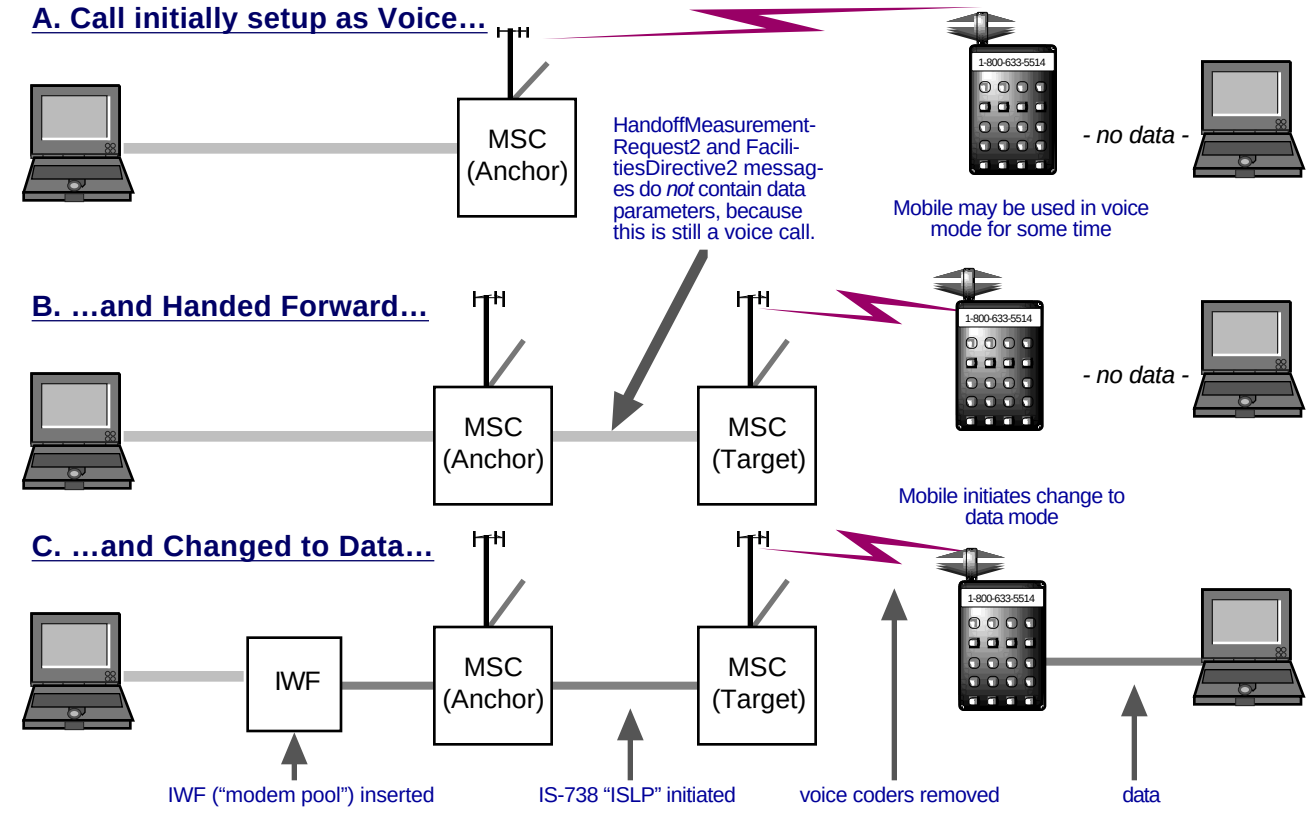


Figure 4: Inter-MSC Data Handoff and Service Change (Voice to Data)



Status of IS-41 Rev. C and TIA/EIA-41-D Implementations

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Vendor and Radio Technology

Intersystem Operations	Alcatel			Ericsson		GTE	Lucent			Motorola		Nortel		
	Analog	CDMA	TDMA	Analog	TDMA	*all*	Analog	CDMA	TDMA	Analog	CDMA	Analog	CDMA	TDMA
Authentication	4	4	4	4	4	4	4	4	4	4	4	4	4	4
CNAP/CNAR		4Q'98	4Q'98		🕐	4		🕐	🕐			🕐	🕐	🕐
CNIP/CNIR		4	4	4	4	4	4	4	4	4	4	4	4	4
Data (IS-737)					4								🕐	🕐
Inter-MSC handoff: Analog to…	4		4	4	4		4		4	4		4		4
Inter-MSC handoff: CDMA to…	4	4					4	4		4	4	4	2Q'99	
Inter-MSC handoff: TDMA to…	4		4	4	4		4		4	4		4		4
IMSI (IS-751)					🕐			🕐	🕐				🕐	🕐
Hyperband handoff (TSB-76)			4		4			4	4		4		4	4
LNP Phase I	4Q'98	4Q'98	4Q'98	4	4	🕐	🕐	🕐	🕐	🕐	🕐	4	4	4
MWN		4	4	🕐	🕐	4		4	4	🕐	🕐	4	4	4
Origination Triggers	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SMS Origination		4Q'98	4Q'98		4	4		🕐	🧪				🕐	🕐
SMS Termination		4	4		4	4		4	4	4	4	4	4	4
Termination Triggers				🕐	🕐	4	4	4	4	4	4	🕐	🕐	🕐
Voice Privacy			4		4	🧪		4	4				🕐	🕐

Glossary

Analog	EIA/TIA-553 or IS-91. Some more advanced features may only be supported for IS-91 phones.
CDMA	IS-95 Code Division Multiple Access digital cellular/PCS radio interface.
CNAP/CNAR	Calling Name Presentation/Restriction
CNIP/CNIR:	Calling Number Identification Presentation/Restriction
Data	Support for data transmissions from digital cellular/PCS terminals when roaming (IS-737).
IMSI	Support for E.212 International Mobile Station Identity (IS-751).
I/S Handoff	Inter-system (i.e. inter-MSC) handoff. CDMA inter-system handoff is always a 'hard' handoff, 'soft' handoff is not supported.
Hyperband Handoff	Inter-system handoff between cellular and PCS bands, or between different PCS bands using TSB–76. CDMA 'soft' handoff between bands is not supported.
LNP Phase I	Local Number Portability Phase I (routing to ported wireline directory numbers) using IS–756. Phase II (not yet standardized) will support ported mobile directory numbers.
MWN	Message (e.g. voice mail) Waiting Notification using audible or visual signals.
SMS	Short Message Service.
TDMA	IS-136 Time Division Multiple Access digital cellular/PCS radio interface.

Symbols:

4	In field trial or commercial service.
XQ'9X	Specifies the quarter during which commercial availability is expected (e.g. 4Q'98).
🧪	In lab trial.
🕐	Under Development
	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.

Updates: Please contact the editor by email at crowed@cnp-wireless.com, by phone at +1–403–289–6609 or by fax at +1–403–289–6658.

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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/IS-98	Base Station/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
J-STD-019	SP-3383	Base station minimum performance standards	In press
J-STD-008	SP-3384	IS-95 adapted for 1800 MHz frequency band	In press
J-STD-018	SP-3385	Mobile minimum performance standards (for J-STD-008)	In press
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
IS-127-1	**PN-4146**	**Addendum to IS-127 (EVRC)**	**08/98**
IS-657		Packet data services (Internet, CDPD)	07/96
IS-658		Data inter-working function interface (e.g. modem pool)	07/96
IS-683	PN-3569	Over the air activation and service provisioning	02/97
IS-683-A	**PN-3889**	**OTA update: Roaming system selection and programming lock**	**06/98**
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 data)	02/98
IS-707-A	**PN-4145**	**Revision to IS-707 to be consistent with TIA/EIA-95 capabilities**	**V&V**
IS-718	**PN-3648**	**Minimum performance standards for EVRC voice coder**	**08/98**
IS-733	PN-3972	High rate CDMA voice coder (max. 13 kbps)	03/98
IS-736	**PN-3973**	**Minimum performance specification for IS-733**	**In press**
TIA/EIA-95-B	**SP-3693**	**IS-95 for 800 MHz and 1800 MHz frequencies (including J-STD-008)**	**2nd ballot**
TIA/EIA-96-C	**SP-4138**	**CDMA variable rate voice coder (max. 8 kbps)**	**08/98**
TIA/EIA-97-B	**SP-3814**	**Minimum performance standards for base stations**	**08/98**
TIA/EIA-98-B	**SP-3815**	**Minimum performance standards for mobile stations**	**08/98**
TIA/EIA-98-C	SP-xxxx	Merges TIA/EIA-98-B and J-STD-018	Development
TIA/EIA-126-B	**SP-4136**	**ANSI version of IS-126 (MS loopback option)**	**08/98**
TIA/EIA-637-A	**SP-xxxx**	**ANSI version of IS-637 (short message service, including TSB-79)**	**Development**
TSB-58-A	PN-4158	Parameter value assignments	V&V (on hold)
TSB-74		14.4 kbps radio link protocol and inter-band operations	12/95

Thanks to Sam Broyles (Qualcomm) and Phil Brown (CISR) for providing information for this table