Cellular Networking Perspectives

David Crowe [Editor] • Phone 1-403-289-6609 • Fax 403-289-6658 Vol. 7, No. 10 October, 1998

In This Issue...

Next issue: November 2, 1998

CALEA Deadline Extended to June, 2000

The US FCC has extended the deadline for carriers to conform to the CALEA electronic surveillance ("wiretap") legislation to June 30, 2000. The FCC decision basically endorses the TIA/-ATIS J–STD–025 interim/trial use standard with the exception of the parts related to providing location and packet data monitoring. The FCC has not yet made a decision on the FBI 'punch-list' items, which could add or delete items to the basic basket in the industry standard. Although the use of J–STD–025 was endorsed, it is not mandatory, if carriers wish to interpret the legislation directly.

Further (non-technical) issues remain with CALEA, particularly compensation of carriers installing equipment in 1995 or later, and whether the FBI capacity requirements are excessive.

What Does 125 Meters RMS Mean Anyway?

The FCC Report and Order on Enhanced 9-1-1 services (CC Docket 94–102) requires that by October 1, 2001, for 9–1–1 calls, the "…the mobile station must be located in two dimensions (i.e., longitude and latitude) within a radius of no more than 125 meters. Accuracy to 125 meters would be measured using root mean square (RMS) techniques, which means that location devices would be required to be accurate to within 125 meters [~410 feet] in about 67 percent of all cases." This is confusing to people who are not sure what RMS means, and has been interpreted to simply mean that 67% of measurements should be within 125 meters of the actual location. A strict interpretation of root mean square implies the use of a geometric mean that provides an average that gives less weight to extreme measurements.

The simple interpretation ("Phase 2 Location…will be accurate to within 125m, in 67% of these cases.") has been endorsed by the WEIAD, a group involving wireless carriers, equipment vendors, the E911 community and the CTIA. WEIAD will forward this recommendation to the FCC.

Let us Link to You … And We'll Give You The Shirt Off Our Back

We want to link from our website (www.cnp-wireless.com) to the websites of all our subscribers, because you represent a cross-section of the wireless industry. If you are one of the first 20 to provide us with the information that we are requesting *plus* a quote that we can place with your link information, then we will send you one of our unique, environmentally friendly golf shirts (specify L or XL). The quote should explain "Why I read *Cellular Networking Perspectives* every month."

The information that we require can be provided via our website links page:

www.cnp–wireless.com/-pointers.html#comments

Cellular Networking Perspectives (issn 1195-3233) is published monthly by Cellular Networking Perspectives Ltd., 2636 Toronto Cresc. NW, Calgary AB, T2N 3W1, Canada.
Contact Information: Phone: 1-800-633-5514 (+1-403-274-4749) **Fax:** +1-403-289-6658 **Email:** cnpsales@cnp-wireless.com **Web:** http://www.cnp-wireless.com/.
Subscriptions: CDN$300 in Canada (incl. GST), US$300 in the USA and US$400 elsewhere. Payment by cheque, bank transfer, American Express, MasterCard or Visa.
Delivery: Email or 1st class mail. **Back Issues:** Available individually for $35 in the US and Canada and $40 elsewhere, or in bulk at reduced rates. **Discounts:** Educational and small business discount: 25% off any order. **Copies:** Each subscriber is licensed to make up to 10 copies of each issue or back issue. Please call for rates to allow more copies.

Update on AMPS Closure in Australia

The legislated closure of the AMPS system in Australia is looming closer. The Australian government announced in September that they would provide AUS$25 million to GSM carriers Optus and Vodafone to build more GSM cellsites along major regional highways to improve GSM coverage.

In July 1998, the government announced that "every area of Australia which now gets analogue mobile phone coverage will be upgraded to received CDMA coverage [by Telstra]" and that "no part of the analogue network will close down before the CDMA network is introduced."

Both of these initiatives rely on GSM or CDMA attaining coverage as good as AMPS provides today, otherwise the government will be forced to either remove coverage from AMPS subscribers when the system is closed, subsidize more cellsites or hope that the GSM carriers agree to give permission (as required by law) for AMPS-only cellsites to continue operation.

Digital Circuit Switched Data, Part I: Overview

Digital cellular and PCS phones are still largely used for voice communication, just like most analog phones. GSM systems are more advanced in the provision of data services, having several years head start tackling some fundamental problems communicating from a digital phone to the "analog" end of a modem. Ironically, although it would seem that digital wireless phones should have an advantage over analog phones for communicating data, they actually have some particular difficulties to overcome.

Recently, several standards to support circuit-switched data for digital wireless phones (both TDMA and CDMA) have been developed.

Background Information

About Modems

A modem is a device that converts digital signals received over a communications line from a computer or terminal by the "digital" end of a modem into special tones sent out the "analog" end (and vice-versa). The advantage of this arrangement is that, although the signals are still digital (in the sense that they carry information as discrete "bits") they can be carried through the PSTN as if they were voice (see Figure 1). This technique has limits, for example when the telephone network digitizes voice information on the backbone. The almost universal use of T1 facilities in North America containing 24 DS0 timeslots, each running at 56kbps, for example, puts a theoretical upper limit of 56 kbps on modem communications. Outside North America, digitization is usually accomplished using E1 facilities, which normally run each DS0 at the slightly higher rate of 64 kbps.

Many analog cellular phones can transmit and receive tones on behalf of a modem. Landline modems can be used, but far better results are obtained with special cellular modems (e.g. using the Paradyne (www.paradyne.com) ETC or Compaq Microcom (www.compaq.com/products/networking/) MNP10 protocols). Unless both users support the same cellular modem protocol, this arrangement requires a "modem pool" which is a configuration of pairs of back-to-back modems supplied by a wireless carrier, with the analog end of a landline modem facing toward the PSTN and the digital end of a cellular modem facing the mobile (see Figure 2). Modem pools are usually accessed by dialing a special code such as *DATA (*3282) for outgoing calls.

Circuit versus Packet Data

Data is generally transmitted through networks using either a circuit-switched approach or a packet-switched approach. This article mainly discusses circuit data standards, but a comparison with packet data is useful.

The circuit switched approach requires dedicated facilities to be allocated from one data party to the other before information transfer can begin (just like a voice call). Circuit data is closely associated with the use of modems because the purpose of a modem is to allow transmission of data over voice facilities (which are usually circuit switched). Packet switched data, in contrast, routes each packet of data independently over shared facilities, although some preliminary setup may be required to perform validation and authentication of terminals, for example. Packet switching is used over fixed facilities by the Internet backbone and over radio facilities by the CDPD wireless data system, for example. Combined circuit/packet networks are possible. The Internet provides a good example of this, with individual users communicating with an ISP over a circuit-switched connection, with ISP's using packet switching to communicate internally.

Figure 1: Landline Modem Connection

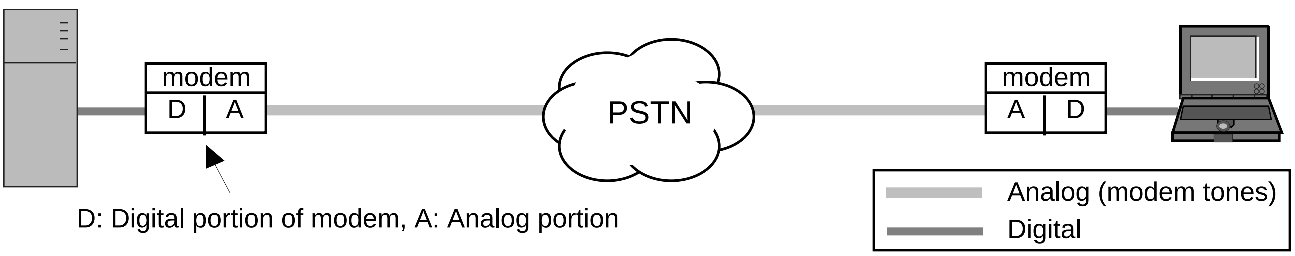
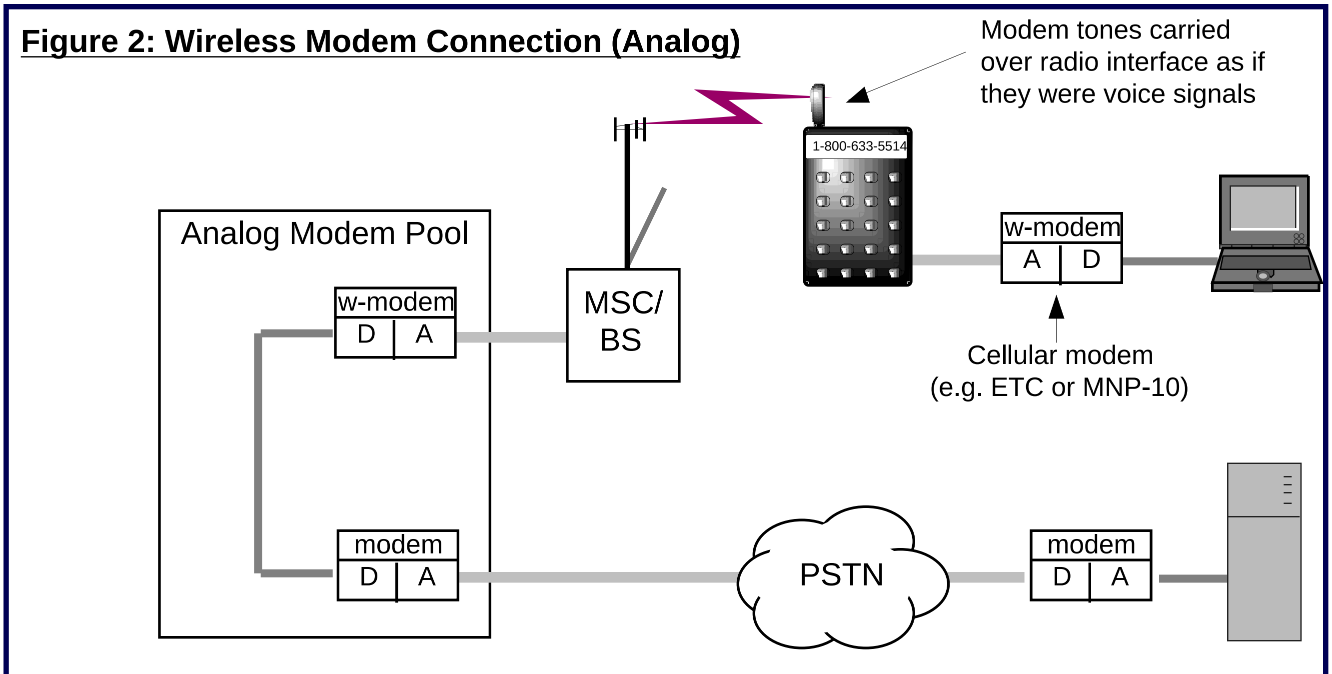


Figure 2: Wireless Modem Connection (Analog)



Commercial Packet Data Systems

Dedicated Data Networks

ARDIS (www.ardis.com) and RAM (www.ram.com) are examples of dedicated wireless data networks, with separate radio facilities. They operate at 19.2kbps and 8kbps, respectively (with the raw bandwidth shared between multiple users).

Analog Voice Channel (CDPD)

CDPD (www.cdpd.org), recently standardized as TIA/EIA/IS-732, uses 30 kHz analog cellular voice channels to transmit packets of data, sharing its raw speed of 19.2 kbps among multiple users. Multiple channels can be assigned (but only by reducing the number of channels available to voice users). Originally, CDPD was supposed to use voice channels when idle, but this proved too difficult to implement.

Analog Control Channel

Aeris (www.aeris.net) and Cellemetry (www.cellemetry.com) have systems that "sneak" small (4-16 byte) packets over the analog control channel. Aeris originates a call with a leading "*", which causes a TIA/EIA-41 FeatureRequest message to be transmitted to a pseudo-HLR, with the data in the dialed digits. Cellemetry terminals use the registration process, which initiates a TIA/EIA–41 RegistrationNotification message to the pseudo-HLR, with the data in the ESN field.

Both systems are, in effect, using a small portion of the 1kbps analog control channel for data, and are therefore applicable only to low volume data applications.

Short Message Service

Short Message Service (SMS) is provided by both IS–136 TDMA and IS–95 CDMA (and, to a limited extent, by some analog phones). Both digital technologies allow the SMS packets to transmit data other than text or numeric messages, so they can be used for medium volume data transmissions. SMS can be considered to be a method of using a portion of the bandwidth of the (approximately) 10 kbps digital control channels to transmit data.

Paging

Paging is also an example of a wireless packet data system, although even two way paging systems are oriented to most traffic being sent *to* a wireless terminal, with the return direction being limited mostly to acknowledgements.

Digital Data Difficulties

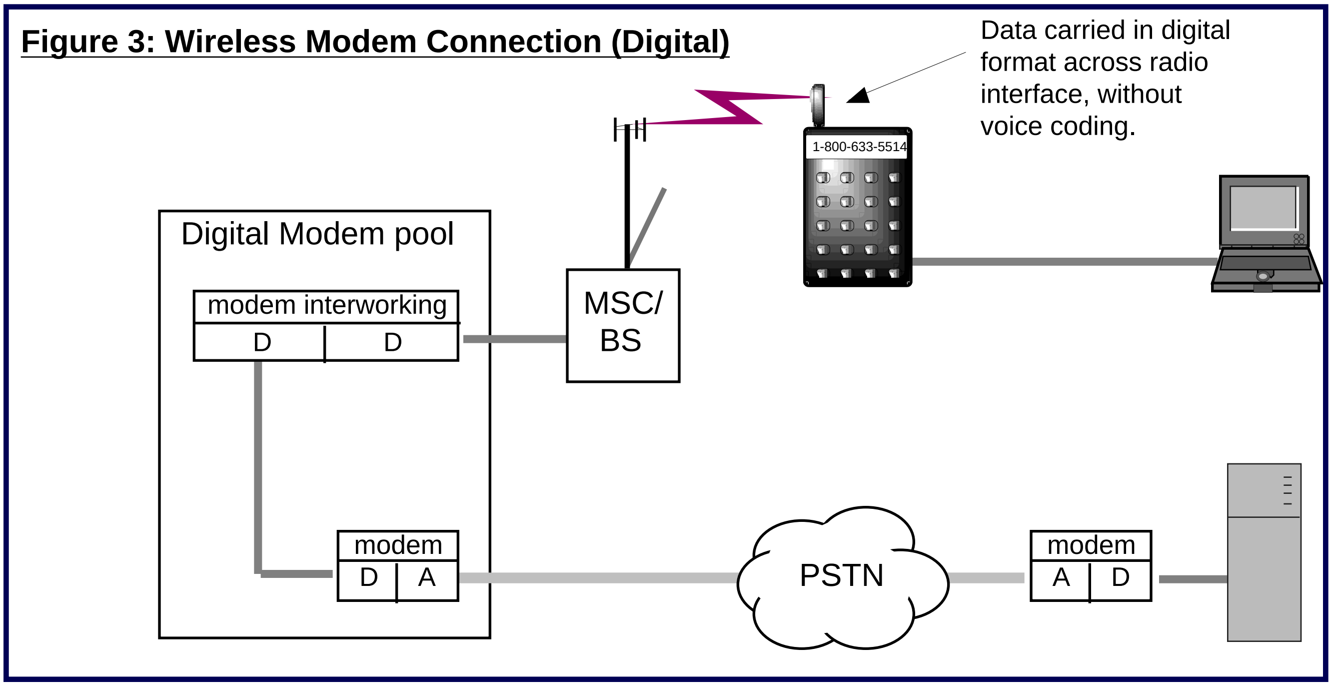
Transmission of data from digital wireless phones raises a number of difficulties that are generally not found with data transmission from analog phones.

The Voice Coder Problem

Digital cellular phones cannot directly utilize modems because of the nature of digital voice coders. These devices are optimized to digitize and compress human utterances to a low bit rate (8-13 kbps, compared to the 1,200 kbps used for CD-quality audio) for transmission over a 'narrow' channel (9.6-14.4 kbps). They provide reasonable voice quality within these constraints by modeling the human vocal tract. Consequently, modem tones are distorted. Even the extremely low bit rate (45.45 baud) modems used in TTY communication by the deaf and hard of hearing cannot be transmitted by most digital cellular phones (both TDMA and CDMA).

The solution is to eliminate the voice coders from the radio interface. However, this requires coordination between the mobile and base station, and is a particular problem for mobile terminated data calls (see below). Furthermore, it leaves the base station with information in a digital format that is not direct-

Figure 3: Wireless Modem Connection (Digital)



ly compatible with landline modems. Either digital processing is required to convert the data to the serial format accepted by most modems, or specialized modems with a non-standard digital portion are required. Because of this restriction, modem pools are mandatory for communication between a digital wireless phone and a landline modem (see Figure 3).

An alternative solution is to bypass the use of modems entirely through a direct digital connection to a data network. This is particularly applicable to internet connections (see Figure 4).

The Termination Problem

Land to mobile terminations are a problem because the PSTN does not transmit an indication that a data call is being made. Without any special handling, a digital wireless phone would answer and start to receive garbled modem tones. At this point, it would be difficult for the mobile to react, because not only does the mobile need to switch out the voice coder, but it would have to signal the base station to do the same. Furthermore, the wireless system needs to switch the appropriate modem pool into the call path.

There are several solutions to the data termination problem:

Separate Directory Number

A mobile may have one directory number for voice communication and another for data.

Pro:

Transparent to caller.

Con:

Uses more directory numbers.

Shared Directory Number

A carrier may provide a single “data port” number for mobile data terminations, requiring overdial of the MDN or MIN after termination to the port. This is similar to the “roamer port” concept but the opposite of the *DATA concept, which applies to originations.

Pro:

Efficient use of directory numbers.

Con:

Complex for callers.

Page Response in Data Mode

A mobile may respond to a page or alert in data mode, requiring a switch to data communication at that time.

Pro:

Transparent to HLR.

Con:

Requires the mobile user to know that they are going to receive a data call. Probably requires a voice call to coordinate. Complex call processing required.

Voice to Data (Service Negotiation)

A mobile may answer a call in voice mode, and transfer to data mode later. This is known as *Service Negotiation* and is particularly well developed in CDMA standards.

Pro:

Can be transparent to the caller. Allows mid-call bit rate changes.

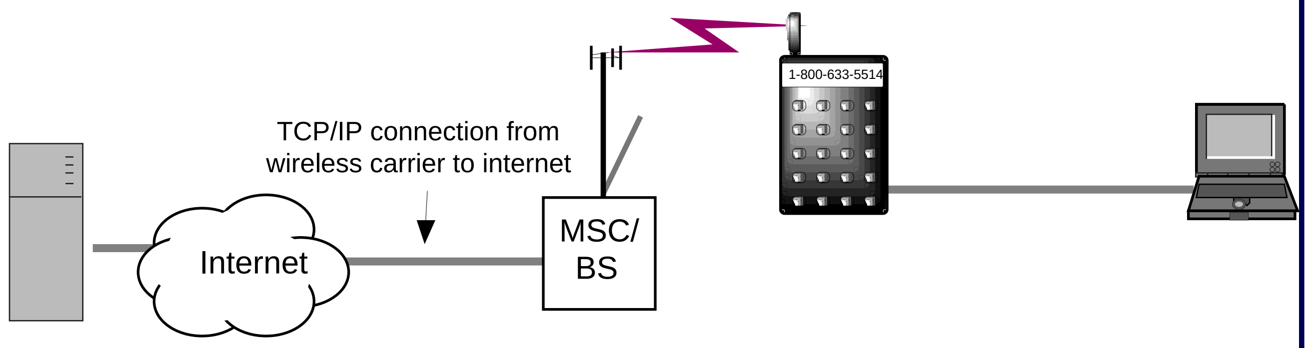
Con:

Complex call processing required.

The Handoff Problem

Intersystem handoff causes another problem with data calls. The modem pool has to remain in the Anchor MSC when the data mobile moves to the Serving MSC, relying on an inter-MSC trunk to maintain connectivity. This causes a bit rate adaptation problem, because the data terminal is probably transmitting at a speed slower than the 56 or 64 kbps provided by the inter-MSC facility. A special standard, TIA/EIA/IS-728, provides rate adaptation by transmitting a special bit sequence (known as a flag) during times when there is no data to be transmitted

Figure 4: Digital Wireless Data With Direct Digital Connection



to or from the mobile (see Figure 5). This inter-MSC protocol is known as ISLP (Inter-System Link Protocol).

The Bit Rate Conundrum

One non-technical hurdle facing wireless data over systems designed for voice is the increasing disparity between desired data bit rates and voice coder bit rates. When digital cellular first emerged in the early 1990's, landline modems were running at similar bit rates to voice coders (e.g. 9.6kbps and 14.4kbps). Since then, landline data rates have risen to 28.8kbps and, more recently, to 56kbps. The expected leap to xDSL standards will bring landline data rates into the multi-Mbps range. It is certainly possible to increase wireless data rates to higher values, but only at a significant cost in capacity. Assuming that future voice coders will run in the 8kbps range, one 64kbps data user would be using about 8 times the radio resources of a voice user. Data transmissions at the proposed 3rd generation rate of 384 kbps would use the capacity of 48 voice users. The challenge for the carriers is more one of business than technology. Can carriers charge several times the going voice rate for data users? Or, can data users be persuaded to transmit data largely at off-peak times? Without answers to these questions, it is unlikely that carriers will invest in wireless data capabilities that run at speeds significantly higher than voice coders.

Bit Rate Flexibility

Technologies vary in their ability to support a variety of data rates. IS-136 TDMA is the least flexible, since all data must fit into one or more timeslots. One pair of timeslots (as assigned to a voice user) can support a rate of about 9.6 kbps, and double and triple allocations of timeslots can be provided, to a maximum of about 28.8 kbps. Beyond that, multiple frequencies would be required, which is probably only applicable for specialized applications.

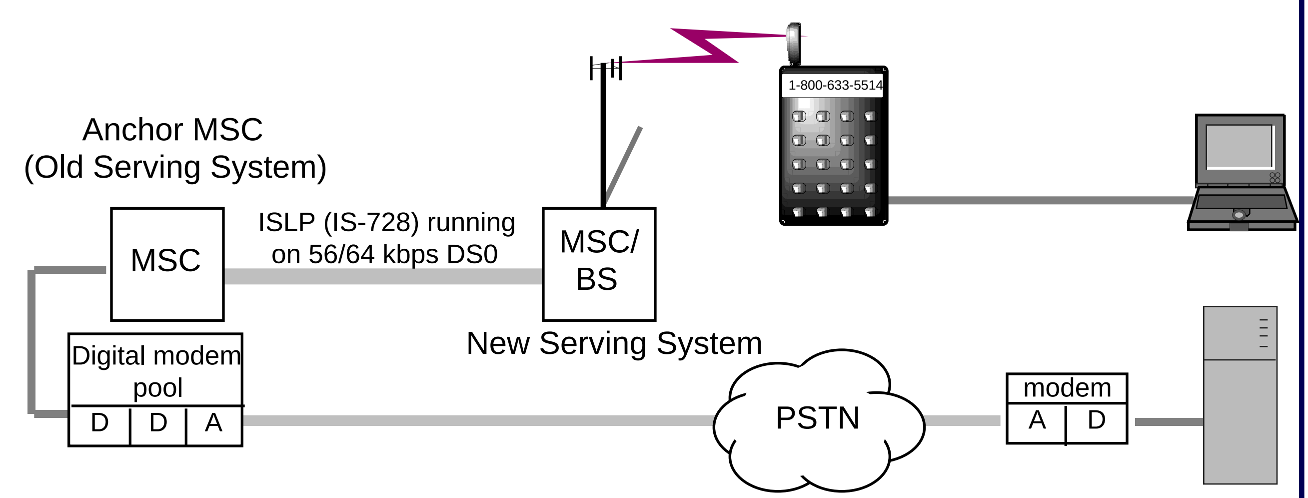
IS-95 CDMA is more flexible. Currently data rates of 9.6 kbps and 14.4 kbps can be supported, with 64 kbps being planned.

Analog, by comparison, can support rates up to 19.2 kbps (Compaq Microcom MNP 10EC protocol) or 21.6 kbps (Paradyne ETC2 protocol).

To be continued…

The November 1998 issue of *Cellular Networking Perspectives* will continue with a discussion of the inter-system messaging required to make data communications operate seamlessly, and with a list of standards related to wireless circuit-data communications.

Figure 5: Digital Wireless Data after Inter-MSC Handoff



TIA TR-45.4 Subcommittee
Radio to Switching Technology
Standards Status Report

Cellular Networking Perspectives

Editor David Crowe • Phone 403-289-6609 • Fax 403-289-6658 *Last published April, 1998*

Published Documents

Standard	Description	Published
IS-634-0	MSC-BS "A" Interface Standard	12/95
IS-634-A	**MSC-BS "A" Interface standard, supporting analog, CDMA, SMS, data services, frame relay transport, and 1800MHz PCS**	**published**
IS-94	Mobile Station - Land Station Compatibility Specification for Analog Cellular Auxiliary PCS (CAPCS)	05/94
TSB-80	**IS-634-0 Addendum (corrections, SMS, subrate voice frame format)**	**11/96**
TSB-104	PCS Service Description (now IS-104 in committee TR-46)	06/94

Completed Internal Documents

PN	Description	WG	Editor
3142	Cellular Microcell/Microsystems Requirements Document	III	Steve Jones
3296	MSC-BS Interface (A-Interface) Requirements for Public 800 MHz	II	Mike Burke

Active TR-45.4 Projects (PN=TIA Project Number)

PN	Description	Editor	IS/TSB
PN-3746 [on hold]	**ISDN based A-Interface, adding: • address alignment with Mobility Management • CDMA and TDMA support, and • support for architectures with separate mobility management and call control functions**		**IS-653-A**
PN-3964 [ballot failed]	**Use of A-Interface standards in Wireless Local Loop (WLL)**	**Joe Kwak, Lucent**	**TSB-xxx**
SP-4277	**ANSI version of MSC-BS "A" interface**	**Mike Dolan, Lucent**	**TIA/EIA-634-B**
PN-xxxx	**Addendum to TIA/EIA-634-B for 3rd generation systems**		**TIA/EIA-634-B.x**
PN-xxxx	**Addendum to TIA/EIA-634-B to support TIA/EIA-95 (CDMA)**		**TIA/EIA-634-B.x**
PN-xxxx	**Addendum to TIA/EIA-634-B to support TIA/EIA-136 (TDMA)**		**TIA/EIA-634-B.x**
SP-xxxx	**Next revision of TIA/EIA-634 "A" Interface (including addendums)**		**TIA/EIA-634-C**
PN-xxxx	**Air interface(s) for fixed wireless access - Stage I Description only**		

Note:
1. IS- Interim Standard, J-STD- Joint T1/TIA Standard, PN- Project Number, SP- ANSI Standards Proposal , TSB– Telecommunications Systems Bulletins.
2. **Bold Type** indicates modification since previous publication.
3. Published TIA standards can be obtained from Global Engineering Documents at 1-800-854-7179.

Thanks to Steve Jones (NEC) and Eileen McGrath-Hadwen (Consultant) for their assistance compiling the information in this table.