

# Cellular Networking Perspectives

David Crowe [Editor] • Phone: 1-800-633-5514 • Fax: 403-289-6658

Vol. 6, No. 2, February 1997

## *In This Issue...*

### **Welcome, CSR-R Subscribers** *p. 1*

Cellular Networking Perspectives welcomes subscribers from CSR-R, which ceased publication in January, 1997.

### **MSC Anti-Fraud Measures** *p. 1*

The MSC has an important role to play in detecting fraud, especially for mobiles that do not support authentication.

### **PCS Multiband Handoff with TIA TSB-76, Part II** *p. 2*

Handoff between cellular and PCS bands is possible, although with significant limitations.

### **Local Number Portability** *4*

The FCC has mandated local number portability for cellular and PCS carriers by 1998/1999. Now the CTIA has formally asked the TIA for standardization.

### **TR-45.2 Standards Update** *p. 4*

The latest information on wireless network standardization. What's for ballot, what's not?

### **TIA TR-45.2 Cellular/PCS Network Standards Report** *p. 6*

A summary of all wireless network standards that have been published, or are under development. Ideal for pinning on your wall.

**Look forward to your next issue on:  
March 3, 1997**

## **Welcome, CSR-R Subscribers**

**C**ellular Networking Perspectives welcomes CSR-R subscribers!

CSR-R (Communications Standards Report - Radiocommunications) ceased publication on January 1, 1997.

Following an agreement between CSR and Cellular Networking Perspectives, all CSR-R subscribers are able to complete their subscription with copies of *Cellular Networking Perspectives*.

CSR-R subscribers will find that *Cellular Networking Perspectives* covers many of the same topics as CSR-R did, although often from a different angle. While CSR-R took a 'horizontal' view, covering a wide range of standards activities every month, Cellular Networking Perspectives takes more of a 'vertical' view, looking in detail at the purpose, functionality and status of a single standard each month, in parallel with more wide-ranging articles.

Cellular Networking Perspectives is available to all of our subscribers at no extra charge by email. We send Adobe Acrobat files to ensure that all formatting, diagrams and tables are transmitted as they are on the printed page. Please contact us at 102371.3324@compuserve.com to switch your subscription from mail to email. Detailed instructions on accessing the email version of this bulletin can be found in the January 1997 issue, or can be obtained from us upon request.

Communications Standards Review will

continue to publish Communications Standards Review-Telecommunications (CSR-T), a technical journal reporting on TIA, ETSI and ITU telecommunications standards meetings, and Communications Standards Summary (CSS), reporting on the status of all TIA standards committee projects. For more information on Communications Standards Review, phone +1 415 856-9018 or find them on the web at <http://www.csrstds.com>.

## **MSC Anti-Fraud Measures**

**O**bservant reader Ernesto Ramos of Movilnet, Venezuela, has pointed out that in our discussions of fraud (Oct., Nov., Dec., 1995 and Jan. 1996 issues) we neglected to point out the role of the MSC in detecting fraud. Using Ericsson equipment as an example, he noted that many fraudulent events can be detected by an MSC through additional software to monitor call processing - such as two simultaneous calls involving mobiles using the same MIN. Any access occurring when a mobile is in a call (origination, page response or registration) can be a symptom of fraud. Even roaming fraud can be detected if a registration cancellation (e.g., using the IS-41 Registration-Cancellation message) occurs while a mobile is in a call. Registrations can also be used, by themselves to detect fraud. If an MSC is configured to trigger a registration every hour, a mobile that registers regularly twice in each hour is a probable indication of fraud. Note that the occasional extra registration is legiti-

mate (if a mobile visits another system and then returns, for example) and, for some mobiles, extra registrations occur due to idiosyncrasies of the internal software. MSC manufacturers other than Ericsson implement similar checks.

It is easier for an MSC to detect an unusual event than to decide which of the two mobiles it has detected is legitimate. Carriers can decide to make an automatic guess at which call is fraudulent, and do an automatic teardown. In this case, they will have to deal with upset customers on occasion. Alternatively they can use this MSC fraud detection software just to monitor fraud, and contact the legitimate subscriber for a new MIN, ESN or PIN when they verify that the unusual events detected by the MSC are truly fraudulent.

Authentication will reduce the need for MSC based fraud management techniques, but as it only applies to newer mobiles, the need for heuristic techniques will continue to exist for several years. o

## PCS Multiband Handoff with TIA TSB-76, Part II

The TIA PCS Multiband Handoff standard (TSB-76) provides the capability to perform inter-system handoff between and within PCS and Cellular bands and in a limited number of cross-technology situations (e.g. 1800 MHz analog to 800 Mhz TDMA digital). An important component of the handoff decision process is the channel that is used to determine signal strength in each situation. This is shown in Table 1:

## Forced Handoff

It is possible to simplify the difficulty of determining which cell to handoff to by performing a forced handoff. The effectiveness of this technique depends on the quality of information available to substitute for signal strength:

1. Location technology may be available that can fix the position of the mobile with enough accuracy to know which of several candidate adjacent cells is most likely to be able to receive the mobile. This is inherent in CDMA systems, and may soon be added on to other technologies to provide compliance with FCC requirements for enhanced wireless 9-1-1 emergency calling. Note that location technology being proposed for Enhanced Wireless 9-1-1 has an acceptable

**Table 1: Handoff Measurements**

		Serving Cell Protocol					
		800 MHz AMPS/NAMPS	1800 MHz AMPS/NAMPS	800 MHz TDMA	1800 MHz TDMA	800 MHz CDMA	1800 MHz CDMA
Candidate Cell Protocol	800 MHz AMPS/NAMPS	/	n/a <sup>3</sup>	ACCH	ACCH	PILOT <sup>1</sup>	PILOT <sup>1</sup>
	1800 MHz AMPS/NAMPS	n/a <sup>3</sup>	/	n/a <sup>3</sup>	n/a <sup>3</sup>	n/a <sup>3</sup>	n/a <sup>3</sup>
	800 MHz TDMA	AVCH	AVCH	/	ACCH <sup>2</sup>	n/a	n/a
	1800 MHz TDMA	n/a <sup>3</sup>	DCCH	ACCH <sup>2</sup>	/	n/a	n/a
	800 MHz CDMA	n/a	n/a	n/a	n/a	/	PILOT
	1800 MHz CDMA	n/a	n/a	n/a	n/a	PILOT	/

ACCH - Candidate analog control channel (measured by mobile)

DCCH - Candidate digital control channel (measured by mobile)

AVCH - Serving analog voice channel (measured by base station)

PILOT -Candidate Pilot channel (measured by mobile)

### Notes

1. A standalone pilot beacon is beneficial if the candidate cell is in a system that does not support CDMA. Otherwise, a forced handoff may be used.
2. Other signal measuring arrangements would have to be made for all-digital systems (e.g. DCCH).
3. Theoretically possible, but requires further definition in TSB-76 and analog air interface standards.

accuracy of at least 125 meters, 67% of the time, and will be most useful in less dense environments with reasonably large cells.

2. The inter-band candidate cell may be in the same serving area, and have coverage that includes the entire serving cell (as might be the case for an 1800 MHz overlay that re-uses 800 MHz cellsites).
3. There is only one cell in the other band adjacent to the current cell, and no cell in the current band can provide satisfactory coverage.
4. The mobile can no longer be served by the current cell and the candidate cell in another band that covers the largest fraction of the immediately adjacent area is chosen. The failure rate in this case will be high.

In an area that has complex radio coverage (e.g. including microcells or multiple neighbouring systems in different bands), forced handoff may not be useful.

### Analog in the PCS Band

TSB-76 does not fully support the use of analog (AMPS or NAMPS) in the 1800 MHz PCS band, nor are radio interface standards yet available to support this capability. TSB-76 would not prevent the operation of mobiles in an analog mode in the PCS band, but handoff to different technologies and different bands (whether within PCS or in a cellular band) would not be possible using its extensions to the IS-41 protocol (except by using proprietary extensions to the protocol, or by agreeing to use digital parameters to carry frequency band information).

Standards are not yet available to support analog phone operation in the 1800 MHz PCS band, although IS-91 is currently being enhanced (Revision B) to support this capability. See the "TIA TR-45.1 Analog Air Interface Standards Report" in the January 1997 issue for more details.

### Compatibility with Other Technologies

TSB-76 does not support handoff between TIA AMPS-compatible standards and other technologies, such as GSM and PACS. It should be noted that PACS authentication is supported in TSB-76, but not handoff.

### CDMA to TDMA Handoff

There is no current technical capability (or business motivation) to provide CDMA/TDMA handoff in TSB-76 or any other TIA standard.

### Intersystem Paging

TSB-76 provides some modifications to allow CDMA inter-band intersystem paging to occur. The inter-system paging technique is used to resolve some "Border Cell" problems that prevent the location of a mobile from always being known (see May, June and July 1996 issues of *Cellular Networking Perspectives* for a more detailed description). Both methods of intersystem paging are supported (TLDN call delivery direct to the border MSC or call delivery to the page initiator MSC followed by a pseudo-handoff to the border system). Modifications to support analog and TDMA mobiles are not necessary, because air interface-related parameters are not required for these technologies to

perform inter-system paging.

### System Selection

Another aspect to the problem of controlling the system that a mobile uses outside their home serving area is the ability to control which system a mobile registers in when there is a choice (of up to 8, if both cellular licenses and all 6 PCS licenses are in operation). We will cover this topic, including the Network Directed System Selection (NDSS) concept, in a future issue.

### IS-41 Messaging

The bottom line of TSB-76 is the impact on IS-41 intersystem messaging, summarized in Table 2.

### Summary

Inter-band handoff is most important for new PCS carriers that have roaming arrangements with cellular carriers, and for cellular carriers that are using PCS to extend their coverage into other territory. This technology has significant known limitations (and possibly some that are not yet known) and may be very expensive. The decision to implement will depend on the individual cost-benefit ratio for each carrier. Even if inter-band handoff is implemented, it is not enough. An important complement to this technology is to control mobiles so that they lock onto the system that is most beneficial to the home carrier (i.e. NDSS).

### Acknowledgements

Our thanks to Gustavo Pavón of Ericsson, Chuck Ishman of Motorola, Dave Wenk and Charles Barnett of Hughes and Sam Broyles of Qualcomm for their assistance with this article. o

**Table 2: TSB-76 Modifications to IS-41 Intersystem Messages**

IS-41 Message	Purpose	TSB-76 modifications
AuthenticationRequest	Roamer authentication	Support for PACS
FacilitiesDirective2	Handoff forward	CDMA/TDMA multiband handoff
HandoffBack2	Handoff back	CDMA/TDMA multiband handoff
HandoffMeasurementRequest2	Signal strength measurement	CDMA/TDMA multiband handoff
HandoffToThird2	Handoff path minimization	CDMA/TDMA multiband handoff
InterSystemPage	Border system paging	CDMA multiband intersystem page
InterSystemPage2	Border system paging	CDMA multiband intersystem page

## Local Number Portability

---

The threat of local number portability has been hanging over the head of major US cellular carriers since June 1996, when the FCC adopted rules (CC Docket 95-116) to require it for all local exchange carriers as well as cellular, PCS and other wireless carriers (i.e. CMRS in FCC lingo). This capability will provide some ability for consumers to change phone service providers while retaining their phone number and features, at the cost of considerable complexity and expense to the carriers. The CTIA has developed a Standards Requirements Document (SRD) after a "Request For Information" process in August 1996 and a forum on number portability in October 1996. This summary of the CTIA's position on the subject, on behalf of wireless carriers, was presented to the TIA subcommittee TR-45.2 on January 22, 1997 to kick-off the development of wireless standards.

### FCC Requirements

There are many types of portability, but the FCC has mandated only local number portability, which allows a phone user to retain their phone number when changing service providers within a defined local area (MSA). This allows a customer to churn from the A cellular carrier to the B cellular carrier, to any of the PCS carriers or even to abandon their wireless phone and attach the same phone number to a landline phone subscription. Local number portability does not allow a customer to retain their phone number when moving to a different geographic area. However, given that a wireless phone has no physical 'home' location, unlike a wired phone, there may be situations when the right of a customer to port their number is not clear. Also, PCS carriers have boundaries (MTA and BTA) that do not correspond with an MSA.

The FCC has established a short timeline for the implementation of number portability, requiring "cellular, broadband PCS, and covered SMR providers to have the capability of delivering calls

from their networks to ported numbers anywhere in the USA by December 31, 1998, and to offer service provider portability, including the ability to support roaming, throughout their networks by June 30, 1999." These deadlines can be slipped by up to 9 months by the chief of the FCC Wireless Telecommunications Bureau

### CTIA Position

The CTIA has made several important points related to the implementation of local number portability for wireless carriers:

- When changing carriers, the MIN (or IMSI) of the phone will be changed, although the mobile directory number can remain the same. This is a very important position, as it breaks the assumed equality of the MIN and the directory number that has existed in cellular phones since the beginning of the industry. The importance of this position is that number portability will not apply to mobile accesses (e.g. registrations and originations) because the mobile identification will directly identify the HLR. Portability complications can be limited to determining the service provider of the party called from a mobile, and not of the calling mobile. This separation of identifiers is a position that we have long advocated (see the December 1994 issue for more details).
- The capabilities and constraints of wireless carriers are not the same as those of wireline carriers, due to fundamental technological differences. Consequently, changes to the wireline solution will be required to adapt it to wireless communications.
- SS7 protocols are preferred for implementation of number portability. This may spell the end of the use of MF tone-based signaling for cellular carriers (still the dominant form of interconnect) ... unless smaller cellular carriers revolt and demand an MF-based solution.

### TIA Actions

The TIA received a CTIA Standards Requirement Document on January 22, 1996, and has not had time to consider how standardization could assist wireless carriers in minimizing the impact of number portability. The TIA could take several approaches:

- Add number portability to the list of Wireless Intelligent Network capabilities.
- Define number portability as a new IS-41 capability.
- Align with the wireline and use the same IN technology.

We will report on the TIA direction, and the technical content of any number portability standards related to wireless, in future issues.

### TR-45.2 Standards Update

---

A flood of new standards are currently either under ballot review, awaiting ballot comments or near the ballot process. Finalizing these standards for publication will probably consume the first half of 1997 for the TIA TR-45.2 standards subcommittee.

### In Press

**PCS Multi-band (TSB-76, PN-3624)** • This TSB defines modifications to IS-41 messages and procedures to allow interoperability between Cellular and PCS systems, and between the different licensed frequency bands within Cellular and PCS systems.  
*Published September 1996.*

### Ballot

**Online Call Record Transfer (IS-124 Rev. A, PN-3293)** • This standard will include a variety of improvements and corrections over Revision 0, such as internationalization (i.e. support of IMSI) and some support for data calls. Due to the large number of ballot-induced changes, *a second ballot is in progress.*

**IS-41 Rev. C ANSI Ballot (TIA/EIA-41, SP-3588)** • The “IS-41 Rev. C” ANSI ballot review was completed at the September, 1996 TR-45.2 meeting. The document has been approved for publication. Note the name change from TIA/EIA-689 to TIA/EIA-41.

**International Applications (TSB-29 Rev. B, PN-3173)** • This revision adds lists of known non-NANP MIN usage, a list of applicable global titles and a recommendation to use ANSI TCAP even if ITU SCCP and MTP SS7 layers are used. The IFAST (International Forum on AMPS Standards Technology) has requested that publication be delayed until no sooner than the April, 1997 meeting. *Ballot comments are under review.*

## In Development

**Subscriber Features (IS-53 Rev. B, PN-3362)** • The future of this standard is under debate. It is likely that descriptions of features will be published in future in “vertical” documents that also contain scenarios that describe the inter-system messages required to make the features work in an inter-system environment.

**TDMA DCCH (PN-3579)** • Definition of network support for the IS-136 Rev. A features “User Group” and “Non-public mode service”. *Ballot comments due February 7, 1997.*

**Inter-System Link Protocol (ISLP) (PN-3660)** • A new inter-MSC rate adaption protocol is required to support the transmission of data from digital phones following an intersystem handoff. *Ballot comments have been reviewed and the publication version is being developed.*

**Over-The-Air Service Provisioning (PN-3769)** • OTASP will provide the ability to program, or re-program, a digital (TDMA or CDMA) mobile over the radio interface. *Ballot comments are due by February 14, 1997.*

**Data Services (PN-3770)** • Transmitting data from CDMA and TDMA digital phones is more complex because voice coders are incompatible with analog modem tones. *Ballot comments are due by March 17, 1997 (TIA ballot erroneously states February 17 1997).*

**Law Enforcement Intercept (PN-3580)** • Squeezed between the cost concerns of the industry, the constraints of the US CALEA law and the demands of law enforcement, a new standard for intercept is emerging. It will apply to both IS-41 and GSM based wireless networks. This standard is undergoing V&V and subsequently will be sent for ANSI ballot.

**WIN: Wireless Intelligent Network (PN-3661)** • The description of intelligent networking for IS-41 based mobility networks is complete at a high level. The description of IS-41 transaction and parameter modifications is under development. The schedule for *ballot is May-June, 1997.*

**Enhanced Wireless Emergency Services (PN-3581)** • A standard to use normal PSTN signaling (Feature Group D MF or SS7 ISUP signaling) to support the FCC-mandated Phase I for enhanced wireless 9-1-1 is nearing completion. It will apply to both IS-41 and GSM based wireless networks. Both cell/sector location and mobile identification will be transmitted to the emergency services system using standard PSTN interconnect signaling. This standard has been approved for ballot.

**CDMA Capabilities (PN-3619)** • The definition of advanced features based on IS-95 Rev. A capabilities, such as TMSI is expected to be approved for ballot in April 1997.

**TIA/EIA-41 Rev. A (was IS-41 Rev. D)** • Work on TIA/EIA-41 Rev. A (originally IS-41 Rev. D, and then TIA/EIA-589 Rev. A) will begin in earnest once the TIA/EIA-41 Rev. 0 document and subsequent TSBs are published. The exact format and contents of this document is under review.

It is possible, but not yet finally decided, that it will be restricted to the so-called Stage III protocol (transaction and parameter descriptions, along with pseudo-code procedures). Note that it is possible that this revision may be named Revision D to avoid confusion between IS-41 Rev. A and TIA/EIA-41 Rev. A, which will differ in complexity by at least 1,000 pages.

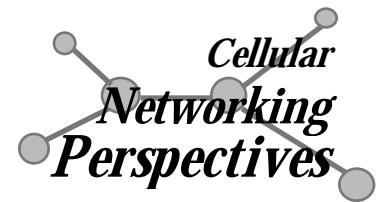
**Interconnection (IS-93 Rev. A, PN-3295)** • Modifications to this PSTN interconnection standard to support emergency services are being considered in the development of PN-3581 (see above). Modifications to support identification of international roamers to inter-exchange carriers is also possible.

**Call Detail/Billing Records (IS-124-B, PN-3725)** • A new project has been initiated to study modifications to IS-124 to fully support data services and intelligent peripherals. Work will begin once the re-ballot of IS-124 Rev. A is completed.

**Emergency Services, Phase II (PN- pending)** • The second phase of enhanced wireless emergency services will probably use a datalink to the ALI (Automatic Location Information Database) to provide enhanced location information to the emergency services system, required to an accuracy of 125 meters (67% of the time) by a recent FCC rule making.

**International Mobile Station Identity (IMSI; PN- pending)** • Support for the E.212 IMSI mobile identifier will resolve international roaming problems caused by the current 10 digit MIN identifier. Initially, these modifications were going to be published as part of TIA/EIA-41 Rev. A, but as this standard has been delayed by the onslaught of separate standards (see above), it has been decided to publish a TSB against TIA/EIA-41 Rev. 0 to support IMSI. o

# TIA TR-45.2 Cellular/PCS Network Standards Report



Editor David Crowe • Phone: 1-800-633-5514 • Fax: 403-289-6658

last published October, 1996

## Superseded Interim Standards and TSBs

IS/TSB	Description	Published
IS-41-B	Cellular Radiotelecommunications Inter-System Operations	12/91
IS-52-0	Cellular Subscriber Dialing Plan and Service Codes	11/89
IS-53-0	Cellular Features Description	09/91
TSB-41	Technical Notes for IS-41 Revision B	11/94
TSB-51	Inter-System Authentication, Signaling Message Encryption and Voice Privacy	05/93
TSB-55	IS-41 Rev. A/B Forward Compatibility	05/94
TSB-64	Wideband Spread Spectrum Intersystem Operations	02/94
TSB-65	Mobile Border System Problems	04/94

## ANSI Standards

ANSI #	SP #	TIA IS-	Subject	Status
<b>TIA/EIA-41</b>	<b>SP-3588</b>	<b>IS-41-C</b>	<b>Intersystem Operations</b>	<b>In Press</b>
TIA/EIA-660		IS-52-A	Dialing Plan	Published 09/96
TIA/EIA-664		IS-53-A	Features	Published 09/96
<b>TIA/EIA-689</b>		<b>IS-41-C</b>	<b>See TIA/EIA-41</b>	<b>cancelled</b>

## Completed EIA/TIA Interim Standards

IS	Description	Published
IS-41-C	Cellular Radio Telecommunications Intersystem Operations	02/96
IS-52-A	Uniform Dialing Procedures for use in Cellular Radiotelephone Systems	03/95
IS-53-A	Cellular Features Description	04/95
IS-93-0	Ai and Di Interfaces Standard (PSTN/MSC)	12/93
IS-124-0	Cellular Inter-System Non-Signaling Data Communications	11/93
<b>IS-124-A</b>	<b>Cellular Inter-System Non-Signaling Data Communications</b>	<b>re-ballot</b>
<b>IS-xxx</b>	<b>Inter-System Link Protocol</b>	<b>ballot</b>

## Completed Telecommunications Systems Bulletins (TSBs)

TSB	Description	Published
TSB-29-A	International Implementation of Cellular Systems Compliant with TIA-553	09/92
TSB-29-B	International Implementation of Wireless Systems	ballot
TSB-56-A	Application Level Testing for IS-41 Rev. B, IS-53 Rev. 0 and TSB-51	06/94
<b>TSB-76</b>	<b>PCS Multi-Band Support</b>	<b>09/96</b>
<b>TSB-xx</b>	<b>IS-41 Support for IS-136 DCCH (TDMA digital control channel)</b>	<b>ballot</b>
<b>TSB-xx</b>	<b>IS-41 support for Over-the-air Service Provisioning (OTASP)</b>	<b>ballot</b>
<b>TSB-xx</b>	<b>IS-41 support for data services for digital terminals (TDMA and CDMA)</b>	<b>ballot</b>

## Active TR-45.2 Projects (PN = TIA Project Number)

PN	Title	Editor	WG	IS/TSB
3295	Ai and Di Interfaces Standard	David Crowe	VII	IS-93-A
3362	Cellular Features Description (Rev. B)	Terry Watts	I	IS-53-B
<b>3528</b>	<b>Multiple HLR Query ("Double Dipping")</b>	<b>n/a</b>	<b>VI</b>	<b>cancelled</b>
3580	Law Enforcement Intercept Requirements	Kirk Carlson	0	<b>IS-xxx</b>
3581	Enhanced Wireless 9-1-1 Emergency Services (Phase I)	Terri Brooks	0	<b>TSB-xxx</b>
3590	Intersystem Operations	Terry Watts	II,III	<b>TIA/EIA-41 Rev. 1</b>
3619	IS-41 Support for IS-95-A (advanced CDMA)	Sam Broyles	II	<b>TSB-xxx</b>
3661	Wireless Intelligent Network	Terry Jacobson	II	<b>TIA/EIA-41 Rev. 1</b>
3725	Call detail/billing record transfer for data/enhanced services	Peter Larsen	IV	<b>IS-124-B</b>
<b>n/a</b>	<b>International Mobile Station Identity (E.212 IMSI)</b>	<b>David Crowe</b>	<b>VI</b>	<b>TSB-xxx</b>
<b>n/a</b>	<b>Enhanced 9-1-1, Phase II (125 m. location accuracy)</b>	<b>Terri Brooks</b>	<b>0</b>	<b>TSB-xxx</b>