

# Cellular Networking Perspectives

Editor David Crowe • Phone 403-289-6609 • Fax 403-289-6658

Vol 2 No. 3 March 1993

## In This Issue ...

The main topic of this issue of *Cellular Networking Perspectives* is a summary of the problems and opportunities facing the cellular industry, based on seminars, speeches and displays at Wireless '93, the CTIA's annual conference and exposition. The issues addressed are:

- The Cancer Scare
- PCS Spectrum and Services
- State of the Art in Fraud Management
- Voice Privacy
- Roaming
- The North American Numbering Plan

The cellular industry appears as well focused as any highly competitive industry can be. Cellular networking issues are playing a very important role in the future of cellular. Whether it be IS-41 networking to provide enhanced fraud control and call delivery services, or on-line transfer of call records, the industry is recognizing that the future holds greater integration of cellular systems with each other and with other networks.

As cellular expands geographically and to new market segments, providing service in more than one language will become more important. We discuss a proposal by Rogers Cantel to standardize a preferred language feature in TIA IS-53 and to provide this information in the subscriber profile transmitted from an HLR to a serving system while roaming.

The implementation of IS-41 Rev. A is moving along well, according to the updated status table in this issue. Changes from the January report are indicated by **bold type**. The major changes are a report from McCaw that Ericsson field trials with AT&T, Motorola and NTI have reached commercial service, as has the Motorola/NTI trial. Also, a Motorola/AT&T field trial using SS7 is now also in commercial service.

## Multi-Lingual Cellular... Mais Oui!

Rogers Cantel, the largest Canadian cellular carrier, has proposed standardization of a preferred language capability for roamers. This service would provide recordings, operator service and directory assistance in the language a subscriber is most comfortable in, where available. This service is already provided in Canada which is officially French/English bilingual. This service could also provide better service to Spanish speaking subscribers in the US and to international roamers, both English speaking roamers in Spanish speaking countries with AMPS cellular service, and Spanish speaking roamers in the US and Canada.

**Standards:** Preferred language service will require a service description in TIA IS-53 and minor modifications to the subscriber profile information defined in the TIA IS-41 protocol. This service was well received by the TIA TR-45.2 sub-committee and is likely to become part of both IS-53 Rev. A and IS-41 Rev. C, both scheduled for publication later in 1993.

## TR45.2 News

The TIA cellular networking sub-committee, TR-45.2, next meets near Boston on March 29 through April 2, 1993. Major items on the agenda will be:

- On-line call detail record protocol (DMH).
- IS-53 Rev. A (subscriber features).
- IS-41 Rev. B test plan.
- Border cell TSB.
- PSTN interface standardization.
- IS-41 compatibility problems.
- Election of a WG VI (international) vice-chair.

## Wireless '93 - Cellular in Summary

Wireless '93, the annual CTIA Convention and Exposition, held from March 2nd through 4th in Dallas was a showcase for the latest in cellular technology and a sounding board for the concerns of the cellular industry. It opened with video clips of John Sculley, William Gates and other high tech gurus describing wireless technology as an integral component of their future business. Wireless '93 closed with awards to cellular phone users who used them to perform extraordinary acts of heroism, proving that cellular technology is also becoming an integral part of the lives of ordinary people. We shall use this event as an opportunity to report on some of the major problems and opportunities in the arena of Cellular Networking.

Judging by Wireless '93 the major concerns of the cellular industry are the current cancer scare and the allocation of spectrum to PCS. Less serious concerns, or perhaps just concerns the industry has been living with longer, include fraud, the North American numbering plan, seamless roaming over the Americas and the best choice of data and digital voice technologies.

The major new trends in technology exhibited at Wireless '93 with an impact on cellular networking are:

- Real-time billing.
- Real-time fraud detection based on IS-41 and Call Detail Record analysis.
- Digital voice technology; TDMA, E-TDMA from Hughes Network Systems and CDMA from Qualcomm.
- Data over cellular.
- Voice privacy.

---

## Will "Larry King Live" Kill Cellular Dead?

---

More than enough has been written about the cellular cancer scare. The evidence behind the scare might be next to non-existent, but potential and perceived danger from RF emissions is an issue that the wireless telecommunications industry is going to have to live with. The irony will be that some people who drive too fast, smoke and drink too much, spend too much time in front of a TV and leave their guns loaded in their bedside tables will refuse to use a cellular portable.

The cancer scare will change the cellular industry in another way. The media can no longer be seen as unconditionally friendly to the cellular industry. They are no longer so enamored cellular as an exotic new technology that they will ignore opportunities for sensationalism or for deserved criticism.

The response of the cellular industry to the scare has been quite good. While not ruling out the possibility that harmful effects might be discovered in future studies, and not denying that RF emissions at other power levels and frequencies might be harmful, industry leaders have pointed to the mountains of research that indicate that 800 MHz emissions at 0.6 Watts are safe. Their offer to fund further independent research into this issue should mollify those that still have concerns that some yet unstudied attribute of cellular emissions will be shown to cause harm to humans.

---

## PCS Spectrum ... To Us or Not to Us?

---

The attitude of the cellular industry to PCS has become much more focused over the last year. Rather than cloudy claims of miraculous performance at minimal cost the cellular industry is focusing on issues of spectrum and services. The most important issue by far is access to PCS spectrum. If the cellular industry is denied access then PCS ceases to be a problem! Even then, if the cellular industry cannot determine the services that will sell PCS to consumers, they will not make money from PCS. Technology appears to be a secondary problem.

Several companies and organizations have suggested that cellular carriers be prohibited from competing for PCS spectrum. Even some in the cellular industry are suggesting that cellular carriers be prohibited from PCS licenses at least in the markets they already serve with cellular. While the stated concern is a lack of competition in

markets if PCS and cellular services are provided by the same carrier, many of the companies that are complaining come from much less competitive industries, such as local telephone service and cable TV. It is hard to understand their concerns if sufficient licenses, say 5 per PCS market, are awarded. Then, without excessive regulation, there will always be competitors to the PCS providers controlled by local cellular carriers.

Cellular carriers may be worried about spectrum allocation but that is not stopping them from launching field trials of new personal services. The purpose is to determine which personal services can be used to market PCS, contrasted with the business oriented services that cellular has mainly provided so far. These new services will likely revolve around call management for the home and for the self-employed, such as the ability to control which of several devices, such as wired or wireless phones, pager or voice mail each incoming call should be routed to based on dynamic parameters such as the calling number and time of day.

The technology being used for the trials is not exotic, just whatever is conveniently at hand, not what would be used in commercial PCS systems. Bell Atlantic Mobile Systems, for example, is using Motorola's NAMPS which multiplexes three calls onto one channel using analog technology. PCS systems, in contrast, will rely on digital technology to gain sufficient capacity, voice privacy and fraud protection.

The biggest technical trick for PCS appears to be the provision of low cost microcells, to provide the low power, high density coverage required. Microcells based on standalone cellular base stations will likely prove too expensive due to replication of common equipment. Microcells will more likely be much less intelligent and self-contained than base stations, merely translating the RF signal into an optical signal, and vice-versa, so it can be carried over fiber-optic cables to a large, centralized base station serving a number of microcells. This will be particularly attractive if the fiber infrastructure can be used for other services, such as wired phone service and video entertainment.

In conclusion, the provision of Personal Communications Services may have to rely on the cellular industry for PCS service, switching and wireless terminal expertise, and on cable and local exchange carriers for the fiber-optic infrastructure.

**Standards:** The TIA is defining microcell standards for the cellular (800 MHz) band in sub-committee TR45.5 and

standards for PCS services and equipment in the new committee TR-46. It has not been decided whether standards for PCS mobility and other inter-system operations will be standardized by the TIA TR-45.2 committee, nor whether existing standards, such as IS-41, will be used.

---

## Fraud

---

Fraud in cellular is far from a minor problem, but being such an old problem it does not command the same attention as a cancer scare. The cellular industry has taken a multi-faceted approach to fraud, involving legislative initiatives, police raids and the development and enhancement of technology to prevent illegal use of cellular systems.

Legislative initiatives may make it illegal to possess a "Clone-Phone", and police raids may break up tumbling and cloning and stolen phone rings, but more important is the networking technology that can be used to prevent fraud in the first place.

The single most effective technology to reduce fraud is still MIN/ESN validation. IS-41 protocols running on a continent-wide SS7 network will allow pre-call validation of all roamers, eliminating all air-interface fraud except cloning. The industry is working hard to provide IS-41 compatible equipment, and the CTIA and several carriers are planning or deploying extensive SS7 networks.

Clones are the big remaining headache. There is no single solution to cloning, but both real-time call detail record analysis and authentication have the long term potential to keep cloning under control.

Analysis of call detail records for cloning fraud is becoming commonplace. Sophisticated algorithms, some using artificial intelligence techniques, can detect unusual calling patterns for a MIN, such as:

- Location in a high fraud cell.
- Termination to certain international destinations associated with high fraud.
- Sudden increase in frequency of calling or duration of calls.
- Multiple calls at the same time.
- Calls from two distant places a short time apart.

There are an increasing number of products that monitor call detail records from MSC's. both for fraud and billing purposes.

A longer term defense against clones is authentication, as defined in TIA IS-54 Rev. B. Authentication cannot eliminate

cloning, but will make it very difficult indeed if carefully implemented. The major drawback to authentication is the population of 11 million non-authenticating mobiles currently in service, most of which could not be upgraded to perform authentication, even if the huge cost of such a retrofit could be justified.

**Standards:** The TIA TR-45.2 sub-committee, in WG IV, is devising an on-line call detail record transfer protocol, known internally as 'DMH' which is intended for fraud detection as well as enhanced billing services. IS-41 provides real-time roamer validation in a restricted form in Rev. 0, and in its full form in Rev. A and B. Authentication procedures are supported for roamers in TIA TSB-51, an addendum to IS-41 Rev. B. The TIA Ad-Hoc Authentication Group (AHAG) has defined authentication procedures that will be used on TDMA mobiles (IS-54 Rev. B), newer analog mobiles (TIA/EIA-553 Rev. A) and on CDMA mobiles. Some parts of the authentication algorithms are restricted by the US government from export.

---

## Eavesdropping

---

Voice privacy is undoubtedly a bigger concern to most cellular phone users than cancer. There is no question that this is a real problem, although most people do not understand that while fishing for random tidbits of conversations is easy, finding and keeping a specific conversation is a much greater challenge. The industry is responding to the increasing demand for a solution to this problem with proprietary analog solutions and standard digital solutions.

Antel and AT&T are providing analog voice scrambling in several cities in the US North-east. This requires a special phone, and cannot provide scrambling when roaming except in cities using AT&T systems. Support in IS-41 would be required to provide this feature while roaming.

Digital cellular provides a better solution to the eavesdropping problem. Using digital encryption technology, both TDMA and CDMA terminals will provide fairly solid voice privacy. Even this is not completely fail-safe, with Uncle Sam, among others, still able to eavesdrop reasonably easily. The problem with this solution at present is the low number of digital terminals, digital systems and the IS-41/SS7 network to support them. Voice privacy may turn out to be one of the best selling features of digital cellular, especially if it can establish itself as more convenient and sophisticated than analog scrambling.

**Standards:** Voice encryption is provided for TDMA mobiles in IS-54 Rev. B, for analog (including NAMPS) mobiles in the upcoming TIA/EIA-553 Revision A and will also be provided in CDMA terminals.

---

## Roaming

---

Roaming is the future of wireless communications, but it has yet to reach its full potential. There are many impediments to roaming, as many of them business issues as technical. However, with increasing problems resulting from lack of seamless roaming, and increasing business opportunities from its presence, the situation for roamers will gradually improve.

Business issues with an impact on roaming include the cost of the service, the inter-carrier agreements required for roaming, the MFJ restrictions on the RBOC's and, outside the US, language and other cultural barriers. On the positive side, roaming revenues are about 12% of total cellular revenues throughout the industry, and much higher (e.g. 30-40%) in many RSA's.

The main remaining technical barrier to roaming is the installation of IS-41 capability in each MSC and HLR and the provision of X.25 or SS7 datalinks to provide IS-41 connectivity throughout the Americas.

Roamers face two big problems making calls outside their home systems, cost and complexity. Many carriers, especially RSA's see roamers as a significant source of income requiring little care. Consequently many potential roamers feel that they are getting ripped off, and on some systems they are. Even when paying several times more than home subscribers, they do not receive the same range of functionality nor the same grade of customer service. If roaming is to grow, these problems must be addressed. Charges to roamers must be reasonably predictable, fair, and their confusion upon entering a system with a subtly different dialing plan than their home system must be alleviated with customer service designed for their needs.

If making calls is difficult for roamers, receiving calls is even harder. Most systems provide the first generation call delivery systems, Follow Me Roaming from GTE or RoamingAmerica from EDS PCC. These systems require manual activation daily, and whenever an invisible boundary between systems is crossed. IS-41 solves these problems but is not yet available in enough places. This barrier may be removed because of two recent developments. RBOC's, under restrictions dating

from the 1984 divestiture of AT&T, have only recently determined that it is legal for them to offer automatic call delivery services. As the biggest carriers, their participation was mandatory to making universal implementation of IS-41 a reality. A second development is the increasing size of IS-41 SS7 networks, required to provide the real-time network upon which IS-41 is based. If the CTIA's contract to build an open IS-41/SS7 network is realized this year, IS-41 connectivity may finally become a universal reality, in North America at least. Beyond this hurdle there remains the issue of providing new services, such as 'Calling Party Pays', to allow roamers to control call delivery costs.

When roaming outside Canada and the US, several more barriers exist. These barriers are so steep that many potential roamers simply leave their portables at home. The language barrier makes it difficult for roamers to obtain customer service in their native language. This is compounded by the use of completely different dialing plans inside and use outside the US and Canada. There are also some unique technical issues, such as the use of CCITT SS7 in South America, requiring protocol conversion before interconnection to North American systems. Another problem is that the MIN identifying a cellular phone is a North American 10 digit number and numbers assigned to South American terminals may conflict with numbers used in North America. However, with all these problems the use of IS-41 networking is growing, with a nationwide IS-41 network being planned for completion in Mexico later this year.

Just as it was a single air interface standard that allowed AMPS cellular to become so successful, the implementation of a single networking standard, IS-41, provides the framework for truly seamless roaming; if the will is there to solve the business issues.

**Standards:** The TIA standard IS-41 defines automatic roaming procedures. TSB-51 is an addendum to IS-41 Rev. B that supports authenticating terminals. TIA TSB-29-A provides some guidelines for SID and MIN assignments in countries outside the North American Numbering Plan. Unfortunately this document will soon be outdated by changes to the NANP. Working Group VI of TR45.2, which produced TSB-29, is responsible for studying all international roaming issues, and may be addressing some of the outstanding issues later this year.

## North American Numbering Plan

Readers of this newsletter may be tiring of the North American Numbering Plan (NANP) soap opera. But perhaps the end is in sight. Everyone, even including Bellcore's NANP administrator appears to be anticipating that the FCC will divest the NANP administration from Bellcore and reconstitute it as an independent body. Several things will have to happen before this can occur, however. The yet to be appointed chair of the FCC will have to settle into their new job and decide that numbering is a priority before such a new agency can be set up. And even when the FCC has established the desire to spin off the NANP administration from Bellcore, it will have to gain the agreement of the Canadian and Caribbean business and government partners in the NANP. In the long term these developments may have a positive effect on innovation in telecommunications services, in the short term the uncertainty may continue to retard the development of new services requiring allocation of numbering resources at the area code level.

## Glossary

**AMPS**•The name given to the original cellular system developed by AT&T. This term is still used to refer to the cluster of standards derived from it; EIA/TIA-553, IS-54 and the upcoming CDMA standards. AMPS cellular is in use in North and South America and many other places in the world.

**Bellcore**•A research organization owned by the RBOC's. Among its many other functions is responsibility for administration of the **NANP**.

**CTIA**•Cellular Telecommunications Industry Association. The trade organization of **AMPS** cellular service providers in North America.

**CDMA**•Code Division Multiple Access. A broadband digital cellular air interface being standardized by the TIA TR45.5 committee. Qualcomm, its developers, claim a greater than 10 times capacity increase over analog cellular.

**E-TDMA**•A **TDMA** air interface technology that transmits voice only when a party is speaking. Hughes Network Systems, its

developers, claim a greater than 10 times capacity increase over analog cellular.

**IS-41**•The TIA standard for cellular inter-system operations. It exists in three different revisions; 0, A and B, each with successively greater functionality.

**IS-53**•The standard describing cellular subscriber features, developed by TR-45.2.

**IS-54**•The TDMA digital cellular air interface standard developed by TR-45.3.

**MIN**•The 10 digit directory number assigned to every cellular phone.

**MSC**•Mobile Switching Centre. Synonymous with MTSO.

**NAMPS**•An air interface that, using analog techniques, multiplexes three conversations on one analog cellular channel. Developed by Motorola and in commercial service in several cities.

**NANPA**•**NANP** Administrator. A branch of **Bellcore**.

**NANP**•The North American Numbering Plan, covering the area known as **World Zone 1**.

**PCS**•Personal Communications Services. It will likely be similar to cellular in many ways but with services oriented to home users and self-employed business people.

**RBOC**•Regional Bell Operating Company. A local exchanges carrier formed from the breakup of AT&T. Each RBOC and their cellular subsidiaries are restricted from providing long distance service by the US Department of Justice.

**SID**•System ID. A unique number assigned to every AMPS cellular system either by the FCC in the US and Canada, or by the TIA elsewhere.

**SS7**•A packet switching protocol designed for use between telephone exchanges and databases. It exists in two major variants; CCITT and ANSI.

**TDMA**•Time Division Multiple Access. A new digital cellular air interface standardized in TIA IS-54 Rev. B by the TR45.3 sub-committee.

**TIA**•Telecommunications Industry Association.

**WORLD ZONE 1**•The USA, Canada and several Caribbean countries that use the North American Numbering Plan (**NANP**)

## Subscriptions

For a Subscription to Cellular Networking Perspectives, send your name, company, address and fax number, along with a cheque or money-order to:

Cellular Networking Perspectives  
2636 Toronto Crescent NW  
Calgary, AB T2N 3W1 Canada

1 year subscription (12 issues):  
Canada CDN\$250.00  
USA US\$250.00  
Other US\$300.00

Subscribers are licensed to copy within their company or organization as long as credit is given.

©1993, David R. Crowe

## Back Issues Available

Back issues are always available. Major topics in recent issues are:

### August, 1992

Authentication, Validation and Voice Privacy.

### September, 1992

North American Numbering Plan changes, part I.

### October, 1992

North American Numbering Plan changes, part II.

### November, 1992

Inter-System Handoff, part I - Handoff Forward/Back.

### December, 1992

Inter-System Handoff, part II - Path Minimization.

### January, 1993

Inter-System Handoff, part III - Feature Interactions

### February, 1993

Inter-System Handoff, part IV - New Air Interfaces

The price of a back issue is:

CDN\$25	Canadian fax number
US\$25	US fax number
US\$30	Other fax numbers

Subscribers may fax requests for back issues and be invoiced later.

# Status of IS-41 Rev. A Implementation

# Cellular Networking Perspectives

IS-41 Revision A Status (Standard Published, January 1991)						
Vendor1	Vendor 2	Status	Completion	HVD	D/L	Field Trial Location
Astronet	AT&T	Field Trial	11/92	-VD	X	Baltimore/Washington (BAMS)
	GTE TSI	Field Trial	In progress	-VD	X	Baltimore/Washington (BAMS)
	NTI	Lab Trial	Scheduled	-VD	X	Texas/New Mexico (ENMR)
AT&T	Astronet	Field Trial	In progress	-VD	X	Baltimore/Washington (BAMS)
	EDS	Lab Trial	12/92	-V-	X	
	Ericsson	Commercial	12/92	HVD	S	Salt Lake City (McCaw)
	GTE TSI	Commercial		-V-	X	Baltimore/Washington (BAMS)
	Motorola	Commercial	05/92	HVD	X	Fresno (GTE/Contel)
		Commercial	10/92	HVD	S	
NTI	Commercial	05/92	HVD	X	Detroit (Ameritech)	
EDS	AT&T	Lab Trial	12/92	-V-	X	
	Ericsson	Lab Trial	01/93	-V-	S	
	Motorola	Commercial	08/92	-V-	X	Los Angeles and Atlanta (PacTel)
Ericsson	AT&T	Commercial	12/92	HVD	S	Portland and others (McCaw)
	EDS	Lab Trial	01/93	-V-	S	
	Motorola	Commercial	12/92	HVD	S	Stockton and others (McCaw)
	NTI	Commercial	12/92	HVD	S	Tampa and Minneapolis (McCaw)
GTE TSI	Astronet	Field Trial	11/92	-VD	X	Baltimore/Washington (BAMS)
	AT&T	Commercial		-VD	X	Baltimore/Washington (BAMS)
	Motorola	Field Trial	2Q'93	-VD	X	Seattle (US West)
	NTI	Commercial	01/93	-V-	X	Spokane (US West)
Field Trial		09/92	-VD	S	Greensboro (GTE Mobilnet)	
Motorola	AT&T	Commercial	05/92	HVD	X	Sacramento (PacTel)
		Commercial	10/92	HVD	S	Dallas (McCaw)
	EDS	Commercial	08/92	-V-	X	Los Angeles (PacTel)
	Ericsson	Commercial	12/92	HVD	S	Dallas (McCaw)
	GTE TSI	Field Trial	2Q'93	-VD	X	Seattle (US West)
	NTI	Commercial	02/93	HVD	X	Philadelphia(Metrophone)
NTI	AT&T	Commercial	05/92	HVD	X	Windsor(Bell Cellular)
	Ericsson	Commercial	12/92	HVD	S	Ft. Meyers (ICN/Palmer)
	GTE TSI	Commercial	01/93	-V-	X	Spokane (US West)
		Field Trial	09/92	-VD	S	Greensboro (GTE Mobilnet)
Motorola	Commercial	02/93	HVD	X	Allentown(Vanguard)	

Explanation: Status: Development, Planning, Lab Trial, Field Trial or Commercial  
 Completion: Date of actual or expected completion of phase of testing.  
 HVD: Type of Test ("H" - Includes Handoff, "V" - Includes Roamer Validation, "D" - Includes Call Delivery)  
 D/L: Datalink Protocol (X - X.25 or S - SS7)  
 Location: Location of Vendor1 Equipment (usually listed for first trial only)