Cellular Networking Perspectives

Editor David Crowe • Phone 403-289-6609 • Fax 403-289-6658 Vol. 2, No. 7 July, 1993

In This Issue ...

ITN Named CTIA Backbone IS-41 Network Provider

The CTIA announced on July 13th that Independent Telecommunications Network, Inc. (ITN) has been named as the provider of a new US backbone signaling network, based on SS7 and IS-41 technology. This will be an important stimulus to the implementation of IS-41 nationwide, and to the wider application of the most modern automatic roaming technology. Although the CTIA has appointed ITN as the official provider of SS7/IS-41 to the industry, all agreements will be between individual cellular carriers and ITN. Carriers may alternatively elect to remain on their own networks, using gateways to communicate to carriers on the ITN and other networks.◊

New TIA Standardization Efforts Loom

The TIA is being bombarded with standardization proposals that impact the cellular network and will most likely be partially undertaken by the TR-45.2 sub-committee. New standardization efforts that have been proposed include:

- CDMA Intersystem Handoff

  CDMA proponents succeeded in June in initiating a project to write a TSB detailing CDMA inter-system operations with IS-41 Rev. B. Ironically, the TSB, if produced, may well be published after IS-41 Rev. C. There is still some benefit, however, as IS-41 Rev. C, as the biggest revision of inter-system operations to date, will be a long time in development before field trials begin. A CDMA TSB will allow at least limited field trials of CDMA intersystem handoff.

- MSC/BSC "A" Interface

  GSM, the European digital cellular standard, uses a standard interface to connect any MSC to any BSC. It is not surprising that a recent Motorola proposal to standardize this "A" interface is based on GSM. The proposal received support from several of vendors and cellular carriers. Those who spoke against the proposal either were concerned about the workload of TR-45.2 and its ability to deliver on its current commitments, or they believe that a standard interface will stifle innovation.

  It is important to note that the proposed standard is for the interface to the BSC, the Base Station Controller, not the Base Station (BS). Each BSC will continue to use a proprietary interface to each BS and the transceivers that it controls. A standard "A" interface could radically change the cellular industry, allowing companies to concentrate on their strengths in either radio or switching technology. Companies with strengths in both areas may be less enthusiastic about a standard with the potential to reduce their market share.

  Details of the Motorola "A" interface proposal are not yet available, but it is known that it incorporates procedures and messages to support AMPS (EIA/ TIA-553), NAMPS (IS-91), TDMA (IS-54) and CDMA (IS-95) base stations. If standardized it will likely be by a new Working Group of TR-45.2, perhaps jointly with TR-45.4 (800 MHz Microcells and Microsystems).

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- CDPD Packet Data

  The CDPD protocol for packetized data in 30 khz cellular channels is currently being developed by an industry consortium. They have indicated a desire to have the TIA turn their first complete version (1.0) into a standard. If standardized, it will likely be by a newly created sub-committee of TR-45.◊

Wireless Terminal Location Management Part II - Problems, Problems

Intelligent mobility management is critical to supporting many capabilities of wireless systems, including call delivery, fraud management and location tracking services. This much was discussed in Part I. There are additional challenges, however, that stem from flaws in the design of cellular air interfaces. The root cause of these problems was a lack of attention to the cellular network during the design of cellular air interfaces. PCS and future cellular air interfaces can avoid such problems only if they are developed as a system, with the radio path being seen as part of a universal network.

We discuss below several of the major categories of air interface problems, including potential solutions. For more detailed discussion of individual problems it is worthwhile examining the TIA document *Mobile Border System Problems*, currently out for ballot as a TSB.

A. The Rescan Conundrum

The cellular rescan problem occurs when a mobile responds to a stimulus from one base station by transmitting to a base station in another system. This can occur because mobiles *rescan* to the strongest control channel before transmitting origination, page response or registration access messages. This problem may result in loss of accurate location information or an inability to serve the mobile. One scenario is illustrated in Figure 1.

To eliminate the rescan before each access would result in mobiles accessing the system with a less than optimal signal strength. Alternatively mobiles could rescan more frequently while idle, but this would dramatically increase the rate of mobile registration

To alleviate some of the problems, procedures in the new *Mobile Border System Problems* TSB allow some coordination between neighbouring systems based either on knowledge of neighbouring systems, or on the exchange of location information via the HLR. Neither solution is very good, but they are the best available without air interface changes.

Future wireless systems do not need to live with rescan problems. If base stations are viewed as nodes in a large network, an obvious solution is for the stimulating base station to transmit its network address, which would be passed via the mobile to the system receiving the response. This would allow the base station receiving the response to easily communicate with the stimulating base station's system and arrange through IS-41 or similar protocols to serve the mobile correctly.

B. Duplicate Messages

Radio waves cannot be contained precisely. This is both a big advantage and a constant challenge. Cellular system design strives to balance having RF where it is wanted, and keeping it away from where it will interfere. Like many real-life problems a completely optimal design cannot be achieved, and could only be maintained as long as cars did not move, buildings did not get built and trees did not grow and shed leaves with the seasons. The duplicate message problems occurs when a message from a mobile is received by more than one base station. As you might expect, the two base stations could be in different systems, and confusion can result.

IS-41 actually exacerbates this problem because of the way VLR's filter out repeated registrations. If one of the registrations is received by the currently visited system it may be ignored as redundant. If this is the case, the other registration, probably weaker, will be accepted! With the

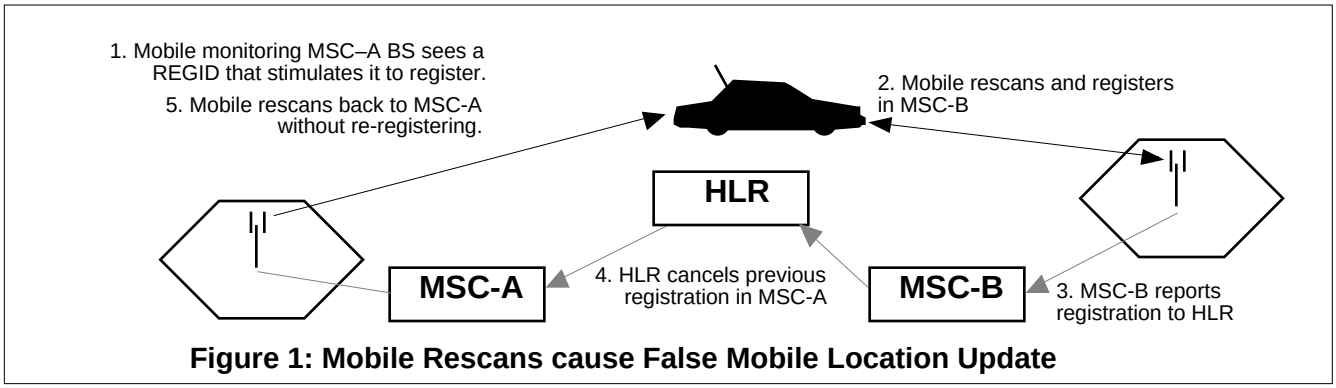

Figure 1: Mobile Rescans cause False Mobile Location Update

new Mobile *Border System Problems* TSB the signal strengths of the registration accesses are compared, to enable the strongest, and most desirable, registration to be determined.

This is not an ideal solution, being quite complex. Better solutions would exist if the air interface would stamp each mobile access with a sequence number.

only way to stimulate registrations by these mobiles is by regularly incrementing the Registration ID, resulting in periodic registrations by *all* mobiles, not just those with the Stack of 4 problem. This problem will exist in cellular systems until the last mobile of this vintage goes to the great cellsite in the sky.

This problem was designed into AMPS (IS-3, now EIA/TIA-553) because of concerns about excessive registrations in areas bordering

cedures and messaging to support inter-system operations for fax and asynchronous data transmission by TDMA terminals.

Task Groups speed up progress in an area by allowing work in smaller, more focussed groups. They can only make informal recommendations to the Working Group that created them and thus are usually used in uncontroversial areas. In practice their recommendations are usually accepted by their Working Group.◊

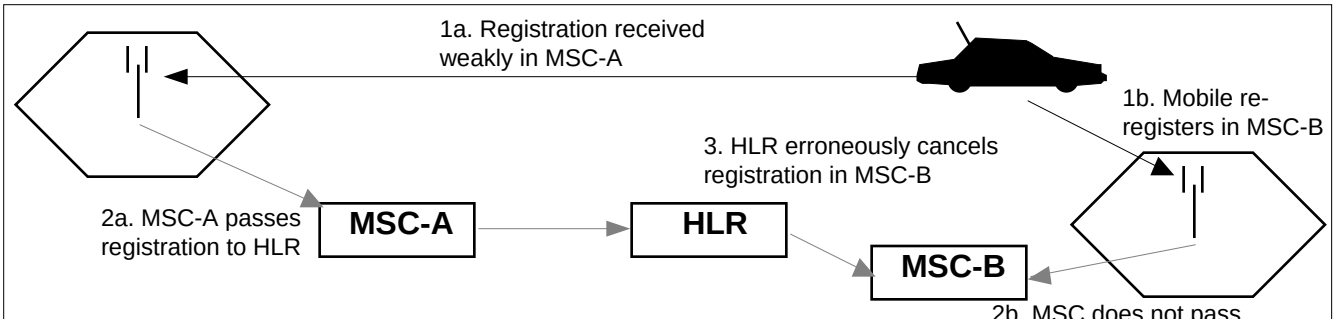

Figure 2: Out of Sequence Registrations

C. Out of Sequence Messages

When messages ce around IS-41 networks they may arrive at a common point (usually an HLR) in a different order from which they were sent. This may be due to different network structures, protocols, queuing delays or bit rates. This can cause the location of a mobile to be corrupted at the HLR in scenarios similar to that shown in figure 2.

While the cause of this problem is very different from the duplication of messages, similar solutions, such as stamping mobile accesses with sequence numbers may apply.

D. Stack of 4 SID's

This problem affects only older analog mobiles now, but is an interesting illustration of how a poor understanding of the cellular network can result in a worse solution than total ignorance! Early analog mobiles would not always register when they scanned onto a control channel with a different System ID (SID). They maintained a stack of four SID's and would only register when they saw one different from any of the four they had stored. This effectively disabled the SID stimulus for autonomous registration in all but the most mobile mobiles. The multiple cellular systems. Unfortunately, the reasoning did not extend to an analysis of how the network would be able to determine the location of a mobile.

For PCS air interface and network designers the message is that their work has to proceed in parallel with frequent communication between both groups. This will be essential to provide greater seamlessness in PCS systems and to avoid costs of inefficient workarounds to artificial problems. Next month, in the third and final part of this series we provide a list of recommendations to avoid location management problems in the future.◊

TR-45.2 Grows More Tentacles

One month after TR-45.2 lopped off two task groups it has initiated three more, Working Group I of TR-45.2 has created Task Group 1 to produce IS-41 page replacements based on interpretations and clarifications of IS–41 to be published soon in the IS-41 Rev. B Technical Notes TSB. Task Group 2 of the same Working Group will edit the CDMA inter-system handoff document in an effort to speed up production of this TSB without significant impact on other TR-45.2 activities. WG III created Task Group 1 to generate IS-41 pro-

TR45.2 Continues to Pump Standards Out

The TR45.2 sub-committee continues to move documents through the tedious process of publication as an Interim Standard or TSB. The latest document to visibly move forwards is TSB-55 on the subject of IS-41 Rev. A Compatibility. This, along with the IS-41 Rev. B Technical Notes, is crucial to the smooth rollout of IS-41 Rev. B. The DMH online call record transfer standard and the Border Cell problem resolution TSB have been received by the TIA and mailed to TR-45.2 members for review and balloting.

The status of each document that the TIA TR-45.2 sub-committee has in progress is listed below in order of estimated publication date.

Border Cell TSB • The draft document to resolve several problems that occur on the border of cellular systems is also **out for ballot** as a TSB.

Intersystem Non-Signaling Data Communications (DMH) • This document describes record layouts and protocols for online transmission of cellular call detail records for billing,

fraud detection and other purposes. This document is **out for ballot** as an Interim Standard.

IS-41 Rev. A Compatibility (TSB–55) • Procedures to allow IS-41 Rev. A implementations to be forward-compatible with Rev. B. Remaining open issues are being resolved by WG II. The document has been forwarded to the TIA for ballot.

IS-41 Rev. B Technical Notes (TSB–41) • Will resolve several ambiguities in IS-41 that have resulted in incompatibilities between implementations of IS-41 Rev. A by different vendors. The completed baseline document has been reviewed and will likely be approved for **ballot in August**.

IS-41 Rev. B Test Plan (TSB-42) • An application level test plan for IS-41 Rev. B is being developed by WG II Task Group 2. If a group of tests concerning the interaction of Call Waiting, 3 Way Calling and Inter-System Handoff are approved in August, the test plan will be forwarded to the TIA for ballot.

CDMA TSB • A TSB on CDMA intersystems operations is being developed for publication as a TSB against IS-41 Rev. B and for inclusion in IS-41 Rev. C. A Working Group I task group has been formed to speed up development of the document without slowing down IS-41 Rev. C development.

IS-41 Revision C • An initial draft of this revision of the cellular intersystem operations standard was available to committee members at the July meeting of TR-45.2. This document is still in a very preliminary state, not yet including, for example, text from TSB-51 on authentication. Publication is **scheduled for December, 1993** but it is unlikely that this date will be met.

Comments Welcome

We welcome comments on the format of this newsletter, suggestions for future topics, corrections or additional information.

Subscriber Features (IS-53 Rev. A) • A completely revised and rewritten version of the baseline document was reviewed at the July meeting. A decision on accepting this Synacom contribution has not yet been made. Publication is **scheduled for December, 1993**, but it appears unlikely that this date can be met.

PSTN Interface (PN-3098) •A definition of both the analog (i.e. MF signaling) and digital (SS7 signaling) interfaces required to connect MSCs to the PSTN has been written. It will be undergoing Verification and Validation (V&V) between the July and August TR-45.2 meetings. Publication is **scheduled for December, 1993**, but the document could be out for ballot as early as August.

Cellular Dialing Plan (IS-52) • Plans are being made to revise the cellular dialing plan standard, IS-52 Rev. 0. It will include the feature activation and deactivation codes that previously resided in IS-53. IS-52 Rev. A will also describe the recommended treatment for ANI (Automatic Number Identification). No progress was made at the July TR-45.2 meeting.

International Applications (TSB–29 Rev. B) • There are several recognized problems with the use of AMPS cellular outside North America. WG VI of TR45.2 is studying solutions to these problems. Publication is scheduled for December, 1993, but it is recognized to have a lower priority than other documents and its deadline will probably be allowed to slip.◊

IS-41 Rev. B Trial Update

Motorola and NTI are planning an IS-41 Rev. B field trial for a location not yet determined. The trials will test Handoff, Call Delivery and Validation functions using both X.25 and SS7 datalinks. Further updates on the status of IS-41 Rev. B trials will be published as the information becomes available.◊

ISSN Number Assigned

Cellular Networking Perspectives has been assigned an International Standard Serial Number ISSN 1195-3233. This number will be registered in the international catalogue in Paris and may be useful for librarians in cataloguing and ordering.◊

Back Issues Available

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

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. IS-41 Rev. 0 Field Trials.

March, 1993
Wireless '93 in review.

April, 1993
TR-45.2 News. IS-41 Explained. TR-45.2 International Working Group VI.

May, 1993
IS-41 Rev. A Status Report. IS–41 Rev. B Status. NovAtel. DMH. IS-41 Enables Innov-ation. TR45.2 Project Status.

June, 1993
Wireless Terminal Location Management, Part I. Brace for the Standards Flood. TR-45.2 Working Group Report.

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

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Vendor1	Vendor2	Status	Completion	HVD	D/L	Location
Astronet	**AT&T**	**Commercial**	**06/93**	**- VD**	**X**	**Baltimore/Washington (BAM)**
	GTE TSI	**Commercial**	**06/93**	**- VD**	**X**	**Baltimore/Washington (BAM)**
	NTI	**Lab Trial**	**05/93**	**- VD**	**X**	**Texas/New Mexico (ENMR)**
AT&T	**Astronet**	**Commercial**	**06/93**	**- VD**	**X**	**Baltimore/Washington (BAM)**
	EDS	Lab Trial	12/92	- V -	X	
	Ericsson	Commercial	12/92	HVD	S	Salt Lake City (McCaw)
	GTE TSI	Commercial	06/92	- V -	X	Baltimore/Washington (BAM)
		Commercial	06/93	- - D	X	Baltimore/Washington (BAM)
		Commercial	**02/93**	**- V -**	**S**	**Tampa, Fresno**
		Field Trial	**02/93**	**- - D**	**S**	**Tampa, Fresno**
	Motorola	Commercial	05/92	HVD	X	Fresno (GTE/Contel)
		Commercial	10/92	HVD	S	(McCaw)
	NTI	Commercial	05/92	HVD	X	Detroit (Ameritech)
		Commercial		- VD	S	(McCaw)
EDS	AT&T	Lab Trial	12/92	- V -	X	
	Ericsson	Lab Trial	01/93	- V -	S	
	Motorola	Commercial	08/92	- V -	X	Atlanta (PacTel)
	NTI	**Commercial**		**- V -**	**X**	**Ft. Myers, FL (Palmer)**
Ericsson	AT&T	Commercial	12/92	HVD	S	Portland and others (McCaw)
	EDS	Lab Trial	01/93	- V -	S	
	Motorola	Commercial	12/92	- VD	S	Stockton and others (McCaw)
		Commercial	**07/93**	**H - -**	**S**	**Albany**
	NTI	Commercial	12/92	HVD	S	Tampa and Minneapolis (McCaw)
GTE TSI	**Astronet**	**Commercial**	**06/93**	**- VD**	**X**	**Baltimore/Washington (BAM)**
	AT&T	Commercial	06/92	- V -	X	Baltimore/Washington (BAM)
		Commercial	06/93	- - D	X	Baltimore/Washington (BAM)
		Commercial	**02/93**	**- V -**	**S**	**Tampa, Fresno**
		Field Trial	**02/93**	**- - D**	**S**	**Tampa, Fresno**
	Ericsson	Planning		- VD	S	Mexico
	Motorola	**Commercial**	**06/93**	**- VD**	**X**	**Toledo**
	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	- VD	S	Dallas (McCaw)
		Commercial	**07/93**	**H - -**	**X**	**Syracuse**
	GTE TSI	**Commercial**	**06/93**	**- VD**	**X**	**Toledo**
	NTI	Commercial		- VD	S	(McCaw)
		Commercial	02/93	HVD	X	Philadelphia(Metrophone)
NEC	AT&T	Lab Test	06/93	HVD	X	Brazil (Telebras)
NTI	**Astronet**	**Lab Trial**	**05/93**	**- VD**	**X**	**Texas/New Mexico (ENMR)**
	AT&T	Commercial	05/92	HVD	X	Windsor(Bell Cellular)
		Commercial		- VD	S	(McCaw)
	Ericsson	Commercial	12/92	HVD	S	Ft. Myers (ICN/Palmer)
	EDS	**Commercial**		**- V -**	**X**	**Ft. Myers, FL (Palmer)**
	GTE TSI	**Commercial**	**01/93**	**- V -**	**X**	**Spokane (US West)**
		Field Trial	**09/92**	**- VD**	**S**	**Greensboro (GTE Mobilnet)**
	Motorola	Commercial		- VD	S	(McCaw)
		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 listed phase of testing.
HVD:	Type of Test ("H" - Includes Handoff, "V" - Includes Validation, "D" - Includes Call Delivery).
D/L:	Datalink Protocol (X - X.25 Level 2, S - ANSI SS7 or C - CCITT #7).
Location:	Location of Vendor1 equipment and carrier (usually listed for first trial only).