

Cellular Networking Perspectives

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Comments Welcome

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

Interchangeable Area Codes Will Disrupt International Roaming

The planned introduction of interchangeable area codes in North America in 1995 will unintentionally disrupt international roaming for cellular phones.

The problem is strictly technical, based on the implicit assumption by AMPS cellular protocol designers that cellular phones would only be used in the United States. Consequently, mobile identification numbers (MIN's) were made 10 digits long, the same size as a North American landline number without country identification. By luck, some digits in North American numbers are restricted, but that is starting to change.

Today, area codes always have a 0 or 1 in the second digit position (e.g. 201, 210). Starting in 1995, area codes with the digits 2 through 9 in the second position will be introduced. An example of the possible problems that this will cause is the new 530 area code to be used in Arizona, which borders on Mexico. Mexican mobiles are programmed with their CCITT assigned country code 53 as the first two digits of their MIN. Luckily, no Mexican city codes start with the digit 0. However, luck will run out when the area codes 531 through 539 are assigned, starting in 1997.

In the worst case, a cellular MIN could have 3 interpretations based on the first 3 digits; a US or Canadian area code, a CCITT landline country code or a CCITT mobile country code.

The best solution to this problem is to migrate to 15 digit mobile identification numbers for new phones. Alternatively,

for existing phones, multiple network queries can be performed. This is hardly an ideal solution. The TIA is actively seeking solutions to this problem, in TR45.2 Working Group VI on international issues and in subcommittees TR45.1 for analog cellular, TR45.3 for TDMA digital cellular and TR45.5 for CDMA digital cellular.

Big Brother Would Like to Listen to the Big Bad Wolf

Advances in telecommunications are making life more difficult for those who want to listen in on private telephone conversations, even those that have a legal right to do so. The Alliance for Telecommunications Industry Solutions (ATIS, formerly ECSA), responsible for much wireline telecommunications standardization, formed a committee to study the issue of legal wiretaps in an increasingly digital and mobile environment in March 1993. This committee, innocuously call the Electronic Communications Service Provider Committee (ECSP) has, in turn spawned the Personal Communications Service Action Team (PCSAT) to study this issue in Personal Communications Systems .

Organizations that have a legal right to monitor calls have stated several requirements, that are individually achievable, but probably not as a group. The major requirements are:

- a. To deliver call setup information and audio to a central monitoring facility in real-time.

- b. To remove any encryption or compression before delivering the wiretap.
- c. To intercept transparently (e.g. no delays, extraneous noises or change in audio quality).
- d. Verification that the call setup information is associated with the audio.
- e. Multiple, simultaneous intercepts.
- f. Access to phone calls within 24 hours (normally).

There are many problems in the development of standards to achieve these requirements. Some of them are technical, some administrative but most are political:

- How can calls be delivered to a central monitoring facility through switched facilities without either introducing delays or missing part of the call?
- How can information about wiretaps be kept secret, except for those that need to know?
- How can wiretaps be delivered to a monitoring facility securely and without the possibility of misdirection?
- Are wiretaps legal on a roamer when a law enforcement agency does not have jurisdiction over both the home and visited system?

The development of wiretap standards will likely take a long time because phone companies, while wanting to comply with legitimate requests, do not want to offend customers through real or hypothetical abuses of any system that they put in place. Also, with such a distributed system, the potential for highly publicized errors is enormous. Imagine the outcry if wiretaps were delivered to an ordinary citizen instead of to the law enforcement monitoring bureau!

Chair of TIA Subcommittee TR45.2, WG VI Resigns

The chair of Working Group VI of TIA Subcommittee TR45.2 on International Applications of TIA cellular standards has resigned, due to an internal promotion at Northern Telecom. A replacement for Arzu Çalis will probably be chosen at the August TR45.2 meeting (August 15-19 in Calgary, Alberta).

Inter-System Call Delivery, Part VI: Border Problems

Mobile location tracking is crucial to the effective implementation of inter-system call delivery using IS-41 or any other mobility management standard that is both efficient and effective. If the network forgets which system a mobile is currently roaming in, call delivery obviously will fail. And yet, location tracking is one of the weakest areas in the design of the North American TIA cellular air interfaces. While newer air interfaces, such as TDMA and CDMA have improved location tracking, even they still lose track of mobiles, although less frequently.

Because of this weakness, and because the vast majority of the 16 million cellular phones in the US are analog, IS-41 call delivery techniques have had to adapt to these "Border Cell" problems. While it is far from optimal to have the network compensate for air interface deficiencies, it is simply not possible to recall and retrofit millions of phones.

What is a Border Cell Problem?

Border cell problems are those problems that occur on the boundary between cellular systems. They often result in systems losing track of mobiles.

The usual symptom of a border cell problem that affects call delivery is paging in the wrong system. This can occur either because the mobile is rapidly switching between systems or because a protocol design glitch occurred that allowed a mobile to be present in a system without registering. This situation can occur very simply, due to fundamental "rescan" problems in cellular terminals.

Rescanning is the process of locking on to the strongest control channel, and is necessary before any calls can be placed or received on a cellular phone. Once a terminal is locked onto a control channel it will stay there until the channel can no longer be received, the phone's rescan timer expires (usually several minutes) or an event occurs that requires a rescan (e.g. originating a call). This means that a phone may no longer be monitoring the strongest control channel in its vicinity when,

some time later, the phone is involved in a call. The designers of the original cellular phone interface (AT&T's AMPS, later TIA IS-3 and now EIA/TIA-553) decided that phones should rescan following, among other events, the receipt of a paging message. This means that it is quite possible for one system to page a mobile because of an incoming call, and for the mobile to respond on a cell in a bordering system. The mobile does not spoil the fun and identify the cell that paged it, that is left to the confused border system that has just received a response to a message that it never sent!

A slightly different rescan problem occurs when a mobile originates a call without first registering, which commonly happens due to the mandatory rescan that occurs at the time of each origination. The serving MSC treats the origination as a registration to allow call waiting to work. However, the mobile does not consider an origination to be an implied registration. Consequently, at the end of the call the mobile will rescan again and, if it is unlucky enough to end up back in the original system, will not reregister. Subsequent call delivery attempts will fail as they will be directed to the system that the mobile originated a call in, not to the original system that the mobile still thinks it is registered in.

TSB-65 Border Cell Solutions

The Border Cell TSB (TSB-65), published in April 1994, provides three solutions to call delivery problems resulting from border cell anomalies:

1. The MSC that pages the mobile can send an IS-41 *InterSystemPage* message to a neighbouring MSC (known as MSC-B, the Border MSC) to have it page the mobile. This both allows for successful paging of mobiles that have recently changed systems and also allows the border MSC-B to process page responses that may have been triggered by the registered MSC-V. This scenario is illustrated in Figure 1.
2. The MSC that pages the mobile (MSC-V) can send an IS-41 *InterSystemPage* message with a "Listen Only" indication to MSC-B to have it listen for unsolicited page resp-

onses from a mobile, without paging itself. This only allows for the reception of page responses in MSC-B that were triggered by page commands sent from MSC-V. While more limited than the first technique, it is considered by some to be allowed under MFJ restrictions while the first technique is not.

3. A system receiving an unexpected page response can distribute it in a TSB-65 *UnsolicitedResponse* message to neighbouring MSCs in the hope that one of them is the MSC that paged the mobile. This is similar to the second technique, but more efficient because network messages are only required when an unsolicited page is detected. Unfortunately, it too is not allowed under some interpretations of MFJ restrictions.

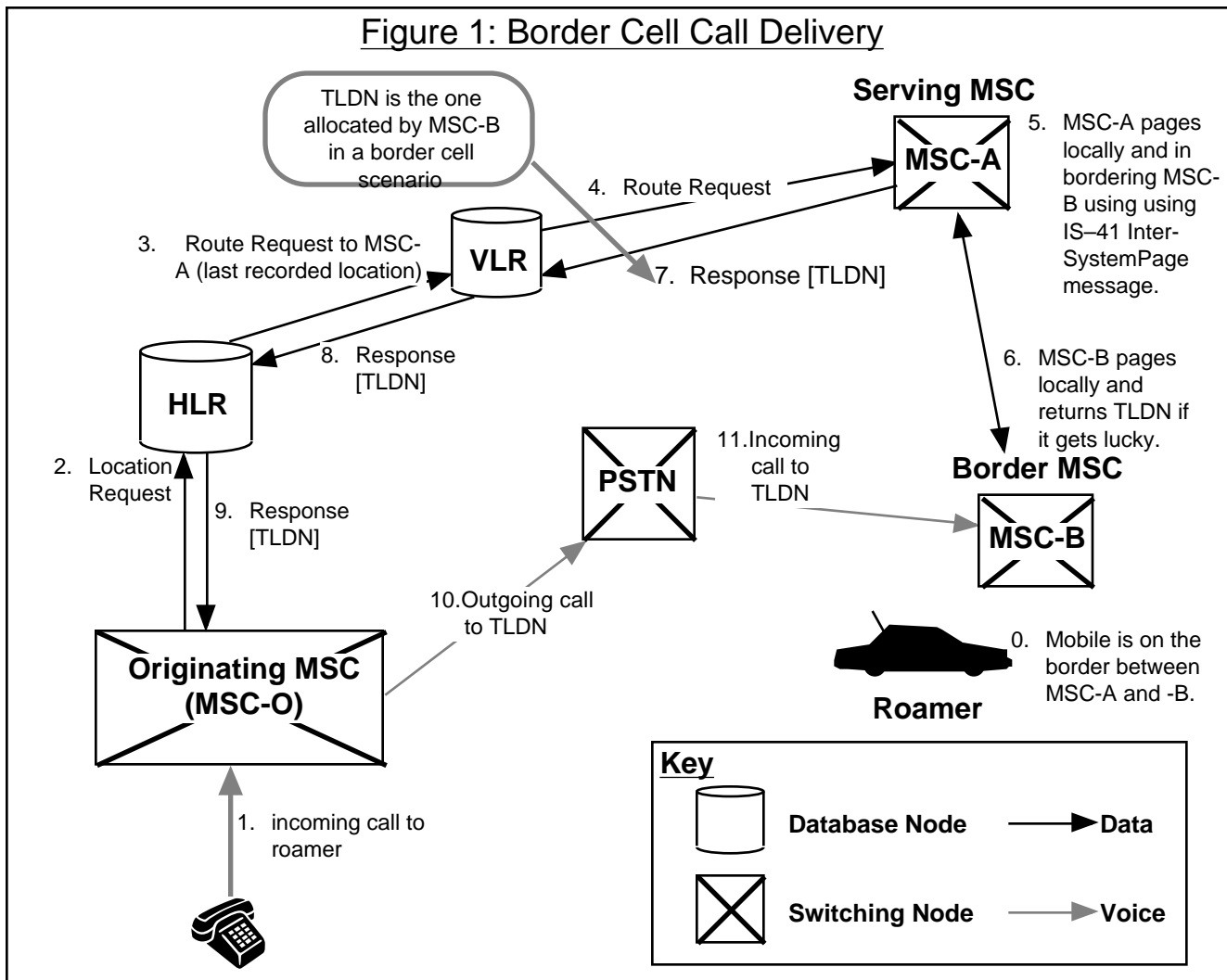
IS-41 Rev. C Border Cell Solutions

The Border Cell TSB solutions work best when paging occurs in response to an IS-41 *RoutingRequest* message. Otherwise, call delivery may have to be slowed down to allow time to set up a second long distance call when the border problem is discovered. IS-41 Revision C will likely contain procedures to allow the "handoff" of a call from the visited system (MSC-V) to a neighbour (MSC-B). This is a benefit because handoff procedures are more efficient, quicker and less costly than using a TLDN to extend a call through the PSTN. As an additional benefit, the procedures allow the connection to the neighbour system to be released by *Handoff Back* or *Path Minimization* procedures (see the November and December, 1992 issues of *Cellular*

Networking Perspectives for more details) if, during the subsequent call, the mobile wanders back to the system where it is registered. An additional benefit is that inter-system handoff is allowed under a US Department of Justice waiver without going through the network overhead and call setup delays of using inter-exchange carriers.

Border Cell Problem Summary

Border Cell problems are a fact of life for cellular systems, and the problem will get worse before it gets better. While IS-41 and TSB-65 border cell solutions are not perfect they are useful tools for enhancing the performance of call delivery and improving service to those that want to receive calls where ever they may roam.



Inter-System Call Delivery, The IS-41 Toolbox

In our discussion of inter-system call delivery we have referred several times to the IS-41 messages that make up the call delivery toolbox. Figure 2, below, provides a summary of these messages, their purpose, and whether they were introduced into the standard with the initial release of IS-41 Call Delivery functionality (Revision A) or specifically to resolve border cell problems (TSB-65).

The messages illustrate the size of the challenge for implementing Call Delivery in a mobile environment. Only two messages are directly concerned with delivering a call (LocationRequest and RoutingRequest). Others are associated with mobile tracking or redirection of calls when a call delivery attempt has to be abandoned. Last, but not least, are the two new messages added in the recent TSB-65 specifically to solve Border Cell problems that are yet another complication to call delivery.

TR-45.2 Standards Update: IS-52 Dialing Plan Standard Approved for Ballot

TR-45.2 has released the cellular dialing plan standard for letter ballot. It describes the types of calls that can be dialed from a cellular phone and the digit patterns used to make these calls. This new version is a complete rewrite of the original version.

The other major news this month is that the resolution of ballot comments for TSB-41 (IS-41 Rev. B Technical Notes) required such major changes that the entire document will be sent out for a full second ballot.

The status of each major outstanding TR45.2 project is listed below:

IS-41 Rev. A Compatibility (TSB-55, SP-3063) • In press.

IS-41 Rev. B Technical Notes (TSB-41, SP-2985) • Ballot comments are being incorporated prior to a **second ballot** starting in August.

Cellular Dialing Plan (IS-52 Rev. A, PN-3166) • To be submitted to the TIA for ballot.

Subscriber Features (IS-53 Rev. A, PN-2977) • "Frozen" until IS-41 Rev. C is ready for ballot. Some minor changes based on the development of IS-41 Rev. C are being incorporated.

IS-41 Revision C (PN-2991) • Messages and procedures to support IS-53 Rev. A features are being developed and reviewed. **Balloting has been delayed until October, 1994.**

International Applications (TSB-29 Rev. B, PN-3173) •

TR-45.2 is studying several problems with international use of AMPS cellular. A TIA Joint Expert's Meeting (JEM) is being considered to resolve the most urgent problem; ambiguity of international mobile identification. The remaining problems are considered a lower priority and will be **completed in 1995.**

Online Call Record Transfer (IS-124 Rev. A, PN-3293) • TR-45.2 is considering revisions to the "DMH" standard for the online transfer of call records for billing, fraud and other purposes. This activity is a low priority and will be **completed in 1995.**

Subscriber Features (IS-53 Rev. B, PN-3362) • A list of features is being accumulated for development in Revision B of this standard. Activity beyond this will not proceed until IS-53 Rev. A is approved for publication.

Back Issues

All our back issues are available by fax or mail. Phone or fax us for a complete list of issues, contents and prices.

Figure 2: IS-41 Call Delivery Toolbox

Transaction	Acronym	Purpose	Interface	Added
RoutingRequest	ROUTREQ	Determining Call Delivery Routing	HLR->VLR ->MSC-V	IS-41-A
LocationRequest	LOCREQ	Determining Call Delivery Routing	MSC-G->HLR	IS-41-A
RegistrationNotification	REGNOT	Tracking Mobile Location	MSC-V->VLR ->HLR	IS-41-A
RegistrationCancellation	REGCANC	Freeing VLR resources	HLR->VLR ->MSC-V	IS-41-A
CSSInactive	CSSINACT	Stopping Call Delivery Attempts (for inactive mobiles)	VLR->HLR	IS-41-A
TransferToNumberRequest	TTNR	Obtaining Redirection Number when Call Delivery Fails	MSC-G/-V->HLR	IS-41-A
RedirectionRequest	REDREQ	Triggering Redirection when Call Delivery Fails	MSC-V->MSC-G	IS-41-A
IntersystemPage	ISPAGE	Paging in Neighbouring MSC	MSC-V->MSC-B	TSB-65
UnsolicitedResponse	UNSOL	Reporting Unsolicited Page	MSC-B->MSC-V	TSB-65

TIA TR-46 Committee
Public 1800 MHz PCS
Network Standards Project Report

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Published Interim Standards

IS	Title	Published
104	PCS Service Descriptions	05/94

Published Telecommunications Systems Bulletins (TSBs)

TSB	Title	Published

Projects in Ballot Process (SP = Standards Proposal Number)

SP	Title	Editor	IS/TSB
3211	Network Interconnection (based on IS-93)	P.J. Louis	IS-128

Completed Internal Documents

PN	Title	Editor	Completed
3167	System Requirements for 1800 MHz PCS	Stephen Jones	03/94

Active TR46.1 Projects (PN=TIA Project Number)

PN	Title	Editor	WG IS/TSB
3169	Network Reference Model	Vera Kripalani	II <i>internal</i>
3307	A Interface Requirements	Stephen Jones	
3368	System Requirements, Revised	Stephen Jones	I
3369	PCS Service Descriptions, Revision A	Stephen Jones	I IS-104-A

Active TR46.2 Projects (PN=TIA Project Number)

PN	Title	Editor	WG IS/TSB
3212	Intersystem Operations between PCS 1800 Systems		IS-129
3341	Intersystem Operations - IS-41 MAP based	P.J. Louis	
3342	- GSM MAP based	Eric Figueras	
3343	GSM A Interface (BS/MS)C)		
3344	ISDN A Interface (BS/MS)C)		
	GSM/IS-41 MAP Interoperability		