

Cellular Networking Perspectives

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Dial 9-1-1 for Confusion

The FCC is concerned about the level of service provided on emergency (9-1-1) calls from mobile phones. The complications of mobility results in poorer 9-1-1 service than in landline calls. The major problems are:

- The location of the calling mobile is either unknown or known only very vaguely (e.g. within a mile).
- Cellular phones cannot be called back easily, especially when the caller is roaming.
- Special subscriber information, stored in special 9-1-1 databases is not available for roamers.
- Cellular callers cannot be prevented from disconnecting.

The Telecommunications Industry Association (TIA) is starting to study this issue in subcommittee TR-45.2. A Joint Expert's Meeting (JEM) may be held on this topic around the middle of this year. To resolve all problems, both air interface and network changes will be required.

Trends at Wireless '94

The annual CTIA show, Wireless '94, is a good opportunity to see trends in the cellular industry, at least those trends that have left the lab and entered the marketplace.

The Seamless Network

At Wireless '93 the CTIA backbone network, operated by ITN, did not exist. While ITN is now providing an SS7 network to carry IS-41 traffic for

several carriers, more important are its proposed connections between networks. ITN has agreements to interconnect its SS7 IS-41 network with the AT&T Cellular Signaling Network, AvData's satellite packet switch network, the EDS and GTE networks supporting both IS-41 and proprietary protocols and the NACN connecting 45 carriers in Canada, the US and Mexico. These agreements, when implemented, will finally provide North America wide IS-41 connectivity to support seamless roaming. Now all that is needed is a central clearinghouse for roamer agreements, to remove the need for carriers to negotiate roamer agreements individually.

A+ Interface

Celcore, a provider of small cellular switches, can connect with 3 manufacturer's base stations using their version of the Base Station/MSB "A" interface. They plan to support the TIA standard "A+" interface when it is available.

Cellular Indoors

Southwestern Bell reported on trials of their Freedom Link cellular service in one of the largest buildings in the world. Through the use of 'leaky coax' antennas, regular cellular handsets can be used in low power operation throughout the building. The in-building cells are treated as a wireless PBX, allowing 5 digit dialing within the building.

Data over Cellular

CDPD was just a promise one year ago. This year products were being displayed, but the commercial rollout of infrastructure and applications has not yet happened.

Inter-System Call Delivery, Part II: The Exceptions are the Rule

In Part I of this series we discussed the TIA network reference model for call delivery and the normal call delivery case. However, normal is unusual for inter-system call delivery. In this part of our discussion of inter-system call delivery we will discuss how features such as call forwarding and call waiting complicate call delivery to roamers.

Many of the features defined in the TIA cellular features standard, IS-53, both the published Revision 0 and upcoming Revision A, have a significant impact on inter-system call delivery. Figure 1 illustrates the points in the flow of 'normal' call delivery where call forwarding or call waiting can redirect

the normal train of events.

Call Forwarding Unconditional

Call forwarding unconditional (i.e. all calls forwarded) cuts call delivery off before it has a chance to get started. The HLR returns the call forward number to the originating system without even querying the status of the mobile (Figure 1, Item A). The originating system does not have to know that the number returned is not a Temporary Local Directory Number (TLDN), it just routes the incoming call to it.

Call Forwarding Busy

Calls to a mobile with call forwarding on busy activated get a little bit further. The HLR has to query the VLR and Serving MSC, where the busy status of the mobile is known, before the busy condition is detected. The VLR returns a busy indication to the HLR which causes the HLR to return the call for-

warding number to the originating system (Figure 1, Item B).

Call Waiting

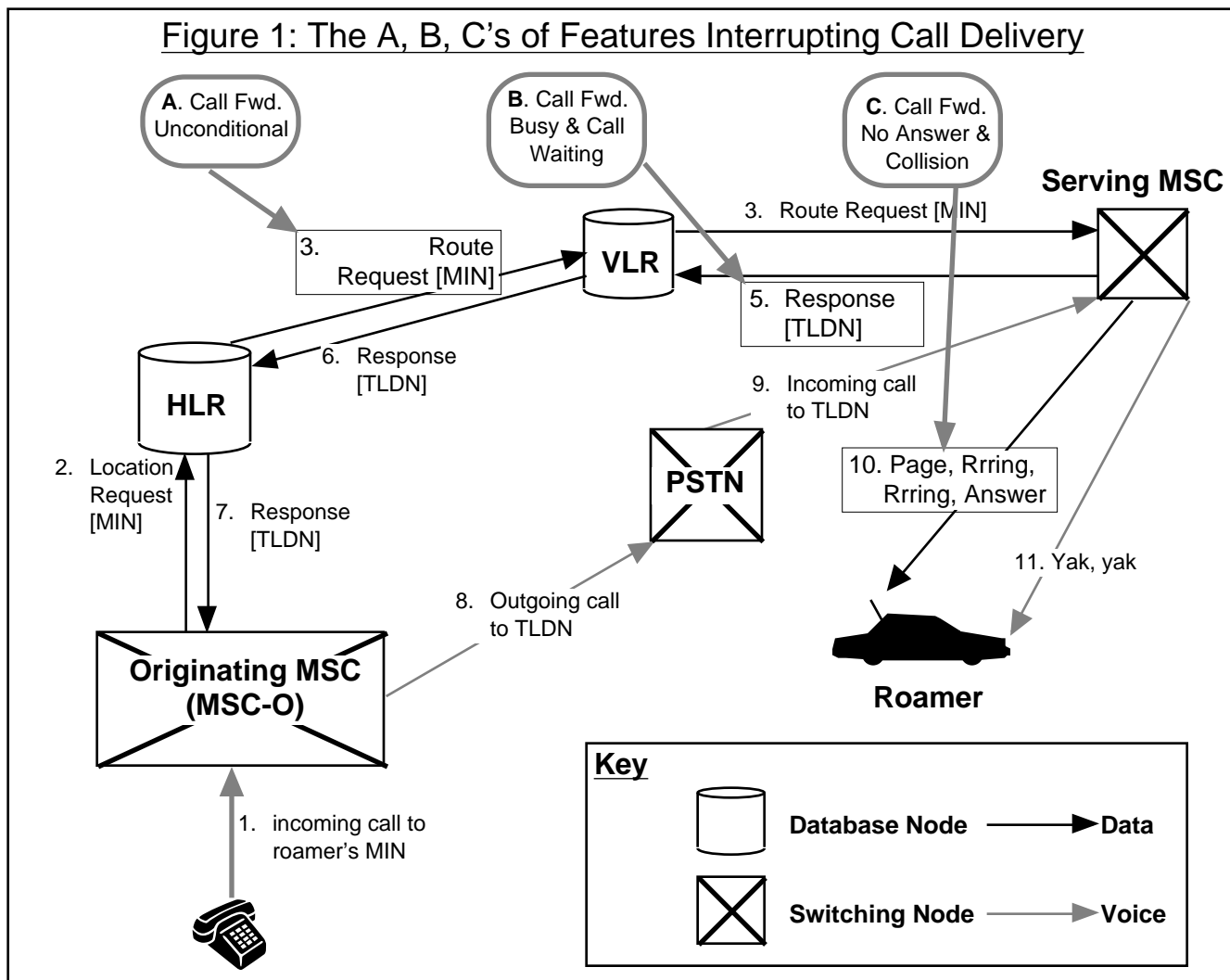
Call Waiting is a wrinkle on the Call Forwarding Busy scenario. If an IS-41 Route Request arrives at a visited system where the mobile is:

- Busy *and*
- has call waiting activated *but*
- no call is currently waiting

then a busy indication is *not* returned to the HLR, but a TLDN, as if the mobile was idle. Only when the call routed by the TLDN arrives at the visited system is special call waiting handling required.

Call Forward No Answer

Call Forward No Answer requires a call to a mobile to proceed as far as paging or even to alerting (ringing) the mobile. If the mobile is not turned on (and thus does not respond to a page) or is not answered,



a special IS-41 message, Redirection Request, can be sent to the originating system with the reason the call should be redirected. The originating system uses another IS-41 message, Transfer To Number Request to obtain the appropriate call forwarding number from the HLR. Figure 2 illustrates this scenario.

Call Collision

One unfortunate aspect of any real-time system is the hazard of interfering operations overlapping in time. Because the world keeps changing while a call is being processed, the mobile that was idle when the visited system was queried by a Route Request may be busy by the time the call guided by the TLDN arrives at the visited system. Another, even more exotic situation occurs when a mobile involved in one call at the time of a RouteRequest query with call waiting available is involved in two calls by the time the TLDN call

arrives. In both cases Call Forward Busy treatment can be provided but, as illustrated in gory detail by Figure 2, in a much more complicated fashion. In these call collisions cases, Call Forward Busy is handled like the normal Call Forward No-Answer case.

Other Features

IS-53 Revision A, under development, describes many new features, almost all of which interact with call delivery in some way. Without going into excessive detail, the following interactions are prominent:

- Flexible Alerting
This feature pages and alerts a group of related phones at the same time. Imagine the confusion if all the phones are roaming in different systems!
- Mobile Access Hunting
This feature pages and alerts a group of related mobiles one after

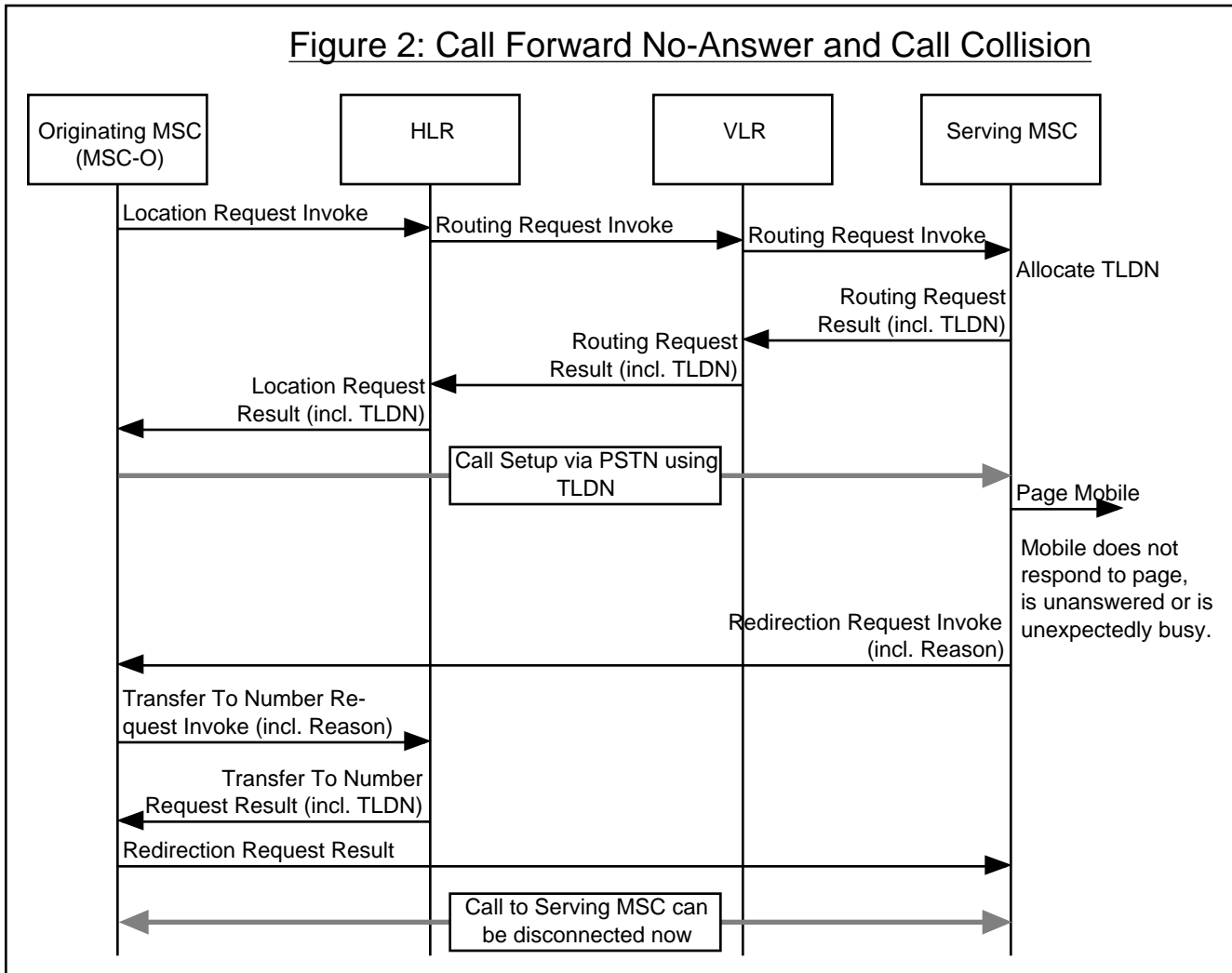
the other, connecting the call to the first to answer. Again, imagine the situation if some of the terminals are roaming.

- Calling Number Identification Presentation
This feature displays the number of the calling party on the display of a cellular phone (assuming that the phone has that capability). This information has to be transferred from the originating system to the visited system, requiring IS-41 modifications or the use of SS7 connections throughout the PSTN portion of the call, something that is currently rare in cellular.

Coming Up...

More complications to call delivery, particularly MFJ restrictions which makes some call delivery scenarios illegal!

Figure 2: Call Forward No-Answer and Call Collision



Back Issues Available

Back issues are available from July, 1992 to the present. Articles in recent issues are:

August, 1993

Bellcore Relinquishes Control of the NANP•Smart Cards, Dumb Phones?• A+ Interface Looks for a Home•Wireless Terminal Location Management Part III - Lessons for PCS•Goldilocks and the Three IS-41 Addressing Types

October, 1993

FCC Allocates PCS Frequencies•IS-53 Revision A, Part I - Cellular Feature Overload• Taking MINs to the Max - Problems with International Roaming•TIA TR-45.2 Project Status Report.

November, 1993

IS-41 Rev. A Compatibility Guidelines•IS-93: Timely or Time Bomb?• IS-53 Revision A, Part II - More Cellular Features•Status of IS-41 Rev. B Implementation.

December, 1993

IS-53 Revision A, Part III - The Last of the Features(?)•Summary of Features to be Included in TIA IS-53 Revision A•Structure of TIA Mobile & Personal Communications Committees

January, 1994

TR46: PCS Civil War•IS-53 Revision A, Part IV - Our Perspective on Features• Structure of TIA Committee TR46: Mobile & Personal Communications 1800 MHz "PCS" Standards• TIA TR-45.2 Project Status Report.

February, 1994

TR45.2 International WG VI - Musical Chairs•IS-41: The Networking Standard for PCS•TIA TR-46 Committee Public 1800 MHz PCS Project Status Report•TIA TR-45.4 Subcommittee Public 800 MHz PCS/Microsystems Project Status Report.

March, 1994

PTAG Announces Support for TIA Cellular Standards in PCS•Inter-System Call Delivery, Part I: Overview•TR-45.2 Standards Update: Border Cell TSB to be Published•TIA TR-45.2 Cellular Intersystem Operations Subcommittee Report

The price of a back issue is, by mail or fax is:

CDN\$25 Canada
US\$25 United States
US\$30 Other Countries

TR-45.2 Standards Update: IS-41 Rev. A Compatibility TSB Approved for Publication

TR-45.2 has approved TSB-55 on IS-41 Revision A Forward Compatibility for publication after successful resolution of concerns expressed in negative ballots by Motorola and McCaw. This document describes restrictions on IS-41 Rev. A implementations to ensure that inter-working with IS-41 Revision B is possible. The restrictions reduce the pickiness of compliant Rev. A implementations. As an example, an IS-41 Rev. A system that rejects incoming messages with unknown parameters will reject most IS-41 Rev. B messages. This TSB shows that there are times that thorough input checking, usually considered a sign of high quality software, is actually a nuisance.

The status of the major outstanding TR-45.2 projects follows:

Border Cell TSB (TSB-65, SP-2910) • In publication.

IS-41 Rev. A Compatibility (TSB-55, SP-3063) • Approved for publication.

IS-41 Rev. B Test Plan (TSB-42, SP-2978) • An application level test plan for IS-41 Rev. B, IS-53 Rev. 0 and TSB-51 has been **balloted as TSB-42**. Because of higher priorities, ballot comments were not reviewed at the March TR45.2 meeting, but will be **reviewed during the April, 1994 meeting.**

IS-41 Rev. B Technical Notes (TSB-41, PN-2985) • Will resolve many ambiguities in IS-41 Rev. B that have been detected as incompatibilities between different implementations of IS-41 Rev. A. Disagreements over the meaning of MSCID are still not resolved. Until these disagreements are resolved or TR45.2 agrees to remove this section, **TSB-41 will remain on hold.**

Cellular Dialing Plan (IS-52 Rev. A, PN-3166) • IS-52 has been rewritten but more review and discussion is required before its acceptance. **Balloting is scheduled for April, 1994, but will likely be deferred at least one month.**

Subscriber Features (IS-53 Rev. A, PN-2977) • Descriptions of all features have been accepted as baseline text. **Balloting is scheduled for May, 1994.**

IS-41 Revision C (PN-2991) • A baseline draft of this major revision to IS-41 has been developed. Most of the remaining work will be to incorporate the twenty new IS-53 Rev. A features and to support extended 15 digit mobile identifications to facilitate international roaming. Discussions are ongoing on major reformatting of the standard to make it more readable. **Balloting is scheduled for July, 1994.**

International Applications (TSB-29 Rev. B, PN-3173) • TR-45.2 is studying several problems with international use of AMPS cellular. This is considered a low priority project and will be **completed in 1995.**

Online Call Record Transfer (IS-124 Rev. A, PN-3293) • TR-45.2 recently opened this new project number to revise the just published "DMH" standard for the online transfer of call records for billing, fraud and other purposes. This activity is considered a low priority and will be **completed in 1995.**

New Copying Policy

The copying policy of *Cellular Networking Perspectives* has been revised. Effective with each subscription renewal or new subscription, each subscriber will be entitled to make up to 10 copies of each issue within their company. Subscription rates to permit making more than 10 copies are available upon request. Subscribers are welcome to make occasional copies for the purpose of recommending this newsletter to others within or outside their company.

GSM Seminar

Synacom Technology, Inc. is sponsoring a two day seminar on GSM Digital Cellular Communications in San Francisco on May 19th-20th, 1994. This seminar will emphasize the network aspects of GSM. For more information contact Synacom at (408) 296-0303, fax (408) 296-0982 or e-mail josie@synacom.com.

Status of IS-41 Rev. A Implementation

Cellular Networking Perspectives

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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)
	(HLR)	Commercial	12/93	-VD	X	Texas
	NTI	Commercial	12/93	-VD	X	NC 12, NC 13
AT&T	Astronet	Commercial	06/93	-VD	X	Baltimore/Washington (BAM)
	EDS PCD	Lab Trial		-V-	XS	
	Ericsson	Commercial	12/92	HVD	S	Salt Lake City (McCaw)
	GTE TSI	Commercial	<i>in service</i>	-VD	XS	<i>Several locations</i>
	Motorola	Commercial	<i>in service</i>	HVD	XS	<i>Several locations</i>
	NTI	Commercial	<i>in service</i>	HVD	XS	<i>Several locations</i>
EDS PCD	AT&T	Lab Trial		-V-	XS	
	Ericsson	Field Trial	11/93	-V-	S	Los Angeles (L.A. Cellular)
	Motorola	Commercial	08/92	-V-	X	Atlanta (PacTel)
Ericsson	AT&T	Commercial	12/92	HVD	S	Portland and others (McCaw)
	EDS PCD	Field Trial		-V-	S	Los Angeles (L.A. Cellular)
	Motorola	Commercial	<i>in service</i>	HVD	XS	<i>Several locations</i>
	NEC	Field Trial		HVD	S	Brazil
	NTI	Commercial	12/92	HVD	S	Tampa and Minneapolis (McCaw)
GTE TSI	Astronet	Commercial	06/93	-VD	X	Baltimore/Washington (BAM)
	(HLR)	Commercial	12/93	-VD	X	Lubbock, Texas
	AT&T	Commercial	<i>in service</i>	-VD	XS	<i>Several locations</i>
	Ericsson	Planning		-VD	S	Mexico
	Motorola	Commercial	06/93	-VD	X	Toledo
	NTI	Commercial	<i>in service</i>	-VD	XS	<i>Several locations</i>
	Plexsys	Lab Trial	12/93	-VD	X	
Motorola	AT&T	Commercial	<i>in service</i>	HVD	XS	<i>Several locations</i>
	EDS PCD	Commercial	08/92	-V-	X	Los Angeles (PacTel)
	Ericsson	Commercial	<i>in service</i>	HVD	XS	<i>Several locations</i>
	GTE TSI	Commercial	06/93	-VD	X	Toledo
	NEC	Field Trial	4Q/93	HVD		Brazil
	NTI	Commercial	<i>in service</i>	HVD	XS	<i>Several locations</i>
NEC	Ericsson	Field Trial		HVD	X	Brazil
	Motorola	Field Trial	4Q/93	HVD	X	Brazil
	NTI	Field Trial		HVD	X	Brazil
NTI	Astronet	Commercial	12/93	-VD	X	NC 12, NC 13
	AT&T	Commercial	<i>in service</i>	HVD	XS	<i>Several locations</i>
	Ericsson	Commercial	12/92	HVD	S	Ft. Myers (ICN/Palmer)
	GTE TSI	Commercial	<i>in service</i>	-VD	XS	<i>Several locations</i>
	Motorola	Commercial	<i>in service</i>	HVD	XS	<i>Several locations</i>
	NEC	Field Trial		HVD	X	Brazil
Plexsys	GTE TSI	Lab Trial	12/93	-VD	X	

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).