

Cellular Networking Perspectives

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PCS hot, PCS cold. Some like it GSM, some like it AMPS.

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An introduction to the basics of TIA IS-41 cellular intersystem call delivery.

TR-45.2 Standards Update: Border Cell TSB to be Published p. 4

Major news in February was the approval for publication of TSB-65 on cellular border cell problems, significant in its own right and as one of the precursors to IS-41 Rev. C.

TIA TR-45.2 Cellular Intersystem Operations Subcommittee Report p. 5

A summary of all Working Groups and Task Groups in the TIA TR-45.2 subcommittee, and the projects that each group is currently working on.

PTAG Announces Support for TIA Cellular Standards in PCS

The PCS Technology Advocacy Group has recommended the use of TIA cellular standards to cover major portions of PCS requirements. Their recommendation includes an air interface based on the IS-95 CDMA standard for "high tier" applications and intelligent networking based on the IS-41 intersystem operations standard. They also recommended the use of the Bellcore WACS system for a low tier air interface and ISDN protocols for the switch to radio equipment interface.

This recommendation by the members of PTAG (Bell Atlantic, Sprint, Time Warner and US West) appears to solidify the split in the PCS industry between companies that prefer adapting the European GSM standard to North American requirements against those that would prefer adapting North American standards to the 1800 MHz band.

Inter-System Call Delivery, Part I: Overview

IS-41 Intersystem Call Delivery enables calls to be placed to a cellular phone no matter where it is in the North American cellular coverage area. This is seen as a good thing by some people.

Call Delivery is the automatic roaming capability most visible to end-users, although inter-system handoff and roamer validation are at least as important. Although intersystem call delivery has existed in cellular from the very beginning, it is the fully automatic nature of IS-41 call delivery that sets it apart and above its predecessors. The earliest method of call delivery was the Roamer Port, still in use today. Its major disadvantage is that the onus on locating and routing to the roaming mobile is entirely on the calling party. When the IS-41 standard was slow in delivering fully automatic call delivery two businesses, showing entrepreneurial spirit, provided proprietary semi-automatic call delivery methods. Both GTE FMR and EDS RoamingAmerica provide call delivery under the control of the roaming mobile, a significant improvement over the Roamer Port method. These services suffer mainly because they must be manually activated every time a roamer crosses an invisible system boundary.

Call Delivery was incorporated later into IS-41 than intersystem handoff because it requires a nationwide signaling network to allow delivery of calls between any home system and any system being visited by a roamer. Handoff was the first capability

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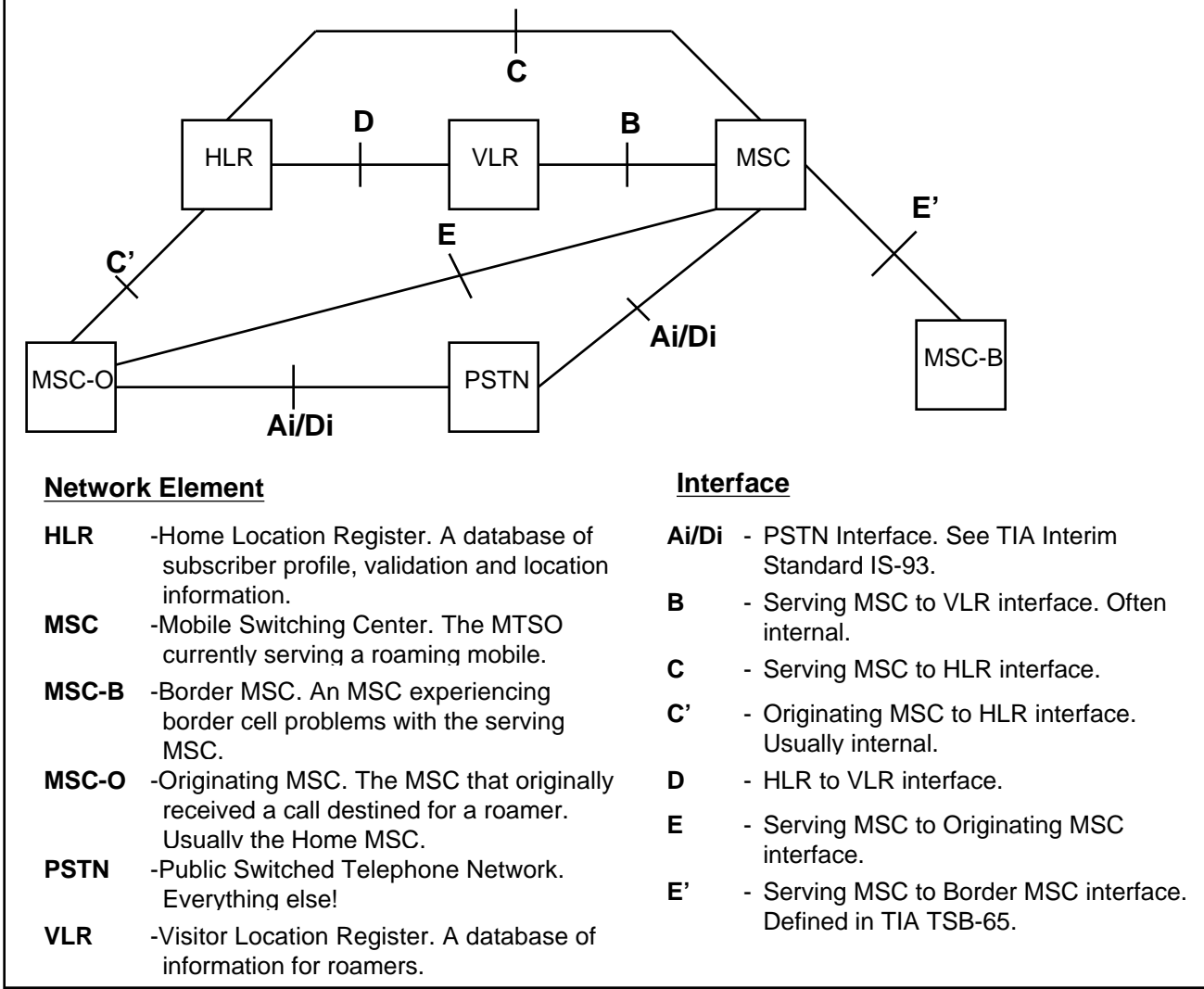
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Comments Welcome

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

Figure 1: Network Reference Model for Cellular Intersystem Call Delivery



provided in IS-41 because it required only point-to-point data links and trunks between two neighbouring systems.

Network Reference Model

The conceptual network reference model used in this discussion is shown in Figure 1. It is conceptual because actual implementations of IS-41 often eliminate interfaces by merging network elements. For example, MSC and VLR functions are usually provided in one physical box just as HLR and MSC-O functions are usually combined. The conceptual view of the network provided by the reference model is useful because it is relatively independent of implementation, and allows for more

forward looking standards to be developed. It was the acceptance of this reference model that made the business of making standalone HLRs possible.

Basic Call Delivery

The basic IS-41 call delivery scenario is quite simple. We describe it first to form a base from which all the variants due to feature interactions, network configurations and business and regulatory restrictions can be described.

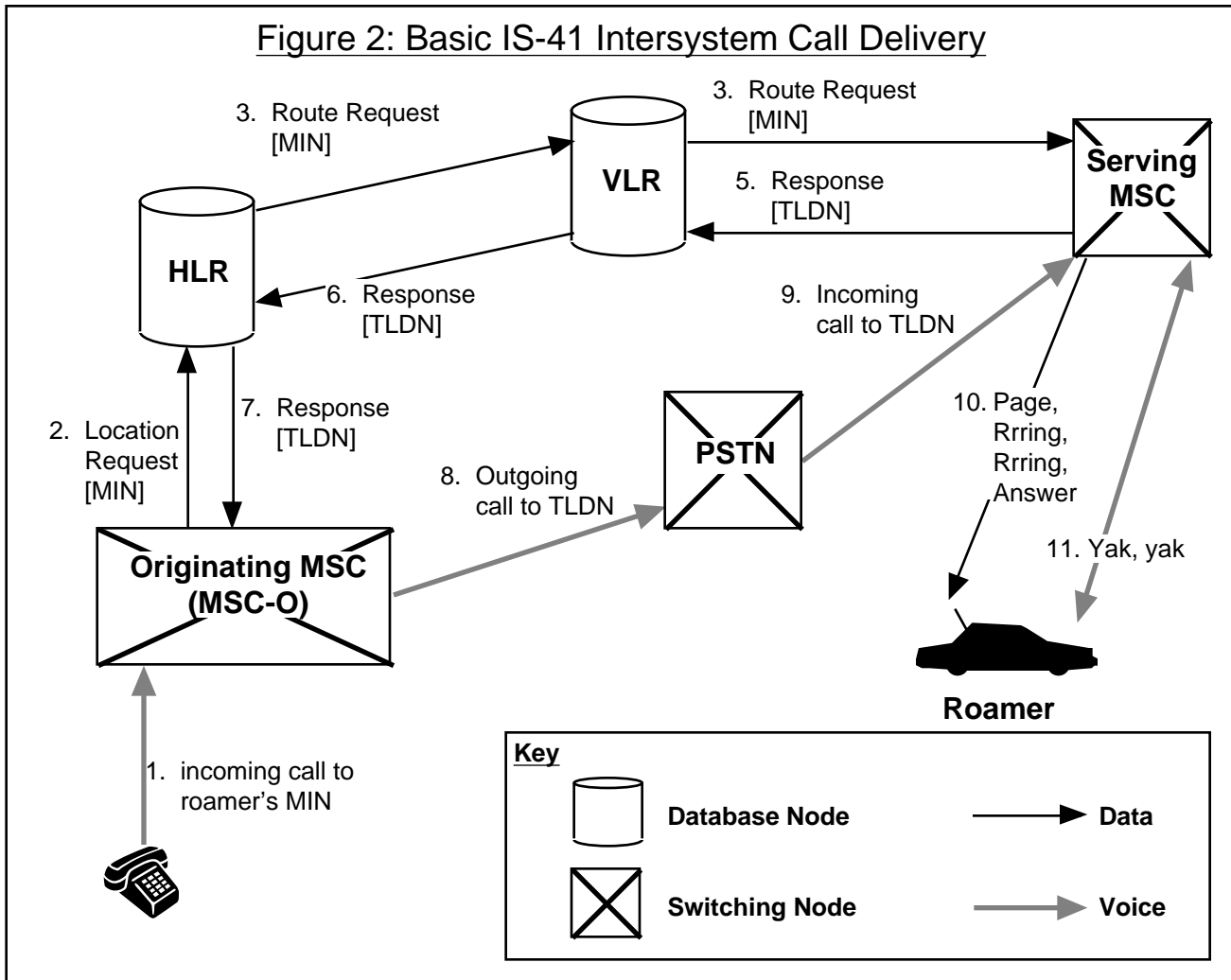
Intersystem call delivery, as defined by IS-41, consists of two major phases: first determining how to reach a mobile and then extending the

pending incoming call using the "TLDN" routing information from the first phase.

The TLDN Concept

Mobile routing is controlled in IS-41 call delivery by a Temporary Local Directory Number (TLDN). A TLDN is simply a phone number owned by the visited MSC that has been set aside to facilitate intersystem call delivery. Because a TLDN looks, to the PSTN, like any other number owned by the visited MSC, it allows the mobility-challenged PSTN to route calls to a roaming mobile phone. If the MIN was used, the PSTN would of course route the call to the home system. Using a TLDN is not the only method that could be used for inter-system call delivery and, in many cases more efficient methods are

Figure 2: Basic IS-41 Intersystem Call Delivery



possible. But the TLDN is the only method that works in all cases in today's regulatory environment within the capabilities of today's PSTN switching infrastructure.

The TLDN should not be confused with the location used in mobile location tracking. The TLDN is a PSTN address that allows voice calls to be directed through the PSTN for a single call and is unique to a single mobile for the duration of call setup. The mobile location is the address of the VLR or MSC where a mobile is currently registered and is shared by all mobiles registered at that location. A mobile location is valid as long as a mobile is registered in one location while a TLDN is valid for only the setup portion of call delivery. For IS-41 call delivery, the mobile location is used to route the RouteRequest message over a data network to the correct VLR/MSC and the TLDN is used to extend the incoming call

through the PSTN voice network.

The Basic Call Delivery Process

Figure 2 illustrates the basic IS-41 inter-system call delivery process:

1. Someone, somewhere, from any type of phone dials the phone number (e.g. MIN) of a mobile that is currently roaming.
2. The MSC that receives this call (MSC-O) sends an IS-41 Location Request message to the HLR.
3. The HLR has been continually tracking the location of the mobile and is therefore able to send a Route Request message to the VLR where the mobile is currently registered.
4. The VLR has been tracking the location of the roaming mobile within its domain and forwards

the Route Request message to the current serving MSC.

5. The serving MSC allocates a Temporary Local Directory Number (TLDN) for the purposes of the call. The TLDN is sent to the VLR in the response to the previous Route Request.
6. The VLR forwards the Route Request, containing the TLDN, to the HLR.
7. The HLR responds to the initial Location Request with the TLDN from the serving MSC.
8. The Originating MSC outpulses the TLDN to the PSTN.
9. The PSTN routes the call to the serving MSC based on the TLDN digits. The serving MSC can now return this TLDN to the pool of idle TLDNs.
10. The serving MSC pages the roaming mobile and, after the mobile responds to the page, it alerts (rings) the mobile

Back Issues Available

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

July, 1993

ITN Named CTIA Backbone IS-41 Network Provider•Wireless Terminal Location Management, Part II• TR-45.2 Grows More Tentacles•TR-45.2 Continues to Pump Standards Out.

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 •Status of IS-41 Rev. A Implementation.

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.

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until the roamer answers by pressing SEND.

11. The caller and the roamer can talk while the system rests.

Call Delivery Continued ...

Future issues of *Cellular Networking Perspectives* will complete the discussion of IS-41 inter-system call delivery. Topics remaining to be discussed include:

- The interaction of features, such as call forwarding and call waiting, with call delivery.
- The impact of MFJ restrictions on call delivery.
- Billing considerations.
- Interactions between call delivery and other IS-41 capabilities such as handoff, validation and location management.
- A summary of IS-41 revisions and associated TSBs, and the incremental enhancements to call delivery they have provided.
- Why the least cost routing capabilities of IS-41 call delivery are not yet used.
- Compatibility between systems supporting IS-41 call delivery and those supporting older protocols.

TR-45.2 Standards Update: Border Cell TSB to be Published

TR-45.2 has approved TSB-65 on Mobile Border System Problems for publication after successful completion of a second ballot. This document describes extensions to IS-41 Rev. B intersystem operations to resolve, or at least mitigate, problems that occur on boundaries between cellular systems due to errors or limitations of the AMPS analog and, to a lesser extent, digital air interfaces.

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

Border Cell TSB (TSB-65, SP-2910) • Approved for publication, following approval of editing changes by an editorial review team.

IS-41 Rev. A Compatibility (TSB-55, SP-3063) • Procedures to allow IS-41 Rev. A implementations to be forward-compatible with Rev. B. Differences over resolution of SS7 Subsystem Number (SSN) compatibility concerns will be resolved at the March TR45.2 meeting by consensus or by vote. **TSB-55 is scheduled for release for publication in March, 1994.**

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 **been balloted as TSB-42.**

Ballot comments will be reviewed at the March TR45.2 meeting.

IS-41 Rev. B Technical Notes (TSB-41, PN-2985) • Will resolve several ambiguities in IS-41 Rev. B that have been detected as incompatibilities between different implementations of IS-41 Rev. A. If disagreements over the compatibility requirements for MSCID can be resolved, **TSB-41 will be released for publication in March, 1994.**

Cellular Dialing Plan (IS-52 Rev. A, PN-3166) • IS-52 is being almost completely rewritten. **Balloting is scheduled for April, 1994.**

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, but many procedures, messages and parameters remain to be defined. 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. **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.**

TIA TR-45.2 Cellular Intersystem Operations Subcommittee Report

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WG	TG	Mandate	Chair	PN	Title	Editor
Plenary		Cellular System Operations	John Marinho	2910	Border Cell Problems (TSB-65)	David Crowe
I		Messaging and Protocols	Charles Ishman	2985	Technical Notes for IS-41 Revision B	Arzu Çalis
				2991	Cellular Radio Telecommunications Inter-system Operations (IS-41-C)	Terry Watts
				3063	IS-41 Rev. A/B Forward Compatibility	Charles Ishman
	1	Decision Points Text	David Crowe	2991	IS-41 Rev. C	
	2	Authentication Procedures for IS-41 Rev. C	Terry Jacobson	2991	IS-41 Rev. C	
II		Automatic Roaming	Cheryl Blum			
III		Inter-system Handoff	Thomas Ginter			
	1	Fax & Data	Thomas Ginter		Circuit Switch Fax & Data Over Digital (TDMA) Cellular	
IV		Message Accounting	John Willse	3293	Cellular Inter-System Non-Signaling Data Communications (IS-124-A)	Kirk Carlson
V		Features	Terry Watts	2977	Cellular Features Description (IS-53 Rev. A)	Terry Watts
VI		International Applications	Arzu Çalis	3173	International Implementation of Cellular Radiotelephone Systems Compliant with ANSI/EIA/TIA-553 (TSB-29-B)	Steve Jones
VII		Interfaces to Other Telecommunications Networks	P.J. Louis	3295	Ai and Di Interfaces Standard (PSTN/MS) (IS-93 Rev. A)	
	1	IS-52 Rev. A Editing	Charlene Meins	3166	Uniform Dialing Procedures for use in Cellular Radiotelephone Systems (IS-52 Rev. A)	Steve Jones

Notes: WG - Working Group number (assigned by TIA TR-45.2 sub-committee)
TG - Task Group or Editorial Group number
PN - Project Number (assigned by the TIA)