

Cellular Networking Perspectives

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Vol. 5, No. 6 June, 1996

In This Issue...

Perspectives by Email! p. 1
Cellular Networking Perspectives will soon be available by email, as well as by fax and postal delivery.

Price Increase Notification p. 1
The price of *Cellular Networking Perspectives* is increasing, effective July 1, 1996. A regular subscription increases from \$250 to \$300 per year.

Web Pickings This Month p. 1
Try out our expanded TIA page at <http://www.cnp-wireless.com/tia.html>.

New Chair for TR-45.5 p. 1
The TIA TR-45.5 subcommittee for CDMA digital wireless communications has a new chairman.

***Life on the Border,
Part II: Intersystem Page Defences*** p. 1
The most powerful defence against border cell problems is intersystem paging, using the TIA standards TSB-65 or IS-41 Rev. C.

TR45.2 Standards Update p. 5
An update on the TIA subcommittee TR-45.2 projects to develop standards for wireless networks.

***TIA TR-45.4 Subcommittee
Public 800 MHz PCS/Microsystems
Project Status Report*** p. 6
A list of the standards developed by the TIA subcommittee TR-45.4 focussing on the BS/MS "A" interface.

***Look forward to your next issue on:
July 3, 1996***

Perspectives by Email!

We will soon be starting a beta trial for distributing *Cellular Networking Perspectives* by email. If you would like to participate, please email Muneerah Vasanji at 102371.3324@compuserve.com. We will send volunteers one or two sample email newsletters and ask that you fill out a short survey giving your impressions of alternative distribution methods. □

Price Increase Notification

The price of *Cellular Networking Perspectives* is increasing effective July 1, 1996. A regular annual subscription increases from \$ 250 to \$ 300 per year. Individual back issues are available at \$ 30.00 per issue. To take advantage of our current rates, renew your subscriptions before July 1, 1996. You can also benefit from our new bulk rates for back issues ordered by the year. For a complete listing of our new prices, refer to page 7 of this issue. Our subscriptions department will answer all your questions regarding the new prices. Just call 1-800-633-5514 or email at cnp-sales@cnp-wireless.com. □

Web Pickings This Month

Try out our beefed up web page on the TIA this month: <http://www.cnp-wireless.com/tia.html>. And don't forget that our quiz is changed monthly (<http://www.cnp-wireless.com/quiz.html>). You too can win a T-Shirt, or at least a free back issue, if you act quickly! And, as a reader of this newsletter, you have the advantage that all the information you need to answer the questions can be found in recent issues. □

New chair for TR-45.5

TR-45.5, the TIA standards subcommittee responsible for CDMA digital cellular and PCS standards, recently appointed a new chair: Jean Alphonse, the Assistant Director, Wireless Technology Development for Ameritech Cellular Services. Jean's priority for the committee in 1996 is to merge the IS-95 Rev. A cellular standard and the J-STD-008 PCS standard in IS-95 Revision B by the end of the year. This merged version will also include TSB-74, which allows for 14.4 kbps voice and data operation. □

Life on the Border, Part II: Intersystem Page Defences

The TIA standards committee TR-45.2 has long recognized the existence of border cell problems (see the May, 1996 issue for more details). TIA TSB-65 first described solutions to some border cell problems, as extensions to the IS-41 Revision B intersystem operations standard. IS-41 Revision C further enhanced the suite of solutions. These standards allow a carrier to better defend their border, resulting in fewer lost and dropped calls. However, it is impossible to completely solve problems using a network based approach when the problems arise mainly in the mobiles, and each solution has some drawbacks. Consequently, border cell solutions have to be implemented with open eyes, and with a readiness to monitor traffic statistics to verify the effectiveness of the solutions and a willingness to try different alternatives to find the optimal solution for your system.

A Varied Toolbox

TSB-65 and IS-41 Revision C provide an extensive toolbox for alleviating border cell problems. The most important tool, Intersystem Paging, solves a variety of problems. It will be discussed in this issue, the remaining problems will be discussed in the July, 1996 issue.

1. Intersystem Paging

This must be a good tool because it has so many flavours! It helps resolve problems that arise from failures in mobile location tracking, paging rescans to a neighbouring system or even when a mobile decides to move to a new system at the same time that a call is arriving for it.

2. Registration Discrimination

This set of two tools assists with multiple access problems (i.e. the same message being received by two different control channels) and internal network race conditions (messages arriving out of order because they traverse different network paths to a common point, such as an HLR).

3. Mobile Marking

By marking a mobile for special treatment after it originates a call without first registering, the subsequent loss of incoming calls can be reduced in likelihood. This technique has nothing in common with the method dogs use to mark trees and posts on the border of their territory!

4. Authentication Coordination

This solution, introduced in IS-41 Rev. C, solves an important (and recently introduced) border cell problem relating to the random numbers used in CAVE authentication. It is an important solution to prevent fraudsters from taking advantage of border cell anomalies to circumvent authentication.

Intersystem Paging

Intersystem paging solutions are based on the recognition that, if a mobile's location is not known, it is most likely in a neighbouring system. By providing tools that allow a page received in a neighbouring system to be handled, problems relating to an incorrect mobile location stored at an HLR, paging rescan or a recent registration can be overcome. These solutions are not perfect, and only reduce the frequency with which incoming calls will fail. They also increase the use of network and radio resources, which must be carefully managed to ensure that "the remedy is not worse than the disease". These solutions also introduce a compatibility problem from the sheer number of options. Since it is unlikely that every manufacturer and carrier will implement every solution, it is likely that some border areas will not have any solution because the choices of the two neighbouring equipment manufacturers or carriers are different.

Pre-Delivery Paging

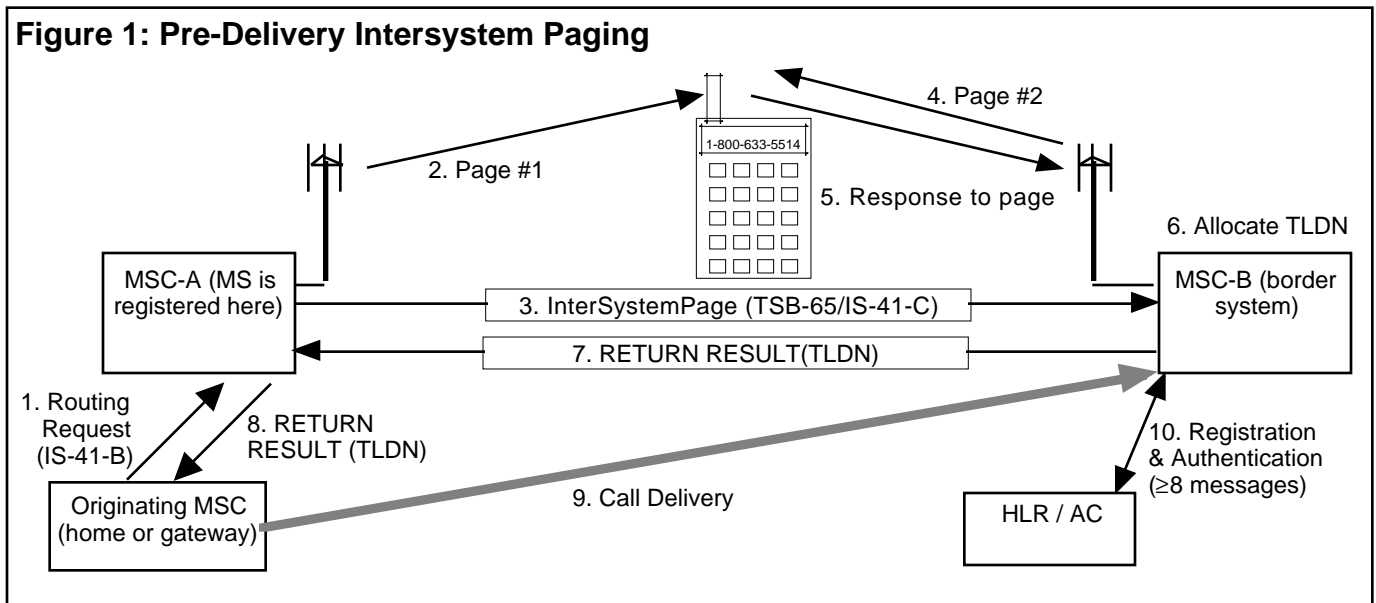
Figure 1 illustrates the flow of messages

required for intersystem paging before call delivery occurs. When a system receives notification of a pending incoming call for a roamer in its area (through the IS-41 RoutingRequest message), it can initiate paging both within its system and in one or more neighbouring systems (through the IS-41/TSB-65 InterSystemPage message). If paging is successful, the border system can allocate a TLDN (Temporary Local Directory Number) for routing (see the March, 1994 issue for a description of the use of a TLDN). This TLDN will be passed back to the originating system, instead of a TLDN allocated by the MSC where the mobile is registered. This allows the actual call delivery to bypass the current serving system, and go directly from the originating system to the border system (Figure 1, step 9).

When inter-system paging is successful, the system receiving the page response can choose one of two options for the mobile in the interim until the call delivery occurs:

1. Page again later.

This method treats the page response as just an indication that the mobile is present. When TLDN call routing is complete (step 9 in Figure 1), the mobile must be paged again and then assigned a voice channel. Some calls will be lost, because this choice cannot guarantee that the mobile will be available a few seconds later (especially in a border cell!). This choice also consumes more control channel bandwidth.



2. Assign the mobile to a voice channel. This method leaves the mobile in an intermediate state during TLDN call setup. The mobile will be unable to originate a call, yet to the user will still appear to be idle (which could be confusing). It also uses a voice channel for an operation that does not generate revenue.

Either choice is legitimate, and illustrates again the number of tough decisions that resolving border cell problems requires. Each choice must be measured against questions such as "Do we have enough control channel bandwidth? Do we have spare voice channel capacity? Will it confuse our customers?"

This solution utilizes a new IS-41 message, *InterSystemPage*. This is sent from the system where the mobile is registered (current serving system) to the border system, to initiate paging. The response contains, among other parameters, the TLDN that will be used to route the call.

Prior to the dismantling of Department of Justice MFJ restrictions, this inter-system paging solution was thought to be illegal by some. This is one of the reasons that several different solutions were standardized. However, with the new telecom reform bill in the US, all carriers can take advantage of this solution without fear of legal retribution.

Unsolicited Page Response

If inter-system paging is not initiated, rescanning problems may cause some page

responses to show up in a border system anyway. This occurs because a mobile that receives a page message will rescan for the strongest control channel before responding. This channel may be in a neighbouring system. In this case, TSB-65 allows the border MSC to send IS-41 *UnsolicitedResponse* messages to one or more neighbouring systems that it thinks 'might' have initiated the page. This message contains a TLDN that again can be used to route the call directly from the originating system to the border system, bypassing the system where the mobile was registered, and to which the IS-41 *RoutingRequest* message was directed.

Unsolicited Page Response handling can be effective if paging rescanning problems are the most significant problems (and not other types of rescanning problems that result in the mobile being 'lost'), if control channel usage is a significant concern, and if most border cells abut only one other system. It applies only to page responses that were initiated by pre-delivery paging.

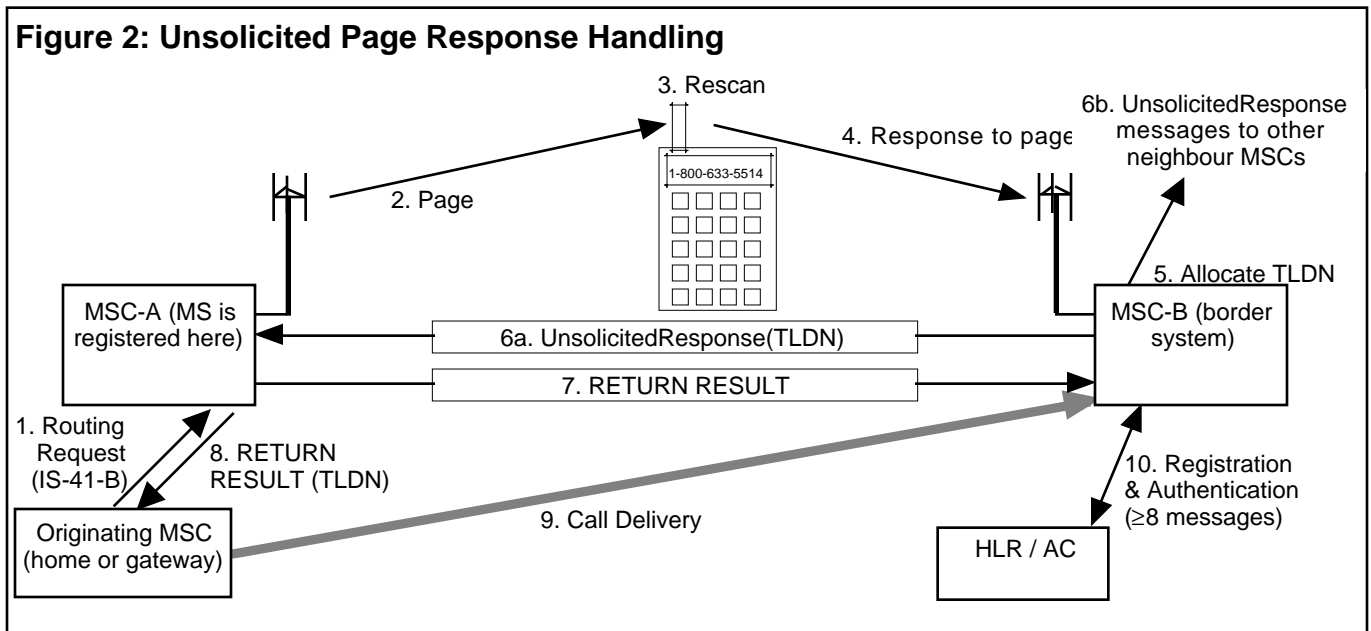
Post-Delivery Paging ("Handoff")

All solutions for border cell problems in TSB-65 relied on paging occurring prior to allocation of a TLDN by the serving system. This is surprising because paging is not normally done at this point. Also, at the time the TSB was written, inter-system paging was believed to be illegal by many (due to MFJ restrictions) unless weighed down with restrictions (such as 'listen only', described below, which sig-

nificantly reduces its effectiveness). These drawbacks of previous inter-system paging methods are the reason that IS-41 Revision C included one more method of inter-system paging, a method that is by far the most complex, at least from an IS-41 inter-system signaling perspective.

Post-delivery inter-system paging requires three new IS-41 messages:

- **InterSystemPage2**
This message is similar to the original *InterSystemPage* message, in that it initiates paging in a border system (Figure 3, step 3b). However, it differs substantially because it contains parameters that allow call setup to occur on inter-system "handoff" trunks, rather than using the TLDN method. For this reason, the response to this message does not contain a TLDN (Figure 3, step 6)
- **InterSystemSetup**
If a response to an *InterSystemPage2* message indicates that a page response was received, the *InterSystemSetup* message is used to allocate an inter-MSC voice circuit (Figure 3, step 7). Except in cases of glare, the response to this message confirms the choice of the circuit (Figure 3, step 8). These circuits are also used for inter-MSC handoff, and are managed by the same OA&M messages (e.g. *Blocking* and *ResetCircuit*).
- **InterSystemAnswer**
Inter-system paging obviously occurs



before a call is answered. The Anchor MSC must be notified when the mobile answers, using this new message. This message also has the beneficial side effect of allowing an IS-41 inter-MSC handoff to occur before a call is answered.

It might appear from the diagram, that this method results in more inter-system signaling, but actually the opposite is true. This is because the other methods require four IS-41 command/response sequences after the call is established:

- (1) RegistrationNotification to the HLR,
- (2) RegistrationCancellation to the old serving system and (3) Authentication Request to the HLR, which (4) must be forwarded by the HLR to the AC. If the MSCs and VLRs are not combined, even more messages are generated.

An apparent disadvantage of the Post-delivery method is that it involves the current serving system as an 'Anchor MSC' in the voice path of the call, and requires the allocation of inter-MSC circuits.

However, this is a benefit in reducing the incidence of subsequent border cell problems by keeping the mobile's location unchanged. Other methods cause the mobile location (as recorded at the HLR) to be moved to the border system, yet the mobile does not know this. If the mobile returns to the system where it was

registered after the call ends (which is quite likely), it will not register (as the mobile still believes it is registered there), yet the HLR will continue to record the location as the border system (that received the page response). Pre-delivery solutions perpetuate the need for inter-system paging by solving a problem for one call, but often creating a problem for future calls.

Listen Only Paging

A variation on normal inter-system paging is to ask the border system to only "listen" for a page response. This only resolves border cell problems caused by page response rescans, and not when the mobile location is recorded incorrectly. The main advantage of this method is that it does not violate MFJ restrictions, an advantage that is no longer relevant. The only remaining advantage is that it reduces the usage of control channel bandwidth. It is unlikely that with the recent change in the US regulatory framework, that this tradeoff of control channel bandwidth versus termination success rate will be chosen.

Listen Only Paging is similar to the Unsolicited Page Response solution. Neither solution requires paging in a border system and both solutions are limited to resolving problems caused by paging rescans. The network signaling bandwidth used by both solutions varies. Sometimes

one solution will be more efficient, sometimes the other. Listen Only Paging requires a message to be sent to every neighbouring MSC that might *hear the page response*, while the Unsolicited Page Response solution requires a message to be sent to every neighbouring MSC that might have *initiated the page*.

The Listen Only Paging solution applies to both pre-delivery paging and post-delivery paging, with an indicator parameter incorporated in the IS-41 InterSystemPage and InterSystemPage2 messages.

Comparison of Solutions

All of the inter-system paging solutions to border cell problems have advantages and drawbacks. As can be seen from Table 1, the more resources the solutions consume, the more benefits they confer, but no solution is without some drawbacks.

Continued...

In the July, 1996 issue we will cover the remaining solutions to border cell problems that are described in TSB-65 and IS-41 Revision C. □

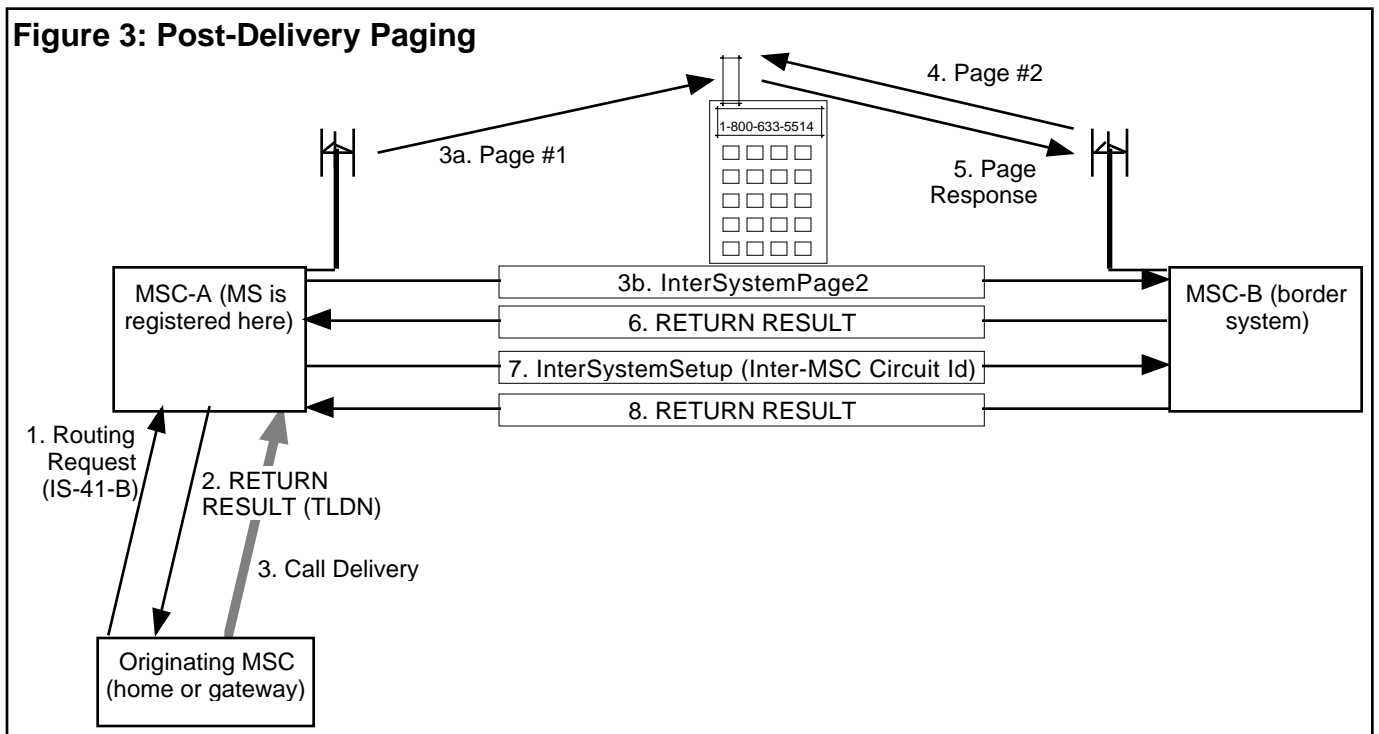


Table 1: Comparison of Intersystem Paging Solutions

Solution	Problems Solved			Resource Waste			
	Lost Mobile?	Paging Rescan?	Registr'n Race?	IS-41 signaling	Inter-MSC Circuit	Control Channel	Voice Channel
Pre-Delivery Paging:							
page again	+	+	+	high	no	high	no
assign voice channel	+	++	++	high	no	medium	yes
Unsolicited Response:							
page again	-	+	-	high	no	medium	no
assign voice channel	-	++	-	high	no	low	yes
Post-Delivery Paging	++	++	++	medium	yes	medium	no
Listen Only Paging:							
pre-delivery	-	+	-	high	no	medium	no
post-delivery	-	+	-	high	yes	low	no

TR-45.2 Standards Update

TIA subcommittee TR-45.2 is gradually putting together all the pieces required to publish IS-41 Revision D. IS-124 Revision A is out for ballot (although without modifications to support data and intelligent peripherals).

In Press

Cellular Dialing Plan (IS-52 Rev. A, ANSI/TIA/EIA-660)

- IS-52 Rev. A was published as a TIA interim standard in March, 1995. It is *in press*, with minor modifications, as ANSI/TIA/EIA standard 660.

Subscriber Features (IS-53 Rev. A, ANSI/TIA/EIA-664)

- IS-53 Rev. A was published as a TIA interim standard in April, 1995. It is *in press* with no changes, as ANSI/TIA/EIA standard 664.

IS-41 Revision C (SP-3588)

- Published as a TIA interim standard in February, 1996. ANSI ballot (as Standards Proposal SP-3588) will complete July 1, 1996.

Nearing Completion

PCS Multi-band (TSB-XX, PN-3624)

- This TSB will define modifications to IS-41 messages and procedures to allow interoperability between Cellular and PCS systems, and between the different licensed frequency bands within Cellular and PCS systems. Ballot comments are being reviewed, and are scheduled for resolution by the end of May, 1996.

Online Call Record Transfer (IS-124 Rev. A, PN-3293)

- Includes a variety of improvements and corrections over Rev. 0, including internationalization (i.e. support of IMSI). Not included are major changes to support intelligent network peripherals and data. These will be incorporated in a subsequent TSB or in IS-124 Rev. B (PN-3725). Out for ballot until July 5, 1996.

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

- In Verification & Validation (V&V). This revision adds lists of known non-NANP MIN usage, a list of applicable global titles and a recommendation to use ANSI TCAP even if ITU SCCP and MTP SS7 layers are used.

Subscriber Features (IS-53 Rev. B, PN-3362)

- A number of new voice and data features. Scheduled for ballot in June, 1996.

In Development

Inter-System Link Protocol (ISLP) (PN-3660)

- A new inter-MSC protocol is required to support the transmission of data from digital phones following an inter-system handoff. Scheduled for ballot as an interim standard starting July, 1996.

Emergency Services (PN-3581)

- A Stage II (network) description of enhanced wireless 9-1-1 has been approved as baseline, and Stage III (protocol encoding) is proceeding.

TDMA DCCH (PN-3579)

- Definition of network support for new features inherent in the IS-136 digital control channel (IS-136). Scheduled for incorporation in IS-41 Rev. D.

CDMA Capabilities (PN-3619)

- The definition of features based on IS-95 Rev. A capabilities. Scheduled for incorporation in IS-41-D.

Data Services (PN Pending)

- Transmitting data from CDMA and TDMA digital is more complex because voice coders are incompatible with analog modem tones. While air interface solutions have been published, solutions to allow automatic roaming and inter-system handoff are being developed for inclusion in IS-41-D.

IS-41 Rev. D

- Task groups (listed above), working on the projects are developing text for each of the capabilities in IS-41 Rev. D. This revision will include IS-53-B features and non-feature capabilities, such as IMSI. The ballot is currently scheduled to start in *August, 1996*. PCS multiband work, and possibly the output of other task groups, will be published in TSBs prior to publication of IS-41-D.

Law Enforcement Intercept (PN-3580)

- Law enforcement requirements are being developed by TR-45.2, with liaison and assistance from TR-46, T1P1 and T1S1. Several major areas of disagreement still exist, although the concept of a single telecommunications standard (including both wireline and wireless systems) appears to be

acceptable. *Scheduled for ballot in August, 1996.*

recently slipped to *December, 1996.*
WIN features are no longer planned for inclusion in IS-41 Rev. D

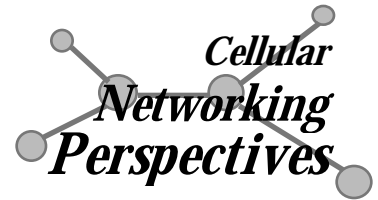
WIN: Wireless Intelligent Network (PN-3661)

- An ad hoc group, meeting outside TIA TR-45.2 subcommittee meetings, is developing a call model and IS-41 procedures to support WIN features. Currently, target features include Incoming Call Screening, Voice Controlled Services and Calling Name Presentation. The schedule for ballot

Call Detail/Billing Records (PN-3725)

- A new project has been initiated to study modifications to IS-124 to support data services and intelligent peripherals. These modifications were not completed in time for IS-124-A. A workplan is being developed. □

TIA TR-45.4 Subcommittee Public 800 MHz PCS/Microsystems Project Status Report



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Last Published July, 1995

Published Documents

Standard	Description	WG	Published
EIA/TIA-634	MSC-BS "A" Interface Standard	II	01/96
IS-94	Mobile Station - Land Station Compatibility Specification for Analog Cellular Auxiliary PCS (CAPCS)	III	05/94
TSB-104	PCS Service Description (now IS-104 in committee TR-46)	I	06/94

Completed Internal Documents

PN	Description	WG	Editor
3142	Cellular Microcell/Microsystems Requirements Document	III	Steve Jones
3296	MSC-BS Interface (A-Interface) Requirements for Public 800 MHz	II	Mike Burke

Active TR45.4 Projects (PN=TIA Project Number)

PN	Description	Editor	IS/TSB
3662	IS-634-0 Addendum (corrections, SMS, subrate voice frame format)	Steve Jones	TSB-xx
3539	MSC-BS Interface (A-Interface) Standard, supporting: <ul style="list-style-type: none"> • IS-136-A (TDMA DCCH) • IS-95 Rev. A (CDMA) • IS-91 Rev. A (analog) • EIA/TIA-553 Rev. A (analog) • IS-41 Rev. C and IS-53 Rev. A • Short message service • Data services for CDMA (IS-99) and TDMA (IS-130, IS-135) • Frame Relay transport • 1800 MHz band operation • Optimization 	Steve Jones	IS-634-A
3746	ISDN based A-Interface, adding: <ul style="list-style-type: none"> • address alignment with Mobility Management Application Protocol (MMAP) • CDMA and TDMA support, and • support for architectures with separate mobility management and call control functions (e.g. PACS) 		IS-653-A