

# Cellular Networking Perspectives

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Vol. 4, No. 1 January, 1995

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**Next issue due: Feb. 7, 1995**

## Comments Welcome

We welcome comments on the contents and format of this newsletter, suggestions for future topics, letters, submissions and corrections.

**Phone us: 1-800-633-5514**

## The First PIN Prick

In the December, 1994 issue of *Cellular Networking Perspectives* we warned against the use of user-entered PIN numbers to protect against cloning fraud (*The Emperor's New PIN*). We have just received an unofficial report of a subscriber with a PIN being cloned in the New York City area. If this report is true it has taken cloners even less time than we anticipated to figure out how to walk around the PIN hurdle. The real answer? Authentication.◇

## Meet us in Cellular Marketing

We are pleased to announce that David Crowe will be writing a column in Cellular Marketing magazine, starting with the March, 1995 issue.◇

## We Pay for Leads

One of the ways that *Cellular Networking Perspectives* gets better known is through the recommendations of telecommunications professionals like yourself. We certainly appreciate the recommendations we have received in the past and, to show our gratitude, we will send a \$25 cheque to anyone who provides us with a recommendation that results in a new subscription. If you know of someone who could benefit from a subscription, send their name, position, company, address, phone and fax number to us by fax at 403-289-6658, e-mail at 71574.3157@compuserve.com or call us at 1-800-633-5514. Let us know whether we can use your name when we contact the potential

## Cellular Calls Home

TI A subcommittee TR-45.1 is defining a standard that will allow a cellular phone to act as a cordless phone in the subscriber's home. This will require a modified analog cellular air interface, to be defined in IS-91 Revision A and a new interface to the PSTN to control delivery of incoming calls. The big advantage of this system is that with one handset, subscribers can get the benefits of cordless (free airtime) and cellular (coverage) in one package.

Major issues facing this standardization effort are the allocation of channels within the cellular band and redirecting incoming calls.

Channels that will not interfere with the surrounding cellular system can be allocated through low power operation and an interference avoidance algorithm.

Incoming calls can be routed to the cellular phone in its residential mode by communication between the personal base station (PB) and the cellular system. This is mediated by a new entity, known as an ACRE (Authorization & Call Routing Equipment). The PB will register the mobile whenever it is detected at home, including the home phone number. If the ACRE accepts the registration, it can then arrange for incoming calls to the cellular number to be routed to the home phone number. PB/ACRE communication includes mutual authentication, to prevent fraudulent use of the network. The PB and ACRE connect to each other by dial-up and exchange information using either DTMF tones at 40 bps or modem tones at 1200 bps. The ACRE can communicate to the cellular network as an IS-41 capable VLR.◇

## WIN: The Wireless Intelligent Network

The Cellular Telephone Industry Association (CTIA) has developed a Standards Requirement Document (SRD) for the Wireless Intelligent Network (WIN). Its goal is to allow the implementation of custom features that can be defined by individual carriers yet can work seamlessly in other systems and not require standardization. These ideas have been presented to the TIA TR-45.2 subcommittee for implementation.

The current process for adding a feature that can be used by roamers is quite cumbersome:

- a. IS-53 has to be modified to define the new feature.
- b. IS-41 has to be modified to define intersystem capabilities to support the feature for roamers.
- c. Each standard is subject to months of discussion and a lengthy ballot process before publication.

The CTIA model is based on the wireline IN concepts, in which a switch (i.e. MSC) will merely report the execution of 'trigger points' to an intelligent adjunct. The adjunct will then decide whether call processing can proceed normally or whether it needs to be diverted. What complicates the WIN concept in a wireless environment is the mobility of the terminal. The local adjunct for a roamer may not know anything about the subscriber. It then has to either forward all trigger requests to the home adjunct or receive trigger profile information from the home.

This then is the conundrum for the development of the Wireless Intelligent Network: development of standard protocols between the home and visited WIN nodes would require a very similar standards development process to the process currently used to develop IS-41 and IS-53. Alternatively, transporting all triggers back to the home WIN nodes could consume huge quantities of network bandwidth. Handling the triggers locally would require standardized trigger handling, limiting flexibility. The goal of WIN is worthwhile, but its implementation will require a careful selection of standardized interfaces, standardized processing and network bandwidth. ◊

## TSB-41: The IS-41 Rev. B Technical Notes

One of the most controversial standardization developments in the TIA TR-45.2 subcommittee was writing the IS-41 Rev. B Technical Notes, now being published as TIA/EIA TSB-41. The controversy was due to the nature of this document that essentially modifies the IS-41 Rev. B standard based on its chosen solutions to ambiguities and errors that were found during implementation. Obviously where companies had implemented different solutions to problems or had interpreted ambiguous areas of IS-41 differently, effort was made by them to direct the development of TSB-41 in the direction most favourable to them. However, after two years of wrangling, agreement was reached, although it took an unprecedented two ballots, with some significant changes made during the ballot process.

### Document Structure

TSB-41 consists of two major parts: Decision Points and Replacement Text. The Decision Points are the statement of 38 problems found in IS-41 Rev. B, followed by a list of agreed to changes or clarifications. The Replacement Text consists of modifications to IS-41 Rev. B to support the decision points. Some of the decision points will not be documented by IS-41 text until Rev. C is published.

### Decision Points

The 38 decision points cover a wide range of topics such as:

- #2. What is the Validation and Profile Expiration Period? (Answer: validation expires with the Authorization Period and profile information only expires when explicitly revoked, for example by a RegistrationCancellation message).
- #5. What is the period of a denied authorization? (Answer: this is the responsibility of the VLR which can decide how long to retain a record for an invalid roamer. The HLR has no responsibility to maintain a location pointer to this subscriber).
- #7. What happens when a VLR receives a message from an HLR with an invalid ESN? (Answer:

the message should not be processed. Some companies unsuccessfully argued that this should be a method for an HLR to update the ESN for a roamer).

- #37. What happens when only partial profile information is received by a VLR? (Answer: the fields received should be used to update the profile. Other information should be left alone, not deleted).

Many of these decision points cover quite obscure areas of the IS-41 Rev. B standard, but resolution was necessary to prevent subscribers from receiving poor service due to incompatibilities between implementations. A study of all decision points is essential for designers and implementers of IS-41 Rev. B software and networks.

### Replacement Text

The Replacement Text portion of TSB-41 is also extremely important as it details changes to IS-41 Rev. B that have been accepted by the industry. A summary of the changes follows.

### Inactive vs. Deregistered

The definition of an 'Inactive' mobile was unclear in IS-41 Rev. B. Clarification of this concept is important because this mobile state is central to workarounds to US Department of Justice restrictions on the RBOC cellular subsidiaries that disable voice mail for incoming calls to, for example, busy phones. Some companies interpreted the inactive state as meaning that the VLR had erased any record of the roamer and others that the VLR had just marked the record as inactive. The resolution was a classic compromise, to treat the existing IS-41 Rev. B message as marking the record inactive at the VLR and HLR but allowing a new parameter (DeregistrationType) to indicate that deregistration is intended instead. Deregistration differs from inactivity in that the VLR record is assumed to have been deleted, therefore the HLR will not notify the VLR when the mobile registers elsewhere.

### Handoff Power Level Adjustments

Handoff between cells that operate at different maximum power levels is complicated by the change in power level that may occur after handoff. This requires compensation of the measured signal strength from some cells. The re-

sponse to a HandoffMeasurementRequest message does contain a power level, but it was not clear whether this was for the candidate cell or for the mobile. The clarification in TSB-41 is that this is the mobile power level and the candidate cell power level must be obtained from local tables in the MSC initiating the handoff. IS-41 Rev. C may have a more elegant solution, allowing the candidate cell maximum power level to be provided by IS-41 messaging (as an optional parameter).

### Flash after Handoff

If the SEND key is pressed during conversation a "Flash" is generated. This must be processed by the Anchor MSC (e.g. to initiate 3 Way Calling or respond to a Call Waiting indication) which requires an IS-41 inter-MSC message (FlashRequest) if the call has been handed off to another MSC. Originally the FlashRequest message had no response, resulting in a compatibility problem for the initiating MSC that would not know if the Anchor was unable to process the flash (e.g. an IS-41 Rev. A Anchor MSC). TSB-41 adds a response to this message, to allow for positive feedback.

### Obsolete Messages

The ServiceProfileRequest, ServiceProfileDirective and CallDataRequest messages are considered obsolete. TSB-41 recommends that they not be generated, but that they should be processed if received, for compatibility with IS-41 Rev. A systems. The ServiceProfile messages can be replaced by the two equivalent Qualification messages. No use has ever been identified for the CallDataRequest.

### Modified Parameter Identifiers

Three IS-41 parameter identification numbers were modified in TSB-41: Shortened-BurstIndicator, PC\_SSN and LocationAreaId. This aligns the encoding with other TCAP identifiers. These parameter identifiers were affected because they are longer than previous identifiers (2 octets). All future parameter identifiers, including the new DeregistrationType parameter, will also be encoded in the same fashion.

### Invalid Messages from VLR

An HLR should check that CSSInactive messages from a VLR are from the mobile was last registered. This prevents processing of illegitimate messages or, more likely, the processing of messages that are delayed in the network and arrive after the mobile registers at another VLR. This logic will also apply to any future IS-41 messages that do

## Index of 1994 Issues

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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.

### February, 1994 02/94

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 03/94

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.

### April, 1994 04/94

Dial 9-1-1 for Confusion•Trends at Wireless '94•Inter-System Call Delivery, Part II: The Exceptions are the Rule•TR-45.2 Standards Update: IS-41 Rev. A Compatibility TSB Approved for Publication•Status of IS-41 Rev. A Implementation.

### May, 1994 05/94

9-1-1 Joint Expert's Meeting•Mixed IS-41 Field Trials•Short Message Service Joint Expert's Meeting• Inter-System Call Delivery, Part III: When Lawyers Design Systems• Guest's Corner: PCS•TR-45.2 Standards Update: IS-41 Test Plan Approved for Publication.

### June, 1994 06/94

IS-41 Rev. C Delayed Again•TSB-41 Out for Ballot•Inter-System Call Delivery, Part IV: Optimizing• TR-45.2 Standards Update: IS-41 Rev. B Technical Notes Out for Ballot•TIA Interim Standard IS-41 Rev. C: Summary of Proposed Contents•TIA TR-45 Air Interfaces Standards Report.

### July, 1994 07/94

FCC Revises PCS Decision•FCC may Impose Equal Access on all Cellular Carriers•Intersystem Call Delivery, Part V: Compatibility• TR45.2 Standards Update•FCC to Investigate Interconnection Obligations•TIA TR45.2 Project Status Report.

### August, 1994 08/94

Interchangeable Area Codes Will Disrupt International Roaming•Big Brother Would Like to Listen to the Big Bad Wolf•Inter-System Call Delivery, Part VI: Border Problems•Inter-System Call Delivery: The IS-41 Toolbox•TR-45.2 Standards Update: IS-52 Dialing Plan Standard Approved for Ballot•TIA TR-46 Committee Public 1800 MHz PCS Network Standards Project Report.

### September, 1994 09/94

TIA Joint Expert's Meeting to Study International Roaming Problems• CTIA Forum on Cellular Extension Telephone Service, October 27th, 1994•New Chair for TR45.2 WG VI on International issues• Guest's Cell: P.J. Louis on Wireless Interconnect•TIA IS-52: The Cellular Dialing Plan Standard•TR-45.2 Standards Update: TSB-41 and IS-52 Out for Ballot•Status of IS-41 Rev. B Implementation.

### October, 1994 10/94

TR-45.2 Standards update: IS-53 Rev. A Out for Ballot•TIA Emergency Services JEM In Summary•TIA TR-45.2 Project Status Report.

### November, 1994 11/94

Emergency Services JEM Number 2: Anything New?•A Sneak Preview of IS-41 Revision C•TR-45.2 Standards Update: IS-41 Technical Notes Approved for Publication.

### December, 1994 12/94

The Emperor's New PIN•The TIA International Roaming JEM•Why MINs are Phone Numbers and Why They Shouldn't Be•TR-45.2 Standards Update: IS-52 Dialing Plan Approved for Publication•

not imply registration but that do imply that the mobile is present.

### MarketID Concept

The IS-41 BillingID parameter contains a SID in IS-41 Rev. B. Since this may be a BID (Cibernet Billing Identification Number), this field has been replaced by the new term MarketID.

### MIN Encoding

The encoding for the all-important MIN parameter had never been defined in IS-41, probably because it seemed obvious. The only document that MIN encoding had ever been defined in was the never-published TSB-27. Ironically, this document was wrong (or at least was different from the encoding used in all known IS-41 implementations!). While the BCD encoding of the digits 1 through 9 is simply the four-bit binary encoding of the digit, the encoding of the 0 digit in BCD could be '0000' (especially in telecommunications systems, such as cellular air interfaces) or '1010' (10, just like the zero digit on a rotary dial phone!). TSB-41 clarifies that the BCD encoding of '0000' for the digit 0 is used.

### New Authorization Denial Reason: No Business Agreement

Recognizing that service is sometimes denied to roamers because no business agreement exists with their home system, a new AuthorizationDenied reason code of 'NotAuthorizedForTheMSC' was created.

### AuthorizationDenied Parameter Excludes Other Qualification/Profile Parameters

TSB-41 clarifies that if authorization is denied for a subscriber (indicated by the presence of the AuthorizationDenied parameter in a message from the HLR to a VLR) no other qualification or profile parameters should be present. Some companies unsuccessfully argued that AuthorizationDenied and AuthorizationPeriod could be used to define the time that a VLR should store an invalid roamer record. No guidance is given for messages that violate this new rule. Presumably, the additional parameters may be ignored.

### New Access Denial / Redirection Reasons: No Page Response and Unavailable

To allow more flexibility in the hand-

ling of no-page-response and other (unspecified) unavailability situations, two new redirection reason codes (in the poorly named FeatureIdentifier parameter) and access denial reason codes (in the aptly named AccessDenied parameter) were allocated to separate these conditions from the no answer condition. It is still expected that in many cases the same treatment will be given in all three cases (e.g. call forward no-answer may apply).

### Summary

TSB-41 should be implemented in IS-41 Rev. B equipment or networks. Adherence to this document is advised in most cases, although judgment should be used over the seriousness of some issues that it resolves. In particular, TSB-41 will assist with compatibility with future IS-41 Revision C systems.◊

### TR-45.2 Standards Update: IS-53 Revision A Approved for Publication

TIA subcommittee TR-45.2

has approved IS-53, describing cellular features for publication, following extensive editing based on ballot comments.

The status of each major outstanding TR45.2 project is listed below, in approximate order of completion:

#### IS-41 Rev. B Technical Notes (TSB-41, SP-2985) • In Press.

**Cellular Dialing Plan (IS-52 Rev. A, PN-3166) • In Press.** All accepted ballot comment changes have been incorporated in a pre-publication version. Following review of this version for accuracy, IS-52 will be submitted to the TIA for publication.

**Subscriber Features (IS-53 Rev. A, PN-2977) • In Press.** Following review of the more than 100 pages of ballot comments, IS-53 Revision A was approved for publication, pending incorporation of the approved ballot comments and approval of the updated version. IS-53 Revision A describes 25 features that may be used in cellular systems. A brief description of each feature may be found in the October, November and December, 1993 issues

of this newsletter.

**IS-41 Revision C (PN-2991) •** This revision of IS-41 was scheduled for ballot in October, 1994. That date has been slipped to **ballot starting March, 1995**. Sections 1 through 5 are now officially in V&V (Verification and Validation), except for Short Message Service sections. Section 6 may be approved for V&V in January, 1995. The ballot period will likely be 60 days. Following TIA approval of IS-41 Rev. C, this document must be sent for overdue ANSI balloting. When past these two hurdles, IS-41, currently a TIA interim standard, will receive a new number as a full standard.

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

TR-45.2 is studying several problems with international use of AMPS cellular. A decision on whether ITU-T standard E.164 or E.212 should be the basis for mobile identification in future terminals will be made at a full TR45 meeting in February. WG VI of TR45.2 will be studying this and other issues, particularly international SS7 global title translation, 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.

**Subscriber Features (IS-53 Rev. B, PN-3362) •** A list of features (45 so far) is being accumulated for development in Revision B of this standard. A proposal from the CTIA for a Wireless Intelligent Network may eliminate the need to individually describe all these features.

**IS-41 Rev. D •** Consideration is being given to items for inclusion in IS-41 Revision D. Work on these new capabilities will proceed following publication of IS-41 Rev. C. See the December 1994 issue for a list of items under consideration for IS-41 Rev. D.◊

### Correction on Emergency Services JEM Article

An article in the November issue stated incorrectly that SMR and ESMR interests were not represented at the Emergency Services JEM held by PCIA, ATIS and TIA from October 11-14, 1994. Actually there was a participant from NEXTEL present◊

# Status of IS-41 Rev. A Implementation

# Cellular Networking Perspectives

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Vendor1	Vendor2	Status	Date	HVD	D/L	Location
Astronet	AT&T	Commercial	06/93	VD	X	Baltimore/Washington (BAM)
	Alcatel-SEL	<b>Commercial</b>	<b>08/94</b>	<b>HVD</b>	<b>X</b>	<b>AL6 (Alcatel using IS-41 Rev. B)</b>
	GTE TSI	Commercial	06/93	VD	X	Baltimore/Washington (BAM)
	(VLR)	Commercial	12/93	VD	X	Texas
	NACN	Commercial	04/94	VD	X	Enid, OK
	NTI	Commercial	12/93	VD	X	NC 12, NC 13
AT&T	Astronet	Commercial	06/93	VD	X	Baltimore/Washington (BAM)
	<b>EDS PCD</b>	<b>Field Trial</b>	<b>1Q'95</b>	<b>V</b>	<b>XS</b>	<b>Austin, Texas</b>
	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	<b>AT&amp;T</b>	<b>Field Trial</b>	<b>1Q'95</b>	<b>V</b>	<b>XS</b>	<b>Austin, Texas</b>
	<b>Ericsson</b>	<b>Commercial</b>	<b>03/94</b>	<b>V</b>	<b>S</b>	<b>Los Angeles (L.A. Cellular)</b>
	Motorola	Commercial	08/92	V	X	Atlanta (AirTouch)
Ericsson	AT&T	Commercial	12/92	HVD	S	Portland and others (McCaw)
	<b>EDS PCD</b>	<b>Field Trial</b>	<b>03/94</b>	<b>V</b>	<b>S</b>	<b>Los Angeles (L.A. Cellular)</b>
	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.  
                          Date:                    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).

# Status of IS-41 Rev. B Implementation

# Cellular Networking Perspectives

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Vendor1	Vendor2	Status	Date	Type	Location
Alcatel-SEL	Astronet*	Commercial	08/94	H V D S	Mobile, Alabama (BellSouth)
	AT&T	Field Trial	09/94	V D S	Orlando, Florida (BellSouth)
		Field Trial	1Q'95	H+ S	Orlando, Florida (BellSouth)
	EDS PCD	Commercial	08/94	V D S	Mobile, Alabama (BellSouth)
	GTE TSI	Commercial	08/94	V D S	Mobile, Alabama (BellSouth)
	Motorola	Field Trial	09/94	V D S	Jacksonville, Florida (BellSouth)
		Field Trial	1Q'94	H S	Jacksonville, Florida (BellSouth)
Astronet		Development			
AT&T	Alcatel-SEL	Field Trial	09/94	H+V D S	Florida (BellSouth)
	GTE TSI	Planning		V DXS	Location not announced (BAM)
	NEC	Commercial		H V D S	Brazil
	NTI	Planning		H+V DX T	location not announced
Celcore	AT&T	Lab Trial		V DX	St. Louis, Missouri (SWBMS)
EDS PCD	Alcatel-SEL	Commercial	08/94	V D S	Mobile, Alabama (BellSouth)
	Ericsson	Planning		V X	Location not announced
Ericsson	EDS PCD	Planning		V X	location not announced
	Motorola	Field Trial		H V D S	location not announced
	NTI	Planning		H VAD S	location not announced
	NTI*	Commercial		V D S	location not announced
GTE TSI	Alcatel-SEL	Commercial	08/94	V D S	Mobile, Alabama (BellSouth)
	AT&T	Lab Trial	TBD	V DXS	Location not announced (BAM)
Motorola	Alcatel-SEL	Field Trial	4Q'94	H V D S	Orlando (BellSouth)
	Astronet*	Commercial	4Q'94	V DX	Several locations
	AT&T*	Commercial		V D S	Several locations
	EDS PCD*	Commercial		V X	Dedham, MA
	Ericsson*	Commercial		V D S	Piscataway, NJ (Comcast)
	GTE TSI*	Commercial		V DX	Orlando, Florida
	NEC	Commercial		V D S	Brazil
	NTI (MTX)*	Commercial		H V DX	Denver, CO
	NTI(800CM)*	Commercial		V DX	Raleigh, NC
NEC	AT&T	Commercial		H V D S	Brazil
	Motorola	Commercial		V D S	Brazil
NTI	AT&T	Lab Trial	TBD	H V DX	Windsor (Bell Mobility)
	Ericsson	Planning		H VAD S	Ft. Myers (Palmer)

Explanation:

\* Other vendor is using IS-41 Rev. A with TSB-55 for compatibility.

Status: Development, Planning, Lab Trial, Field Trial or Commercial.

Date: Date of actual or expected completion of listed phase of testing.

Type: Type of test:

- H Includes handoff forward and back
- H+ Also includes path minimization and/or flash handling
- V Includes validation.
- A Includes authentication (TSB-51).
- D Includes call delivery.
- X Uses X.25 datalink protocol.
- S Uses ANSI SS7 datalink protocol.
- C Uses CCITT SS7 datalink protocol.
- T Uses TDMA (IS-54) digital mobiles.
- W Uses CDMA (IS-95) digital mobiles.

Location: Location of test and carrier. Usually listed for first trial only.