

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.

Emergency Services JEM Number 2: Anything New?

During the week of October 11-14, 1994, the Personal Communications Industry Association (PCIA), Alliance for Telecommunications Industry Standards (ATIS) subcommittees T1S1 and T1P1, and the Telecommunications Industry Association (TIA) sponsored a joint experts meeting (JEM) on wireless emergency services (i.e. 9-1-1 and E-9-1-1).

The meeting was jointly chaired by Mary Boyd, Executive Director for the Texas Advisory Commission on State Emergency Communications and Gary Jones of Omnipoint. The purpose of the meeting was to discuss wireless emergency communications for the 1800 MHz personal communications services (PCS) industry. For many who participated it appeared to be a rehash of the August 1994 TR45 JEM on Wireless Emergency Services, including discussions of location technology, radio technology, and network signaling. The only difference was that the meeting considered the new 1800 MHz PCS carriers. Note that SMR, ESMR, and Paging interests were not represented.

One difference at this 9-1-1 JEM was the presence of representatives of IVHS (Intelligent Vehicular Highway System, now known as ITS: Intelligent Transportation System) organizations. They added a perspective that was not present at the TR45 JEM. Apart from this, for many who had been present at the TR45 JEM the meeting reinforced their view that Public Safety requirements are the

same regardless of frequency band. Specific implementations (e.g., specific location technologies, intelligent network platforms, etc.) were not endorsed by either this JEM or the TIA TR45 JEM in August.

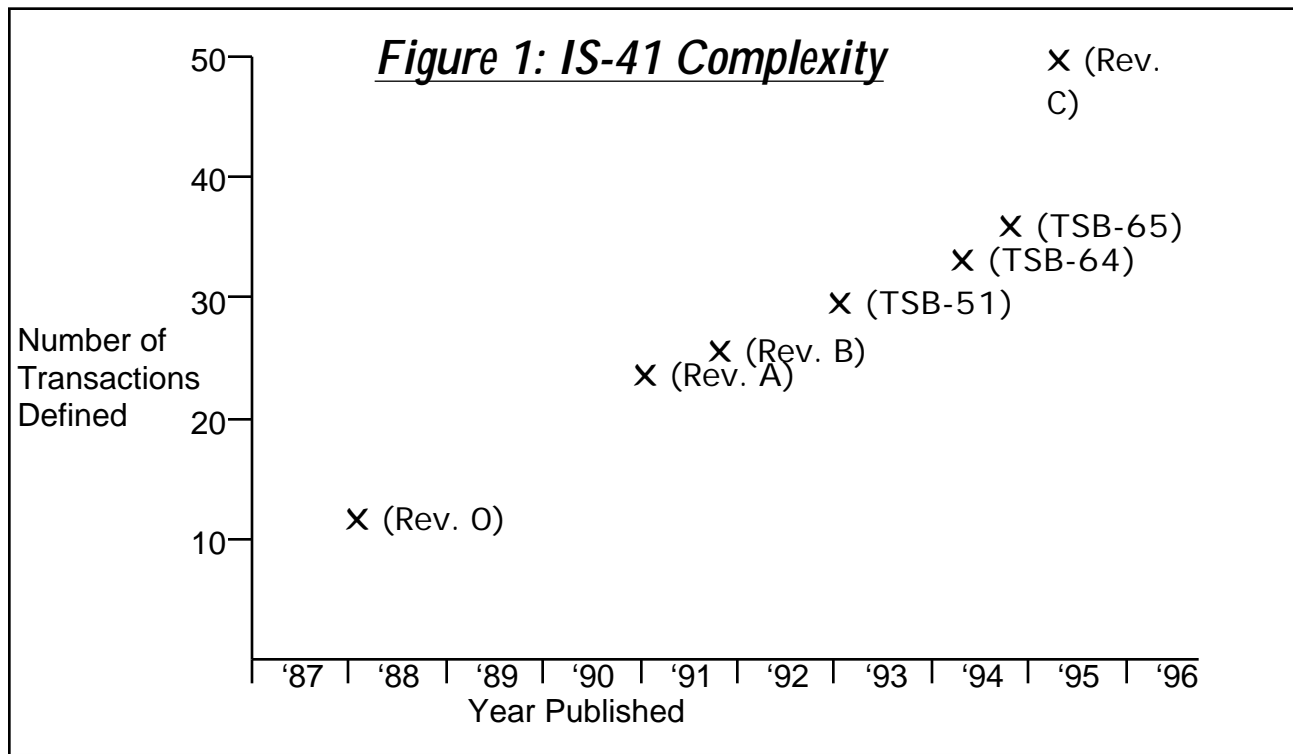
Further work on wireless emergency services will be coordinated by TR45.2 Working Group VII for 800 MHz cellular systems and by the TR46.1 Subcommittee in the 1800 MHz arena.

Report provided by P.J. Louis
Chairman TR45.2 Working Group VII
Chairman TR46.1 Subcommittee

A Sneak Preview of IS-41 Revision C

IS-41 Revision C is a quantum leap in inter-system operations beyond IS-41 Revision B, the document being approximately five times as heavy, unless printed on exceptionally thin paper. Figure 1 illustrates the growth in complexity of IS-41 since Revision 0 was first released in 1987, by tracking the rapidly increasing number of transactions. This is an arbitrary, but conservative yardstick, as it ignores the large number of previously defined transactions that have been modified in this revision.

IS-41 Rev. C will probably be sent out for ballot late in 1994, with publication likely in the second quarter of 1995. This revision will provide capabilities that are similar in flexibility to the Intelligent Network, but that are adapted for mobility and roaming.



Implementations of IS-41 Rev. C should allow a difficult balancing act between carrier feature differentiation and personal seamlessness to succeed. This is possible because IS-41 Rev. C, unlike earlier versions, defines tools more than specific solutions. Based on these tools carriers should be able to create services based on the need of their subscribers, yet allow their subscribers to utilise them while roaming.

This issue attempts to predict the capabilities of IS-41 Revision C based on its current status. However, because this standard has not yet been published, it is still subject to change.

The Network Reference Model

All TIA committee TR45 standards are based on a common network reference model. A simplified version is shown in Figure 2. A network reference model defines logical entities that can be combined in arbitrary ways. For example, an MSC is often combined with a VLR. On the other hand, even when an HLR is combined with an MSC or VLR, it may act as an independent unit for roam-

ing subscribers. The elements of the model are:

AC	Authentication Centre. The repository for mobile authentication and voice encryption data.
BSS	Base Station Subsystem. The radio interface to cellular terminals.
HLR	Home Location Register. The database of subscriber validation, profile and location information.
MC	Message Centre. The entity that stores and routes short messages.
MSC	Mobile Switching Centre. Also known as a Mobile Telephone Switching Office.
MSC-G	Gateway MSC. The switch at which calls enter the IS-41 capable cellular network.
PSTN	Public Switched Telephone Network.
VLR	Visitor Location Register.

The Development Process

IS-41 Rev. C was developed in a three stage process by the Telecommunications Industry Association (TIA) TR-45.2 subcommittee.

- I. Stage I defines the external operation of features and capabilities. This stage was developed by TR45.2 Working Group V and the results will be published in IS-53 Revision A (currently out for ballot).
- II. Stage II defines the network interactions required to implement Stage I features. This stage was developed by TR45.2 Working Groups II (Automatic Roaming) and III (Handoff) and the results will be published in IS-41 Revision C sections 2, 3 and 4. In future, WG II and WG III may be combined since there are more drawbacks than advantages to studying Stage II descriptions for Automatic Roaming and Handoff separately.
- III. Stage III defines the encoding and procedures required to implement the Stage II description. This stage is developed by TR45.2 WG I and the results will be published in IS-41 Revision C sections 5 and 6.

Document Structure

IS-41 Revision C contains one more section than Revision B to conform with the three stage development process. Section 6 contains the procedures, considered to be Stage III, that were distributed within Sections 2, 3 and 4 in earlier revisions:

1. Section 1 provides an introduction and overview to IS-41. This includes the network reference model described in Figure 2.
2. Section 2 describes the network operations to support intersystem handoff.
3. Section 3 describes the network operations to support automatic roaming capabilities such as call delivery and remote feature control.
4. Section 4 describes OA&M (Operations, Administration and Maintenance) network operation, including common channel signaling to manage intersystem handoff trunks.
5. Section 5 describes the encoding for IS-41 messages and parameters.
6. Section 6 describes the procedures invoked to send or receive IS-41 messages.

New Features

IS-41 Revision C supports most of the features described in IS-53 Revision A. Some of these features are extremely complicated and require extensive IS-41 modifications to work for roamers. An example is the Flexible Alerting feature that allows a group of cellular and other phones to be rung simultaneously whenever a *pilot* number is dialed, connecting to whichever phone answers first. IS-41 Rev. C does not implement each feature like this as a separate capability, but provides building blocks that will allow features that combine and extend those described in IS-53 Rev. A. Each carrier will be able to define features in their own way, to support their own subscribers, in the knowledge that IS-41 will support their features seamlessly for their subscribers even when roaming. This can occur even if the visited system implements the feature for their own subscribers in a different

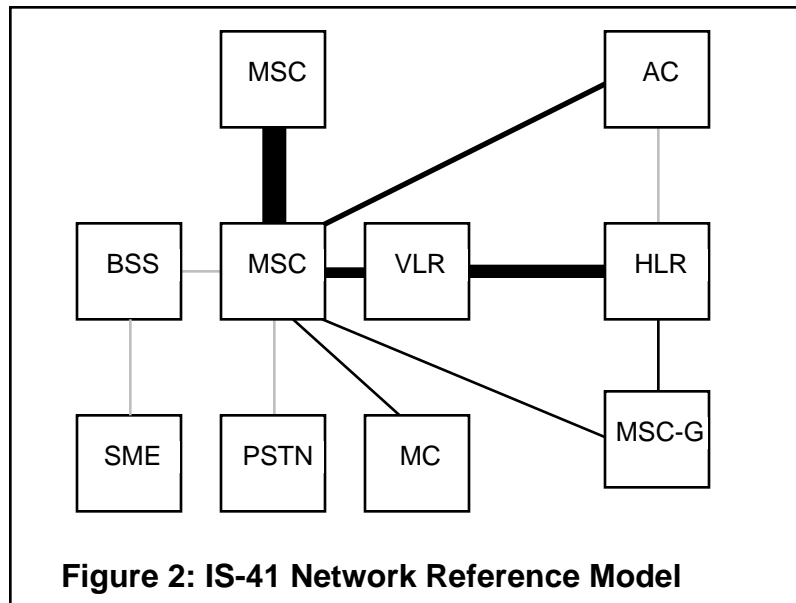


Figure 2: IS-41 Network Reference Model

way, or not at all.

IS-41 features can be divided into several major (and overlapping) classes. For a separate description of all features see the October, November, December, 1993 through January, 1994 issues of Cellular Networking Perspectives.

1. Calling Number Identification features build on the availability of calling number information to control incoming calls or present the calling number to the called terminal. This information is not currently available to most cellular carriers, but will be increasingly in the future with the implementation of SS7 interconnection to local exchange, inter-exchange and other telecommunications networks.
2. Call Control features restrict incoming or outgoing calls for a mobile. For examples, Password Call Acceptance requires that a password be correctly entered before allowing a termination, while the Subscriber PIN Access feature (SPINA) allows a terminal to be blocked by the network from making any calls until unblocked by entering a Personal Identification Number (PIN). These features are designed for quite different purposes (customer convenience or fraud control) but can be implemented with similar building blocks.
3. Group calling features allow a group

of phones to be paged in series (Mobile Access Hunting) or in parallel (Flexible Alerting). These features can be used as described or as the basis for more exotic personal mobility features.

4. Short Message Service features allow short numeric and text messages to be received or even generated by cellular terminals, allowing features like paging and electronic mail to be integrated into a cellular terminal.

Several of the new features supported in IS-41 Rev. C require "IN"-like capabilities in the visited MSC/VLR to support roamers. If, for example, an origination trigger is set for a roamer, then whenever that subscriber makes a call that matches certain conditions, the dialed digits will be sent to the HLR for analysis. This allows a dialog to be entered during call setup, controlled either by the home system directly or by the visited system executing orders from the HLR. As an example, a subscriber's terminal may be locked by the Subscriber PIN Access (SPINA) feature. Whenever a call is originated from the affected mobile, the visited system will send the dialed digits to the home system. Unless the dialed digits correspond to the unlock code, the HLR will respond indicating that the call attempt should be denied. Another example, in

this case of a feature not defined in IS-53 Rev. A or IS-41 Rev. C, is the ability for groups of subscribers to dial 4 digit numbers to reach others within their company. In this case, the HLR will accept the 4 dialed digits from the visited system and return a corresponding 10 digit number to which the caller will be connected.

The basic transactions defined in IS-41 Revision C to support advanced "intelligent" features are:

1. Origination Request. This message transports dialed digits from a visited system to the roamer's home system for analysis.
2. Feature Request. Similar to the Origination Request, this message transports dialed feature digits (e.g. *XX...) to the home system for analysis.
3. Remote User Interaction Directive (RUIDIR). This message allows a home system to give commands to a visited system to remotely control a dialog. An example would be "Play announcement Number 5 and then collect 4 digits". The visited system will perform the operation and then return the results (including, in this case, any digits received in response to the recording) to the home system which, after analyzing them, may send another RUIDIR or some other IS-41 operation.
4. RedirectionRequest / TransferTo-NumberRequest. These messages, defined in IS-41 Rev. A, have been enhanced to allow a dialog to be performed remotely from the system that a mobile is visiting (e.g. the home system) and then to allow redirection of the call to another number when the dialog is complete.

Incorporated TSB's

Several TSB's (Telecommunications Systems Bulletins) based on IS-41 Revision A and B have been incorporated into IS-41 Rev. C, with enhancements in some cases:

1. TSB-51 describes inter-system procedures to support terminals with authentication, voice privacy or signaling message encryption capabilities. IS-41 Revision C also incor-

porates a number of clarifications and corrections. One notable addition is the ability for neighbouring systems to coordinate the broadcast random numbers (RAND and RANDC) that are central to the authentication and voice encryption algorithms. Another change is the ability for authentication information to be forwarded to the current serving MSC from the anchor MSC, to allow authentication operations to be performed following an inter-system handoff.

2. TSB-64 defines inter-system procedures to support CDMA terminals, particularly inter-system handoff.
3. TSB-65 defines inter-system procedures to resolve border cell problems, particularly those that result in inaccurate mobile locating, requiring paging in multiple systems. IS-41 Rev. C has incorporated this document with enhancements, particularly the ability to set up calls to a neighbouring system using direct trunks following call setup through an inter-exchange carrier to the system the mobile was registered in.
4. TSB-41 resolves problems and ambiguities with the IS-41 Revision B standard. Significant changes are the addition of a response to the FlashRequest message, separation of the concepts of inactivity and deregistration for a mobile and a warning that the CallDataRequest, ProfileRequest and ProfileDirective messages may not be supported in later revisions of IS-41.
5. TSB-55 applies forward compatibility rules retroactively to IS-41 Revision A systems. One item that is applicable to IS-41 Rev. B and C systems is the restriction of many Rev. A systems to only accept SS7 messages with a subsystem number (SSN) of 5, not allowing the values defined in IS-41 Rev. B.

Other Supported Standards

IS-41 Revision C also offers inter-system support for several other standards.

1. IS-88. IS-41 Rev. C allows IS-88 ("NAMPS") mobiles to handoff between systems. These mobiles can squeeze a conversation into one-

third of a normal 30 khz analog cellular channel using analog frequency division multiplexing techniques.

2. IS-124. IS-41 Rev. C provides an accurate count of the number of segments in a call to the anchor MSC in a call involving inter-system handoff. This is useful for the optimum operation of the IS-124 online call detail record transfer protocol for calls involving multiple inter-system handoffs.
3. IS-91. This new analog cellular air interface standard is not intentionally supported by IS-41 Rev. C, but major components of it will be as it includes support for NAMPS terminals from IS-88 and support for authentication from IS-54 Rev. B.

Beyond Revision C

Looking at just the size of IS-41 Revision C it is hard to believe that there are any more inter-systems operations left to standardize. But the list of requirements for IS-53 Revision B and IS-41 Revision D is actually quite long, and growing all the time. The following items are likely to be included in IS-41 Revision D:

SMS Broadcast

Short messages must currently be sent to a single terminal. An additional feature allow messages to be sent to groups of terminals. Examples would be all subscribers in the vicinity of an accident (geographical group) or all subscribers subscribing to a particular service (subscription group). The latter type of broadcast becomes particularly challenging when roaming is considered, unless broadcasting in all cells in North America is desirable.

Sleep Mode

Advanced CDMA or TDMA digital mobiles can go into a low powered sleep mode. In one mode (TDMA sleep mode or CDMA slotted mode) terminals can power off almost completely except for short intervals, synchronized with the base station, when they wake up and are informed whether there are any messages for them. A challenge in this mode is to determine the services

that still apply. For example, should an incoming call be delayed 5 seconds? 10 seconds? until the mobile next wakes up?

Circuit-Switched Data

Sending data on digital cellular phones is more difficult than in analog because the process of digitizing voice destroys the tones that modems use to communicate. Instead, data has to be sent as true digital data over the channel. Efforts to standardize this are underway in TIA TR45.3 for TDMA terminals and in TR-45.5 for CDMA terminals. This new air interface capability will have significant network implications. Each MSC will, for example, have to manage modem pools as the analog modem must be located in the network and not in the terminal.

TDMA Digital Control Channel

The TR45.3 committee is developing a new standard that will allow TDMA terminals to communicate using a completely new and much more sophisticated control channel. Again, many of the new features will have significant network implications.

Enhanced Emergency Services

As noted earlier in this issue, two Joint Expert's Meetings on the subject of improving 9-1-1 emergency service have been held this year. In order to implement most of the desired new features, significant network changes will be required.

International Mobile Identification

The current use of 10 digit mobile identifications (MIN) is known to be inadequate. The recommendations of the Nov. 7th-10th Joint Expert's Meeting on this subject will probably include a recommendation to use 15 digit International Mobile Station Identification (IMSI) for new terminals. This change will have a major impact on IS-41 as the MIN is used in almost all inter-system messages.

Wireless Wiretap

With the recent passage of a new wiretap bill, the stage is set for the support of lawful wiretaps in cellular

systems. Wireless systems provide a number of challenges for those that would monitor calls. First the location of the mobile must be determined. Then the validity of the warrant in that location must be determined and a wiretap initiated. Complications arise because of the desire of law enforcement agencies to monitor from a central location while capturing all of the conversation and call related information and without delays or other clues that monitoring is occurring. Cellular carriers must be convinced that interconnection to a monitoring centre can only be used for lawful monitoring and that the additional expense will be paid for by someone other than their subscribers.

TR-45.2 Standards Update: IS-41 Technical Notes Approved for Publication

TIA subcommittee TR-45.2 has approved TSB-41, known as the IS-41 Revision B Technical Notes for publication after two ballots. The IS-52 Dialing Plan standard ballot comments are still under review, and IS-53 Revision A is still in the ballot process.

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

IS-41 Rev. B Technical Notes (TSB-41, SP-2985) • Approved for publication pending some final editing changes. This document describes clarifications and modifications to IS-41 Revision B to facilitate interoperability.

Cellular Dialing Plan (IS-52 Rev. A, PN-3166) • The ballot has been completed. All but one set of ballot comments have been reviewed and all votes against the standard have been modified to approvals due to incorporation of many suggestions made in the ballots. In particular, modifications due to North American Numbering Plan changes starting in 1995 have been included. The review of ballot comments will finish at the November TR45.2 meeting.

Subscriber Features (IS-53

Rev. A, PN-2977) • Out for ballot until November 10, 1994. This standard describes the operation of about 20 new features beyond the 5 defined in Revision 0.

IS-41 Revision C (PN-2991) • This revision of IS-41 was scheduled for ballot in October, 1994. That date has been slipped to December, 1994. The ballot period will likely be 60 days. Following TIA approval of IS-41 Rev. C, this document must be sent for 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 TIA Joint Expert's Meeting (JEM) will be held the week of November 7, 1994 to try to resolve the most urgent problem; ambiguity of international mobile identification. The remaining problems are considered a lower priority and will be studied following the JEM.

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.

IS-41 Rev. D • Consideration is being given to items for inclusion in IS-41 Revision D. These will likely include IMSI (International Mobile Station Identification), TDMA Digital Control Channel, Broadcast Short Message Service, Enhanced 9-1-1 service, Wiretap, Sleep Mode, TDMA and CDMA circuit switched data and features from IS-53 Rev. B. Work on these new capabilities will proceed following publication of IS-41 Rev. C.