Cellular Networking Perspectives

David Crowe [Editor] • Phone 1-403-289-6609 • Fax 403-289-6658 Vol. 6, No. 10 October, 1997

In This Issue ...

Factoid

Law Enforcement intercept orders in the US for 1996: 1,149 (581 Federal, 568 State).

Number involving cellphones: 335 (211 Federal, 124 State).

Over 2/3 of cellphone intercepts were in: NY, FL, CA, TX.

source: Admin. office of the US Courts.

Next issue: November 3, 1997

Roaming with the IS-136 TDMA Digital Control Channel, Part I

The IS-136 "digital" control channel (DCCH) provides a number of unique capabilities, many of them oriented to 'Virtual Wireless PBX' operations. This is an area where TDMA proponents see an advantage over CDMA. Several of these capabilities have been incorporated into a new inter-systems operation standard, known as IS-730, which can be considered as an addendum to ANSI/TIA/EIA-41. What are these features, and how useful are they in a roaming environment?

The two major features for which wide area roaming support is defined in IS–730 are User Group Paging and Public/Residential System ID's. Others include support for the System Operator Code (SOC), the Base Station Manufacturer Code (BSMC) and control channel mode monitoring by the HLR.

User Group Paging

IS-136 allows a group of mobiles to share a common identifier for the purposes of paging. When the user group id (UGID) is used as the paging address by a digital control channel, the first member of the group to respond to the special alerting signal receives the call. This is similar in concept to the IS–41 Rev. C feature known (somewhat misleadingly) as *Flexible Alerting*, although this feature does not rely on any technology-specific mobile capabilities. Another feature of IS-41 Rev. C, known as *Mobile Access Hunting* also allows for paging of multiple mobiles, but because it performs paging in sequence rather than in parallel, its applications are quite different. Table 1 compares User Group Paging, Flexible Alerting and Mobile Access Hunting.

User Group Paging has a minor interaction with 'sleep mode', which normally requires the mobile to wake up for short regular intervals that are defined as a function of its MIN and its paging frame class (i.e. how far apart the awake intervals are). For user group paging, all mobiles in a user group must be awake at the same time, and consequently the time that they wake up is a function of the User Group ID (UGID) and the paging frame class for the user group. This restricts mobiles to being members of only one user group at a time.

Benefits

The benefit of user group paging over services like Flexible Alerting is that it can, at least in a single cell environment, reduce the amount of paging required to handle an 'extension phone' service. User Group Paging may also be more reliable than Flexible Alerting assuming mobiles are put on a traffic channel when they accept the call (see "When to Page?" below).

User Group paging also differs from Flexible Alerting by requiring a manual acknowledgement of the incoming page. This means that calls will not be terminated to unattended phones or to people in the group who temporarily do not want to receive user group calls.

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Table 1: Comparison of Three Multiple Termination Features

	User Group Paging	Flexible Alerting	Mobile Access Hunting
Air Interface Standard	IS-136	*any*	*any*
Intersystem standard	IS-730 (PN-3579)	IS-41 Rev. C/ANSI-41	IS-41 Rev. C/ANSI-41
Mobile Membership	1 group at a time	Any number of groups	Any number of groups
Paging Sequence	All in parallel	All in parallel	One at a time, in order
Pre-delivery paging	Once for each cellsite with an idle member	Not required	Not required
Target paging	Not required	Once per idle member	Once
IS-41 ROUTREQ/TLDN message count	One for each MSC with an idle member	One per member	One for each termination attempt
TLDN handling	Timeout all but one	Timeout all but one	No timeout required
Traffic channel usage	One per MSC with an accepting member	One per idle member	One for each termination attempt

Problems

There are several disadvantages of User Group Paging as compared to Flexible Alerting:

- Requires special mobiles (IS-136 TDMA digital phones).
- Mobile must be operating on the IS–136 digital control channel.
- HLR Visited System must both support IS–730.
- Users must respond twice to each incoming call, once to accept the call, and once to answer the call (although the answer could be automatically generated by the phone to simplify the user interface).

Other disadvantages of this feature are in common with Flexible Alerting:

- HLR and Visited System must support IS-41 Rev. C or ANSI/TIA/-EIA-41.
- Call Delivery TLDN's are held unnecessarily long due to the need to timeout TLDN's in all systems except the one chosen to terminate the call.
- Each call to the group may require multiple control channel paging messages.
- Multiple mobiles may be placed on a voice channel, yet only one will be chosen to receive the incoming call.

When to Page?

One of the critical decisions that has to be made during the design of any intersystem call delivery feature is at what point in call processing to page the destination mobile. There are three alternatives:

1. Traditionally, the system first checks that the mobile is available (through the IS-41 LocationRequest/RoutingRequest transactions) and delivers the call (using the TLDN for routing) before paging. This minimizes the holding time of radio resources and the usage of the control channel, but is less reliable, because a mobile may become involved in a call during the call delivery interval or the mobile may have been powered down or out of the service area the entire time, making the attempted call delivery fruitless.
2. Page the mobile before allocating a TLDN and hold it on a traffic channel while the call is being delivered. This increases the probability that the mobile is still available following TLDN call setup, but also increases the holding time of traffic channels and may confuse users who find their phone occasionally in a strange state where it is not ringing, but not able to originate a call either.
3. Page the mobile twice, once to verify the availability of the mobile (without assigning it a traffic channel) and a second time following TLDN call delivery to place the mobile on a traffic channel. This avoids wasteful TLDN call setup, but does not prevent the mobile from originating a call during TLDN call setup.

Theoretically, User Group Paging and Flexible Alerting could use any of the three paging methods, but from a practical perspective, the features are forced to use different methods. User Group Paging must page and assign a traffic channel before TLDN call setup (alternative 2, above) because the user must manually accept the incoming user group call. If this was not done User Group Paging could attempt to terminate to a user who would refuse to accept the incoming call. Flexible Alerting, on the other hand must use the traditional paging system (alternative 1, above). Otherwise it would be necessary to place every mobile in the group on a traffic channel until one mobile answered. It would also be possible to use alternative 3, above, which would reduce the wasted usage of traffic channels, at the expense of an almost doubled paging load. We will use these assumptions throughout this article.

How it Works

User Group Paging, in a roaming environment, is illustrated in Figure 1. The steps in the process are;

1. An incoming call is received at the Home MSC for the user group. The number dialed will likely not be the phone number for any of the individual members of the group, but a 'pilot' directory number used to identify the group. Each mobile may also have an individual directory number used to terminate calls to that specific mobile.

2. The Home MSC initiates an IS-41 LocationRequest INVOKE message (LOCREQ) with the same directory number to the HLR. Note that this MSC, without direct access to the subscriber database, does not yet know that this is a special type of call.
3. The HLR consults its database to find the status and location of every member of the user group. For every MSC that has at least one active member it initiates an IS-41 RoutingRequest INVOKE message (ROUTEREQ). Note that the HLR does not track the busy/idle status of any mobiles, but can tell when mobiles are turned off or otherwise inactive.
4. All MSC's that receive the ROUTEREQ consult their databases to determine the status and location of every visiting member of the user group. For every cell that has at least one idle member the MSC initiates a single page message using the User Group ID (UGID) as the identifier, instead of the normal MIN or IMSI. Note that an MSC does track the busy/idle status of mobiles, and can therefore avoid paging in cells where all mobiles are busy.

   All paged mobiles will alert with a distinctive alert. This is required to notify the user of the phone that they have to manually accept the incoming call.
5. In this scenario, the user of at least one of three mobiles in BS-1 accepts the call and the single mobile in BS-3. The user of the phone in BS-2 does not accept the call.
6. To prevent the mobiles that have responded from getting involved in another call, a traffic channel is assigned to the mobiles in BS-1 and BS-3.
7. Both MSC-A and MSC-B have determined that there is at least one mobile willing to accept the call, and each transmits a RoutingRequest RETURN RESULT (routreq) back to the HLR containing a TLDN (Temporary Local Directory Number) that can be used to route the call.
8. The HLR is forced to pick one of the MSC's to receive the call, presumably by responding to the first routreq received. In this case the HLR picks MSC-B.
9. The Home MSC routes the call to MSC-B, using the TLDN assigned by MSC-B. Note that no indication can be given to MSC-A that its TLDN will not be used. This forces a timeout on the TLDN and, more importantly, on the mobile that is waiting on the assigned traffic channel.
10. The chosen mobile is alerted a second time.
11. When the mobile answers, conversation can begin. Note that it would be possible for the mobile to automatically answer the phone at this point to simplify the user interface for this service.

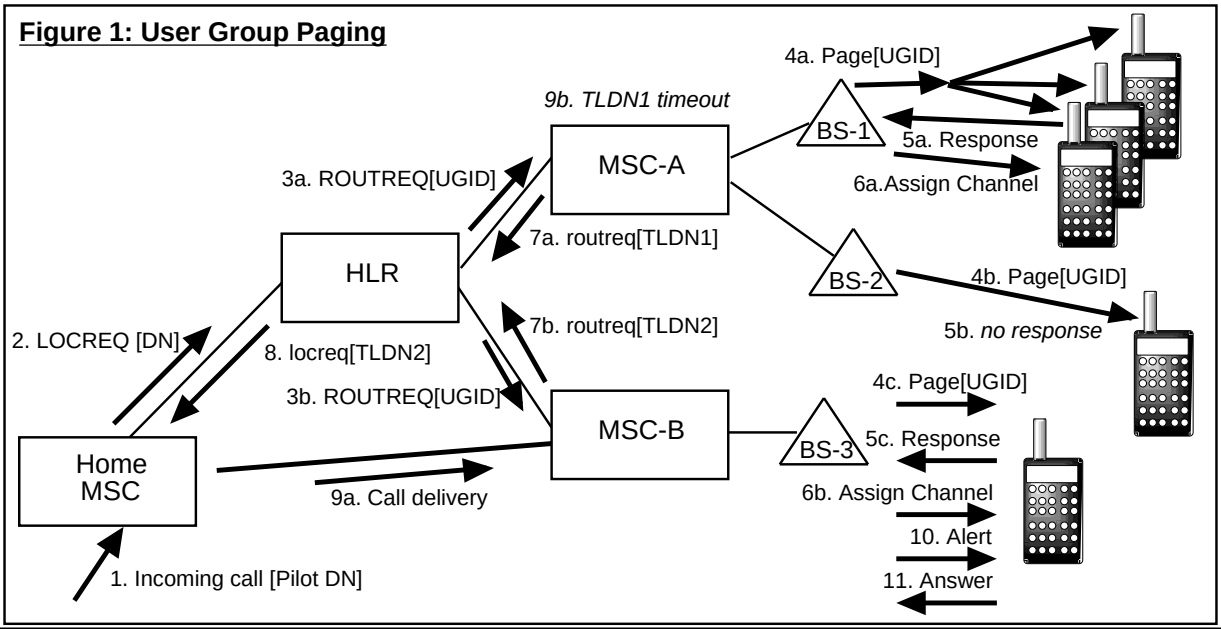
Compatibility

The User Group Paging feature causes more of a compatibility challenge than Flexible Alerting. The MIN is currently a mandatory parameter in the ROUTREQ message, yet for User Group Paging the MIN must be downgraded to an optional parameter, replaced by the User Group ID. This change requires both the HLR's and MSC's to support IS–730 if they are to provide this feature.

Size & Scope of a UGID

User Group IDs vary in size, with the larger UGID formats providing a larger scope. The smallest UGID format is 20 bits, with a local scope. A 24 bit UGID is usable within the domain of a single system operator. A 34 bit UGID is usable nationally and the largest UGID

Figure 1: User Group Paging



format, weighing in at 50 bits, provides an internationally unique identifier.

Is it Worth It?

User Group Paging may well be a useful feature in a wireless PBX environment, although it may have more sex appeal than substance, even there. Supporting this feature in a roaming environment requires IS-136 mobiles, complex software, a significant load of network messages and radio interface messages as well as some waste of radio and network resources. It is conceivable that this feature will be supported in a constrained multi-MSC environment (e.g. a large office complex or campus environment that requires multiple MSC's), but it is, in our opinion, unlikely to ever be supported in a wide area roaming environment. It will be difficult for users of this service to distinguish it from Flexible Alerting. This, combined with the likely low penetration of this highly specialized service, will probably allow the simpler and more general purpose (although somewhat less efficient) Flexible Alerting feature to win out over User Group Paging in the end.

Base Station Manufacturer and System Operator Codes: SOC & BSMC

Every IS-136 TDMA digital mobile and every corresponding base station can be associated with codes that identify the system operator (or significant partners) and the base station manufacturer. The base station broadcasts a single Base Station Manufacturer Code (BSMC) on every digital control channel, a single primary System Operator Code (SOC) and an optional list of multiple alternate SOC's.

If a mobile recognizes one of these codes, and supports special signaling, it can then initiate SOC- or BSMC-proprietary signaling. Little use has yet been made of this capability, although there are rumours that Ericsson is developing some capabilities based on BSMC signaling.

Intelligent Roaming

Although SOC-specific signaling has not been implemented, the SOC is a useful identifier for 'intelligent roaming'. This feature allows a mobile to determine which of up to 8 possible cellular and PCS systems that may be available in a location would be the best to register with. Unlike the Network Directed System Selection feature preferred by CDMA proponents, this capability does not rely on the cooperation of the network (which may have a business motivation to not cooperate!). Intelligent Roaming could be implemented with System ID codes (SID's), but is simpler with SOC's because one SOC will usually correspond to many SID's, thus significantly reducing the size of the database that must be managed, and the frequency with which it must be updated.

Intersystem Impact

Normally, SOC/BSMC signaling is negotiated within a single cellsite. However, in the case of inter-MSC handoff and inter-system paging, information about the Anchor MSC's SOC and BSMC value needs to be provided to neighbouring MSC's. IS-730 does not provide completely general support for SOC/BSMC signaling. It does not allow a transition from one SOC or BSMC in one MSC to a different SOC or BSMC, but does allow the target MSC for the handoff to maintain the same SOC or BSMC signaling if it supports it. Figure 2 illustrates this scenario.

Assignment

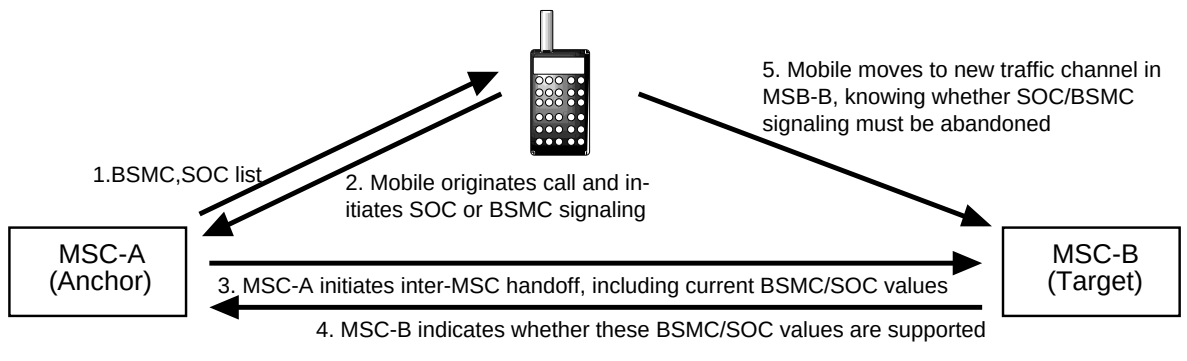
SOC and BSMC values are assigned by the TIA TR-45 standards committee, by written application to:

Editor, IS-136
Committee TR–45
TIA
2500 Wilson Blvd, Suite 300
Arlington, VA 22201, USA

To be continued...

In the November issue we will conclude our discussion of DCCH features and capabilities, by addressing Control Channel Mode Monitoring, Public System Identification number (PSID) and Residential System Identification (RSID) features. We will also provide a tabular summary of all IS-41 messages that have been modified in the IS-730 standard, and will conclude with our perspective on the benefits of the various new features offered by IS-730 and the IS-136 digital control channel.

Figure 2: Inter-MSC Handoff with SOC/BSMC Signaling



ATIS T1P1/TIA TR-46 Committee *PCS-1900 Standards* Project Status Report

Cellular Networking Perspectives

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First Publication

Published Standards

Standard	Description	Status
IS-104-A	PCS Service Descriptions	Published
IS-129	Interworking/interoperability between DCS-1900 and IS-41 MAPs	Published 07/96
IS-651-0	SS7/GSM "A" Interface (RS/PCSC)	Published 07/95
IS-652-0	Intersystem Operations - DCS-1900 (GSM) MAP based	Published 05/96
IS-653-0	ISDN "A" Interface (RS/PCSC). Includes SS7 as a transport option.	Published 10/96
J-STD-007	PCS Air Interface Specification	in press
ANSI J-STD-023	PCN to PCN Intersystem Operations based on PCS1900 Standard (prev. IS-652)	ANSI pub.
ANSI J-STD-024	PCS, SS7 based A-interface Standard (previously IS-651)	ANSI pub.
J-STD-015	W-CDMA Air Interface Compatibility Standards for 1.85 to 1.99 GHz PCS Applications	in press

Standards in Ballot

Standard	PN/SP	Description	Status
J-STD-007-A		Calling Name Presentation supplement to J-STD-007	2nd ballot
n/a		PCS 1900 Service Provider Number Portability	Ballot
TSB-84	PN-3777	PCS to PCS Interference	2nd ballot

Active T1P1/TR-46 Projects

PN	Description	Group	Status
	Determining Location of a GSM Phone	T1P1.5	development
	Adaption of GSM A-Interface to PCS-1900	T1P1.5	CR to ETSI
	GSM support for 14.4 kb/s data	T1P1.5	CR to ETSI

Note: 1. CR - Change Request, ETSI - European Telecommunications Standards Institute, IS– Interim Standard, J–STD- Joint T1/TIA Standard, PN– Project Number, SP– ANSI Standards Proposal , TIA - Telecommunications Industry Association, TSB– Telecommunications Systems Bulletin.

2. Published standards can be obtained from Global Engineering Documents at 1-800-854-7179.

Thanks to Terri Brooks (Nokia) for her assistance compiling the information in this table.

TIA TR-45.4 Subcommittee
Radio to Switching Technology
Standards Status Report

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Published Documents

Standard	Description	WG	Published
EIA/TIA-634	MSC-BS "A" Interface Standard	II	12/95
IS-94	Mobile Station - Land Station Compatibility Specification for Analog Cellular Auxiliary PCS (CAPCS)	III	05/94
TSB-80	**IS-634-0 Addendum (corrections, SMS, subrate voice frame format)**	**II**	**11/96**
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 TR-45.4 Projects (PN=TIA Project Number)

PN	Description	Editor	IS/TSB
PN-3539	MSC-BS Interface (A-Interface) Standard, including support for:	Mike Dolan	IS-634-A
[reballot]	• 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/TDMA (IS-99, IS-130, IS-135) • Frame Relay • 1800 MHz • Optimization		
~~**PN-3746**~~	~~**ISDN based A-Interface, adding**~~ ~~**• address alignment with Mobility Management Application Protocol (MMAP)**~~ ~~**• CDMA and TDMA support, and**~~ ~~**• support for architectures with separate mobility management and call control functions**~~		~~**IS-653-A**~~
PN-3964	**Use of A-Interface standards in Wireless Local Loop (WLL) [on hold until reballot of PN-3539]**		**TSB-xxx**

Note:
1. IS- Interim Standard, J-STD- Joint T1/TIA Standard, PN- Project Number, SP- ANSI Standards Proposal , TSB– Telecommunications Systems Bulletins.
2. **Bold Type** indicates modification since previous publication.
3. Published TIA standards can be obtained from Global Engineering Documents at 1-800-854-7179.

Thanks to Steve Jones (NEC) and Eileen McGrath-Hadwen (Consultant) for their assistance.