

Cellular Networking Perspectives

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In This Issue ...

We are pleased to introduce our first IS-41 field trial Status Report. This month we are reporting on the most active area: IS-41 Rev. A field trials. In February we will report on IS-41 Rev. 0 field trials, which are by now mostly complete. IS-41 Rev. B reports will start once trials are announced, probably later this year. *Late-breaking news*, from a reliable source, is that Motorola and NTI will put IS-41 Rev. A into commercial service between Philadelphia and Allentown, Pennsylvania as soon as the carrier's marketing plans are ready.

The universal implementation of IS-41 call delivery and validation has come much closer with recent developments. Private SS7/IS-41 networks, joining together equipment from several vendors, are growing rapidly, such as the McCaw network in the US and the Cantel network in Canada. The RBOC's, supported by a recent Department of Justice decision, appear to be confident that IS-41 services, done right, do not conflict with Equal Access restrictions. And the CTIA is planning on having a cellular industry wide SS7 network in place this year. This network will be devoted exclusively to IS-41 networking. These developments will be a tremendous boost in the industry battle against fraud as well as making truly seamless roaming possible.

We continue our discussion of inter-system handoff, with an analysis of the difficulties that occur when a cellular phone is in a 3 way conference or has a call waiting. The solution to this problem shows how difficult it can be to provide truly seamless coverage. Yet, it will be the solutions to problems like these that will one day allow cellular to provide a grade of service at least as good as the wireline network.

In our examination of the Working Groups that comprise the TR-45.2 sub-committee we turn to Working Group IV, which is responsible for developing message accounting procedures. This encompasses subscriber billing and revenue sharing between several MSC's involved in the same call. Obviously the ability to bill correctly under all circumstances is necessary to make roaming services commercially viable, but the ability to share revenue among several carriers for one call is just as important for creating the cooperation necessary to make the provision of roaming services commercially desirable.

Inter-System Handoff Part III - 3 Party Call Interactions

A tired account rep. receives a call from an important customer on his portable phone in a subway station. The customer demands immediate answers to some tough questions. Our quick-thinking salesman sets up a 3

way conference call to the company expert on the way out of the subway station. Quickly he describes the problem and the customer to the expert in private conversation, then gets the expert and customer talking, solves the problem, makes the sale and bingo! He is a hero, for a day at least. What our hero certainly did not realize is that an inter-system handoff was required at some point on the way outside from the micro-cellular to a macro-cellular system. Unfortunately for our hero, even in areas with IS-41 handoff implemented, this scenario could not occur today, because it requires procedures that are only defined in Revision B of IS-41, currently not even in field trial. These new procedures overcome some significant and awkward interactions between inter-system handoff and 3 Party Calls.

3 Party Calls

For background, it is worth examining how normal 3 Way Conference Calls and Call Waiting calls are set up. We will describe 3 Party Calling as defined in TIA standard IS-53, although not all systems follow this recommendation. Call Waiting and 3 Way Conferencing differ mainly in the way they are set up, the type of bridging function they require and the interpretation of hook-flashes received after set up. Call Waiting occurs when a caller attempts to reach a busy mobile,

while a 3 Way Conference is set up by a mobile in one call by dialing another number, land or mobile and require a conference bridge to provide 3 way conversation. Hookflashes are used to establish 3 way conversation after private conversation with the add-on party. Call Waiting just requires the conversation path to be toggled between the mobile and the other parties, using a hookflash as the trigger.

Development of Special 3 Party Calling Procedures by TR-45.2

TR45.2 realized early on in the development of IS-41 that inter-MSD handoff of 3 Party Calls required special procedures. It considered two ways to handle 3 party calls after an inter-MSD handoff and to handle inter-MSD handoffs during a 3 party call. One method is to hand off the bridging function so it can be controlled in the MSD receiving the hookflashes. The other method is to route hookflashes back to the Anchor MSD and keep control of the bridging function there. The committee decided on the latter approach, which was documented in IS-41 Rev. B, for the following major reasons:

- It keeps the most important billing information in one place; the anchor MSD.
- Routing hookflashes back to the anchor MSD is simpler than handing off the bridging function.
- The Anchor MSD is the point at which the mobile entered the call in the first place, leading to more predictable charging and handling of 7 digit dialing. Also, the treatment of conference originations corresponds with the state of the mobile's Roam indication which is not affected by inter-system handoffs.
- Routing a call to a busy roamer with call waiting is easier and more reliable if the

point of termination is not moving.

- Interpretation of hookflashes is consistent throughout a call even when neighbouring MSD's interpret them in different ways.
- Information about the state of a 3 Party Call is not required to be transmitted between MSD's.

There are two major variants on the 3 Party/Handoff scenario. Either an inter-MSD handoff occurs before the 3 party call is set up, or a 3 party call is set up and then an inter-MSD handoff occurs. We will consider both of these scenarios in turn.

Inter-MSD Handoff During a 3 Party Call

Figure 1 illustrates the process of handing off a 3 Party Call to a neighbouring MSD. The call is first setup as a 3 Party Call (conference call or call waiting) in the anchor MSD (Step 1a). Then, using normal IS-41 handoff procedures the call is extended to MSD-B (Step 1b). Subsequent hookflashes from the mobile are transmitted from the Serving MSD to the Anchor MSD in an IS-41 *FlashRequest Invoke* message. In a conference call the hookflash may join all three parties together in 3 way conversation, while in call waiting, each hookflash received will alternate the mobile's voice path between each of the other two phones.

3 Party Call Setup After Inter-MSD Handoff

A 3 Party Call following an inter-MSD handoff has to be set up in a rather awkward fashion. The awkwardness at the time of set up makes for much easier handling later: short term pain for long term gain. Since 3 Way conference calls are set up very differently from Call Waiting they will be discussed separately.

Conference Setup After Inter-MSD Handoff

Figure 2 illustrates the process required to set up a 3 Party conference call after an inter-MSD Handoff. Initially the call is setup and handed-off as a normal 2 party call with the PSTN connection at the Anchor MSD and the mobile in the Serving MSD. When a hookflash is received from the mobile it is passed transparently back to the Anchor MSD in an IS-41 *FlashRequest Invoke* message. The Anchor uses the dialed digits contained in the *FlashRequest* to set up the add-on call. A second hookflash received by the Serving MSD and also passed back to the Anchor MSD results in the allocation of a conference bridge in the Anchor MSD allowing a 3 way conference conversation. Following this, further handoffs are possible in exactly the same way that a 2 party call would be handed off. In fact, only the Anchor MSD ever knows that a 3 Way Conference call has been set up!

Call Waiting After Inter-MSD Handoff

Call Waiting to a roaming mobile after an Inter-MSD handoff is illustrated in Figure 3. The incoming call is directed to the Anchor MSD. If the anchor determines that Call Waiting treatment should be applied and the mobile has handed off to another MSD, the anchor puts the incoming call on hold and transmits a short beep over the inter-MSD trunk to the Serving MSD. The subscriber, hearing the beep, can press the mobile's SEND button to indicate a desire to answer the waiting call. The mobile will transmit a hookflash to the Serving MSD which will be passed to the Anchor MSD in an IS-41 *Flash-Request Invoke*. This initial hook-flash will cause the Anchor MSD to answer the call, connecting the waiting party and putting the other party on hold. Subsequent hookflashes, also passed back to the Anchor MSD,

will alternate the mobile's voice path between the two parties. The Serving MSC is not only unaware that Call Waiting is occurring, it cannot distinguish this scenario from 3 Way Conferencing. Only your Anchor knows for sure!

Importance of 3 Party Calls

Should the interactions between 3 Party Calls and Inter-System Handoff just be ignored? After all, few calls would be disconnected or degraded by its absence. However, if cellular is to claim to be a seamless network and if it is ever to provide a landline grade of service, it has to deliver on its promises, no matter how difficult it is to do so. Subscribers are increasingly less likely to be ecstatic just because their phone works and more likely to complain about the inadequacy of service that only a few years ago would have been considered unachievable. Subscribers are also likely to make more and more use of services such as Call Waiting and more likely to experience inter-MSC handoffs as the gaps between service areas close and as micro-cellular systems become more common.

WGIV - Revenue Accounting

Working Group IV of TR45.2 is responsible for cellular standards related to revenue accounting. This includes standards to provide the information to bill for calls made while roaming and also the less well known, but equally important, ability to allow revenue settlement; sharing revenue between cellular systems from the use of resources such as inter-MSC trunks. Until 1991 Working Group IV mainly assisted in the development of IS-41 by ensuring that IS-41 and IS-53 developments allowed revenue accounting to occur. Their level of activity increased substantially when they started to define a standard for the semi-

real-time transfer of call detail records from a cellular system. This standard, known internally as 'DMH' (Data Message Handler) will allow for enhanced billing services and for more effective fraud control based on faster access to the data in call detail records. Once it is in operation it is expected that new business opportunities will result from other uses that can be made of timely access to call detail information

The top priority of WG IV in 1993 is to publish the DMH standard, officially known as "Cellular Radio Telecommunications Inter-system Non-Signaling Data Communications". WG IV will also continue to assist with projects in other areas of TR45.2, particularly message accounting for new services provided in IS-53 Rev. A, CDMA or TDMA with the Digital Control Channel or with data terminals.

The chair of WG IV is John Willse, who represents Cibernet on the TR45.2 subcommittee. John is also assisting Cibernet with the development of a Cibernet Online Roaming Database which will provide access to information such as the blocks of numbers and SID's assigned to each cellular carrier. John's experience with cellular dates back to his work on the AMPS design team; developing specifications for the processing of call detail records for the first two cellular systems in Baltimore-Washington and Chicago. His AMPS work also included one of the first inter-system protocols; the clearinghouse interface to support the exchange of billing information for calls by roamers. This record format, known as CIBER, is now maintained by Cibernet. John worked with mobile communications billing systems preceding cellular, such as Air to Ground, Ship to Shore and IMTS systems. He started working in tele-

communications in 1948 as a lineman with New York Telephones. When he tired of climbing poles he took advantage of an opportunity to work on early computerized billing system, which eventually led to his current position.

Glossary

Anchor MSC•The MSC with the first point of radio contact in a call.

Cibernet•A company set up by the CTIA to maintain and enhance record formats used to communicate cellular billing-related information.

CTIA•Cellular Telecommunications Industry Association.

Hookflash•A way to communicate with a cellular system during a call by pressing the SEND button on a mobile. Used in 3 Party Calls.

IS-41•The TIA interim-standard that defines inter-system operations, such as inter-MSC handoff.

MSC•A Mobile Switching Center. Also known as a Mobile Telephone Switching Office (MTSO).

RBOC•Regional Bell Operating Company. One of the telephone companies created from the breakup of AT&T, and under special restrictions, such as not being able to provide long distance phone service.

Serving MSC•The MSC that currently has radio contact with a mobile.

SS7•Signaling System Number 7. A data communications protocol specially designed to transmit information between telephone exchanges, such as MSC's.

TIA•Telecommunications Industry Association. The organization that has created all North American cellular standards, both for terminals and systems.

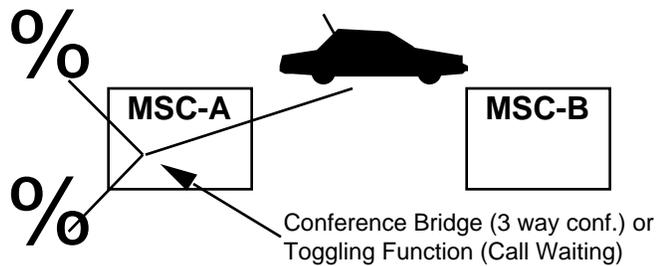


Figure 1a: 3 Party Call before Inter-MS-C Handoff

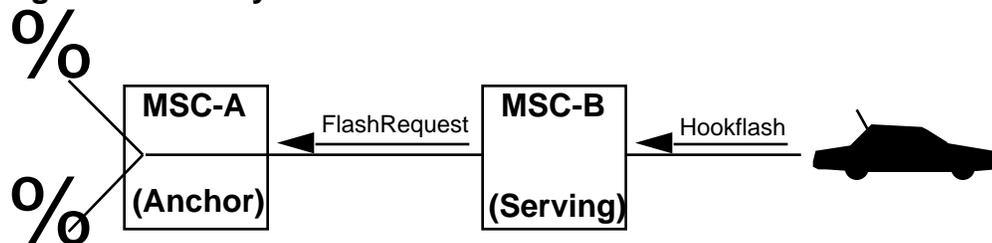


Figure 1b: 3 Party Call after Inter-MS-C Handoff to MSC-B

Figure 1: 3 Party Call Setup Followed by Inter-System Handoff

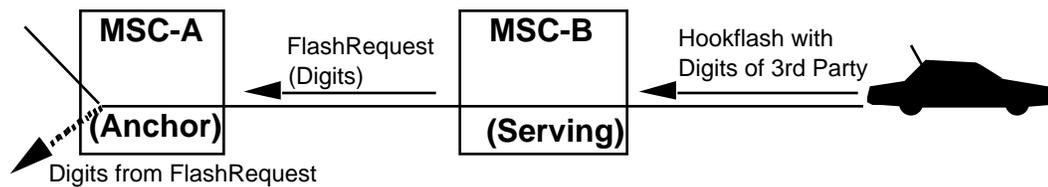


Figure 2: 3 Way Conference Setup After Inter-System Handoff

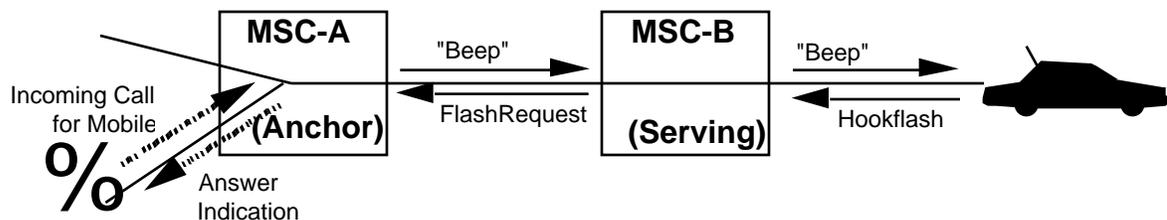


Figure 3: Call Waiting Setup After Inter-System Handoff

Status of IS-41 Rev. A Implementation

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IS-41 Revision A Status (Standard Published, January 1991)						
Vendor1	Vendor 2	Status	Completion	HVD	D/L	Field Trial Location
Astronet	AT&T	Field Trial	11/92	- VD	X	Baltimore/Washington (BAMS)
	GTE TSI	Field Trial	In progress	- VD	X	Baltimore/Washington (BAMS)
	NTI	Lab Trial	Scheduled	- VD	X	Texas/New Mexico (ENMR)
AT&T	Astronet	Field Trial	In progress	- VD	X	Baltimore/Washington (BAMS)
	EDS	Lab Trial	12/92	- V -	X	
	Ericsson	Field Trial	4Q'91	HVD	S	Salt Lake City (McCaw)
	GTE TSI	Commercial		- V -	X	Baltimore/Washington (BAMS)
	Motorola	Commercial	05/92	HVD	X	Fresno (GTE/Contel)
	NTI	Field Trial	05/92	HVD	X	Detroit (Ameritech)
EDS	AT&T	Lab Trial	12/92	- V -	X	
	Ericsson	Lab Trial	01/93	- V -	S	
	Motorola	Commercial	08/92	- V -	X	Los Angeles (PacTel)
Ericsson	AT&T	Field Trial	4Q'91	HVD	S	Portland (McCaw)
	EDS	Lab Trial	01/93	- V -	S	
	Motorola	Field Trial	12/92	HVD	S	Stockton (McCaw)
	NTI	Commercial	12/92	HVD	S	Tampa (McCaw)
GTE TSI	Astronet	Field Trial	11/92	- VD	X	Baltimore/Washington (BAMS)
	AT&T	Commercial		- VD	X	Baltimore/Washington (BAMS)
	Motorola	Lab Trial	12/92	- VD	X	Seattle (US West)
	NTI	Commercial	01/93	- V -	X	Spokane (US West)
		Field Trial	09/92	- VD	S	Greensboro (GTE Mobilnet)
Motorola	AT&T	Commercial	05/92	HVD	X	Sacramento (PacTel)
	EDS	Commercial	08/92	- V -	X	Los Angeles (PacTel)
	Ericsson	Commercial	12/92	HVD	S	Dallas (McCaw)
	GTE TSI	Lab Trial	12/92	- VD	X	Seattle (US West)
	NTI	Field Trial	01/93	HVD	X	Philadelphia(Metrophone)
NTI	AT&T	Commercial	05/92	HVD	X	Windsor(Bell Cellular)
	Ericsson	Commercial	12/92	HVD	S	Ft. Meyers (ICN/Palmer)
	GTE TSI	Commercial	01/93	- V -	X	Spokane (US West)
		Field Trial	09/92	- VD	S	Greensboro (GTE Mobilnet)
	Motorola	Field Trial	01/93	HVD	X	Allentown(Vanguard)

Explanation: Status: Development, Planning, Lab Trial, Field Trial or Commercial
 Completion: Date of actual or expected completion of phase of testing.
 HVD: Type of Test ("H" - Includes Handoff, "V" - Includes Roamer Validation, "D" - Includes Call Delivery)
 D/L: Datalink Protocol (X - X.25 or S - SS7)
 Location: Location of Vendor1 Equipment (usually listed for first trial only)

Note: • For the name and phone numbers of the vendor representatives please contact the editor.
 • IS-41 Rev. A procedures include Handoff, Validation and Call Delivery.