

Cellular Networking Perspectives

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In This Issue ...

We continue our description of Inter-System handoff that started in the November issue. We will delve into the more complex topic of Path Minimization, an important way to minimize facility usage in complex cellular networks.

Our detailed examination of the TIA TR45.2 Subcommittee continues with Working Group III which is responsible for Inter-System handoff procedures.

TR45.2 is working on many different standards documents. In this issue we summarize their current status.

We wish you and your loved ones a Merry Christmas and a Happy and Safe New Year.

New in '93; IS-41 Status Report

The January issue will contain a list of planned and completed IS-41 inter-vendor lab and field trials, including those that are in commercial service. This information was previously published in the recently discontinued CTIA newsletter Cellular Technology Report .

Cellular Network Perspectives wishes to thank the vendor representatives who compiled this information on behalf of their companies and also Gary Brunt, editor of Cellular Technology Report.

Standards and TSBs Being Developed by TR45.2

There are several standards documents currently under development by the TR45.2 subcommittee. The status of the most important unpublished documents following the December TR45.2 meeting is:

Authentication, Signaling Message Encryption and Voice Privacy

Describes modifications to IS-41 Rev. B handoff and call delivery procedures to support IS-54 authentication and encryption of roamers. In publication as TSB-51.

IS-41 Test Plan•An application level test plan for IS-41 Rev. A and IS-53 Rev. 0. In publication as TSB-56.

TechNotes•Will resolve several ambiguities in IS-41 that have resulted in incompatibilities between implementations of IS-41 Rev. A. Being developed by WG II for publication in 1Q'93.

Rev. A Compatibility•Procedures to allow IS-41 Rev. A implementations to be forward-compatible with Rev. B and beyond. Being developed by WG II for publication in 1Q'93.

IS-53 Rev. A•A major revision to the cellular Features Description standard. Being developed by WG V for publication in 1Q'93.

PSTN Interface•A description of both the analog (i.e. MF signaling) and digital (SS7 signaling) interfaces required to connect MSCs to the PSTN. This document

may replace Bellcore TR-NPL-000145 (1986) which is currently used to define analog interfaces for cellular. Being developed by WG VII.

Intersystem Non-Signaling Data Communications

Procedures and messages for on-line transfer of call detail records. Baseline text should be completed by the January, 1993 TR45.2 meeting, with SDL diagrams and ASN.1 notation to follow. Being developed by WG IV.

IS-41 Handoff Part II - Path Minimization

The IS-41 Rev. 0 handoff procedures were adequate for initial inter-systems operation, but it was recognized early in the development of IS-41 that, with increasing network complexity, the basic Handoff Forward and Handoff Back procedures (described in Cellular Networking Perspectives, November 1992) could result in excessive usage of inter-MSC trunks and other resources. Path Minimization procedures, defined in IS-41 Rev. B, can largely eliminate such inefficiency, although further steps may have to be taken eventually.

Path Minimization

Path minimization involves the elimination of unnecessary inter-MSC trunks between an Anchor MSC and a Target MSC. The process is illustrated in Figure 1.

Prior to Step A in Figure 1, a call has been set up at an anchor MSC (MSC-A) and handed off, using IS-41 Handoff Forward procedures, to a neighbouring MSC (MSC-B).

A. Set Up Path to Target MSC...

In Step A.1 the reduced signal strength of the mobile results in handoff measurements in cells in MSC-C (as well as probably within MSC-B and possibly MSC-A). The signal strength of the mobile is measured by MSC-C and returned to the serving MSC in step A.2. MSC-B determines it is best to handoff the mobile to MSC-C, which becomes the Target MSC. Because the Serving MSC is not the Anchor MSC Path Minimization is a possibility. A HandoffToThird Invoke message is transmitted to the anchor MSC (A.3). If the anchor is able to handoff to MSC-C it sends a standard FacilitiesDirective Invoke (A.4) to this, the Target MSC.

B. Coordinate Mobile Handoff...

In Step B the target MSC allocates a voice channel for the mobile and returns a FacilitiesDirective Result (B.1) to the anchor MSC, which, in turn, returns a HandoffToThird Result (B.2) to Serving MSC B. A handoff command causes the mobile to tune to the newly allocated voice channel (B.3). When the target MSC detects the mobile (B.4) it sends a MobileOnChannel to the anchor MSC (B.5). The anchor MSC can then eliminate the unneeded inter-MSC trunk to the previous serving MSC B with a FacilitiesRelease Invoke message (B.6).

C. Remove Redundant Resources

In Step C the release of the facility is confirmed by the old serving MSC (B.1). Meanwhile the mobile continues to transmit in the new serving MSC-C which has assumed the role of serving MSC.

Benefits of Path Minimization

The major benefits of path minimization are:

- The number of inter-MSC trunks used following Path Minimization will be no greater than before the handoff, unlike Handoff Forward which always adds one inter-MSC trunk.
- The number of MSCs involved in a call following Path Minimization will also be no greater than before. This reduces

resource usage in MSCs, such as memory for Call Detail Records and connections through the switching matrix.

- The use of MSCs as tandems following handoff (except for the anchor MSC) will be reduced.
- Handoff can occur between MSCs even when no trunks are configured or currently available. This may allow handoffs between MSCs even when the handoff traffic between them cannot justify the cost of a T1.

Tandem MSCs

IS-41 supports Path Minimization even when the Serving MSC and Anchor MSC are separated by one or more Tandem MSCs. In this case, if an anchor MSC cannot perform Path Minimization, each tandem MSC is entitled to initiate the procedure upon receipt of a HandoffToThird Error. This has several benefits:

- The number of inter-MSC trunks used in the call may actually drop following a handoff.
- The chances of a Path Minimization handoff occurring are greater if more than one MSC is able to initiate it.

More Advanced Scenarios

One remaining restriction on handoff is that the Anchor MSC and Target MSC have to be directly connected by inter-MSC trunks. This restriction is caused because a FacilitiesDirective Invoke does not contain the address of the Target MSC.

If this restriction was removed it would allow additional handoff scenarios such as routing a handoff through an intermediate MSC if no direct trunks are available. It would also allow a very different inter-MSC handoff strategy where every handoff would be set up by the Anchor MSC over the best route available at the time of handoff. However, it would require much more complex cellular networks before any benefits of this additional complexity in IS-41 would be realized.

Summary

Path Minimization will become important as cellular systems become more ubiquitous and diverse in function and as consumers demand ever better service. Inter-MSC handoff is currently a rare event, occurring on the fringes of systems. However, with the integration of microcellular overlays, satellite systems and PCS into the cellular network inter-system handoff will occur more frequently in the interior of cellular systems. In future, walking down the stairs of a subway station may result in an inter-MSC handoff between the conventional cellular system outside, a microcell system on the platform and another specialized system on the train.

Handoff Forward to 1993

In January Cellular Networking Perspectives will discuss the interactions between inter-system handoff and 3 party calls: call waiting and 3 way conferencing. Although it superficially seems that there should be no interactions, there are, they cause significant problems and it took lengthy debate at TR45.2 to determine a good solution. This solution, defined in IS-41 Rev. B, will be discussed.

In the February issue the discussion of inter-system handoff will be completed with discussions of billing implications, equal access handoff and the impacts of new air interfaces such as IS-54 TDMA, CDMA and PCS.

Comments Welcome

Please fax any comments to the editor. We welcome comments on the format of this newsletter, suggestions for future topics, corrections or additional information. Our fax number is 403•289•6658.

Working Group III - Handoff Glossary

The mandate of TR45.2 Working Group III is to develop procedures for inter-system handoff. This working group developed the generic Handoff Forward and Handoff Back procedures described in the November issue of this newsletter as well as Path Minimization, described in this issue. More recently, WG III has developed special procedures for handoff of IS-54 mobiles (including authentication and voice encryption). This group is currently developing solutions for problems found in border areas between two cellular systems and is attempting to resolve some ambiguities found in IS-41 Rev. B. As for authentication, these solutions will first be published as TSBs; effectively addenda to IS41 Rev. B.

A priority of WG III in 1993 will be the procedures for inter-system handoff of terminals with new air interfaces such as CDMA, TDMA mobiles on a Digital Control Channel and TDMA data terminals (DCC). WG III must also consider whether the new features in Revision A of IS-53 will impact inter-system handoff. All of these new procedures will be aimed at Revision C of IS-41.

Working Group III develops procedures and messages which are then incorporated in the next release of IS-41 by Working Group I or, as was the case with authentication procedures, in a TSB. Working Group III has worked closely with the Automatic Roaming group (WG II) over the past year, as most of the new work in IS-41 has required changes to both Automatic Roaming and Handoff procedures.

The chair of Working Group III is Thomas Ginter of Ericsson. He developed cellular switching systems software at NovAtel for 4 years before joining Ericsson. He started attending TR45.2 meetings while at NovAtel as the editor of the IS-41 Test Plan (TSB-56) and has continued contributing to TR45.2 as WG III chair and Ericsson representative.

Anchor MSC•The first MSC involved in a call. For Mobile-to-Land and Land-to-Mobile calls, it is the point of PSTN inter-connection. The Anchor MSC is the only MSC that must always remain connected in a call.

CTIA•Cellular Telecommunications Industry Association. Trade organization of cellular carriers.

IS•Interim Standard. A TIA standard that has not yet received ANSI approval.

IS-53•The standard that describes how subscriber features should work in a cellular system. It includes descriptions of Call Forwarding, Call Waiting and others.

IS-54•The standard that describes the TDMA digital air interface.

Pivot MSC•The MSC that initiates the Handoff Forward portion of Path Minimization and controls the release of inter-MSC trunks to the old serving MSC. Usually, but not always, the anchor MSC.

Serving MSC•The MSC currently serving a mobile in a call.

Tandem MSC•An MSC functioning as a tandem exchange in a cellular call, not connected to either a mobile or PSTN party except through other MSCs. This situation can occur after two Handoff Forwards.

Target MSC•The MSC to which a handoff is being directed. This MSC will become the Serving MSC if the handoff is successful.

TIA•Telecommunications Industry Association.

TR45.2•Cellular Inter-System/Roaming standards setting subcommittee. Members are mostly either vendors or purchasers of cellular system equipment or services.

TSB•Telecommunications Systems Bulletin. A publication of the TIA without the status of a standard. Commonly used to distribute important information to the cellular community or to update a standard between major scheduled revisions.

1992 Back Issues Available

Back issues are always available. Major topics in each issue are:

July

Introduction to the TIA cellular standards setting committees.

August

Authentication, Validation and Voice Privacy.

September

North American Numbering Plan changes, part I.

October

North American Numbering Plan changes, part II.

November

Inter-System Handoff, part I - Handoff Forward/Back.

December

Inter-System Handoff, part II - Path Minimization.

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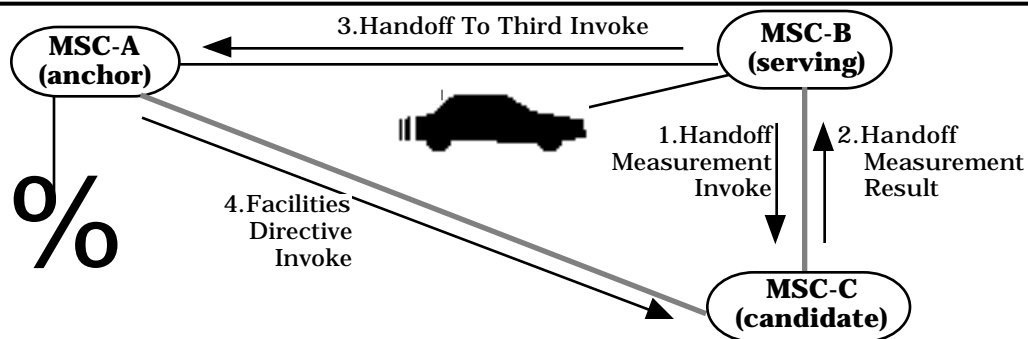
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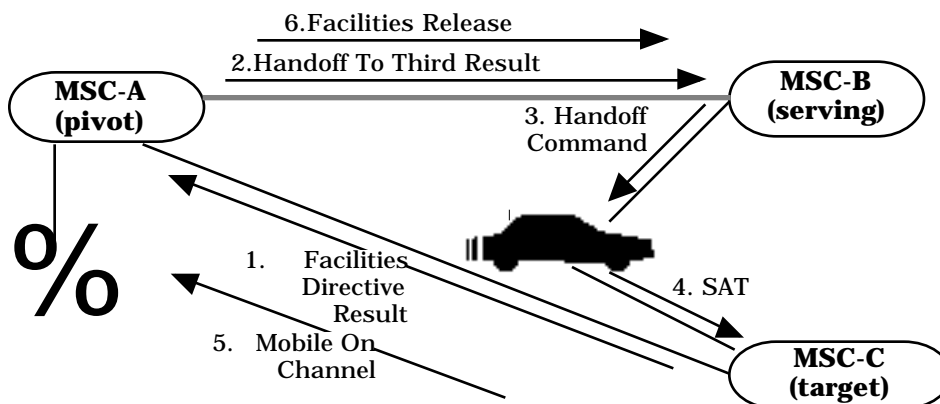
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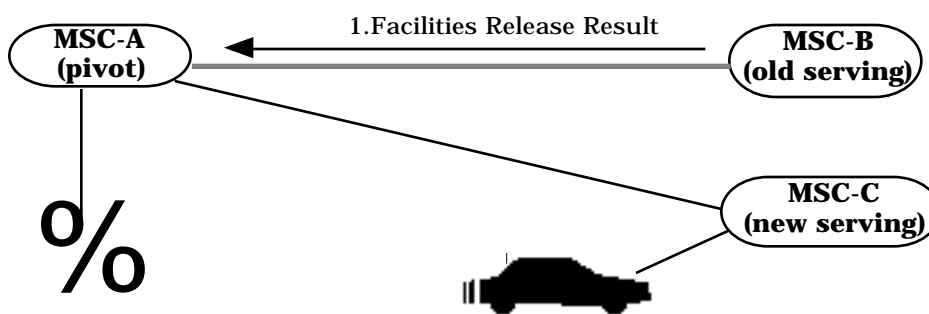
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Step A: Serving MSC requests Path Minimized handoff to Target



Step B: Target Allocates Channel for Handoff via Pivot MSC



Step C: Mobile at New Serving, Trunk to Old Serving Released



Figure 1: Inter-MSC Handoff Path Minimization using TIA/IS-41 Protocols