

Home Location Register Redundancy

DESCRIPTION



NOTICE

The information contained in this document is believed to be accurate in all respects but is not warranted by Mitel Networks™ Corporation (MITEL®). Mitel makes no warranty of any kind with regards to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The information is subject to change without notice and should not be construed in any way as a commitment by Mitel or any of its affiliates or subsidiaries. Mitel and its affiliates and subsidiaries assume no responsibility for any errors or omissions in this document. Revisions of this document or new editions of it may be issued to incorporate such changes.

No part of this document can be reproduced or transmitted in any form or by any means - electronic or mechanical - for any purpose without written permission from Mitel Networks Corporation.

TRADEMARKS

The trademarks, service marks, logos and graphics (collectively "Trademarks") appearing on Mitel's Internet sites or in its publications are registered and unregistered trademarks of Mitel Networks Corporation (MNC) or its subsidiaries (collectively "Mitel") or others. Use of the Trademarks is prohibited without the express consent from Mitel. Please contact our legal department at legal@mitel.com for additional information. For a list of the worldwide Mitel Networks Corporation registered trademarks, please refer to the website: <http://www.mitel.com/trademarks>.

© Copyright 2018, Mitel Networks Corporation

All rights reserved

1

INTRODUCTION

This is a description of the HLR Redundancy feature in the MX-ONE Service Node.

The feature is available to IP terminals, that is, SIP and H.323 phones or clients. If an arbitrary server (LIM) fails or becomes unavailable, these extension types can register or re-register in any server (LIM) in operation in the same system. In other words, a backup HLR will be created, and the extension can be registered to that backup HLR.

When the ordinary HLR recovers, it is also possible to re-register to this HLR. This is however not done immediately, but with a delay.

There is one general system license for HLR Redundancy feature.

The HLR Redundancy feature is sort of an alternative to the Server Redundancy feature. If you are using Server Redundancy, there is no reason to activate the HLR Redundancy feature, in fact it is recommended not to activate it.

1.1

SCOPE

This document provides a high-level description of the HLR Redundancy feature.

1.2

TARGET GROUP

This document is intended for System Administrators.

1.3

GLOSSARY

Backup HLR

A temporary HLR created in another server (LIM) than the ordinary HLR's, used when the ordinary HLR's server cannot be accessed.

Change-back

The changing from temporary backup HLR to the ordinary HLR. Registration of the ULR will be to the ordinary HLR after the change.

Change-over

The changing from ordinary HLR to a temporary backup HLR. Registration of the ULR will be to the backup HLR after the change

Ordinary HLR

The HLR created by command/management functions in a specific server (LIM), which the user is registered to in normal operation of the system.

Queue LIM

A concept used in certain functions, and in the system database. Queues or similar functionality for extensions or groups will be put in one LIM, and the queue resources are dynamic. The Queue LIM is static data that is known in the system database.

Redundancy

The duplication or multiplication of a certain function, which makes it possible to retain the function, at least partially, by accessing another server, which provides a backup function. The distributed system concept and the existence of an external database are essential for the redundancy.

Replication

The copying of modified data from a database entity to its replicas. Done according to the system database's rules for replication.

For a complete list of abbreviations and glossary, see the description for *ACRONYMS, ABBREVIATIONS AND GLOSSARY*.

2

FUNCTIONS

2.1

OVERVIEW

HLR Redundancy means that a backup registration of certain extensions will be performed, when the ordinary HLR cannot be accessed. A temporary backup HLR in a different server (LIM) is used. If the ordinary HLR recovers, a re-registration back towards this HLR can be done. In order not to overload the ordinary HLR's server, the re-registration will be performed with a delay and distribution in time,

Some services, like group functions and busy or queue functions are lost while registered to the backup HLR. Some services that depend on common or centralized resources can also be lost depending on configuration, see the section Interactions with other features.

If an arbitrary server (LIM) fails, SIP- and H.323-extensions can be temporarily registered to a backup HLR, located in another server (LIM) than the ordinary home LIM. With other words, a backup HLR is created when a generic user tries to register or re-register. To be able to create the backup HLR, a system database (Cassandra) with replication functions is used. The ULR will register towards the backup HLR.

Note: Certain types of generic extensions, can be configured as “auto-registered”, and cannot support HLR redundancy. Those types are Remote extensions, certain SIP extensions (conference phones, elevator or reception SIP phones, MS Skype4B/Lync Forking clients for example), certain DECT base stations and DECT-SMS servers, which are also implemented as a kind of auto-registered generic extension.

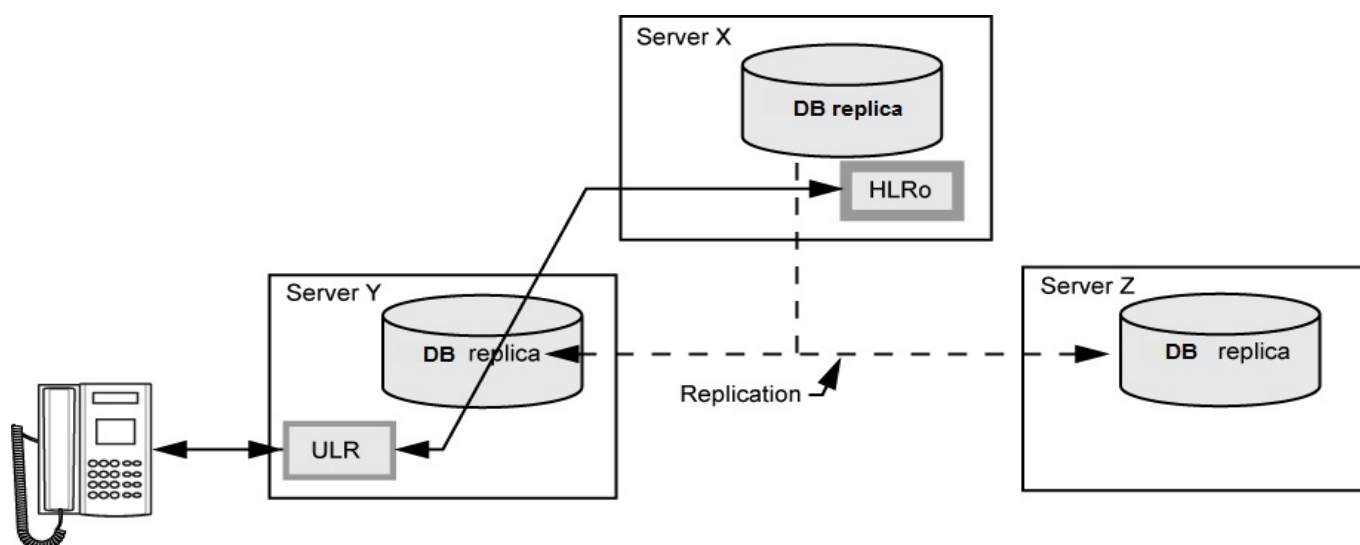


Figure 1: General Architecture - Before Change-over

In the figure above Server X is the ordinary home server, where HLR is located. Server X is accessible, so the ordinary HLR is activated in Server X. ULR is registered to ordinary HLR, but located in Server Y.

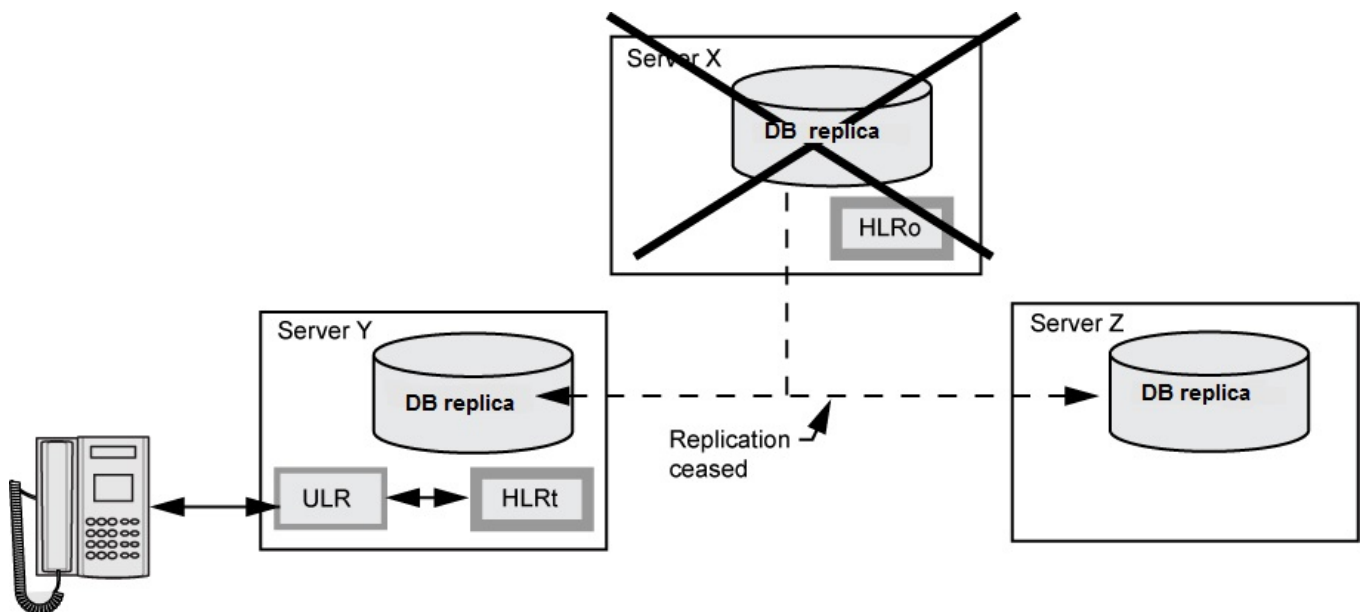


Figure 2: General Architecture - After Change-over

In the figure above Server X is the ordinary home server, where HLR normally should be located. Now Server X is inaccessible, so a temporary HLR is created in Server Y. ULR is registered to the temporary HLR.

Note: In the figure above the lost system database entity is in server 1, i.e. Server X is server1. HLRs can of course be spread in all LIMs.

There are a number of scenarios where HLR redundancy is relevant, from 2-LIM systems up to 124-LIM systems, with or without network redundancy. There are also scenarios with different server types or server capacities, from low capacity Mitel ASU Lite to high capacity standard servers. Ideally all servers should have similar capacities, to get a well functioning and balanced system database environment.

2.2 USER INTERFACE (INVOCATION)

2.2.1 INITIATION FROM A SIP EXTENSION

There is no user invocation of the feature. The system or the terminal will detect the conditions for change-over to backup HLR or change-back to ordinary HLR. A faster change-back to ordinary HLR can be initiated by doing a standard logoff (detach), and new logon.

2.2.2 INITIATION FROM AN H.323 EXTENSION

There is no user invocation of the feature. The system or the terminal will detect the conditions for change-over to backup HLR or change-back to ordinary HLR. A faster change-back to ordinary HLR can be initiated by doing a standard logoff (detach), and new logon.

2.3

HLR REDUNDANCY FUNCTIONALITY

2.3.1

PREREQUISITES

Even if all types of generic extensions theoretically could utilize the HLR redundancy feature, the following type of generic extensions are supported:

- IP extensions (terminals sending register request)

All busy services, group services, monitor services, and several other services, are lost while logged on to a backup HLR. See section 3 Interaction with Other Features on page 9 for more details.

For H.323 phones, if gatekeeper discovery is used (i.e. the broadcast solution which can be activated), only one domain can be supported, so the involved gatekeepers (LIMs) must be in the same domain. There is a load distribution function for registration of IP terminals (H323 extensions) to a gatekeeper (GK).

Parallel ringing is **not supported**. Incoming calls to a parallel ringing extension when home LIM is down, will result in that it only rings at the main number.

2.3.2

CONDITIONS FOR CHANGE-OVER

When an extension logs on to a server and tries to contact the HLR and it cannot be reached, then HLR data will be loaded or created in the server (LIM) that shall carry out the temporary logon. The HLR data in the system database replica will be copied to the created backup HLR. This registration procedure will update the HLR location, that is, all available LIMs will know in which LIM the active HLR is located.

Conditions for change-over are:

- Server (LIM) out of order
- Server (LIM) isolation (if the ULR is in a different LIM than the ordinary HLR)
- Manual blocking of entire server (LIM)

If the extension is involved in a call when a condition occurs, change-over will not be done directly. A so called keep-alive status message is sent periodically to all LIMs in a sequential ring. The change-over will be delayed until next keep-alive check when the extension is not involved in a call.

2.3.3

LOCATION REGISTRATION TO BACKUP HLR

2.3.3.1

General

When a condition for change-over has been detected by functioning servers (LIMs) in the system, any user who cannot access its ordinary home LIM can instead register to a backup HLR in another LIM. Propagation and detection of the change-over condition can take some time. The temporary HLR is created as a result of the users registration request, based on data in the system database.

As an example, the time before detecting the conditions for change-over may be in the range 10-80 seconds, depending on number of LIMs and CPU power. In addition, there will be a delay of anything from 0 to 10 minutes (or even more since this is a configurable timer in the terminal) before the re-registration is requested.

2.3.3.2 *User Logged on When Ordinary HLR Is Lost*

In this case there is an existing ULR, which can be either in the lost home LIM, or in some other LIM which is assumed to be in operation. In the first case, the terminal must request location registration in another LIM. In the second case a location registration request in the ULR LIM would have a chance to succeed in creating a temporary HLR in that same LIM and register to it.

2.3.3.3 *User Not Logged on When Ordinary HLR Is Lost*

In this case there is no existing ULR, no periodic keep-alive signaling, and the terminal (end point) must be involved in selecting the server (LIM) to register in. The terminal will primarily try to register in the ordinary home LIM. When that fails, the terminal must request location registration in an alternative server (LIM) by sending new register request.

2.3.3.4 *Load Regulation of Registrations at Change-over*

For reasons of overload risk and risk for suppression of traffic execution, the MX-ONE Service Node must limit the number of registrations per time unit, that is, it must have a load regulation for the location registration function. The periodic re-registration (keep-alive check) that is done for logged on IP terminals has a default period of 10 minutes, and is used to trigger the re-registration. The timer duration can be changed. The IP terminals should preferably be configured to register to different backup servers, and at different times, in order to distribute the load.

A server with backup HLR can only allow a certain maximum number of registrations, and this maximum depends on the CPU processing capacity, and the amount of data that needs to be conveyed between the LIMs. A server using Mitel ASU Lite, will allow a lower maximum than a server using, for example, a standard server.

For example in a branch-office scenario the capacity of the backup HLR server could be much lower than the ordinary HLR server, in which case it will not be possible to register more than a small percentage of the extensions to backup HLRs.

2.3.3.5 *Rejection Cases*

The location re-registration to the ordinary HLR can fail with the reasons specified in description *IP EXTENSION*. In addition there is also the rejection case when the temporary HLR resource cannot be seized, due to the maximum limit of permitted TEMPORARY HLRs in a LIM.

2.3.3.6 *Abnormal Cases*

Due to, for example, bad networks or malfunctioning network elements, the system could end up in a situation with isolated segments of LIMs that operate separately for a period. One could get inconsistent functionality in the different segments, depending on whether certain common functions are available or not in the segment. There could also be situations where there is more than one backup HLR for the same user in different segments.

Note: Ideally we should have no common functions. If they exist, they should be possible to duplicate or backup. Existing common functions are currently operator distribution, queue and paging.

2.3.4 LOGOFF/DETACH WHILE REGISTERED TO A BACKUP LIM

If an IP extension user logs off while being registered to a backup HLR, that will basically be a normal logoff/detach. However, if it was the last or only extension that logged off, the temporary HLR is removed. The server (the LIM with temporary HLR) will inform all other accessible LIMs that the active HLR is now the ordinary HLR, even though the ordinary HLR server is probably still not accessible.

2.3.5 CONDITIONS FOR CHANGE-BACK TO ORDINARY LIM

2.3.5.1 *General*

If an inaccessible server (LIM) is recovered, that is, it is restarted correct, or is no longer isolated, or is manually de-blocked, then the system will still maintain the registration to the temporary backup HLR until the user de-registers, or until a periodic keep-alive re-registration is executed. The system will then re-register the ordinary HLR as active HLR, and deactivate the backup HLR.

The user can in this situation also manually log off and logon again, in which case the registration will primarily be to the ordinary HLR.

If the extension is involved in a call when the condition occurs, change-back will not be done immediately. It will instead be delayed until the next periodic keep-alive check, when the extension is not involved in a call.

2.3.5.2 *Load Regulation of Location Registration at Change-back*

To not risk overload and suppression of traffic execution, the number of registrations per time unit must be limited. That is, the system has a load regulation for the location registration function. When a location registration is requested, the system will check the CPU load in a similar way as the load check done in traffic.

The periodic re-registration (keep-alive check) that is done for logged on IP terminals, has a default period of 10 minutes. It is used to trigger the re-registration, also at change-back to the ordinary HLR. The timer can be changed, and the time-outs are distributed in time for different terminals.

2.3.5.3 *Rejection Cases*

The location re-registration to the ordinary HLR can fail with the reasons specified in description *IP EXTENSION*. There is no ordinary HLR congestion case, since that entity is always there, created by command.

2.3.6 ONGOING CALLS AT CHANGE-OVER OR CHANGE-BACK

If an IP extension is involved in a call when a condition for change-over or change-back occurs, no change will be done as long as the call continues. The change-over or change-back will wait for the next periodic keep-alive check, when there is no ongoing call for the user.

2.4 MITEL 6900/6800/6700 SIP TERMINALS

For more information about the redundancy functionality for Mitel 6900/6800/6700 terminals, see Installation instructions for Mitel 6900/6800/6700 SIP terminals.

3 INTERACTION WITH OTHER FEATURES

The functionality for other features while registered to a backup HLR is described in this chapter.

3.1 ADC/CTI GROUP

ACD/CTI group functions will be lost if the group is in the ordinary HLR LIM, since the queue function is a central function. ACD can be configured for backup in one other server (LIM), see *AUTOMATIC CALL DISTRIBUTION*.

3.2 AUTHORIZATION CODE

Authorization code should generally work, since this data is stored in the system database, and thus available in all LIMs. If the authorization code is used for locking an extension, the lock information will be lost at change-over, since it is dynamic data.

3.3 AUTOMATIC REGISTRATION OF EXTENSIONS

Generic extensions configured for automatic registration cannot support the HLR redundancy feature (since they lack the required protocols).

Note: Certain types of generic extensions, can be configured as “auto-registered”. Those types are Remote extensions, certain SIP extensions (conference phones, elevator or reception SIP phones, MS Skype4B/Lync Forking clients for example), certain DECT base stations and DECT-SMS servers, which are also implemented as a kind of auto-registered generic extension, are not able to support HLR Redundancy.

3.4 CALLBACK AND ON-HOOK QUEUING

Callback and On-hook queuing are queue functions that would be lost while logged on to temporary HLR. The reason is that Queue LIM would be the inaccessible ordinary HLR LIM, so any queue missions already in that LIM would be stuck or lost there, and not be able to execute. New calls that might try to queue, will be able to do so while the user is logged on to the temporary HLR. Change-back to ordinary HLR will be done even if there are waiting callback missions. These callback missions will be lost, that is, they will not be re-establish towards the ordinary HLR.

3.5 CALL WAITING

Call waiting is a queue function that would be partly lost while logged on to temporary HLR, but new call waiting request received while being logged on to temporary HLR will succeed.

3.6 CHARGING/CALL METERING

The Charging function has a direct one-to-one association to the HLR/Directory number of an extension, due to the Charging group concept. This association is lost at change-over. In other words, an outgoing trunk call that should be charged, made by an extension that is logged on to a temporary HLR, will not be charged to that extension number. Call Information Logging will still log the right charged party number.

3.7 COMMON BELL GROUP

A generic extension that is member of a common bell group will lose its membership while registered to a backup HLR. When it re-registers to the ordinary master HLR it will regain the common bell group membership.

3.8 CONFERENCE (AND INTRUSION)

These multi-party services are dependent of central resources, like the TMU, or other media mixing functions. Thus it is a configuration matter if the services are available or not while logged on to a temporary HLR.

3.9 CORDLESS EXTENSION TRAFFIC (DECT)

HLR redundancy is not supported for DECT extensions, nor for SMS servers.

3.10 CSTA MONITORING AND SERVICES

The CSTA features will, if possible, be retained at change-over to temporary HLR. CSTA monitoring is automatically re-established at change-over to temporary HLR, and at change-back to ordinary HLR. The CSTA features will sometimes be lost, depending on configuration/location of the CSTA ports.

3.11 DIVERSION SERVICES

The Diversion services will be lost at change-over to temporary HLR, at least most of them, since the diversion status data is dynamic, and not stored in the system database. Since generic extensions currently only support Follow-me, Message Diversion and ECF, these are the only services concerned.

The Diversion services can be activated again while logged on to temporary HLR, but the data will be lost at change-back to ordinary HLR.

3.12 DUAL FORKING

Generic extensions that are involved in Dual Forking, will partly lose the feature while registered to a temporary HLR. This is because the state and monitoring information will be lost, since it is dynamic data. When the extension re-registers to the ordinary master HLR it will regain the Dual Forking function. Note that there are two ULRs registered to one HLR for the Dual Forking feature.

3.13 EMERGENCY CALLS

Emergency calls for an H.323 extension utilize a dedicated H.323 route, and this route would have to be configured to spread the trunks in several or all LIMs, in order to make Emergency calls possible together with HLR redundancy.

Emergency calls from SIP extensions also work when logged on to a temporary HLR.

3.14 EMERGENCY EXTENSION (AUTOMATIC CONFERENCE)

Since neither H.323 nor SIP extension can be Emergency extension, there is no direct interaction.

Note: This multi-party service is dependent of central resources, like the TMU, or other media mixing functions. These multi-party resources must be in the ordinary HLR LIM, so when a change-over occur, the emergency extension function is always lost. The multi-party resources are seized already at command initiation time, when the emergency extension is initiated.

3.15 EMERGENCY SWITCHING

In an emergency switched system, Location registration and Detach requests will be accepted, including HLR Redundancy change-over.

3.16 FEATURE KEYS IN EXTENSIONS

Generic extensions that support feature keys will keep most of the feature keys while registered to a backup HLR. The key information is stored in the system database. Some types of keys, like MNS, will lose their functionality, because the monitoring data is static, that is, reload data but not stored in the system database. When changing back to ordinary HLR, the lost key functions will be regained.

3.17 FREE SEATING

Extensions (ATS and DTS) that are using the Free seating feature, will lose the service if the ordinary HLR becomes inaccessible.

When the user re-registers to the ordinary master HLR, it will **not** regain the free seating service. The service would have to be requested/activated again. Since there is no periodic keep-alive signaling, change-over and change-back is not supported.

3.18 GROUP CALL PICKUP

Group call pickup is a queue function that will sometimes be lost, but sometimes will work while logged on to the temporary HLR. The pickup group does not have an access number, but there is still a LIM association, both for the group and the queue, so there is a configuration dependency.

3.19 HUNT GROUP

A generic extension that is member of a PBX hunt group will lose its membership while registered to a temporary HLR. Even if the LIM where the hunt group is located, which is also the queue LIM for the group, is still accessible, the hunt group function will cease to work for the member. When the extension re-registers to the ordinary master HLR, it will regain the hunt group membership.

3.20 INDIVIDUAL CALL PICKUP

Individual call pickup is a function that can experience temporary problems at change-over, that is, the pickup will be rejected. It otherwise works, also when logged on to the temporary HLR.

3.21 LAST EXTERNAL NUMBER REDIAL

The centrally stored Last external Number Redial number (LNR) is not supported for generic extensions, and the data is not stored in the system database, since it is dynamic data. If the terminal supports a local LNR feature in the terminal, that function should work also in cases where backup HLRs used.

3.22 MESSAGE WAITING AND MANUAL MESSAGE WAITING

MMW and Message Waiting are queue function that will be lost while logged on to temporary HLR. A new Message Waiting indication received while logged on to an HLR can be supported, but will be lost at change-back to ordinary HLR.

Since the messages are stored in an external application can Message Waiting be re-created, if the external application does an update while the user is registered to a temporary HLR.

3.23 MULTIPLE REPRESENTATION OF EXTENSIONS/MNS

Generic extensions that support monitoring will lose the monitoring function while registered to a temporary HLR. When it re-registers to the ordinary master HLR it will regain the monitoring, that is, the MNS or a similar feature.

3.24 OPERATOR SPECIFIC SERVICES

The operators will experience some inconsistent behavior when calling extensions that have the HLR Redundancy feature, because of the temporary loss of, for example,

busy and queue features. For example Camp-on busy, Call Announcing, and other services that use queue resources, will sometimes work and sometimes not.

The operator functionality, both distribution and queuing functions, and the individual operators, is deployment/configuration dependent because of the dependency on multi-party resources, which could be in an inaccessible LIM.

3.25 PARALLEL RINGING

Generic extensions that have Parallel Ringing will partly lose the feature while registered to a backup HLR. This is because the dynamic state and monitoring information will be lost.

When the extension re-registers to the ordinary master HLR it will regain the Parallel Ringing function.

Note: Parallel Ringing resources are created/seized in traffic when the ULR is seized, and released when the call is answered or when calling party clears.

3.26 PARKING, INQUIRY, ALTERNATION AND TRANSFER

These features will generally work also when changing to a backup temporary HLR. Single line access extensions would lose the inquiry queue mission at change-over, if we allow change-over in parked calls.

Parking of trunk calls has a timed recall function, which will sometimes work even if a change-over to a temporary HLR is done. If the trunk is in a different LIM than the ordinary HLR, the recall can be supported but otherwise the recall will not work.

3.27 PERSONAL NUMBER (IRD DISTRIBUTION)

The active Personal Number (PEN) list number is stored in system database, so this information should be available in all LIMs through replication. Thus Personal Number can work if the system database is contacted in the temporary HLR LIM. In Boss-Secretary scenarios, parts of the functionality will cease to work since monitoring may be lost.

Note: PEN resources are created/seized in traffic at seizure of the ULR, and released when the call is ended.

3.28 RECORDED VOICE ANNOUNCEMENTS

RVA is dependent of HW resources, Media Gateways, so there is a LIM and configuration dependency. If the RVA resources are in an inaccessible LIM, then the RVA function may be lost at change-over.

3.29 REMOTE EXTENSION

HLR backup/redundancy is not supported for Remote extensions.

3.30 ROUTING AND LEAST COST ROUTING

Trunk resources must be configured in a suitable way to facilitate HLR backup/redundancy. Trunk resources should be available in all LIMs, so a temporary loss of the ordinary HLR LIM, will not prohibit outbound trunk traffic.

3.31 SINGLE NUMBER INDICATION

The Single Number Indication (SNI) feature, which is used together with Parallel Ringing, will be lost at a change-over to a temporary HLR, because the SNI data is not part of the HLR data.

3.32 SOM, SURVEILLANCE, OBSERVATION AND MONITORING

The SOM functions will not work or be maintained for a user logged on to a temporary HLR, unless the SOM monitoring is restarted. The location and configuration of the dedicated trunks used for the SOM will also affect the functionality.

3.33 OTHER POSSIBLY AFFECTED FUNCTIONS (DUE TO LOCATION OF COMMON FUNCTIONS)

There are a number of services that use a so called common function which can be lost when an ordinary HLR LIM becomes inaccessible. Those services are Paging, Path Replacement, Operator distribution, Traffic recording and SS7 trunk.

3.34 MULTIPLE TERMINAL SERVICE

IP extensions that have Multiple Terminals service (for example for Parallel ringing) will lose the feature while registered to a backup HLRT. A call to the extension will only ring on the main number. When the extension re-registers to the ordinary master HLRT it will regain the full Multiple Terminal service function.

3.35 FORKING

IP extensions that are involved in Forking, will partly lose the feature while registered to a temporary HLRT. This is because the state and monitoring information will be lost, since it is dynamic data. When the extension re-registers to the ordinary master HLR it will regain the Forking function. Note that there are two ULRs registered to one HLR for the Forking feature.

4 ADMINISTRATION

There are commands to activate and deactivate the HLR redundancy feature. The status can also be printed. Default is **inactive**.

If trying to remove an IP extension while it is registered to a temporary HLR, the command will be rejected to avoid data inconsistency.

IP extensions can be forced to log off via command. This will also remove the backup HLR in case the extension is registered to a temporary HLR, and could be used for example in fault situations where a change-back has failed.

5 CONFIGURATION (MARKET PARAMETERS)

There are no market dependent parameters for the HLR Redundancy feature.

The timer for the periodic keep-alive re-registration of IP extensions can be changed in the terminals, and thus affect the HLR Redundancy function.