RELEASE NOTE

Report GSM 11.32

Visitor Location Register Specification

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1. Reason for changes

No changes since the previously distributed version.

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Visitor Location Register Specification

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PREFATORY NOTE

ETSI has constituted stable and consistent documents which give specifications for the implementation of the European Cellular Telecommunications System. Historically, these documents have been identified as "GSM recommendations".

Some of these recommendations may subsequently become Interim European Telecommunications Standards (I-ETSs) or European Telecommunications Standards (ETSs), whilst some continue with the status of ETSI-GSM Technical Specifications. These ETSI-GSM Technical Specifications are for editorial reasons still referred to as GSM recommendations in some current GSM documents.

The numbering and version control system is the same for ETSI-GSM Technical Specifications as for "GSM recommendations".

0. SCOPE

The scope of this report is to give guidelines concerning the specification of the Visitor Location Register (VLR).   In the case of discrepancy between this report and the approved core GSM recommendations the later shall prevail.   Each function is specified as either mandatory or optional.

The different functions provided by the VLR are identified with an indication of the relevant recommendations where the definitive specifications can be found.

The purpose of this report is to give an overview of the VLR functions needed to implement the GSM system, in order to help both the Administrations/Operators in the procurement of their equipments and the manufacturers tendering the VLR.

A list of the contents which may be found in a national specification for such equipment is given as an appendix to this report.   Note that some items in this list are not specified by GSM, but are left to the discretion of the operators.

1. INTRODUCTION

The VLR, as described in this and all other GSM recommendations, is not a physical entity and need not be implemented as such, it is, rather, a set of functions which are required to manage the mobile nature of subscribers active in the PLMN area(s) related to the VLR.

The VLR provides a local store of all the variables and all the functions needed to handle calls to and from subscribers in the location areas related to the VLR.   It also supports location updating of subscribers and retrieves from the HLR the information required for local storage.   It may also retrieve some information about subscribers that have just entered its area from the VLR related to the previous area that the MS was registered in.

VLR functions may be incorporated into a single physical entity or distributed or combined with other PLMN entities such as a MSC.

2. DEFINITIONS

The term Visitor Location Register (VLR) is defined in Recommendation GSM 01.04 and a more full description can be found in Recommendation GSM 03.02.

3. ARCHITECTURE

The network architecture is defined in Recommendation GSM 03.02 where it is shown how the VLR is related to other functional entities of the PLMN.

The architecture allows several ways to implement VLRs in order to meet various national needs and allow flexiblity for future development of GSM PLMNs.

Irrespective of national solutions the requirements specified below as mandatory are required in order to allow full connectivity of GSM PLMNs nationally and internationally.

4. INTERFACE

The VLR must support signalling to and from MSCs and HLRs (both of the home and other PLMNs) and to other VLRs in the same PLMN.

The signalling used to provide information transfer between a VLR and OMC is a national matter. However, international standards are emerging which will facilitate the transfer of such information between VLRs and different OMC implementations, using standard protocols. These standards will be embodied in the Telecommunication Management Network (TMN) concept - this is described in Recommendation GSM 12.00. Also, Recommendations GSM 12.01 and 12.14 define information transfer principles with other O&M entities.

4.1. Support of Mobile Application Part (MAP)

Interfaces within a PLMN are a national matter and would preferably use MAP(GSM 09.02).

Interfaces between PLMNs are mandatory and must use MAP.

5. FUNCTIONS OF THE VLR

5.1. Organization of subscriber data

The VLR must store subscriber data for registered MSs. Recommendation GSM 03.08 gives the full description.

5.2. Management and allocation of numbers and identities

5.2.1. MSRN

Two alternatives are available for assigning the MSRN to a roamed MS. These are:

    Alternative 1 - Upon initial registration or location updating, the VLR assigns a MSRN and passes this to the HLR for routing calls to the MS.

    Alternative 2 - Upon demand by the HLR the VLR assigns a MSRN on a per call basis.

In the case of a call to a mobile station roaming in a VPLMN where Alternative 2 is used, its HLR will perform the interrogation of the VLR in all cases.

When Alternative 1 applies, the VLR must allocate a mobile station roaming number to each MS registered in the VLR, as defined in Recommendation GSM 03.03, when

    - an unknown MS registers in the VLR,

    - a known MS registers in a new location area of the VLR where a new mobile station roaming number must be allocated for routing purposes. In general, the roaming number is changed when a MS moves to a new MSC area.

The VLR may also re-allocate mobile station roaming numbers if required, e.g. the numbering plan is changed.

The VLR removes the mobile station roaming number when

    - a location cancellation is received from the HLR of the MS,

    - a roaming not allowed indication is received from the HLR,

    - any indication that the MS is not allowed service (e.g. authenticity not established) is detected in the VLR or received from the HLR. See also Recommendations GSM 09.02, 03.12 and 03.20.

When Alternative 2 applies, the VLR cancels the MSRN when

    - the call has been successfully set-up

    - time out as defined in recommendations GSM 03.08 and 09.02 (unsuccessful call set-up).

5.2.2. Allocation of Handover Numbers

The VLR may allocate handover numbers (i.e. numbers with a structure similar to the mobile station roaming number) in order to support handover from other MSCs (see also Recommendation GSM 03.09).

5.2.3. Allocation of TMSI

The VLR must be capable of allocating Temporary Mobile Station Identities (TMSI) in order to support the subscriber identity confidentiality function (see Recommendations GSM 03.01 and 03.20). See Recommendation GSM 03.03 for the structure of the TMSI and the principles for allocation.

5.3. Call handling functions of the VLR

The MSC will retrieve subscriber data from the VLR for each MS originating and MS terminating call see recommendations GSM 03.01, 03.02 and 03.04.

For MS originating calls, the MSC will identify the MS by its TMSI or IMSI depending on which identity is received from the MS. For MS terminating calls, the MSC will identify the called MS by the mobile station roaming number received at call set-up.

The procedures are defined in Recommendation GSM 09.02. That Recommendation also shows which unsuccessful call events are reported to the MSC.

5.4. Handling of supplementary services

There follows a brief overview of the main functions required in the VLR for supporting the services described in Recommendations GSM 02.04 and GSM 03.11 that are to be included in Phase 1 implementation. For implementation details refer to Recommendations GSM 03.11, 03.82 and 03.88.

The VLR may be required to modify a supplementary service requested if that supplementary service is not supported see recommendations GSM 02.88 and 03.88.

Supplementary service	VLR Function required
Call forwarding unconditional	No specific function required.
Call forwarding on mobile subscriber busy	MAF008
Call forwarding on no reply	MAF009
Call forwarding on mobile subscriber not reachable	MAF010 and MAF011
Barring of all outgoing calls	MAF017
Barring of outgoing international calls	MAF018
Barring of outgoing international calls except those directed to the home PLMN country	MAF020
Barring of all incoming calls	No specific function required.
Barring of incoming calls when roaming outside the home PLMN country	No specific function required.

5.5. Short Message Service Handling

The procedures related to the point-to-point Short Message Service (SMS) are given in Recommendation GSM 03.40.

The VLR must store a Messages_Waiting_Flag (MWF), defined in Recommendation GSM 03.40, which is a temporary subscriber data, indicating if any messages are waiting to be delivered to the MS.

5.6. Authentication

The procedures related to authentication are given in Recommendation GSM 03.20. The detailed procedures are also given in Recommendation GSM 09.02. They include

- procedures between the MSC and the VLR for basic authentication.

- procedures between the VLR and the HLR by which the VLR obtains RAND/SRES vectors (Random Number / Signed Response Vectors)

- procedures between the VLR and the previous VLR where the new VLR obtains RAND/SRES vectors from the previous VLR (authentication at location registration).

The VLR must contain functions by which the RAND/SRES comparison described in Recommendation GSM 03.20 can be performed. The VLR may also (national option) contain functions where the authentication key is used directly for authentication, see Recommendation GSM 03.20.

5.7. Location registration

The definition of location registration is contained in Recommendation GSM 03.01.

The functions of the VLR related to location registration are given in Recommendation GSM 03.12.

The procedures are specified in Recommendation GSM 09.02.

Functions of the VLR related to location registration are :

5.7.1. **The VLR will initiate location register** updating of the HLR when a MSC associated with the VLR requests location registration of a MS which is previously unknown to the VLR

When Alternative 1 of paragraph 5.2 applies, the VLR allocates a mobile station roaming number which is passed to the HLR with the VLR number.

When Alternative 2 of paragraph 5.2 applies, the VLR will give the VLR number and may give the MSC number to the HLR.

If a roaming allowed indication together with subscriber parameters for the MS are received from the HLR, the VLR will store subscriber information for the MS. If a negative result is received (e.g. unknown subscriber, roaming not allowed), no information on the MS is stored in the VLR.

5.7.2. The VLR will also update the HLR if the MS is known to the VLR, but the updating, call set-up or operation of a supplementary service takes place in a new location area of the VLR where a new mobile station roaming number has to be allocated.

5.7.3. Updating of the HLR is also required when mobile station roaming numbers have to be re-allocated.

5.7.4. Updating of the HLR in also required when the MSC address has to be changed

5.7.5. In the normal case, updating of the HLR is not required if a location updating takes place between location areas of the VLR with no change of the routing information. If a reset message has been received from the HLR and the reset flag has not been removed against the MS, the VLR will perform a normal location updating of the HLR (see Recommendation GSM 03.07).

5.7.6. The VLR should delete a MS from the register when

- a location cancellation is requested by the HLR,

- a MS may also be deleted if it has been silent for a long time. This is a network option in order to avoid exhaustion of mobile station roaming numbers and should only be applied when shortage of such numbers occurs.

5.7.7. If the VLR receives supplementary services parameters or other parameters which are not supported by the VLR and these parameters are not essential for providing basic services to the MS, these parameters are ignored and the facilities associated with them will not be offered.

5.8. **Support of encryption**

The ciphering key (Kc) is transferred to the VLR together with the RAND/SRES vectors, see Recommendation GSM 03.20. The management of the key is defined in Recommendation GSM 03.20.

5.9. **Handover**

If required, the VLR must be capable of allocating handover numbers as described in section 5.2 above. See also Recommendations GSM 03.09 and 09.02. The handover number is removed at the end of the call.

5.10. IMSI detach/attach operation

This function is a PLMN option it is described in Recommendation GSM 03.12. The procedures between the MSC and the VLR are defined in Recommendation GSM 09.02.

The VLR may contain facilities by which the function is controlled, i.e. whether IMSI detach operation is allowed or not allowed for a period of time.

If required, the VLR must operate a IMSI detached flag as described in Recommendation GSM 03.12.

5.11. Use of TMSI or IMSI

The VLR must contain a supervisory function by which it can determine that TMSI cannot be used on the radio path, e.g. because the subscriber file in the VLR is under restoration.

The procedures are described in recommendation GSM 03.07.

5.12. Search procedure

The VLR should support the search procedure of Recommendation GSM 09.02 after an outage.

6. RESTORATION OF VLRs and HLRs

Recommendation 09.02 contains restoration procedures to be used after outage of the VLR itself or after outage of a HLR.

7. OPERATION AND MAINTENANCE

General aspects of O&M matters are dealt with in the GSM 12 series recommendations; Recommendation GSM 12.14 presents the general principle of VLR maintenance.

8. PERFORMANCE OBJECTIVES

Performance objectives for VLRs are given in Recommendation GSM 03.05.

9. QUALITY CONTROL

This is a national matter.

10. ACCEPTANCE TESTING

This is a national matter.

11. ENVIRONMENTAL CONDITIONS

This is a national matter.

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