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enhanced Railway Emergency Call Specification

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EVOLUTION SHEET

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1. Introduction

1.1. Scope

This document specifies the requirements for enhanced Railway Emergency Call (eREC) from a system perspective.

To ensure interoperability between railways, this document defines:

1. The generic system concept of eREC.
2. The system functionality of the GSM-R network required for eREC.
3. The system functionality of the GSM-R mobiles required for eREC.
4. The interfaces of eREC entities responsible for eREC call processing and signalling, eREC Re- and Deregistration and eREC Sector Identity Updates.
5. The content, format and structure of the messages, which are exchanged on the various interfaces.

1.2. Background

The current Railway Emergency Call (REC) implementation is based on a single Group ID (299 or 599), whereas the Group Call Area is determined by the cell identified with the originating mobile and the Group ID. This has been found to be less than ideal resulting in production loss or safety risk. The issue has been described in detail in erig-2678 (O-2706). With the introduction of enhanced REC (eREC) for TEC (299) and SEC (599) as described in this document, an improved solution is available which results in less production loss while maintaining safety levels.

1.3. References

Ref. Nr.	Document Title	Document Number	Issue	Date	Author
[EIRENE FRS]	EIRENE FRS	UIC CODE 950	7.3.0	8 March 2012	Functional Group
[EIRENE SRS]	EIRENE SRS	UIC CODE 951	15.3.0	8 March 2012	Operators Group
[TS 22.090]	Unstructured Supplementary Service Data (USSD) - Stage 1	ETSI TS 122 090 3GPP TS 22 090	3.1.0	Release 99 2000-03	ETSI/3GPP
[TS 27.007]	Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; AT command set for User Equipment (UE)	ETSI TS 127 007 3GPP TS 27 007	3.14.0	Release 99 2010-04	ETSI/3GPP
[FIS FA]	FIS for Functional Addressing	E 12 T 6001	5.1	29 October 2009	GSM-R OG & GSM-R IG
[GSM-R Codes]	GSM-R International Network Codes	E-2459	-	latest available version	OG
[eREC parameters]	Definition and structure of eREC parameters	O-3152	1.1	16 December 2013	eREC WG
[FFFS CHPC]	FFFS for CHP Calls	F10T6002	5		GSM-R OG & GSM-R IG
[FIS CHPC]	FIS for CHP Calls	F12T6002	5		GSM-R OG & GSM-R IG
[TS 102 610]	Usage of the User to User Information Element for GSM Operation on Railways	TS 102 610	1.3.0	2012	ETSI TC-RT

1.4. Abbreviations and Definitions

Abbreviation	Description
Active eREC Sector Identity	A Sector Identity which can be used for eREC call initiation/reception or eREC call reception when an eREC mobile is in eREC Mode.
AT	ATtention; this two-character abbreviation is always used to start a command line to be sent from TE to TA
Balise Update Method	A method for updating an eREC Sector Identity by a balise (in the track) and a balise reader attached to an eREC mobile.
BX	Border Crossing
CC	Country Code
CHPC	Confirmation for High Priority Calls
CI	The Country Indicator is applied for an international group call within a shared area. It indicates the country to which the anchor MSC (A-MSC) belongs to. The five digit shared service area is structured as 9+CI+X+Y+Z whereas "9" is the flag for an international service area.
CLI	Calling Line Identification
CT	Call Type
eREC	enhanced Railway Emergency Call
eREC area	One or more GSM-R cells for which eREC Sector Identity(ies) are defined in the network.
eREC call processing entity	A network entity responsible for eREC call establishment and call notification.
eREC mobile	An EIRENE mobile which supports eREC functionality.
eREC Mode	The state of an eREC mobile in which it has registered to eREC Service and has active eREC Sector Identit(y)ies.
eREC network	An EIRENE network which supports eREC functionality.
eREC Node	A network entity which is responsible for processing eREC Service Registrations, eREC Service Deregistrations and USSD Updates of Sector Identities (if the latter is supported by the network).
eREC sector	A particular area defined by sharp geographical boundaries for which eREC is applicable.
eREC Sector Identity	The identity of a particular eREC sector. At call set up the eREC Sector Identity is signalled to the network and notified to receiving mobiles in the eREC sector. An eREC Sector Identity is not necessarily unique, it may be reused at a sufficiently large geographical distance.
eREC Sector Identity Update Method	A method for transferring eREC Sector Identity updates to an eREC mobile. Three methods are supported: HMI Update Method, Balise Update Method and USSD Update Method.
eREC Sector Identity Validation Method	A method to validate an eREC Sector Identity received via an eREC Sector Identity Update Method.
eREC Service	A set of methods and functions supported by both an eREC network and an eREC mobile which facilitates eREC call set up and call reception in an eREC sector.
eREC Service Deregistration	A request to the network to disable provision of eREC Service to an eREC mobile.
eREC Service Registration	A request to the network to enable provision of eREC Service to an eREC mobile.
eREC Standby Mode	The state of an eREC mobile in which it is registered to eREC Service but has no active eREC Sector Identity(ies).
FA	Functional Addressing
FC	Function Code
GCA	Group Call Area
GCR	Group Call Register
GSM-R	GSM for Railways
HMI	Human Machine Interface
HMI Update Method	A method for updating an eREC Sector Identity by human intervention (manual action via the user interface of an eREC mobile).
LN	Location Number
MCC	Mobile Country Code
MNC	Mobile Network Code
MSC	Mobile Services Switching Centre
MSISDN	Mobile Station Integrated Services Digital Network
MS	Mobile Station
MT	Mobile Termination
NDC	National Destination Code
REC	Railway Emergency Call
REC mobile	A (legacy) mobile which supports REC functionality only.
REC Mode	The state of an eREC mobile in which it is not registered to eREC and has no active eREC Sector Identity(ies).
SEC	Shunting Emergency Call
SMS-CB	Short Message Service Cell Broadcast
SSP	Service Switching Point
STP	Signalling Transfer Point
TA	Terminal Adaptor, e.g. a GSM data card (equal to DCE; Data Circuit terminating Equipment)
TE	Terminal Equipment
TEC	Train Emergency Call
TN	Train Number

Abbreviation	Description
UIN	User Identifier Number
USSD	Unstructured Supplementary Service Data
USSD Update Method	A method for updating eREC Sector Identity(ies) via the GSM-R network using USSD as a bearer service (the eREC Sector Identity is obtained from a train location information database).
VGCA	Voice Group Call Area
VGCS	Voice Group Call Service
VLR	Visitor Location Register
V-MSC	Visitor MSC

2. eREC overview

2.1. General

a. eREC uses VGCS as a basis. The mechanisms for eREC in terms of call set up, call notification and associated signalling equal the mechanisms of REC. The difference between a REC and an eREC is that with eREC, an additional attribute is associated (i.e. eREC Sector Identity) which makes it possible to discriminate between one or more eRECs in the same area.

b. In a railway environment, eREC is typically applied in geographical areas where REC operation causes production loss (e.g. parallel railway lines at a short geographical distance, dense (station) areas, level crossings). In a typical GSM-R network, both REC and eREC will be operational. REC will be predominantly available and preserve safety whereas eREC will be applied on a smaller scale and limit production loss to a minimum.

2.2. Generic system concept

a. The generic concept of eREC is described in Figure 1.

eREC call
Processing
Entity

eREC Node

**eREC Service Registration/ Deregistration
(piggybacked to FA Re-/Deregistration)**
➢ eREC Service is provisioned if an eREC mobile is registered
➢ eREC Service is prohibited if an eREC mobile deregisters

eREC Sector Identity Update
eREC Sector Identity(ies) are updated by one of the following methods:

➢ By a track-based system via a GSM-R service (i.e. USSD)
➢ By means of a HMI action
➢ By means of a local track based system (i.e. balise)

NIS

Controller

eREC call set up
An eREC mobile sets up a 299 or 599 VGCS call and prepends the eREC Sector Identity to the Group Call Identity

eREC call notification
The network passes the eREC Sector Identity to the mobiles as part of the Group Call Reference and only mobiles in the same sector react
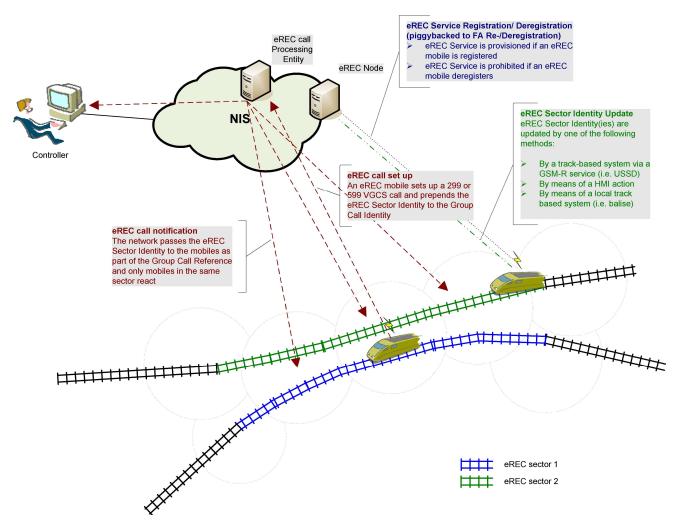
eREC sector 1
eREC sector 2

Figure 1 eREC generic system concept

b. The principles of operation are outlined below:

1. eREC Service is activated for an eREC mobile when it registers to it. The registration/ deregistration process is described in section 4.3.

2. Before entering an eREC sector, an eREC mobile shall receive an update informing the mobile about the eREC Sector Identity(ies) which are applicable for the area to be entered. The eREC Sector Identity Update Method is described in section 4.

3. When required an eREC mobile in eREC Mode (refer to section 7.2) sets up an eREC (VGCS) and passes the eREC Sector Identity to the network (i.e. the eREC Call Processing Entity). The mechanism is described in section 5.1.

   i. The network establishes the eREC in all cells belonging to the corresponding Group Call Area as for a VGCS 299 or 599 call. The eREC Sector Identity is notified on the air interface as described in section 3.3.

   ii. A mobile in eREC Mode in any of the cells of the established eREC joins the call if and only if the eREC Sector Identity notified by the network on the air interface matches one of the eREC Sector Identities obtained through the eREC Sector Identity Update Method.

    iii.   An eREC mobile in REC Mode or eREC Standby Mode in any of the cells of the established eREC will not examine the eREC Sector Identity notified by the network and will therefore join the call.

    iv.   A REC mobile in any of the cells of the established eREC is unaware of the distinction between REC and eREC and will therefore join the call as if it were a REC. This preserves backwards compatibility.

Note:
GSM-R networks which support eREC functionality shall also support REC for backwards compatibility.

4.   When required an eREC mobile in REC Mode or eREC Standby Mode, or a REC mobile, sets up a REC (VGCS) according to the EIRENE specifications.

    i.   The network establishes the REC in all cells belonging to the corresponding Group Call Area as a VGCS 299 or 599 call. The special non-selective eREC Sector Identity as described in section 3.1 may be notified on the air interface, or a pre-defined selective eREC Sector Identity may be notified, depending on network configuration (refer to section 5.1, note 3).

    ii.   If the eREC Sector Identity notified by the network is a selective one then a mobile in eREC Mode in any of the cells of the established REC joins the call if and only if the eREC Sector Identity notified by the network on the air interface matches one of the eREC Sector Identities obtained via the eREC Sector Identity Update Method.

    iii.   If the eREC Sector Identity notified by the network is the non-selective one then a mobile in eREC Mode in any of the cells of the established REC will join the call regardless of the eREC Sector Identity(ies) obtained via the eREC Sector Identity Update Method.

    iv.   A REC mobile in any of the cells of the established REC is unaware of the distinction between REC and eREC and will therefore join the call.

5.   eREC service is deactivated when an eREC mobile deregisters from eREC service or after a certain timer-controlled interval of time (refer to section 5.2).

3.   <u>eREC call set up and call notification</u>

3.1. General

a. The fifth digit of the Group Call Area ID of the Group Call Reference of a 299 or 599 emergency call contains the eREC Sector Identity as depicted in Figure 2.
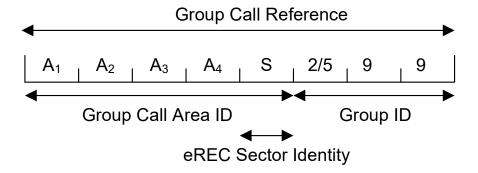
Figure 2 Structure of the eREC Group Call Reference

b. The eREC Sector Identity ranges from S = 1 to S = 9.

c. S = 0 is used for non selective eRECs (e.g. an eREC mobile will join a call with S = 0, independent of its active eREC Sector Identity(ies)).

3.2. eREC call set up

3.2.1. VGCS service subscriber originated calls

a. To initiate an eREC, a VGCS service subscriber shall dial Group ID 299 (or 599 for shunting) prepended by the eREC Sector Identity in the range 1 to 9, e.g. 3299.

   Note: in case more than one eREC Sector ID value is stored on the mobile (as a result of eREC Sector Identity Update procedure), the eREC Sector ID value to be used at eREC call establishment time is the first one in the list.

b. To initiate a REC call, a VGCS service subscriber shall dial 299 or 599.

c. For a VGCS service subscriber originated eREC call or REC call, the dialled digits are binary encoded in the Call Reference Information Element (27 bits) which carries the Group ID. This makes it possible for the network to distinguish a S299 call from a 299 call and a S599 call from a 599 call.

3.2.2. Dispatcher originated calls

a. A dispatcher originated eREC call is set up by dialling a number which complies with the structure as defined in [EIRENE SRS]:

   1. For international calls only:
      Breakout Code + International Code (900 + xCC (or CCC)) or
      International prefix (i.e. "+" or "00") + Country Code + Network Destination Code (CC + NDC)

   2. Call Type
      CT = 50 for VGCS calls

   3. User Identifier Number
      The UIN field format for group calls is a Service Area (SA) indicator consisting of 5 digits, which identifies the area in which the group call is to be active. The last digit of the Service Area represents the eREC Sector Identity.

4. Function Code
The FC field format for group calls consists of a 3-digit Group ID.

3.3. eREC call notification

a. An eREC shall be notified in exactly the same way as that currently used for REC. The notification message contains the Group Call Reference which is defined in Figure 2.

4. eREC Service Registration, Deregistration, Sector Identity Updates and Validation

4.1. General

a. When registering on a train number (CT-2) or on a (dummy) shunting number (CT-6), an eREC mobile also applies for eREC Service. The registration procedure is described in section 4.3.1.

b. When an eREC mobile enters a (new) eREC sector, its eREC Sector Identity(ies) have to be updated. This preserves that the eREC mobile is able to join eREC calls corresponding to its sector identity(ies). The potential sources of the updates are described in section 4.2. The procedure of the update and validation process is described in section 4.5 and 4.6.

c. When deregistering from a train number (CT-2) or (dummy) shunting number (CT-6), an eREC mobile also deregisters from eREC Service. The deregistration procedure is described in section 4.3.2.

d. eREC Service Registration and eREC Service Deregistration information is transferred as part of FA Registration and Deregistration (i.e. eREC information is piggybacked to FA messages). Separate USSD messaging is used for eREC Sector Identity updates over the GSM-R network (i.e. when using a train location information system as the source of sector identity updates). The characteristics and properties of the USSD service are described in detail in section 6.

4.2. eREC Sector Identity update sources

a. Once registered to eREC Service, an eREC mobile is able to receive eREC Sector Identity updates by one or more of the following means (track-based or train-based):

1. Over the GSM-R network: the GSM-R network transfers the eREC Sector Identity(ies) to the eREC mobile using USSD (the eREC Sector Identity(ies) is (are) obtained from a train location information database, which is beyond the scope of this specification).

2. Human Machine Interface: the eREC Sector Identity is entered by the user via a manual action on the eREC mobile (e.g. by selection of a menu entry and choosing the eREC Sector Identity from a list or by typing it). When this method is used, only a single Sector Identity is provided to the eREC mobile application.

3. Balise: a balise contains the eREC Sector Identity(ies) which are transferred to the eREC mobile at the border of two eREC sectors. An on-board balise reader receives the information and updates the eREC mobile accordingly.

b. Table 1 describes the compliancy for both mobile and network for the various eREC Sector Identity Update Methods.

	Over the GSM-R network (USSD)	HMI	Balise
eREC Mobile	Mandatory	Mandatory	Optional
GSM-R Network	Optional	Not applicable	Not applicable

Table 1 eREC Sector Identity Update Methods

c. As a minimum it shall be possible to update the eREC Sector Identity via the HMI of the eREC mobile.

d. Using balises and balise-readers for eREC Sector Identity Updates is a national matter.

e. Use of eREC Sector Identity updates over the GSM-R network is a national matter. The eREC mobile shall however be able to process and interpret these types of updates.

4.3. eREC Service Registration/ Deregistration

4.3.1. eREC Service Registration

a. eREC Service Registration serves two purposes:

   1. To inform an eREC mobile about whether it will receive eREC Service from the network.

   2. To inform an eREC mobile about eREC network settings and to instruct the mobile to adopt these.

b. With registration on train number (CT-2) or (dummy) shunting number (CT-6), an eREC mobile requests eREC Service by including **eRECServiceRegistration** information in the registration message. Such a request is granted by the network by sending **eRECServiceRegistrationConfirmation** information as part of the FA response message which informs the mobile about the applicable eREC network settings.
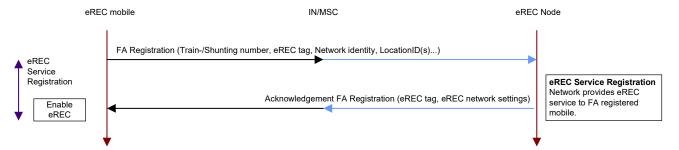

Figure 3 eREC Service Registration

c. The mobile stays in REC Mode and ignores any eREC Sector Identity updates until the eREC Service Registration process succeeds.

d. **eRECServiceRegistration** information comprises the following parameters:

   1. Train number (CT-2) or (dummy) shunting number (CT-6) (as part of the existing FA registration procedure).

   2. eREC tag (indicating that eREC information follows).

   3. One or more LocationIDs:

    a. CellID (mandatory).

    b. GPS and/or Galileo (optional).

    c. Odometry (optional).

e. **eRECServiceRegistrationConfirmation** information contains eREC network settings. The purpose of these settings is to tell the mobile how to behave and which eREC Update Method(s) is(are) applicable (refer to section 4.4 for a definition).

4.3.2. eREC Service Deregistration

a. A mobile performs the eREC deregistration process when it deregisters its Train Number (CT-2) or (dummy) Shunting number (CT-6).

b. For eREC Service Deregistration, the procedure as shown in Figure 4 is applicable (i.e. eREC Service Deregistration information is piggybacked on a FA Deregistration (Train number)). This procedure is further explained in section 6.2.

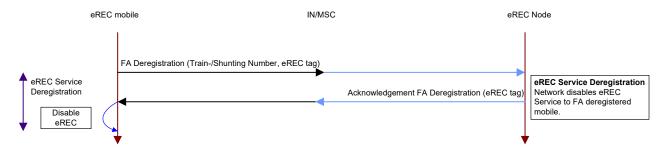c. **eRECServiceDeregistration** information contains the following parameters:

    1. eREC tag

Figure 4 eREC Service Deregistration

4.4. eREC Network settings

a. eREC Sector Identity Update Method
At eREC Service Registration, the network shall indicate which (or which combination of) eREC Sector Identity Update Methods (including associated properties) are applicable. The following eREC Sector Identity Update Methods are possible:

    1. HMI Update Method
    eREC Sector Identity updates are allowed by an HMI input on the mobile.

    2. Balise Update Method
    eREC Sector Identity updates are allowed by a Balise reader input on the mobile.

    3. USSD Update Method
    eREC Sector Identity updates are allowed using USSD as a bearer service.

b. Individual eREC Sector Identity Update Methods can be activated in any combination. The eREC mobile shall process the last eREC Sector Identity Update by resetting the existing eREC Sector Identity list and replacing it with the last received one.

    c. GSM-R network identity (consisting of a MCC + MNC, refer to section 10c).

    d. eREC Sector Identity Validation Method
At eREC Service Registration, the network shall indicate which eREC Sector Identity Validation Method is applicable:

        1. SMS-CB.

        2. eREC Sector Identity is not validated.

    e. $t_{SI\_ValidityPeriod}$ is a timer which runs in an eREC mobile and which indicates the validity period of the active eREC Sector Identity(ies). After expiry of $t_{SI\_ValidityPeriod}$ (i.e. the timer reaches $T_{SI\_ValidityPeriod}$), a mobile returns from eREC Mode to eREC Standby Mode.

    f. $t_{SR\_ValidityPeriod}$ is a timer which runs in an eREC mobile and in the network and which indicates the validity period of the eREC Service Registration. The timer in the mobile runs independently from the timer in the network.
After expiry of $t_{SR\_ValidityPeriod}$ in the mobile (i.e. the timer reaches $T_{SR\_ValidityPeriod}$), a mobile returns from eREC Standby Mode or eREC Mode to REC Mode.
After expiry of $t_{SR\_ValidityPeriod}$ in the network (i.e. the timer reaches $T_{SR\_ValidityPeriod}$), the network removes the corresponding mobile from the list of eREC Service registered mobiles (refer to section 5.2).

    g. Both timers can be assigned a value of NULL. In that case the timer is not applicable (i.e. does not expire).

4.5. USSD Update Method (over the GSM-R network)

a. If the USSD Update Method is active, eREC Sector Identities are updated via the GSM-R network. Both push and pull updates can be used as described below.

b. eREC Sector ID update / request (push / pull) shall be acknowledged as part of the USSD transaction. In case no acknowledgement is received by the originating party (eREC node / eREC mobile), the eREC Sector ID update / request shall be repeated.

c. An eREC sector ID update is pushed by sending an **eRECSectorIDUpdateIndication** by the network.

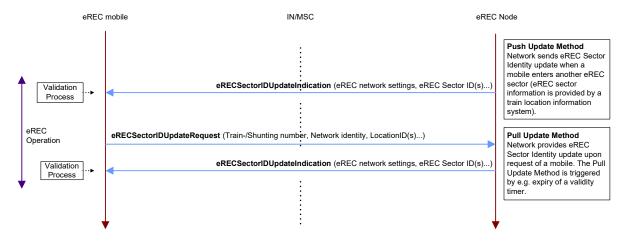**Figure 5 USSD Update Method dialogue**

d. The parameters passed with an **eRECSectorIDUpdateIndication** are:

    1. eREC Sector Identities.
If more than one eREC Sector Identity is sent, the first one is used by the mobile as the active eREC Sector Identity at call set up. All received eREC Sector Identities are applicable during call notification.
Example: if {3, 6, 1} is sent as a Sector ID list, only **3**299 or **3**599 shall be used for eREC call initiation; but all three SectorID values (1, 3 and 6) are acceptable for eREC call reception.

    If no eREC Sector Identity is included (eREC Sector Identity = NULL), the mobile is instructed to operate in eREC Standby Mode.

    2. eREC Network settings (refer to section 4.4 for a definition).

e. An eREC Sector Identity update is requested (pull) by a mobile by sending an **eRECSectorIDUpdateRequest**.
The network then responds with an **eRECSectorIDUpdateIndication**.

f. A Pull update shall be invoked by a mobile:

    1. When leaving a VBS or VGCS group call (in case a listener or talker phase has occurred as described in §7.2 g 4)

    2. In cases of failure (e.g. expiry of a timer or an eREC Sector Identity Validation error).

g. The parameters passed with an **eRECSectorIDUpdateRequest** are:

    1. Dummy Train number (CT-2) or dummy shunting number (CT-6).

    2. eREC tag.

    3. One or more Location IDs (refer to section 4.3.1 for a definition).

h. The **eRECSectorIDUpdateRequest** is coded as a FA Registration on a dummy Train- or Shunting number.

i. Values for timeout and retries for push and pull method shall be used as defined in O-3152, table 11.

4.6. eREC Sector Identity Validation

a. An eREC Sector Identity update may (depending on network settings as described in section 4.4) be validated by means of a validation process at the mobile side.

b. The eREC Sector Identity Validation Method shall be supported by an eREC mobile (mandatory).

c. The eREC Sector Identity Validation Method may be supported by the GSM-R network (optional).

d. SMS Cell Broadcast (SMS-CB) is used as a bearer service for the transfer of validation information to eREC mobiles. At the network side, SMS-CB and associated validation information is where relevant, provided on a cell by cell basis.

e. The validation information consists of all valid eREC Sector Identities which are applicable to the geographical area covered by the cell(s).

f. SMS-CB validation messages convey the following information:

1. eREC application tag.

2. A list of eREC Sector Identities applicable to the geographical area covered by the cell(s). Note that eREC Sector Identity S = 0 is valid by default and does not require validation.

g. The value of the time interval between two validation messages (i.e. the SMS-CB repetition cycle) is a national matter. The minimum value is 2 s, a value of at most 10 s is recommended (see [eREC parameters] §4 for the exact coding and values).

h. If the eREC Sector Identity Validation Method = SMS-CB as described in section 4.4, the eREC mobile performs validation (in eREC Mode only). Each time, the mobile receives an eREC Sector Identity Validation message it compares the received eREC Sector Identity(ies) with its active eREC Sector Identity(ies). Validation is performed for all eREC Sector Identity(ies) on a sector-by-sector basis:

1. If an active eREC Sector Identity is found in the list of received eREC Sector Identity(ies), that eREC Sector Identity is assigned as valid.

2. If an active eREC Sector Identity is not found in the list of received eREC Sector Identity(ies), that eREC Sector Identity is assigned as invalid and shall be deactivated.

3. If the eREC Sector Identity for call initiation/reception is not found in the list of received eREC Sector Identity(ies), a validation error occurs. The eREC mobile then moves to eREC Standby Mode, deactivates all eREC Sector Identity(ies) and requests for an eREC Sector Identity update via an appropriate HMI message (if the HMI Update Method is used) or via a Pull update (if the USSD Update Method is used).

5. Functionality eREC Call Processing Entity and eREC Node

5.1. eREC Call Processing Entity

a. Providing eREC call establishment functionality requires changes at MSC level. The network entities responsible for eREC call establishment and call notification which need modification are:

1. VLR (further denoted as eREC capable VLR).

2. GCR (further denoted as eREC capable GCR).

b. The eREC network shall be able to specifically handle the IMMEDIATE_SETUP2 message at emergency call establishment. For this purpose, the following steps shall first be processed:

- the numeric value extracted from the Call Reference Information Element (27-bit string) in the IMMEDIATE_SETUP2 message shall be interpreted as a decimal number (digit string)

- if this decimal number is 4-digit long, then the first digit is to be extracted and interpreted as an eREC Sector Identity value,

- the remaining 3-digit string is interpreted as a standard Group ID value

c. The eREC capable VLR shall in addition to a regular subscription check for REC be able to perform an enhanced subscription check for eREC by checking the received Group ID (without the prepended Sector Identity digit) if the three digits are 299 or 599.

d. The eREC capable GCR shall be able to configure an entry for each defined eREC sector in a cell for a REC/eREC cell of origin. The value of an eREC Sector Identity ranges from 1 to 9. eREC Sector Identity = 0 shall be configured as default which is used for a REC call initiated by a REC mobile or as fallback for an eREC mobile using a not configured eREC Sector Identity.

e. A normal REC entry for group call areas not designated as eREC areas shall be configured in the eREC capable GCR in the normal way, i.e. that the Group Call Area ID is of format nnnnn where the digits nnnnn can be any decimal digit combination.

f. During call establishment the eREC capable GCR first checks the contents of the received setup information. If an eREC Sector Identity is provided and the three Group ID digits are equal to 299 or 599, an enhanced interrogation procedure for eREC shall be started. Otherwise the regular interrogation is performed.

g. For the enhanced interrogation procedure, the eREC capable GCR uses the eREC Sector Identity and the regular REC Group ID to find a Group Call Reference for the cell of origin for which the last digit (i.e. the fifth) of the Group Call Area ID corresponds to the eREC Sector Identity.

h. If the interrogation using the Cell ID, the derived eREC Sector Identity and regular REC Group ID is unsuccessful, the eREC capable GCR shall perform an interrogation for the default REC, i.e., using eREC Sector Identity = 0. If the interrogation for the default REC is unsuccessful, the GCR shall perform the interrogation for normal REC only using the cell of origin and the received Group ID for the last attempt. If the last interrogation fails, a negative response shall be returned.

i. As an example Figure 6 and Table 2 show the principle of the procedure and the datafill required for eREC for a number of cells.

Note that from a 3GPP point of view the GCR implementation is not standardised. The method of information storage and database design is implementation specific. Therefore the example is for illustrative purposes only.
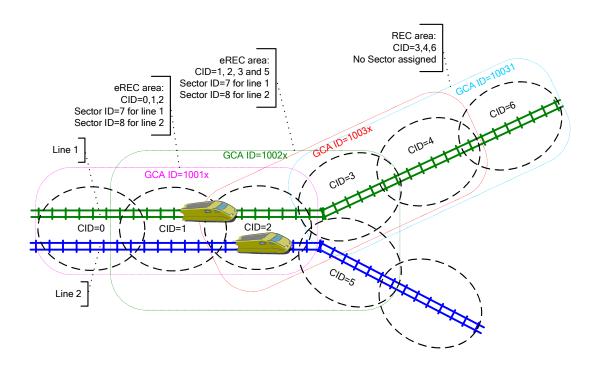

Figure 6 Example of REC and eREC configuration

j. The data sets in the eREC capable GCR associated with a certain eREC cell of origin and eREC Sector Identity can be configured individually, i.e. the list of radio cells (Cell IDs), the MSC addresses, the train controller addresses can all be selected individually for each eREC Sector Identity. In the example configuration, eREC/REC is also notified in the immediate adjacent cells of the cell of origin resulting in one cell additional coverage around the "point of emergency" cell.

REC/eREC cell of origin	eREC Sector Identity	Corresponding Group Call Area ID Note 1)/ 2)	Group ID	Group Call Reference	Cell list of the Group Call Area	Other attributes
1	0	10010	299	10010299	0,1,2	D1 and D2, …
	7	10017	299	10017299	0,1,2	D1, …
	8	10018	299	10018299	0,1,2	D2, …
2	0	10020	299	10020299	1,2,3,5	D1 and D2, …
	7	10027	299	10027299	1,2,3	D1, …
	8	10028	299	10028299	1,2,5	D2, …
3	0	10030	299	10030299	2,3,4	D1 and D2, …
	7	10037	299	10037299	2,3,4	D1, …
4	-	10031	299	10031299	3,4,6	D1, …

Table 2 Example of eREC capable GCR data configuration for each REC/eREC cell of origin

Note 1): the last (fifth) digit of the Group Call Area ID corresponds to the eREC Sector Identity (with the exception of 10031, which simply is a free Group Call Area ID in which the fifth digit has no special meaning).

Note 2): an operator is free to choose Group Call Area IDs of preference for each entry in the table. The eREC configuration does not impose any constraints on the numbers assigned for that purpose.

Note 3): In the example configuration above, it is assumed that all eREC mobiles running on line 1 have been updated to disable eREC Mode before entering cell 4. In that situation any GCA is valid for call notification as proposed in the above table (entry for cell 4).
An alternative could be to maintain eREC sector ID 7 active on the eREC mobiles running on line 1 even after cell 3 (which saves the necessity to update the eREC mobiles to disable the service) and, provided it is the only valid sector in this area, to configure the network to have all REC/eREC calls initiated to use the same GCA valid for sector 7 (which is then referred to as the "pre-defined selective Sector Identity" in section 2.2.b.4.i).
The below table shows the configuration for cell 4 for that alternative (which would then be applicable for all subsequent cells on line 1 as long as no sector change is required).

REC/eREC cell of origin	eREC Sector Identity	Corresponding Group Call Area ID Note 1)/ 2)	Group ID	Group Call Reference	Cell list of the Group Call Area	Other attributes
4	-	10047	299	10047299	3,4,6	D1 …

5.2. eREC Node

a. The eREC Node is responsible for:

1. Processing eREC Service Registration- and eREC Service Deregistration information as received from the FM service.

2. Processing USSD Updates (push and pull) of Sector Identities (if supported by the network).

   a. The eREC Node is responsible for assembling USSD Update messages on the basis of eREC Sector Identities as received from an external train location information database.

   b. The eREC Node is responsible for transferring USSD Updates as received from an external train location information database, to registered eREC mobiles (Push update).

   c. The eREC Node is responsible for transferring USSD Updates to a registered eREC mobile upon request (Pull update).

3. Maintaining a list of active (registered) eREC mobiles.

b. eREC mobiles are removed from the list if one of the following conditions is met:

4. An eREC mobile deregisters from eREC Service.

5. Timer $t_{SR\_ValidityPeriod}$ expires (this (network) timer starts upon eREC Service Registration). Note that this timer also (but independently) runs in an eREC mobile.

c. Note that the eREC node interfaces with the FM service and train location information database. The latter two are not subject to specification in this document.

6. Bearer service and message routing for USSD Update Method

a. eREC Sector Identity update messaging shall be carried over Unstructured Supplementary Service Data (USSD) messages.

6.1. USSD messaging for eREC Service Registration

a. eREC service registrations are initiated from eREC mobiles. eREC registrations are performed as part of the follow me (FM) functional number registration process. eREC parameters are sent to the network in the SI4 field of functional number registration request messages as described in the document on the definition and structure of eREC parameters [eREC parameters].

b. In case the network is not eREC capable, the additional information in the functional registration message is ignored by the FM service.

c. In case the network is eREC capable, the FM service forwards the message to the eREC service in the networks. Once the FM service receives the response of the eREC service to the message it appends the values returned to its own response of the outcome of the functional number registration as described in [eREC parameters] and returns it to the eREC mobile.

d. If the combined FM + eREC registration message is sent from a roaming mobile device, it is first delivered to the home HLR, from there to the FM service node in the visited country and from there to the eREC service of the visited country. No enhancements are necessary on the home HLR, since the eREC information is sent in the SI4 field on the FN registration message. This is transparent to the home HLR.
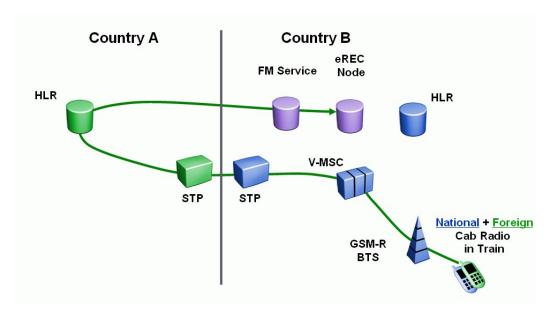
e. Figure 7 shows the message path of the USSD messages.

Figure 7 eREC Service Registration USSD message path

6.2. USSD messaging for eREC Service Deregistration

a. eREC Service Deregistration are sent to the eREC Node as part of Follow Me USSD deregistration messages. This allows trains in eREC Mode to cross a border and attach to a

network which does not apply eREC and thus has no eREC specific message routing functionality in its network nodes.

b. eREC Service Deregistration information is contained in the additional information field of Follow Me USSD deregistration messages as described in chapter 4.2.4.1 FIS for Functional Addressing, refer to [FIS FA]).

c. If a Call Type 2 functional number is deregistered after border crossing the Follow Me deregistration message shall be used for both deregister the CT-2 number and also for deregistering from eREC service. For this purpose the Follow Me Service in the network then forwards a message to the eREC Node.

d. If a Call Type 2 functional number is NOT deregistered after border crossing the Follow Me deregistration message shall be used to only deregister from eREC Service. For this purpose the additional information field shall contain information for the Follow Me service in the network that only the eREC Node needs to be notified but that the CT-2 registration state shall not be modified.

e. If no information is contained in the additional information field of the Follow Me USSD message the FN node shall not communicate with the eREC Node. Such deregistration messages are sent by REC mobiles and eREC mobiles which are in REC Mode.

f. eREC mobiles deregistering a CT-2 number and deregistering from eREC service in their own country shall also use the combined CT-2/eREC deregistration USSD message (as in the roaming case).

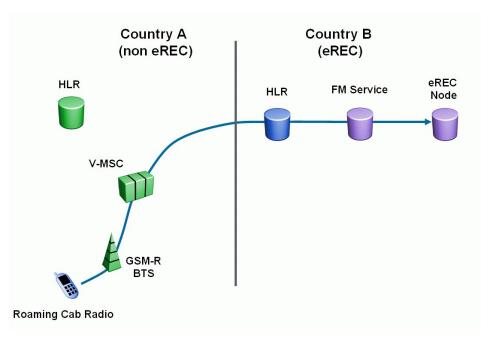g. The message flow for a roaming eREC mobile which invokes eREC Service Deregistration in shown in Figure 8.

Figure 8 eREC Service Deregistration of a roaming eREC mobile (cab radio)

h. eREC Service Deregistration of eREC mobiles for shunting operation are also performed via a Follow Me deregistration message as described above for normal operation. If no CT-6 shunting number is available for deregistration, a dummy CT-6 number is used as described in [eREC

parameters]. This informs the FM service not to act on the message itself but to only forward it to the eREC service.

6.3. Push update USSD messaging

a. eREC Push updates are initiated from the eREC Node in the network. The USSD dialogue between the eREC mobile and the network is the same as for a Functional Number Forced Deregistration Notification.

b. The MSISDN of the receiver is used for global title routing in the network to forward the network initiated USSD message to the Home HLR of the subscriber. The Home HLR then forwards the message to the V-MSC which in turn forwards it to the subscriber.

c. Home HLR routing of network initiated USSD messages ensures that both national and roaming subscribers can receive Push update messages. No eREC specific enhancements are required in the network for network initiated USSD routing via the home network.
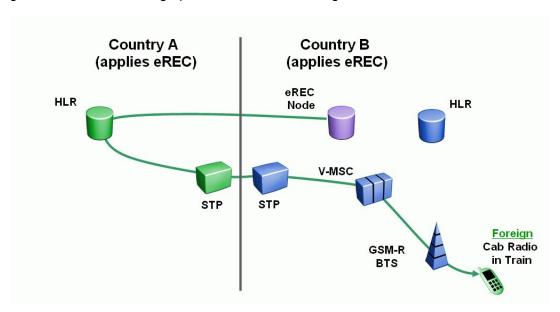
d. Figure 9 shows the message path of the USSD messages.

Figure 9 International Network Initiated USSD message delivery

6.4. Pull update USSD messaging

a. eREC Pull updates are initiated from an eREC mobile by sending an eREC Sector Identity Update Request message. The eREC Node receives the message and replies with the requested information. The connection to the eREC mobile is released by the network as part of the answer.

b. Routing of the Pull update USSD message shall work as described above for eREC Service Registration message routing and shall use a dummy functional number to indicate to the FM service that no registration changes are requested for a functional number. The FM service will then transfer the message to the eREC node, waits for a response and returns the response to the eREC mobile.

7. Mobile equipment functionality

7.1. General

a. Train radio equipment (i.e. cab radios) shall support eREC operation.

b. An eREC mobile shall store the eREC Group Call Reference, as well as other eREC relevant information for the eREC call it was last involved in (refer to section 9.2).

7.2. eREC/REC operation

a. eREC/REC shall operate as described in Figure 10.

b. eREC/REC operation is characterised by three states:

1. REC Mode
   The mobile is not registered to eREC Service and eREC Sector Identity(ies) are inactive. The mobile operates as a legacy REC mobile. The mobile accepts any incoming REC. REC initiation occurs by dialling 299 or 599.

2. eREC Standby Mode
   The mobile is registered to eREC Service but eREC Sector Identity(ies) are inactive. The mobile accepts any incoming REC. REC initiation occurs by dialling 299 or 599.

3. eREC Mode
   The mobile is registered to eREC Service and one or more eREC Sector Identities are active. The mobile only accepts incoming RECs with either S = 0 or if the eREC Sector Identity in the Group Call Reference matches with one of its active Sector Identities. REC initiation occurs by dialling S299 or S599 (with S as the first active Sector Identity of the mobile).

c. In REC Mode, eREC Service Registration is invoked by either a successful FA Registration on Train number (CT-2) or (dummy) shunting (CT-6) number or as part of the procedure for border crossing (refer to section 10).
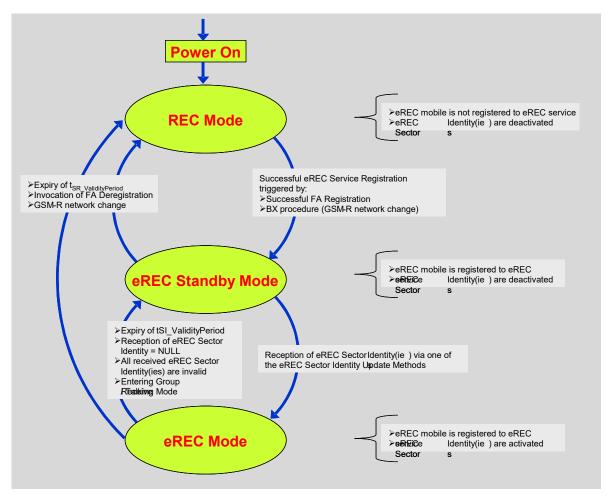
Figure 10 State diagram eREC/REC operation

d. After successful eREC Service Registration, the mobile moves to eREC Standby Mode.

e. If the mobile receives an eREC Sector Identity update containing one or more eREC Sector Identities, it moves to eREC Mode.

f. In eREC Mode, eREC Sector Identity(ies) may be validated (depending on network settings) as described in section 4.6.

g. The mobile returns from eREC Mode to eREC Standby Mode under one or more of the following conditions:

   1. All eREC Sector Identities received, prove to be invalid after performing the eREC Sector Identity Validation process.

   2. An update does not contain any eREC Sector Identities (eREC Sector Identity = NULL).

   3. The validity period of the active eREC Sector Identity(ies) expires.

   4. If the eREC mobile is operated using USSD SectorID update method, the eREC mobile goes in listener mode or talker mode in a VBS or VGCS call.

h. The mobile returns from eREC Mode or eREC Standby Mode to REC Mode under one or more of the following conditions:

    1. The validity period of the eREC Service Registration expires.

    2. FA Deregistration is invoked (independent of the outcome).

    3. The GSM-R network to which the mobile registered, changes as a result of the GSM network selection procedure.

i. An eREC sector Identity update has no effect on an ongoing REC or eREC call at eREC mobile.

j. Note that Figure 10 only shows those (signalling) events that result in a transition from one mode to another. All other events will not result in a mode transition.

7.3. Interworking between MT and TE

a. If an eREC mobile comprises a GSM-R transceiver (MT) and a separate application entity (TE), the commands for call set up and call notification between TE and MT are similar to REC operation (only the eREC Sector Identity would change).

b. In order to check that the MT supports call setup using eREC Sector Identity, a new AT command can be invoked (at cab radio startup for example). The syntax, defined in Change Request 0254 [TS 27.007], is as follows: AT+CGIPC?

c. In order to enable the TE of an eREC mobile to instruct MT module about eREC Sector Identity, AT dial command scheme (as defined in Change Request 0254 [TS 27.007]) is enhanced. With this solution, an eREC call is thus initiated by sending a command as depicted in Figure 11.
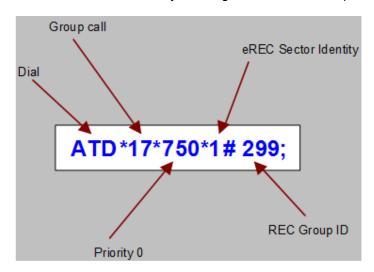

Figure 11 Command for eREC call set up

d. Because the eREC Sector Identity might be invalid, the call may be established in the network with a different Sector Identity compared to the one requested at call set up. The TE must therefore capture the Group Call Reference of the call established using the sequence in Figure 12. This Group Call Reference can then be used to rejoin the correct call in the event of network loss and subsequent recovery during the call.
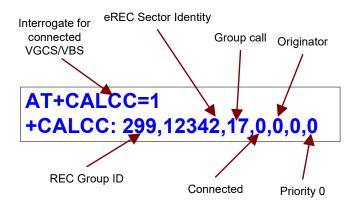
Interrogate for
connected
VGCS/VBS

eREC Sector Identity

Group call   Originator

AT+CALCC=1
+CALCC: 299,12342,17,0,0,0,0

REC Group ID

Connected   Priority 0

Figure 12 Commands to verify eREC Group Call Reference

e. An incoming eREC call is notified by presentation of the unsolicited result code as depicted in Figure 13.

Group call

eREC Sector Identity

Priority 0

+CRING: VGC 12341, 299, 1, 0
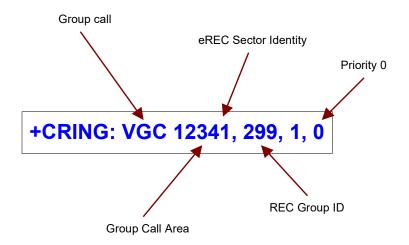
REC Group ID

Group Call Area

Figure 13 Command for eREC call notification

f. An eREC mobile shall not join an eREC call that it is notified of, but for which it does not have the eREC Sector Identity activated. In particular, if an eREC mobile is already involved in a point-to-point, or lower priority group call, then it shall not terminate or leave such a call when receiving an eREC call notification unless the eREC Sector Identity in the notification is one of those currently activated.

g. To avoid pre-emption of low priority calls by eREC calls for which the mobile does not have an active eREC Sector Identity, auto-answering for priority 0 calls shall be set to disabled on the SIM card in an eREC capable mobile.

8.   SIM card functionality

a. The SIM card specification remains unchanged compared to REC operation.

b. In order to be able to receive SMS-CB messages on an eREC mobile, the SIM card needs to be configured for that purpose.

9.   Interfaces

9.1.   Interface to dispatcher equipment (primary controller)

a. The interface to dispatcher equipment remains unchanged compared to REC operation.

b. At VGCS service subscriber originated eREC call set up, the eREC Group Call Reference is transferred to the associated dispatcher equipment as part of CLI signalling.

c. A dispatcher originated eREC call is set up as described in section 3.2.2.

9.2.   Interface to Acknowledgement Centre

a. The interface to the Acknowledgement Centre is enhanced to support eREC operation as specified in [[FFFS CHPC]] & [FIS CHPC].

b. After termination of an eREC call, or if the decision is made not to enter it (if eREC Sector ID is not an active one), the mobile sets up a call to the Acknowledgement Centre (as with REC) and transfers call details in the associated UUIE message. The UUIE message shall contain the eREC Group Call Reference (replacing the REC Group Call Reference), as well as other eREC related information as described in [TS 102 610].

c. Note that this functionality requires the mobile to store information relevant to the eREC Group Call of the eREC call it was last involved in (or notified of) until successful confirmation.

10.   eREC operation at border crossing

a. When an eREC mobile, which may or may not be registered to eREC Service, crosses a border, it shall successively perform the following event-triggered actions:

   1. After an eREC mobile has successfully selected the new network by applying the GSM network selection procedure, it shall activate REC Mode.

   2. An eREC mobile shall invoke eREC Service Registration in the new network.

   3. An eREC mobile shall, if it was registered for eREC Service, invoke eREC Service Deregistration in the old network.

      Note that these actions form part of the procedures for border crossing and require to be harmonised with other procedures such as FA Registration and FA Deregistration.

b. The eREC numbering scheme is compatible with the assignment of Country Indicators for international group calls as specified in E-2459 (refer to [GSM-R Codes]).

   Note: The Country Indicator (CI) is applied for an international group call within a shared area. It

indicates the country to which the anchor MSC (A-MSC) belongs to. The five digit shared service area is structured as 9+CI+X+Y+Z whereas "9" is the flag for an international service area.

c. An eREC mobile shall ignore any eREC Sector Identity update from a network which is not the currently selected one (for this reason eREC network settings contain MCC and MNC, refer to section 4.4).

d. If the new network does not support the eREC service in the shared group call area the non-selective or pre-defined eREC Sector Identity (see 2.2.b.4 i) shall be used.