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ERTMS/GSM-R OPERATORS GROUP
Ad Hoc Working Group on eREC

Definition and structure of eREC parameters

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1. Introduction

1.1. Scope

This document defines format and content of eREC messages and fields, and parameter settings for the enhanced Railway Emergency Call feature.

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). enhanced Railway Emergency Call (eREC) is an improvement over REC, resulting in less production loss while maintaining safety levels. The system requirements for eREC are specified in [eREC specification].

1.3. References

Ref. Nr.	Document Title	Document Number	Issue	Date	Author
[eREC specification]	enhanced Railway Emergency Call Specification	O-3151	1.2	16 December 2013	eREC WG
[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 23.090]	Unstructured Supplementary Service Data (USSD) - Stage 2	ETSI TS 123 090 3GPP TS 23 090	3.2.0	Release 99 2000-01	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
[TS 24.080]	Mobile radio Layer 3 Supplementary Service specification – Formats and coding	ETSI TS 124 080 3GPP TS 24.080	3.71	Release 99 2003-09	ETSI/3GPP
[TS 29.002]	Mobile Application Part (MAP)	ETSI TS 129 002 3GPP TS 29.002	3.20.0	Release 99 2004-06	ETSI/3GPP
[TS 23.041]	Technical realization of Cell Broadcast Service (CBS)	ETSI TS 123 041 3GPP TS 23.041	3.5.0	Release 99 2002-06	ETSI/3GPP

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

Abbreviation	Description
	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 Identity(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
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. USSD Messaging

2.1. Generic description

Unstructured Supplementary Service Data (USSD) is a service built into the GSM standard for transmitting information over signaling channels of the network. It allows fast communication between a user and an application. USSD is defined within the GSM standard in documents [TS 22.090] and [TS 23.090].

In the GSM-R system, USSD is used for functional addressing as described in [FIS FA]. For eREC, USSD is used for eREC Service Registration, eREC Service Deregistration and Sector Identity updates over the GSM-R network (push and pull).

The generic format of a USSD string is: [OC][SC]*[SI1]*[SI2]*[SI3]*[SI4]#

Explanation:

[OC] These two characters of the string denote the Operation Code ([OC] = ** ... for Registration; [OC] = ## ... for Erasure; [OC] = *# ... for Interrogation).

[SC] Two or three characters of the string denote the Service Code. It is used for message routing.

[SIx] There are four fields which may contain Supplementary Information. The last field [SI4] is used for bulk functional number registration and deregistration¹ and contains information for eREC operation.

* Field delimiter

End character

Functional number registration is for example denoted as **214*<functional number>***#.

Functional number deregistration is denoted as ##214*<functional number>***#. The registration/deregistration procedure allows for distinguishing between Train mode and Shunting mode. Train Mode uses CT-2 as part of the functional number whereas Shunting Mode uses CT-6.

The structure of field [SI4] is:

1. BULK + <NUM_FC> + 0x20 + <FC_LIST> + 0x20 + EREC + <eREC parameter list> if Bulk (de)registration is used.
2. EREC + <eREC parameter list> if Bulk (de)registration is not used.

Where NUM_FC is a single digit specifying the number of FCs to follow, FC_LIST is a list of two-digit function codes and 0x20 represents the hexadecimal ASCII value of a space character.

For a definition of the eREC parameter list refer to section 2.5.

2.2. Usage of existing registration/deregistration procedures for eREC

Wherever possible, information exchange required for eREC operation will be embedded (i.e. piggybacked) in existing CT-2 and CT-6 registration/deregistration procedures. This applies to:

1. eRECSERVICERegistration

¹ *Bulk registration* is an option that enables a lead driver to register/deregister multiple function codes within one USSD request. Bulk registration allows the network as an option to override the FC list requested and provide a different FC list. If this option is implemented in the network it is not even necessary for the cab radio to provide a FC list (0 entries). For more details refer to the FFS for functional addressing.

2. eRECSectorIDUpdateRequest
3. eRECSectorIDUpdateRequest

Any eREC information that is required to be returned (e.g. eREC network settings) is appended to the information field of the USSD response message (refer to section 2.7).

For sending eRECSectorIDUpdateIndication information, a new USSD message is defined (refer to section 2.6).

2.3. Usage of dummy CT-2 and CT-6 numbers

eREC registration, deregistration and update procedures require the use of dummy functional numbers in the following cases:

1. For use in shunting when functional number registration is not used.
2. After border crossing when eREC service in the previous country (network) has to be deactivated but the train functional number has to remain active.

The format of a shunting functional number is IC + CT + LN + FC. For a dummy shunting functional number LN = 00000 and FC = 5001.

For example: 0336000005001 (IC = 033 (France), CT = 6, LN = 00000, FC = 5001).

The format of a train functional number is IC + CT + TN + FC. For a dummy train functional number TN = 00000 (5 digits) and FC = 01.

For example: 03320000001 (IC = 033 (France), CT = 2, TN = 00000, FC = 01).

2.4. eREC field definitions

An overview of all eREC field definitions is described in Table 1.

eREC field_ID	eREC field name	Coding	Range	Description
1	MCC	3 digits	000 – 999	Mobile Country Code
2	MNC	3 digits	000 – 999	Mobile Network Code
3	eSIUM	4 characters	AAAA – ZZZZ	eREC Sector Identity Update Method The first character = H if eREC Sector Identity update by HMI input is allowed, the second character = B if eREC Sector Identity update by balise reader input is allowed, the third character = U if eREC Sector Identity update by USSD update is allowed, the fourth character is spare. If an eREC Sector Identity Update Method is not allowed it is denoted as X
4	eSIVM	1 character	A – Z	eREC Sector Identity Validation Method S or N
5	Tsi	5 digits	Null, 1 – 99999	T _{SL_ValidityPeriod} (seconds)
6	Tsr	5 digits	Null, 1 – 99999	T _{SR_ValidityPeriod} (seconds)
7	LAC	4 digits	0000 – FFFF	Location Area Code (hexadecimal coding)

eREC field_ID	eREC field name	Coding	Range	Description
8	CellID	4 digits	0000 – FFFF	Cell Identity (hexadecimal coding)
9	Lat	9 characters	89° 59' 59.99"S 89° 59' 59.99"N	Location information, latitude Example : 17° 33' 8.09"N is coded 17330809N
10	Long	10 characters	179° 59' 59.99"E 179° 59' 59.99"W	Location information, longitude Example : 17° 33' 8.09"W is coded 017330809W
11	Height	4 characters	- 100m - 4500m	Location information
12	Speed	3 digits	0km/h - 500km/h	Location information
13	Heading	3 digits	0° - 350°	Location information
14	ET	4 digits	0s – 2047s	Elapsed time Reference point for last received valid GPS information (used as a reference for Odometry information)
15	Distance	8 digits	0 km - 100 km	Odometry information
16	eSllist	9 digits	000000000 - 999999999	A string of 9 digits is used for coding eREC Sector Identities

Table 1 eREC field definitions

Note:

Most significant characters or digits of each field are transferred first.

2.5. Format and contents of [SI4] field

2.5.1. eREC tag

eREC information is prepended by a tag indicating the start of eREC information (e.g. for distinguishing BULK and eREC information in a train number registration message). The eREC tag is coded as: "EREC".

2.5.2. eRECServiceRegistration message

eREC fields as indicated in Table 2 will be included in the [SI4] field. eREC fields are separated by a ",". If a field is optional and not present only a "," is added.

	eREC Field_ID	eREC Field name	Mandatory/ Optional
1	7	LAC	M
2	8	CellID	M
3	9	Lat	O
4	10	Long	O
5	11	Height	O
6	12	Speed	O
7	13	Heading	O
8	14	ET	O
9	15	Distance	O

Table 2 eREC parameters for eREC Service Registration

Example 1:

214*03120055501*EREC0001,2BA3,,,,,,# is an eREC Service Registration on train number 555 in the Netherlands requiring USSD Sector Identity updates. Location information and odometry information is not present.

Example 2:

214*0336000005001*EREC0001,2BA3,,,,,,# is an eREC Service Registration on dummy shunting number 000005001 in France requiring USSD Sector Identity updates. Location information and odometry information is not present.

2.5.3. eRECServiceDeregistration message

An eREC Service Deregistration does not contain any eREC parameter.

Example 1:

##214*03220055501***BULK02 0203 EREC# is an eREC Service Deregistration in Belgium on train number 555.

Example 2:

##214*04920000001***EREC# is an eREC Service Deregistration in Germany at border crossing. Since it is not intended to deregister the train number, the dummy train number 0000001 is used for eREC Service Deregistration.

2.5.4. eRECSectorIDUpdateRequest message

eREC fields as indicated in Table 3 will be included in the [SI4] field. eREC fields are separated by a “,”. If a field is optional and not present only a “,” is added.

	eREC Field_ID	eREC Field name	Mandatory/ Optional
1	7	LAC	M
2	8	CellID	M
3	9	Lat	O
4	10	Long	O
5	11	Height	O
6	12	Speed	O
7	13	Heading	O
8	14	ET	O
9	15	Distance	O

Table 3 eREC parameters for eREC Sector Identity Update Request

Example:

214*03220000001*EREC0001,2BA3,,,,,,# is an eREC Sector Identity Update Request in Belgium for a train requiring USSD Sector Identity updates. A dummy train number is used. Location information and odometry information is not present.

Note that an eREC mobile is identified by its MSISDN which is implicitly included in the message by the HLR

2.6. Format and contents of eRECSectorIDUpdateIndication

2.6.1. General

For transferring eRECSectorIDUpdateIndications a newly defined USSD message is required. eREC fields as indicated in Table 4 shall be included.

	eREC Field_ID	eREC Field name	Mandatory/ Optional
1	16	eSllist	M
2	3	eSIUM	M
3	1	MCC	M
4	2	MNC	M
5	4	eSIVM	M
6	5	Tsi	M
7	6	Tsr	M

Table 4 eREC parameters for eREC Sector Identity Update Indication

The structure of the message is:

```
##214*EREC<+eREC info>#
```

eREC fields are separated by a “,”.

Example:

##214*EREC126000000,HXUX,204,021,S,21600,86400# is an eREC Sector Identity Update Indication for a train in the Netherlands. Sector 1 is used for eREC call initiation. eREC Sector Identities for call reception are 1, 2 and 6. Sector Identity Updates by both HMI and USSD are allowed. Sectors are validated by SMS-CB.

Note that there is no need to specify the train (or shunting) number; it is provided by eREC node for USSD dialogue between the network and the eREC mobile.

2.6.2. eREC Sector Identity coding

A string of 9 digits is used for the coding of valid eREC Sector Identities (values range is 1-9; non selective Sector Identity 0 is implicitly always valid).

If more than one eREC Sector Identity is sent in an update message, the first one is used by the mobile as the active eREC Sector Identity at call initiation. All received eREC Sector Identities are applicable during call notification.

All significant digits shall be gathered on the left part of the string. A 0 value means no more significant data follows.

A NULL update is coded “000000000”.

Example:

String “126000000” means that sector 1 is used for eREC call initiation. eREC Sector Identities for call reception are 1, 2 and 6.

String “120600000” means that sector 1 is used for eREC call initiation. eREC Sector Identity for call reception are 1 and 2. 6 should be ignored as it is placed after a 0.

2.6.3. USSD Response Message for notification

This message is used to respond that the eRECSectorIDUpdateIndication (notification) message is received by the MS. Its coding is similar to the coding of FORCED DEREGISTRATION NOTIFICATION The USSD response is coded conform 'SS formats and coding' and 'MAP protocol'. Refer to [FIS FA], [TS 24.080] and [TS 29.002].

Component ID	Invoke ID = Invoke ID of Register Message
error Code	see MAP specification 11.11.3

Table 5 USSD response message format for notification

2.7. USSD Response Message for registration and deregistration

USSD response messages may include additional information for eREC. The eRECSectorRegistrationConfirmation message contains eREC fields as indicated in Table 6.

	eREC Field_ID	eREC Field name	Mandatory/ Optional
1	1	MCC	M
2	2	MNC	M
3	3	eSIUM	M
4	4	eSIVM	M
5	5	Tsi	M
6	6	Tsr	M

Table 6 eREC parameters for eREC confirmation messages

Response messages are coded as described in [FIS FA].

Parameter	Type	Length in characters
Outcome code	Mandatory	2
Separating character (space) (0x20)	Optional	1
USSD-Response	Optional	N

Table 7 USSD response message format

eREC information is included as part of the USSD-Response parameter. eREC fields are separated by a “,”.

Example coding of USSD response message:

01 EREC204,021,XXUX,S,21600,86400 informs the mobile of eREC successful registration: visited network supports eREC; Sector Identity Updates are allowed by USSD only; Sectors are validated by SMS-CB.

2.8. Error handling

Errors are handled as with functional addressing. Refer to [FIS FA].

3. SMS-CB settings

3.1. General

SMS-CB periodicity is 1.883s at minimum. This value can be multiplied by 1 up to 1024 as defined in [TS 23.041]. The default value of SMS-CB periodicity is 9.415s (multiplier = 5).

3.2. Generic SMS-CB message content and format

The format of an SMSCB message is defined in [TS 23.041], chapter 9.4 and is shown in Table 8.

Octet Number(s)	Mandatory/ Optional
1 - 2	Serial Number
3 - 4	Message Identifier
5	Data Coding Scheme
6	Page Parameter
7 - 88	Content of Message

Table 8 Format of an SMS-CB message as defined in [TS 23.041], 9.4.1.2

The fields shall be set as follows:

- **Serial Number:**
 - Geographical Scope: 00 (cell wide)
 - Message Code: 1
 - Update Number: any value allowed
- **Message Identifier:** 00 01
- **Data Coding Scheme:** English = 01 (7 Bit ASCII), see 3GPP TS 23.038 [4]
- **Page Parameter:** 11
- **Content of Message:** This field contains the payload of the SMS-CB message. The content of the message shall be encoded using 7 bit ASCII characters in the English alphabet, as described in the Data Coding Scheme field above. This way, the message can be displayed on a handset for debugging purposes later on.

3.3. Coding of SMS-CB message payload with eREC specific information

To allow future applications to use the SMS-CB message, the eREC specific information is encapsulated by using a Type-Length-Value (TLV) mechanism as shown in Table 9 and described below.

7-bit character number	Field
1 - 2	Type (mandatory)
3 - 4	Length (mandatory)
5 - N	Value (dependant)
Following	Next field

Table 9 eREC fields contained in the message body of the SMS-CB message

- **Type:** Two digits, each ranging from 0 – 9 (allowing for 100 different types). For eREC, the type shall be set to 01.
- **Length:** Two digits, each ranging from 0 – 9 (allowing for a length up to 99 characters). This field contains the number of (7 bit) characters following the length field. An eREC message requires 9 digits, therefore, the length field shall be set to '09'.
Note: A length of 00 shall be interpreted as no value following the length field.

- **Value:** N * (7 bit) characters which contain the eREC message. The value is structured as shown in Table 10.

7-bit character number	Field
5 - 13	<p>The list of eREC Sector Identities is coded as a string of 9 digits, where each digit >0 represents an eREC Sector Identity.</p> <p>Example: An eREC mobile in eREC Mode has 1, 2 and 3 as its active eREC Sector Identities. If the mobile receives an SMS-CB message with eREC Sector Identities 1 and 2 (i.e. string "120000000"), it deactivates eREC Sector Identity 3, eREC Sector Identities 1 and 2 are successfully validated and remain active.</p>

Table 10 eREC message contained in the VALUE part of a TLV parameter

3.4. SMS-CB information on SIM

In order to be able to receive SMS-CB messages on an eREC mobile, the SIM card needs to be configured for that purpose. The radio module needs to be capable of forwarding SMS-CB messages received over the serial AT command interface.

4. Miscellaneous eREC parameter settings

Other eREC parameters and their settings are shown in Table 11.

Parameter	Default value	Range	Increment	Applicable to	Description
T _{SI_ValidityPeriod}	21600s	Null, 1s – 99999s	1s	Mobile	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
T _{SR_ValidityPeriod}	86400s	Null, 1s – 99999s	1s	Network and mobile	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.
SMS-CB repetition cycle	5	1.883s – 1928.192s	1	Network	SMS-CB periodicity is 1.883s at minimum. This value can be multiplied by 1 up to 1024 as defined in 3GPP 23.041
N _{USSD_Update_Retry}	3	1 – 10	1	Mobile and Network	Maximum number of retries for pushing an USSD Sector Identity to a mobile and requesting a pull update from the network.
T _{USSD_Update_Timeout}	10s	1s – 1000s	1s	Mobile and Network	Timeout for an attempt to push an USSD Sector Identity to a mobile and requesting a pull update from the network

Table 11 Miscellaneous eREC parameter settings