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# ERTMS/GSM-R Quality of Service Test Specification for EIRENE QoS requirements Voice and non-ETCS data

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## EVOLUTION SHEET

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# 1 INTRODUCTION

## 1.1 Purpose

The purpose of this document is to provide definitions and test specifications for QoS parameters related to circuit switched Voice and non ETCS circuit switched data services.

The test specifications in this document for the MI classified requirements in the EIRENE specifications will be used in context of the certification process of Interoperability Constituents (ICs) like Cab Radio or EDOR by the Notified body (NoBo) and also in the context of assessing the EIRENE network as a sub system. MI classified QoS requirements apply mostly to end-to-end performance.).

The test specifications in this document of the M and I classified requirements in the EIRENE specifications can be used as validation method for end-to-end performance or for subcomponents of the EIRENE system , like the GSM-R network only part, the fixed terminal part, the mobile station part, etc.

The QoS parameters are divided into four groups:

- a) parameters related to the (MI) EIRENE QoS requirements of [EIRENE FRS] and [EIRENE SRS]
- b) parameters related to the (M) EIRENE QoS requirements of [EIRENE FRS] and [EIRENE SRS]
- c) parameters related to the (O) EIRENE QoS requirements of [EIRENE FRS] and [EIRENE SRS]
- d) parameters related to the (I) EIRENE QoS requirements of [EIRENE FRS] and [EIRENE SRS]

The current version of this document deals with the parameters related to the (MI) EIRENE QoS requirements including the directly related M and I requirement to those MI requirements. The test specification for the other (M), (O) and (I) requirements will follow in a later version.

The document contains:

- ⇒ Description of the Testing and Measurement Architecture
- ⇒ Prerequisites and clarifications for QoS testing regarding EIRENE network, mobile station and fixed terminal sub-system
- ⇒ Aspects of test execution
- ⇒ Clarifications of the QoS parameters as needed for the purpose of measurement
- ⇒ The interfaces on which events of the measured parameters are observed and time stamped
- ⇒ The methods of measuring and verification of QoS parameter values.

For each QoS parameter, a description is given for “end-to-end” and, when possible, “network only” and “terminal only” measurements.

When complying with the tests in this document it will be possible:

- ⇒ To demonstrate that the end-to-end requirements are met

- ⇒ and when possible:
- ⇒ To demonstrate that the network only requirements are met
- ⇒ To demonstrate that the terminal equipment requirements are met

## 1.2 References

- [1] [EIRENE FRS] EIRENE Functional Requirement Specification, E-FRS v8.0.0
- [2] [EIRENE SRS] EIRENE System Requirement Specification, E-SRS v16.0.0
- [3] [ETSI EN 301 515] Requirements for GSM operation on railways, v2.3.0
- [4] [ETSI TS 102 281] Detailed requirements for GSM operation on Railways, v3.0.0
- [5] [MORANE P 38 T 9001 5.0] FFFIS for GSM-R SIM cards, version 5.0

## 1.3 Abbreviations and definitions

### Abbreviations

BRI	ISDN Basic Rate Interface
BSC	Base Station Controller
BSS	Base Station Sub-system
BTS	Base Transceiver Station
E2E	End-to-End
EIRENE	European Integrated Railway Radio Enhanced Network
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
ETSI	European Telecommunication Standardization Institute
FN	Functional Number
FRS	Functional Requirement Specification
FTS	Fixed Terminal Sub-system
GSM-R	Global System for Mobile communication – Railways
IC	Interoperability Constituents
Ifts	Interface (fixed network)
ISDN	Integrated Services Digital Network
M	Mandatory
MI	Mandatory (for) Interoperability
MMI	Man Machine Interface
MS	Mobile Station
MOC	Mobile Originated Call (Call from Mobile to Fixed Network)
MTC	Mobile Terminated Call (Call from Fixed Network to Mobile)
MTM	Mobile To Mobile Call (Call from Mobile to Mobile)
NSS	Network Sub-system
O	Optional
QoS	Quality of Service
REC	Railway Emergency Call
Rm	Rm (AT) Interface
S2M	S2M Interface
SIM	Subscriber Identity Module
SRS	System Requirement Specification
Um	Um Interface (air interface)

VGCS Voice Group Call Service

**Definitions**

Confidence interval	A confidence interval expresses the degree of uncertainty associated with a sample statistic. It is an interval estimate combined with a probability statement.
Confidence level	A confidence level refers to the percentage of all possible samples that can be expected to include the true parameter.
Fixed Controller	A Controller whose terminal is connected to network using fixed line (e.g. ISDN).
Operational call	Railway communications directly concerned with train and shunting movements or train operation. For example, controller-driver communications. Controller-driver operational calls normally use ptp calls with priority level 3, and they use Functional Numbers or Location dependent Addressing.
Test Operator	The person performing the QoS measurement

## 2 INTERFACES AND OTHER ASPECTS

### 2.1 Testing Architecture

The following diagram gives a reference architecture for the general arrangement of the equipment for all testing. It is not meant to indicate detailed equipment configurations. Elements to be included will depend on the test being performed.

The architecture of the Core Network (NSS) may be either ETSI Release-99 or 3GPP Release-4 as appropriate and its internal architecture is not relevant to this test specification.

The minimum configuration for the system is a single NSS connected to a single BSS, depending on the tests to be performed, extended by a fixed network and a controller system (FTS), depending on the test configuration. The BSS is a single BSC with two attached BTS providing a single carrier with one control channel and 7 traffic channels per BTS. This is illustrated in Figure 1a. The diagram indicates the interface types used to connect the various components.

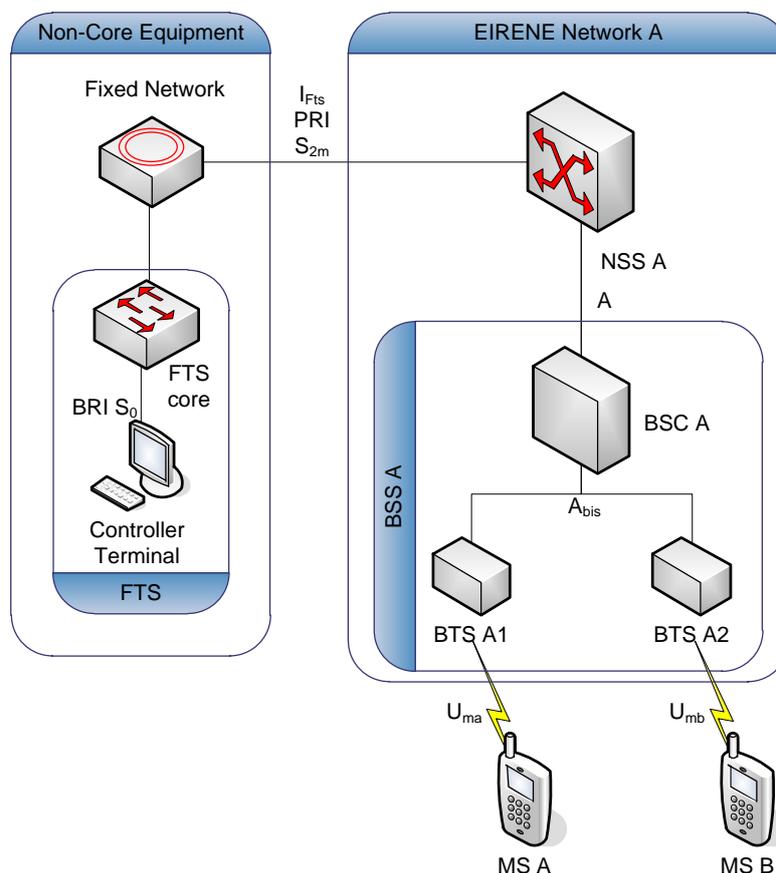


Figure 1a: Reference testing architecture single network

If comparability is required to other networks an equal test configuration like Figure 1a should be used.

Larger, more complex network architectures (for example with multiple BTS, BSC or MSC) may be added in a later version of this specification. An example is given in Figure 1b.

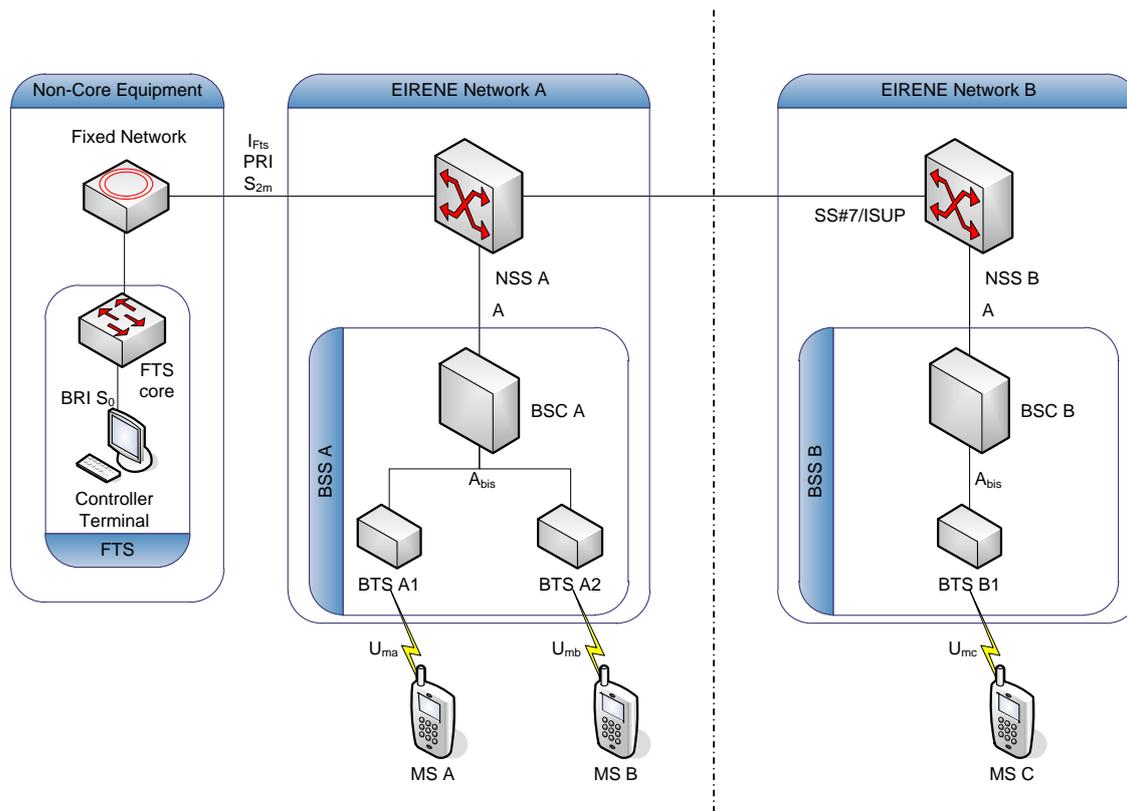


Figure 1b: Reference testing architecture, complex network architecture

The terminal equipment being assessed is located in the “Single Network Configuration” EIRENE Network A. EIRENE Network B is only needed to cover future tests (out of scope of current document) associated with cross-border group calls, border-crossing in general and other roaming functionality.

The reference architecture shown above can be realised in a suitable test laboratory or in the field through mapping the national network design onto the reference architecture. This should allow to determine the measurement points in both cases. It is not within the scope of this specification to mandate one or the other - the tests may be performed either in a laboratory or in the field, as required.

The described minimum configuration does not exclude the use of larger network configurations. If comparability is required to other networks an equal test configuration like Figure 1a should be used.

The Controller equipment is located as part of a Fixed Terminal Sub-system (FTS). This comprises a core element that will normally perform a switching/routing function and a Controller Terminal that provides the user interface. The internal details of the FTS are outside the scope of this specification. In this issue of the test specification the internal FTS connections and the link between the FTS and the NSS are ISDN based (as opposed to Voice over IP, which will be covered in future releases of this specification). The FTS is included in “Non-Core Equipment” in Figure 1a above, together with the

“Fixed Network”. The Fixed Network could comprise any suitable type of transmission system used to connect the FTS to the NSS.

Controller equipment interconnected via radio is outside the scope of EIRENE and is therefore not considered.

## 2.2 Measurement Architecture

Two different voice QoS measurement architectures need to be defined, one for mobile station user to/from FTS user (Figure 2) and another for mobile station user to mobile station user (Figure 3). The architectures are consistent with the reference architectures in the EIRENE SRS. The individual measurement points are indicated in the figures.

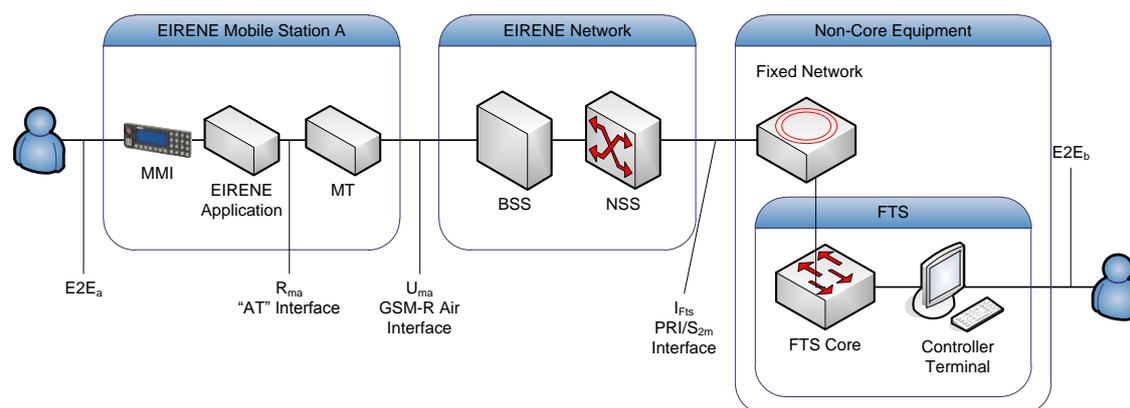


Figure 2: Mobile station user to FTS user measurement architecture

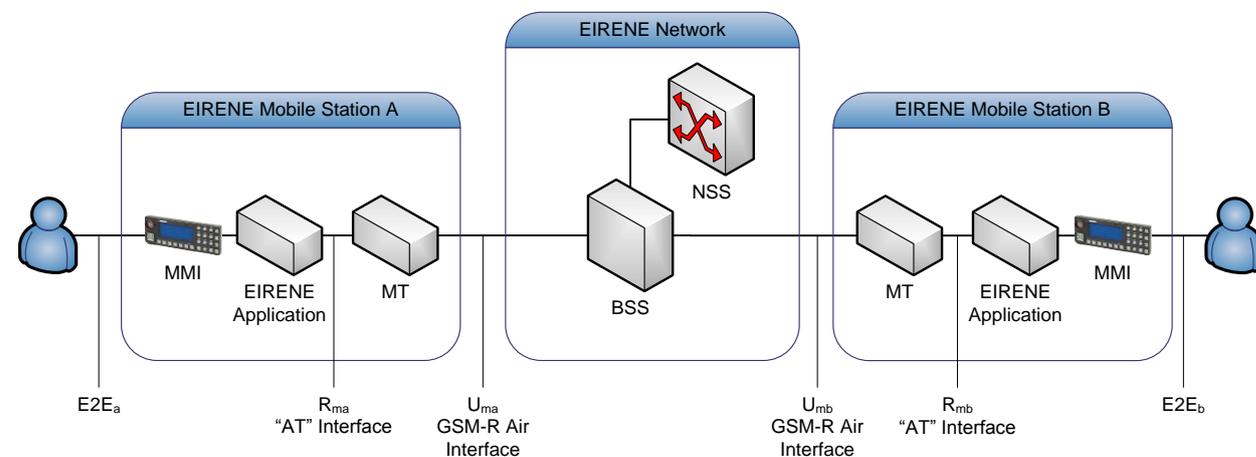


Figure 3: Mobile station user to mobile station user measurement architecture

## 2.3 Prerequisites and clarifications

### 2.3.1 General

The purpose of the tests is to assess the QoS performance of an EIRENE system or sub-system. The following points set out a common basis for all tests. Any variation from this basis will be specified in any tests that requires it. For example, if a particular network is configured differently, then this shall be recorded as part of the corresponding test results.

### 2.3.2 EIRENE network

The network and its interconnections shall be dimensioned such that congestion shall not occur unless specifically forced in order to test pre-emption responses.

The configuration of network specific parameters is a national matter, but it is recommended to have Authentication activated on Location Update (LUP) only. The use of authentication and encryption shall be in accordance with the requirements of the EIRENE SRS sections 3.4.2). To provide consistent and comparable results encryption shall be employed as specified in EIRENE SRS section 10.7.

To prevent the Confirmation of High Priority Calls procedures from interfering with mobile station response times during sequences of railway emergency call set-up measurements sufficient time between the measurements shall be allowed to terminate the Confirmation procedure before starting the next measurement. Alternatively the tested mobile station may be configured not to send Confirmations.

To prevent interference with mobile station response times the EIRENE network shall be configured such that no regular polling of mobile stations (such as Any Time Interrogation to determine current serving cell) is being performed.

The frequencies allocated to the base station(s) shall be chosen in the UIC frequency band (EIRENE SRS section 1.4.3.2) and following good engineering practice to ensure there are no interference effects between the GSM-R BTSs being used in the tests. Steps shall be taken to ensure that there are no interfering signals being received from non-GSM-R networks.

The network shall be configured to utilise Location Dependent Addressing, but not enhanced Location Dependent Addressing unless additional call setup time is allowed and documented.

There must be sufficient traffic resources in the originating cell (VGCS Originator Uplink and Common Downlink) and as well on the network interfaces between BSS - NSS and other relevant interfaces.

### 2.3.3 Mobile station

The mobile stations shall be fitted with a SIM Card that conforms to the [FFFIS for GSM-R SIM Cards]. The SIM shall define the mobile station to be a subscriber of EIRENE Network A unless a specific roaming test is being performed in which case the SIM may be for EIRENE Network B. This will be specified in the details of the test.

To prevent the Confirmation of High Priority Calls procedures from interfering with mobile station response times during sequences of railway emergency calls all SIMs may be configured such that no acknowledgements are to be sent by the mobile stations, also see section 2.3.2.

**Unless specified otherwise** in the details of the test, all mobile stations shall be attached and authenticated to EIRENE Network A. When the test case consists of one mobile device one BTS is sufficient. When a test case considers a mobile-to-mobile scenario two BTSs are required and both mobiles are camping on different cells. Moreover, unless specified otherwise for a particular test, all mobile stations shall be

registered with Functional Numbers and any point-to-point calls shall be made using one of those numbers as the called party number.

### **2.3.4 Fixed terminal sub-system**

Fixed terminals shall have both a subscriber number and one or more Functional Numbers (CT7). For point-to-point calls to Controller Terminals the call shall be delivered to only one specific terminal, not several.

## **2.4 Execution of tests**

Each test shall be performed under test conditions like operational conditions as far as possible while using standardised and easily reproducible test conditions. Unless demanded by a particular test the “Single Network Configuration” of Figure 1a should be utilised as the basis of the test configuration. If tests using a roaming mobile or cross-border group call tests, for example, are to be measured then it must be recognised that the additional delays imposed by the links and processing of more than one NSS core are currently outside the scope of the EIRENE QoS requirements and thus outside the scope of this specification.

All measured parameter values shall be verified with a statistical Confidence Level, preferably 99% but not less than 95 %. In section 7.2 below a recommendation is created for the minimum sample size. This allows calculation of the number of samples needed before a test is completed. The resulting recommendation is to use for all tests a sample size of 200.

The network configuration and the parameters shall be described within test cases and logged during test execution.

Dependent on the exact MMI specification of terminals, in particular Cab, the REC button has to be pressed up to second(s). This additional delay has to be subtracted from the measurement results, because it is considered to be out of scope.

Calls from mobile stations to Controller Terminals shall either be by Location Dependent Addressing or by controller Functional Number (CT7) (E-FRS 3.4.4). During execution of the tests no Call Forwarding shall be in place since this may introduce delays which are outside the scope of this specification. “Follow-Me” is, of course, to be active since this is the basis of Functional Addressing (E-FRS 3.4.4).

### 3 TEST SPECIFICATION FOR PARAMETERS RELATED TO (MI) EIRENE QoS REQUIREMENTS

This chapter describes QoS parameters for Voice and non ETCS circuit switched data services, which are related to mandatory interoperability (MI) requirements in E-FRS and E-SRS including the M and I related requirements (to the MIs).

#### Note

*The logs which will provide the time stamps that are necessary according to the tests are usually not provided during normal operation. They can be obtained by additional test equipment or using maintenance facilities of the equipment under test. For example, it may be necessary to connect a PC to a maintenance port and open a communication link. In this case the equipment will be operating in a monitoring mode that may differ from normal operation. The delay related to this monitoring mode shall be excluded, i.e. subtracted, from the test results.*

#### 3.1 Call set up time of Mobile originated and terminated Railway Emergency calls

Reference to	EIRENE FRS	EIRENE SRS	Other
	3.4.1i (M)	3.4.2 (MI)	
	3.4.2 (MI)	3.4.5 (M/MI)	
	3.4.3 (MI)	5.5.28 (M)	
	3.4.4 (MI)	7.3.11 (M)	
		7A.3.10 (M)	

##### 3.1.1 Definition:

Call set up time for VGCS Railway Emergency Calls (priority 0) originated and terminated by a mobile station.

##### 3.1.2 Pre-conditions for measurement:

Call set up time for VGCS Railway Emergency Call (REC) is applicable for Train emergency calls (VGCS call with Group ID 299, priority 0) and Shunting emergency calls (VGCS call with Group ID 599, priority 0) within GSM-R network.

Two Mobile Station (e.g. Cab Radio) are used, one for originating the VGCS REC, and the other for reception.

Mobile Stations are attached to the GSM-R network, are in Idle mode and are located in the service area.

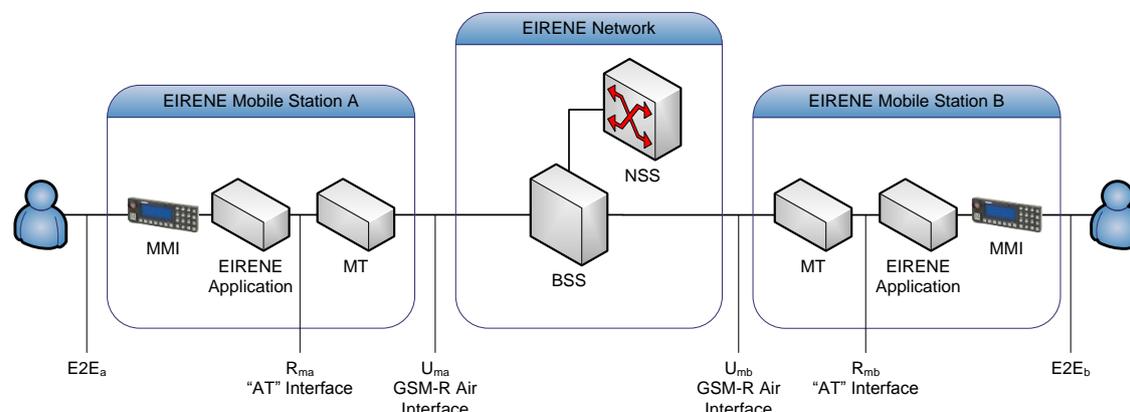
Mobile Stations (including GSM-R SIM) are configured to support VGCS REC with Group ID 299 (Train emergency call) respectively with Group ID 599 (Shunting emergency call), priority 0 and to support of fast call setup procedure (for originating Mobile).

Reduced NCH monitoring feature in Network as well as Mobile Station (especially cab radio) shall not be enabled.

The GSM-R Network is configured with at least one service area for VGCS REC with Group ID 299 respectively with at least one service area for VGCS REC Group ID 599.

Only successfully established connections shall be measured.

### 3.1.3 For measurement:



#### 3.1.3.1 End-to-end

For the measurement between interface E2E<sub>a</sub> and E2E<sub>b</sub> the follow script applies:

Time between pressing the REC button of the tested Mobile Station A until the start of the Stage 1 Warning, i.e. the audible REC indication by the tested Mobile Station B.

This can be adapted by:

##### Part 1: E2E<sub>a</sub> - R<sub>ma</sub>:

Time between pressing the REC button of the tested Mobile Station A until the “ATD\*17\*750#gid;” AT message [R<sub>ma</sub>-interface of Mobile Station A].

##### Part 2: R<sub>ma</sub> – R<sub>mb</sub>:

Time between the "ATD\*17\*750#gid;" AT message [R<sub>ma</sub>-interface of originating Mobile Station A] until the NOTIFICATION "+CRING: VGC gca,gid,0,0" AT message [R<sub>mb</sub>-interface of receiving Mobile Station B].

##### Part 3: R<sub>mb</sub> - E2E<sub>b</sub>:

Time between the NOTIFICATION "+CRING: VGC gca,gid,0,0" AT message [R<sub>mb</sub>-interface of receiving Mobile Station B] until the start of the Stage 1 Warning, i.e. the audible REC indication by the tested Mobile Station B.

End-to-end:

The total time for the end-to-end call setup is: Part 1 + Part 2 + Part 3.

Note 1: The group call must be established in both radio cells.

Note 2: Any intentional delay (of e.g. two seconds) before the MMI and the EIRENE application in the Mobile Station starts processing the REC shall be excluded, i.e. subtracted from the test result.

#### 3.1.3.2 Network only

For the measurement between interface U<sub>ma</sub> and U<sub>mb</sub> the follow script applies:

Time between the CHANNEL REQUEST message of Mobile Station A until the NOTIFICATION message on Mobile Station B.

Note 1: The measurement on Um interfaces requires Mobiles Stations or test equipment with trace capability.

Note 2: For simplifying the measurement also the CONNECT Message on originating MS can be used as end trigger point.

#### **3.1.3.4 Mobile station only**

For the measurement between interface E2E<sub>a</sub> and U<sub>ma</sub>, and between interface U<sub>mb</sub> and E2E<sub>b</sub> the follow script applies:

Time between the End-to-End part minus the Network only part divided by two.

#### **3.1.4 Success criteria:**

- End-to-end Call set-up time for Railway emergency calls as specified in EIRENE FRS requirement 3.4.1i.
- Network Only Call set-up time for Railway emergency calls as specified in EIRENE SRS requirement 3.4.5.
- The call setup delay caused by the Mobile Station as specified in EIRENE SRS requirements 3.4.5, 5.5.28, 7.3.11 and 7A.
- The required call set-up times shall be achieved as specified in EIRENE FRS requirement 3.4.2 and 3.4.3.

## **3.2 Call set up time of Railway Emergency calls mobile originated and terminated at Fixed Controller**

<b>Reference to</b>	<b>EIRENE FRS</b>	<b>EIRENE SRS</b>	<b>Other</b>
	3.4.1i (M)	3.4.2 (MI)	
	3.4.2 (MI)	3.4.3 (I)	
	3.4.3 (MI)	3.4.3i (M)	
	3.4.4 (MI)	3.4.4 (I)	
		3.4.5 (M/MI)	

### **3.2.1 Definition:**

Call set up time for VGCS Railway Emergency Calls (priority 0) originated by a mobile and terminated at a fixed line Controller.

### **3.2.2 Pre-conditions for measurement:**

Call set up time for VGCS Railway Emergency Call (REC) is applicable for Train emergency calls (VGCS call with Group ID 299, priority 0) and Shunting emergency calls (VGCS call with Group ID 599, priority 0) within GSM-R network.

One Mobile Station (e.g. Cab Radio) is used for originating the VGCS REC, one Fixed Controller Terminal is used for terminate the VGCS REC.

The Fixed Controller Terminal System is connected to the GSM-R network.

Mobile Station is attached to the GSM-R network, is in Idle mode and is located in the service area.

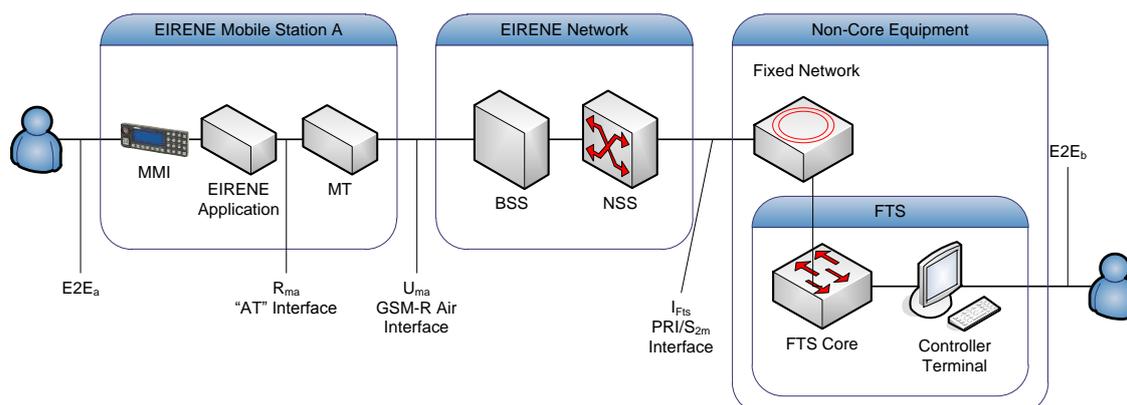
Fixed Controller and Mobile Station (including GSM-R SIM) are configured to support VGCS REC with Group ID 299 (Train emergency call) respectively with Group ID 599 (Shunting emergency call), priority 0.

Reduced NCH monitoring feature in Network as well as Mobile Station (especially cab radio) shall not be enabled.

The GSM-R Network is configured with at least one service area for VGCS REC with Group ID 299 respectively with at least one service area for VGCS REC Group ID 599. For these service areas the Fixed Controller is registered to terminate the VGCS REC with Group ID 299 respectively with Group ID 599.

Only successfully established connections shall be measured.

### 3.2.3 For measurement:



#### 3.2.3.1 End-to-end

For the measurement between interface E2E<sub>a</sub> and E2E<sub>b</sub> the follow script applies:

Time between pressing the REC button of the tested Mobile Station A until the start of the audible REC indication at the terminating Controller Terminal.

This can be adapted by:

##### Part 1: E2E<sub>a</sub> - R<sub>ma</sub>:

Time between pressing the REC button of the tested Mobile Station A until the "ATD\*17\*750#gid;" AT message [R<sub>ma</sub>-interface of Mobile Station A].

##### Part 2: R<sub>ma</sub> - I<sub>Fts</sub>:

Time between the "ATD\*17\*750#gid;" AT message [R<sub>ma</sub>-interface of originating Mobile Station A] until the SETUP message at the I<sub>Fts</sub> interface (PRI/S<sub>2M</sub>).

##### Part 3: I<sub>Fts</sub> - E2E<sub>b</sub>:

Time between the SETUP message at the I<sub>Fts</sub> interface (PRI/S<sub>2M</sub>) until the start of the audible REC indication at the terminating Controller Terminal.

End-to-end:

The total time for the end-to-end call setup is: Part1 + Part 2 + Part 3.

Note 1: The group call must be established at least in the cell of origin.

Note 2: Any intentional delay (of e.g. two seconds) before the MMI and the EIRENE application in the Mobile Station starts processing the REC shall be excluded, i.e. subtracted from the test result.

#### 3.2.3.2 Network only

For the measurement between interface U<sub>ma</sub> and I<sub>Fts</sub> the follow script applies:

Time between the CHANNEL REQUEST message of Mobile Station A until the SETUP message at the I<sub>Fts</sub> interface (PRI/S<sub>2M</sub>).

Note 1: The measurement on Um interfaces requires Mobiles Stations or test equipment with trace capability.

Note 2: For simplifying the measurement also the CONNECT Message on originating MS can be used as end trigger point.

### 3.2.3.3 External network & Controller equipment

For the measurement between interface I<sub>FTS</sub> and E2E<sub>b</sub> the follow script applies:

Time between the SETUP message at the I<sub>FTS</sub> interface (PRI/S<sub>2M</sub>) until the start of the audible REC indication at the terminating Controller Terminal.

### 3.2.3.4 Mobile station only

For the measurement between interface E2E<sub>a</sub> and U<sub>ma</sub> the follow script applies:

Time between the End-to-End part minus the Network only part minus the External network & Controller equipment part.

### 3.2.4 Success criteria:

- End-to-End Call set-up time for Railway emergency calls as specified in EIRENE FRS requirement 3.4.1i
- Network Only Call set-up time for Railway emergency calls as specified in EIRENE SRS requirement 3.4.5
- External network including Controller Equipment Only Call set-up time for Railway emergency calls as specified in EIRENE SRS requirement 3.4.3 and 3.4.3i
- The required call set-up times shall be achieved as specified in EIRENE FRS requirement 3.4.2 and 3.4.3

### **3.3 Call set up time of Railway Emergency calls Fixed Controller originated and mobile terminated**

<b>Reference to</b>	<b>EIRENE FRS</b>	<b>EIRENE SRS</b>	<b>Other</b>
	3.4.1i (M)	3.4.2 (MI)	
	3.4.2 (MI)	3.4.3 (I)	
	3.4.3 (MI)	3.4.3i (M)	
	3.4.4 (MI)	3.4.4 (I)	
		3.4.5 (M/MI)	

#### **3.3.1 Definition:**

Call set up time for VGCS Railway Emergency Calls (priority 0) originated by a fixed line Controller and terminated at a mobile station.

#### **3.3.2 Pre-conditions for measurement:**

Call set up time for VGCS Railway Emergency Call (REC) is applicable for Train emergency calls (VGCS call with Group ID 299, priority 0) and Shunting emergency calls (VGCS call with Group ID 599, priority 0) within GSM-R network.

One Fixed Controller Terminal is used for originating the VGCS REC, one Mobile Station (e.g. Cab Radio) is used for terminate the VGCS REC.

The Fixed Controller Terminal System is connected to the GSM-R network.

Mobile Station is attached to the GSM-R network, is in Idle mode and is located in the service area.

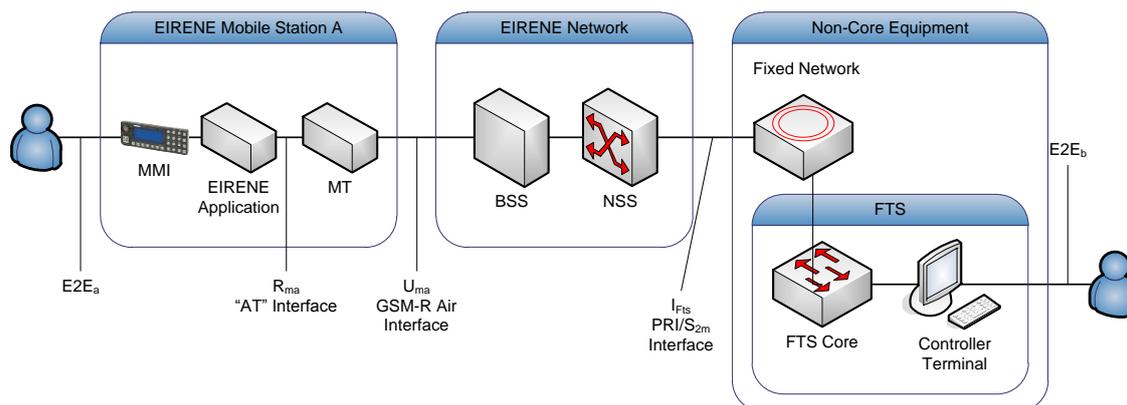
Fixed Controller and Mobile Station (including GSM-R SIM) are configured to support VGCS REC with Group ID 299 (Train emergency call) respectively with Group ID 599 (Shunting emergency call), priority 0.

Reduced NCH monitoring feature in Network as well as Mobile Station (especially cab radio) shall not be enabled.

The GSM-R Network is configured with at least one service area for VGCS REC with Group ID 299 respectively with at least one service area for VGCS REC Group ID 599. For these service areas the Fixed Controller is registered to originate the VGCS REC with Group ID 299 respectively with Group ID 599.

Only successfully established connections shall be measured.

### 3.3.3 For measurement:



#### 3.3.3.1 End-to-end

For the measurement between interface E2E<sub>b</sub> and E2E<sub>a</sub> the follow script applies:

Time between pressing the REC button at the terminating Controller Terminal until the start of Stage 1 Warning, i.e. the audible REC indication by the tested Mobile Station A.

This can be adapted by:

##### Part 1: E2E<sub>b</sub> - I<sub>FTS</sub>:

Time between pressing the REC button at the originating Controller Terminal until the SETUP message at the I<sub>FTS</sub> interface (PRI/S<sub>2M</sub>).

##### Part 2: I<sub>FTS</sub> - R<sub>ma</sub>:

Time between the SETUP message at the I<sub>FTS</sub> interface (PRI/S<sub>2M</sub>) until the NOTIFICATION "+CRING: VGC *gca,gid,0,0*" AT message [R<sub>ma</sub>-interface of receiving Mobile Station A].

##### Part 3: R<sub>ma</sub> - E2E<sub>a</sub>:

Time between the NOTIFICATION "+CRING: VGC *gca,gid,0,0*" AT message [R<sub>ma</sub>-interface of receiving Mobile Station A] until the start of the Stage 1 Warning, i.e. the start of the audible REC indication by the tested Mobile Station A.

##### End-to-end:

The total time for the end-to-end call setup is: Part1 + Part 2 + Part 3.

Note 1: The group call must be established at least in the cell of termination.

Note 2: Any intentional delay (of e.g. two seconds) before the MMI and the EIRENE application in the controller equipment starts processing the REC shall be excluded, i.e. subtracted from the test result.

#### 3.3.3.2 Network only

For the measurement between interface I<sub>FTS</sub> and U<sub>ma</sub> the follow script applies:

Time between the SETUP message at the I<sub>FTS</sub> interface (PRI/S<sub>2M</sub>) until the NOTIFICATION message of Mobile Station A.

Note 1: The measurement on Um interfaces requires Mobiles Stations or test equipment with trace capability.

Note 2: For simplifying the measurement also the CONNECT Message at the I<sub>FTS</sub> interface (PRI/S<sub>2M</sub>) can be used as end trigger point.

### 3.3.3.3 External network & Controller equipment

For the measurement between interface E2E<sub>b</sub> and I<sub>FTS</sub> the follow script applies:

Time between pressing the REC button at the terminating Controller Terminal until the SETUP message at the I<sub>FTS</sub> interface (PRI/S<sub>2M</sub>).

### 3.3.3.4 Mobile station only

For the measurement between interface E2E<sub>a</sub> and U<sub>ma</sub> the follow script applies:

Time between the End-to-End part minus the Network only part minus the External network & Controller equipment part.

### 3.3.4 Success criteria:

- End-to-End Call set-up time for Railway emergency calls as specified in EIRENE FRS requirement 3.4.1i
- Network Only Call set-up time for Railway emergency calls as specified in EIRENE SRS requirement 3.4.5
- External network including Controller Equipment Only Call set-up time for Railway emergency calls as specified in EIRENE SRS requirement 3.4.3 and 3.4.3i
- The required call set-up times shall be achieved as specified in EIRENE FRS requirement 3.4.2 and 3.4.3

### **3.4 Call set up time of Group calls between drivers in the same area (mobile originated VGCS calls)**

<b>Reference to</b>	<b>EIRENE FRS</b>	<b>EIRENE SRS</b>	<b>Other</b>
	3.4.1i (M) 3.4.2 (MI) 3.4.3 (MI) 3.4.4 (MI)	3.4.2 (MI) 3.4.5 (M/MI) 5.5.29 (MI) 7.3.11 (M) 7A.3.10 (M)	

#### **3.4.1 Definition:**

Call set up time of VGCS Group calls (MOC and MTM) between drivers in the same area, (priority 2).

#### **3.4.2 Pre-conditions for measurement:**

Call set up time of Group calls between drivers in the same area is applicable for VGCS call with Group ID 200, priority 2 within GSM-R network.

One Mobile Station (e.g. Cab Radio) is used for originating the VGCS call, at least a second Mobile Station and optional a Fixed Controller used as called party.

Mobile Stations are attached to the GSM-R network, are in Idle mode and are located in the service area.

Mobile Stations (including GSM-R SIM) and an optional Fixed Controller are configured to support VGCS calls with Group ID 200, priority 2.

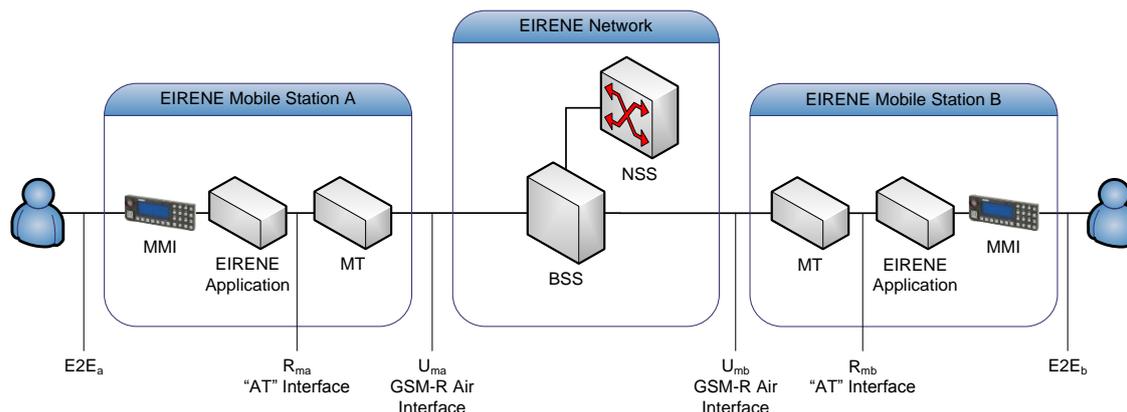
Reduced NCH monitoring feature in Network as well as Mobile Station (especially Cab radio) shall not be enabled.

The GSM-R Network is configured with at least one service area for VGCS calls with Group ID 200.

For this service area an optional Fixed Controller is registered to terminate the VGCS with Group ID 200.

Only successfully established connections shall be measured.

### 3.4.3 For measurement:



#### 3.4.3.1 End-to-end

For the measurement between interface E2E<sub>a</sub> and E2E<sub>b</sub> the follow script applies:

Time between pressing the SEND button (for VGCS call with Group ID 200) of the tested Mobile Station A until the start of the audible indication by the tested Mobile Station B.

This can be adapted by:

##### Part 1: E2E<sub>a</sub> - R<sub>ma</sub>:

Time between pressing the SEND button of the tested Mobile Station A until the "ATD\*17\*752#gid;" AT message [R<sub>ma</sub>-interface of Mobile Station A].

##### Part 2: R<sub>ma</sub> - R<sub>mb</sub>:

Time between the "ATD\*17\*752#gid;" AT message [R<sub>ma</sub>-interface of originating Mobile Station A] until the NOTIFICATION "+CRING: VGC gca,gid,0,2" AT message [R<sub>mb</sub>-interface of receiving Mobile Station B].

##### Part 3: R<sub>mb</sub> - E2E<sub>b</sub>:

Time between the NOTIFICATION "+CRING: VGC gca,gid,0,2" AT message [R<sub>mb</sub>-interface of receiving Mobile Station B] until the start of the audible indication by the tested Mobile Station B.

##### End-to-end:

The total time for the end-to-end call setup is: Part1 + Part 2 + Part 3.

Note 1: The group call must be established in both radio cells.

Note 2: Any intentional delay (of e.g. two seconds) before the MMI and the EIRENE application in the Mobile Station starts processing the REC shall be excluded, i.e. subtracted from the test result.

#### 3.4.3.2 Network only

For the measurement between interface U<sub>ma</sub> and U<sub>mb</sub> the follow script applies:

Time between the CHANNEL REQUEST message of Mobile Station A until the NOTIFICATION message on Mobile Station B.

Note 1: The measurement on Um interfaces requires Mobiles Stations or test equipment with trace capability.

Note 2: For simplifying the measurement also the CONNECT Message on originating MS can be used as end trigger point.

### **3.4.3.3 Mobile station delay**

For the measurement between interface E2E<sub>a</sub> and U<sub>ma</sub>, and between interface U<sub>mb</sub> and E2E<sub>b</sub> the follow script applies:

#### Originating Mobile station (A) delay:

Time between pressing the SEND button of the tested Mobile Station A until the “ATD\*17\*752#gid;” AT message [R<sub>ma</sub>-interface of Mobile Station A].

#### Terminating Mobile station (B) delay:

Time between the NOTIFICATION “+CRING: VGC *gca,gid,0,2*” AT message [R<sub>mb</sub>-interface of receiving Mobile Station B] until the start of the audible indication by the tested Mobile Station B.

### **3.4.4 Success criteria:**

- Group calls between drivers in the same area as specified in EIRENE FRS requirement 3.4.1i
- The call setup delay caused by the Mobile Station as specified in EIRENE SRS requirements 5.5.29, 7.3.11 and 7A.
- The required call set-up times shall be achieved as specified in EIRENE FRS requirement 3.4.2 and 3.4.3

### **3.5 Registration time for up to 10 Functional Numbers (mobile originated)**

<b>Reference to</b>	<b>EIRENE FRS</b>	<b>EIRENE SRS</b>	<b>other</b>
	11.3.2.3(MI)		

#### **3.5.1 Definition:**

Registration time for up to ten Functional Numbers of Cab radio, originated by Mobile Station

#### **3.5.2 Pre-conditions for measurement:**

Registration time is applicable for functional number(s) within GSM-R network.

The Mobile Station (Cab Radio) shall support registration of up to 10 Functional numbers. .

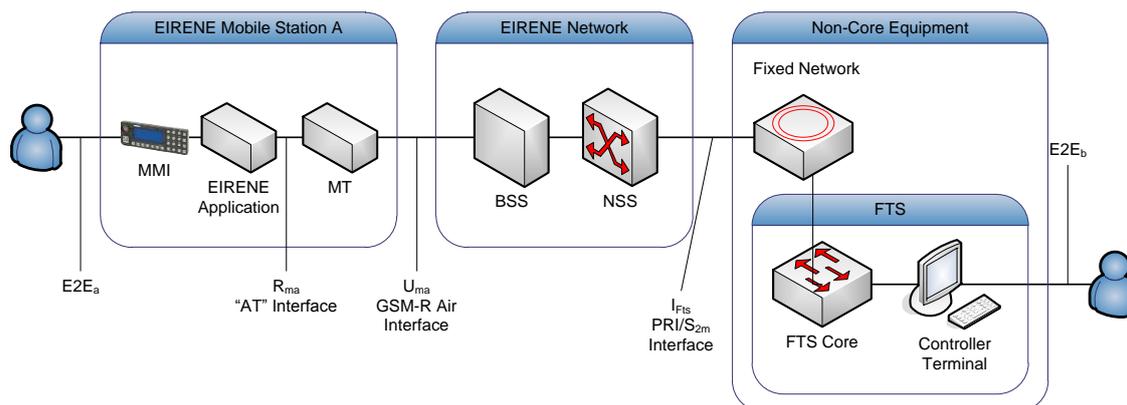
The Functional Numbers to be registered are available in the GSM-R network and not already registered to MSISDN(s).

The Terminal is attached to the GSM-R network and is in Idle mode.

Tests should be performed with ten FN's.

Only successful Registration attempts should be considered.

### 3.5.3 For measurement:



#### 3.5.3.1 End-to-end

For the measurement between interface  $E2E_a$  and  $E2E_a$  the follow script applies:

Time between pressing the SEND button (for registration of functional numbers) of the tested Mobile Station until the visible confirmation on the MMI of the tested Mobile Station A.

This can be adapted by:

$E2E_a - E2E_a$ :

Time between pressing the SEND button of the tested Mobile Station A until the visible confirmation on the MMI of the tested Mobile Station A.

#### 3.5.3.2 Network only

For the measurement between interface  $U_{ma}$  and  $U_{ma}$  the follow script applies:

Time between the CHANNEL REQUEST, used for triggering the Follow-Me service to register the first Functional Number message of Mobile Station A, until the reception of the last message sent by network containing the Follow-Me response of the successful registration of the last Functional Number.

Note 1: Registration of functional numbers uses the Follow-Me Service based on USSD. In result of successful registration attempt the Follow-Me response (sent by the network) contains a specific result code indicating successful registration of the Functional Number.

### 3.5.4 Success criteria:

It shall be possible to register 10 functional numbers within a time as specified in EIRENE FRS requirement 11.3.2.3.

### **3.6 De-registration time for up to 10 Functional Numbers (mobile originated)**

<b>Reference to</b>	<b>EIRENE FRS</b>	<b>EIRENE SRS</b>	<b>other</b>
	11.3.3.3 (MI)		

#### **3.6.1 Definition:**

De-registration time for up to ten Functional Numbers of Cab radio, originated by Mobile Station.

#### **3.6.2 Pre-conditions for measurement:**

De-registration time is applicable for functional number(s) within GSM-R network.

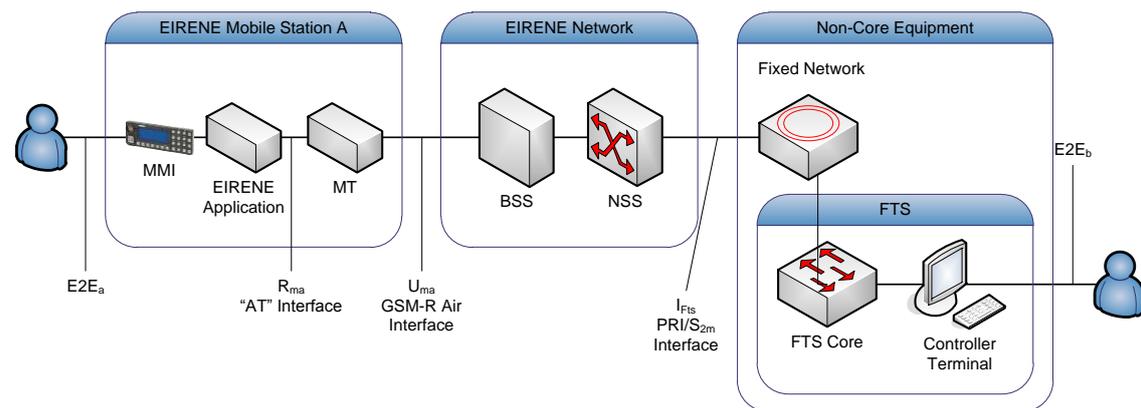
The Mobile Station (Cab Radio) shall support de-registration of up to 10 Functional numbers.

The Functional Numbers to be de-registered are available in the GSM-R network and registered to the MSISDN of the SIM card in the Cab Radio.

The Terminal is attached to the GSM-R network and is in Idle mode.

Tests should be performed with ten FN's.

### 3.6.3 For measurement:



#### 3.6.3.1 End-to-end

For the measurement between interface E2E<sub>a</sub> and E2E<sub>a</sub> the follow script applies:

Time between pressing the SEND button (for de-registration of functional numbers) of the tested Mobile Station until the visible confirmation on the MMI of the tested Mobile Station A.

This can be adapted by:

E2E<sub>a</sub> - E2E<sub>a</sub>:

Time between pressing the SEND button of the tested Mobile Station A until the visible confirmation on the MMI of the tested Mobile Station A.

#### 3.6.3.2 Network only

For the measurement between interface U<sub>ma</sub> and U<sub>ma</sub> the follow script applies:

Time between the CHANNEL REQUEST, used for triggering the Follow-Me service to de-register the first Functional Number message of Mobile Station A, until the reception of the last message sent by network containing the Follow-Me response of the successful de-registration of the last Functional Number.

Note 1: De-registration of functional numbers uses the Follow-Me Service based on USSD. In result of successful de-registration attempt the Follow-Me response (sent by the network) contains a specific result code indicating successful de-registration of the Functional Number.

### 3.6.4 Success criteria:

It shall be possible to deregister 10 functional numbers within a time as specified in EIRENE FRS requirement 11.3.2.3.

## **4 ACCEPTANCE TEST SPECIFICATION OF PARAMETERS RELATED TO (M) EIRENE QoS REQUIREMENTS**

*Not applicable for (MI) EIRENE QoS REQUIREMENTS  
To be defined in a later version of this document*

## **5 ACCEPTANCE TEST SPECIFICATION OF PARAMETERS RELATED TO OPTIONAL EIRENE AND OTHER QoS REQUIREMENTS**

*Not applicable for (MI) EIRENE QoS REQUIREMENTS  
To be defined in a later version of this document*

## **6 MONITORING OF QUALITY OF SERVICE DURING OPERATION**

*To be defined in a later version of this document*

## 7 ANNEXES

### 7.1 EIRENE (MI) requirements relevant for QoS and (directly) related (M) and (I) requirements

EIRENE FRS	Relevant for the QoS for Voice test spec?
3.4.1	Yes
3.4.1i	Yes
3.4.2	Yes
3.4.3	Yes
3.4.4	Yes
5.2.2.20	No
11.3.2.3	Yes
11.3.3.3	Yes
13.2.2.3	No
13.2.2.3ii	No
13.2.2.4	No

EIRENE SRS	Relevant for the QoS for Voice test spec?
3.4.2	Yes
3.4.3	Yes
3.4.3i	Yes
3.4.5	Yes
4.3.5	No
4.4.3	No
5.5.28	Yes
5.5.29	Yes
7.3.11	Yes
7A.3.10	Yes

## 7.2 Recommendation of the minimum sample sizes for QoS for voice parameter validation.

### Sample size (theoretical background)

From a statistical perspective, all QoS voice parameters in this document can be described by a mean  $\mu$ , a standard deviation  $\sigma$  and some kind of statistical distribution (not necessarily a normal distribution). Since the true standard deviation  $\sigma$  is not known, the Student t distribution is used to statistically model these QoS parameters. The standard deviation  $\sigma$  is then replaced by the standard deviation of the sample  $s$ . One of the properties of the t distribution is the degree of freedom (df). The degree of freedom corresponds with the sample size (i.e.  $df = n - 1$ ). The t distribution approaches the standard normal distribution with increasing df.

The confidence interval is denoted as:

$$\bar{x} \pm t^* \cdot \frac{s}{\sqrt{n}} \quad (1)$$

Where:

$\bar{x}$  = is the sample mean (best estimate of the population mean  $\mu$ )  
s = standard deviation of the sample  
n = sample size  
t\* = t-parameter ( $df = n - 1$ )

Note that t\* depends on n.

For a two-sided interval with a confidence level of 99%,  $t^* = 2.66$  ( $n=60$ ), 95%,  $t^* = 2$  ( $n=60$ ), for a two-sided interval with a confidence level of 90%  $t^* = 1.67$  ( $n=60$ ).

### Sample size proposal

Rather good reproducibility is achieved if we choose n such that  $\bar{x}$  does not deviate more than a small percentage from one measurement campaign to another with a high confidence level. Using (1) and making a choice for a deviation of  $\bar{x}$  of 10% results in:

$$0.1\bar{x} = t^* \cdot \frac{s}{\sqrt{n}} \quad (2)$$

$$\text{Solving for n yields: } n = \left( \frac{st^*}{0.1\bar{x}} \right)^2 \quad (3)$$

Measurements in the Netherlands have shown that  $s/\bar{x}$  is much smaller than 0.5 for all parameters (i.e. CED, TD and NRD). Taking a worst case value of  $s/\bar{x} = 0.5$ , a confidence level of 95% (two sided confidence interval), and applying equation (3) results approximately in  $n = 200$  (for 99%  $n=177$ ). This sample size is sufficient for all QoS Voice parameters listed in this document.

- End of document -