REFERENCE O-2875-2.0.0	
Company / organisation	**UIC ERTMS/GSM-R Operators Group** **GSM-R Industry Group**

ERTMS/GSM-R Quality of Service Test Specification for EIRENE QoS requirements

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	NAME	**DATE**	**VISA**
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Review	ERTMS/GSM-R Operators Group GSM-R Industry Group	21 November 2017	E. Van Bommel J. Williams
Approval	ERTMS/GSM-R ERIG ROC IG	22 November 2017	R.Sarfati A. Ende

EVOLUTION SHEET

Version	Date	Author	Modification
0.1	3 April 2007	QoS Working Group	First draft version, based on a QoS Voice Working document O-8007 created by GSM-R QoS Working Group
0.11	16 April 2007	QoS Working Group	Mandatory & Optional requirements from O-8007 changed to new format
0.2	06 June 2007	QoS Working Group	Updates in ch 1-3 Ch 4 added.
0.21	26 March 2009	QoS Working Group	Working version for E2E/Network only discussion. Send delay and receive delay added
0.22	4 September 2011	QoS Working Group	Recommendation for continuous NCH monitoring included
0.3	25 January 2012	QoS Working Group	Update of end-to-end tests for call setup, not finalized items are indicated as t.b.d.
0.4	1 December 2012	QoS Working Group	New setup of O-2875 with focus on EIRENE (MI) requirements based on comments to O-2875-0.3 from OG (O-3133) and from TIG (O-3148)
0.41	23 January 2012	QoS Working Group	Working version for discussion within GSM-R QoS Working Group
0.42	18 February 2013	QoS Working Group	Update after review by QoS Working Group
0.5	5 March 2013	QoS Working Group	Review version for OG and TIG
0.6	12 April 2013	GSM-R TIG/Ola Bergman	Suggested modifications following virtual meeting 4 April 2013 and review
0.7	23 April 2013	QoS WG meeting	Results of QoS WG review
0.8	16 May 2013	GSM-R TIG/Ola Bergman	Modifications agreed in QoS WG meeting 23 April 2013
0.9	16 May 2013	QoS WG meeting 16 May	Results of QoS WG review integrated
0.10	20 June 2013	QoS WG meeting 20 June	Results of QoS WG review integrated
0.11	20 June 2013	QoS WG Erik van Bommel	Consistency and lay out check
0.12	3 July 2013	QoS WG Erik van Bommel	Results Telco with OG and TIG
0.13	12 July 2013	QoS WG Erik van Bommel	2.4: samples size added, 3.1.2, 3.3.2 and 3.3.3 textual changed, 7.2 recommendation added.

0.14	05 Sept. 2013	R.Sarfati	Corrections proposals.
0.15	08 Oct. 2013	OG	Corrections made in OG#53
0.16	18 Feb. 2014	QoS WG Erik van Bommel	Corrections made by WG
0.17	.. Feb 2015	GSM-R IG Ola B, Erich S, Alex E	Modification proposal
0.18	6 March 2015	GSM-R IG Ola B, Markus M, Philippe M	Following discussions in IG#55 and thereafter
0.19	6 March 2015	GSM-R IG	Complete document with track changes from 0.16
0.20	28 April 2015	QoS WG Erik van Bommel	Processing of review of TIG, Bodo Wendler and Bernd Kampschulte by WG and corrections made
0.21	26 May 2015	UIC	Clerical changes
0.22	4 June 2015	UIC-OG	Review by OG#57
0.23	9 June 2015	Update after telco with UIC-OG QoS for VOICE-WG, TIG and ERA.	⇨ Alignment with CR9175-2.0 and 9115-1.2 ⇨ Clarification in chapter 1.1 of purpose of the document. ⇨ Adaption of Test case description based on the MORANE approach and the ”practical” approach
0.24	26 June 2015	UIC-OG	Update after review from: ⇨ Ola Bergman, TIG member ⇨ Bodo Wendler, QoS WG member ⇨ Klaus Dieter Masur, OG member ⇨ Bernd Kampschulte, DB
0.25	30 June 2015	UIC-OG	Minor updates from: Klaus Dieter Masur, OG member
0.26	3 July 2015	UIC-OG	⇨ Minor updates from Robert Sarfati, OG chair. ⇨ Cleaned up by deleting comments already approved and incorporated by TIG (Ola Bergman)
0.27	15 July 2015	Conference Call UIC-IG	⇨ Answered comments raised in all parts of main document.
0.28	27 July 2015	UIC-OG	Update after review comments received from TIG, version ready for discussion in telco with OG and TIG.
0.29	28 July 2015	UIC-OG	Results after telco with OG and TIG. Version for final approval by TIG.

0.30	9 Sept 2015	UIC-OG	Results after telco with OG and TIG. Version for final approval by OG and TIG.
0.31	24 Sept 2015	UIC-OG	Comments received from TIG, first respons from OG. Version ready for telco within OG.
0.32	28 Sept 2015	UIC-OG	Results from Telco OG.
0.33	12 Oct 2015	UIC-OG	Review of QoS WG
0.34	21 Oct 2015	UIC-OG	Review of QoS WG. Telco with TIG. Version agreed by OG#58.
0.35	28 Oct 2015	UIC-OG	Based on review comments of TIG, a note is added in section 3.
0.36	6 Nov 2015	UIC-OG	Based on review comments of TIG, wording added to the note in section 3.
0.37	22 Nov 2015	UIC-OG	Based on review comments of TIG, wording added to the note in section 3. Adaption of CRs 9115 and 9175 updates.
1.0	25 Nov 2015	UIC	Approved version
1.0.1	31 Oct 2016	UIC-OG	Draft version in order to align to EIRENE 8/16, to cover the following items: • New measurements of cell reselection, based SRS 3.3 and on 3216r3 appended • New handover values (related to SRS 3.3) • New PS requirements for NACC (related to SRS 16.3.3) The following changes are made: • Various changes in chapter 1 and 2 to include packet switching • 4.1-4.4: added test cases
1.0.2	15 Nov 2016	UIC-OG	Update after Telco in WG including TIG and ERA.
1.0.3	2 Feb 2017	UIC-OG	Update after OG#62 and response of TIG.
1.0.4	12 Mar 2017	UIC-OG	Review TIG and response UIC-OG included
1.0.5	14 June 2017	UIC-OG	Changed made during OG#63

1.0.6	12 July 2017	UIC-OG	Review TIG and response UIC-OG included
1.0.7	20 July 2017	UIC-OG	Update by UIC-OG
1.0.8	06 Sept. 2017	UIC	Update by RS/IW
1.0.9	14 Sept. 2017	UIC-OG	Update by UIC-OG
1.1.0	14 Sept. 2017	UIC	Approved version UIC
1.1.1	20 Sept. 2017	UIC	Review TIG and response UIC-OG included Approved version UIC
1.1.2	25 Sept. 2017	UIC	Approved version by UIC-OG and TIG
1.1.3	20 Nov. 2017	UIC	Comments from ERA included Approved version by UIC-OG
1.1.4	22 Nov. 2017	UIC	Approved final version by UIC and IG
2.0.0	23 Nov. 2017	UIC	Version for publication

Table of Contents

1 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide definitions and test specifications for QoS parameters related to EIRENE specifications.

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 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 full test specification for the other (M), (O) and (I) requirements will follow in a later version, some are already covered in this 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.

Complying with the tests in this document will allow:

- ⇨ 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
[6]	[CR 9249]	FN numbers registration deregistration

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
GSS	GPRS Sub System (Packet Switched)
IC	Interoperability Constituents
Ifts	Interface (fixed network)
ISDN	Integrated Services Digital Network
LA	Location Area
LLC	Logical Link Control
M	Mandatory
MI	Mandatory (for) Interoperability in EU
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)
NACC	Network Assisted Cell Change
NSS	Network Sub-system (Circuit Switched)
O	Optional
PS	Packet Switched
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+GSS) 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 and a single GSS 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.

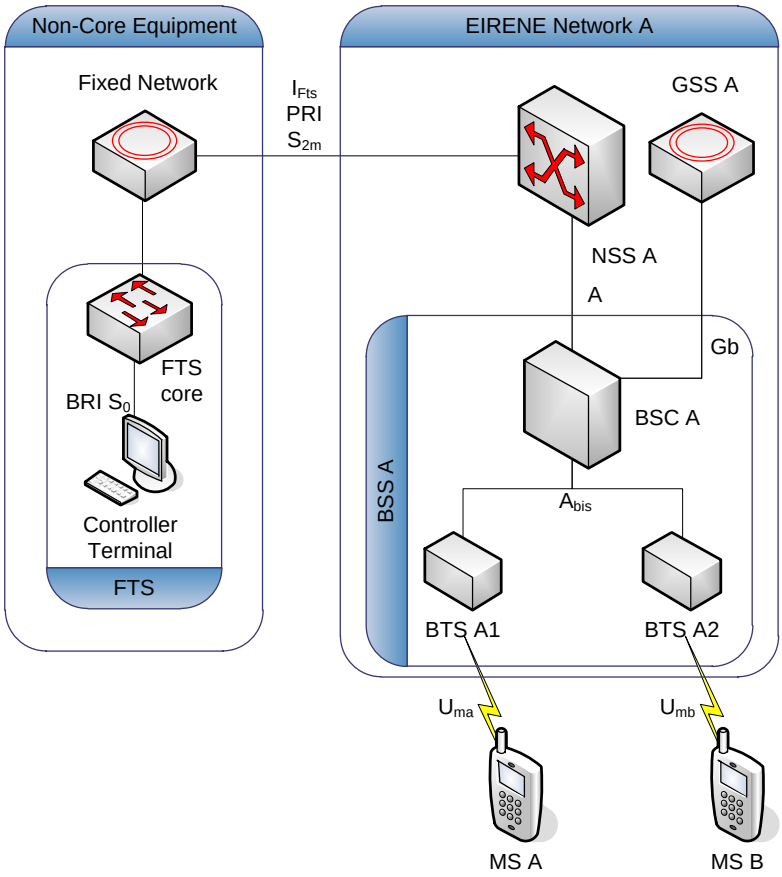

Figure 1a: Reference testing architecture single network

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, MSC or GSS) may be added in a later version of this specification. An example is given in Figure 1b.

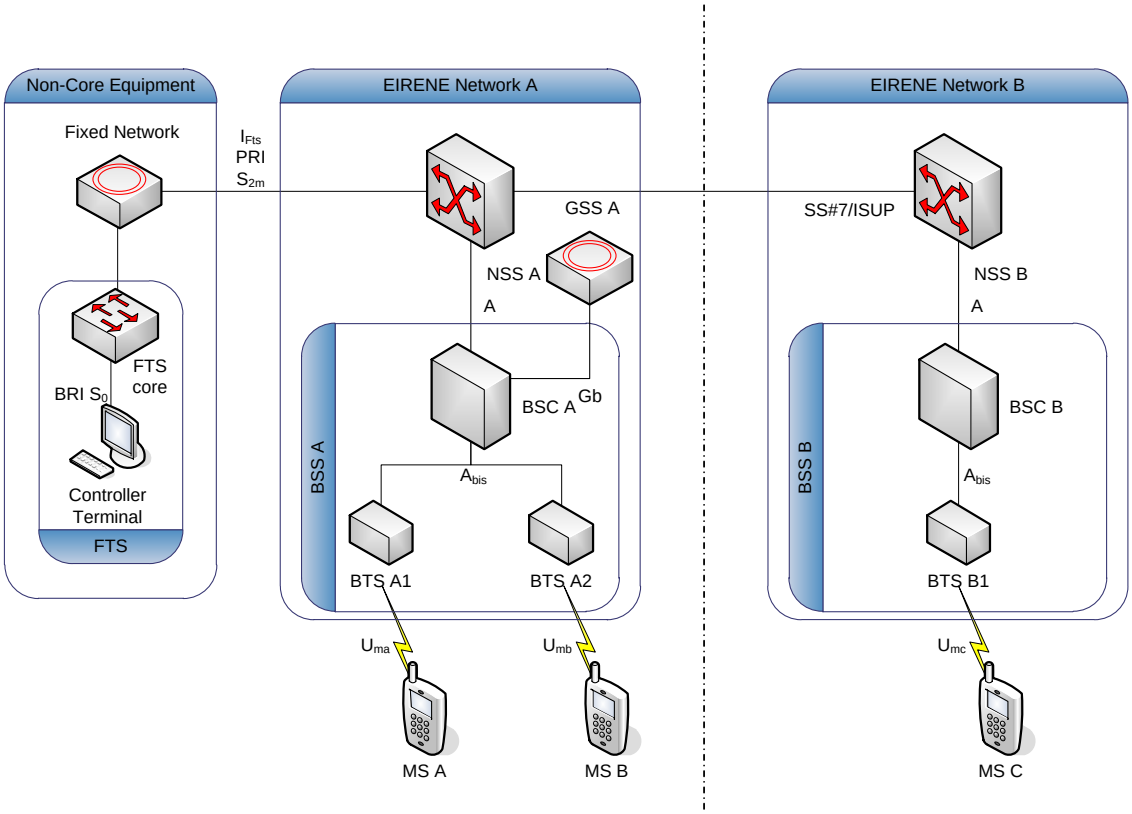

Figure 1b: Reference testing architecture, complex network architecture

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.

For the verification of MI requirements for the network, the tests shall be done in the GSM-R network that is being assessed, after all the provisioning is done and after its configuration is complete: the network under assessment shall be ready to be placed in service.

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 QoS measurement architectures need to be defined for Voice, one for mobile station user to/from FTS user (Figure 2) and another for mobile station user to mobile station user (Figure 3). One QoS measurement architecture needs to be defined for PS (Figure 4). The architectures are consistent with the reference architectures in the EIRENE SRS. The individual measurement points are indicated in the figures.

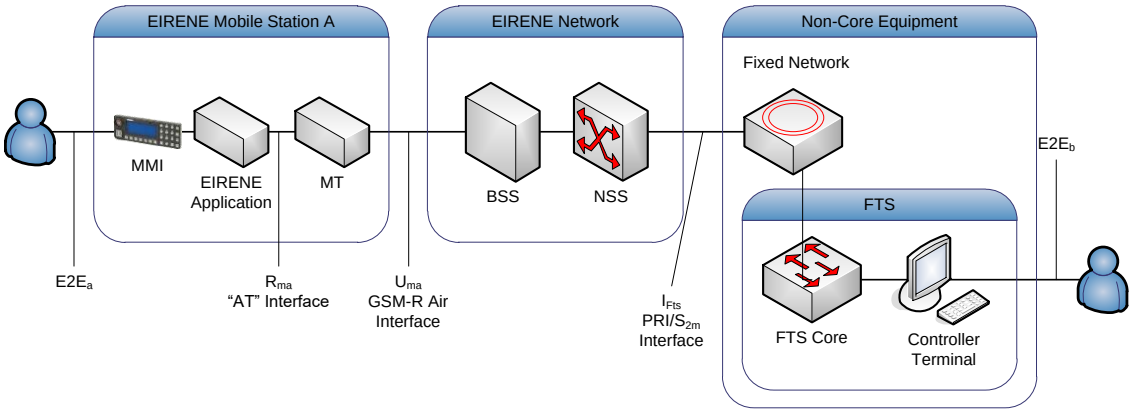

Figure 2: Mobile station user to FTS user measurement architecture

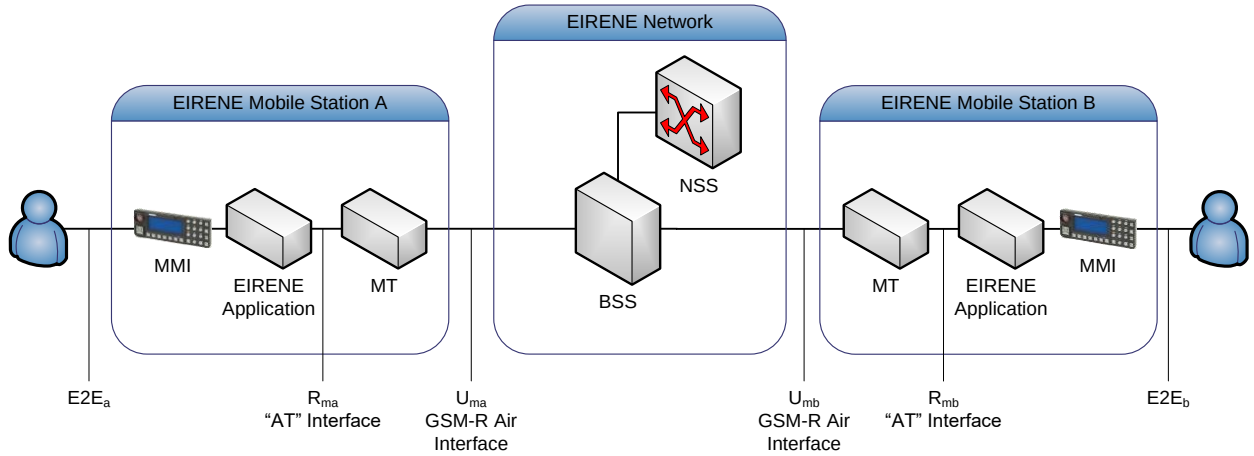

Figure 3: Mobile station user to mobile station user measurement architecture

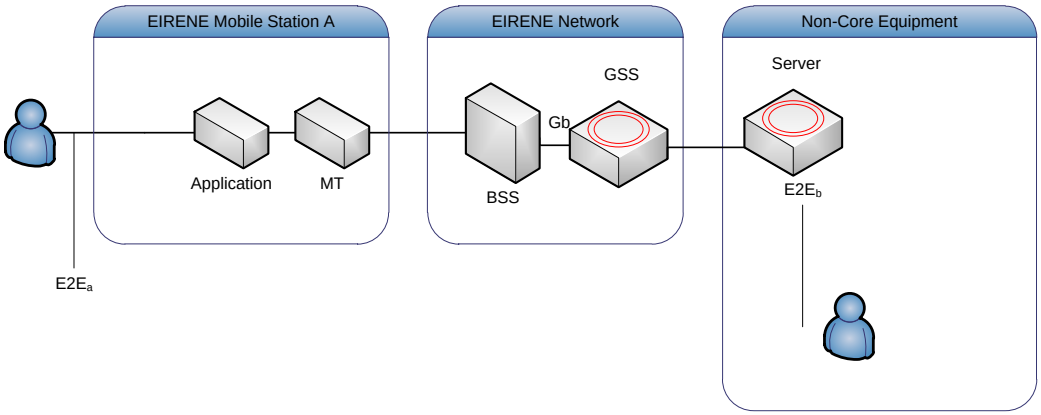

Figure 4: Mobile station user to server measurement architecture

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 used for these specific tests 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.

2.3.5 GPRS sub-system

The GPRS/EGPRS sub-system shall be setup according the EIRENE specifications.

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. For assessment of MI network requirements, the network configuration shall be as set for the network operation and shall not be changed.

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, 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) 3.4.3 (MI) 3.4.4 (MI)	3.4.2 (MI) 3.4.5 (M/MI) 5.5.28 (M) 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:

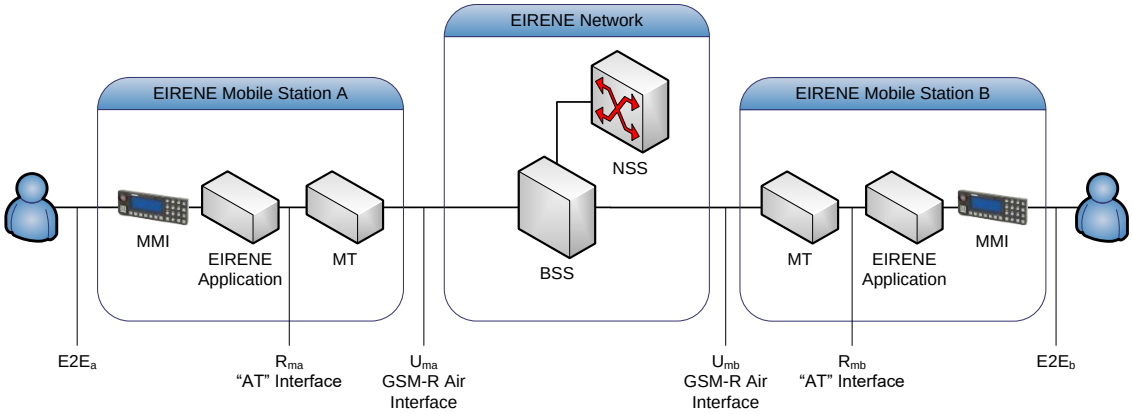

Figure 5: Measurement architecture

3.1.3.1 End-to-end

For the measurement between interface $E2E_a$ and $E2E_b$ 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: $E2E_a$ - R_{ma}:
Time between pressing the REC button of the tested Mobile Station A until the " ATD*17*750#gid;" AT message [R_{ma}-interface of Mobile Station A].

Part 2: R_{ma} – R_{mb}:
Time between the "ATD*17*750#*gid*;" AT message [R_{ma}-interface of originating Mobile Station A] until the NOTIFICATION "+CRING: VGC *gca,gid,0,0"* AT message [R_{mb}-interface of receiving Mobile Station B].

Part 3: R_{mb} - $E2E_b$:
Time between the NOTIFICATION "+CRING: VGC *gca,gid,0,0*" AT message [R_{mb}-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: 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.

3.1.3.2 Network only

For the measurement between interface U_{ma} and U_{mb} 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 $E2E_a$ and U_{ma}, and between interface U_{mb} and $E2E_b$ 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

Reference to	EIRENE FRS	EIRENE SRS	Other
	3.4.1i (M) 3.4.2 (MI) 3.4.3 (MI) 3.4.4 (MI)	3.4.2 (MI) 3.4.3 (I) 3.4.3i (M) 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 to 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:

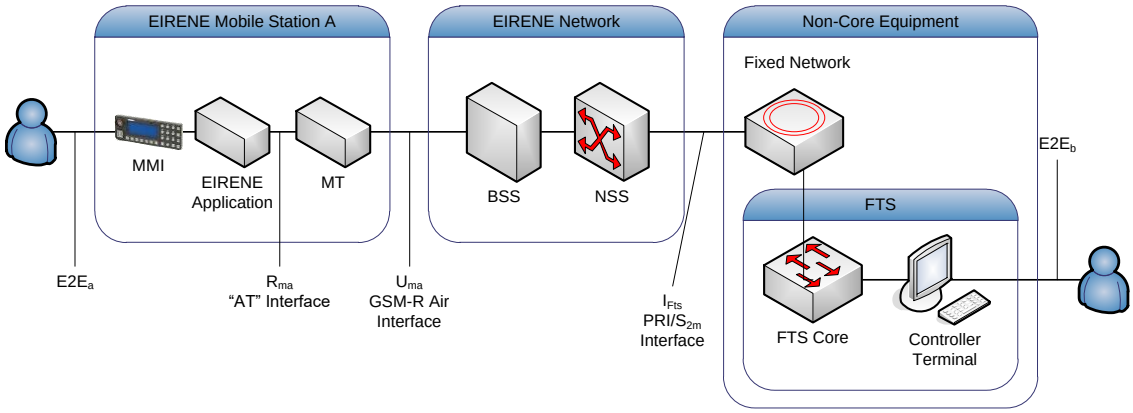

Figure 6: Measurement architecture

3.2.3.1 End-to-end

For the measurement between interface $E2E_a$ and $E2E_b$ 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: $E2E_a$ - R_{ma}:
Time between pressing the REC button of the tested Mobile Station A until the "ATD*17*750#*gid*;" AT message [R_{ma}-interface of Mobile Station A].

Part 2: R_{ma} – I_{FTS}:
Time between the "ATD*17*750#*gid*;" AT message [R_{ma}-interface of originating Mobile Station A] until the SETUP message at the I_{FTS} interface (PRI/S_{2M}).

Part 3: I_{FTS} - $E2E_b$:
Time between the SETUP message at the I_{FTS} interface (PRI/S_{2M}) 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_{ma} and I_{FTS} the follow script applies:

Time between the CHANNEL REQUEST message of Mobile Station A until the SETUP message at the I_{FTS} interface (PRI/S_{2M}).

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_{FTS} and $E2E_b$ the follow script applies:

Time between the SETUP message at the I_{FTS} interface (PRI/S_{2M}) 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 $E2E_a$ and U_{ma} 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

Reference to	EIRENE FRS	EIRENE SRS	Other
	3.4.1i (M) 3.4.2 (MI) 3.4.3 (MI) 3.4.4 (MI)	3.4.2 (MI) 3.4.3 (I) 3.4.3i (M) 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 to 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:

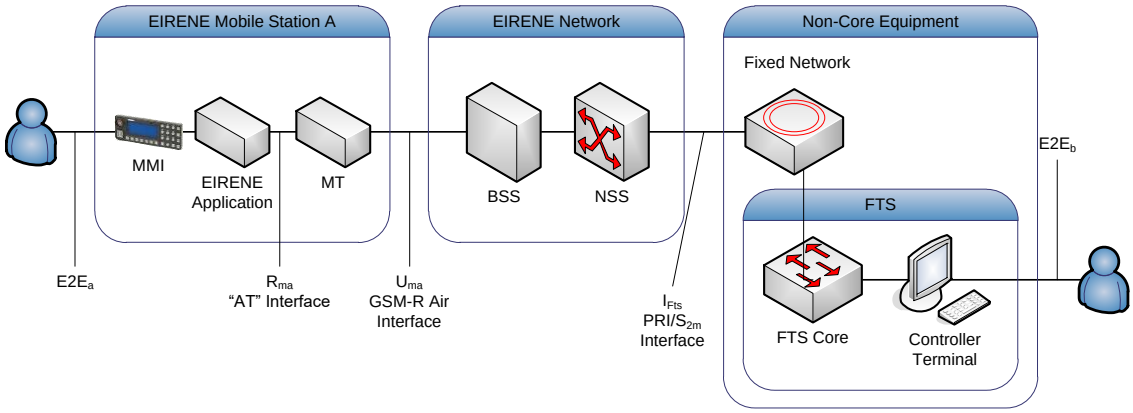

Figure 7: Measurement architecture

3.3.3.1 End-to-end

For the measurement between interface $E2E_b$ and $E2E_a$ 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: $E2E_b$ - I_{FTS}:
Time between pressing the REC button at the originating Controller Terminal until the SETUP message at the I_{FTS} interface (PRI/S_{2M}).

Part 2: I_{FTS} - R_{ma}:
Time between the SETUP message at the I_{FTS} interface (PRI/S_{2M}) until the NOTIFICATION "+CRING: VGC *gca,gid,0,0"* AT message [R_{ma}-interface of receiving Mobile Station A].

Part 3: R_{ma} - $E2E_a$:
Time between the NOTIFICATION "+CRING: VGC *gca,gid,0,0*" AT message [R_{ma}-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_{FTS} and U_{ma} the follow script applies:

Time between the SETUP message at the I_{FTS} interface (PRI/S_{2M}) 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_{FTS} interface (PRI/S_{2M}) can be used as end trigger point.

3.3.3.3 External network & Controller equipment

For the measurement between interface $E2E_b$ and I_{FTS} the follow script applies:

Time between pressing the REC button at the terminating Controller Terminal until the SETUP message at the I_{FTS} interface (PRI/S_{2M}).

3.3.3.4 Mobile station only

For the measurement between interface $E2E_a$ and U_{ma} 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)

Reference to	EIRENE FRS	EIRENE SRS	Other
	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:

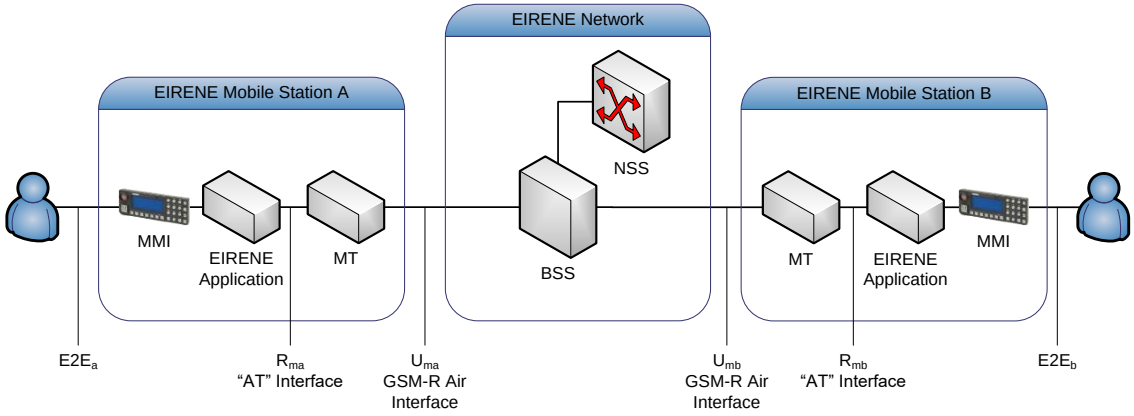

Figure 8: Measurement architecture

3.4.3.1 End-to-end

For the measurement between interface $E2E_a$ and $E2E_b$ 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: $E2E_a$ - R_{ma}:
Time between pressing the SEND button of the tested Mobile Station A until the " ATD*17*752#*gid*;" AT message [R_{ma}-interface of Mobile Station A].

Part 2: R_{ma} – R_{mb}:
Time between the "ATD*17*752#*gid*;" AT message [R_{ma}-interface of originating Mobile Station A] until the NOTIFICATION "+CRING: VGC *gca,gid,0,2"* AT message [R_{mb}-interface of receiving Mobile Station B].

Part 3: R_{mb} - $E2E_b$:
Time between the NOTIFICATION "+CRING: VGC *gca,gid,0,2*" AT message [R_{mb}-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_{ma} and U_{mb} 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 $E2E_a$ and U_{ma}, and between interface U_{mb} and $E2E_b$ 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_{ma}-interface of Mobile Station A].

Terminating Mobile station (B) delay:
Time between the NOTIFICATION "+CRING: VGC *gca,gid,0,2*" AT message [R_{mb}-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 5 Functional Numbers (mobile originated)

Reference to	EIRENE FRS	EIRENE SRS	other
	11.3.2.3(MI) & CR 9249 (MI)[1]		

3.5.1 Definition:

Registration time for five 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 5 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 five FN's.

Only successful Registration attempts should be considered.

[1] See [CR 9249]

3.5.3 For measurement:

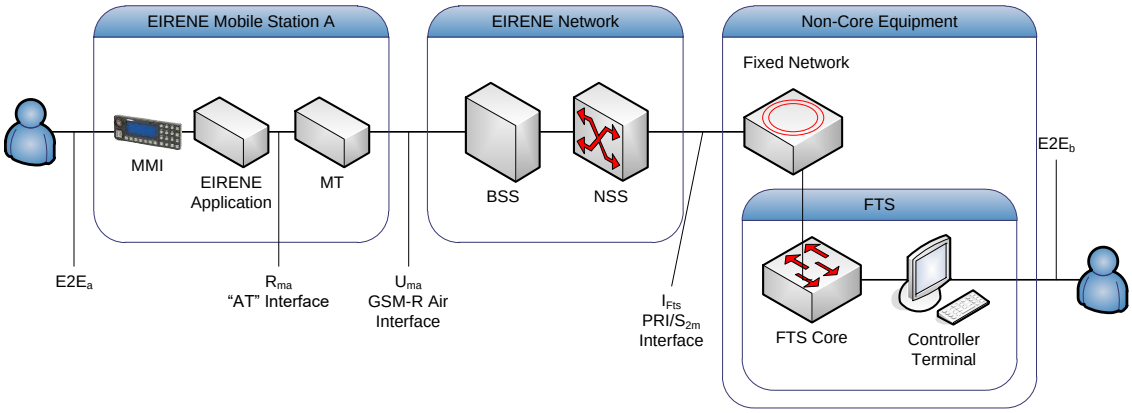

Figure 9: Measurement architecture

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 5 functional numbers within a time as specified in EIRENE FRS requirement 11.3.2.3.

3.6 De-registration time for 5 Functional Numbers (mobile originated)

Reference to	EIRENE FRS	EIRENE SRS	other
	11.3.3.3 (MI) & CR 9249 (MI)[2]		

3.6.1 Definition:

De-registration time for five 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 5 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 five FN's.

[2] See [CR 9249]

3.6.3 For measurement:

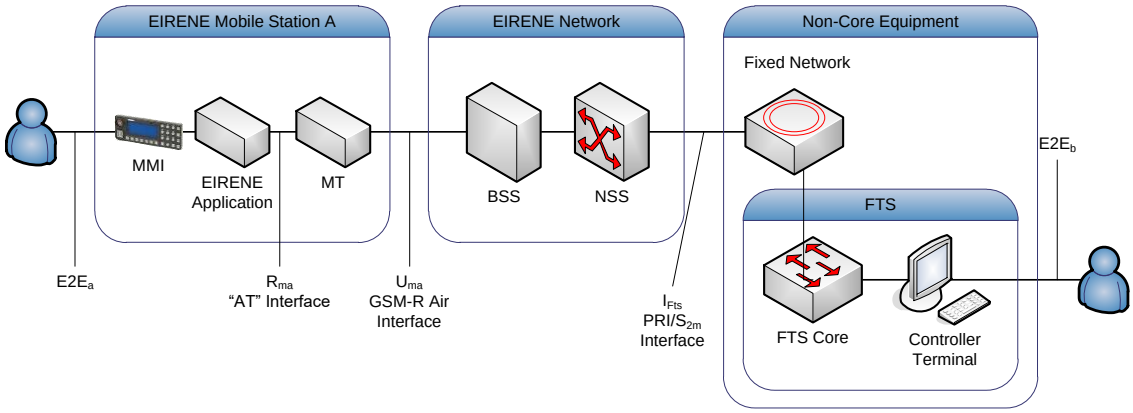

Figure 10: Measurement architecture

3.6.3.1 End-to-end

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

Time between pressing the SEND button (for 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:

$E2E_a$ - $E2E_a$:
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.

3.6.3.2 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 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 5 functional numbers within a time as specified in EIRENE FRS requirement 11.3.3.3.

4 ACCEPTANCE TEST SPECIFICATION OF PARAMETERS RELATED TO (M) EIRENE QOS REQUIREMENTS

This chapter describes QoS parameters for Voice, which are related to mandatory (M) requirements in [EIRENE FRS] and [EIRENE SRS] including the O and I related requirements to the (M)requirements.

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.

4.1 Handover time in dedicated mode (voice call)

Reference to	**EIRENE FRS**	**EIRENE SRS**	**Other**
		3.3.4 (M)	

4.1.1 Definition:

Handover time in dedicated mode, for voice calls.

4.1.2 Pre-conditions for measurement:

Handover time in dedicated mode, (voice calls) is applicable in any point to point voice call within the GSM-R network.

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

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

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

Only successfully established handovers shall be measured.

4.1.3 For measurement:

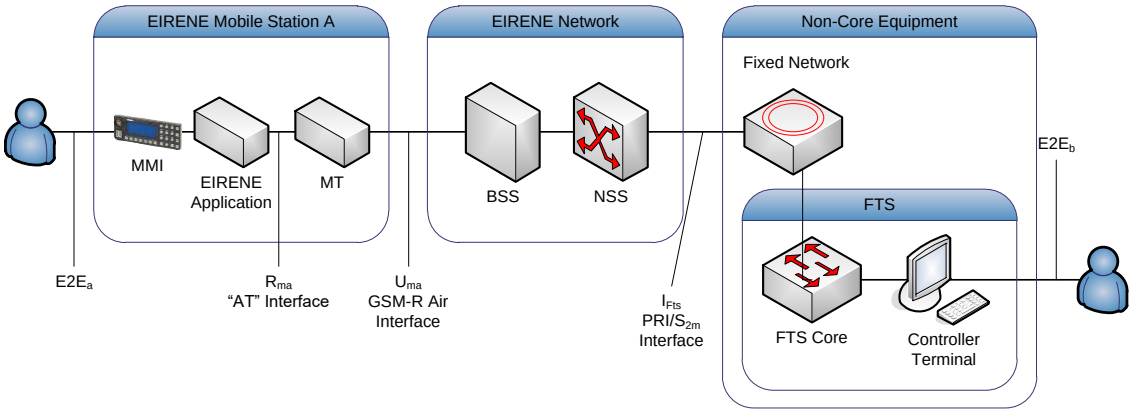

Figure 11: Measurement architecture

4.1.3.1 Network only

For the measurement the interface U_{ma} is used and the follow script applies:
Time between the HANDOVER COMMAND message to Mobile Station A until the HANDOVER COMPLETE message of Mobile Station A.

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

4.1.4 Success criteria:

- The handover time in dedicated mode (voice call) shall be as specified in EIRENE SRS requirement 3.3.4

4.2 Loss of speech due to cell reselection in group receive mode without SI10bis/ter support

Reference to	EIRENE FRS	EIRENE SRS	Other
		3.3.7 (M)	

4.2.1 Definition:

Cell reselection time in group receive mode without SI10bis/ter support.

4.2.2 Pre-conditions for measurement:

Cell reselection time in group receive mode is applicable for any group call (VGCS / VBS) within the GSM-R network.

This test case is only applicable in an intra-BSC case and the corresponding Location Area.

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

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

Mobile Station is attached to the GSM-R network, is in group receive mode and is located in the service area. SI10bis/ter is not supported in the network and the Mobile Station

Fixed Controller and Mobile Station (including GSM-R SIM) are configured to support the group call.
The GSM-R Network is configured with at least one service area for the group call. For the service areas the Fixed Controller is registered to terminate the group call.

Only successfully cell reselections shall be measured.

4.2.3 For measurement:

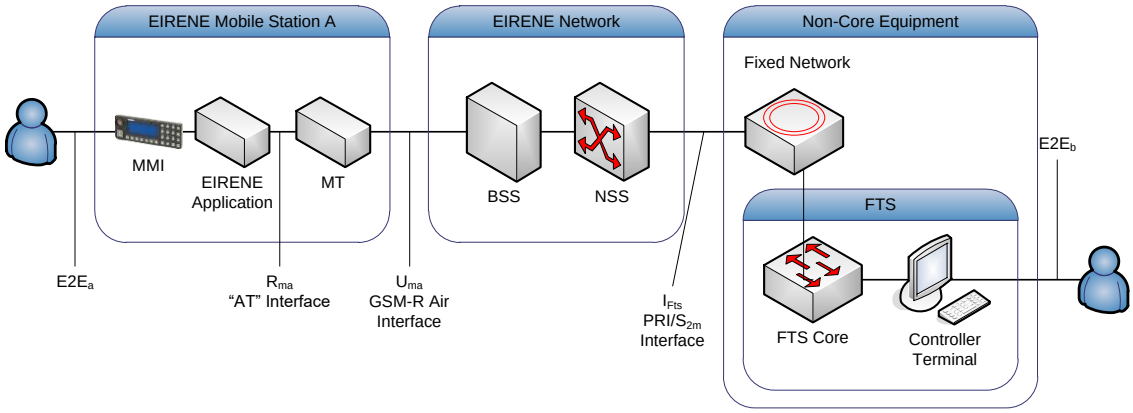

Figure 12: Measurement architecture

4.2.3.1 End-to-end

For the measurement the interface $E2E_a$ is used and the follow script applies:

Time between the start of loss of speech until the return of speech during a cell reselection within the same GCA measured at the Mobile Station A.

This can be adapted by:
At the FTS or a second Mobile Station a continuous speech equivalent tone is generated. This tone is measured at the Mobile Station. The duration of no received speech is applicable for this measurement.

4.2.4 Success criteria:

- Loss of speech as specified in EIRENE SRS requirement 3.3.7

4.3 Loss of speech due to cell reselection in group receive mode with SI10bis/ter support

Reference to	EIRENE FRS	EIRENE SRS	Other
		3.3.10 (M)	

4.3.1 Definition:

Cell reselection time in group receive mode with SI10bis/ter support.

4.3.2 Pre-conditions for measurement:

Cell reselection time in group receive mode is applicable for any group call (VGCS / VBS) within the GSM-R network.

This test case is only applicable in an intra-BSC case and one Location Area.

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

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

Mobile Station is attached to the GSM-R network, is in group receive mode and is located in the service area. SI10bis/ter is supported in the network and the Mobile Station

Fixed Controller and Mobile Station (including GSM-R SIM) are configured to support the group call.

The GSM-R Network is configured with at least one service area for the group call. For the service areas the Fixed Controller is registered to terminate the group call.

Only successfully cell reselections shall be measured.

4.3.3 For measurement:

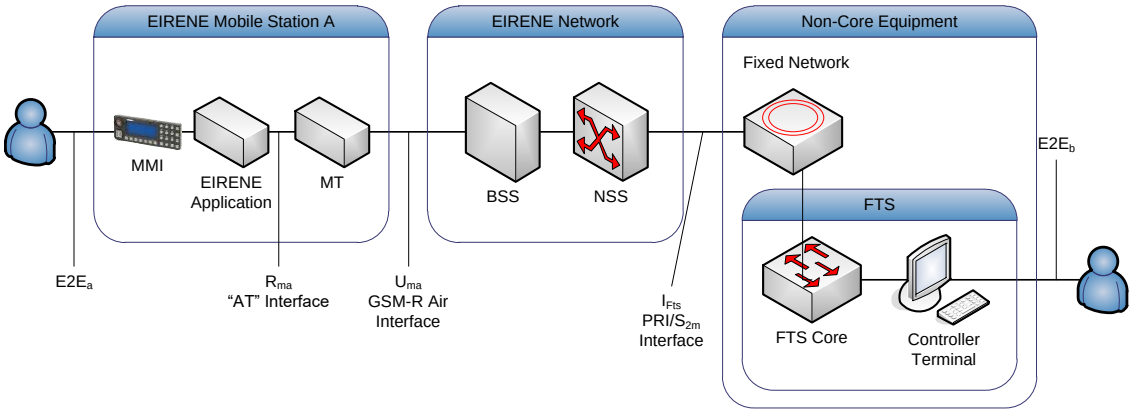

Figure 13: Measurement architecture

4.3.3.1 End-to-end

For the measurement the interface E2E$_a$ is used and the follow script applies:

Time between the start of loss of speech until the return of speech during a cell reselection within the same GCA measured at the Mobile Station A.

This can be adapted by:
At the FTS or a second Mobile Station a continuous speech equivalent tone is generated. This tone is measured at the Mobile Station. The duration of no received speech is applicable for this measurement.

4.3.4 Success criteria:

- Loss of speech as specified in EIRENE SRS requirement 3.3.10

4.4 Discontinuation time of the data flow using GPRS/EGPRS bearer service at cell change

Reference to	EIRENE FRS	EIRENE SRS	Other
		16.3.3vi (M) Applicable if [EIRENE SRS] 2.11.3 is implemented in the network.	

4.4.1 Definition:

The measurement of the discontinuation time of the data flow using GPRS/EGPRS bearer service at cell change is to be fulfilled if option ETCS over GPRS is implemented in the network.

.

4.4.2 Pre-conditions for measurement:

The measurement of the discontinuation time of the data flow using GPRS/EGPRS bearer service at cell change is applicable for user of the packet switched service within GSM-R network.

Every 100 ms one uplink UDP frame is sent, having 40 bytes payload.

Note: Adding IP/SNDCP/LLC header, the data rate will be 6.2 kbps, equivalent to CS1 PDTCH throughput.

One Mobile Station is used in this test.

The Mobile Station is attached to the GSM-R network, is in PDP_ACTIVE state and is located in the service area. NACC is activated in the network.

The Mobile Station (including GSM-R SIM) is configured to support the GPRS/EGPRS service.

4.4.3 For measurement:

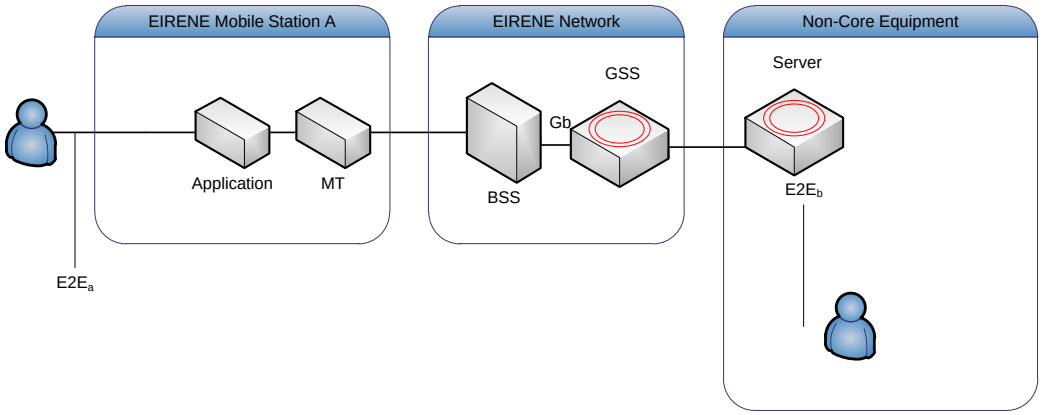

Figure 14: Measurement architecture

4.4.3.1 End-to-end

For the measurement between interface $E2E_a$ and $E2E_b$ the follow script applies:

Time between “start of cell change” and “end of cell change”. These relevant messages are gathered from the Gb interface. Based on figure 5, it is the time between T3 and T1bis.

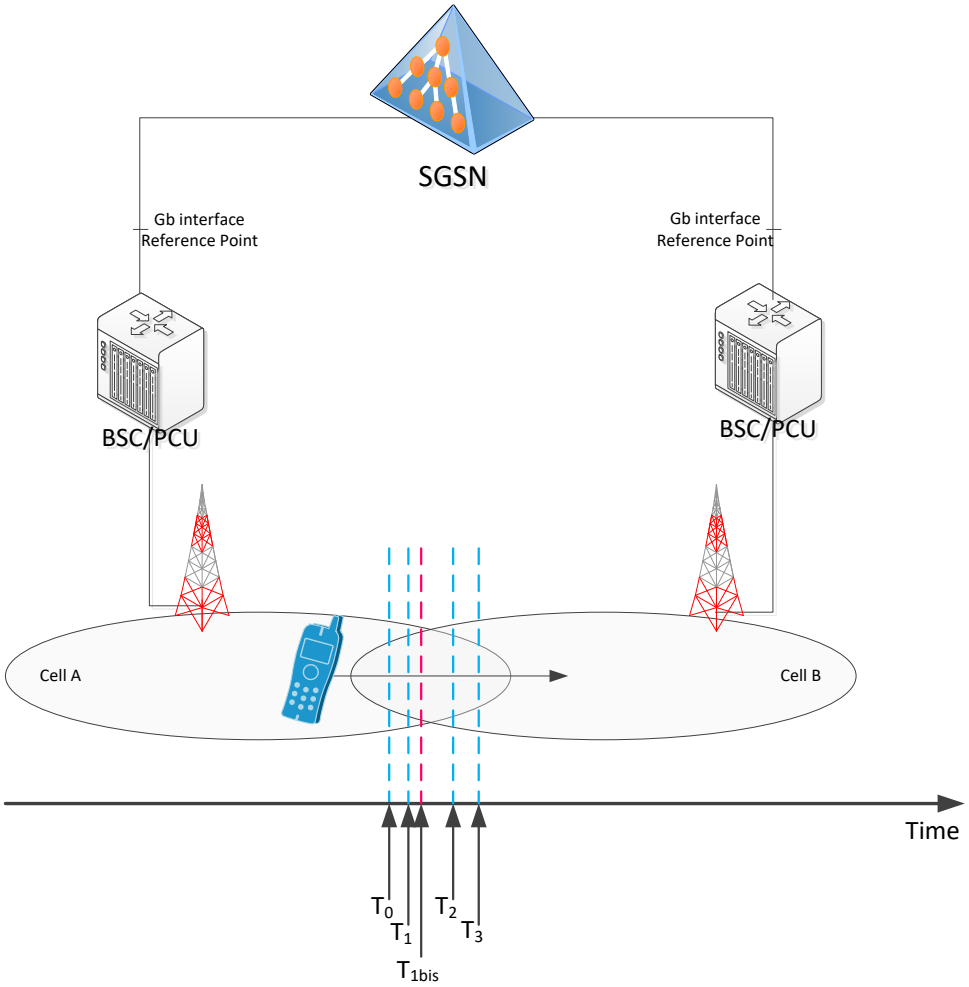

Figure 15: Time between “start of cell change” and “end of cell change”

T_0: mobile algorithm decides that Cell B must be reselected and starts cell reselection procedure

T_1: NACC procedure is completed in Cell A and mobile stops transmitting/listening in Cell A and reselects to Cell B (cell reselection)

T_{1bis}: the last uplink LLC frame is received on Gb for Cell A

T_2: mobile is on cell B and starts establishing TBFs

T_3: the first uplink LLC frame is received on Gb interface for Cell B

4.4.4 Success criteria:

- Discontinuation time of the data flow using GPRS/EGPRS bearer service at cell change as specified in EIRENE SRS requirement 16.3.3vi

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 EIRENE (M) requirements relevant for QoS

EIRENE SRS	Relevant for the QoS for Voice/PS test spec?
3.3.4	Yes
3.3.7	Yes

7.3 EIRENE (M) requirements relevant for QoS, if option is implemented

EIRENE SRS	Relevant for the QoS for Voice/PS test spec?
3.3.10	Yes
16.3.3vi	Yes

7.4 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 μ, a standard deviation σ and some kind of statistical distribution (not necessarily a normal distribution). Since the true standard deviation σ is not known, the Student t distribution is used to statistically model these QoS parameters. The standard deviation σ 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:

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

Where:

$\bar{x}$ =	is the sample mean (best estimate of the population mean μ)
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:

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

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