ERTMS/ETCS – Class 1

GSM-R Interfaces
Class 1 Requirements

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2.3.0 (10-Oct-05)	update for issue		JH

2. TABLE OF CONTENTS

3. REFERENCES

3.1 Normative Documents

3.1.1.1 This document list incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this document only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to apply.

Reference	Date	Title
U-SRS	02.02	ERTMS/ETCS Class 1; Subset 026; Unisig SRS, version 2.2.2
Subset 037	07.03	ERTMS/ETCS Class 1; Subset 037; EuroRadio FIS; Class1 requirements, version 2.2.5
EIRENE FRS	10.03	UIC Project EIRENE; Functional Requirements Specification. Version 6.0, CLA111D003
EIRENE SRS	10.03	UIC Project EIRENE; System Requirements Specification. Version 14.0, CLA111D004
ETS 300011	1992	ISDN; Primary rate user-network interface; Layer 1 specification and test principles
ETS 300102-1	1990	ISDN; User-network interface layer 3; Specification for basic call control
ETS 300125	1991	ISDN; User-network interface data link layer specifications
GSM04.21	12.00	Rate Adaptation on the MS-BSS Interface, v.8.3.0
GSM 07.07	11.98	ETSI TS 100916; Digital cellular telecommunications system (Phase 2+); AT command set for GSM Mobile Equipment (ME), GSM TS 07.07 version 6.5.0 Release 1997
ITU-T V.24	02.00	List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)
ITU-T V.25ter	07/97	Serial asynchronous dialling and control
ITU-T V.110	02.00	Support of data terminal equipments (DTEs) with V-series type interfaces by an integrated services digital network (ISDN)
EuroRadio FFFIS	09.03	UIC ERTMS/GSM-R Unisig; Euroradio Interface Group; Radio Transmission FFFIS for Euroradio; A11T6001; version 12
O-2475	09.03	UIC ERTMS/GSM-R Operators Group; ERTMS/GSM-R Quality of Service Test Specification; O-2475; version 1.0

3.2 Informative Documents

Reference	Date	Title
EEIG 04E117	12.04	ETCS/GSM-R Quality of Service - Operational Analysis, v 0.q(draft)
ERQoS	08.04	GSM-R QoS Impact on EuroRadio and ETCS application, Unisig_ALS_ERQoS, v.010

4. TERMS AND DEFINITIONS

4.1 Abbreviations

AT	ATtention command set
ATD	AT command Dial
B channel	User channel of ISDN
B_m channel	User channel of GSM PLMN on the air interface
BRI	Basic Rate Interface
Byte	1 start bit + 8 data bits + 1 stop bit
DCE	Data Circuit Equipment
DCD	Data Carrier Detect
D channel	Control channel of ISDN
D_m channel	Control channel of GSM PLMN on the air interface
DTE	Data Terminal Equipment
eMLPP	enhanced Multi-Level Precedence and Pre-emption
FIS	Functional Interface Specification
GPRS	General Packet Radio Service (a phase 2+ GSM service)
GSM-R	Global System for Mobile communication/Railway
HDLC	High level Data Link Control
ISDN	Integrated Services Digital Network
MLPP	Multi-Level Precedence and Pre-emption (ISDN service)
MOC	Mobile Originated Call
MS	Mobile Station (a GSM entity)
MT	Mobile Termination/Terminated
MTC	Mobile Terminated Call
MTBD	Mean Time Between Disturbance
OBU	On-Board Unit
PLMN	Public Land Mobile Network
PRI	Primary Rate Interface
QoS	Quality of Services
RBC	Radio Block Centre
T_{TI}	Duration of Transmission Interference period
T_{REC}	Duration of Recovery period
UDI	Unrestricted Digital

4.2 Definitions

4.2.1.1 Definitions for the purpose of this specification are inserted in the respective sections.

5. GENERAL

5.1 Scope of this document

5.1.1.1 The scope of this document is to specify the Radio Communication System requirements to the GSM-R network services (including fixed side access) and interfaces and also the pre-requisites to be fulfilled by GSM-R networks and ETCS infrastructures. Presently the requirements for high-speed lines are covered, requirements for conventional lines may be included in future versions of this document.

5.1.1.2 The data transmission part of the communication protocols is fully described in the EuroRadio FIS [Subset 037].

5.1.1.3 The Radio Transmission FFFIS for EuroRadio [EuroRadio FFFIS] specifies the physical, electrical and functional details related to the interfaces.

5.1.1.4 All requirements apply to GSM-R unless indicated otherwise .

5.2 Introduction

5.2.1.1 The definition of the GSM services and associated physical and communication signalling protocols on the air interface are fully standardised in the specifications produced by the ETSI GSM Technical Committee for the public GSM implementation as well as for the GSM-R. Additionally, some railway specific services are also specified in the EIRENE SRS. However, in both cases, not all are required for ERTMS class 1 system definition.

5.2.1.2 The following ETSI GSM phases 1/2/2+ services **are required**:

a) Transparent data bearer service

b) Enhanced multi-level precedence and pre-emption (eMLPP).

5.2.1.3 Other ETSI GSM phases 1/2/2+ services **are not required for Class 1**. These are the following :

a) GSM supplementary services:

- Call forwarding

b) General packet radio service (GPRS)

5.2.1.4 Other ETSI GSM phases 1/2/2+ services **are not required**. Examples of these are the following :

a) Non-transparent data bearer service

b) GSM supplementary services:

- Line identification

- Call waiting and hold
- Multiparty
- Closed User Group
- Advice of charge
- Call Barring

c) Short message service point to point or cell broadcast

d) Voice broadcast service

e) Voice group call service

5.2.1.5 The following EIRENE railway specific service [EIRENE SRS] **is required**:

a) Location dependent addressing

5.2.1.6 The following EIRENE specific services [EIRENE SRS] **are not required** :

a) Functional addressing

b) Enhanced location dependent addressing

c) Calling and connected line presentation of functional identities

d) Emergency calls

e) Shunting mode

f) Multiple driver communications

6. END-TO-END SERVICE REQUIREMENTS TO GSM-R NETWORKS

6.1 Data bearer service requirements

6.1.1.1 For the transmission of information between OBU and RBC, the EuroRadio protocol uses the bearer services of a GSM-R network. The service provider makes these data bearer services available at defined interfaces.

6.1.1.2 The data bearer services are described as data access and transfer in the GSM network from Terminal Equipment (TE) on the mobile side (i.e. OBU) to a network gateway interworking with Public Switched Telephonic Network (PSTN) or Integrated Services Digital Network (ISDN) on the fixed side (i.e. RBC).

6.1.1.3 The following features and attributes of the required bearer service shall be provided:

a) Data transfer in circuit switched mode

b) Data transfer allowing multiple rate data streams which are rate-adapted [GSM04.21] and [ITU-T V.110]

c) Unrestricted Digital Information (UDI) – only supported through ISDN interworking (no analogue modem in the transmission path)

d) Radio channel in full rate

e) Transfer of data only (no alternate speech/data)

f) Transfer in asynchronous transparent mode

g) The required data rates are listed in the following table:

Bearer service	Requirement
24. Asynchronous 2.4 kbps T	O
25. Asynchronous 4.8 kbps T	M
26. Asynchronous 9.6 kbps T	M

T: Transparent; M: Mandatory; O: Optional

Table1 GSM-R bearer services

6.2 Additional services

6.2.1.1 The following supplementary services shall be provided:

a) Enhanced multi-level precedence and pre-emption.

b) The selection of a particular mobile network shall be possible on-demand.

6.2.1.2 The priority value for command control (safety) shall be assigned to according to [EIRENE FRS §10.2] and [EIRENE SRS §10.2].

6.2.1.3 The following railway specific service shall be provided by GSM-R networks:

a) Location dependent addressing based on the use of short dialling codes in conjunction with cell dependent routing.

6.3 Quality of Service requirements

6.3.1 General

6.3.1.1 As an end-to-end bearer service is used, a restriction of requirements on the service quality placed on the air interface is not sufficient.

6.3.1.2 End-to-end quality of service has to be considered at the service access points.

6.3.1.3 The service access points are:

- the service access points to the signalling stack for the establishment or release of a physical connection,
- the service access points to the data channel.

6.3.1.4 The network shall be able to support transparent train-to-trackside and trackside-to-train data communications at speeds up to 500 km/h e.g. in tunnels, cuttings, on elevated structures, at gradients, on bridges and stations.

6.3.1.5 The network shall provide a Quality of Service for ETCS data transfer that is at least as good as listed below[1]. The parameters are valid for one end-to-end connection for one train running under all operational conditions.

6.3.1.6 The required QoS parameters shall not depend on network load.

6.3.1.7 These performance figures reflect railway operational targets [EEIG 04E117].

6.3.1.8 Note: A justification of the performance figures is given by Annex B.

6.3.1.9 QoS requirements are specified independently of the method of measurement (refer to [O-2475] for specification of testing).

6.3.1.10 Conventional line quality of service requirements may be included in future versions of this document. Also the values may not be applied at all locations and times (e.g. discontinuous radio coverage at some locations).

6.3.1.11 Given the performance constraints of GSM-R, pre-conditions may be necessary to meet the railway operational targets of [EEIG 04E117]. If different operational QoS

[1] Early experience suggests that GSM-R performance can be better than these parameters suggest, after network optimisation and tuning.

targets are required, then other pre-conditions on ETCS application may be necessary. Such a case is not covered by this specification and this aspect of ETCS System Performance becomes the responsibility of whoever specifies different operational targets.

6.3.2 Connection establishment delay

6.3.2.1 Connection establishment delay is defined as:

Value of elapsed time between the connection establishment request and the indication of successful connection establishment.

6.3.2.2 In case of mobile originated calls, the delay is defined between the request by command ATD and indication by the later of the two events response CONNECT or transition of DCD to ON.

6.3.2.3 The connection establishment delay of mobile originated calls shall be <8.5s (95%), ≤10s (100%).

6.3.2.4 Delays >10s shall be evaluated as connection establishment errors.

6.3.2.5 The required connection establishment delay shall not depend on user data rate of the asynchronous bearer service.

6.3.2.6 The required connection establishment delay is not valid for location dependent addressing.

6.3.3 Connection establishment error ratio

6.3.3.1 The Connection establishment error ratio is defined as:

Ratio of the number of unsuccessful connection establishment attempts to the total number of connection establishment attempts.

6.3.3.2 “Unsuccessful connection establishment attempt” covers all possible types of connection establishment errors caused by end-to-end bearer service.

6.3.3.3 Connection establishment delays >10s shall be evaluated as connection establishment errors.

6.3.3.4 The GSM-R networks should be designed in such a way, that at least two consecutive connection establishment attempts will be possible (pre-condition on GSM-R networks), e.g. regarding GSM-R radio coverage related to maximal possible train speed.

6.3.3.5 If the operational QoS targets of [EEIG 04E117] are wanted, then the ETCS infrastructure should be designed in such a way, that at least two consecutive connection establishment attempts will be possible (Recommended pre-condition for ETCS infrastructure).

6.3.3.6 The connection establishment error ratio of mobile originated calls shall be $<10^{-2}$ for each attempt .

6.3.3.7 Note: entry into Level 2 is of particular importance; commonly, a time of 40s may be required in the case the GSM-R mobile station is already registered with the GSM-R network (see [ERQoS]).

6.3.4 Transfer delay

6.3.4.1 The end-to-end transfer delay of a user data block is defined as:

Value of elapsed time between the request for transfer of a user data block and the indication of successfully transferred end-to-end user data block

6.3.4.2 The delay is defined between the delivery of the first bit of the user data block at the service access point of transmitting side and the receiving of the last bit of the same user data block at the service access point of the receiving side.

6.3.4.3 The end-to-end transfer delay of a user data block of 30 bytes shall be ≤0.5s (99%).

6.3.5 Connection loss rate

6.3.5.1 The Connection loss rate is defined as:

Number of connections released unintentionally per accumulated connection time.

6.3.5.2 The requirements for connection loss rate varies depending on ETCS system variables such as T_NVCONTACT and the possible train reactions after connection loss (see section 10.5).

6.3.5.3 If the operational QoS-targets of [EEIG 04E117] are wanted, then the ETCS infrastructure should be designed in such a way, that at least the following conditions are fulfilled (Recommended pre-condition for ETCS infrastructure):

- T_NVCONTACT ≥ 41s **and**
- M_NVCONTACT different to train trip **and**
- a new MA reach the OBU before standstill.

6.3.5.4 If the connection establishment error ratio is $<10^{-2}$, then the connection loss rate shall be $<10^{-2}$/h.

6.3.6 Transmission interference

6.3.6.1 A transmission interference period T_{TI} is the period during the data transmission phase of an existing connection in which, caused by the bearer service, no error-free transmission of user data units of 30 bytes is possible.

6.3.6.2 A transmission interference happens, if the received data units of 30 bytes deviate partially or completely from the associated transmitted data units.

6.3.6.3 The transmission interference period shall be < 0.8s (95%), <1s (99%).

6.3.6.4 An error-free period T_{Rec} shall follow every transmission interference period to re-transmit user data units in error (e.g. wrong or lost) and user data units waiting to be served.

6.3.6.5 The error-free period shall be >20s (95%), >7s(99%).

6.3.7 GSM-R network registration delay

6.3.7.1 The GSM-R network registration delay is defined as:

Value of elapsed time from the request for registration to indication of successful registration by +CREG response.

6.3.7.2 The GSM-R network registration delay shall be ≤30s (95%), ≤35s (99%).

6.3.7.3 GSM-R network registration delays > 40 s are evaluated as registration errors.

6.4 Summary of QoS requirements

6.4.1.1 Table 2 contains the summary of QoS requirements at GSM-R interface.

QoS Parameter	Value (see 6.3)
Connection establishment delay of mobile originated calls	< 8.5s (95%), ≤10s (100%)
Connection establishment error ratio	$<10^{-2}$
Maximum end-to-end transfer delay (of 30 byte data block)	≤ 0.5s (99%)
Connection loss rate	≤ 10^{-2} /h
Transmission interference period	< 0.8s (95%), <1s (99%)
Error-free period	>20s (95%), >7s(99%)
Network registration delay	≤30s (95%), ≤35s (99%), ≤40s (100%)

Table 2 Summary of QoS requirements

7. REQUIREMENTS TO FIXED NETWORK INTERFACE

7.1 Foreword

7.1.1.1 This part of the specification does not define mandatory requirements for interoperability. It is a preferred solution, in case interchangeability between trackside RBC and access point to the fixed network is required for a given implementation.

7.1.1.2 This section gives only limited information. [EuroRadio FFFIS] must be used for full compliance.

7.1.1.3 Note: The requirements to fixed network interface refer to a set of ETSI specifications [ETS 300011, ETS 300125, ETS 300102-1]. This set is the basis of conformance requirements for network terminations. Instead of these specifications updated specifications can be referred, if they state that they are compatible with the following requirements.

7.2 Interface definition

7.2.1.1 The ISDN Primary Rate Interface (PRI) shall be provided as specified by [ETS 300011].

7.2.1.2 The service access point on the fixed network side corresponds with the S_{2M} interface at the T-reference point.

7.2.1.3 The Basic Rate interface might also be used as an option in some particular cases like radio infill unit.

7.2.1.4 In addition to these interfaces, the V.110 rate adaptation scheme shall be applied to the user data channel. The RA2, RA1 and RA0 steps are mandatory.

7.2.1.5 End-to-end flow control in layer 1 shall not be used.

7.3 Communication signalling procedures

7.3.1.1 The signalling protocols shall be provided as specified by:

a) Link Access Procedure on the D channel [ETS 300125]

b) User-network interface layer 3 using Digital Subscriber Signalling [ETS 300102-1]

7.3.1.2 ISDN multi-level precedence and pre-emption (MLPP) supplementary service shall be provided according to the EIRENE specification [EIRENE SRS].

7.3.1.3 The SETUP message contains Information Elements including the bearer capability and the low layer compatibility (refer to [EuroRadio FFFIS] specifying the Euroradio data bearer service requirements.

8. REQUIREMENTS TO MOBILE NETWORK INTERFACE

8.1 Foreword

8.1.1.1 This part of the specification does not define mandatory requirements for interoperability. It is a preferred solution, in case interchangeability between OBU and Mobile Terminal is required for a given implementation.

8.1.1.2 This section gives only limited information. [EuroRadio FFFIS] must be used for full compliance.

8.2 Interface definition

8.2.1.1 If an MT2 interface is used at the mobile side, the service access point at the mobile station corresponds with the R-reference point of the MT2.

8.2.1.2 [GSM 07.07] specifies a profile of AT commands and recommends that this profile be used for controlling Mobile Equipment functions and GSM network services through a Terminal Adapter.

8.2.1.3 For the mobile termination type MT2 the signalling over the V interface has to be in accordance with [GSM 07.07], using the V.25ter command set.

8.2.1.4 The online command state shall not be used to guarantee interoperability. To avoid different behaviour, it is recommended to enable/disable this escape sequence using the appropriate AT command usually referred as ATS2=<manufacturer defined value>. This particular command shall be sent to the mobile terminal as part of its initialisation string.

8.2.1.5 State control using physical circuits is mandatory.

8.2.1.6 The V-interface shall conform to recommendation ITU-T V.24. The signals required are specified in [EuroRadio FFFIS].

8.2.1.7 Note that in the case of class 1 mobile originated calls, it is allowed to set the priority value “command control (safety)” at subscription time.

8.2.1.8 The call control commands, interface control commands and responses used on the V-interface at the R reference point are specified in [EuroRadio FFFIS].

9. ANNEX A (INFORMATIVE) TRANSMISSION INTERFERENCE AND RECOVERY

9.1 General

9.1.1.1 The usual QoS parameter used as measure of accuracy of data transmission via transparent B/B_m channels is the bit error rate.

9.1.1.2 The QoS parameter relevant for layer 2 accuracy is the HDLC frame error rate.

9.1.1.3 It is not possible to define relationships between both rates. The channel behaviour is not known: error bursts and interruptions of data transmission during radio cell handover can happen.

9.1.1.4 Additionally, statistical distributions of values such as error rates do not accurately map the requirements from the ETCS point of view. Transfer of user data is requested in bursts; the transfer delay can be critical for the application. It has to be guaranteed for some application messages that data can be transferred to the train in a defined time interval.

9.1.1.5 A model of service behaviour is necessary reflecting all relevant features of GSM-R networks.

9.1.1.6 This model can be used as a normative reference for acceptance tests and for network maintenance during ETCS operation. It enables the ETCS supplier to demonstrate the correct operation of ETCS constituents during conformance testing without the variations of real world GSM-R networks.

9.1.1.7 Transmission interference and recovery is a first approximation of such a service behaviour model.

9.2 Transmission interference in relation to HDLC

9.2.1.1 Transmission interference is characterised by a period in the received data stream during which the received data units deviate partially or completely from those of the transmitted data stream. The service user cannot see the causes of transmission interference.

9.2.1.2 The user data units erroneously transmitted or omitted during the transmission interference must be corrected by re-transmission. These re-transmissions result in a time delay and in higher load in the B/B_m channel. Therefore, after transmission interference a period of error-free transmission, called the recovery period, must follow.

9.2.1.3 In the normal data transfer phase after recovery, user data units are transmitted to provide the data throughput requested by application messages.

9.2.1.4 Figure 1 shows a simplified relationship of B/B_m channel and HDLC errors: because of the selected options for the HDLC protocol (e.g. multi selective reject) the recovery period and the normal data transfer phase are not strictly separated.

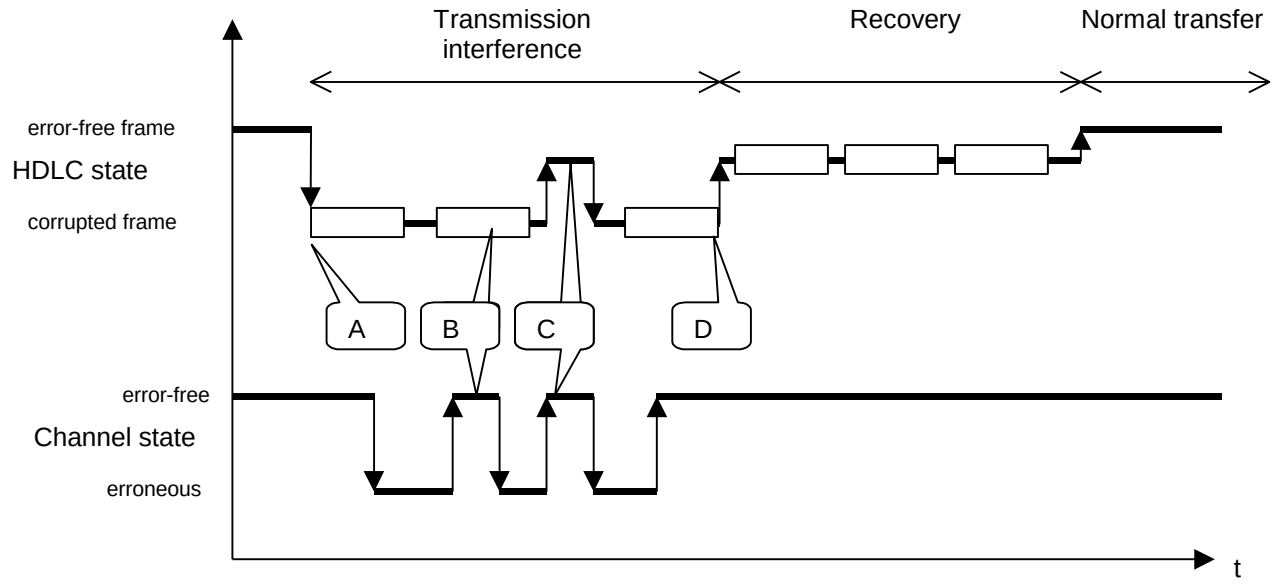

Figure 1 B/B_m channel and HDLC errors

9.2.1.5 Some special cases exist in Figure 1:

A Beginning of HDLC frame (corrupted by transmission) is earlier than beginning of transmission interference

B Error-free time is not sufficient for transfer of HDLC frame

C No HDLC frame is ready for transfer

D End of corrupted HDLC frame is later than end of transmission interference

9.2.1.6 Figure 2 shows as an example the HDLC behaviour in case of transmission interference.

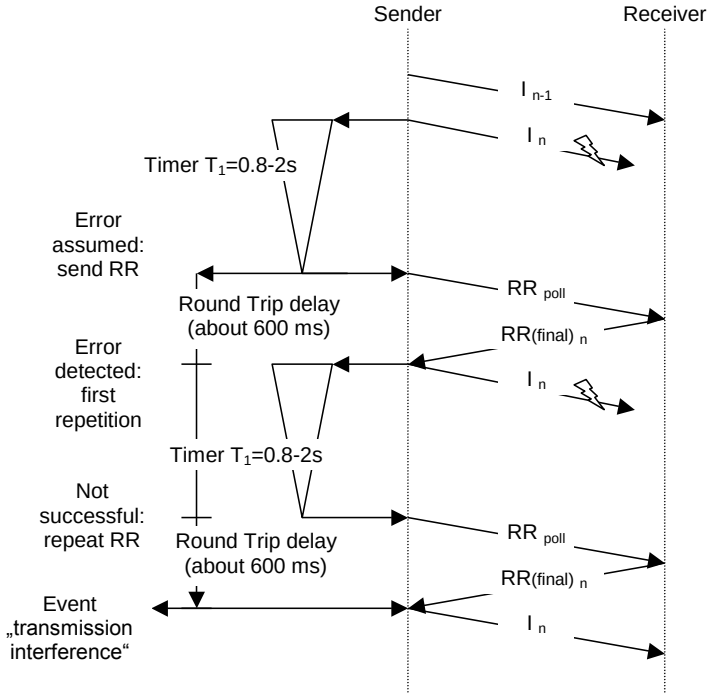

Figure 2 Event "Transmission interference"

9.2.1.7 The sender does not receive an acknowledgement in the case of a corrupted last I frame of a sequence of I frames. The timer T1 expires and a RR (poll bit set) frame will be sent.

9.2.1.8 After receiving an RR frame with an indication of successful transmission of the preceding I frame, the lost I frame will be re-transmitted.

9.2.1.9 Again the sender does not receive an acknowledgement and requests for the sequence number. Eventually, the transmission is successful but the delivery of user data will be delayed towards the receiver.

9.2.1.10 The occurrence of the above defined event represents a QoS event “Transmission interference” at the sender side. The beginning and the end of the transmission interference are not exactly known. But the second repetition clearly indicates an event “Transmission interference”:

a) The transmission interference time was too long or

b) The recovery time was too short.

10. ANNEX B (INFORMATIVE) JUSTIFICATION OF QOS PARAMETER VALUES

10.1 General

10.1.1.1 The railway operational targets have been analyzed [EEIG 04E117]. From these current operational targets (to the ETCS application) QoS requirements to GSM-R networks have been derived.

10.1.1.2 The ETCS target values have to be further evaluated and confirmed by RAMS analysis.

10.1.1.3 [ERQoS] contains detailed calculations for the relevant ETCS scenarios.

10.2 Connection establishment delay

10.2.1.1 No direct requirements can be derived from [EEIG 04E117].

10.2.1.2 A minimum figure is given by Call set-up time requirements [EIRENE FRS §3.4]: “All operational mobile-to-fixed calls not covered by the above (i.e. not railways emergency calls and not Group calls between drivers in the same area)

< 5s (95%), 7.5 (99%)”

10.2.1.3 A connection establishment delay of 8.5s (95%) is a restriction by GSM-R network technology. Real capabilities of GSM-R networks have been taken into account. All delays of the end-to-end connection establishment have to be included, e.g. the delay caused by the mobile termination.

10.3 Connection establishment error ratio

10.3.1.1 It is assumed, that the order containing the establishment of the communication session has been given by trackside equipment (session balise group or RBC) sufficient time before reaching the RBC border. Only operational delays less then 5 min should happen under this assumption.

10.3.1.2 The QoS target for operational delays less then 5 min in case of entry onto level 2 is $2*10^{-5}$ /h [EEIG 04E117 §13 table 6].

10.3.1.3 A complex derivation from [EEIG 04E117] suggests, that the value of connection establishment error ratio of $<10^{-4}$ is acceptable for entry into level 2.

10.3.1.4 If only one safe connection establishment attempt is possible, the error ratio of connection establishment has to be $<10^{-4}$. In case of two attempts (as specified in 6.3.3.4), the probability of an unsuccessful entry into level 2 (caused by connection establishment error) is equal to the product of the connection establishment error

ratios of both attempts. I.e. if the value of connection establishment error ratio is $<10^{-2}$, the probability of unsuccessful entry into level 2 is $10^{-4} = 10^{-2} * 10^{-2}$.

10.3.1.5 Connection establishment error ratio ≤ 10^{-2} is a restriction by GSM-R network technology. The connection establishment error ratio can be achieved when network design is next to perfect and continuously monitored, optimised and maintained.

10.3.1.6 Balise groups must be placed on the approach to the Level 2 area to ensure that GSM-R registration takes place and an RBC session is established in good time to allow the necessary ETCS messages to be passed when required. The positioning of these balise groups must take account of the time needed to complete the registration and communication session establishment process at the applicable line speed.

10.3.1.7 Note: Specification of the overall delay for entry into Level 2 is a matter of skilled infrastructure engineers. A common used value is 40s in case of existing registration with the GSM-R network (see [ERQoS]).

10.3.1.8 An RBC transition order must be sent by the handing over RBC at the right time to ensure that a communication session is established with the accepting RBC to allow the necessary ETCS messages to be passed when required. It must take account of the time needed to complete the communication session establishment process at the applicable line speed.

10.4 Transfer delay

10.4.1.1 The following engineering rule for GSM-R network design can be derived from [EEIG 04E117]: a cell handover should not occur in place where low delay of user data transmission is a strong requirement (see [EEIG 04E117 §7.4]).

10.5 Connection loss rate

10.5.1 QoS targets

10.5.1.1 The impact of the connection loss has been analyzed by [EEIG 04E117 §11.4] for the case, that T_NVCONTACT does **not** expire.

10.5.1.2 The connection loss influences the MA update time. The delay caused by connection loss indication and re-establishment of the ETCS safe connection (at least 27s according to [ERQoS] chapter 7) has to be added to the MA transfer delay (around 1s for 200 octet MA): In case of a connection loss, the operational targets to MA extension <= 12s (99,9964% for high speed lines [EEIG 04E117 §7.6.1]) can never be fulfilled.

10.5.1.3 If a connection loss happens, there will be an operational delay.

10.5.1.4 The QoS target for operational delays for more than 5 min and less than 5 min in case of MA extension are mentioned in [EEIG 04E117 §13 table 6].

10.5.1.5 By eliminating the MA refreshment rate the value of ≤2.7 *10^{-4} /h can be derived from [EEIG 04E117] for an operational delay of more than 5 minutes caused by an MA extension and ≤2.2 * 10^{-3}/h for less than 5 minutes.

10.5.2 Conclusions

10.5.2.1 There is a direct influence of QoS target for operational delays > 5 min to connection loss rate, if after connection loss and connection re-establishment the new MA does not reach the train before standstill, i.e. the requirement for connection loss rate is ≤ 2.7 * 10^{-4} /h.

10.5.2.2 If after connection loss and connection re-establishment the new MA reaches the train before standstill, the train can be accelerated again. There is a direct influence of l QoS target operational delays < 5 min to connection loss rate, i.e. the requirement for connection loss rate is ≤ 2.2 * 10^{-3} /h.

10.5.2.3 In case of M_NVCONTACT = “Train trip”, it is irrelevant, whether the MA reaches the train before standstill or not. An operational delay > 5 min will happen, i.e. the requirement for connection loss rate is ≤ 2.7 * 10^{-4} /h.

10.5.2.4 Connection loss rate ≤ 10^{-2} /h is a restriction by GSM-R network technology. The connection loss rate can be achieved when network design is next to perfect and continuously monitored, optimised and maintained.

10.5.2.5 If after connection loss some delay for connection re-establishment is accepted, the calculations[2] of [ERQoS] show:

a) The time without ETCS supervision caused by the re-establishment of the safe connection after connection loss is at least 27s. The connection loss rate has an direct influence to the operational delay.

b) If 27s ≤ T_NVCONTACT < 41s, then one safe connection re-establishment attempt is possible. The connection loss rate has an direct influence to the operational delay.

c) If 41s ≤ T_NVCONTACT < 61s, then a second connection establishment attempt is possible. The probability of an operational delay (caused by connection loss) is equal to the product of the connection loss rate and connection establishment error ratio.

10.6 Transmission interference

10.6.1.1 The value of maximum transmission interference time T_{TI} should cover all ”normal” transmission errors during a train trip.

[2] Additional delay of 5s by connection loss indication has been taken into account.

10.6.1.2 The worst case seems to be the case ”radio cell handover with pre-emption”. In this case a lower priority call has to be released in the selected radio cell before handover can be completed.

10.6.1.3 During pre-emption of the lower priority call the data transfer in the handing over radio cell will proceed. But a lower quality of service should be assumed: the reason for handover was a ”better” radio cell. After 300 ms movement in the direction towards this radio cell the quality of service will be worse in the handing over radio cell (see Figure 3).

10.6.1.4 The value of maximum acceptable duration of transmission interference (T_{TI}) is assumed as 1 s:

- delay by release of the pre-empted call: around 600ms
- delay by handover: around 300ms [EIRENE SRS §3.3.4]

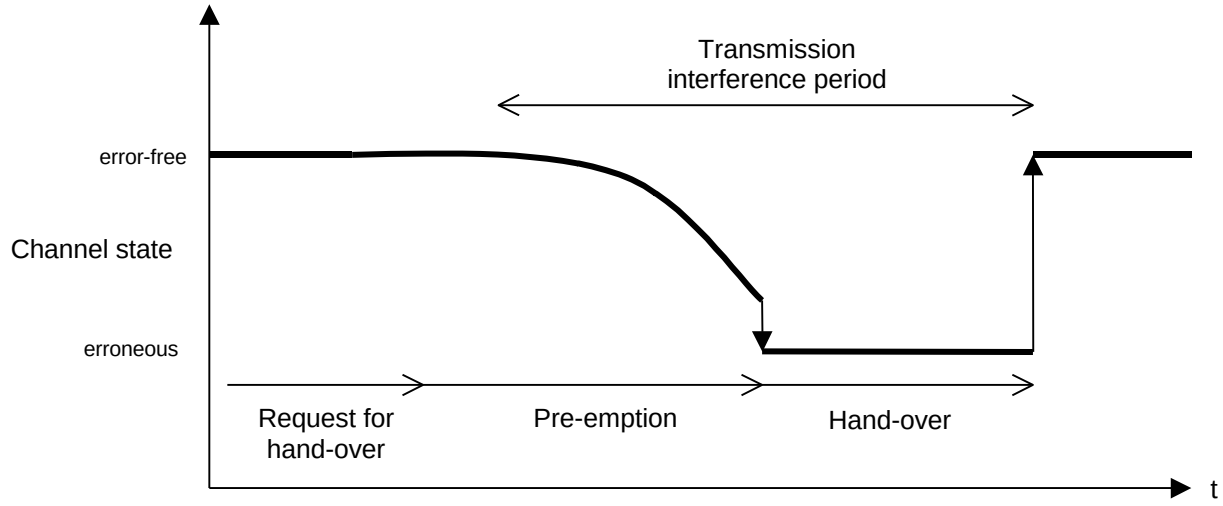

Figure 3 Error rate and radio cell hand-over

10.6.1.5 The minimum recovery time T_{Rec} should cover at least the user data units of one application message waiting to be transmitted.

10.6.1.6 In the case of long application messages (which will be segmented into 30 byteHDLC frames), T_{REC} = 7s is required for transmission of all message segments in a disturbed environment.

10.6.1.7 Note: 7s of error-free transmission is related to 500 octets user data specified as maximum application message length.

10.6.1.8 The justification of the requested distribution is based on the MA transfer delay.

10.6.1.9 The probability for a message to be impacted by a handover depends on the following aspects:

- probability of handover occurrence which depends on the speed of the train and the size of the GSM radio cells

- message size: longer message require longer transfer delay which increases the probability of collision with a handover.
- FER which affects the message transfer delay (due to retransmission of frames)

10.6.1.10 A calculation will offer for

- Train speed : 360 km/h ; radio cells : 2 km; cell hand over every 20 seconds
- Message size : 200 octets
- FER = 2.5*10-1 to 3*10-2

the probability for a message to be impacted by a handover varies roughly from 10^{-1} (10%) to 10^{-2} (1%). As an approximation 5% is taken which means 1 message every 20^{th}.

10.6.1.11 Ping Pong handover (or other interferences) with a disturbance of up to 7s are not tolerated for more than 1% per hour as they could provoke MA delay > 12s (not acceptable following operational requirements [EEIG 04E117 §7.3]) .

10.7 Network registration delay

10.7.1.1 The justification can be derived from the QoS target of [EEIG 04E117 §8.3] "…the ability of a given network to complete the registration process within the nationally specified target value."

10.7.1.2 It is interpreted as direct QoS requirement to GSM-R network. Exceeding the national specified target value (see 10.7.1.1) for network registration is counted as an error. A common used value for this target value is 40s (see [ERQoS]).