UNISIG

ERTMS/ETCS
EuroRadio FIS CS/PS Communication Function Module
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Company	Technical Approval	Management approval
ALSTOM		
AZD		
CAF		
HITACHI RAIL		
MERMEC		
SIEMENS		
THALES		

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1 MODIFICATION HISTORY

Issue Number Date	Section Number	Modification / Description	Author
2.0.0 30-March- 2000		Final issue to ECSAG	U.D. (ed)
2.1.0 23-November-2001	All	Revision	LK
2.1.7		Version with revision marks	LK
2.2.0		Final issue after revision	LK
2.2.1	3.4, 5.2, 5.3, 7.1.2, 7.2.2, 7.2.4, 7.2.5, 7.3.2, 8.2.3, 8.2.4, 8.3.1, Annex A, B.1, C.1	Review comments of Unisig super group inserted	LK
2.2.1+	7.2.5.3.6, 7.2.5.3.7	State table updated (state DATA, event DT SaPDU -> splitting in to Conditions Pre 5 and Pre 6; state AR SaPDU, event AR SaPDU -> DI SaPDU added)	TS
2.2.1.++	7.3.2.2.1	Table 23 Bit numbering changed	TS
2.2.2r	3.4.1.1, 7.2.5.3.6	Editorial changes	LK
2.2.2	-	Clean version	LK
2.2.3	3., 3.1.1.5, 3.1.16, 3.3, 3.4.1, 7.2.2.2.1.4, 7.2.5.3.7, 8.2.3.1.2, 8.3.1.14	Review comments of GSM-R users group inserted, Clarifications, references updated	LK
2.2.4	-	Clean version	LK
2.2.5	-	Formal release	LK
2.2.5.revA	3.4, 5.2, 5.7, 7.3.3, 8.2.2, 8.2.4, 8.2.5, 8.3.1	Proposed changes according to LOP v 020	LK
2.2.5.revB	3.4, 5.2, 5.7, 7.3.3, 8.2.2, 8.2.3, 8.2.4, 8.2.5, 8.3.1, B.1, B.5	Changes of Neu-Ulm meeting	TS+LK

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2.2.5.revC	5.2.1.7, 7.3.3.5.4, 8.2.2.6, 8.2.2.9, 8.2.3.2.3, 8.3.1.1, 8.3.2.2.1, 8.3.3.1.2, B.1.1.1.9	Changes of Berlin meeting	LK
2.2.5.revD	3.4.1, 8.2.5, 8.3.1, 8.3.3, Annex A	Changes of Edinburgh meeting	TS+LK
2.2.5.revE	3.4, 4.1.1.1, 7.2.2.2.2, 7.2.4.2, 7.3.2, 8.2.2, 8.2.4, Annex D, Annex E	Changes of Stockholm meeting and email discussion	LK
2.2.5.revF	3.3, 3.4, 7.2.2, 7.2.4, 7.3.2, 8.2.2, 8.2.5, 8.3.1, AnnexD, AnnexE	Changes of Paris meeting and email discussion	WM+LK
2.2.5.revG	4.1.1.10, 5.71.4, 7.3.3.5.6, 8.2.3.2.5, 8.2.5, 8.2.7, E.2	Changes of Zürich meeting	PL+LK
2.3.0	AnnexE.1, Tables 31, 34, 35	Formal release	JH
2.3.1	incorporate CR825; insert new Annexes E and F; rename old Annex E to Annex G		wg
2.3.2	All; incorporate CR380, CR814, CR970, CR1018; Page setup, layout and references; All §	Changes from meeting July 2011 and review comments	JM/XM
2.3.3-5	All; editorial	Internal wg reviews	JH
2.3.6	-	Formal release	ER WG
2.3.7		CR1018 CR1135	ER WG XM
2.3.8	-	Internal WG review	ER WG
2.3.9	-	Update according SG comments on CR1018 CR1137	XM
3.0.0	5.8, 7.2.2, 7.2.3, Table 29, B.7, deleted annex H. Editorial	Baseline 3 release version	ER WG

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3.0.1	Table 11	CR1151	JM
3.0.2	Front page	Baseline 3 1st maintenance pre-release version	PP
3.1.0	-	Baseline 3 1st maintenance release version	PP
3.1.1		CR741 (Packet data transmission for ETCS)	ER WG
3.1.2		Updated with review comments	ER WG
3.1.3		Updated with TCP parameters and DNS txt field for comments of EUG	ER WG
3.1.4		Updated with comments of the EUG and input from EIRENE. CR1262.	ER WG
3.1.5		Updated with comments, multiplexing for mobile interface, KMS	ER WG
3.1.6		Updated with comments in Unisig_B3R2_documents-consolidated review sheet	ER WG
3.2.0	-	Baseline 3 2nd release version	PP
3.2.1	8.2.2.7 o)	CR1309	PL
3.2.2	3.1.1.8, Table 29, Table 48, 8.3.2.3, Figure 23, 8.4.2, ANNEX F	CR1146 CR1310 CR1319	IH+GR
3.2.3	8.4.2.2 Table 44 “k(RX)” 8.4.1.8 bullet 8 8.4.1.9 4., 5.c.ii) and 7. ANNEX I 8.4.1.8 bullet 9 8.4.1.9 4., 5.c.iii., 7 8.4.2.3.2.2 and 8.4.2.3.3 ANNEX I	CR1146 CR1310 CR5049	SF (on behalf of ER WG)
3.2.4	8.4.1.9 7.c.v ANNEX I	CR5049	ER WG

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3.2.5		Split SS037 to SS037-1 dealing with CFM and SS037-2 dealing with SFM	JS+IH+GR
3.2.6	4	Adapted chapter 4	FK+GR
3.2.7	3.2, 3.3, 3.4, 4	Updated after EECT review	GR
3.2.8	3.1.1.2-6, 3.2, 3.4, 4, 6.5, Annex A Note added to 6.4.1.1 Comment added to 6.3.4.6.4 Table 5 and Table 18 updated for ATO	Added FRMCS support Added ATO equipment type and ATO/KMS ETCS ID types	GR+JM+FK
3.2.9	3.1, 3.2, 3.3, 4, 6.2, 6.3, 6.4, 6.5, Annex B, Annex D	Updated after EECT review CR1423	ER WG
3.3.0	3.1, 3.2, 3.3, 4, 6.2, 6.3, 6.4, 6.5, Annex B, Annex D, Annex H	Updated after EECT review	GR+FK
3.3.1	6.4.3, 6.5.1	Updated after EECT review	GR

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3 GENERAL ASPECTS

3.1 Scope

3.1.1.1 This FIS is applicable for remote data communication of ERTMS data applications.

3.1.1.2 This FIS covers:

- The umbrella of the EuroRadio protocol family, that covers:
  - the communication of safety and non-safety related applications.
  - the communication via GSM-R in CS mode, via GSM-R in PS mode and via FRMCS.
- The definition of the protocol stacks used for GSM-R CS and GSM-R PS communication for non-safety related applications.
- The coordination function to start the correct communication mode depend on the requested remote application.

3.1.1.3 In particular this FIS does not define:

- The application functionality and application information flow.
- The Safety Layer to support safety related applications that is defined in Subset-037-2.
- CFM for FRMCS that is specified in Subset-037-3.
- The open networks used.
- The physical architecture of the radio communication subsystem.

3.2 Structure of Subset 037 family

3.2.1.1 Subset 037 is a family of three documents that describes the EuroRadio protocol stack:

- Subset-037-1 describes the Communication Functional Module applicable to CS and PS data transmission and the coordinating function responsible to select the proper data transmission system between GSM-R CS, GSM-R PS and FRMCS.
- Subset-037-2 describes the Safe Functional Module applicable to radio communication systems providing communication services for safety-related application processes using open networks.
- Subset-037-3 describes the Communication Functional Module applicable to FRMCS.

3.2.1.2 In the Figure 1 is shown the relationship between the three Subsets. Refers to chapter 4 for the details about functions and interfaces.

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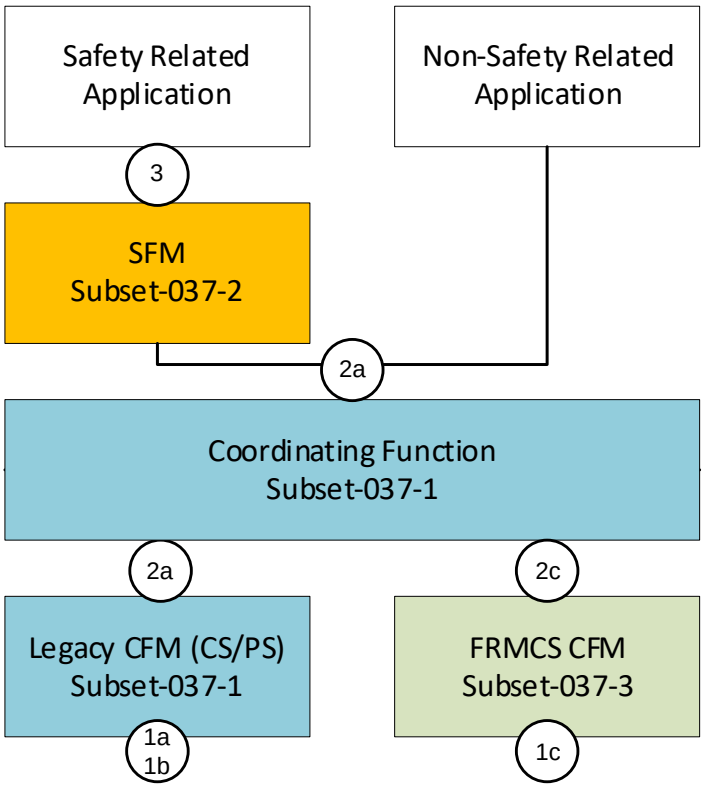


Figure 1 Subset-037 document family

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3.3 Acronyms and abbreviations

3.3.1.1 For general ERTMS/ETCS terms, definitions and abbreviations refer to [Subset-023]. New terms and abbreviations relevant and used in this FIS are specified here.

AR	Authentication Response
AU1	First Authentication message
AU2	Second Authentication message
AU3	Third Authentication message
BAC	Balanced Asynchronous Class
B_m	Full-rate traffic channel
CEPID	Connection EndPoint IDentifier
CFM	Communication Functional Module
CS	Circuit Switched
CSPDN	Circuit Switched Public Data Network
DA	Destination Address
DCE	Data Communication Equipment
DI	Disconnect
D_m	Control Channel
DT	Data
DTE	Data Terminal Equipment
EF	Elementary File (SIM Card)
eMLPP	Enhanced Multi-Level Precedence and Pre-emption
ETS	European Telecommunication Standard
FRMR	FRaMe Reject
FRMCS	Future Railway Mobile Communication System
HDLC	High level Data Link Control
ID	Identity
IEC	International Electrotechnical Commission
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
LAPB	Link Access Protocol Balanced
m	message
MA	Management
MNID	MNID list is a list of Mobile Network IDs.
MT	Mobile Termination
NPDU	Network Protocol Data Unit

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NSAP	Network Service Access Point
NSDU	Network Service Data Unit
NT	Network Termination
O&M	Operation and Maintenance
OSI	Open System Interconnection
PDN	Packet Data Network
PDU	Protocol Data Unit
PDP	Packet Data Protocol
PPP	Point to Point Protocol
PS	Packet Switched
PSD	Packet Switched Data
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RP	ResPonse
RQ	ReQuest
RTO	Retransmission TimeOut
SA	Source Address
SABME	Set Asynchronous Balanced Mode Extended
SAP	Service Access Point
SaPDU	Safety Protocol Data Unit
SFM	Safe Functional Module
SREJ	Selective REJect
TC	Transport Connection
TCEPID	Transport Connection EndPoint IDentifier
TP	Transport Protocol
TP2	Transport Protocol Class 2
TPDU	Transport Protocol Data Unit
TS	Transport Service
TSAP	Transport Service Access Point
TSDU	Transport Service Data Unit
UA	Unnumbered Acknowledge
UI	Unnumbered Information (HDLC frame)
X	Mandatory parameter
X(U)	Use of this parameter is a user option
X(D)	Use of this parameter is a user option. If not provided, a default value will be used.

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3.4 Definitions

3.4.1.1 For general ERTMS/ETCS terms, definitions and abbreviations refer to [Subset-023]. New definitions relevant and used in this FIS are specified here.

EuroRadio: The protocol suite to enable interoperability of several ERTMS data application like ETCS and ATO.

Mandatory feature: The feature has to be provided by on-board and/or trackside equipment where interoperability is required.

Optional feature/Option: The feature might be provided or not. If provided, it has to be provided as specified. Optional features are not required. Interoperability between EuroRadio peers providing and not providing the optional feature has to be guaranteed. Otherwise, the option has to be deactivated.

National Add-on:
The feature is a matter of national railway specification. Interoperability must not be influenced.

CS MODE

Circuit switched transmission mode uses a dedicated end-to-end transmission resource for each logical connection.

FORM FIT FUNCTIONAL INTERFACE SPECIFICATION (FFFIS)
A FFFIS is the complete definition of an interface between functional or physical entities.

The FFFIS includes:
- FIS,
- Electrical characteristics related to data,
- communication protocol[1],
- plug.

The FFFIS guarantees the interoperability but not the exchangeability of physical entities.

FUNCTIONAL INTERFACES SPECIFICATION (FIS)
A FIS specifies the link between functional modules or between physical entities by:
- The required external data flow,
- The required data characteristics,
- The data range and resolution requirements.

FUNCTIONAL MODULE
Set of functions contributing to realize the same global task.

MESSAGE AUTHENTICATION CODE (MAC)
An authenticator which is sent with a message to enable the receiver to detect alterations made to

[1]Note that 'Communication protocol' is used with different meanings in the EuroRadio FIS and FFFIS:
In the FIS a communication protocol is a protocol between peer entities within different End Systems connected by a network.
In the FFFIS a communication protocol is a protocol between functional modules or physical entities located in the same End System.

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the message since it left the sender and to verify that the source of the message is as claimed. The MAC is a function of the whole message and a secret key.

PADDING

The information used to fill the unused part of a message to fill the block size.

PS MODE

Packet switched transmission mode shares radio transmission resources between several logical connections.

PS SERVICE SETUP

GPRS attach followed by PDP context activation, as described in ANNEX G.

PS STATUS

Status of the PS service setup: it's successful or OK only if PS service setup is successful.

RADIO COMMUNICATION SYSTEM

A radio transmission system providing data communication services via open networks. It can be completed by an safety related transmission system to ensure safe data transmission.

TRANSMISSION MODE TABLE

The Transmission mode table contains the transmission mode for each known ETCS ID (i.e. RBC).

3.5 References

3.5.1.1 This FIS incorporates by dated or undated references, provisions from other publications. The relevant parts of 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 FIS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

3GPP 22.011		Service accessibility
3GPP 22.067		Enhanced Multi-Level Precedence and Pre-emption Service (eMLPP) Stage 1
3GPP 27.007		AT command set for User Equipment (UE)
EIRENE SRS		EIRENE Project Team. System Requirement Specification.
ETS 300102-1	1990	ISDN; User-network interface layer 3; Specification for basic call control
EuroRadio FFFIS		UIC ERTMS/GSM-R Unisig; EuroRadio Interface Group; Radio Transmission FFFIS for EuroRadio; A11T6001
ISO/IEC 3309	12.93	HDLC procedures; Frame structure
ISO/IEC 4335	12.93	HDLC procedures; Elements of Procedures
ISO/IEC 7776	07.95	Description of the X.25 LAPB-compatible DTE data link procedure
ISO/IEC 7809	12.93	HDLC procedures; Classes of Procedures

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ITU-T E.212	11.98	The international identification plan for mobile terminals and mobile users
ITU-T T.70	03.93	Network-independent basic transport service for telematic services
ITU-T X.214	11.93	Information Technology - Open System Interconnection - Transport service definition
ITU-T X.224	11.93	Protocol for providing the OSI connection-mode transport service
N-9018		UIC - GSM-R Network Codes
RFC 1034		Domain Names – Concepts and Facilities
RFC 1035		Domain Names – Implementation and Specification
RFC 1122		Requirements for Internet Hosts -- Communication Layers
RFC 2018		TCP Selective Acknowledgment Options
RFC 2883		An Extension to the Selective Acknowledgement (SACK) Option for TCP.
RFC 5482		TCP User Timeout Option
RFC 6633		Deprecation of ICMP Source Quench Messages
RFC 7323		TCP Extensions for High Performance
RFC 791		Internet Protocol
RFC 793		Transmission Control Protocol
SIM FFFIS		MORANE SIM FFFIS for GSM-R SIM cards P38T9001
Subset-023		Glossary of Terms and Abbreviations
Subset-026		System Requirements Specification
Subset-037-2		EuroRadio FIS – Safety Layer
Subset-037-3		Euroradio FIS – FRMCS Client
Subset-093		GSM-R Interfaces Bearer Service Requirements’
Subset-098		RBC-RBC Safe Communication Interface
TS 27.010		3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Terminal Equipment to User Equipment (TE-UE) multiplexer protocol

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4 REFERENCE ARCHITECTURE

4.1.1.1 The Communication Functional Module (CFM) provides the functions of the communication system based on circuit-switched/packet-switched bearer services of the GSM-R/GPRS. Figure 2 contains a detailed reference architecture of the radio communication sub-system. The service interfaces and the protocol interfaces are defined.

4.1.1.2 In Figure 2 the Interface 1 is an interface between the EuroRadio and the chosen transmission medium. It consists of a user plane for transfer of user data and a control plane for connection management. Interface 1a is the GSM/GPRS-Interface (on-board) and it is the recommended on-board interface between the EuroRadio and the MT (refer to [EuroRadio FFFIS]). Interface 1b is the Interface to fixed networks (trackside). In Figure 2 a primary rate interface to ISDN-like networks is shown for CS mode, although ISDN basic rate interface and PSTN are not excluded. For PS mode an Ethernet interface shall be used. Interface 1c is the interface between EuroRadio and On-Board FRMCS. Interface 1d is the interface between EuroRadio and FRMCS Trackside.

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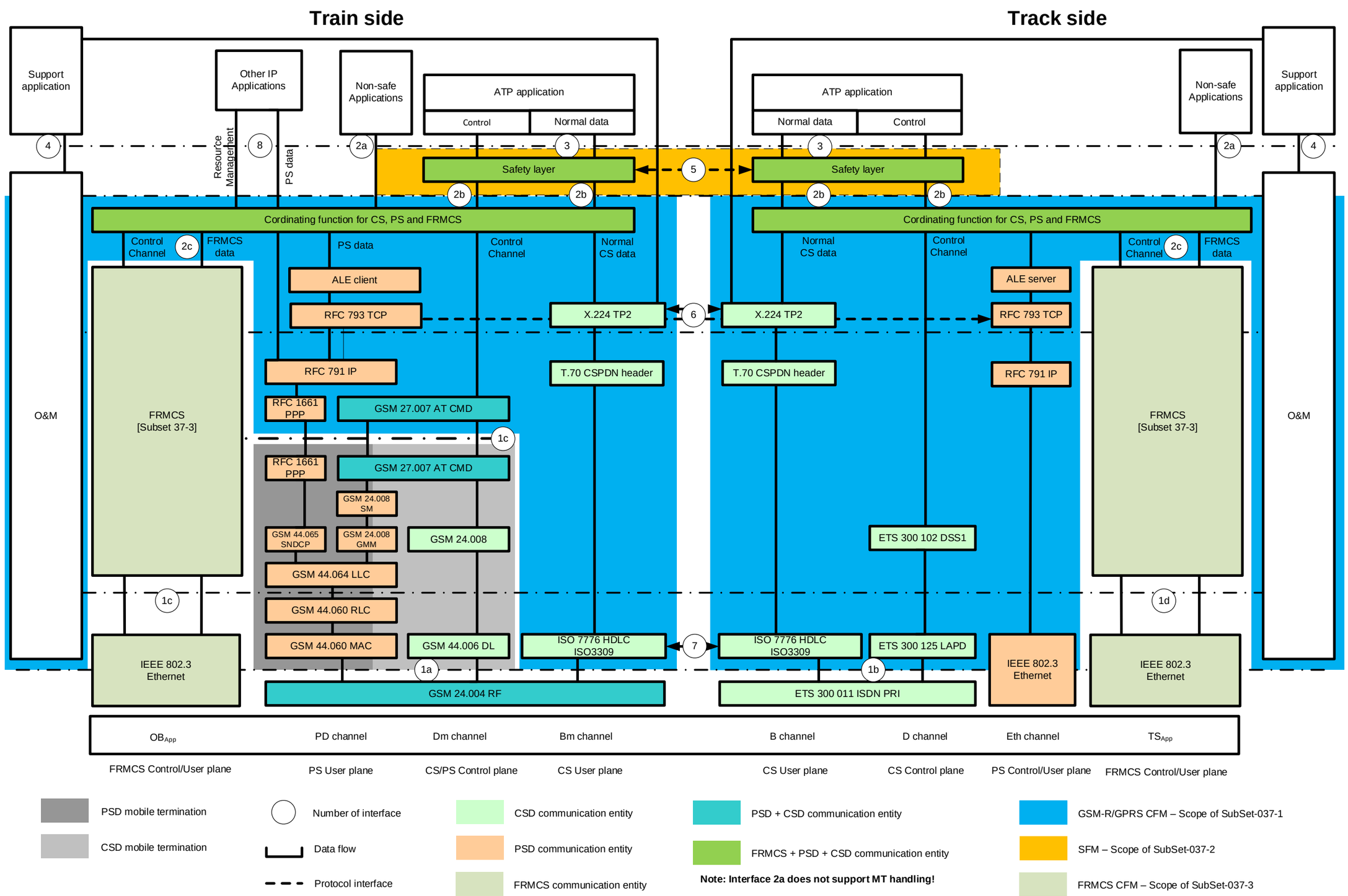


Figure 2 Reference architecture of EuroRadio

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4.1.1.3 Interface 2a is the service interface between non-safe applications or support applications and the coordinating function. Interface 2b is the service interface between SFM and the coordinating function for safety applications. The coordinating function is described in section 6.5.1.

4.1.1.4 Interface 2c is the service interface between coordination function and the FRMCS and it is described in [Subset-037-3].

4.1.1.5 Interface 3 is the Safe Functional Module Interface and it is described in [Subset-037-2] together with the Safety Layer and the interface 5.

4.1.1.6 The service interfaces 2 and 3 are not mandatory for interoperability. Only a functional definition is provided.

4.1.1.7 Logical peer entity interfaces 5, 6 and 7 (7 only for CS mode) are mandatory for interoperability. The interface is specified in terms of protocol data units and communication relevant aspects of module functionality.

Note: interface 6 refers to logical interfaces at the transport level peer entities. This refers both to X.224 entities in CS mode and TCP entities in PS mode.

4.1.1.8 The O&M plane covers all operations and management aspects. Interface 4 is a local service interface to the O&M stack, which is not specified.

4.1.1.9 Interface 8 is a service interface for other on-board IP applications to use packet switched communication. The interface consists of functions to share the mobile terminals, and a data interface to send and receive IP packets. The corresponding counterpart for the trackside is out of scope for this specification.

4.1.1.10 The coordinating function shown in the Figure 2 also supports FRMCS described in the [Subset-037-3].

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5 INTERFACE TO THE MOBILE NETWORK

5.1.1.1 The requirements to the mobile network are specified by [Subset-093].

5.1.1.2 The interface requirements are specified in [EuroRadio FFFIS].

5.1.1.3 The multiplexing protocol [TS 27.010] shall be used to coordinate the possible data streams for one CS and at least 2 PS services between CFM and mobile.

5.1.1.4 The following table specifies the necessary requirements for this protocol.

Table 1 Applicability conditions of [TS 27.010]

Section	Application conditions
§ 1 Modification History	Not relevant.
§ 2 Table of Contents	Not relevant.
§ 3 Abbreviations	Not relevant.
§ 4 Overview of Multiplexing System	For the physical link the mode “advanced without error recovery” shall be used.
§ 5 Non Error Recovery mode Options	All applicable except for the following rows of this table.
§ 5.1.2 Start up services	As mode for the physical link “HDLC - UI frames “ shall be used.
§ 5.1.3 DLC establishment services	For the DLC the frame type UIH shall be used. The convergence layer shall be set to “2” for CS services and “1” for the PS services. The Priority parameter shall be used to give the highest priority to the ETCS application
§ 5.1.5 Power Control services	Power save control will not be used.
§ 6 Error Recovery Mode Option	Not relevant.
Annex A (informative): Advice to TE software implementers	Applicable.
Annex B (informative): Explanatory notes on the CRC Calculation	Applicable.
Annex C (informative): Change History	Not relevant.

5.2 Service primitives for mobile network registration

5.2.1.1 Two service primitives are provided for mobile network registration of Mobile Terminations (MT) and FRMCS (see Table 2):

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- to request mobile network registration and
- to indicate mobile network registration status

5.2.1.2 These service primitives do not provide safe services (i.e. they are not safety relevant and have no impact on the safety protocol).

5.2.1.3 The service primitives are forwarded to/from the Communication Functional Modules (CFM GSM-R and FRMCS) and interpreted as command/response at the interface to mobile network. As a matter of implementation the service primitives of Subset-037-1 section B.6 may be used instead.

5.2.1.4 These service primitives apply to on-boards only.

Table 2 Service primitives for mobile network registration

Primitive / Parameter	Sa-REGISTRATION.request	Sa-REGISTRATION.indication
MNID list	X (>= 0 MNIDs)	X (>= 0 MNIDs)

5.2.1.5 By means of the service primitive “Sa-REGISTRATION.request” the service user is able to request the registration of one or more Mobile Terminations with one or more mobile networks. Registration to FRMCS shall be ignored because it is performed internally by the CFM FRMCS.

5.2.1.6 A **Mobile Network ID** identifies the mobile network a local Mobile Termination is requested to register with. The Mobile Network ID shall consist of the Mobile Country Code and the Mobile Network Code according to [ITU-T E.212].

5.2.1.7 The interpretation of the MNID list is matter of implementation. An example can be:

Empty:

All available Mobile Terminations are requested to be registered using automatic mobile network registration from GSM-R on-board radio equipment (see 3GPP 22.011).

One entry:

All available Mobile Terminations are requested to be registered on the mobile network defined by the entry using manual mobile network registration from the GSM-R on-board radio equipment.

Two different entries (MNID#1, MNID#2):

The available Mobile Terminations have to be split in two parts and to register first part on the mobile network defined by MNID #1 and second part on the mobile network defined by MNID #2.

In case not enough Mobile Terminations are available to perform registration on both mobile networks, registration shall be provided according to MNID priority ranking.

5.2.1.8 The status of registration with mobile networks is indicated by the service primitive “Sa-REGISTRATION.indication” to the service user. The service primitive contains a list of Mobile Network IDs, which are usable because Mobile Termination(s) are registered with them.

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5.2.1.9 Note: the association between MT and MNID in these service primitives is an implementation matter.

5.2.1.10 The service user is not informed on how many Mobile Terminations are available but receives only status of registered mobile network which means implicitly that connection request on these mobile networks can be issued or not.

5.2.1.11 FRMCS Registration shall be stated using MNID “901 999” and name “FRMCS”.

5.2.1.12 If the indicated list of Mobile Network IDs is empty, the registration of Mobile Terminations was not possible or the coverage has been lost.

5.2.1.13 The mobile network registration indication can be given independently of a request. In case of a network registration status change (GSM-R or FRMCS) the user shall be informed via registration indication message.

5.2.1.14 After a successful mobile network registration, GPRS attach shall be initiated on all MTs, but the PDP context activation at least on one MT, see ANNEX G of Subset-037-1.

5.2.1.15 If GPRS attach or PDP context activation is not successful the correct network registration has to be reported by Sa-REGISTRATION.indication.

5.3 Service primitives for Permitted Mobile Networks

5.3.1.1 It is necessary to indicate a list of 'Permitted' Mobile Networks to the driver. This list comprises mobile networks that are both 'available', i.e. the mobile detects their presence, and 'Allowed', i.e. a previously-stored list of mobile networks to which the mobile is allowed to register.

5.3.1.2 Two service primitives are provided for indication of allowed mobile networks (see Table 3):

- to request a list of permitted mobile networks and
- to indicate this permitted list.

5.3.1.3 These service primitives do not provide safe services (i.e. they are not safety relevant and have no impact on the safety protocol).

5.3.1.4 The service primitives are command/response between the Communication Functional Module (CFM) and the mobile terminal (MT). See also communication functional module in Subset-037-1 Annex B.6.

5.3.1.5 These service primitives apply to on-boards only.

Table 3 Service primitives for permitted mobile networks

Primitive / Parameter	Sa-PERMISSION.request	Sa-PERMISSION.indication
MNID list	X (= 0 MNIDs)	X (>= 0 MNIDs)

5.3.1.6 By means of the service primitive “Sa-PERMISSION.request” the service user is able to request the indication of permitted mobile networks. **MNID list** parameter is empty for the request primitive.

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5.3.1.7 The permitted mobile networks are indicated by the service primitive “Sa-PERMISSION.indication” to the service user. The service primitive shall contain a list of MNIDs provided with their respective alphanumeric network names.

5.3.1.8 A **Mobile Network ID** shall consist of the Mobile Country Code and the Mobile Network Code according to [ITU-T E.212].

5.3.1.9 An unsolicited mobile network permission indication shall not be used.

5.3.1.10 If the indicated list of Mobile Network IDs is empty no permitted mobile network is found.

5.3.1.11 The list of allowed mobile networks shall be formed by information read from the SIM card (see [EuroRadio FFFIS]).
The needed information is stored in three elementary files on the SIM: EF_{Gsmr}, EF_{IC} and EF_{NW}.
EF_{Gsmr} contain the MNIDs.
EF_{NW} contain the alphanumeric network names.
EF_{IC} contain an index that connects the records in EF_{Gsmr} and EF_{NW}.
For details, see [SIM FFFIS].

5.3.1.12 The list of available mobile networks shall be found through a scan of the available and allowed networks (see [EuroRadio FFFIS]). A mobile network shall be considered as available if reported as such by at least one MT.

5.3.1.13 Mobile networks marked as ‘forbidden’ in the response are excluded from the list of available mobile networks.

5.3.1.14 The list of permitted mobile networks shall be composed only of the mobile networks which are part of both the list of available mobile networks and the list of allowed mobile networks.

5.3.1.15 See Subset-037-1 ANNEX F for an informative example of how to create the list of permitted mobile networks.

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6 COMMUNICATION FUNCTIONAL MODULE

6.1 Introduction

6.1.1.1 This chapter specifies the Communication Functional Module (CFM), its services, and the protocol stack based on circuit switched and packet switched bearer services of GSM/GPRS and fixed networks. The CFM covers the OSI layers 4 (transport layer), 3 (network layer), and 2 (data link layer).

6.1.1.2 Note: The service interface is not mandatory. The service primitives of Annex B describe the interface at a functional level only.

6.2 Service definition

6.2.1 Model of communication services

6.2.1.1 The communication services that the Communication Functional Module offers to its users (Safe Functional Module and optionally non-safe users) are based on the services provided by the transport layer of ISO/OSI reference model [ITU-T X.214]. These services concern:

- Transport connection establishment/release;
- Reliable data transmission;
- Transparent data transmission.

6.2.1.2 A communication functional module offers also reliability enhancement of the transmission channel.

6.2.1.3 A CFM entity communicates with its users (CFM user[2]) through one or more Transport Service Access Point (TSAP) by means of transport service primitives. The CFM entities supporting a transport connection exchange Transport Protocol Data Units (TPDU) for normal data use the service of the lower layers, through the respective Service Access Points.

6.2.1.4 For CS mode, more than one transport connection per physical channel can optionally be supported by a CFM. This option is not required for ETCS level 1 radio in-fill unit. Instead, for PS mode, more than one transport connection per physical channel shall always be supported by a CFM.

6.2.1.5 Figure 3 contains a model only. It does not restrict any implementations.

6.2.2 Connection establishment

6.2.2.1 The process of establishing a transport connection is initiated at the time when the communication service user requests a connection set up to the Communication Functional Module. This service is accessed through the service primitive T-CONNECT.request with its associated parameters at the TSAP. At the time of connection set up request, the user

[2] CFM user is applied to indicate a service user of the CFM. The correct OSI term would be TS user.

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has the possibility to specify its needs by means of QoS class and of the application type to be served.

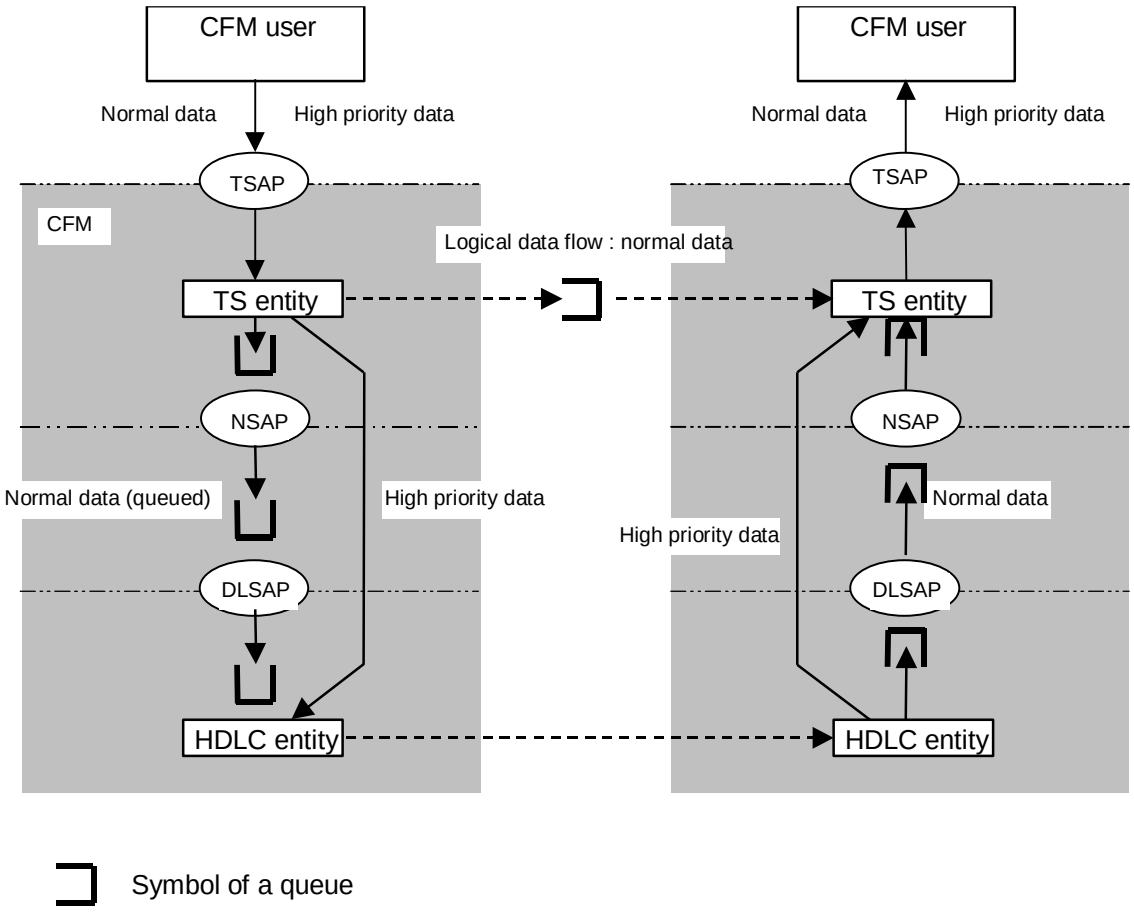


Figure 3 Model of communication service (CS mode)

6.2.2.2 The communication functional module evaluates the value of the QoS class and the application type. The associated set of quality of service parameter values will be used:

- to select the proper bearer service for physical connection establishment, when this connection does not yet exist;
- optionally, to select the scheduling features of transport layer multiplexing.

Note: QoS class will be ignored in case of a PS connection.

6.2.3 Data transfer

6.2.3.1 The data transfer service is provided after a successful transport connection set up. This service is accessed through the service primitive T-DATA.request with its associated parameters at the TSAP. The Communication Functional Module provides transparent and reliable transfer of user data in both directions simultaneously, and hides to its users the way in which the data are handled internally.

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6.2.4 Connection release

6.2.4.1 The transport connection release is provided by the Communication Functional Module through the use of the transport service primitive T-DISCONNECT.request, with its associated parameters. The connection release due to the Communication Functional Module, or caused by lower layers, will be indicated to the user.

6.2.5 Quality of Service (only for CS mode)

6.2.5.1 The term Quality of Service (QoS) refers to certain characteristics of a transport connection as observed between the endpoints.

6.2.5.2 The QoS parameters give transport service (TS) users a method of specifying their needs, and give the TS provider a basis for selection of the protocol or for requesting services of lower layers. The QoS is normally negotiated between the TS users and the TS provider on a per transport connection basis, using the T-CONNECT request, indication, response, and confirm TS primitives. The negotiated QoS values then apply throughout the lifetime of the transport connection. For the purposes of this FIS for the use in the transport protocol the values for all parameters are fixed for a given application type, in which case QoS negotiation on a per transport connection basis is restricted to local negotiation between the requesting side and its local transport providing entity.

6.2.5.3 There is no guarantee that the originally negotiated QoS will be maintained throughout the transport connection lifetime. The Transport Service provider does not explicitly signal changes in QoS.

6.2.5.4 Possible choices and default values for each parameter will normally be specified at the time of initial TS provider installation.

6.3 Communication protocols for CS

6.3.1 Introduction

6.3.1.1 This section provides a precise specification of the communication protocols of the user channel over CS. The protocol specifications are described layer by layer as delta specifications to existing standards.

6.3.2 Data Link Layer

6.3.2.1 According to the OSI reference model the reliable transfer of data is provided by the data link layer. The data link layer of the B/B_m-channel provides functional and procedural means to establish, maintain, and release connections and to transfer data. It will detect and correct data transfer errors, which may occur in the physical layer.

6.3.2.2 The protocol of layer 2 (DTE-DTE communication) will transmit data according to the sequence of their data request primitives.

6.3.2.3 The layer 2 protocol is covered by the HDLC standards. The application conditions are given as delta specifications.

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6.3.2.4 The frame structure according to [ISO/IEC 3309] and the elements of the control procedures according to [ISO/IEC 4335] shall be used.

6.3.2.5 The HDLC balanced asynchronous class (BAC) of procedures shall be used. The HDLC basic procedure shall provide the following error detection and recovery features:

- automatic re-transmission after missing acknowledge;
- 16 bit frame check sequence.

6.3.2.6 Some standardized options of HDLC are required as defined in [ISO/IEC 7809]:

- option 3.2: multi-selective reject (SREJ);
- option 4: unnumbered information (UI)[3];
- option 10: extended sequence numbering (SABME);
- option 15.1: Start/stop transmission.

Note: Option 8 is not used (see 6.3.2.9).

Note: Option 2 is not used.

6.3.2.7 The elements supporting the procedure and options are described in [ISO/IEC 7776] except for the following rules[4]:

a) Only the single link procedure is used.

b) An independent HDLC protocol is used in each B/B_m channel.

c) An ”unsolicited DM” is not used.

d) In the case of FRMR condition link reset shall not be used. The receiver of FRMR shall send a DISC frame as a response (see [ISO/IEC 7776] section 5.6).

e) An ”unsolicited UA response frame” in the information transfer phase is ignored.

f) ”Basic mode of operation” is not used.

g) Extended sequence numbering (modulo 128) is used.

h) The calling system plays the DTE role and the called system plays the DCE role. These roles include the layer 2 addressing. The system initiating the establishment of the B/B_m channel is considered to be the calling system.

i) The end system with the DTE role is responsible for the establishment and release of the layer 2 connection. Only the end system with the DTE role is allowed to send SABME frames. However, the other system can also release the connection.

j) In the case of ordered release of the connection, the layer 2 connection should be released before the B/B_m channel.

k) The interframe time fill-in shall be “Mark”.

l) The layer 2 protocol shall not insert any inter-octet time fill-in ([ISO/IEC 4335] §4.1.4.2).

m) Only control escape transparency shall be used ([ISO/IEC 7776] §3.5.2.2).

[4] For further detailed information see Annex D.

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n) Receiving a SABME frame before the first I frame is received shall not lead to the link resetting procedure but be handled as an additional attempt to perform link set-up.

o) Received unnumbered frames shall be ignored.

6.3.2.8 The order of transmitting bits within each octet in the information field is to send the least significant bit first.

6.3.2.9 Response I frames shall be sent only with F=1. Response I frames with F=0 shall not be sent.

6.3.2.10 SREJ shall be sent as response frame only.

6.3.3 Network Layer

6.3.3.1 CS Connection Management Function

6.3.3.1.1 The CS Connection Management function provides the synchronisation mechanism required between the usage of the B/B_m- channel protocol stack and the signalling protocol stack.

6.3.3.1.2 The following tasks shall be performed by the CS Connection Management function:

a) Registration with requested and appropriate GSM.

b) Establishment of network connection(s) by means of the 3GPP 27.007 and ETS 300102 signalling protocol (see [ETS 300102-1]).

c) Mapping of the requested QoS parameters into signalling information.

d) Connection refusal when applicable

e) Connection release by means of the 3GPP 27.007 and ETS 300102 signalling protocols

f) Handling of the GSM/ISDN supplementary services information.

g) Error reporting and retrieving information on error reasons received from 3GPP 27.007 and ETS 300102 signalling protocols.

h) disconnect of data link layer followed by release of physical connection in case of disconnect phase (e.g. when the number of retransmission attempts exceeds N2 or in case of FRMR condition detected) (see [ISO/IEC 7776] section 5.3.3, 5.3.4).

6.3.3.1.3 If a B/B_m-channel connection is not already established, the receipt of an N-CONNECT.request primitive shall cause the control plane signalling procedures for circuit switched connection to establish a B/$B_m$channel connection. The requested QOS parameters for the N-connection shall be mapped onto user-network signalling information elements.

6.3.3.1.4 During B/B_m- channel connection establishment, supplementary services information and signalling protocol cause codes shall be handled as specified in [GSM/R interfaces].

6.3.3.1.5 Note: A simplified handling of signalling information and error reasons is allowed.

6.3.3.1.6 When the B/B_m- channel connection is established in layer 1, the CS Connection Management function informs the B/B_m- channel network layer entity and B/B_m- channel

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data link layer entity. The data link layer entity performs synchronisation with its peer data link layer entity and informs the network layer entity after successful synchronisation.

6.3.3.1.7 Each EuroRadio has to operate one or more B/B_m-channels with EuroRadio peer. The layer 3 and layer 2 entities are processed independently in each B/B_m- channel.

6.3.3.1.8 When the N-DISCONNECT.request is received, the B/B_m- channel is released by the 3GPP 27.007 and ETS 300102 signalling protocols.

6.3.3.2 B/B_mChannel network Layer

6.3.3.2.1 According to the OSI reference model the network layer of a B/B_m- channel provides functional and procedural means to establish, maintain, and release network connections between open systems containing communicating transport entities independent from routing and relay considerations.

6.3.3.2.2 For Layer 3, the T.70 network layer protocol for CSPDNs shall be used in the B/B_m-channel. Only the T.70 header (refer to [ITU-T T.70] Section 3.3.3 and Figure 4) is applied: Segmentation/re-assembly of the NSDU out of/into sequences of NPDUs and setting of the M-Bit.

6.3.3.2.3 Note: ISDN B-channel circuit switched mode: T.90 specifies in appendix II the T.70 network layer protocol as an optional protocol usable on a per call basis.

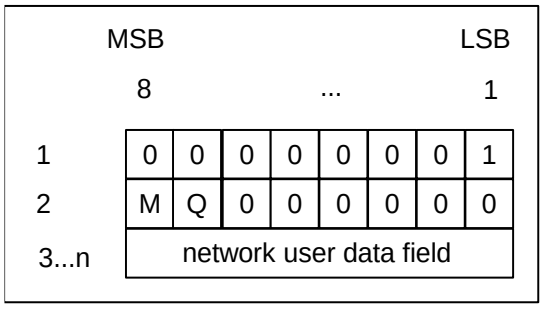


Figure 4 Format of NPDU

6.3.3.2.4 When the more data mark (M) is set to 1 it indicates that more data is to follow. The Q-bit is reserved; currently the value is set to 0.

6.3.3.2.5 Error handling of T.70 header is a matter of implementation.

6.3.4 Transport Layer

6.3.4.1 Functions

6.3.4.1.1 The transport layer only establishes a transport connection if a network connection exists. If the network connection does not exist at the moment when an association is requested, the transport entity first of all requests the establishment of such a connection and then automatically sets up the transport connection. Each different application type should have established its own transport connection for the intended duration of the communication.

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TP2 shall be used in order to provide more than one transport connection over the same network connection.

6.3.4.1.2 The layer 4 protocol is covered by [ITU-T X.224] ”Protocol for providing the OSI connection-mode transport service”; the application conditions are given as delta specifications in section 0. The elements of transport procedure class 2 (TP2) listed in Table 4 shall be used. Some special problems of the protocol are described in the following sections.

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Table 4 Procedure elements of TP2

Protocol mechanism	X.224 Cross-ref.	Variant or Option	TP Class 2	used	not used
Assignment to network connection	6.1.1		x	*	
TPDU transfer	6.2		x	*	
Segmenting and reassembling	6.3		x	*	
Concatenation and separation	6.4		x		*
Connection establishment	6.5		x	*	
Connection refusal	6.6		x	*	
Normal release	6.7	Explicit	x	*	
Error release	6.8		x	*	
Association of TPDU's with transport connection	6.9		x	*	
TPDU numbering	6.10	Normal Extended	m (Note 1) o (Note 1)	*	 *
Expedited data transfer	6.11	Network Expedited	x (Note 1)		*
Reassignment after failure	6.12		na		*
Retention and acknowledgement of TPDU's	6.13	Confirmation of receipt	na		*
Re synchronisation	6.14		na		*
Multiplexing and de-multiplexing	6.15		x (Note 2)	(Note 3)	*
Explicit flow control	6.16		m	*	
Checksum	6.17		x		*
Frozen references	6.18				*
Re transmission on time-out	6.19		na		*
Resequencing	6.20		na		*
Inactivity control	6.21		na		*
Treatment of protocol errors	6.22		x	*	
Splitting and recombining	6.23				*

Notes
X Procedure always included in class 2
na Not applicable in TP class 2
m Negotiable procedure whose implementation in equipment is mandatory
o Negotiable procedure whose implementation in equipment is optional
1 Not applicable in class 2 when non-use of explicit flow control is selected.
2 Multiplexing may lead to degradation of the quality of service if the non-use of explicit flow control has been selected.
3 Option. This option is not required for ETCS level1 radio in-fill unit.

6.3.4.2 **Priority handling**

6.3.4.2.1 The priority has to be handled:

- during set-up phase of the physical connection (”eMLPP priority”): The GSM phase 2+ supplementary service ”Enhanced Multi-Level Precedence and Pre-emption service (eMLPP)” [3GPP 22.067] provides different levels of priority for

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call set-up and for call continuity. The GSM operator allocates set-up classes and pre-emption capabilities to each priority level according to the railway specifications (refer to EIRENE SRS). The priority is requested during set-up of the physical connection by the CS Connection Management function. The priority level 1 (Control-command safety) will be used for all application types.

- by the scheduling algorithm during multiplexing (”transport priority”): A transport priority is defined for the different application types (see section 6.5.2.4.4)

6.3.4.2.2 Note: All priority treatment of the transport layer refers to transport priorities.

6.3.4.2.3 The action taken by the transport protocol during connection lifetime is not explicitly defined in ITU-T X.224.

6.3.4.2.4 The following policy has to be adopted in each CFM at transport connection set-up request:

- If sufficient resources are available to provide the service (in both the local and distant system) the new connection will be established.
- Otherwise the connection request is refused.

6.3.4.2.5 The handling of transport priority during the data phase of the transport connection is specified in the following section.

6.3.4.3 **Multiplexing**

6.3.4.3.1 Multiplexing of two or more transport connections onto a single network connection can be provided as an option. This option is not required for ETCS level 1 radio in-fill unit.

6.3.4.3.2 Multiplexing requires the following functions:

a) The identification of the transport connection source is provided by an appropriate DST-REF parameter of each DT TPDU and additionally the SRC-REF parameter of CR, CC, DR, and DC TPDUs. These parameters are used to identify each TPDU in a given transport connection and ensures that data from different transport connections are not mixed or mis-routed.

b) Peer flow control regulates the rate at which TPDUs of individual transport connections are sent to the peer transport entity. The use of explicit flow control on each transport connection will conform to ITU-T X.224 recommendation sub-section 10.2.4.2 and will be used in addition to any other form of flow control performed in the lower layers.

c) The scheduling of the next transport connection to be served over the network connection: The connection associated with application type ATP has to be served first.

d) The transport connection endpoint identifier (TCEPID) at the TSAP provides local identification of the transport connection. Service boundary flow control is provided as a matter of implementation. These local flow control mechanisms shall be in accordance to transport priority requests.

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6.3.4.4 **Release of the network connection**

6.3.4.4.1 The release of network connection occurs when all the transport connections associated with it have been released.

6.3.4.4.2 In the case of an abnormal release by the network, all associated transport connections are released and the transport service users are immediately informed.

6.3.4.5 **Segmenting/reassembling**

6.3.4.5.1 If the size of the transport service data unit (TSDU), which is requested for transmission to the transport layer, exceeds the maximum size of the user data part of the DT TPDU, then segmentation must first be performed on the TSDU. One TSDU is mapped into more than one TPDU with added protocol control information.

6.3.4.5.2 The segmenting/reassembling reduces the throughput because of the increased overhead in the TPDUs. Normal priority user data is segmented, if it does not fit into one TPDU. The recommended length of TSDUs is <= 123 octets.

6.3.4.5.3 The transmitting transport entity should apply the length 128 octets for all TPDUs except the last one.

6.3.4.5.4 The peer transport entity has to identify the transport connection of the received segments and to reassemble the segments into the TSDU.

6.3.4.5.5 The receiving transport entity shall be able to accept TPDUs of different length: from 1 up to 128 octets.

6.3.4.5.6 If one TPDU (which is requested for transmission to the network layer as NSDU) is handled by the network entity, the next TPDU has to wait. Segmenting of long lower priority TSDU provides the possibility to multiplex TPDUs of higher priority with the stream of lower priority TSDU segments.

6.3.4.6 **Addressing**

6.3.4.6.1 The ConnectRequest TPDU (CR TPDU) and the ConnectConfirm TPDU (CC TPDU) contain address information: the calling transport selector, and the called transport selector or the responding transport selector in the respective TSAP IDs. The transport selector consists of the sub-parameters application type, ETCS ID type and ETCS ID (Figure 5 and Table 5).

6.3.4.6.2 Note: The parameter code and length shown in Figure 5 indicate the structure according to X.224 section 13.3.4

Parameter code (1 octet)	Parameter length (1 octet)	Application type (1 octet)	ETCS ID type (1 octet)	ETCS ID (3 octets)

Figure 5 Structure of the transport selector

6.3.4.6.3 The first octet of the transport selector is used for the assignment of the application type (Table 5). The first 5 bits specify the main application type. The minor application types specify the main application types in more details. Every main application type can comprise eight applications. The general structure of the parameter ”application type” is:

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application type (1 octet) = main application type (5 bits)

+ minor application type(3 bits)

6.3.4.6.4 The application type of calling and called transport selectors has to be identical. If the called CFM does not support a requested application type, the establishment request will be rejected by DR TPDU.

Table 5 Format and encoding of transport selector

Octet	Bit 8765 4321	Content
1	1100 0001 1100 0010	Parameter code of calling TSAP or Parameter code of called TSAP
2	0000 0101	Parameter length (fixed length=5)
3	xxxx xxxx	Application type[1]
	0001 0xxx 0001 0000 0001 0001 0001 0111	ATP ERTMS/ETCS level 2/3 ERTMS/ETCS level 1 National use[2]
	0001 1xxx 0001 1010 0001 1011 0001 1100	National use for trackside equipment RBC-Interlocking communication RBC-RBC communication Interlocking-Interlocking communication
	0010 0xxx 0010 0000 0010 0001	Key management KMC/KMC communication KM domain internal communication
	0011 000x 0011 0000 0011 0001	ATO communication ATO/ATO communication ATO domain internal communication
	1111 1111	Reserved for error handling
4	 0000 0000 0000 0001 0000 0010 0000 0011 0000 0100 0000 0101 0000 0110 0000 1000 0000 1001 0000 1010 1111 1111	ETCS ID type Radio in-fill unit RBC Engine Reserved for Balise Reserved for Field element (eg, Level crossing) Key management entity (trackside) Interlocking related entity ATO-TS ATO-OB KMS-OB Unknown [3]
5-7		ETCS ID

Note:
1. Application type ATP is mandatory. All other application type values are reserved.
2. Minor application type “National use” is reserved for non-interoperable national applications.
3. Can only be used together with an ETCS ID value “unknown”.

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6.3.5 Applicability conditions of [ITU-T X.224]

Table 6 Applicability conditions of [ITU-T X.224]

Section	Application conditions
Introduction	These application conditions only apply for the EuroRadio specification.
§ 1	Transport procedure class 2 (TP class 2) for the connection-oriented data transfer shall be used. All other TP classes of X.224 shall not shall not be used. ”Conformance testing” shall not be used.
§ 4.2	ED, EA, and RJ TPDU shall not be used.
§ 5.1	The communication services are specified in section 6.2. Tab.1/X.224 shall not be used.
§ 5.2	The network service used is a ”connection oriented network service(CONS)”. The parameter exchange between the transport entity and the network service provider is implementation dependent. The network service primitives according to X.213 should be used. The following applies for Tab.2a/X.224, if used: • N-DATA-ACKNOWLEDGE primitives shall not be used. • N-EXPEDITED-DATA primitives shall not be used. With N-CONNECT primitives, ”receipt confirmation option”, ”expedited data option” and ”NS user data” shall not be used. • With N-DISCONNECT primitives, ”NS user data” shall not be used. • N-UNITDATA shall not be used. • Tab. 2b/X.224 shall not be used.
§ 5.3.1	The future functions ”encryption”, ”accounting mechanisms”, ”status exchange”, ”blocking”, ”temporary release of network connections”, and ”alternative checksum algorithm” shall not be used. ”Monitoring of QoS” shall not be used.
§ 5.3.1.1	c) ”error detection” shall not be used. d) ”error recovery” shall not be used.
§ 5.3.1.2	b) All transport connections from trainborne transport layer entity to the same trackside layer entity and vice versa are multiplexed onto one network connection.[5] (Option) c) The default size of the TPDU shall be 128 octets. e) The called network address, if provided, shall be used as network address. If this network address is not provided by T-CONNECT.request, the ETCS IDs have to be mapped[6]. f) A TCEPID should be used to distinguish between transport connections. g) ”TS user data” can be used. h) ”inactivity timers” shall not be used.
§ 5.3.1.3	a) ”concatenation and separation” shall not be used. c) ”splitting and recombining” shall not be used. f) ”expedited data” shall not be used.
§ 5.4.1	TP class 2 shall be used.
§ 5.4.2	The TP class cannot be negotiated. The accepted class and its options must be equal to the required class 2.
§ 5.4.3	A network connection of Type A is a precondition.
§ 5.4.4	TP class 0 shall not be used.
§ 5.4.5	TP class 1 shall not be used.
§ 5.4.6.2	”Explicit flow control” shall be used.
§ 5.4.7	TP class 3 shall not be used.
§ 5.4.8	TP class 4 shall not be used.

[5]Refer to section 6.3.4.3

[6]Refer to section **Chyba! Nenalezen zdroj odkazů.**

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Section	Application conditions
§ 5.5	TP class 4 with ”connectionless-mode network service (CNLS)” shall not be used.
§ 6.1.1.3	All transport connections between the same pair of transport layer entities are multiplexed onto one network connection.[7] (Option) Procedures for ”re-synchronisation”, ”reassignment after failure” and ”splitting” shall not be used. Note 3: The value of the appropriate delay should be 0s.[8] Note 4: shall not be used. Note 5: shall not be used.
§ 6.1.2	”connectionless-mode network service” shall not be used.
§ 6.2.2	N-EXPEDITED-DATA and N-UNITDATA primitives shall not be used.
§ 6.2.3	”connectionless-mode network service” shall not be used. The network expedited variant shall not be used.
§ 6.4	”concatenation and separation” shall not be used.
§ 6.5.2	N-UNITDATA primitives shall not be used.
§ 6.5.3	The following TPDU parameters shall not be used: • use of extended format; • version number; • protection; • checksum; • additional option selection; • alternate protocol classes; • acknowledge time; • inactivity time; • residual error rate; • reassignment time; • Option “non-use of explicit flow control in class 2”. The following TPDU parameters should not be used: • TPDU size (proposed and selected); • preferred maximum TPDU size (proposed and selected). If these parameters are used, the receiver shall ignore them.

[7]Refer to section 6.3.4.3

[8]Refer to section 6.3.4.4

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Section	Application conditions
§ 6.5.4	Transport connections are only established by the initiator of the network connection. Optionally, the responder can try to establish a transport connection. If it cannot be negotiated with peer transport layer entity or peer TS user, the transport connection establishment request will be rejected. "splitting and recombining" shall not be used. The timer TS1 is a matter of local implementation. The network expedited variant shall not be used. a) A TCEPID should be used as a reference. c) "initial credit" equals to 15 for transport connections with application type ATP; "initial credit" equals to 1 for all other transport connections (if option "Multiplexing" is used). e) "acknowledge time" shall not be used. f) "checksum" shall not be used. g) "protection" shall not be used. h) "inactivity time" shall not be used. o) Option "non-use of explicit flow control in class 2" shall not be used. The following parameters shall not be negotiated: i) "Protocol class" shall be always 2; "alternative class" shall not be used. Table 3/X.224 shall not be used. The following parameters shall not be negotiated: j) The default size of the TPDU shall be 128 octets. This shall be maximum size usable. k) "Preferred maximum TPDU size" should not be used. l) "extended format" shall not be used. m) "checksum" shall not be used. n) The parameter value of "priority" shall be set according to the value of transport priority[9]. p) "network receipt confirmation" and "network expedited data transfer" shall not be used. q) "transport expedited data transfer" shall not be used. r) "use of selective acknowledgement" shall not be used. s) "use of request acknowledgement" shall not be used. t) "version number" shall not be used. u) "reassignment time parameter" shall not be used.
§ 6.5.5	"connectionless-mode network service" shall not be used.
§ 6.6	The required class and options must be accepted.
§ 6.7.1	The explicit "release procedure" shall be used.[10]
§ 6.7.1.4	The implicit "release procedure" shall not be used. If the network connection is interrupted, an error indication should be given to the application.
§ 6.7.1.5	The orderly release of the transport connection requires the availability of the network connection. The release may result in discarding of TPDUs. Note 5: a network connection shall be immediately released in order when all transport connections multiplexed onto the network connection have been released. Note 6: The timer TS2 is a matter of local implementation.
§6.7.2	"connectionless-mode network service" shall not be used.
§ 6.8	"Error release" shall be used. On receipt of N-RESET.indication a N-DISCONNECT.request has to be issued.
§ 6.9.1.2	N-EXPEDITED-DATA primitives shall not be used.
§ 6.9.1.4.2	f) Add: The DST-REF parameter shall be mapped onto the local "transport connection endpoint identifier (TCEPID)".
§ 6.9.2	"connectionless-mode network service" shall not be used.
§ 6.11	"expedited data transfer" shall not be used.

[9]Refer to section 6.5.2.4.4

[10]Refer to 6.3.4.4

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Section	Application conditions
§ 6.12	”reassignment after failure” shall not be used.
§ 6.13	”retention and acknowledgement of TPDUs” shall not be used.
§ 6.14	”re-synchronisation” shall not be used.
§ 6.15	Details of multiplexing are specified in section 6.3.4.3.
§ 6.15.2	ED, EA, and RJ TPDUs shall not be used.
§ 6.15.3	Note 2: ”concatenation” shall not be used.
§ 6.16	Explicit flow control shall be used.
§ 6.17	”checksum” shall not be used.
§ 6.18	”frozen reference” shall not be used.
§ 6.19	”re transmission on time-out” shall not be used.
§ 6.20	”resequencing” shall not be used.
§ 6.21	”inactivity control” shall not be used.
§ 6.22.2	”connectionless-mode network service” shall not be used.
§ 6.23	”splitting and combining” shall not be used.
§ 7	Tab.6/X.224 shall not be used. Refer to Table 4.
§ 8	TP class 0 shall not be used.
§ 9	TP class 1 shall not be used.
§ 10.2.1	d) ”concatenation and separation” shall not be used. f) ”multiplexing and de-multiplexing” are used.
§ 10.2.3	Data transfer without flow control shall not be used.
§ 10.2.4.1	”segmenting and reassembling” are used.
§ 10.2.4.3	”Expedited data transfer” shall not be used.
§ 11	TP class 3 shall not be used.
§ 12	TP class 4 shall not be used.
§ 13.1	Table 8/X.224: ED, EA and RJ TPDUs shall not be used.
§ 13.3.3	b) ”initial credit” equals 15 for transport connections with application type ATP ”initial credit” equals to 1 for all other transport connections (if option ”Multiplexing” is used). e) TP class 2; Options: ”use of normal format in all classes” ”use of explicit flow control in class 2”.
§ 13.3.4	The following parameters shall be used in the variable part: a) TSAP-IDs are used. The parameter length shall be equal to 5. The parameter value contains the respective transport selector[11]. l) ”Priority” shall be used. The parameter value shall be set according to the value of transport priority [12].
§ 13.5.4	The variable part of the DR TPDU should not be used.
§ 13.7.1	”extended format” shall not be used.
§ 13.7.4	The variable part shall not be used.
§ 13.8	ED TPDUs shall not be used.
§ 13.9.1	”extended format” shall not be used.

[11]Refer to section 6.3.4.6

[12]Refer to section 6.5.2.4.4

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Section	Application conditions
§ 13.9.4	The variable part shall not be used.
§ 13.10	EA TPDUs shall not be used.
§ 13.11	RJ TPDUs shall not be used.
§ 14	”Conformance” with ITU-T Rec. X.224 shall not be required.
Annex A	TP class 0, 1, 3 and 4 and ”connectionless mode network service” shall not be used.
Annex B	The ”network connection management sub protocol(NCMS)” shall not be used.
Annex C	”Conformance” with ITU-T Rec. X.224 shall not be required.
Annex D	”checksum” shall not be used.
Annex E	shall not be used.

6.3.6 Time sequences

6.3.6.1 The time sequences are shown in the appropriate OSI layer service definition standards (e.g. for layer 4 refer to [ITU-T X.214]). This chapter illustrates the interaction of the layers.

6.3.6.2 Figure 6 contains the connection establishment by trainborne EuroRadio only. The signalling connection between EuroRadio and the Mobile Termination is established after “power-on” of the Mobile Termination to provide the radio resources and mobility management.

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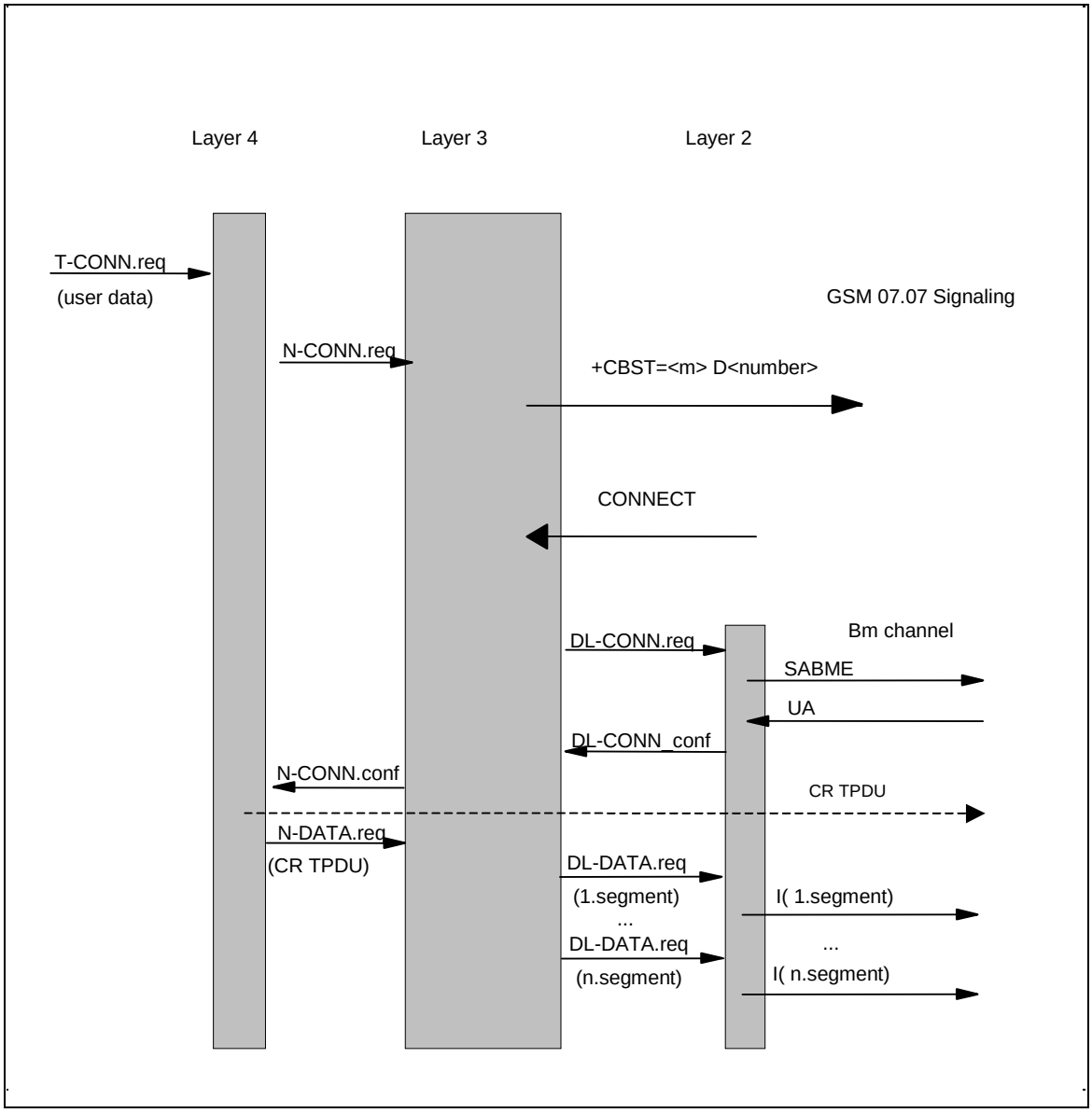


Figure 6 Detailed protocol sequence during connection establishment (requesting side only)

6.3.6.3 Note: The lower part of Figure 6 shows the segmentation of the CR TPDU as an example of a TPDU size > 123 octets.

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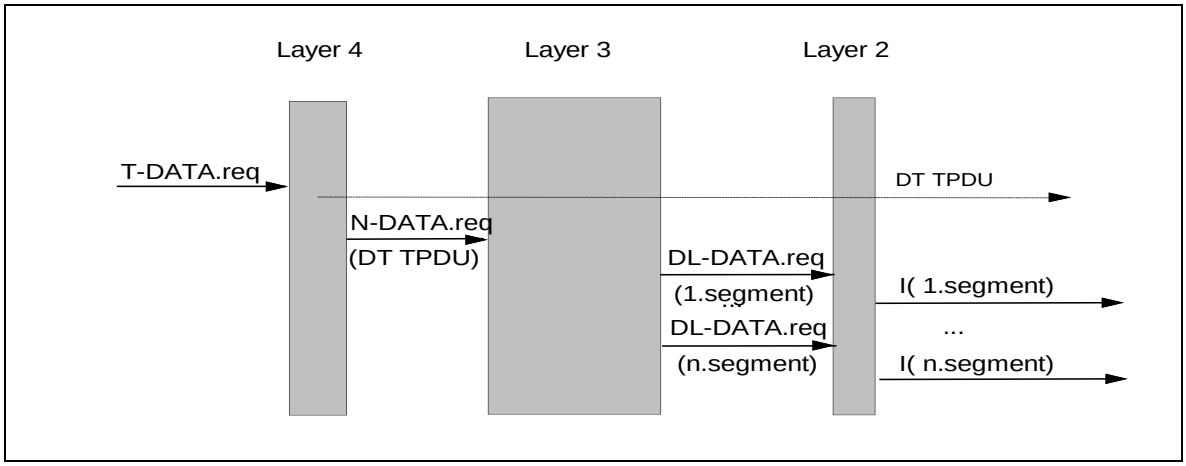


Figure 7 Detailed protocol sequence during data transfer (requesting side only)

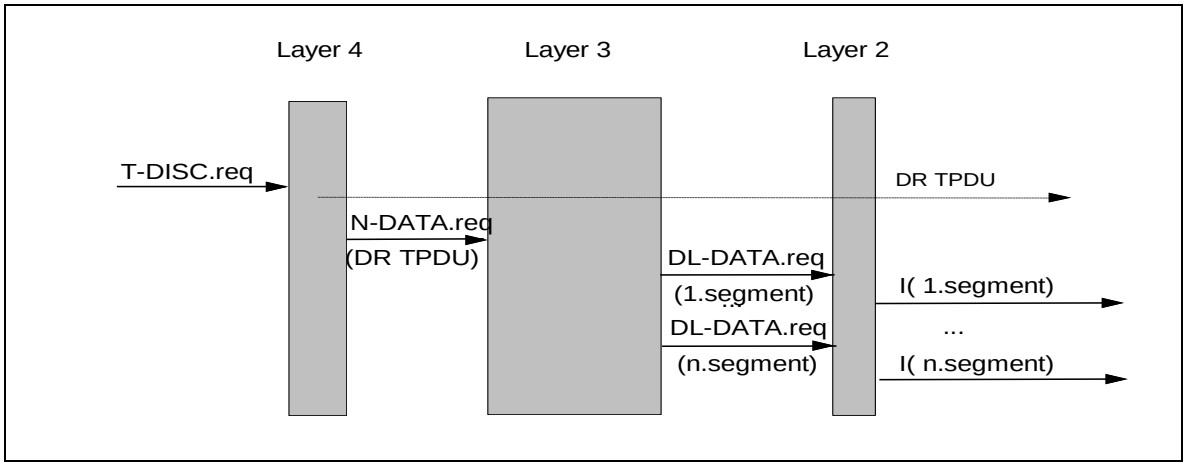


Figure 8 Detailed protocol sequence during connection release (requesting side only)

6.3.7 Relationships of PDUs and SDUs

6.3.7.1 This chapter contains examples of layer overheads based on a 25 octet data field in HDLC frames.

6.3.7.2 The safety layer (as described in [Subset-037-2]), if applied, adds a header and the MAC to the user data.

6.3.7.3 Transport connections are multiplexed on one network connection according to their transport priority. The layer 4 adds a header to the user data.

6.3.7.4 If the TS user provides a normal priority TSDU of appropriate length (<=123 octets), the layer 4 does not segment/reassemble the user data (Figure 9). Segmenting and reassembling in layer 3 results in a 2 byte segment header.

6.3.7.5 In the case of a non-safe connection Figure 9 is still valid, but without the second line (SaPDU).

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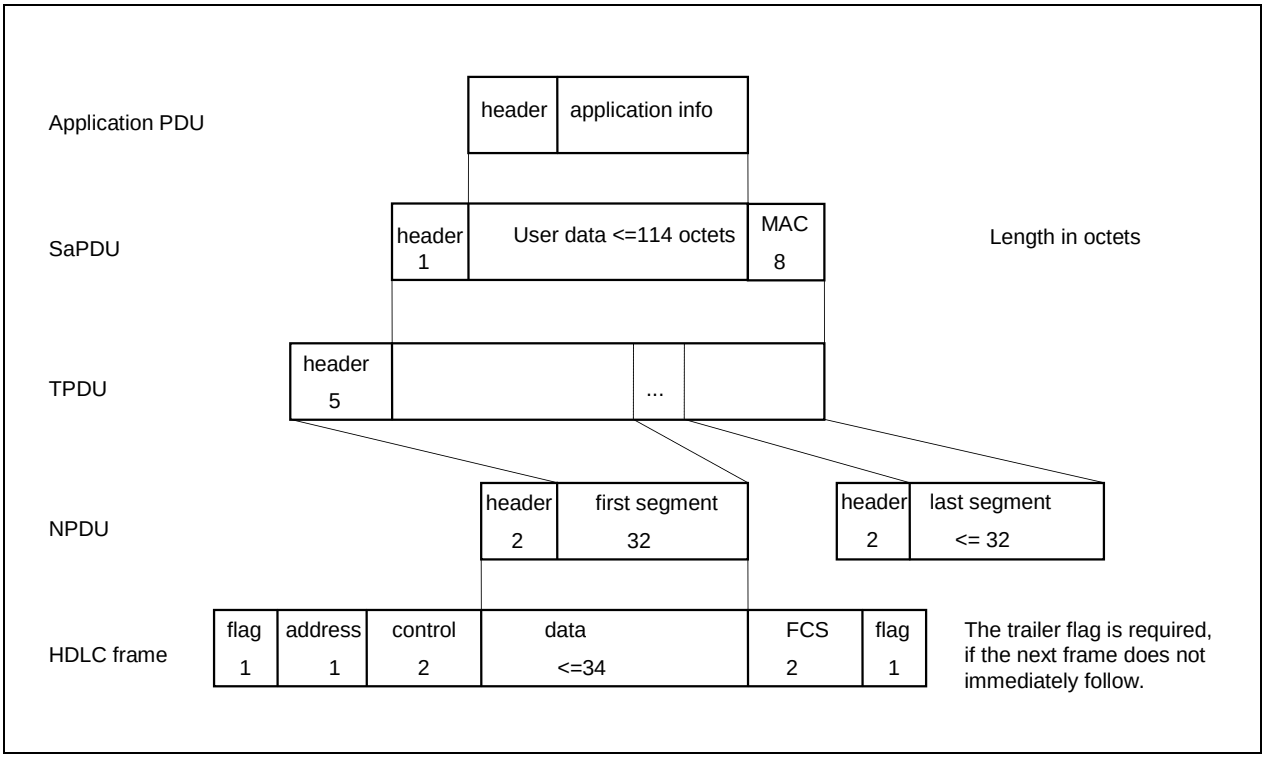


Figure 9 Example of segmenting/reassembling in layer 3

6.3.7.6 If the TS user did not provide a normal priority TSDU of appropriate length, the layer 4 segments/reassembles the user data into/from TPDUs of standard length of 128 octets. Segmenting and reassembling in layer 4 will result in a 5 byte header added to each segment (Figure 10). The layer 3 header is additionally required to be consistent with the NPDU format of the other connections.

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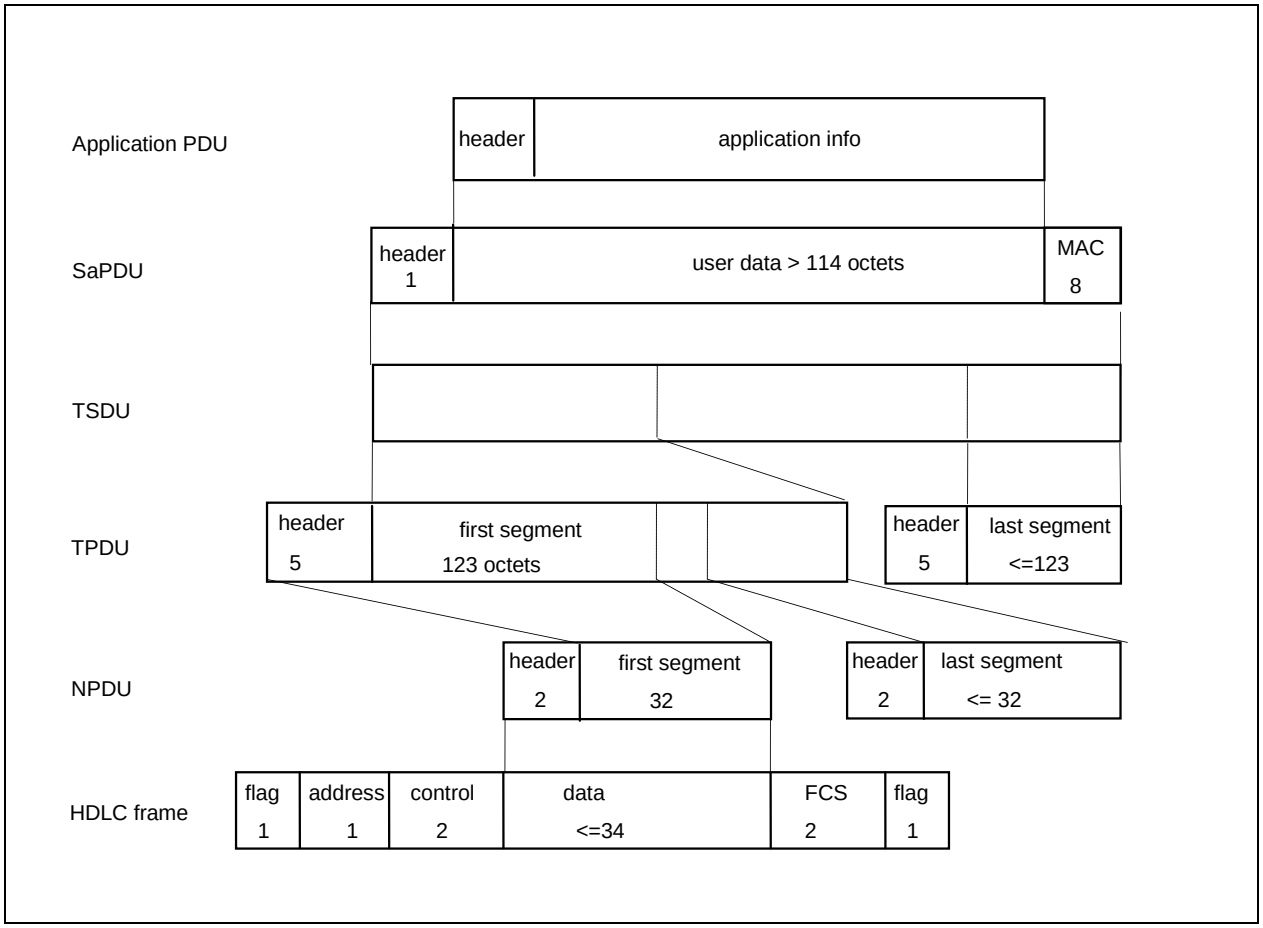


Figure 10 Example of segmenting/reassembling in layer 4 and layer 3

6.4 Communication protocols for PS

6.4.1 Introduction

6.4.1.1 This section provides a precise specification of the communication protocols of the user channel over PS. The protocol specifications are described layer by layer. Table 7 shows the delta to existing standards.

Note: The word PS used in this specification refers to Packet Switched communication over GSM-R, i.e., GPRS. Packet Switched communication via FRMCS is specified in Subset-037-3.

6.4.1.2 An APN shall be provided that is dedicated to ETCS traffic.

6.4.1.3 One dedicated PDP context ID for ETCS purposes shall be subscribed to each MT.

6.4.1.4 Only mobile initiated PDP context activations shall be supported for ETCS.

6.4.1.5 A PDP context shall be deactivated only by the OBU.

6.4.2 Adaptation Layer Entity (ALE)

6.4.2.1 **Functions**

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6.4.2.1.1 The main functions of ALE are:

a) Adaptation between EuroRadio Safety Layer and TCP layer.

b) Establishment and Release of the TCP connection.

c) Conversion between Safety Layer packets to/from TCP stream.

d) Monitoring of channel availability.

6.4.2.1.2 All the above ALE functions are based on [Subset-098] (RBC-RBC Safe Communication Interface), using the requirements specified in Table 7. The paragraphs below explain the adaptation of Subset-098 for on-board to trackside safe communication.

Table 7. Applicability conditions of Subset-098

Section	Application conditions
§ 1 Modification History	Not relevant.
§ 2 Table of Contents	Not relevant.
§ 3 introduction	Not relevant.
§ 4 Reference architecture	Not relevant.
§ 5 Safe Functional Module	Not relevant.
§ 6 Communication Functional Module	All applicable except for the following rows of this table.
§ 6.1 General	Not relevant, however not only RBC-RBC Safe Communication Interface, but generic on-board and trackside equipment.
§ 6.2.1.1.1	Systems are assumed both fixed and mobile.
§ 6.2.1.1.2	Physical redundancy not supported on OBU side.
§ 6.3.1.1.1	Running not only on ground based systems.
§ 6.3.1.1.4	The diagram in figure 28 shows an example for a fixed connection, not over GSM-R (GPRS).
§ 6.3.2.1.3	Only Class D.
§ 6.3.2.1.4	One single physical link only, with only one TCP connection, no redundancy used.
§ 6.3.3 Class A request	Not relevant.
§ 6.3.4.1.1	A request for a Class D quality of service shall result in the Adaptation Layer attempting to make only one TCP connections to the remote Adaptation Layer entity. This connection shall be used to transfer all data and control messages. The safe connection shall operate only on this link. The exact details of how this link shall be monitored and managed are contained in §6.6.
§ 6.4.1.1.3	Managing of the redundancy is not applicable.
§ 6.5.2.1.1	Transport priority is not used.
§ 6.5.2.2.1	Specified in chapter 6.4.2.3.
§ 6.5.2.5.4	TCP_LISTEN_ON_PORT specified in 6.4.2.4.1
§ 6.5.2.6.1	Every connection between two subsystems is realised through only one transport connection.
§ 6.6.1 Class A (optional for	Not relevant.

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Section	Application conditions
implementation)	
§ 6.6.2	Class D is used. One single physical link only, with only one TCP connection, no redundancy used.
§ 6.8	Specified in chapter 6.4.3
§ 6.8.3.1.2	IP v4 is mandatory,
§ 6.9.3.1.1	Specified in chapter 6.4.2.3.
§ 7 INFORMATIVE ANNEX	Not relevant.

6.4.2.2 Redundancy of the ALE Server physical interfaces

6.4.2.2.1 The communication between OBU and RBC is realised by ALE client (on-board) / server (trackside).

6.4.2.2.2 The ALE Server (trackside) may have several physical interfaces, but only one IP address is responded to an ALE Client (on-board) by a DNS response, subsequent to a DNS query of the ALE Client during connection establishment. The process how the ALE Client manages the IP address of the server is a matter of implementation.

6.4.2.3 Addressing

6.4.2.3.1 Dynamic IP address allocation shall be used for the ALE client (on-board) and the IP address is obtained during the PDP context activation (see Figure 11).

6.4.2.3.2 Instead, the ALE server (trackside) IP address shall be permanent.

6.4.2.3.3 If the optional parameter Network Address does not contain an IP address in the T-CONNECT.request primitive a DNS query shall be used to resolve IP address.

6.4.2.3.4 To translate the ETCS id of the ALE server a DNS lookup shall be used.

6.4.2.3.5 The format of the string (host name) sent to the DNS shall be: “id<ETCS ID>.ty<ETCS-ID Type>.etcs”, using lowercase hexadecimal ASCII character representation of the <ETCS ID> and <ETCS-ID Type>. Example: If the ETCS id type is RBC and the ETCS ID is ‘1001 0011 1100 0000 1111 0101, the formatted string will be ‘id93c0f5.ty01.etcs’. See also [Subset-037-2].

6.4.2.3.6 The DNS feature shall comply with [RFC 1034] and [RFC 1035].

6.4.2.3.7 A (logical) ETCS DNS lookup shall be split in separate requests, sent simultaneously, each only querying for a single record (QCOUNT=1); i.e. the request for IP address and TXT field shall be performed by two separate DNS requests. This applies to all ETCS DNS lookup attempts referred throughout Subset-037 specification.

6.4.2.3.8 A DNS response can contain more than one TXT record in random order. Among the received TXT records, one single record shall contain the format “txm=” and, if applicable, “tp=” which are both reserved for ER. This TXT record shall be identified by syntax check in the OBU.

6.4.2.4 Listening port

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6.4.2.4.1 The listening TCP port is 7911.

Note: The use of this port is for private networks only.

6.4.2.5 **Connection Monitoring**

6.4.2.5.1 Standard TCP Keep Alive shall be used, together with other TCP parameters and features, see Table 8.

6.4.2.6 **Connection Management functions**

6.4.2.6.1 The Connection Management function manages the AT-command interface and the switching between the control plane (command state) and the user plane (data state).

6.4.2.6.2 The following tasks are performed by the Connection Management function:

a) Registration with requested and appropriate GSM (same for CS and PS)
b) Connection refusal in case of an error
c) Error reporting and retrieving information on error reasons
d) Check GPRS attach status and attach if not already attached
e) Check PDP context activation and activate PDP context if not already active
f) Change the interface state to MT into on-line data state before connection establishment.
g) Change the interface state to MT into AT command state after release of all transport connections associated with the specific MT.
h) Establish the PPP and extract the ETCS DNS IP address.
i) Association of a MT with a requested transport connection.

6.4.2.6.3 In case a new PS mode connection is requested within the same network of an already established one (e.g. RBC handover within the same network), the same MT as for the already established connection shall be used.

6.4.3 TCP Layer

6.4.3.1 The transport layer protocol is TCP [RFC 793].

6.4.3.2 In the following Table 8, Mandatory (M) and Optional (O) TCP Features are specified from ETCS operation point of view.

6.4.3.3 The values of some TCP Parameters can be proposed in the DNS TXT field, see 6.5.1.17, but the applicability of such proposed values is optional, depending on the implementation.

6.4.3.4 The configurable or not per connection is done from the Linux TCP implementation point of view. Other implementations could have other restrictions.

Table 8. Applicability conditions of TCP

	Feature	RFC	M/O	Value	Comments
1	Initial RTO	793 1122	M	>= TCP_RTO_MIN < TCP_RTO_MAX (Recommended: = TCP_RTO_MIN)	Also known as “TCP_timeout_init” *Note: not configurable per connection*

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	Feature	RFC	M/O	Value	Comments
2	Minimum Retransmission Time	793 1122	M	1-5s (Recommended: 4 s)	TCP_RTO_MIN: The RTO is not allowed to be lower than this value *Note: not configurable per connection*
3	Maximum Retransmission Timeout	793 1122	M	>=5s (Recommended: 10 s)	TCP_RTO_MAX: Should be set to a value that defines the maximum allowed time before a forced re-transmission *Note: not configurable per connection*
4	Karn and Jacobson's algorithm, with exponential back-off	1122	M	Used	Standard TCP feature to compute RTO *Note: not configurable per connection*
6	TcpMaxConnectRetransmissions	793 1122	M	3	Number of SYN-packet retries; also known as “TCP_SYN_retries” *Note: not configurable per connection*
7	TcpMaxDataRetransmissions	793 1122.	M	1-5 (Recommended: 3)	Also known as “TCP_retries2” *Note: not configurable per connection*
8	TcpKeepAliveTime	793 1122	M	10-20 s (Recommended: 12 s)	The interval to wait before probing the idle connection *Note: configurable per connection*
9	TcpKeepAliveInterval	793 1122	M	2-5 s (Recommended: 3 s)	The interval to wait before retrying the probe after an initial failure to respond: *Note: configurable per connection*
10	TcpKeepAliveProbes	793 1122	M	2-4 (Recommended: 3)	The maximum number of times to retry the probe *Note: configurable per connection*
11	TcpUserTimeout	5482	O	>=10 (Recommended: 20 s)	The TCP user timeout controls how long transmitted data may remain unacknowledged before a connection is forcefully closed. It is checked during RTO update. *Note: configurable per connection*
12	TcpSack	2018 2883	M	enabled	Selective Acknowledgement *Note: not configurable per connection*
13	TcpTimestamps	7323	M	disabled	*Note: not configurable per connection*
14	TcpNoDelay	1122 6633	M	enabled	Disables Nagel’s algorithm which concatenates small messages before sending them *Note: configurable per connection at API level but the changing configuration is intentionally not supported by the DNS TXT field*
15	TCP Push Bit	793	M	enabled	Force the processing of the receiver buffer *Note: not configurable per connection*
16	Max TCP segment size	793	M	<= 1416	Maximum value is MTU - sizeof(max TCP Header) - sizeof(max IP Header)

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	Feature	RFC	M/O	Value	Comments
				(Recommended: = 1416)	Where guaranteed MTU=1500 byte, sizeof(max TCP Header)=60 byte, sizeof(max IP Header) = 24 byte *Note: configurable per connection*

6.4.4 Network Layer

6.4.4.1 The network layer protocol is IPv4 [RFC 791].

6.4.5 Data Link Layer

6.4.5.1 These interfaces, like PPP or Ethernet, are specified in the [EuroRadio FFFIS]

6.4.6 Time sequences

6.4.6.1 The time sequences are shown for the sublayers of the protocol stack which are applied on top of GPRS.

6.4.6.2 Figure 11 contains the signalling flow for PS service setup (see also ANNEX G), applicable at OBU side only. This signalling flow is necessary in the following cases:

- after initialization of the Mobile Termination to provide the radio resources and mobility management.
- on explicit request from the application (i.e. border crossing).
- following loss of radio coverage.

6.4.6.3 Network registration shall be performed followed by:

- on all mobiles: a single attempt of GPRS attachment (+CGATT) with timeout of 5s;
- on one mobile: a single attempt of PDP context activation (+CGACT) with timeout of 3s.

6.4.6.4 The successful network registration shall be reported to the application, even in case of GPRS attachment (+CGATT) and/or PDP context activation failure, which shall then be continuously monitored on one mobile by a polling task in the following conditions:

- Start the polling on all MT's, successfully registered on a network, not associated to transport connections and in command state, otherwise don't poll.
- Every predefined polling period (max 10s), perform GPRS attachment (+CGATT) and PDP context activation (+CGACT).
- As soon as successful/unsuccessful PS status is received form the MT, the PS status is changed accordingly.
- When the polling period expires, if there is no PS status received from the MT, the PS status is not updated and the ongoing GPRS attachment (+CGATT) and PDP context activation (+CGACT) shall be aborted and restarted.
- If the association of the MT with a transport connection is requested by an application while polling is ongoing, the polling shall be aborted anytime, and the status of PS shall be the last known one (successful or unsuccessful).

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- The polling procedure is managed independently on all MTs.

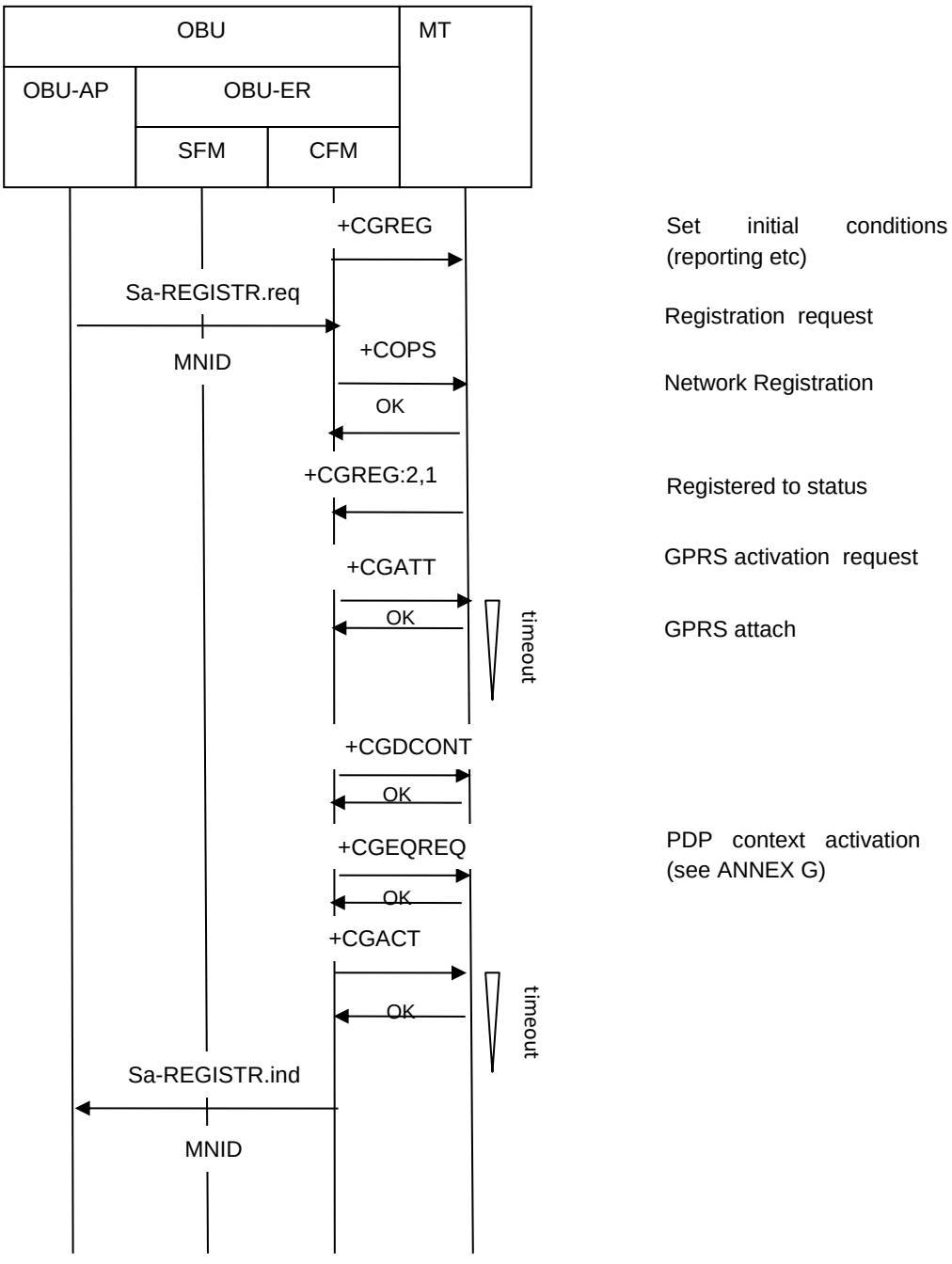
6.4.6.5 Figure 12 contains the connection establishment (OBU side only) protocol sequence.

6.4.6.6 Figure 13 contains the detailed protocol sequence during data transfer.

6.4.6.7 Figure 14 contains the detailed protocol sequence for connection release.

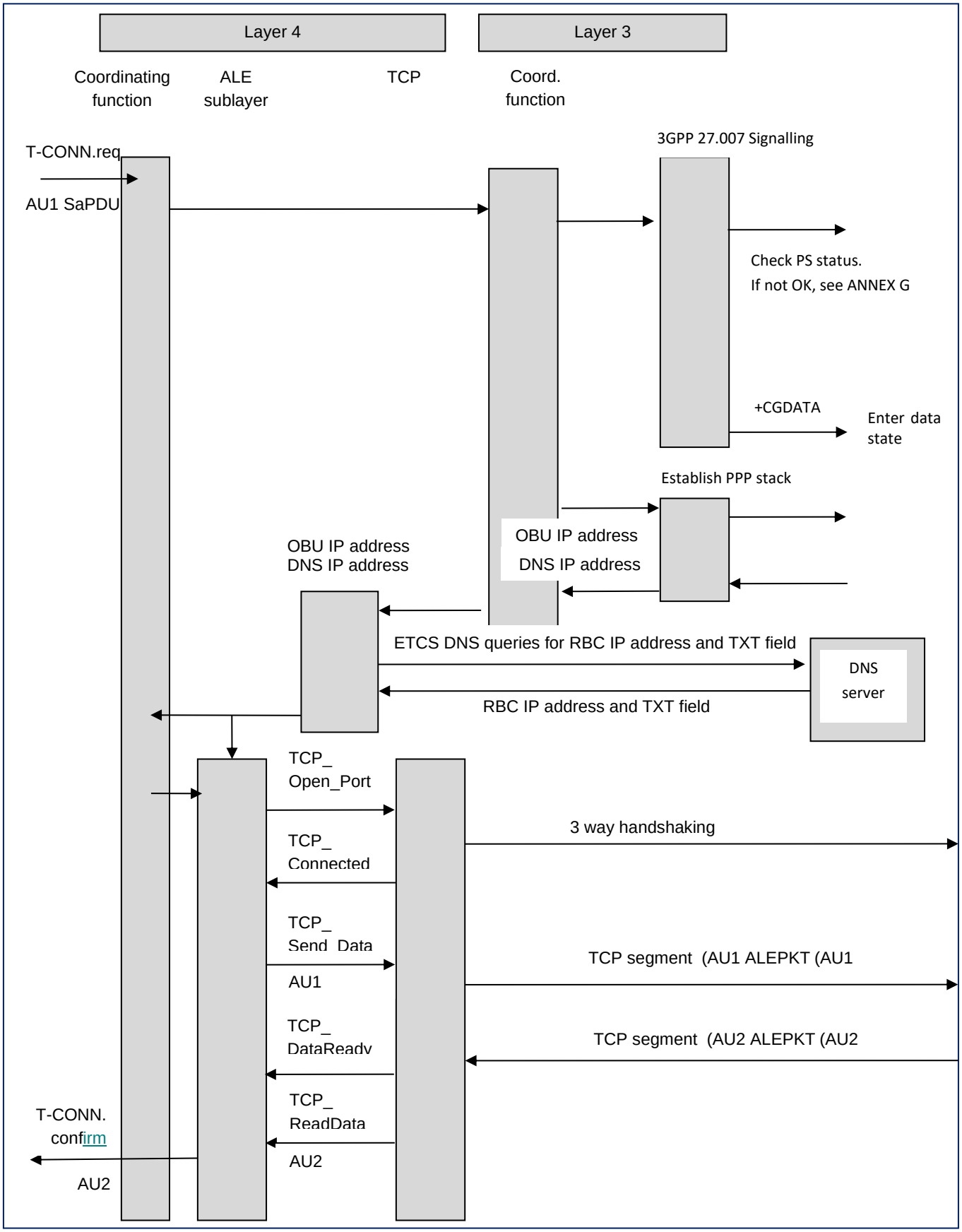
6.4.6.8 Note: the exchange of AU3 and AR SaPDUs are out of scope for transport connection establishment.

6.4.6.9 Note: the AT commands shown in the pictures are specified in the [EuroRadio FFFIS].



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Figure 11 Time sequence "Network registration and PS service setup" (OBU side only)



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Figure 12 Time sequence "Connection establishment" (OBU side only)

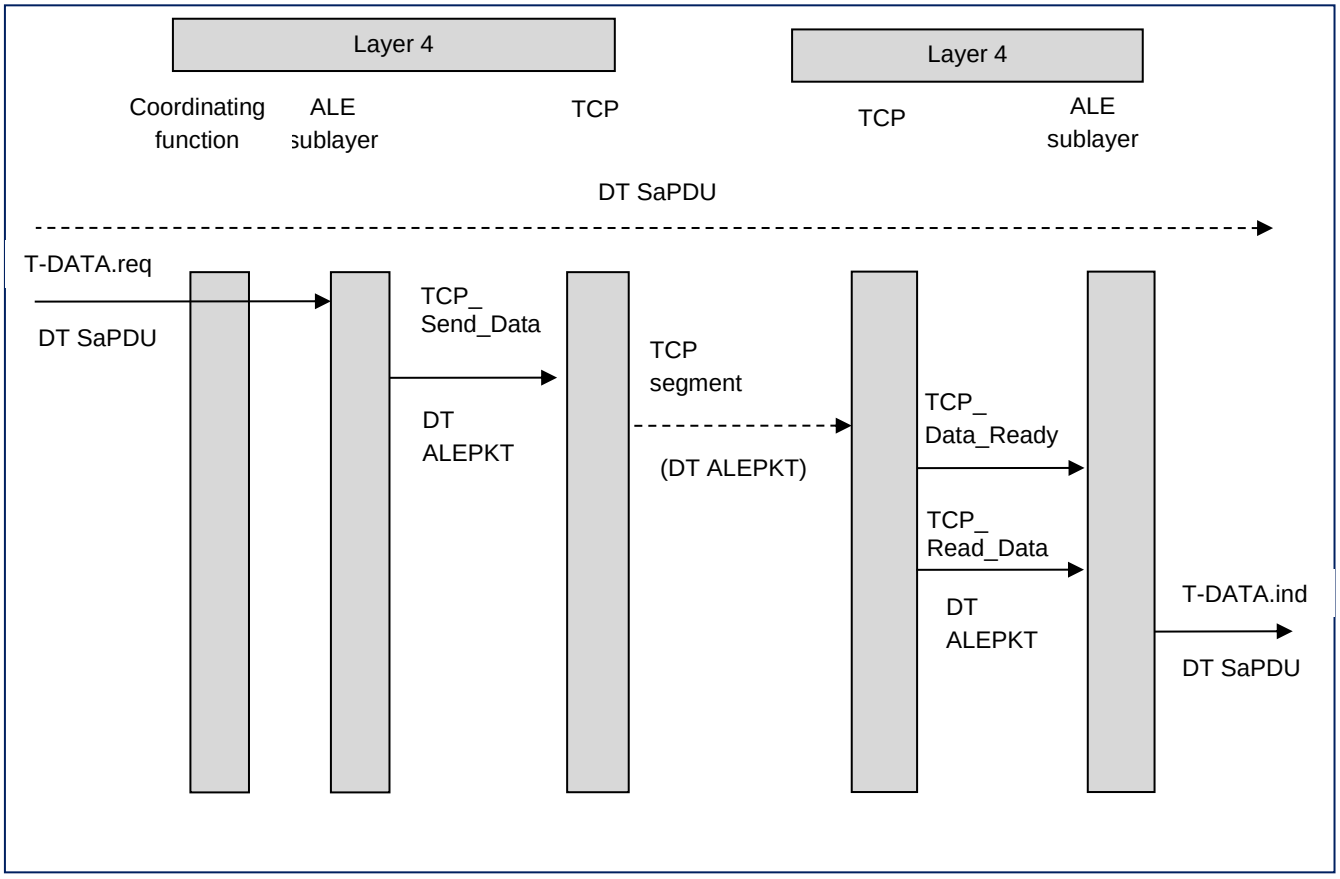


Figure 13 Time sequence "Data Transfer"

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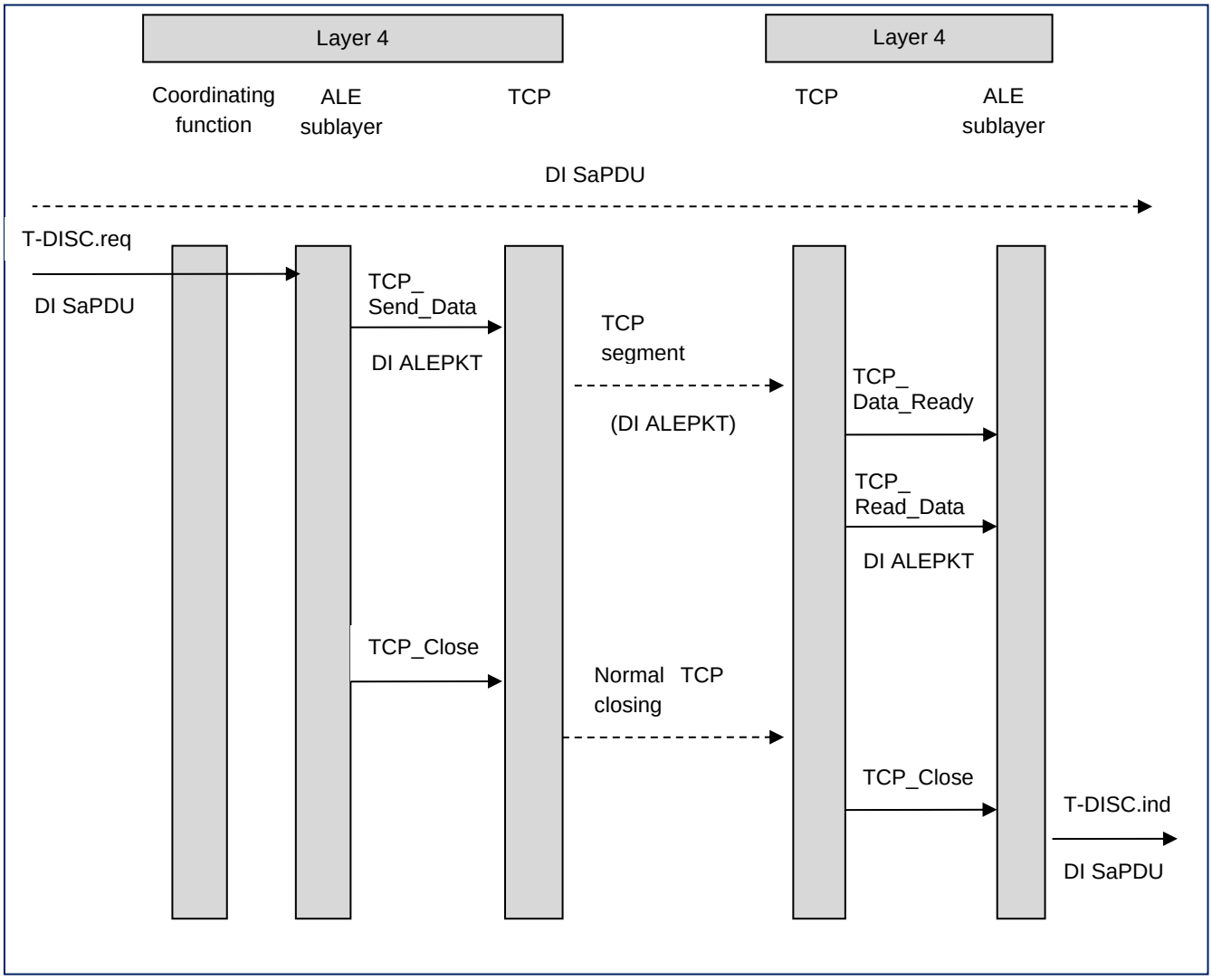


Figure 14 Time sequence "Connection Release"

6.4.7 Relationship of PDUs

6.4.7.1 This section contains examples of layer overheads of the protocol stack based on top of GPRS.

6.4.7.2 The safety layer adds a header and the MAC to the user data.

6.4.7.3 The ALE sublayer adds a 10 octet header (or more, if Packet Type equals 1 or 2) to the user data.

6.4.7.4 The transport layer adds a 24 octet header (or more) to the user data.

6.4.7.5 The IP layer adds a 20 or 24 octet header to the user data.

6.4.7.6 Neither the ALE sublayer nor the transport layer segment/reassemble the user data.

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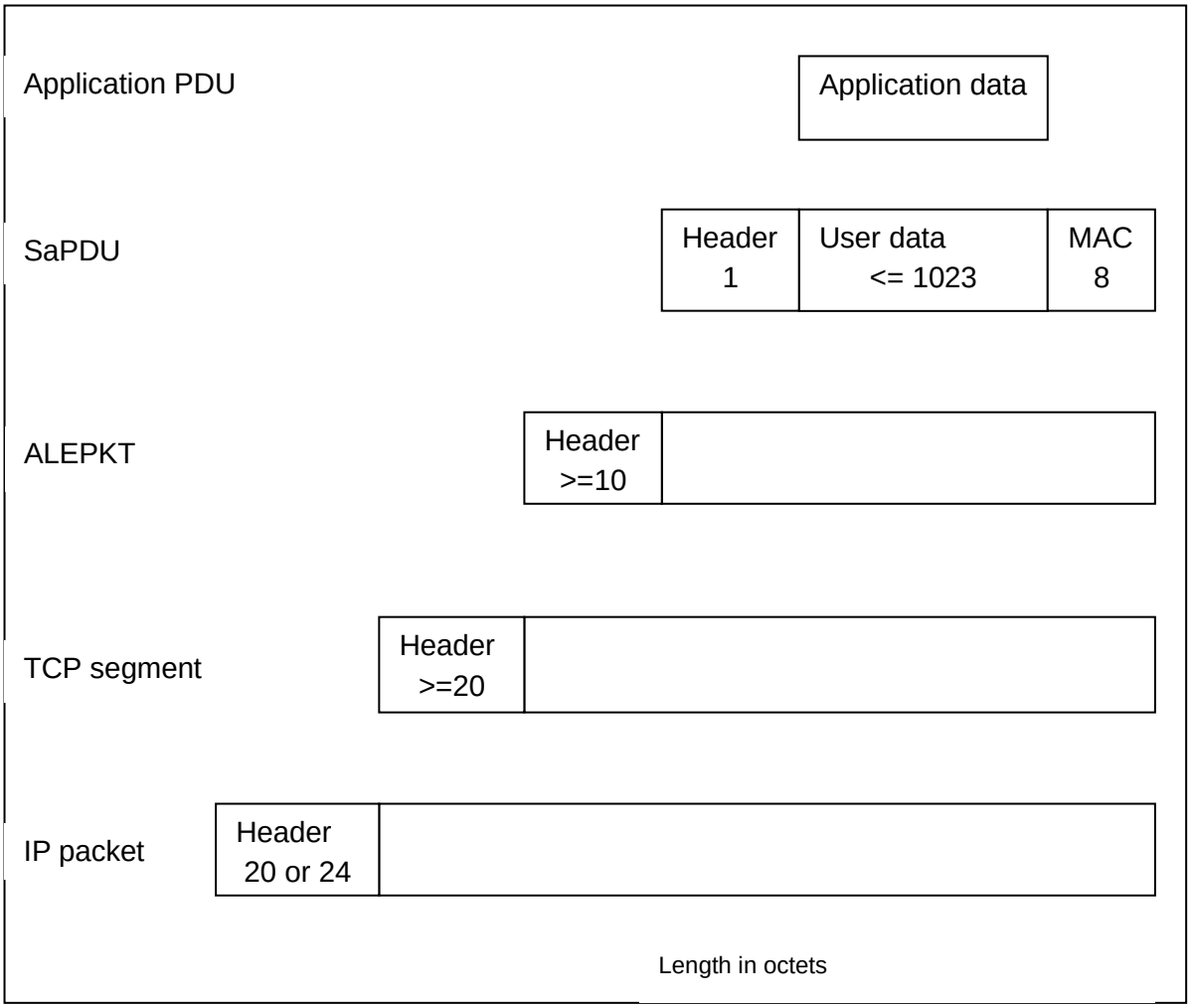


Figure 15 Relation between PDUs

6.5 Management of Communication Functional Module

6.5.1 Coordinating Function

6.5.1.1 The task of the coordinating function is to select the proper Communication Functional Module between Legacy GSM-R CS mode, Legacy GSM-R PS mode or FRMCS.

6.5.1.2 The main principle for choosing the transmission mode is to use FRMCS whenever possible, GPRS Packet Switched mode as a second alternative, and as a last alternative, Circuit Switched mode.

6.5.1.3 The coordinating function will store the last used mode per trackside ETCS ID in a ‘transmission mode table’, and for subsequent communication sessions the mode stored in the table will be used for setting up a communication session.

6.5.1.4 During an ongoing communication session, the coordinating function will try to proove the connection availability in parallel with the same ETCS ID via a more preferred mode without any action on the User Plane. That is, if the ongoing communication is using CS mode, then PS mode and FRMCS mode will be examined in parallel, and if the ongoing communication

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is using PS mode, then FRMCS mode will be examined in parallel. The most preferred mode possible is then stored in the transmission mode table.

6.5.1.5 The CFM has to establish the connections on demand between peer applications (i.e. CFM users). The details of the following tasks are a matter of implementation.

6.5.1.6 The communication functional module optionally offers several logical connections between the trackside and the on-board equipment via the same physical channel. This option is not required for ETCS level 1 radio in-fill unit. See 6.2.1.4.

6.5.1.7 The ”transport address” is a generic name that is used to identify a set of transport service access points (TSAPs) which are all located at the interface between a higher layer and the transport layer of the CFM. If a generic name is used to denote an object, then exactly one member of the set of objects will be selected.

6.5.1.8 The transport address is used to access a single transport service (TS) user entity. The network address by itself is not sufficient to identify a particular CFM user entity. It is necessary to refer to the requested CFM user entity type by using a special identifier or address qualifier: the application type.

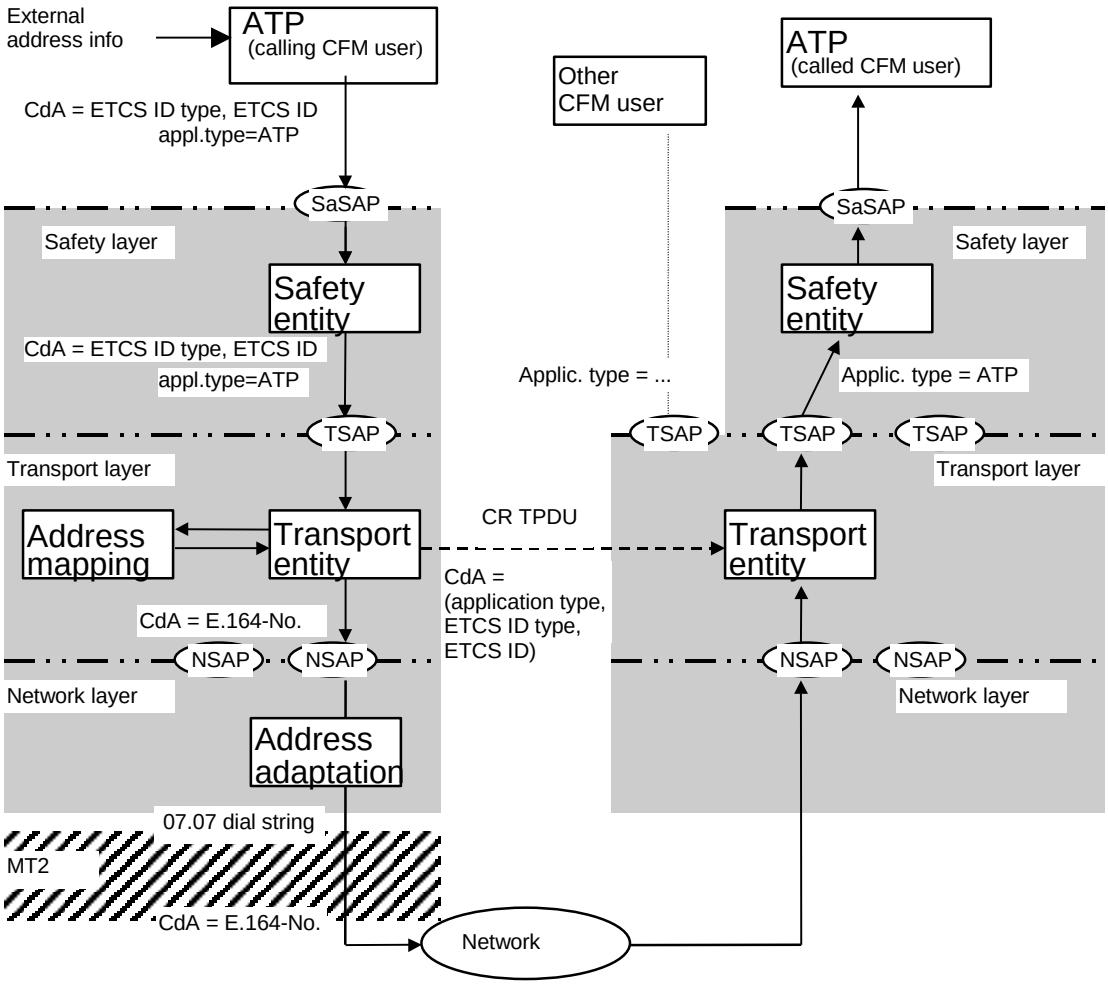


Figure 16 Example of address mapping

6.5.1.9 Transport layer entities and CFM user entities are bound together at TSAPs. Every CFM user entity may be bound to one or more TSAPs. This is a matter of implementation. There

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is no relationship between TSAPs and multiplexing. The multiplexed transport connections may terminate at different TSAPs.

6.5.1.10 The addresses are used in the T-CONNECT primitives (transport address) and N-CONNECT-primitives (network address) at the service interface. If a CFM user entity (e.g. the safety layer entity) wants to establish a connection with another CFM user entity, it provides information to address the called CFM user (e.g. an ETCS ID type and ETCS ID) and the application type. This address information has to be mapped into the format and structure requested by the CFM for connection establishment.

6.5.1.11 Figure 16 gives an example of address information mappings during the connection establishment from trainborne CFM to trackside CFM. The calling TS user entity (i.e. in this example the safety layer entity) obtains the called transport address from the application (ETCS ID type and ETCS ID). The address information will be passed through the SFM towards the CFM.

6.5.1.12 The calling CFM has the following tasks:

- To check, that a Mobile Termination is registered with the mobile network contained in the T-CONNECT.request;
- In PS mode, to check that the MT is attached to the mobile network contained in the T-CONNECT.request and to attach the MT if necessary;
- In PS mode, to activate the PDP context activation if not yet active;
- To associate the requested connection with an appropriate Mobile Termination;
- To derive the called network address from address information indicating the called CFM user;
- To insert into the connection request (CR) TPDU the called transport selector (in the case of train initiated physical connection establishment according to Figure 5) and the calling transport selector;
- To select the local NSAP by which the network service primitives (if applicable) is issued.
- After the PS service setup is successful (see ANNEX G), to perform an independent simultaneous ETCS DNS queries for A and TXT field using the ETCS ID type and ETCS ID contained in the received T-CONNECT.request.
- To store the Transmission mode (PS or CS) received in the ETCS DNS responses, to be used to establish the connection requested in the T-CONNECT.request.
- The table associating the transmission mode (PS or CS or FRMCS) with the ETCS ID type and ETCS IDs shall not be pre-configured, and shall be stored to be used also after reboots.

6.5.1.13 The following rules are implemented by the coordinating function to derive the called network address in the case of train initiated connection establishment (see also ANNEX H):

1. If the T-CONNECT.request primitive received contains an unknown ETCS ID type and ETCS ID, the address contained in the T-CONNECT.request primitive shall be used for physical connection establishment. The network address is transparent for

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CFM. If the network address is not contained in the T-CONNECT.request primitive, the call shall be established towards the most appropriate RBC by means of the short dialling code, refer to [EIRENE SRS]). All the following points shall be ignored.

2. The ETCS on-board equipment shall check the information stored in the Transmission Mode table associated to the ETCS ID type and ETCS ID contained in the received T-CONNECT.request primitive.
3. If the Transmission Mode information associated is FRMCS and if the FRMCS connection establishment is not successful the Transmission Mode information shall be set to CS.
4. If the Transmission Mode information associated is not FRMCS the Transmission Mode information shall be updated simultaneously to the CS or PS connection:
    a. Check the status of network service registration, if not registered do nothing.
    b. Start FRMCS connection establishment
    c. If connection setup is successful store FRMCS in the table and disconnect, if not do nothing.
5. If there is no Transmission Mode information associated and the PS service setup is not successful, the following actions shall be executed:
    a. the Transmission Mode information shall be set to CS;
    b. the address contained in the T-CONNECT.request primitive shall be used for physical connection establishment. The network address is transparent for CFM;
    c. if the network address is not contained in the T-CONNECT.request primitive, the call shall be established towards the most appropriate RBC by means of the short dialling code, refer to [EIRENE SRS]).
6. If there is no Transmission Mode information associated, the FRMCS service setup is not successful and the PS service setup is successful, independent simultaneous ETCS DNS queries for A and TXT field using the ETCS ID type and ETCS ID contained in the received T-CONNECT.request primitive shall be sent. The ETCS DNS queries shall be repeated every *dns_lookup_reptime* up to the *dns_lookup_timeout* if no response is received:
    a. If the responses from the ETCS DNS contain no IP address and a TXT field indication CS Mode (see below), the Transmission Mode information shall be set to CS and the address contained in the T-CONNECT.request primitive has to be used for physical connection establishment. The network address is transparent for CFM; if the network address is not contained in the T-CONNECT.request primitive, the call has to be established towards the most appropriate RBC by means of the short dialling code, refer to [EIRENE SRS]);
    b. If the responses from the ETCS DNS contain an IP address, the Transmission Mode information shall be set to PS and the IP address shall be used for the connection establishment; the IP address shall not be stored for subsequent connection establishment requests to the same RBC.
    c. In the following error cases the behaviour shall be the same as for a:

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i. if the PPP Activation timed out after ppp_activation_timeout, see 8.4.2.3.3.1;

ii. or if no response is received from the DNS after dns_lookup_timeout, see 6.5.2.3.2.1;

iii. or if is received a response from the DNS with an error message;

iv. or if the responses from the DNS contain no IP address but no TXT file;

v. or if the response from the DNS contains a wrongly formatted TXT field,

7. If the Transmission Mode information associated is CS, the following actions shall be executed:

   a. the address contained in the T-CONNECT.request primitive has to be used for physical connection establishment. The network address is transparent for CFM;

   b. if the network address is not contained in the T-CONNECT.request primitive, the call has to be established towards the most appropriate RBC by means of the short dialling code, refer to [EIRENE SRS]).

   c. Update of the Transmission Mode information simultaneously to the CS connection:

      i. Check for association of MT to transport connections. If all MT are associated, the update will be delayed until one is not associated. If the established CS connection is released before an MT is available the update shall be aborted.

      ii. After the PS service setup is successful on the MT, an ETCS DNS query for the A field using the ETCS ID type and ETCS ID contained in the received T-CONNECT.request primitive shall be executed.

      iii. If the responses from the DNS contain an IP address, the Transmission Mode information associated to the ETCS ID type and ETCS ID contained in the received T-CONNECT.request primitive shall be changed to PS, but the IP address itself shall not be stored.

      iv. In all the other cases nothing shall be done.

8. If the Transmission Mode information associated is PS and if the PS service setup is not successful, a T-DISCONNECT.indication primitive with reason 3 and sub-reason 2, according to Table 15, shall be sent to the CFM user.

9. If the Transmission Mode information associated is PS and if the PS service setup is successful, independent simultaneous ETCS DNS queries for A and TXT field using the ETCS ID type and ETCS ID contained in the received T-CONNECT.request primitive shall be sent. The ETCS DNS queries shall be repeated every *dns_lookup_reptime* up to the *dns_lookup_timeout* if no response is received:

   a. If the responses from the ETCS DNS contain no IP address but a TXT field indication CS Mode (see below), the Transmission Mode information shall be

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set to CS and a T-DISCONNECT.indication primitive with appropriate reason shall be sent to the CFM user;

b. If the responses from the ETCS DNS contain an IP address, the IP address shall be used for the physical connection establishment, while the TXT field shall be used for suggested specific transmission protocol parameters (see 6.5.1.17); the IP address shall not be stored, before any other TCP connection or reconnection, a DNS query shall be made;

c. In the following cases, a T-DISCONNECT.indication primitive with appropriate reason shall be sent to the CFM user:

   i. if the PPP Activation is not completed after ppp_activation_timeout (defined in 8.4.2.3.3.1);

   ii. or if no response is received from the DNS after dns_lookup_timeout (defined in 6.5.2.3.2.1);

   iii. or if a response is received from the DNS with an error message;

   iv. or if the responses from the DNS contain neither an IP address nor a TXT file;

   v. or if the responses from the DNS contain a wrongly formatted TXT field;

   vi. or in case of a not successful connection establishment.

6.5.1.14 The DNS Record TXT field in scope of EuroRadio is a semicolon separated and ended list of uniquely named, by equal sign, comma separated lists containing unique strings including empty strings. Characters are ASCII. E.g. "txm=cs;foo=bla;tp=blub,,b;".

6.5.1.15 Transmission mode PS will be indicated by an IP address in the A field of the DNS record.

6.5.1.16 If no PS mode will be supported by the RBC other supported RBC EuroRadio transmission modes are indicated by the “txm” named list of the DNS record’s TXT field. Indicate able transmission modes are:

- CS by the string “cs” contained in the txm list

Future releases might support additional transmission modes.

Note: To force the fallback to CS mode for an RBC, no A record shall be contained within the respective DNS response (but only the TXT field with “txm=cs”).

6.5.1.17 Suggested specific transmission protocol parameters are indicated by the “tp” named list of the DNS record’s TXT field. Each entry of this list matches, in order, to a transport parameter as per Table 8 which is commented as “configurable per connection”. I.e. for “tp=<p1>,<p2>,<p3>,<p4>,<p5>;” the following correspondence holds:

- <p1> : TcpKeepAliveTime
- <p2> : TcpKeepAliveInterval
- <p3> : TcpKeepAliveProbes
- <p4> : TcpUserTimeout
- <p5> : Max TCP segment size.

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Omitting the setting of a parameter is indicated by an empty string at the corresponding list position. The strings are to be interpreted as of the intended value's unit (e.g. the <p1> parameter represents seconds, the <p3> parameter represents "count").

Numbers are decimals represented as strings, i.e. "580" for the decimal number 580.

In the following cases, the suggested parameters shall not apply at all:

- In case of definition range mismatch between any single parameter with its general value range as per Table 8 "Value" column
- In case of expected parameter count mismatch

The use of a suggested parameter is mandatory unless it is not settable in the used TCP implementation.

6.5.1.18 Note: The details of local call and ID management (e.g. address mapping) are out of scope for this FIS.

6.5.1.19 Table 9 shows the defined combinations of address information values.

Table 9 Address information (train initiated call set-up)

ETCS ID type	ETCS ID	Network address	Action	Remarks
RBC	RBC ID	RBC network address provided	CS mode: use network address, update the Transmission Mode via the other MT if possible PS mode: retrieve IP address from DNS	
RBC	RBC ID	Network address not provided or Default value "NA unknown"	CS mode: use short dialling code "Most appropriate RBC", update the Transmission Mode via the other MT if possible PS mode: retrieve IP address from DNS	Short dialling code 15xx [EIRENE SRS]
"unknown"	Default value "ETCS ID unknown"	Network address not provided or Default value "NA unknown"	CS mode: use short dialling code "Most appropriate RBC", NO update of the Transmission Mode via the other MT PS mode: cannot be used	Default for addressing in CS
"unknown"	Default value "ETCS ID unknown"	RBC network address provided	CS/PS mode: use network address	PS mode: not used for ETCS applications

6.5.1.20 The ConnectRequest TPDU (CR TPDU) and the ConnectConfirm TPDU (CC TPDU) contain the calling and the called transport selectors in the format specified for the TPDUs (see section 6.3.4.6).

6.5.1.21 In CS mode the trackside called network address will be a generic address to identify a set of network service access points (NSAPs), which are bound to the "Primary rate access" (ISDN-like networks). The called network number should be a "hunting number": incoming calls to the network number will be distributed by the terminating exchange (or the PABX) among a group of interfaces. One of the idle interfaces will be selected to receive the call.

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6.5.1.22 In PS mode the trackside called network address will be an IP address identifying the peer RBC.

6.5.1.23 The trackside sets of TSAPs are bound to special CFM user entities (e.g. in Figure 16 the safety layer entity is bound to a special TSAP). The CFM user entity A is bound to a TSAP but actually not used (may be it is a non-safe application layer entity, which has to use another TSAP and application type).

6.5.1.24 The transport layer entity in the called CFM uses:

- the address information contained in the connection request (CR) TPDU to derive the called ETCS ID type and ETCS ID and to select one appropriate TSAP (based on the application type received);
- the responding ETCS ID type and ETCS ID contained in the T-CONNECT.response primitive to build the connection confirm (CC) TPDU.

6.5.1.25 If the transport layer entity of the called side is not able to select a TSAP bound with the requested application type, the CR TPDU will be rejected.

6.5.2 Configuration management

6.5.2.1 The local O&M stack provides an initial set of configuration parameters, which are to be set as follows.

6.5.2.2 **Configuration parameters for CS mode**

Table 10 Layer 2 configuration parameters for CS mode

Parameter	Symbol	Interoperability relevant	Recommended value (if not interoperability relevant)	Mandatory value (if interoperability relevant)	Comments
Address			A, B	Calling entity: A Called entity: B	
Maximum number of bits in an I frame	N1	Yes		240 ≤ N1(Tx) ≤ 1024 N1(Rx)=1024	Parameter k and N1 can be different in both directions. Flags are not included
Window size	k	Yes		$k = \frac{X * 2 * TF}{(N1 + 16) * 1.25} + 2$ k(Rx) = 17, for N1=240 e.g.: N1(Tx)=312 k(Tx)=14	As a consequence of the max value for N1(Tx), receive buffers have to support N1 =1024. In the Rx side, the values are fixed to their maximum. Recommended value for transmission N1 = 312 (This is equal to 4 frames per 1 TPDU) (see ANNEX E, consideration 1)
Acknowledge time	T1	Yes		T1=1.5 s	See ANNEX F, consideration 2
Local processing delay time	T2	Yes		< 80 ms	Implementation dependent

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Parameter	Symbol	Interoperability relevant	Recommended value (if not interoperability relevant)	Mandatory value (if interoperability relevant)	Comments
Out of service time	T3	No	T3 >> T4		Matter of implementation (to be used only if T4 is supported)
Inactivity time	T4	No	T4=2 s		Matter of implementation (see ANNEX F, consideration 3)
Maximum number of retransmission attempts	N2	Yes		4	Note: ISO/IEC 7776 specifies the number of transmissions = N2+1 (see ANNEX F, consideration 4)
Error detection and correction				FCS-16	No options

6.5.2.2.1 Interoperability relevant parameter values according to Table 10 are mandatory; non-interoperability relevant parameters can be used for tuning the HDLC.

6.5.2.2.2 The description of the layer 2 configuration parameters for CS mode is provided by [ISO/IEC 7776] section 5.7.

6.5.2.2.3 Timer T5 shall not be used.

6.5.2.2.4 The description of the layer 3 configuration parameters for CS mode is provided in [ITU-T T.70].

Table 11 Layer 3 configuration parameters for CS mode

Parameter	Symbol	Range of values	Applied value	Comments
Maximum number of octets in a segment	N_{L3seg}		N_{L3seg}=(N1/8)-5	The layer 3 header is included. N_{L3seg} is related to the layer 2 frame length N1

6.5.2.2.5 The description of the layer 4 configuration parameters for CS mode is provided by [ITU-T X.224].

Table 12 Layer 4 configuration parameters for CS mode

Parameter	Symbol	Range of values	Applied value	Comments
TP class	TP x		TP 2	No choice
Procedure elements				Refer to Table 4
Standard TPDU length	N_{TPDU}	1 - 128 octets	128 octets	
Initial credit	N_{TIC}	1 – 15	15 1	Application type = ATP All other optional application types

6.5.2.3 **Configuration parameters for PS mode**

6.5.2.3.1 TCP Configuration Parameters

6.5.2.3.1.1 Refer to see Table 8 for the values to be set to the TCP parameters.

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6.5.2.3.2 ETCS DNS query Configuration Parameters

6.5.2.3.2.1 The dns_lookup_timeout parameter shall be set to 5 sec.

6.5.2.3.2.2 The dns_lookup_reptime parameter shall be set to 1s.

6.5.2.3.3 PPP Activation parameter

6.5.2.3.3.1 The ppp_activation_timeout parameter shall be set to 2 sec.

6.5.2.4 QoS parameters

6.5.2.4.1 Normally, the QoS parameters give CFM users a method of specifying their needs, and give the CFM a basis for selection of the protocol or for requesting services of lower layers. For the purposes of this FIS sets of QoS parameters values are specified.

6.5.2.4.2 Each value of service primitive parameter **QoS class** is associated with a set of QoS parameter values, which represents the requirements to the physical connection to be established. The requirements are independent from application type.

6.5.2.4.3 Only for CS mode, the default value for the QoS parameter **User data rate** is 4800 bit/s. For PS mode it is not used.

6.5.2.4.4 The range of QoS parameter **Transport priority** is 0-5. Table 13 contains the association with application types.

Table 13 Transport priority

Value	Associated application type	Comments
0	-	Not used
1	Application type ATP	Highest value used
All other values are reserved.		

6.5.2.4.5 Only for CS mode, QoS classes 0-9 are reserved for application type ATP of ERTMS/ETCS. The data rate and eMLPP priority (refer to section 6.3.4.2) parameters have to be used during physical connection set-up. For PS mode it is not used.

Table 14 Mapping of QoS classes 0-9

QoS class	Service	Nominal bit rate [bit/s]	eMLPP priority
1	CS	4 800	1
	All other QoS class values are reserved for future use.		

6.5.3 Supervision / Diagnostics

6.5.3.1 Error handling

6.5.3.1.1 If an error occurs in the communication functional module or if the communication functional module receives an indication of an error, the error and its reason will be indicated. The different reasons require different error handling actions. The errors can be ignored, locally logged or indicated.

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6.5.3.1.2 If there is a problem with call establishment, the CFM should try by itself to recover the problem. Only if the problem cannot be solved, (i.e. the transport connection cannot be established), will the CFM inform the CFM user.

Table 15 Error types of the CFM and their handling

Reason/ code	Sub-reasons		Error handling action
Network error Code =1	1 2 3	Number not assigned; invalid number format Channel unacceptable Impossibility to establish physical connection for other reason (e.g. V.25ter response No DIALTONE)	Indication of a persistent error is created by the provider and is contained in the reason parameter of the T-DISCONNECT.indication
Network resource not available Code =2	1 2 3	No channel available Network congestion Other sub-reason (e.g. V.25ter response NO CARRIER)	Indication of a transient error is created by the provider and is contained in the reason parameter of the T-DISCONNECT.indication
Service or option is temporarily not available Code =3	1 2	QoS not available Bearer capability not available	Indication of a transient error is created by the provider and is contained in the reason parameter of the T-DISCONNECT.indication
Reason unknown Code =5			Error indication is created by the called communication functional module and is contained in the reason parameter of the T-DISCONNECT.indication.
Called TS user not available Code =6	1 2 3	Application of requested type is not supported Called user unknown (e.g. V.25ter response NO ANSWER) Called user not available (e.g. V.25ter response BUSY)	Error indication is created by the called communication functional module and is contained in the user data of the DR TPDU. The calling CFM will report the error to the calling application with the T-DISCONNECT.indication
Internal error Code =7	1 2 3	Mandatory element[13] is missing (e.g. element of a TS primitive) Inappropriate state Other sub-reasons (e.g. V.25ter response ERROR)	Error logging Deletion of the invalid message
mobile registration error Code =8	1	No Mobile Termination has been registered	T-DISCONNECT.indication The application should re-try network registration
Notes: 1. All other reason/sub-reason values are reserved. 2. Reasons and sub-reasons are a matter of implementation. 3. Reason Code 0 is reserved for normal release requested by a CFM user.			

6.5.3.2 Error reporting

6.5.3.2.1 The safety functional module and/or the applications are informed about error situations that lead to a disconnection by using the T-DISCONNECT indication service primitive.

Table 16 Parameter of the T-DISCONNECT Primitive and their contents

Parameter of the T-DISCONNECT Primitive	Contents
Reason	TS user invoked / TS provider invoked In the case of TS provider disconnection: error type/sub-reason (see Table 15)
User data	User data of the DISCONNECT request of the remote TS user (internal information from the remote TS user)

[13] Caused by the local application

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6.5.3.3 **Error logging**

6.5.3.3.1 Error logging is a matter of the implementation.

6.6 Resource Management for on-board IP communication applications

6.6.1.1 Communication resources not currently used by ETCS may be used by other on-board applications for IP communication.

6.6.1.2 The use of communication resources is managed according to the priority of the application. Assigned resources may therefore be revoked if an application with higher priority requests communication resources.

6.6.1.3 Three service primitives are provided:

- **Rm-SERVICE.request**

  User request for communication resources.

- **Rm-SERVICE.release**

  Release of communication resources by user or by resource manager.

- **Rm-SERVICE.indication**

  Result from a request for communication resources.

Table 17 Service primitives of the Resource Management

Primitive / Parameter	Rm-SERVICE. request	Rm-SERVICE. indication	Rm-SERVICE. release
Application Type	X		
Service ID		X	X
Reason		X	
Sub-reason		X	

6.6.1.4 The request for communication resources is made by using the **Rm-SERVICE.request** primitive. The parameter Application Type is supplied by the user. The resource manager will use this parameter to set the priority of the application and to assign APN and radio network quality of service parameters as specified in the table below.

6.6.1.5 Supported application types are listed in the following table.

Table 18 Application Types supported by the Resource Management

Application	Application Type	APN	QoS
Key Management	KMS	kms *Note: The APN will be extended by the*	As configured in APN, so 'AT+CGEQREQ', as

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		network by MNC and MCC according to [EIRENE SRS]	in G.3.1.2, is not necessary
Automatic Train Operation	ATO	ato *Note: Functional name, will be managed by the network*	FFS

6.6.1.6 At reception of Rm-SERVICE.request the resource manager will perform the following:

- Check if communication resources are available or that it is possible to revoke resources from an application with lower priority.
- If not already done, attach to GPRS, activate PDP context according to the application type and start the PPP protocol.
- Indicate the result to the user.

6.6.1.7 The result of a request of communication resources is sent to the user in the **Rm-SERVICE.indication** primitive. A Service ID is assigned and the outcome is indicated by the parameters Reason and Sub-reason.

Table 19 Successful Resource Management request

Reason Code	Sub-reason Code	Description
0		Communication resources are assigned to the user. The communication resource is identified by parameter Service ID.

Table 20 Sub-reasons for the reason NOT-Successful Resource Management request

Reason Code	Sub-reason Code	Description
1	1	Packet switched communication is not supported by network
	2	Communication resources are not available
	3	Network error
	4	Other fault

6.6.1.8 The parameter Service ID is a local identification of the communication resource.

6.6.1.9 A normal release of a communication resource is initiated by the user with the **Rm-SERVICE.release** primitive.

6.6.1.10 Revocation of a communication resource is initiated by the resource manager with the **Rm-SERVICE.release** primitive, as a result of another application with higher priority requesting communication resources or any network or equipment issue.

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ANNEX A. Intentionally deleted

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ANNEX B. (Option) Interface to communications services

B.1.1.1 Communication services are accessed by means of service primitives similar to the service primitives defined in [ITU-T X.214] for connection mode service.

B.1.1.2 Note: It is a matter of implementation to adapt this interface to implementation needs and constraints, where there is no exchange on the air gap and where there is no impact on the behaviour of the system.

B.1.1.3 The internal interface between the modules SFM and CFM is not mandatory.

B.1.1.4 The interface to communication services can be provided for non-safe applications.

B.2. Service primitives for connection establishment

B.2.1.1 The following table gives the service primitives used for connection establishment and their corresponding parameters.

Table 21 Service primitives of the communication layer for connection set-up

Primitive Parameters	T-CONNECT request	T-CONNECT indication	T-CONNECT response	T-CONNECT confirm
TCEPID		X	X(=)	X
Called address:				
Address type	X			
Network address	X(D)			
Mobile Network ID	X(U)			
Called ETCS ID type	X	X		
Called ETCS ID	X	X		
Calling address:				
Calling ETCS ID type	X	X(=)		
Calling ETCS ID	X	X(=)		
Responding address:				
Responding ETCS ID type			X	X(=)
Responding ETCS ID			X	X(=)
Application type	X	X(=)		
QoS class	X(D)			
User data	X(U)	X(=)	X(U)	X(=)

X Mandatory parameter.

(=) The value of that parameter is identical to the value of the corresponding parameter of the preceding transport primitive.

X(U) Use of this parameter is a CFM user option.

X(D) Use of this parameter is an user option. If not provided, a default value will be used by CFM internally

B.2.1.2 The parameter **TCEPID** (Transport Connection End Point Identifier) is provided locally to distinguish between different transport connections.

B.2.1.3 The **Address type** qualifies the usage of sub-parameters of called address.

B.2.1.4 The **Mobile Network ID** identifies the mobile network. The Mobile Network ID shall consist of the Mobile Country Code and the Mobile Network Code according to [ITU-T E.212].

B.2.1.5 In the case of mobile originated calls, the connection request should contain the sub-parameter Mobile Network ID, to request the appropriate network associated with the called user.

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B.2.1.6 The **Network Address**, if provided, identifies the network address of the called CFM user. This parameter is composed of sub-fields, e.g. the length of the called number, the type of number, the numbering plan, and the number itself.

B.2.1.7 The parameter ETCS ID type together with ETCS ID is unique and are used by the transport layer during connection establishment. The ETCS ID type and ETCS ID together with the application type identifies the service user."

B.2.1.8 Within the scope of ETCS and refers to ETCS equipment. The ETCS IDs are used by the transport layer during connection establishment. The ETCS ID type and ETCS ID together with the application type identifies the service user. ETCS ID.

B.2.1.9 The **Calling ETCS ID** identifies, together with the application type, the transport connection initiator. The **Called ETCS ID** identifies together with the application type the called CFM user. The **Responding ETCS ID** identifies the accepting/responding CFM user, which was locally selected by the responding transport entity.

B.2.1.10 **Application type**: The application type is identical at the calling and called side (see section 6.3.4.6).

B.2.1.11 The **QoS class** is associated with a set of quality of service parameter values. The QoS parameters will not be negotiated. The requested QoS parameter values have to be accepted by the service provider and the peer application. Otherwise the connection establishment has to be rejected.

B.2.1.12 The user data length is restricted to 32 octets.

B.2.1.13 The following figure shows the sequence of transport service primitives at TSAP for connection establishment:

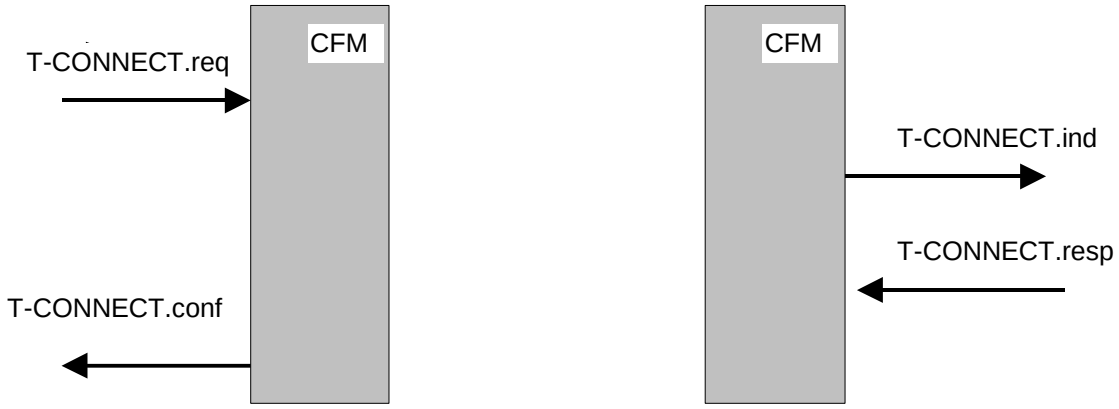


Figure 17 Sequence of primitives for connection set up

B.3. Service primitives for data transfer

B.3.1.1 The following table gives the service primitives of the communication layer used for data transfer:

Table 22 Service primitives of the communication layer for data transfer

Primitive Parameters	T-DATA.request	T-DATA.indication
TCEPID	X	X
User data	X	X(=)

B.3.1.2 A request for data transfer is made by a service user (after a successful transport connection set up) through the use of the T-DATA.request service primitive, with user data as a parameter. These data are delivered to the intended user through the use of the primitive T-DATA.indication with user data as a parameter.

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B.3.1.3 User data are transparent to the CFM. The recommended length is <= 123 octets. If more than 123 octets are requested, the CFM segments/reassembles the user data.

B.4. Service primitives for connection release

B.4.1.1 The transport connection release is provided by the communication layer through the service primitive T-DISCONNECT.request. The connection release is indicated to the user using the service primitive T-DISCONNECT.indication. The connection release is indicated to the communication layer user as a consequence of a disconnection request issued by the user (normal release), as a consequence of connection establishment rejection or because of a network failure.

B.4.1.2 The following table gives the service primitives used for connection release.

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Table 23 Service primitives of the communication layer for connection release

Primitive Parameters	T-DISCONNECT.request	T-DISCONNECT.indication
TCEPID	X	X
Reason		X(U)[1]
User data	X(U)	X(=)
Note: 1. It has to be used in the error case.		

B.4.1.3 Optionally, user data can be included (maximum 64 octets).

B.4.1.4 The following figure shows the sequence of transport service primitives at TSAP for connection release.

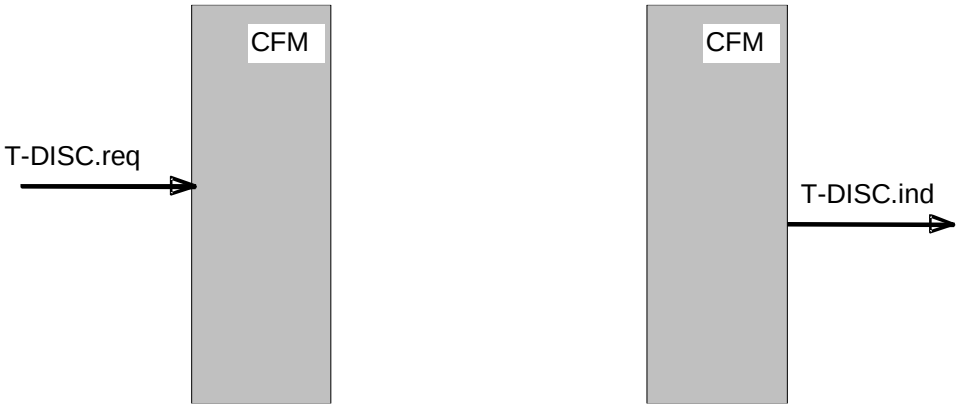


Figure 18 Sequence of primitives for connection release initiated by a CFM user

B.5. Service primitives for network registration

B.5.1.1 Two service primitives are provided for network registration of Mobile Terminations (MT) (see Table 24):

- to request mobile network registration
- to indicate mobile network registration status

B.5.1.2 These service primitives apply to on-boards only.

Table 24 Service primitives for network registration

Primitive Parameter	T-REGISTRATION.request	T-REGISTRATION.indication
MNID list	X (>= 0 MNIDs)	(>= 0 MNIDs)

B.5.1.3 By means of the service primitive “T-REGISTRATION.request” the service user is able to request the registration of one or more Mobile Terminations with one or more mobile networks.

B.5.1.4 A **Mobile Network ID** identifies the mobile network a local Mobile Termination is requested to register with. The Mobile Network ID shall consist of the Mobile Country Code and the Mobile Network Code according to [ITU-T E.212].

B.5.1.5 The interpretation of the MNID list is matter of implementation. E.g.:

Empty:

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All available Mobile Terminations are requested to be registered using automatic network registration from GSM-R on-board radio equipment (see 3GPP 22.011).

One entry:

All available Mobile Terminations are requested to be registered on network defined by the entry using manual network registration from GSM-R on-board radio equipment.

Two different entries (MNID#1, MNID#2):

The available Mobile Terminations have to be split in two parts and to register first part on network defined by MNID #1 and second part on network defined by MNID #2.

If FRMCS registration is available, additional one entry shall be added in the list.

B.5.1.6 In case not enough Mobile Terminations are available to perform registration on both networks, registration shall be provided according to MNID priority ranking.

B.5.1.7 The status of registration with mobile networks is indicated by the service primitive “T-REGISTRATION.indication” to the service user. The service primitive contains a list of Mobile Network IDs, which are usable because Mobile Termination(s) are registered with them.

B.5.1.8 Note: the association between MT and MNID in these service primitives is a local implementation matter.

B.5.1.9 The service user is not informed on how many Mobile Terminations are available but receives only status of registered network which means implicitly that connection request on these networks can be issued or not.

B.5.1.10 If the indicated list of Mobile Network IDs is empty, the registration of Mobile Terminations was not possible or the coverage has been lost.

B.5.1.11 The network registration indication can be given independently of a request. This feature allows indications after power-up or after loss of coverage. Any change on network registration can be indicated.

B.6. Service primitives for permitted networks

B.6.1.1 Two service primitives are provided for indication of permitted networks (see Table 25):

- to request a list of permitted mobile networks and
- to indicate this permitted list.

B.6.1.2 These service primitives apply to on-boards only.

Table 25 Service primitives for permitted networks

Primitive / Parameter	T-PERMISSION.request	T-PERMISSION.indication
MNID list	X (= 0 MNIDs)	X (>= 0 MNIDs)

B.6.1.3 By means of the service primitive “T-PERMISSION.request” the service user is able to request the indication of permitted mobile networks. **MNID list** parameter is empty for the request primitive.

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B.6.1.4 The permitted mobile networks are indicated by the service primitive “T-PERMISSION.indication” to the service user. The service primitive shall contain a list of MNIDs provided with their respective alphanumeric network names.

B.6.1.5 A **Mobile Network ID** shall consist of the Mobile Country Code and the Mobile Network Code according to [ITU-T E.212].

B.6.1.6 The network permission indication cannot be given independently of a request.

B.6.1.7 If the indicated list of Mobile Network IDs is empty no permitted network is found.

B.6.1.8 See ANNEX F for an informative example of how to create the list of permitted networks.

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ANNEX C. (Option) Safety Protocol Management

Intentionally deleted.

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ANNEX D. (Informative) Applicability conditions of ISO/IEC 7776 (1995)

D.1.1.1 Notes:

1. Only DTE to remote DTE will be considered since this is the case applicable to EuroRadio.
2. “Not applicable” means this case is not possible for EuroRadio.
3. “shall be used” and “shall not be used” indicate the application conditions for EuroRadio.
4. “Optional” means this feature can be implemented or not; if implemented it shall be compliant with the specification.

Section	Application conditions
Foreword	Annex A (conformance) shall not be used
Introduction	"Protocol Implementation Conformance Statement" shall not be used
§ 1 Scope	Shall be used Only the following features/options shall be used • DTE/DTE communication • Start/Stop transmission • Extended (mod 128) operation • Single link procedure Bilateral agreements means: “General agreement for all EuroRadio implementations is made by this application conditions” Clause 7 (conformance) shall not be used
§ 2 Normative references	Shall be used ISO/IEC 7478, X.25, ISO/IEC 9646-1,2:1994 ISO/IEC 646 are not applicable
§ 3 Frame structure	Shall be used. Table 1 (modulo 8) shall not be used.
§ 3.1 Flag sequence	Shall be used.
§3.2 Address field	Shall be used.
§ 3.3 Control field	Shall be used. Basic (modulo 8) operation shall not be used.
§3.4 Information field	Shall be used.
§ 3.5.1 Transparency Synchronous transmission	Not Applicable.
§ 3.5.2 Transparency Start/stop transmission	Shall be used. Control-escape transparency only shall be used.
§3.5.2.1 Seven-bit data path transparency	Shall not be used.
§ 3.5.2.2 Control-escape transparency	Shall be used.
§ 3.5.2.3 Extended transparency	Shall not be used.
§ 3.5.2.3.1 Flow-control transparency	Shall not be used.
§ 3.5.2.3.2 Control-character octet transparency	Shall not be used.

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Section	Application conditions
§ 3.6 Frame check sequence (FCS) field	Shall be used.
§ 3.7.1 Order of bit transmission	Shall be used. The order of transmitting bits within each octet in the information field is to send the least significant bit first.
§ 3.7.2 Start/stop transmission	Shall be used.
§ 3.8.1 Invalid frames Synchronous transmission	Not Applicable.
§ 3.8.2 Invalid frames Start/stop transmission	Shall be used.
§ 3.9.1 Frame abortion Synchronous transmission	Not Applicable.
§ 3.9.2 Frame abortion Start/stop transmission	Shall be used.
§ 3.10.1 Interframe time fill Synchronous transmission	Not Applicable.
§ 3.10.2 Interframe time fill Start/stop transmission	Shall be used. Flags shall not be used as interframe time fill. [FIS 8.2.2.7l)]
§ 3.11.1 Data link channel states Synchronous transmission	Not Applicable.
§ 3.11.2.1 Data link channel states Start/stop transmission Active channel state	Channel state shall not be used. Flags shall not be used as interframe time fill in. [FIS 8.2.2.7l)].
§ 3.11.2.2 Data link channel states Start/stop transmission Idle channel state	Channel state shall not be used. Timer T5 shall not be used.
§ 4.1.1 Control field formats	Shall be used. Table 3 (Modulo 8 operation) shall not be used.
§ 4.1.1.1 Information transfer format — I	Shall be used.
§ 4.1.1.2 Supervisory format — S	Shall be used.
§ 4.1.1.3 Unnumbered format — U	Shall be used.
§ 4.1.2.1 Modulus	Shall be used. Modulo 8 shall not be used.
§ 4.1.2.2.1 Send state variable V(S)	Shall be used.
§ 4.1.2.2.2 Send sequence number N(S)	Shall be used.

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Section	Application conditions
§ 4.1.2.2.3 Receive state variable V(R)	Shall be used.
§ 4.1.2.2.4 Receive sequence number N(R)	Shall be used.
§ 4.1.2.2.5 Poll/Final bit P/F	Shall be used.
§ 4.2 Functions of the poll/final bit	Shall be used.
§ 4.3 Commands and responses	Shall be used. Table 5 (Modulo 8) shall not be used. Table 6 (modulo 128): response I frames shall be accepted only with F=1 Supervisory frame REJ shall not be used. Supervisory frame SREJ shall be used as response frame only. Unnumbered information frame UI shall not be used.
§ 4.3.1 Information (I) command	Shall be used.
§ 4.3.2 Receive ready (RR) command and response	Shall be used.
§ 4.3.3 Receive not ready (RNR) command and response	Shall be used.
§ 4.3.4 Reject (REJ) command and response	Shall not be used.
§ 4.3.5 Set asynchronous balanced mode (SABM) command/Set asynchronous balanced mode extended (SABME) command	Shall be used. SABME only shall be used.
§ 4.3.6 Disconnect (DISC) command	Shall be used.
§ 4.3.7 Unnumbered acknowledgement (UA) response	Shall be used.
§ 4.3.8 Disconnected mode (DM) response	Shall be used. An ”unsolicited DM” shall not be used. [FIS 8.2.2.7d)]
§ 4.3.9 Frame reject (FRMR) response	Shall be used. REJ and UI shall be identified as “not implemented”. SREJ shall be identified as “implemented”. Table 7 (modulo 8) shall not be used.
§ 4.4.1 Busy condition	Shall be used.
§ 4.4.2 N(S) sequence error	Shall be used. The first sentence (The information field….shall be discarded) shall not be used. The last sentence shall be used only for the means specified in 4.4.2.1 (Checkpoint recovery) and 4.4.2.3 (Timeout recovery).
§ 4.4.2.1 Checkpoint recovery	Shall be used.

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Section	Application conditions
§ 4.4.2.2 REJ recovery	Shall not be used. SREJ recovery shall be used instead.
§ 4.4.2.3 Time-out recovery	Shall be used.
§ 4.4.3 Invalid frame condition	Shall be used.
§ 4.4.4 Frame rejection condition	Shall be used. In the case of FRMR reject condition; link reset shall not be used. The receiver of FRMR shall send a DISC frame as a response. [FIS 8.2.2.7e)]
§ 5.1 Procedure for addressing	Shall be used. Single link operation (SLP) only shall be used. The end system initiating the establishment of the B/B_m channel is considered to be the “calling end system”. The calling end system plays the DTE role and the called system plays the DCE role in respect to addressing. [FIS 8.2.2.7i)]
§ 5.2 Procedure for the use of the P/F bit	Shall be used.
§ 5.3.1 Procedures for link set-up and disconnection Link set-up	Shall be used. The calling end system shall initiate link set-up. [FIS 8.2.2.7j)] SABME only shall be used. The DTE shall never re-initiate link set-up.
§ 5.3.2 Information transfer phase	Shall be used. Timer T4 is optional. In the information transfer phase a SABME command shall not be sent, because link resetting is not allowed (see §5.3.1). When receiving a SABME command while in the information transfer phase, the DTE shall send a DISC command and then initiate the release of the B/Bm channel. For backward compatibility response I frames shall be accepted with F=1 (see [ISO/IEC 7809] section 5.4.2.1 and 5.4.2.2). [FIS 8.2.2.9].
§ 5.3.3 Link disconnection	Shall be used. Receiving of SABME is not applicable. Optionally, the sender of the DISC can initiate the release of the B/B_m channel.
§ 5.3.4 Disconnected phase	Shall be used. Both DTE shall never re-initiate link set-up. The last two clauses shall not be used.
§ 5.3.5 Collision of unnumbered commands	Not Applicable.
§ 5.3.6 Collision of DM response with SABM/SABME or DISC command	Not Applicable. An ”unsolicited DM” shall not be used. [FIS 8.2.2.7d)]
§ 5.3.7 Collision of DM responses	Not Applicable. An ”unsolicited DM” shall not be used. [FIS 8.2.2.7d)]
§ 5.4 Procedures for information transfer	Shall be used. Modulo 8 shall not be used.
§ 5.4.1 Sending I frames	Shall be used.
§ 5.4.2 Receiving an I frame	Shall be used. The acknowledgement of the received I- frame shall be sent as soon as possible, in any case not later than T2.
§ 5.4.3 Reception of invalid frames	Shall be used.

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Section	Application conditions
§ 5.4.4 Reception of out-of-sequence frames	Shall not be used. SREJ recovery action shall be used instead.
§ 5.4.5 Receiving acknowledgment	Shall be used.
§ 5.4.6 Receiving a REJ frame	Not Applicable. REJ frame shall not be used. A received REJ shall result in a FRMR.
§ 5.4.7 Receiving an RNR frame	Shall be used. REJ shall not be used.
§ 5.4.8 DTE busy condition	Shall be used. REJ shall not be used.
§ 5.4.9 Waiting acknowledgement	Shall be used. REJ shall not be used. SREJ shall be used instead.
§ 5.5 Conditions for link resetting or link re-initialization (link set-up)	Shall be used. Link resetting procedures (5.6.1) shall not be used.
§ 5.6.1 Procedure for link resetting Link reset	Shall not be used.
§ 5.6.2 Procedure for link resetting Request for link reset	Shall be used. Link resetting procedures (5.6.1) shall not be used.
§ 5.7.1.1 Timer T1	Shall be used. Table 40 ”Layer2 configuration parameters“ contains the value(s).
§ 5.7.1.2 Timer T2	Shall be used.
§ 5.7.1.3 Timer T3	Optional.
§ 5.7.1.4 Parameter T4	Optional.
§ 5.7.1.5 Parameter T5	Not Used.
§ 5.7.2 Maximum number of transmissions N2	Shall be used. See note in ER FIS §8.3.2.2
§ 5.7.3 Maximum number of bits in an I frame N1	Shall be used.
§ 5.7.4 Maximum number of outstanding I frames k	Shall be used.
§ 6 Multilink procedure	Not Used.
§ 7.1 Static Conformance	Conformance to chapter 7 is not required. Subset 092-1 contains the conformance requirements to ER FIS.
§ 7.2 Dynamic Conformance	Conformance to chapter 7 is not required. Subset 092-1 contains the conformance requirements to ER FIS.
Annex B	Informative.

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ANNEX E.(Informative) HDLC Layer 2 configuration parameters for CS mode

E.1.1.1 This Annex is included to clarify the following values.

E.1.1.2 There are some dependencies for choosing the HDLC parameters. The following considerations are valid for ETCS data links. For other links the values can be calculated equivalent.

E.1.1.3 Consideration 1:
To send with full bandwidth, the Tx Buffer must have at least a capacity to transmit continuously data frames up to receiving the acknowledgement of the first transmitted frame. The Tx Buffer should not be significantly larger than this value because of blocking retransmission frames. This value depends on the windows size k, the number of bits per frame N1 (corrected by start and stop bit, which attributes to the buffer bit count by a factor of 1+2/8=1.25 and including a maximum of two start/stop flags which adds another 16 bits per HDLC frame), the nominal user rate of the link (X=4800 bit/s) and two times the transmission + processing delay of a frame (TF assumed with 500 ms, corresponding to a round trip time of 2 * TF = 1 s). Specific values for k and N1 must therefore respect the following relationship, taking also into account 2 HDLC frames in the opposite direction:

$$k = \frac{X * 2 * TF}{(N1 + 16) * 1.25} + 2$$

E.1.1.4 Consideration 2:
T1 has to be larger than *two times transfer delay to avoid checkpointing at each HDLC transmission. An additional margin for buffer delays* of the other entity of 500 ms is necessary. Hence T1 is set to 1.5 s.

E.1.1.5 Consideration 3:
T4 is an optional parameter controlling the keep alive mechanism of HDLC. A small value decreases the time to detect an interrupted data link. A value between T1 and two times T1 is reasonable. T4=2 s is recommended.

E.1.1.6 Consideration 4:
The time T to try to transmit a frame until eventually disconnecting in case of not receiving any acknowledgment, depends on the number of retransmissions N2 and the timer T1:

$$T = (N2 + 1) * T1$$

This time should be high enough to reach a high probability of MA transmission within 12 s as required by the infrastructure providers. According to field experiences of different projects and vendors this time is considered to be about 8s. With T1=1.5 s (see consideration 2), Hence N2 is set to 4.

E.1.1.7 In the following table, a representation of the T_NVCONTACT computation is given assuming a general message rate of 4 s and a position report rate of 4 s:

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Table 62 T_NVCONTACT computation

Time Event	min.	max.	Description
time elapsed since the last reset of T_NVCONTACT	0		General Message reception in parallel to the sending of the Position Report that will be lost
		7	General Message reception 4s before interference, Position Report sent and its ACK received just before the interference that caused the loss of the next general message
Transmission/retransmission	7.5	7.5	(N2+1)*T1 with N2 = 4 and T1 = 1.5 s
recall / mobile recovery	1		free mobile available (1s is an assumption)
		5	no free mobile available (5s is an assumption)
Connection Establishment Delay	8.5	8.5	Refer to Subset-093
Protocol establishment	4	4	HDLC, TP2 and safety layer protocol establishment (4s is an assumption)
new message available for transmission	0	4*	no synchronization between the cyclic sending of General Messages and the connection re-establishment
transmission of the message	1		transmit General Message
		2.5	transmit MA
Final Time	***22***	***38.5****	

- T_NVCONTACT < 22 s: T_NVCONTACT reaction will be triggered
- 22 s ≤ T_NVCONTACT ≤ 38.5s: T_NVCONTACT reaction can be triggered
- 38.5 s ≤ T_NVCONTACT: T_NVCONTACT reaction should not be triggered.

  * In case the RBC systematically sends a General Message upon re-establishment of the connection, the max value of 38.5s is reduced to 34.5s.

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ANNEX F. (Informative) How to create the list of permitted networks – Example

F.1. Read allowed networks and their alphanumeric name from the SIM card

Procedure : 1.) Determine the number of records in EF_{Gsmr} and then read all populated records from that EF.

2.) For each record read from EF_{Gsmr}, read the corresponding record from EF_{IC}.

3.) For each record read from EF_{IC}, read the corresponding record from EF_{NW}.

4.) From the information read, create an ordered list in the EuroRadio comprising MCC/MNC and alphanumeric network name for all networks read from EF_{Gsmr}.

F.1.1.1 Note: Before reading the records it is necessary to work out how many records there are in the file since the SIM FFFIS only specifies a maximum of 50 records. This can be done by reading the EF status, which returns the overall length and the record size.

F.1.1.2 Table 26 shows an example of how to read the content of EF_{Gsmr}.

Table 26: Read content of EF_{Gsmr}

Command and **Response**	Comment
AT+CRSM=192,28661,0,0,15	Read 15 octets to get status of EF 28661=0x6FF5=GSMR
+CRSM: 144,0,"0000013B6FF504001A00AA01020109" OK	Returned file length=0x13B=315 octets length of records=9 thus 35 records
AT+CRSM=178,28661,1,4,9	Read record 1 from EF_{GSMR} (home network)
+CRSM: 144,0,"22F203F86F8D6F8E01" OK	MCC-MNC=222-30 index into EF_{IC}= 01
AT+CRSM=178,28661,2,4,9	Read record 2 from EF_{GSMR}
+CRSM: 144,0,"22F860F96F8D6F8E02" OK	MCC-MNC=228-06 index into EF_{IC} = 02
…	*Further records not shown*

F.1.1.3 Table 27 shows example of how to read records from EF_{IC}

Table 27: Read content of EF_{IC}

Command and **Response**	Comment
AT+CRSM=178,28557,1,4,7	Read record 1 from EF_{IC}
+CRSM: 144,0,"F06F8E30F90001" OK	Index into EF_{NW}= 0x0001 = 1
AT+CRSM=178,28557,2,4,7	Read record 2
+CRSM: 144,0,"F06F8E40F10002" OK	Index into EF_{NW} = 0x0002 = 2
…	*Further records not shown*

F.1.1.4 Table 28 shows example of how to read contents from EF_{NW}

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Table 28: Read content of EF_{NW}

Command and **Response**	Comment
AT+CRSM=178,28544,1,4,8	Read record 1 from EF_{NW}
+CRSM: 144,0,"47534D5220524649" **OK**	Network name = "GSM-R I"
AT+CRSM=178,28544,2,4,8	Read record 2
+CRSM: 144,0,"47534D52204348FF" **OK**	Network name = "GSM-R CH"
…	*Further records not shown*

Assuming the information read from the SIM in the previous three sections a list of alphanumeric network names, e.g. "GSM-R I", see [N-9018].

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F.2. Build list of permitted networks

Procedure : *0.) Prerequisite: procedure of §* F.1 *shall have been performed*

1.) When demanded by the driver (through Sa-PERMISSION.request), obtain the list of currently available networks from the MT.

2.) Exclude from this list any networks that are marked as “Forbidden”.

3.) Exclude from this list any network whose MCC/MNC does not appear in the list prepared in § F.1 above.

4.) Use the filtered set of MCC/MNC values created in previous steps to select the alphanumeric network names from the list created in § F.1 above and create the list of valid ETCS networks.

5.) Display this list to the driver, with the home network first, if that is currently available.

F.2.1.1 Request available network from the MT

Table 29: Request available network from the MT

Command and **Response**	Comment
AT+COPS=?	Request available networks
+COPS: (2,,"GSM-R I","22230") (1,,"MobiSir","24021") (1,,,"28621") (1,,"GSM-R CH","22806") (1,,"TIM","22201") (3,,"Vodafone","22210") ,,(0,1,3,4),(0,1,2) OK	Network 222-30 is current network Network 240-21 is available Network 286-21 is available Network 228-06 is available Network 222-01 is available Network 222-10 is forbidden

F.2.1.2 Filter list according to network suitability

Network 222-10 is forbidden and so is excluded. Network 286-21 is not on the SIM and is therefore excluded. This leaves the following list of networks:

222-30
240-21
228-06
222-01

F.2.1.3 Create Final List for Driver

The list created above is then merged with the list of accurate names to create the following list to display to the driver:

GSM-R I
GSM-R S
GSM-R CH
TIM

Note: It is important to note that in the above list two of the networks have different names from those that were returned in the original response to the +COPS command. The name displayed is that on

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the SIM rather than in the MT firmware. The home network is “GSM-R I”: this is available and therefore displayed first in the list.

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ANNEX G. (Informative) GSM-R Procedures for PS mode

G.1. Procedures

G.1.1.1 The on-board enables communication in PS mode by two procedures, GPRS Attach and PDP Context Activation.

G.1.1.2 The procedures are required only to one MT and it is optional to do also to all available MTs.

G.1.1.3 The procedures are only possible to perform when GPRS service is enabled in the current radio cell.

G.1.1.4 As a precondition GPRS service is supported by the mobile terminal and enabled in related subscriber data (defined in the HLR)

G.1.1.5 The information below is valid for class B mobile terminals.

G.1.1.6 The sequence for the procedures is the following:
1. Network Registration
2. GPRS Attach
3. PDP Context Activation

G.2. GPRS Attach

G.2.1.1 The GPRS Attach registers the mobile terminal in the packet data network and starts mobility management for the mobile terminal. Mobility management is the functionality in the network to manage the current location of the mobile terminal.

G.2.1.2 GPRS Attach is managed by the AT command 'AT+CGATT'.

G.2.1.3 The mobile terminal must be registered to a network before executing the GPRS Attach.

G.2.1.4 GPRS Attach is requested immediately after network registration and before safe connection setup, if the mobile termination was not yet GPRS attached. Note: Depend on the Network Mode registration and GPRS Attach could be done in one step (Network Mode 1).

G.2.1.5 After successful GPRS attach, the MT may transit non-GPRS enabled cells. However, the GPRS attachment is kept. Thus, the packet service will be available as soon as the MT camps on a GPRS enabled cell without the need to perform a new attachment.

G.3. PDP Context Activation

G.3.1.1 The PDP Context enables the mobile terminal to access and use packet data networks. The access point and protocol to use (e.g. IP) are passed as parameters in the activation order. At activation the mobile terminal will obtain an IP address and will also get the IP address for the default gateway and the IP address for the default DNS.

G.3.1.2 PDP Context is managed by the AT commands as specified in [EuroRadio FFFIS]
- 'AT+CGDCONT' to set parameters APN and protocol.
- 'AT+CGEQREQ' to set QoS parameters, QoS parameter traffic class = 'streaming'
- 'AT+CGACT' to activate/deactivate the PDP Context

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ANNEX H. (Informative) GSM-R CS – GSM-R PS - FRMCS mode selection scheme

H.1.1.1 This annex contains the sequence of actions for GSM-R CS / GSM-R PS / FRMCS mode selection, including the simultaneous ETCS DNS queries management, associated to the ETCS ID type and a not unknown ETCS ID contained in the received T-CONNECT.request primitive (if the ETCS ID is unknown see Table 9). It shall be assumed that:

- the FRMCS transmission mode is the preferred choice (table empty or FRMCS explicitly written).
- Refer to [Subset-037-3] for the connection establishment of FRMCS transmission mode.
- the PS status OK box refers to the polling function in § 6.4.6.3.
- the “PPP connect setup?” box also include connect/re-activation/re-setup if necessary, before going to the ‘No’ branch.

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H.1.1.2 The following figure shows the sequence of actions described above.

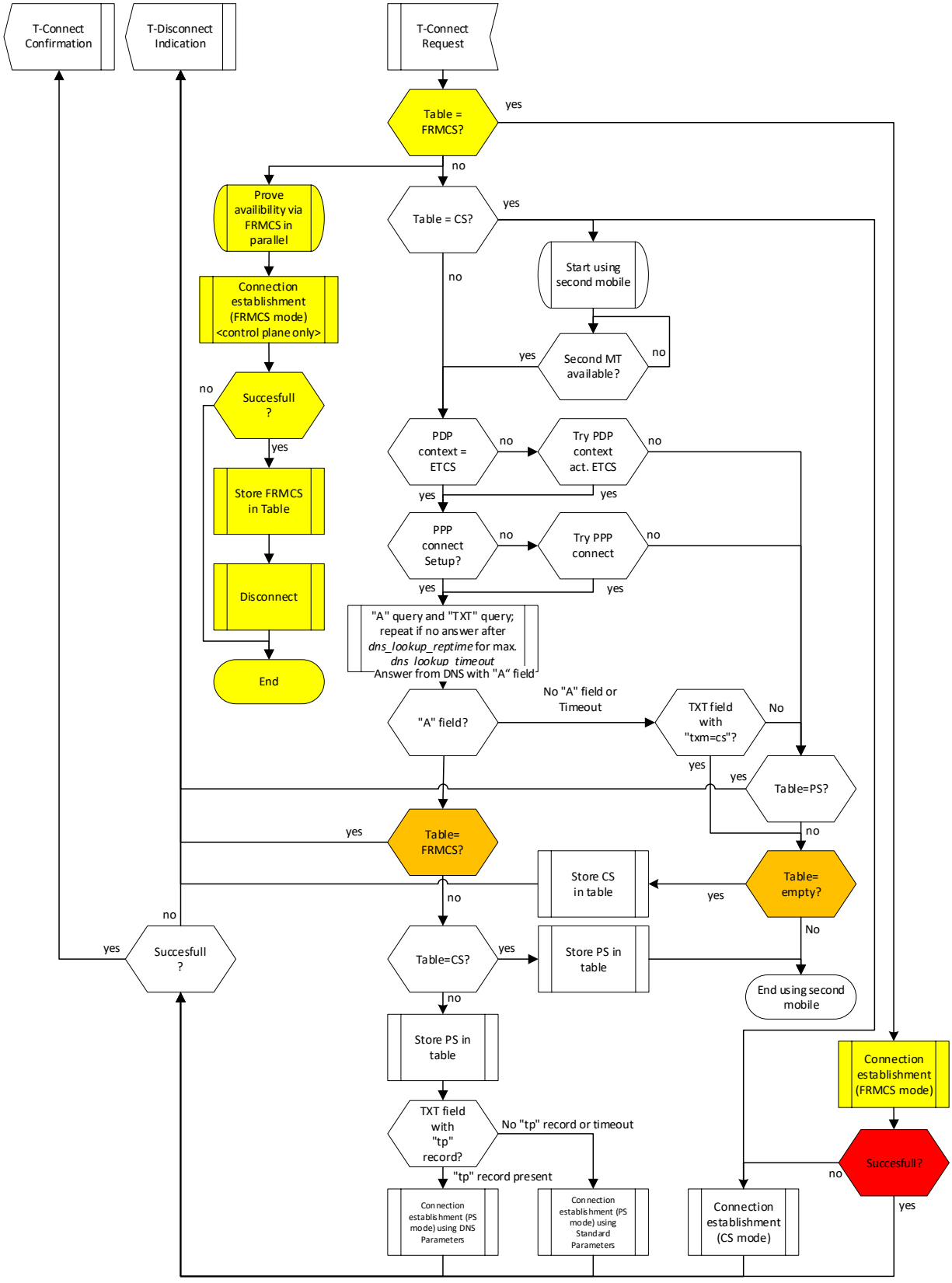


Figure 19 Sequence of actions for GSM-R CS / GSM-R PS / FRMCS selection, including simultaneous ETCS DNS queries management

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