ERTMS/ATO

ATO-OB / ATO-TS FFFIS

Transport and Security Layers

REF: SUBSET – 148

ISSUE: 1.0.0

DATE: 05-07-2023

Company	Technical Approval	Management approval
ALSTOM		
AZD		
CAF		
HITACHI RAIL STS		
MERMEC		
SIEMENS		
THALES		

1 MODIFICATION HISTORY

Issue Number Date	Section Number	Modification / Description	Author
0.0.1 13-07-2017	All	First issue of the document	UNISIG ATO WP
0.0.2 17-05-2018	All	First draft version of the document	UNISIG ER WG
0.0.3 22-02-2019	All	Reviewed version	UNISIG ER WG
0.0.4 08-04-2019	All	Removed TLS-PSK	UNISIG ER WG
0.0.5 02-07-2019	All	Reviewed version after Shift2Rail Comments	UNISIG ER WG
0.0.6 03-02-2020	All	Reviewed version after Shift2Rail Comments	UNISIG ER WG
0.0.7 30-09-2020	All	Reviewed version after EECT ETCS Comments	UNISIG ER WG
0.0.10 29-04-2021	All	Reviewed after EECT Radio comments	EECT Radio
0.0.11 31-05-2021	All	Added Interface with ATO Application and Framing	UNISIG ER WG
0.0.12 02-08-2021	All	Removed parts about trackside architecture as it has moved to EIRENE SRS. Removed non-used references. Re-definition of FQDN New chapter 6.1.2.3	UNISIG ER WG
0.0.13 16-11-2021	All	Updated Addressing and added clarification about EDOR & Trackside interface	UNISIG ER WG
0.1.04 01-04-2022	All	Rework after review	UNISIG ER WG
0.1.05 25-06-2022	All	Rework after first EECT review	UNISIG ER WG
	All	Improvements: - Introduction of FRMCS - Include EIRENE SRS changes for ATO communication	UNISIG ER WG
0.1.06	All	Rework after second EECT review	UNISIG ER WG
	All	Improvement: Handling of MNw/oR networks	UNISIG ER WG
0.1.07	All	Rework after EECT review	UNISIG ER WG
	6.3.3	Change access to ATO domain to local APN per network for MNo/wR	UNISIG ER WG
0.9.0	6.1.1.1.1	Rework during and after EECT meeting	UNISIG ER WG
0.9.01	6.3.3.2.8 8.2.6.1.1	Correction of reference Correction witch octets have to complement	UNISIG ER WG
0.10.0	10.2.1.1.8	Harmonisation of FQDN with Subset-037-3	UNISIG ER WG

Issue Number Date	Section Number	Modification / Description	Author
0.10.1	-	Update for pre-release version (3rd consolidation review for Baseline 4 1st release version).	UNISIG SG
0.10.2	5.2, 5.3, Table 3,	Change “ATO over ETCS” to “ERTMS/ATO”	UNISIG ER WG
0.10.3 03-07-2023	Title Table 3	Title corrected according to TSI 2023 4th review Change titles of reference documents (Subset-037-1, Subset-126, Subset-146, FFFIS ER)	UNISIG ER WG
1.0.0 05-07-2023	-	Version for ERTMS/ATO Baseline 1 1st release and ERTMS/RMR Baseline 1 1st release	UNISIG ER WG

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5 INTRODUCTION

5.1 Scope and purpose of the document

5.1.1.1.1 This document defines the communication system for ATO application in GoA2 using GSM-R/ MNw/oR and FRMCS networks. It encompasses:

- interface between ATO application and ATO communication
- the functional model for ATO communication up to the transport layer
- the coordinating function for PS Mode and FRMCS communication
- the accessibility context providing necessary IP connectivity between ATO-OB and ATO-TS for PS Mode
- the transport protocol stack used for ATO communication for PS Mode
- necessary support functions

5.1.1.1.2 It does not encompass:

- The used Security Layer, described in [Subset-146].
- The used CFM for FRMCS communication, described in [Subset-037-3].

5.1.1.1.3 Clause 6 describes the communication system in general and reference for details (if necessary) to the following clauses.

5.1.1.1.4 ATO-OB and ATO-TS are considered as SIL 0 applications. The safety is guaranteed by ETCS-OB.

5.2 Acronyms and abbreviations

5.2.1.1.1 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.

5.2.1.1.2 For ATO related abbreviations see ERTMS/ATO Glossary [13E154].

5.2.1.1.3 For Euroradio related abbreviations see Euroradio FIS [Subset-037-1].

Table 1: Abbreviations

Term	Definition
APN	Access Point Name
CFM	Communication Functional Model
MNw/oR	Mobile Network without Rail: Wireless communication network, operated by a public or private Mobile Network Operator excluding GSM-R networks. Note: Support of MNw/oR is project specific and not mandatory.
TSAP	Transport Service Access Point

5.3 Definitions

5.3.1.1.1 For ETCS related definitions see Glossary of Terms and Abbreviations [Subset-023].

5.3.1.1.2 For ATO related definitions see ERTMS/ATO Glossary [13E154].

5.3.1.1.3 For Euroradio related definitions see Euroradio FIS [Subset-037-1].

5.3.1.1.4 In the table below are reported the definitions that are relevant for this Subset.

Table 2: Definitions

Term	Definition
Always-on	The IP connectivity is always available
ATO Communication Entity	The communication device provides the IP connectivity via mobile networks (GSM-R or MNw/oR).
PS Mode	Packet Switched communication mode supported by GSM-R networks and MNw/oR.

5.4 Reference and applicable documents

5.4.1.1.1 This section presents the reference and applicable documents.

Table 3: Reference and applicable document

Reference	Title	Author	Issue
[13E154]	ERTMS/ATO Glossary	EEIG ERTMS User Group	
[EIRENE SRS]	EIRENE System Requirements Specification	EIRENE	
[ETCS Variables]	Assignment of Values to ETCS Variables	ERA	
[FFFIS ER]	Radio Transmission FFFIS for EuroRadio	UIC	
[IEEE 802.3]	IEEE Standard for Ethernet	IEEE	2018
[O-8350]	FFFS for Voice and Data Services, Interconnection & Roaming between GSM-R networks, Q2 2023	UIC	3.0.0
[RFC 791]	Internet Protocol, RFC791 aka IETF STD 5, last update 2/2013 (RFC6864)	IETF	8/1981
[RFC 793]	Transmission Control Protocol, RFC793 aka IETF STD 7, last update 2/2012 (RFC6528)	IETF	8/1981
[RFC1034]	Domain Names – Concepts and Facilities	IETF	11/1987
[RFC1035]	Domain Names – Implementation and Specification	IETF	11/1987
[Subset-023]	Glossary of Terms and Abbreviations	UNISIG	
[Subset-037-1]	Euroradio FIS, GSM-R CS/PS Communication Function Module and Coordinating Function FRMCS/GSM-R	UNISIG	
[Subset-037-3]	EuroRadio FIS, FRMCS Communication Functional Module	UNISIG	
[Subset-125]	ERTMS/ATO System Requirements Specification	UNISIG	
[Subset-126]	ATO-OB / ATO-TS FFFIS, Application Layer	UNISIG	
[Subset-146]	ERTMS End-to-End Security	UNISIG	

6 COMMUNICATION PROPERTIES

6.1 Transmission Requirements of ATO

6.1.1.1.1 At least one of the following communication services, PS Mode or FRMCS, shall be supported (Trackside FRMCS is FFS).

6.1.1.1.2 The transmission shall keep the user packet structure.

6.1.1.1.3 The packet sizes shall not be limited by the communication channel.

6.1.1.1.4 The transmission shall keep the packet sequence.

6.1.1.1.5 The packets shall be protected against random transmission errors.

6.1.1.1.6 The communication shall be protected against cyber-attacks.

6.2 Quality of Service Requirements of ATO

6.2.1.1.1 The assumption is to have a continuous communication between ATO-OB and ATO-TS.

6.2.1.1.2 As a minimum at each location, where a journey starts, radio coverage is required.

6.2.1.1.3 Interruption of a radio connection is acceptable as long as all information covering that area is available on the train. The train will continue with previous information without updates.

Note 1: ATO-OB operates according to Journey Profiles sent by ATO-TS when the connection is established. In case of connection loss, it continues to operate without disengaging following the Journey Profile currently stored on-board.

Note 2: When connection is lost, TMS and ATO-TS are not able to send Journey Profiles updates; but this is accepted by the Users Team members.

6.2.1.1.4 The average estimated bandwidth is less than 1 Kbits/s (about 20% overhead at transmission level).

6.2.1.1.5 A peak bit rate higher than 10 kbit/s is required (about 20% overhead at transmission level).

Note: In case of MNw/oR QoS and Roaming will be handled according to the best effort principle.

6.3 Reference Architecture

6.3.1 Coordination between PS Mode and FRMCS communication

6.3.1.1.1 During migration time a coordination between the PS Mode and FRMCS by a Coordinating Function will be necessary.

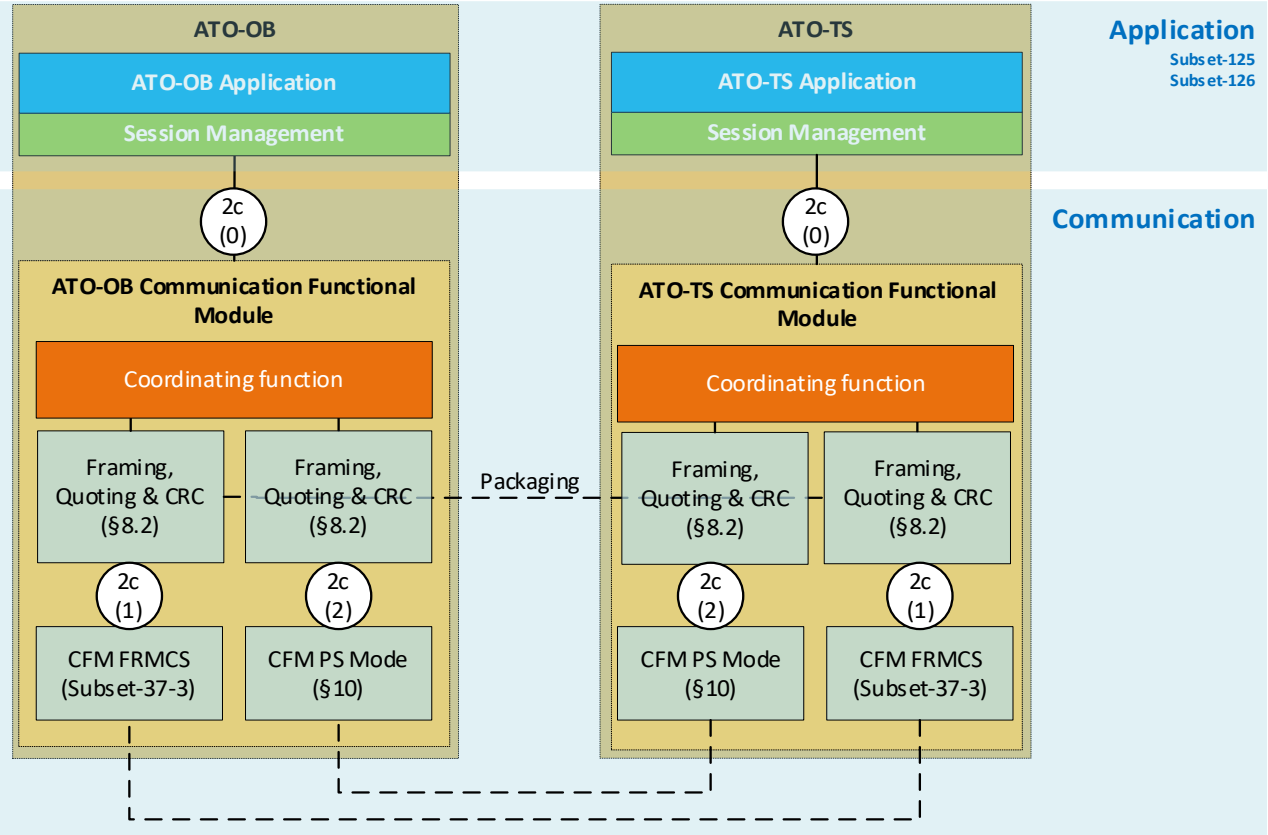

Figure 1. Coordination of communication services

6.3.1.1.2 The application level (session layer and higher) will be defined in the application responsibility and is out of scope of this document. The interface (2c) will be described in clause 7.

6.3.1.1.3 The interface (2c) between ATO Application and ATO Communication Functional Module makes the ATO Application independent from the specific communication technology, i.e., to allow a future replacement of the communication system.

6.3.1.1.4 In contrast to the coordinating function used by ETCS the transmission mode (see [Subset-037-1]) of the last connection will not be stored in an internal table for two reasons:

- The location of a connection establishment to an ATO-TS is not strictly linked to the area covered by this ATO-TS and therefore the area that has to be covered by FRMCS for an ATO-TS cannot be determined exactly. Connection establishment request from locations not covered by FRMCS to an FRMCS-ATO-TS are to be expected and will not work with the stored mode.
- The connection establishment delay is less critical for ATO as for ETCS. A short delay caused by the try to connect via FRMCS is acceptable.

6.3.1.1.5 The “Framing, Quoting & CRC function” is used to avoid the limitation of packet size as provided by the standard transport protocols.

6.3.2 Architecture model for CFM FRMCS

6.3.2.1.1 For FRMCS the communication module defined in [Subset-037-3] will be used. It uses the same interface as described in clause 7 of this Subset. All primitives in both directions shall be mapped without any manipulations.

6.3.3 Architecture model for CFM PS Mode

6.3.3.1.1 The CFM PS Mode uses the same interface as described in clause 7 of this Subset. All primitives in both directions shall be mapped without any manipulations.

6.3.3.1.2 Figure 2 represents the PS Mode reference architecture. The responsibilities are as follows

- CFM user: User of the communication services provided by the CFM.
- Transport end-to-end: Provides end-to-end data connections to the application via the interface (2c) and it defines the environment for the ATO CFM in the Transmission domain.
- ATO Communication Entity: Provides the IP Connectivity to the Transport at interface (4). Definition and Realisation is in responsibility of the projects.
- Transmission (wireless & IP backbone network): Transmission encompasses all functions between interfaces 1a and 1b.

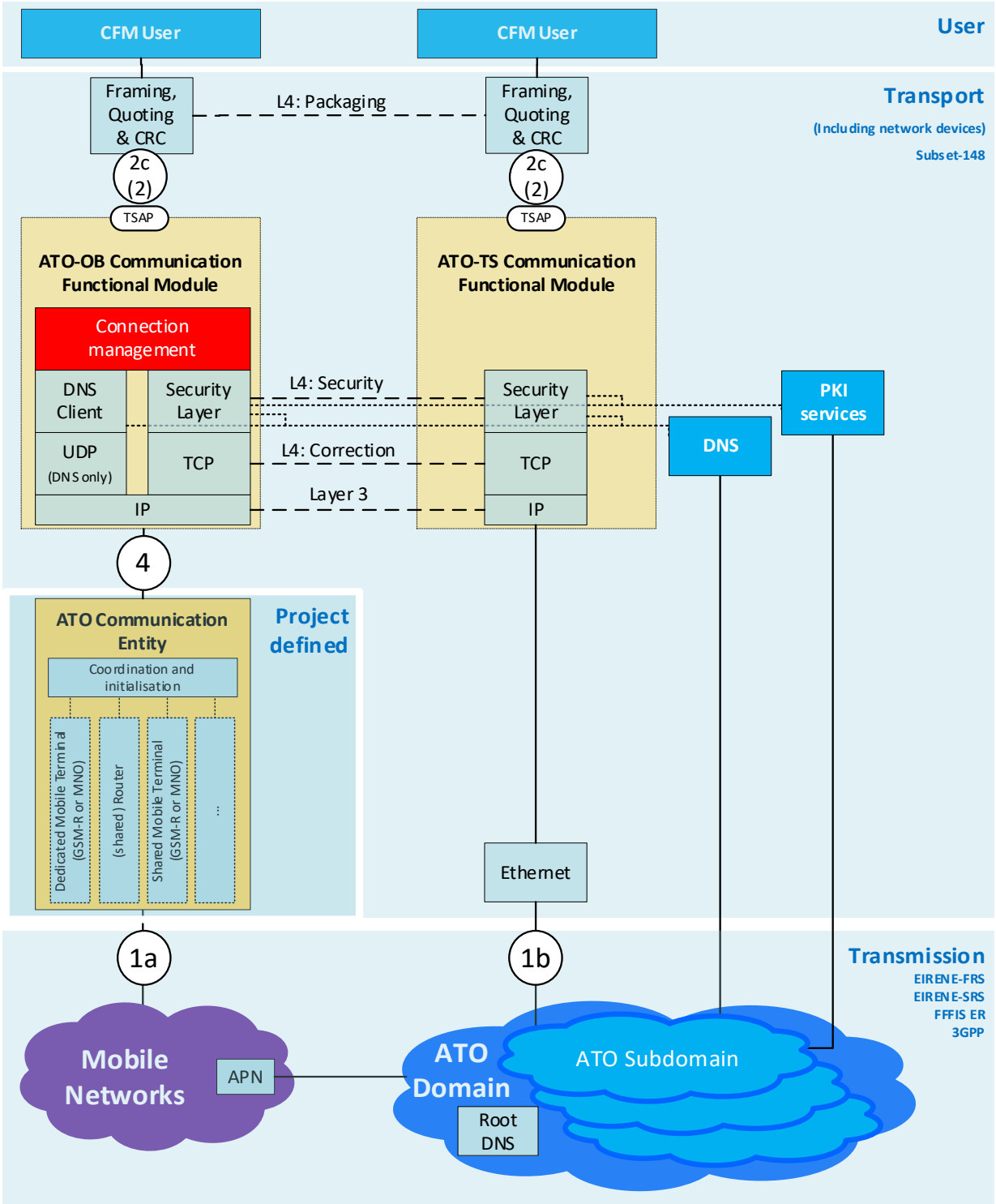

Figure 2. ATO Reference architecture

6.3.3.2 **Transmission**

6.3.3.2.1 The transmission encompasses the corresponding PS mobile networks and corresponding packet data networks associated to the APN. Thus, the ATO-OB is able to establish a connection with the ATO-TS, the DNS and the PKI services that resides in the ATO Domain.

6.3.3.2.2 Besides GSM-R mobile networks communication may involve the use of MNw/oR, which then requires connectivity to the railway ATO domain. The use of MNw/oR could be limited in relation to coverage/Quality of Service compared to GSM-R services.

6.3.3.2.3 Figure 3 shows the network structure more in detail.

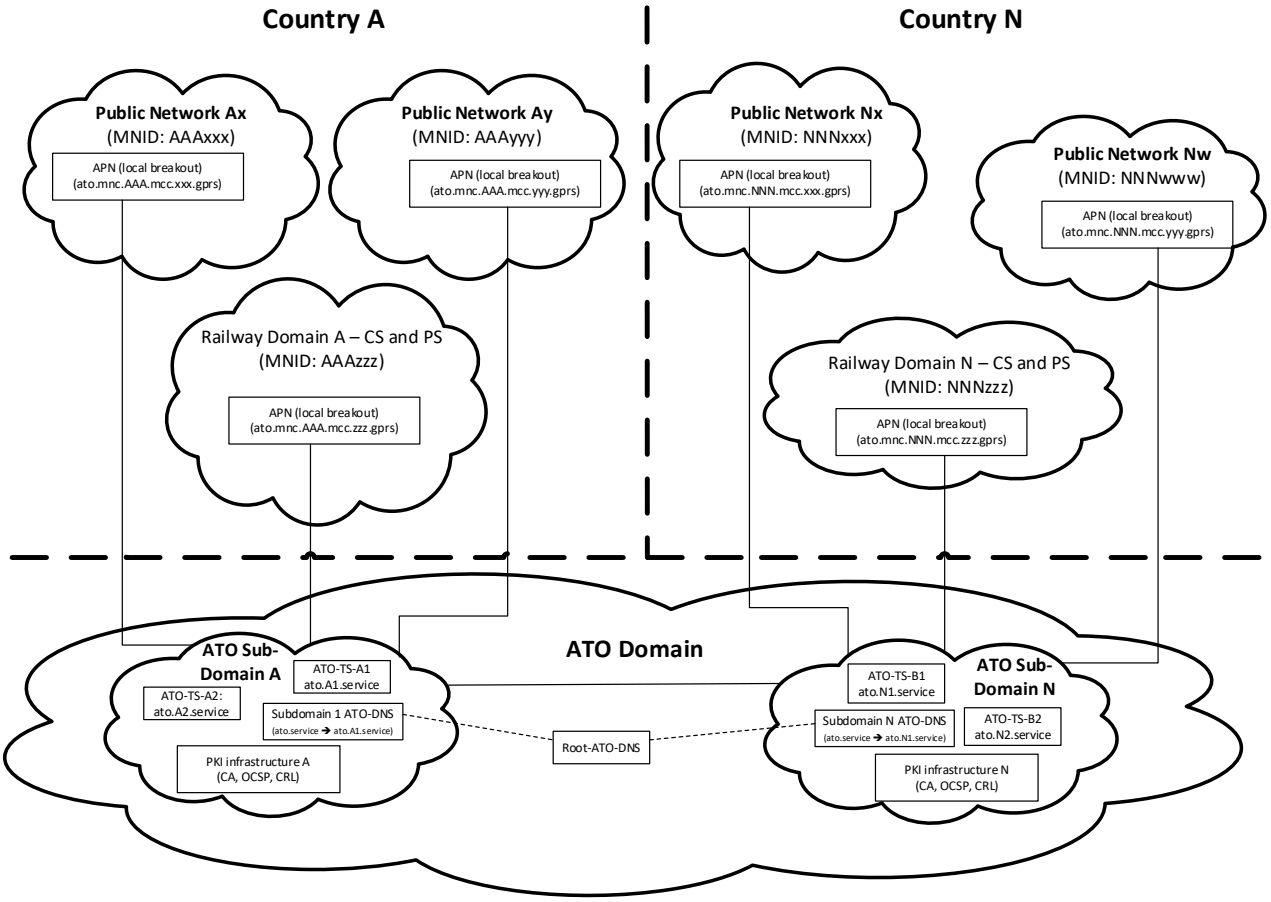

Figure 3: ATO network structure

6.3.3.2.4 The figure takes as an assumption that there is one railway domain/ network of one Infrastructure Manager per country, but this is no limitation.

6.3.3.2.5 ATO communication requires local breakout to the applicable ATO-TS via an APN in accordance to [EIRENE SRS]. This requirement is also valid for MNw/oR.

6.3.3.2.6 The harmonised APN, “ato”, shall be used in each mobile networks offering ATO communication connectivity in accordance to [EIRENE SRS], §9.13.13. This requirement is also valid for MNw/oR.

6.3.3.2.7 For APN “ato” the QoS profile “ATO application” shall be used in accordance to [EIRENE SRS], §9.13.14. In case of MNw/oR the used profile will be project specific.

6.3.3.2.8 The use of MNw/oR network domains different to the one referred in clause 6.3.3.2, bullet 2, is subject to specific implementation and it is out of the scope of this document (the right side of the figure only shows a possible scenario).

6.3.3.3 IP Connectivity

6.3.3.3.1 The ATO-TS shall use an Ethernet Interface (1b) in accordance with [FFFIS ER] (§3.3.5, besides 3.3.5.2.5) to connect to the ATO Domain.

6.3.3.3.2 The onboard ATO Communication Entity (see clause 9) provides IP connectivity at interface (4) to the ATO Domain using the mobile network(s) connected to interface (1a).

6.3.3.4 ATO Communication Functional Module PS Mode

6.3.3.4.1 The ATO Communication Functional Module PS Mode (see clause 10) handles the transport layer and depends on the used network services. The session management is done by the ATO Application.

6.3.3.5 ATO Application

6.3.3.5.1 Each country/region maintains its own ATO Subdomain as part of the entire ATO Domain.

6.3.3.5.2 The necessary connectivity for ATO Domain as well as corresponding ATO Subdomains and routing principles are specified in [O-8350].

6.3.3.6 Support function: Domain Name Service

6.3.3.6.1 The DNS approach for ATO shall follow a hierarchical structure consisting of:

- Root level (Root DNS)
- Subdomain DNSs

6.3.3.6.2 The DNS propagated to the clients, Root or Subdomain DNS, is FFS.

6.3.3.6.3 DNS entity redundancy shall be treated inside the ERTMS entity that only one DNS IP address is propagated to the mobile terminals / routers used by ATO-OB in accordance to [EIRENE SRS], §9.15.9.

Note: Depending on feature realisation, also the network may be required to support the redundancy secondary to the respective ERTMS entity. At least physical connectivity cannot be solved within ERTMS entity alone because multiple physical cables will be needed to be handled by the network as well. Also, connection availability monitoring by ERTMS entity of physical links may need some higher (compared to physical) layer support e.g. ICMP, IP multicast, subnetting constrains etc.

6.3.3.7 **Support function: PKI Services**

6.3.3.7.1 The communication system requires access to the authorities providing the public keys used for the security layer protocols (details see [Subset-146]).

6.3.3.7.2 The authorities will be addressed by the FQDNs included in the key.

7 INTERFACE TO THE ATO APPLICATION

7.1 General Description

7.1.1.1.1 This interface (2c) is internal to the ATO Application and is not mandatory. The service primitives describe the interface at a functional level only.

7.1.1.1.2 The communication layer shall support the data exchange according to [Subset-125] and [Subset-126].

7.1.1.1.3 Connection establishment and release shall be triggered by the ATO-OB Application.

7.1.1.1.4 In case the connection is not established or is dropped, ATO-OB Application shall retry.

7.1.1.1.5 It shall be possible to establish multiple connections to different ATO-TSs.

7.2 Model of communication services

7.2.1.1.1 The communication services that the ATO CFM offers to the ATO Application are based on the services provided by the transport layer of ISO/OSI reference model. These services concern:

- Transport connection establishment/release
- Reliable data transmission
- Transparent packet-oriented data transmission

7.2.1.1.2 A CFM entity communicates with its CFM User through one or more Transport Service Access Point (TSAP) by means of transport service primitives.

7.3 Service primitives for Connectivity Status

7.3.1.1.1 Two service primitives are provided to inform the user about the status of IP Connectivity

- to request Connectivity status and
- to indicate Connectivity status

Table 4 Service primitives for network registration

Primitive Parameter	T-CONNECTIVITY.request	T- CONNECTIVITY.indication
Connectivity state		X
X Mandatory parameter (0 – no connectivity; 1 – connectivity provided)		

7.3.1.1.2 By means of the service primitive T-CONNECTIVITY.request the service user is able to request the connectivity of ATO Communication Entity to one or more mobile networks.

7.3.1.1.3 The status of the connectivity is indicated by the service primitive T-CONNECTIVITY.indication to the service user.

7.3.1.1.4 The connectivity indication can be given independently of a request. This feature allows indications after power-up or after loss of connectivity. Any change on connectivity can be indicated.

7.4 Service primitives for Connection establishment

7.4.1.1.1 The process of establishing a transport connection is initiated at the time when the communication service user requests a connection setup to the ATO CFM. This service is accessed through the service primitive T-CONNECT.request with its associated parameters at the TSAP.

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

Table 5 Service primitives of the communication layer for connection establishment

Primitive Parameters	T-CONNECT request	T-CONNECT indication	T-CONNECT response	T-CONNECT confirm
TCEPID		X	X(=)	X
Called address: Called ETCS ID type Called ETCS ID	 X X	 X X		
Calling address: Calling ETCS ID type Calling ETCS ID	 X X	 X(=) X(=)		
Responding address: Responding ETCS ID type Responding ETCS ID			 X X	 X(=) X(=)
X Mandatory parameter. (=) The value of that parameter is identical to the value of the corresponding parameter of the preceding transport primitive. ETCS ID type: see [Subset-037-1], Table 5, Octet 4 ETCS ID: 3 octet value: cccc cccc ccaa aaaa aaaa aaaa c…c Country or region ID (NID_C) a…a ATO trackside entity ID (NID_ATOTS)				

Note: ETCS IDs will be uses by ATO as address in the same way as ETCS.

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

7.4.1.1.4 The parameter ETCS ID type together with ETCS ID is unique 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.

7.4.1.1.5 The Calling ETCS ID identifies, together with the application type, the transport connection initiator. The Called ETCS ID identifies together with the ETCS ID type the

called CFM user. The responding ETCS ID identifies the accepting/responding CFM user, which was locally selected by the responding transport entity.

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

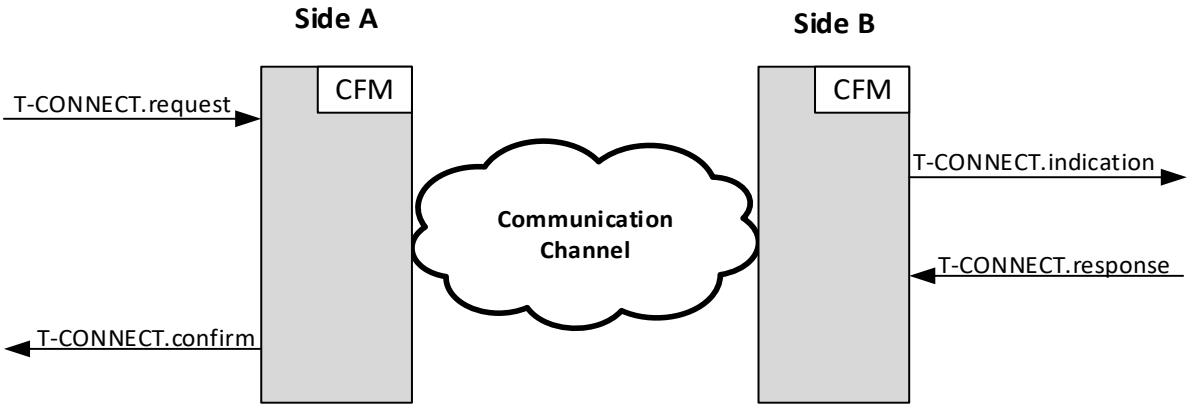

Figure 4: Sequence of primitives for connection setup

7.4.1.1.7 An unsuccessful connection establishment will be indicated to the application by the T-DISCONNECT.indication (see 7.6).

7.5 Service primitives for data transfer

7.5.1.1.1 The data transfer service is provided after a successful transport connection setup. This service is accessed through the service primitive T-DATA.request with its associated parameters at the TSAP. The ATO CFM 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.

7.5.1.1.2 The following table gives the service primitives of the communication layer used for data transfer:

Table 6: Service primitives of the communication layer for data transfer

Primitive Parameters	T-DATA.request	T-DATA.indication
TCEPID	X	X
User Data	X	X

7.5.1.1.3 A request for data transfer is made by a service user (after a successful transport connection setup) 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.

7.5.1.1.4 The following figure shows the sequence of transport service primitives for the data transfer.

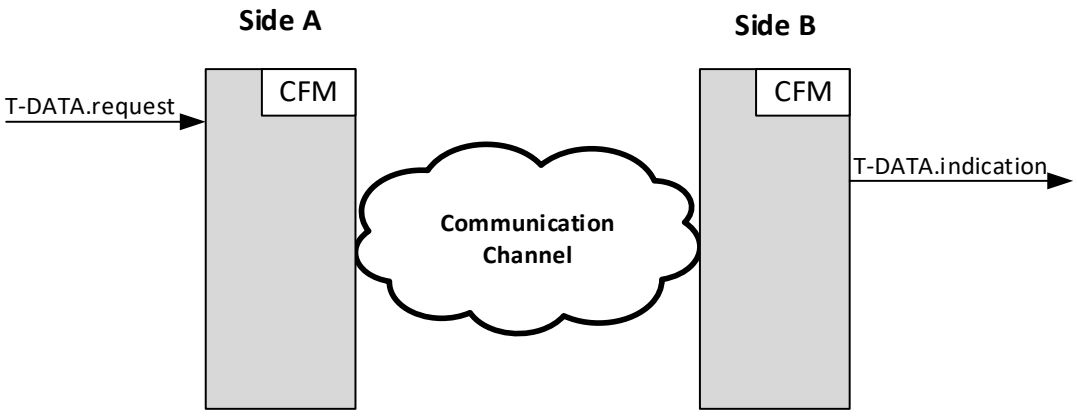

Figure 5: Sequence of primitives for data transfer

7.6 Service primitives for connection release

7.6.1.1.1 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.

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

Table 7: Service primitives of the communication layer for connection release

Primitive Parameters	T-DISCONNECT.request	T-DISCONNECT.indication
TCEPID	X	X
Reason		X[1]
Note 1: It shall be used in the error case.		

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

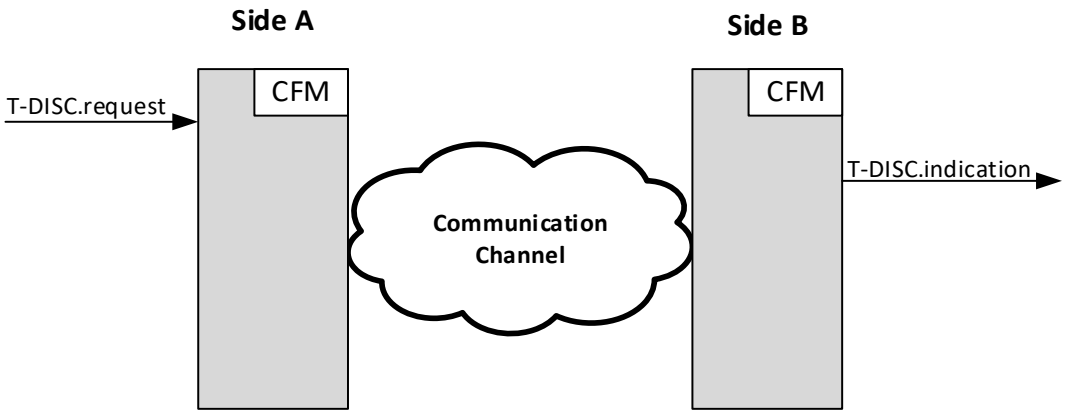

Figure 6. Sequence of primitives for connection release initiated by a CFM user

7.6.1.1.4 If an error occurs in the ATO CFM or if the ATO CFM receives an indication of an error, the error will be indicated. The errors can be ignored, locally logged or indicated.

7.6.1.1.5 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 8: Error causes of the CFM

Reason/ code	Sub-reasons		comment
Normal release Code = 0	0	Normal release	
Persistent error Code = 1	1	No further information	Communication not possible
Temporary Error Code = 2	1	No further information	CFM User should retry
Note: All other reason/sub-reason values are reserved.			

8 COMMON FUNCTIONS

8.1 Coordinating Function

8.1.1.1.1 For outgoing connections, the Coordinating Function decides, if the connection requested by the T-CONNECT.request primitive will use PS Mode or FRMCS communication services. It shall follow the following steps (see Figure 7):

1. Try connection establishment using FRMCS.
2. If successful inform the ATO Application using the T-CONNECT confirm primitive.
3. Do the DNS request as described in [Subset-037-1].
4. If no “A” record was received inform application using the T-DISCONNECT.indication primitive.
5. Try connection establishment using PS Mode, if available using the TCP parameter in “tp” record.
6. Inform the application about the success using the T-CONNECT.confirm/ T-DISCONNECT.indication primitive.

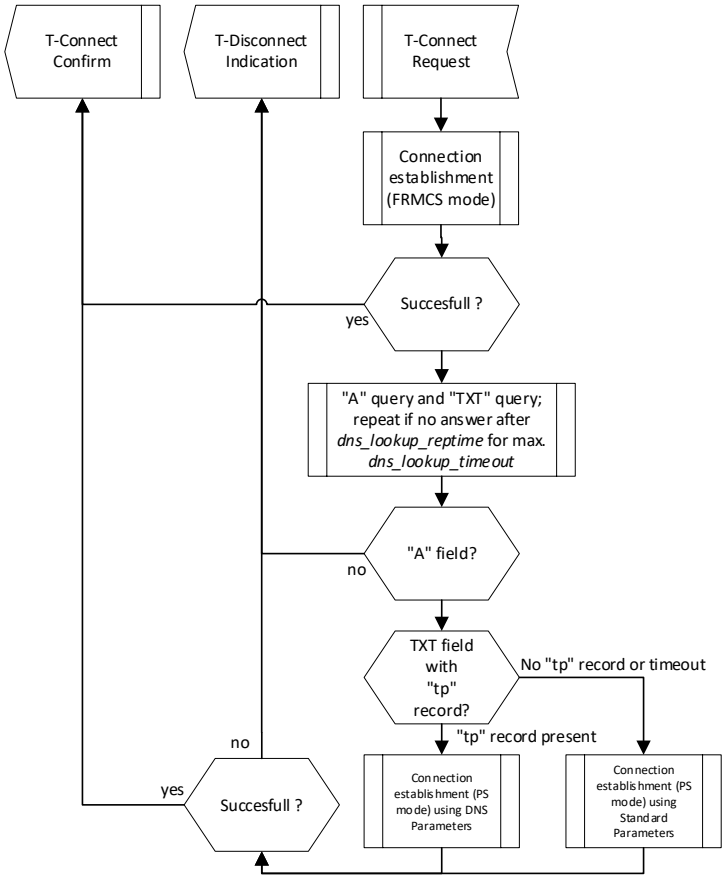

Figure 7. Coordinating function for ATO

8.1.1.1.2 Incoming connections from both CFMs shall be forwarded without manipulation to the ATO Application.

8.1.1.1.3 “Connectivity provided” shall be reported to the ATO Application via interface (2c (0)) using the T- CONNECTIVITY.indication primitive if at least one of the CFMs provides IP connectivity.

8.2 Packet Integrity (Framing, Quoting & CRC)

8.2.1 General

8.2.1.1.1 Standard transport protocols have a limited packet size (ALE, SCTP, TLS, …) or does not support packet transport (TCP). In consequence transmitted packets will be segmented and/or combined during transport.

8.2.1.1.2 This layer is used to regenerate the packet structure of the ATO packets without a limitation of the packet size by the communication layer.

8.2.1.1.3 This protocol layer is not specific and shall be used for PS Mode and FRMCS. It is responsible for transmission of “unlimited” packets.

8.2.1.1.4 Because segmentation can happen on all IP based transmissions and the packet integrity layer only influence the user plane it is an implementation option to implement it at the entity, where the ATO application is running.

8.2.2 Frame Structure

8.2.2.1.1 The following frame structure shall be used:

Table 9: Framed Packet structure

Framed Packet				
Item	**Variable Name**	**Description**	**Length**	**Resolution/Formula**
Frame Start				
1)	Start Flag	Flag to identify the Frame Start.	1 octet	Value: 0x7E
ATO Packet				
2)	ATO Packet	ATO Packet	unlimited	stream of octets with variable length.
Checksum				
3)	CRC	Checksum	32 bits	CRC-32
Frame End				
4)	End Flag	Flag to identify the Frame End.	1 octet	Value: 0x7E

8.2.3 Checksum

8.2.3.1.1 For error detection, the cyclic redundancy check mechanism CRC32, based on the IEEE 802.3 (Ethernet) specification, shall be used with the following parameters:

Table 10 CRC Parameters

Parameter	Value
Name	CRC-32/BZIP2
Width	32 bits
Generator-Polynomial	0x04C11DB7
Init	0xFFFFFFFF (-1)
RefIn	False
RefOut	False
Final XOR value (Inversion of CRC)	0xFFFFFFFF (-1)
Check value for test vector “123456789” (UTF8)	0xFC891918

8.2.3.1.2 The order of the CRC is MSB first, LSB last.

8.2.3.1.3 The CRC value shall be computed over the ATO Packet without including Start and End Flag.

8.2.4 Quoting

8.2.4.1.1 The quoting mechanism is used to identify if an octet is part of the payload or the frame structure. It shall be applied for the ATO packet and for the CRC.

8.2.4.1.2 The Escape Octet used for the quoting mechanism has the following format.

Bit	1	2	3	4	5	6	7	8
0x7D	1	0	1	1	1	1	1	0

Figure 8: Escape Octet

8.2.4.1.3 Each octet in the raw binary data of an ATO Packet and the CRC equal to the following octets shall be escaped by the Escape Octet inserted immediately preceding that specific octet.:

- Start/End Flag
- Escape Octet

8.2.4.1.4 After inserting the Escape Octet, the 6th bit (binary weight 0x20) of the octet to be escaped shall be complemented.

8.2.5 Framing

8.2.5.1.1 Framing shall be used to mark the start and end of payload in the binary stream of data.

8.2.5.1.2 Each start of a packet shall be indicated with a Flag Octet which has the following format:

Bit	1	2	3	4	5	6	7	8
0x7E	0	1	1	1	1	1	1	0

Figure 9: Flag Octet

8.2.5.1.3 Each end of a packet shall be indicated with the same Flag Octet used for the start.

8.2.5.1.4 End Flag shall not be omitted for consecutive frames.

8.2.5.1.5 Before the End Flag in the end of the ATO packet the checksum shall be added.

8.2.5.1.6 The most significant byte shall be transmitted first.

8.2.6 Frame Management

8.2.6.1.1 The transmitter shall:

- Calculate the checksum of the ATO Packet and insert it behind the ATO Packet
- Identify any occurrence of the Flag or Escape Octets in the ATO Packet or checksum
- Insert the Escape Octet immediately preceding the byte resulting from the above
- Complement the 6th bit of the byte equal to the Flag or Escape Octets
- Add Start Flag before and End Flag

8.2.6.1.2 The receiver shall examine the frame between the Start Flag and the End Flag:

- Discard any Escape Octet byte inside the payload
- Restore the immediately following byte by complementing its 6th bit
- Calculate the checksum for the original ATO packet
- Discard the packet if the calculated checksum differs from the transmitted

  Note: Detection/retransmission of discharged packets is in responsibility of the application.

8.2.7 Framing Example

8.2.7.1.1 The following figure gives an example (value of the ATO Packet are randomly):

ATO Packet		0x01		0x7d	0x2		0x7e	0x03					
Packet	0x7e	0x01	0x7d	0x5d	0x2	0x7d	0x5e	0x03	0x74 (CRC4)	0xa6 (CRC3)	0xd4 (CRC2)	0x0b (CRC1)	0x7e

Figure 10: Framing Example

9 ATO COMMUNICATION ENTITY

9.1.1.1.1 The Implementation of a ATO Communication Entity is out of scope of this Subset. It is in the responsibility of the projects to realise such an entity to fulfil the requirements defined for the interfaces (4) and (1a) in this document.

9.1.1.1.2 Interface (1a) shall follow the specifications of the used mobile network.

9.1.1.1.3 Interface (4) shall provide IP Connectivity on a functional level.

9.1.1.1.4 The ATO Communication Entity shall provide the following functionality to the ATO-CFM:

- ensures the selection and registration to the appropriate mobile network
- select the Radio Access Technology
- establish and hold IP connectivity between ATO-OB and ATO Domain (“always-on” principle).
- status indication to the CFM PS Mode of the IP connectivity to the ATO Domain (no connectivity / connectivity provided).
- data exchange with the ATO Domain

9.1.1.1.5 The ATO Communication Entity may include one or more mobile terminals and/or routers, dedicated to the ATO-OB or shared with other applications.

9.1.1.1.6 The coordination of multiple mobile radios to access the ATO Domain, coordination between them is needed to select one active radio.

9.1.1.1.7 To use the EDOR as a mobile terminal it shall be requested using the Resource Management according to [Subset-037-1], §6.6. It will be provided as logical Ethernet interface to the ATO Domain using the local GSM-R network.

9.1.1.1.8 The environmental characteristics of the ATO Communication Entity shall be the same as defined in [EIRENE SRS], chapter 16, for the EDOR.

10 ATO COMMUNICATION FUNCTIONAL MODULE PS MODE

10.1 Scope and purpose

10.1.1.1.1 This chapter provides the specification of the CFM PS Mode associated with the PS user plane to establish an end-to-end communication between ATO-OB and ATO-TS.

10.1.1.1.2 It encompasses:

1. the interface to the user (see clause 7)
2. the network layer addressing (see clause 10.2)
3. the packet integrity (see clause 8.2)
4. the security layer (see clause 10.3)
5. the transport protocol (see clause 10.4)

10.2 Addressing

10.2.1.1.1 For the network layer, IPv4 [RFC 791] shall be used for ATO-OB and ATO-TS.

10.2.1.1.2 Dynamic IP address allocation shall be used for the ATO Communication Entity.

10.2.1.1.3 IP address for the local interface (1a) [Figure 2] and applicable DNS server information shall be obtained during “IP connectivity” establishment to the data network (PDP context activation).

10.2.1.1.4 The allocation of (a) logical ATO-TS address(es) shall be permanent.

10.2.1.1.5 ATO-TS entity redundancy shall be treated inside the ERTMS entity that only one ATO-TS IP-address is propagated to the ATO-OB [EIRENE SRS], §9.15.9.

Note: Depending on feature realisation, also the network may be required to support the redundancy secondary to the respective ERTMS entity. At least physical connectivity cannot be solved within ERTMS entity alone because multiple physical cables will be needed to be handled by the network as well. Also, connection availability monitoring by ERTMS entity of physical links may need some higher (compared to physical) layer support e.g. ICMP, IP multicast, subnetting constrains etc.

10.2.1.1.6 The ATO related DNS shall comply with [RFC1034], [RFC1035] and with [Subset-037-1].

10.2.1.1.7 The DNS query shall follow the procedures defined in [Subset-037-1] for PS Mode only.

Note: If no responses will be received from the DNS, a deactivation of the PDP context in the APN could be the reason. In such a case a reestablishment of the IP Connectivity by the ATO Communication Entity could be necessary.

10.2.1.1.8 The FQDN, used to identify the ATO-TS equipment, shall comply with the following format:

“id<ETCS-ID>.ty<ETCS ID Type>.cc<NID_C>.ertms”

	formatted as
ETCS-ID	6-digit lowercase hex ASCII string
ETCS-ID type	2-digit lowercase hex ASCII string
NID_C	3-digit lowercase hex ASCII string

Example: id031123.ty08.cc00c.ertms

10.2.1.1.9 For the parameter “ETCS-ID”, “ETCS ID type” and “NID_C” see Table 5.

10.3 Security Layer

10.3.1.1.1 The communication between ATO-OB and ATO-TS shall be secured.

10.3.1.1.2 Authentication shall be done for both sides: ATO-OB and ATO-TS.

10.3.1.1.3 ATO packets shall be protected against modification.

10.3.1.1.4 Use of encryption is not mandatory. It shall be proposed by the client and can be accepted by the server.

10.3.1.1.5 Decision to use or use not encryption shall be based on a risk analysis.

10.3.1.1.6 The communication shall be protected against replay attacks.

10.3.1.1.7 The security layer for ATO is specified in [Subset-146]. See [Subset-146] Annex A for details.

10.4 Transport Layer

10.4.1.1.1 The transport layer protocol is TCP [RFC 793] for the ATO related communication.

10.4.1.1.2 The values of the TCP parameters specified in [Subset-037-1], Table 6 shall be used except the ones stated in this section.

10.4.1.1.3 The ATO-TS listening TCP port shall be 7910.

Note: No other application can use this port on the same entity.

10.4.1.1.4 The “TcpUserTimeout” shall be set to a value higher than the one specified in [Subset-037-1], Table 6. The recommended value is 5 minutes. RTO values should be adapted accordantly in responsibility of development.

10.4.1.1.5 The recommended “Max TCP segment size” for the ATO Application is 550 bytes. Other values are in responsibility of development.

10.4.1.1.6 The values of some TCP Parameters can be provided in the DNS TXT field as described in §6.5.1.10-13 of [Subset-037-1]. These suggested parameter values are mandatory unless they are not settable in the used TCP implementation. The parameter “txm” will not be supported for ATO.