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Interested committees:

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Part 2-3: TCN communication profile

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

PROJECT NUMBER: IEC 61375-2-3 ED2	
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IEC TC 9 : ELECTRICAL EQUIPMENT AND SYSTEMS FOR RAILWAYS	
SECRETARIAT: France	SECRETARY: Mr Denis MIGLIANICO
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	

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TITLE: Electronic railway equipment - Train communication network (TCN) - Part 2-3: TCN communication profile

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRONIC RAILWAY EQUIPMENT –
TRAIN COMMUNICATION NETWORK (TCN) –****Part 2-3: TCN communication profile****FOREWORD**

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International Standard IEC 61375-2-3 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This bilingual version (2019-01) corresponds to the monolingual English version, published in 2015-07.

The text of this standard is based on the following documents:

FDIS	Report on voting
9/2029/FDIS	9/2048/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61375 series, published under the general title *Electronic railway equipment – Train communication network (TCN)*, can be found on the IEC website

628 The committee has decided that the contents of this publication will remain unchanged until the
629 stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to
630 the specific publication. At this date, the publication will be

- 631 • reconfirmed,
632 • withdrawn,
633 • replaced by a revised edition, or
634 • amended.

635 The contents of the corrigenda of December 2015 and October 2016 have been included in
636 this copy.

637

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

638

639

640

INTRODUCTION

641 The IEC 61375 standard series specifies a Train Communication Network for usage in railway
642 vehicles (trains) mainly intended for the exchange of TCMS related information, but not
643 restricted to it. The specification starts from the physical layer up to the application layer and it
644 involves different communication technologies. This part of IEC 61375 (IEC 61375-2-3) defines
645 the communication profile of the Train Communication Network so as to achieve interoperability
646 between Consists connected by Ethernet Train Backbones as defined in IEC 61375-2-5.

647 The reasons for prompting the preparation of this part of IEC 61375 are:

- 648 • definition of the requirements necessary for communication interoperability on Ethernet
649 Train Backbone level;
- 650 • full documentation of the requirements of all users, aligning them and setting them out
651 in standard form;
- 652 • providing guidelines for the technical solution adopted for the train backbone
653 interoperable communication;
- 654 • defining a conformance test guideline (Annex F) which gives guidance for checking the
655 conformity of consists to the communication profile.

656 Concrete train applications for certain functionalities are not dealt with in this part of IEC 61375.
657 They are contained in IEC 61375-2-4.

658 The creation of this second edition of the standard has been motivated by advances in
659 technology, namely:

- 660 • Improved Quality of Service in Ethernet communication by using Time Sensitive Network
661 (TSN) features,
- 662 • Extensions for multiple network domains
- 663 • Extensions for OMTS (subclause 5.6.3)
- 664 • Support for extended train compositions as specified in IEC 61375-2-5 (e.g., as required
665 for freight trains)
- 666 • New ETB control services for freight trains: function “wake-up”, function “passive consist
667 detection” and function “DC based consist orientation detection”
- 668 • Extensions needed for reaching a higher safety level in train inauguration (like the
669 “BEACON proxy” function or the “DC based consist orientation detection” function)
- 670 • Extensions needed for reaching a higher safety level in safe data transmission
- 671 • Extensions needed to support (cyber) security

672 Furthermore, enhancements in the standard text are made to improve readability and to lower
673 the risk of misinterpretations by improving clarity.

674

ELECTRONIC RAILWAY EQUIPMENT – TRAIN COMMUNICATION NETWORK (TCN) –

Part 2-3: TCN communication profile

1 Scope

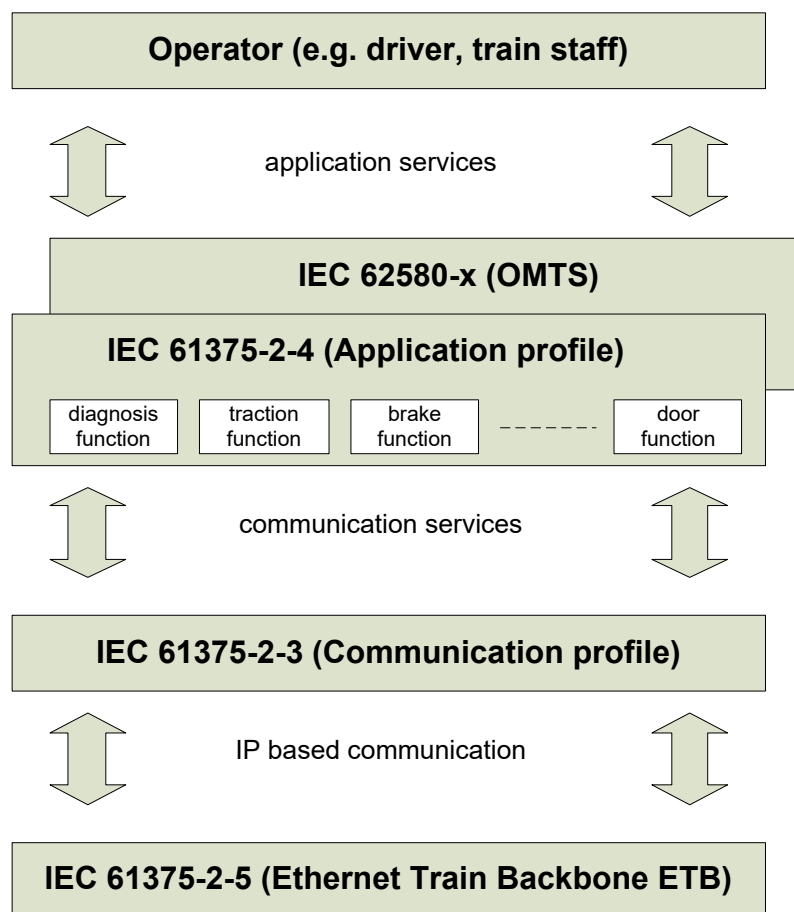
This part of IEC 61375 specifies rules for the data exchange between consists in trains. The aggregation of these rules defines the TCN communication profile.

The objective of the communication profile is to ensure interoperability between consists of the said trains with respect to the exchange of information. For this it defines all those items which are necessary for communication interoperability:

- an architecture with defined train directions related to different train views;
- a common functional addressing concept;
- common communication protocol for data exchange between functions;
- a set of services for train communication control.

As a restriction, this communication profile is adhered to the Ethernet Train Backbone (ETB) technology as defined in IEC 61375-2-5. Towards the consist networks, a more abstract interface is defined which does not restrict the appliance of any consist network technology as for instance MVB (IEC 61375-3-1), CANOpen (IEC 61375-3-3) or ECN (IEC 61375-3-4).

It is not within the scope of the communication profile to define application data content and its meaning (e.g. syntax and semantics). This is within the responsibility of the application profiles. Namely two application profiles are explicitly supported as shown in Figure 1: the TCMS application profile as defined in IEC 61375-2-4, and the onboard multimedia and telematic subsystem (OMTS) related application profiles as defined in the IEC 62580 series.



IEC

Figure 1 – IEC 61375-2-3 as connecting element between train backbone and application

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61375-1, *Electronic railway equipment – Train communication network (TCN) – Part 1: General architecture*

3 Terms, definitions, abbreviations, acronyms, and conventions

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org>

3.1.1

active consist

consist with at least one active train backbone node

3.1.2**application layer**

upper layer in the OSI model, interfacing directly to the application

[SOURCE: IEC 60050-811:2017, 811-37-03]

3.1.3**big endian**

ordering scheme for storing or transmitting data in which the most significant part of a multiple-octet data is stored at the lowest octet address, and transmitted first

[SOURCE: IEC 60050-811:2017, 811-37-07]

3.1.4**bridge <in a train communication network>**

device which stores and forwards frames from one bus to another on the base of their Link Layer addresses

[SOURCE: IEC 60050-811:2017, 811-37-09]

3.1.5**broadcast**

nearly simultaneous transmission of the same information to several destinations

Note 1 to entry: Broadcast in the TCN is not considered reliable, i.e., some destinations may receive the information and others not.

[SOURCE: IEC 60050-811:2017, 811-37-10]

3.1.6**closed train**

train composed of one or a set of Consists, where the composition does not change during normal operation

Note 1 to entry: Consists are coupled in a workshop to establish a closed train for operation.

EXAMPLE metro, sub-urban train, high speed train units.

[SOURCE: IEC 60050-811:2017, 811-37-17]

3.1.7**communication devices**

devices connected to Consist Network or train backbone with the ability to transport source or sink data

[SOURCE: IEC 60050-811:2017, 811-37-18]

3.1.8**consist**

single vehicle or a group of vehicles which are not separated during normal operation

Note 1 to entry: A consist contains no, one or several consist networks.

[SOURCE: IEC 60050-811:2017, 811-37-20]

3.1.9**consist network**

communication network interconnecting communication devices in one consist

Note 1 to entry: Consist networks do not spread beyond consist boundaries.

[SOURCE: IEC 60050-811:2017, 811-37-21, modified – The definition has been replaced with “communication network interconnecting communication devices in one consist”]

3.1.10**consist network address**

network address, which does not change after inauguration and which is used to address communication device in the own consist network

3.1.11**consist sequence number**

sequence number of the Consist in the train as obtained during train inauguration

3.1.12**domain, <in a train communication network>**

Network subnet associated to a well-defined set of functionalities, such as TCMS or OMTS

3.1.13**end device**

unit connected to one Consist Network or to one set of Consist Networks prepared for redundancy reasons

[SOURCE: IEC 60050-811:2017, 811-37-33]

3.1.14**end node**

node which terminates the train backbone

[SOURCE: IEC 60050-811:2017, 811-37-34]

3.1.15**Ethernet Train Backbone**

train backbone based on switched Ethernet technology

Note 1 to entry: Specified in IEC 61375-2-5.

3.1.16**Ethernet Train Backbone Node**

node connected to the Ethernet train backbone receiving a sequence number during inauguration and capable of forwarding user data packets between Consist Network and Train Backbone

3.1.17**leading vehicle**

vehicle which controls the movements of the train

3.1.18**multicast**

transmission of the same message to a group of receivers, identified by their Group Address

Note 1 to entry: The word "multicast" is used even if the group includes all receivers.

[SOURCE: IEC 60050-811:2017, 811-37-66]

3.1.19**multimedia network**

network in a train which is used for data transmission of multimedia and telematic data

3.1.20**multimedia services**

services which are used for multimedia

Note 1 to entry: Onboard multimedia services are defined in IEC 62580-1.

3.1.21**multiple unit train**

train comprising one or more train-units which can be controlled simultaneously from one cab and able to operate at normal speed in either direction without re-marshalling

809 [SOURCE: IEC 60050-811:2017, 811-02-12]

810 **3.1.22**

811 **network, <in a train communication network>**

812 set of possibly different communication systems which interchange information in a commonly
813 agreed way

814 [SOURCE: IEC 60050-811:2017, 811-37-68]

815 **3.1.23**

816 **network address**

817 address which identifies a communication device on network layer

818 [SOURCE: IEC 60050-811:2017, 811-37-69]

819 **3.1.24**

820 **network device**

821 components used to set up Consist Networks and Train Networks

822 Note 1 to entry: These may be passive components like cables or connectors, active unmanaged components like
823 repeaters, media converters or (unmanaged) switches, or managed active components like gateways, routers and
824 (managed) switches.

825 [SOURCE: IEC 60050-811:2017, 811-37-70]

826 **3.1.25**

827 **network layer**

828 layer in the OSI model responsible for routing between different busses

829 [SOURCE: IEC 60050-811:2017, 811-37-72]

830 **3.1.26**

831 **network management, <in a train communication network>**

832 operations necessary to remotely configure, monitor, diagnose and maintain the network

833 [SOURCE: IEC 60050-811:2017, 811-37-73]

834 **3.1.27**

835 **node, <in a train communication network>**

836 device on the train backbone that acts as a gateway between train backbone and consist
837 network

838 [SOURCE: IEC 60050-811:2017, 811-37-74]

839 **3.1.28**

840 **operational network**

841 network in a train which is used for the transmission of train operational and safety critical data

842 **3.1.29**

843 **operational train view**

844 driver or train attendance view of a train as a sequence of vehicles

845 **3.1.30**

846 **octet**

847 byte

848 ordered set of eight binary digits, operated on as an entity

849 [SOURCE: IEC 60050-171:2019, 171-02-12]

850 **3.1.31**

851 **open train**

852 train composed of one or a set of consists, where the configuration can change during operation

853 EXAMPLE: Locomotive-hauled international UIC (International Union of Railways, the international railways
854 operators association) trains

855 [SOURCE: IEC 60050-811:2017, 811-37-79]

856 **3.1.32**
857 **operational train direction**
858 direction of train as seen by driver or train attendance

859 **3.1.33**
860 **operational train directory**
861 data structure describing the train composition as seen by driver or train attendance, including
862 information about the leading vehicle and vehicle gaps

863 Note 1 to entry: The operational train directory is a part of the train topology database.

864 **3.1.34**
865 **operator**
866 enterprise or organization which is operating trains

867 **3.1.35**
868 **passive consist**
869 consist with no active train backbone node

870 Note 1 to entry: this is the case when a consist is powerless, in sleeping mode or its train backbone nodes are out
871 of order

872 Note 2 to entry: passive consists are registered as vehicle gaps in operational train directory

873 **3.1.36**
874 **safe data transmission**
875 data transmission of safety related data

876 **3.1.37**
877 **sporadic data**
878 transmission of data on a demand basis

879 **3.1.38**
880 **switch, <in a train communication network>**
881 MAC bridge as defined in IEEE 802.1D

882 Note 1 to entry: MAC means "Medium Access Control", a sub-layer within the Link Layer ruling which device is
883 entitled to send on the bus.

884 [SOURCE: IEC 60050-811:2017, 811-37-101]

885 **3.1.39**
886 **topology**
887 possible cable interconnection and number of devices in a given network

888 **3.1.40**
889 **topography counter**
890 unique identifier of a train composition

891 **3.1.41**
892 **train backbone, <in a train communication network>**
893 train bus

894 bus connecting the consists of a train, in particular the wire train bus, and which conforms to
895 the TCN

896 [SOURCE: IEC 60050-811:2017, 811-37-107]

897 **3.1.42**
898 **train backbone view**
899 train seen as a sequence of consist networks determined by ETB inauguration

3.1.43**train directory**

data structure which describes the train composition and provides user information about the consists

3.1.44**train network address**

dynamic network address, which is used to address communication devices in other consist networks.

Note 1 to entry: This address can change after each inauguration.

[SOURCE: IEC 60050-811:2017, 811-37-109]"

3.1.45**train reference direction**

train direction determined by train inauguration

3.1.46**train view**

train seen as sequence of consists determined by the ETB inauguration

3.1.47**transport layer**

layer of the OSI model responsible for end-to-end flow control and error recovery

[SOURCE: IEC 60050-811:2017, 811-37-113]

3.1.48**vehicle, <in a train communication network>**

single coach, wagon or locomotive

3.1.49**vehicle gap**

gap

vehicle listed in the confirmed vehicle list of the operational train directory which is not reachable over ETB

Note 1 to entry: A vehicle gap is caused by a passive consist.

Note 2 to entry: A vehicle gap can be at one train end or in the middle of a train. There may also exist more than one vehicle gap in a train.

Note 3 to entry: Vehicle gaps may be determined by the driver while comparing the indicated unconfirmed train composition with the real train composition, leading to a correction of the train composition. There may also be other mechanism available to discover vehicle gaps and to initiate train composition correction.

3.2 Abbreviations and acronyms

ALG	Application Layer Gateway
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
BCF	Beacon Control Function
CCU	Central/Consist Control Unit
CN	Consist Network
COD	Consist Orientation Detection
ComId	Communication Identifier
CRC	Cyclic Redundancy Check
CST	Consist

945	CSTINFO	Consist Information telegram
946	CTC	Conventional Train Control
947	DAC	Digital Automatic Coupler
948	DC	Direct Current
949	DEV	Device
950	DNS	Domain Name System
951	DoS	Denial of Service
952	FCS	Frame Check Sequence
953	ECN	Ethernet Consist Network
954	ECSC	ETB Control Service Client
955	ECSP	ETB Control Service Provider
956	ED	End Device
957	ETB	Ethernet Train Backbone
958	ETBCTRL	ETB Control packet
959	ETBN	Ethernet Train Backbone Node
960	EU	European Union
961	FCT	Function
962	IEEE	Institute of Electrical and Electronics Engineers
963	IETF	Internet Engineering Task Force
964	IP	Internet Protocol
965	LEN	Length
966	MAC	Medium Access Control
967	MC	Multicast
968	MD	Message Data
969	MD-PDU	Message Data Protocol Data Unit
970	MIB	Management Information Base
971	MTU	Maximal Transmission Unit
972	MVB	Multifunction Vehicle Bus
973	NAT	Network Address Translation
974	NOK	Not OK
975	OID	Object Identifier
976	OMTS	Onboard Multimedia and Telematic Subsystems
977	OSI	Open System Interconnection
978	PD	Process Data
979	PD-PDU	Process Data Protocol Data Unit
980	PICS	Protocol Implementation Conformance Statement

981	PROP	Properties
982	QoS	Quality of Service
983	RFC	Request For Comments
984	SDSINK	Safe Data Sink
985	SDSRC	Safe Data Source
986	SDT	Safe Data Transmission
987	SDTv2	Safe Data Transmission (Version 2)
988	SDTv4	Safe Data Transmission (Version 4)
989	SID	Source Identifier
990	SIL	Safety Integrity Level
991	SMI	Safe Message Identifier
992	SNMP	Simple Network Management Protocol
993	SSC	Safety Sequence Counter
994	STC	Safe Topography Counter
995	TCN	Train Communication Network
996	TCMS	Train Control and Monitoring System
997	TCP	Transmission Control Protocol
998	TLV	Type-Length-Value
999	TP	Test Procedure
1000	TSS&TP	Test Suite Structure and Test Purpose
1001	TRDP	Train Real Time Data Protocol
1002	TTDB	Train Topology Database
1003	TTL	Time to Live
1004	TTDP	Train Topology Discovery Protocol
1005	UDP	User Datagram Protocol
1006	UIC	Union Internationale des Chemins de Fer
1007	UML	Unified Modeling Language
1008	URI	Uniform Resource Identifier
1009	URL	Uniform Resource Locator
1010	UUID	Universally Unique Identifier
1011	UuT	Unit under Test
1012	VDP	Vital Data Packet
1013	VLAN	Virtual Local Area Network
1014	WTB	Wire Train Bus
1015	XML	Extended Markup Language

1016 XSD XML Schema Definition

1017 **3.3 Conventions**

1018 **3.3.1 Base of numeric values**

1019 This part of IEC 61375 uses a decimal representation for all numeric values unless otherwise
1020 noted.

1021 Analog and fractional values include a comma.

1022 EXAMPLE The voltage is 20,0 V.

1023 Binary and hexadecimal values are represented using the ASN.1 (ISO/IEC 8824) convention.

1024 EXAMPLE Decimal 20 coded on 8 bits = '0001 0100'B = '14'H.

1025 **3.3.2 Character strings and citations**

1026 Character strings are placed within double quotes.

1027 EXAMPLE "ComProfTestAppl".

1028 Single quotes are used for citations (quotations).

1029 EXAMPLE parameter 'etbTopoCnt'.

1030 Sometimes character strings are parameter values, in which case they can be written as
1031 citations.

1032 EXAMPLE telegram type 'Mn'.

1033 **3.3.3 Naming conventions**

1034 Keywords are written with a capital letter at the beginning.

1035 If the keyword name is composed, the different parts of the name are united with a space, and
1036 all parts begin with a capital letter.

1037 EXAMPLES "Train Backbone", "Consist", "Consist Network".

1038 Parameters are written with a capital letter at the beginning.

1039 If the parameter name is composed, the different parts of the name are united without a space,
1040 and all parts begin with a capital letter except for the first part which begins with a lower case
1041 letter.

1042 EXAMPLE 'etbTopoCnt'.

1043 **3.3.4 Diagram conventions**

1044 Whenever appropriate, UML diagram types are used. In particular, the following UML diagram
1045 types are applied:

- 1046 • UML state machines
- 1047 • UML sequence diagram

1048 For conditions used in these diagram types the following conventions are applied:

operators	=	Assignment operator: set a value
	==	Equality operator: equal
	!=	Equality operator: not equal
	OR	Logical operator: {expression} OR {expression}
	AND	Logical operator: {expression} AND {expression}
boolean	FALSE	Antivalent2 value 0: 01 _b
	TRUE	Antivalent2 value 1: 10 _b

1049

1050 For triggers and guards used in these diagram types the following conventions are applied:

- 1051 • A trigger is an external event, e.g. a user command, which triggers a state transition
- 1052 • In the special case that a trigger is the reception of a (periodic) ETBCTRL packet, the
- 1053 control flags within the ETBCTRL packet determine the state transition. For those cases
- 1054 only the guards are indicated in the UML state machines

1055 3.3.5 Annotation of data structures

1056 3.3.5.1 General

1057 Data structures are defined following the presentation and encoding of transmitted and stored
1058 data as ruled in IEC 61375-2-1, which bases on ISO ASN.1 syntax.

1059 All data within a data structure are organized in big-endian format (most significant octet of a
1060 data item first).

1061 All data within a data structure are naturally aligned (stored at offset address which is a multiple
1062 of their size).

1063 Data values of parameters within data or telegram structures which are marked 'application
1064 defined' are either defined by IEC 61375-2-4 or are left to the user to be defined.

1065 3.3.5.2 Additional data types

1066 In addition to the data types defined in IEC 61375-2-1, the following data types are used:

1067 (1) LABEL ::= ARRAY [16] OF CHAR

1068 (2) AntivalentType ::= ANTIVALENT8

1069 with the encoding:

7	6	5	4	3	2	1	0	interpretation
2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰	
0	0	0	0	0	0	0	1	FALSE
0	0	0	0	0	0	1	0	TRUE
0	0	0	0	0	0	1	1	UNDEFINED
any other value								ERROR

1070

1071 3.3.5.3 Data type keywords

1072 In addition to the keywords/notations defined in IEC 61375-2-1 as an extension to ASN.1, some
1073 shorter, but equivalent keywords/notations are used within this part of IEC 61375 in order to
1074 improve the readability of data structures. These keywords are (see Table 1):

1075

Table 1 – Data type keywords and notations

Keyword/notation used in this part of IEC 61375	Equivalent keyword/notation used in IEC 61375-2-1
UINT#	UNSIGNED#
INT#	INTEGER#
CHAR	CHARACTER8
Type [IndexList]	ARRAY [IndexList] OF Type
(# = any unsigned integer)	

1076

1077

4 Architecture

4.1 General

This clause defines the train related communication system architecture, which is the basis for the communication profile. The train related communication system architecture is defined from two different viewpoints, the physical train architecture, and the logical train architecture. The physical train architecture provides a system breakdown by considering components and interfaces in between, whereas the logical train architecture is based on functional breakdown dealing with functions and their interactions. Both views are necessary for defining important communication profile concepts, like for instance the definition of the train topology database or the definition of a train wide logical addressing concept based on URIs.

4.2 Physical train architecture (system breakdown)

4.2.1 General

The physical train architecture defines a train as composed of closed trains, consists, vehicles, devices and the interfaces in between.

4.2.2 Train network architectures

4.2.2.1 Train structure

IEC 61375-1 defines a train as a composition of closed trains and consists, each consist having one or several vehicles, and each closed train having one or several consists as shown in Figure 2.

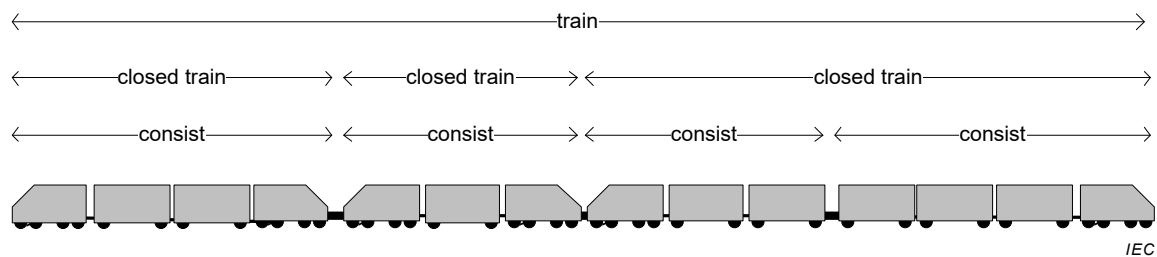


Figure 2 – Train structure in accordance to IEC 61375-1 (example)

For this part of the standard, the following restriction is made:

Although a closed train is a composition of one or several consists (closed train consists), it shall be seen as one operational consist for the scope of this communication profile. In this sense, a train is only composed of (operational) consists as shown in Figure 3, whereby some of the operational consists may be a closed train. Consequently, every closed train has also to behave like a consist with respect to this communication profile.

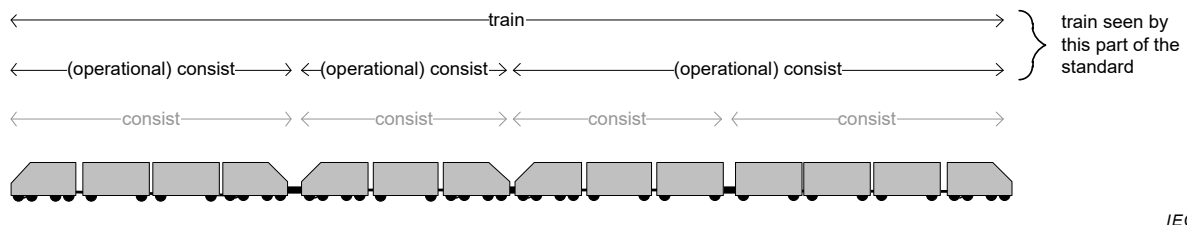


Figure 3 – Train structure seen from viewpoint of the communication profile (example)

NOTE 1 Communication inside a closed train, e.g. between the closed train consists which constitute the closed train, is not in the scope of this standard.

This communication profile is applicable for trains with a maximum number of 63 vehicles (regular train composition as defined in IEC 61375-2-5:20XX) or 127 vehicles (extended train composition as defined in IEC 61375-2-5:20XX).

NOTE 2 How vehicles are allocated to consists depends on the chosen consist design. For example, each vehicle in a train can be a consist, in which case a regular train composition contains 63 consists, or two trainsets with 32 and 31 vehicles form each one consist, in which case the regular train composition contains only 2 consists.

4.2.2.2 Train network allocation

IEC 61375-1 defines a train wide network as a composition of consist networks interconnected by a common train backbone as shown in the example of Figure 4, where one or several consist networks per consist are connected to the ETB via a redundant pair of ETBN. It is important to note that communication within the consists is divided into domains, as specified in IEC 61375-2-5.

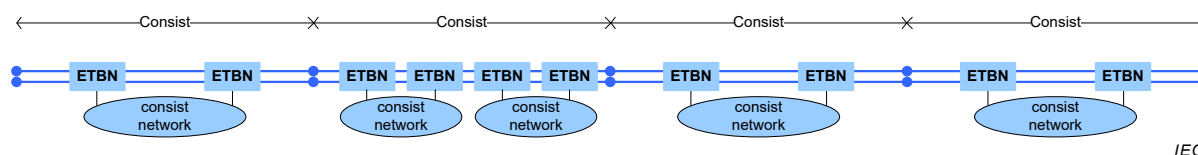


Figure 4 – Train network (example)

Furthermore, IEC 61375-2-5 allows applying up to 4 train domains.

This communication profile defines the usage of the domains in the following way:

- One domain (with subordinated consist networks) shall be used as operational network, supporting TCMS services.
- One or several domains (with subordinated consist networks) shall be used as multimedia network supporting OMTS services or any other services.

The operational domain may not be used for OMTS services.

NOTE If one physical network is used for both TCMS services and OMTS services, a separation can be done on an upper layer, e.g. on link layer by using VLAN. The expectation is, however, that requirements related to safety and security are harder to fulfil for such type of network.

4.2.2.3 ETBN redundancy

At least one ETBN shall be provided per consist network. For redundancy purposes, it is recommended that two ETBNs are at least provided on traction units and for the backbone connection of the driving cab equipment of driving trailers (this also applies to multiple unit trains).

4.2.2.4 Safety and security aspects

The operational network shall be a category 1 (preferred) or a category 2 transmission system as defined by IEC 62280.

4.2.2.5 IP Address space

Both operational network and multimedia network shall use one common train network address space as defined in IEC 61375-2-5 (i.e. 10.128/9). The train network address space for each network shall be identified.

NOTE If both networks are physically separated, the domain id, 10th and 11th bit in train network address, is used for identification.

4.2.2.6 Interconnecting operational network and multimedia network

4.2.2.6.1 ETB Dependency

In order to ensure interoperability between trains with multiple ETBs, all functions connected to those ETBs shall share a common train view and a common operational train view as defined in 4.2.4.1.

4.2.2.6.2 Network couplings

There are several ways of coupling operational network and multimedia network (see Figure 5).

- Both networks can share a common CN, in which case the two networks are coupled on OSI layer 2.
- Both networks can be interconnected by an IP router (eventually with firewall functions), thus providing a coupling on OSI layer 3.
- Both networks can be separated by an application layer gateway (ALG), meaning a coupling on OSI layer 7.

NOTE Modern IP routers with firewall functionality allow also a filtering on (application data) content. In this case the networks are coupled on both layer 3 and layer 7.

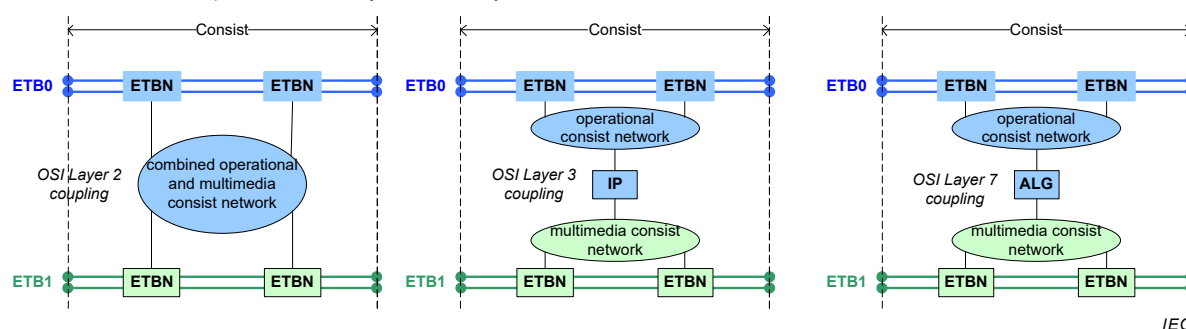


Figure 5 – Possible couplings of operational network and multimedia network

If there is a coupling on at least OSI layer 3, Eds connected to the operational consist network are said to be related to the operational domain (TCMS domain), and Eds connected to the multimedia consist network are said to be related to the multimedia domain (OMTS Domain).

In case of OSI layer 2 coupling this relationship is undetermined.

NOTE The relationship of Eds is an information that is relevant for IP MC group assignments, see 5.4.5.2.

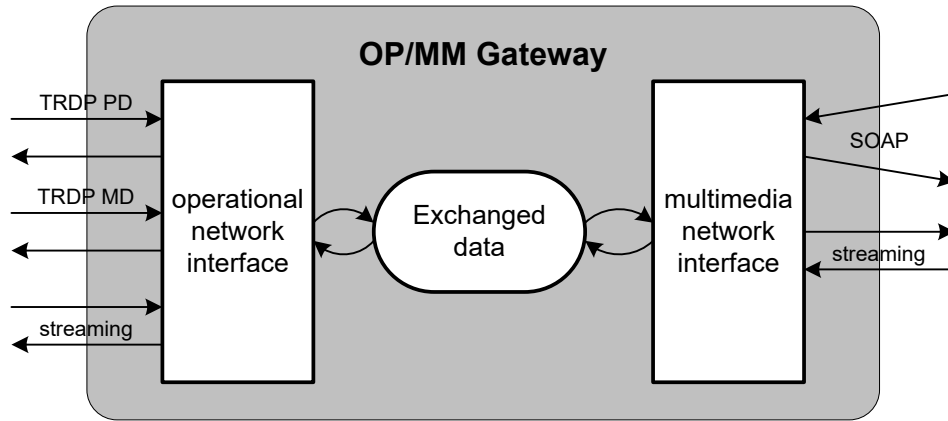
4.2.2.6.3 Data exchange between operational network and multimedia network

The way of data exchange between the operational network and multimedia network depends on the coupling of the two networks. While couplings on OSI layer 2 and 3 allow a data exchange on IP telegram base that is mostly handled within the communication layers of modern operating systems, a coupling on OSI layer 7 provides a better application control of exchanged data.

The following example describes a possible ALG design of an operational/multimedia gateway:

EXAMPLE:

The gateway for interconnecting the operational network and the multimedia network (Figure 6) belongs formally to the operational network. This gateway is not only needed for the reasons of security and closed system. It also serves as entry point for multimedia network applications to operational network applications and vice versa, offering services to the respective side, which allows exchanging information with the respective, other side. This also means that the gateway has to provide two different interfaces: the interface to operational section based on the communication protocols used in the operational section, and the interface to the multimedia section implementing the protocols of the multimedia section. As an example, the gateway may receive the train directory information from the operational section ECSP within a TRDP Message Data packet, and offers this information in a web service to the multimedia section participants. Other interface service examples are to provide data streaming (video and audio). So both client/server related interface services as well as real-time data interface services might be needed. As real-time data requires a high throughput, those data are normally routed on OSI layer 3 rather than processed on layer 7. In order to cope with the security, additional security measures are then required as for instance firewall functionality.



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Figure 6 – Gateway between operational network and multimedia network (example)

4.2.2.7 Safety and security aspects

An architecture with a coupled operational network and multimedia network shall not compromise the transmission system categorization of the operational network as defined in 4.2.2.4.

In case the multimedia network is a category 3 transmission system in accordance to IEC 62280, at least a coupling on OSI layer 3 with firewall capabilities shall be envisaged, better a coupling on OSI layer 7.

It is not within the scope of this standard to define the necessary capabilities of the firewall as this is highly related to the system design and its security requirements.

The suitability of the coupling to preserve the transmission system categorization of the operational network shall be demonstrated within the system safety case.

4.2.2.8 Network Reconciliation

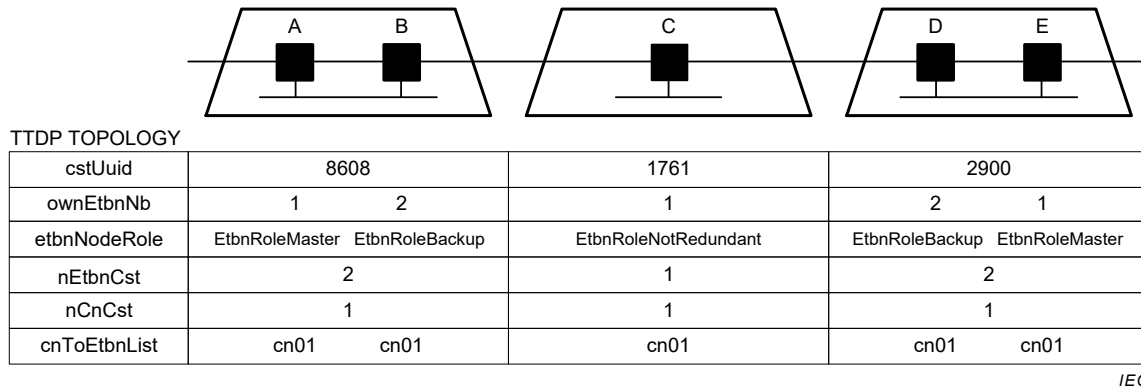
For applications of the multimedia network, it will be necessary to have the same operational train view (see 4.2.4.1) as for an application of the operational network, such as the sequence of consists and the position of the leading vehicle, in order to realize an unambiguous addressing scheme within the train.

As a common rule, the operational train view determined by the operational network and manifested within the operational train directory of the TTDB as defined in 5.3 shall be authoritative for the multimedia network. Hence, consist sequence and position of the leading vehicle shall be adopted from the operational network.

4.2.3 Closed Trains

4.2.3.1 General

As defined in IEC 61375-1, a closed train is composed by consists. The example in Figure 7 shows three coupled consists with UUID 8608, 1761, 2900. Each consist takes part in the ETB inauguration as defined in IEC 61375-2-5.



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NOTE The table TTDP TOPOLOGY in Figure 7 contains only the relevant elements.

Figure 7 – Example: three coupled Consists

Consist with UUID 8608 contains two ETBNs “A” and “B” with the static relative positions 1 and 2 in the consist. ETBNs “A” and “B” are redundant. Both ETBNs are connected to the first and only consist network.

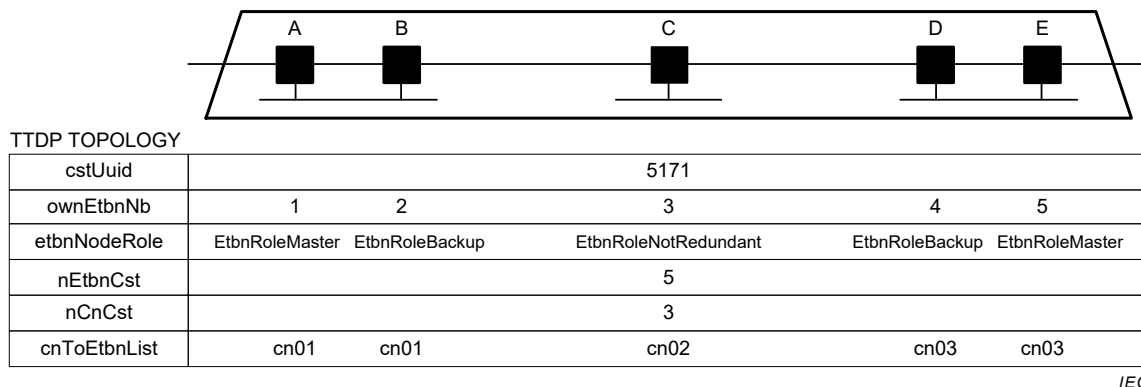
Consist with UUID 1761 contains the ETBN “C” with the static relative position 1 in the consist. ETBN “C” is non-redundant. The ETBN is connected to the first and only consist network.

Consist with UUID 2900 contains two ETBNs “D” and “E” with the static relative positions 1 and 2 in the consist. ETBNs “D” and “E” are redundant. Both ETBNs are connected to the first and only consist network.

4.2.3.2 Closed Train Representation in ETB inauguration

For the ETB inauguration according to IEC 61375-2-5, the closed train shall be represented as a single consist.

For the composition of a closed train the parameters for the TTDP TOPOLOGY frame contents as defined in IEC 61375-2-5 shall be adapted. Figure 8 shows the external view of the closed train example and the relevant TTDP TOPOLOGY frame elements.



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Figure 8 – Example: Closed Train

In the example in Figure 8 the consist with UUID 5171 contains the five ETBNs “A”, “B”, “C”, “D” and “E” from Figure 7 with the static relative positions 1, 2, 3, 4 and 5 in the consist.

respectively. ETBNs "A"/"B" and "D"/"E" are redundant. The total number of ETBNs in the Consist is five. The total number of Consist Networks in the Consist is three. The ETBNs "A" and "B" are connected to the first Consist Network. The ETBN "C" is connected to the second Consist Network. The ETBNs "D" and "E" are connected to the third Consist Network.

During ETB inauguration each ETBN of the closed train (i.e. consist with UUID 5171) sends its TTDP TOPOLOGY frame. Therefore, another externally coupled consist knows all about the network topology of the closed train.

4.2.3.3 Deficit of information about train composition

Since the closed train in Figure 8 is represented as a single consist, the information about the mapping from ETBNs and connected consist networks to vehicles is lost. This loss of information can be recovered during computation of the TTDB.

4.2.4 Directions

4.2.4.1 Train views

A train can be viewed from different perspectives, which depend on the role of the viewer.

In the train backbone view, a train is composed of consist networks which are connected to one ETB, which in turn shall contain several domains, via ETBNs. This view represents the network topology of the train. A train backbone topology will be changed if ETBNs are connected or removed. This view is defined in IEC 61375-2-5.

In the train view, a train is composed of consists and the consists are composed of vehicles. A TCN train composition will be changed if consists are removed or appended. Its defined extremities determine the directions in the train.

In the operational train view (driver's and attendance view), a train is composed of a series of consists as well as a series of vehicles. Directions in the train are defined by the main view direction of the driver's cab in the leading vehicle. An operational train view will be changed if the leading cab is changed or if consists are appended or removed and there is no leading cab.

4.2.4.2 Train reference directions

The TCN directions and orientation within a train, consist and vehicle are specified in IEC 61375-1.

In addition, IEC 61375-1 specifies the numbering of vehicles in a consist and the numbering of consists within a train. The numbering is related to the Extremity 1 of a vehicle, a consist, or a train.

IEC 61375-1 leaves open how the extremities will be assigned. The following rules for assigning the extremities shall apply:

- Extremity 1 of a vehicle shall be statically predefined by the design of that vehicle.
- Extremity 1 of a consist shall be statically predefined by the design of that consist.
- Extremity 1 of a train is the train end, which is pointed to by the ETB reference direction 1 as defined in IEC 61375-2-5.

4.2.4.3 Operational directions

From operator/driver point of view, one end of a train is the train head and the opposite end the train rear, which are determined by the operational train direction. The operational train direction points from the train rear to the train head. The operational train directions are defined according to the rules a) to e).

- a) If there is a leading vehicle in the train, the operational train direction is determined by the viewing direction of the driving cab of the leading vehicle.

If there is no leading vehicle, then the operational train direction shall be determined by the following rules:

- 1284 b) If there was a previously leading vehicle, then this vehicle together with its previously
1285 operational train direction determines the operational train direction.
- 1286 c) Entry removed.
- 1287 d) If there are multiple consists in the train and a traction consist at one end, then this end
1288 defines the train head and traction consist includes vehicle 01 and determines the
1289 operational train direction.
- 1290 e) In all other cases, the operational train direction shall correspond to the ETB reference
1291 direction according to IEC 61375-2-5.

1292 **4.2.5 Consist and vehicle basic properties**

1293 **4.2.5.1 General**

1294 Consists and vehicles shall be described by a basic set of consist and vehicle properties, which
1295 will be stored within the Train topology database. For this a distinction should be made between
1296 static, topological and dynamic properties:

- 1297 – Static properties are features built into the vehicle or consist and thus only dependent
1298 on its class or design, as for example “vehicle identifier”, “vehicle has first class seats”,
1299 “traction unit with electric drive”.
- 1300 – Topological properties are properties, which present the physical configuration of train
1301 structure, as for example vehicle sequence or vehicle orientation.
- 1302 – Dynamic properties are properties which define a train assignment, as for example
1303 “leading vehicle”, “vehicle sequence number” or “train reference direction”.

1304

4.2.5.2 Vehicle and consist type information

Vehicles and consists may receive a type classifier which makes it easier for applications to check whether vehicles or consists have common static properties. Those type classifiers are defined as follows:

VehType	LABEL	-- Type of the vehicle
		Zero terminated string
CstType	LABEL	-- Type of the consist
		Zero terminated string

The definition of type classifiers is application specific. For the scope of this communication profile, the type classifier is only informal.

4.2.5.3 Static Properties

A list of static consist and vehicle properties is provided in IEC 61375-2-4.

4.2.5.4 Identification

A consist shall be uniquely identified by a consist UUID as defined in IEC 61375-2-5.

An application defined vehicle identifier shall uniquely identify a vehicle.

EXAMPLE UIC defined a 12-digit wagon number for the unique identification of coaches, as for example the number "50 80 31 – 34 025 – 2".

4.3 Logical Train Architecture (Functional Breakdown)**4.3.1 General**

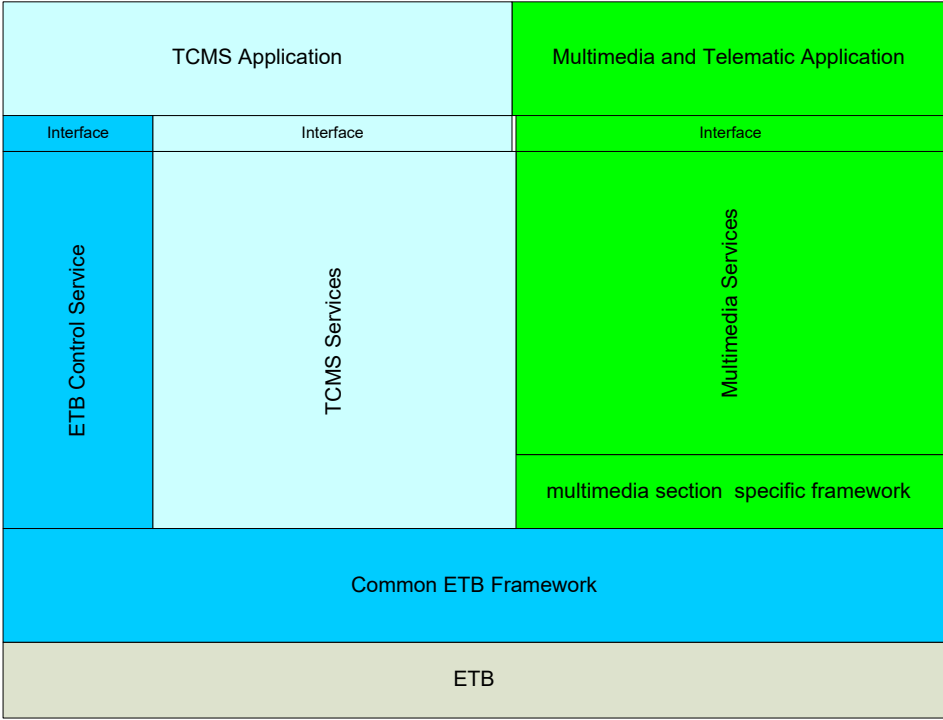
The logical train architecture defines a train as composed of services and the information exchanged between the services and between user and services.

4.3.2 Service classification

Services can be classified in (see Figure 9):

- Operational services, as defined in this part of IEC 61375 and in IEC 61375-2-4.
- Multimedia services, as defined in IEC 62580.

Subject of this part of the standard are ETB control services and shared ETB system services. Operational services are defined in IEC 61375-2-4.



- IEC 61375-2-5
- IEC 61375-2-3
- IEC 61375-2-4
- IEC 62580

IEC

Figure 9 – Service classification

All the services use functions, protocols, and definitions from a common ETB framework, which is defined in Clause 5.

For multimedia services, a multimedia specific framework may be added which provides multimedia specific functions, protocols, and definitions. The definition of the multimedia specific framework is not within the scope of this standard.

4.3.3 Operational Services Overview

Besides TCMS services as specified in IEC 61375-2-4, this part of the standard defines in Clause 6 an ETB control service whose service functions are listed in Table 2.

NOTE The functional breakdown of TCMS services is related to EN 15380-4.

1345

Table 2 – ETB control service

Function	Short form	Classification	Location	Related subclause	Description
Manage leading vehicle information	Function Leading	control	Consist	6.5	Set or reset leading vehicle on request and handle leading vehicle conflicts
Confirm train configuration	Function Confirmation/Correction	control	Consist	6.6	Allow a user to confirm or to correct the indicated train composition
Manage energy saving mode Manage battery protection mode	Function Sleep Mode	control	Consist	6.8	Set train to low power mode, wake up on command or on ETB activity
Wakeup train	Function Wake-up	control	Consist	6.9	Wake up by using a DC voltage signal over the data line
Detect passive consists	Function Passive Consist Detection	control	Consist	6.10	Detect presence and number of passive consists between active consists and at train extremities
Independent consist orientation detection	Function DC-based consist orientation detection	control	Consist	6.11	Discover consist orientation by an independent technology to support functional safety (safe train inauguration)

1346

1347 **4.3.4 Service Provider**

1348 The ETB control services shall be provided by the ECSP (see also 6.2).

1349 One instance of the ECSP providing the ETB control services shall be available in each consist,
1350 whereupon all ECSP in the train interact to commonly provide the ETB control services as
1351 defined in 6.4.

1352 In consists with several consist networks, the ETB control services shall only be provided within
1353 one consist network. This will be the consist network which also hosts the end device
1354 responsible for ETB control (ECSC). The reason for this restriction is to avoid control conflicts
1355 within a consist.

1356 For redundant ECSP within a consist, only one ECSP shall actively provide the ETB control
1357 services.

1358 **5 Common ETB framework**

1359 **5.1 General**

1360 **5.1.1 Overview**

1361 The common ETB framework defines basic functions and basic concepts, which together
1362 provide the infrastructure the services are bedded in. In particular, it defines:

- 1363 – CSTINFO Telegram (see 5.2)
- 1364 – Train Topology Database TTDB (see 5.3)

- 1365 – Service addressing (see 5.4)
- 1366 – TCN-DNS Server (see 5.5)
- 1367 – Data exchange (see 5.6)
- 1368 – Announcement of supported functions (see 5.7)
- 1369 – Beacon Telegrams and Beacon Proxy function (see 5.8)

1370 5.1.2 Interoperability

1371 Telegrams exchanged on ETB between consists and their related data structures are versioned
1372 using a data structure for version information which is defined as:

```
1373 VERSION ::= RECORD
1374 {
1375     mainVersion      UINT8      -- main version, incremented for
1376                               incompatible changes
1377
1378     value range: 1..255 (0 = reserved)
1379
1380     subVersion       UINT8      -- sub version, incremented for
1381                               compatible changes
1382                               value range: 0..255
1383 }
1384
1385
```

1386 In order to ensure interoperability between consists, all changes affecting normative clauses of
1387 this standard shall be treated as incompatible changes, leading to an increment of parameter
1388 'mainVersion', unless otherwise specified.

1389 This standard does not define a “negotiation” of the supported versions when two consists are
1390 coupled implementing different versions of the standard's normative clauses. Such a
1391 negotiation would be needed if compatible changes were allowed.

1392 Compatible changes might be applied for informal parts, like for instance the data exchange
1393 between ECSC and ECSP defined in Annex E.

1394 5.2 CSTINFO telegram

1395 5.2.1 General

1396 As defined in part IEC 61375-2-5, following an ETB train inauguration, one entitled device in
1397 each consist shall send out a CSTINFO telegram over ETB to all other entitled devices within
1398 the train to inform about consist properties.

1399 For the sake of simplicity, the ECSP shall be entitled to send the CSTINFO telegrams.

1400 5.2.2 Closed train support (Option)

1401 For the ETB inauguration a closed train is represented as a single consist (see 4.2.3.2).
1402 Therefore, one ECSP within the closed train shall send a CSTINFO telegram which describes
1403 the closed train as one consist (consist info class 2, see 5.2.4).

1404 In order to learn the consist structure of a closed train, one ECSP within a closed train consist
1405 shall send a CSTINFO telegram (consist info class 3, see 5.2.4).

1406 5.2.3 Protocol

1407 The protocol for sending CSTINFO telegrams is defined in 5.3.2.

1408 5.2.4 CSTINFO classes

1409 CSTINFO classes are defined to distinguish the CSTINFO telegrams sent by consists, closed
1410 trains and closed train consists. The following three classes are defined:

- 1411 • CSTINFO class 1: CSTINFO telegrams sent by consists which are no closed trains
 - 1412 • CSTINFO class 2: CSTINFO telegrams sent by closed trains
 - 1413 • CSTINFO class 3: CSTINFO telegrams sent by closed train consists
- 1414 Consists which are no closed trains shall be able to receive and process CSTINFO classes 1
1415 and 2 but need not be able to receive consist info class 3 telegrams.
- 1416 Only CSTINFO class 2 telegrams shall provide a closed train consist list (array “cltrCstList”
1417 CSTINFO telegram). For CSTINFO classes 1 and 3 this array shall be omitted (parameter
1418 “cltrCstListCnt” set to 0, see 5.2.5).

1419 **5.2.5 CSTINFO Notification Message**

1420 CSTINFO messages shall be sent within the payload of a Train Realtime Data Protocol (TRDP)
1421 message as defined in Clause A.7.

1422 The CSTINFO size shall be restricted to the maximal DatasetLength parameter value of a MD-
1423 PDU as defined in Clause A.7.

1424 **TRDP MD Notification telegram parameters:**

MsgType:	‘Mn’
Protocol:	UDP
ComId:	2
SourceURI (user part):	void
DestinationURI (user part):	void
DestinationURI (host part):	grpECSP.anyVeh.aCst.aCITrn.ITrn
SourceURI (host part):	-
Dataset:	CSTINFO

1425

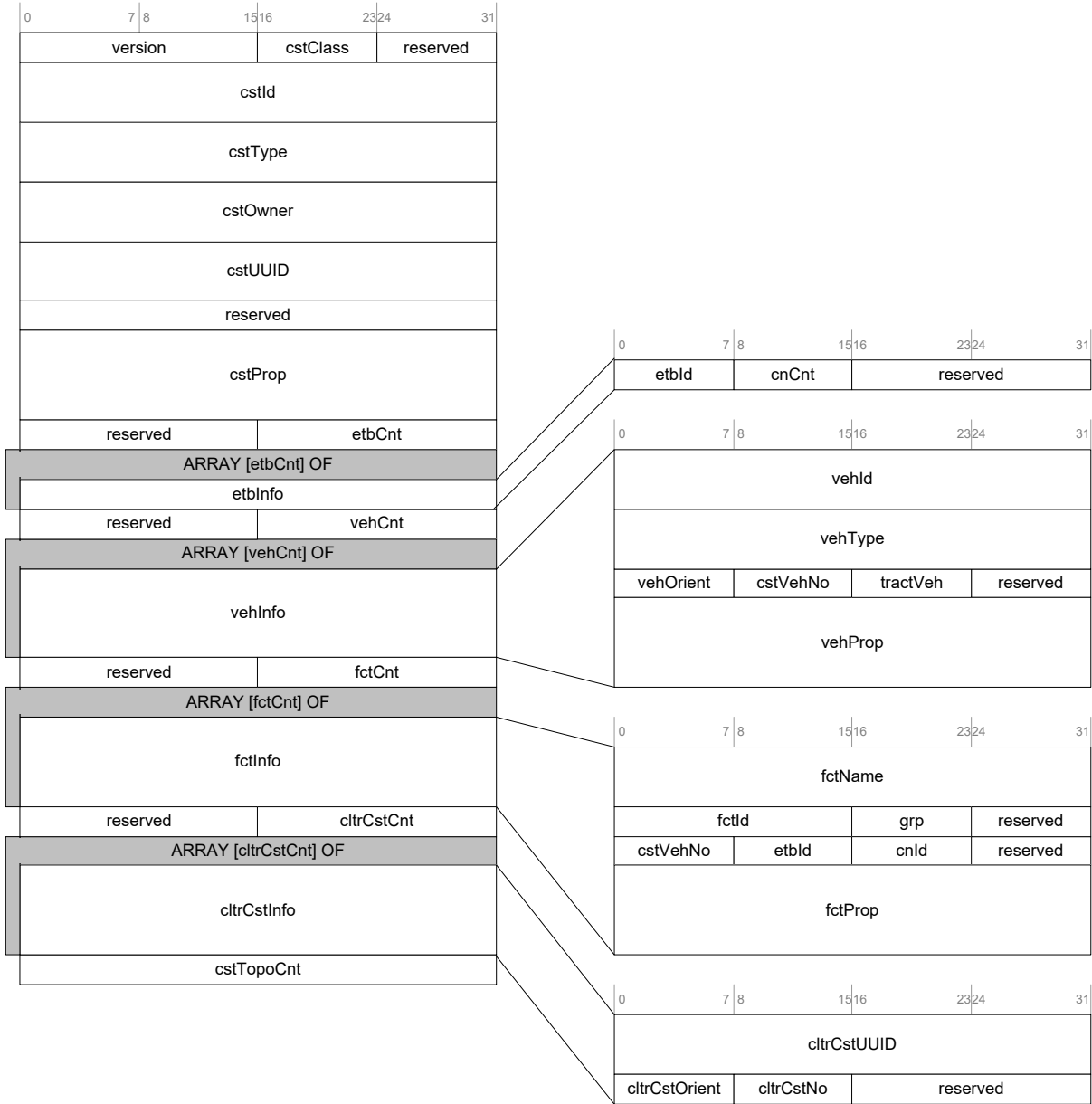
1426 The TRDP MD UserDataset is defined as (see Figure 10):

1427

```

1428 CSTINFO ::= RECORD
1429 {
1430   cstInfo      CONSIST_INFO  -- consist information as defined in
1431                               subclause 5.3.3.2.6
1432 }
1433
```

1434



1435

1436

Figure 10 – CSTINFO notification data

1437 **5.2.6 CSTINFO Request**

1438

CSTINFO telegram sending can be controlled and requested by sending a CSTINFOCTRL notification message as depicted in Figure 11.

1439

1440 The protocol for sending CSTINFOCTRL notification messages is defined in 5.3.2.

1441

CSTINFOCTRL notification message shall be sent within the payload of a Train Realtime Data Protocol (TRDP) message as defined in Clause A.7.

1442

1443

CSTINFOCTRL notification messages support two control modes (differentiated with parameter 'trnCstNo'):

1444

trnCstNo > 0

Used to request the sending of CSTINFO telegrams. The receiving ECSP shall memorize the parameter value 'trnTopoCnt'. This mode shall be used by the ECSP responsible for the CSTINFO exchange within a consist (see 5.3.2.3)

trnCstNo = 0

Used to request the sending of CSTINFO telegrams, but without tracking the 'trnTopoCnt' parameter value. This mode shall be used by all devices interested in CSTINFO except for the ECSP responsible for the CSTINFO exchange.

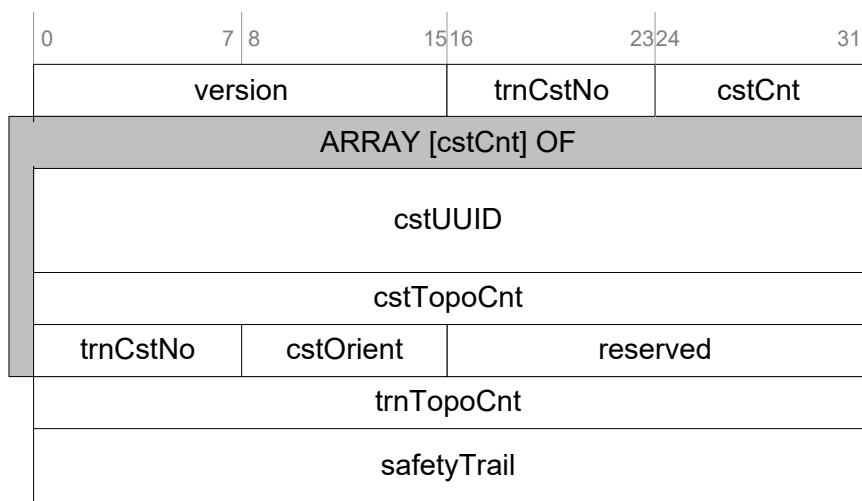
1445 TRDP MD Notification telegram parameters:

MsgType:	'Mn'
Protocol:	UDP
ComId:	3
SMI:	3 (only needed if SDTv2 is used)
UserDataVersion:	'0100'H (only needed if SDTv2 is used)
SourceURI (user part):	void
DestinationURI (user part):	void
DestinationURI (host part):	grpECSP.anyVeh.aCst.aCITrn.ITrn
SourceURI (host part):	-
Dataset:	CSTINFOCTRL

1446 The TRDP MD UserDataset is defined as (see Figure 11):

```

1447 CSTINFOCTRL ::= RECORD
1448 {
1449     version      VERSION      -- version of the telegram
1450                                mainVersion = 1
1451                                subversion = 0
1452     trnCstNo     UINT8        -- train consist number
1453                                0 = without trnTopoCnt tracking
1454                                > 0 = with trnTopoCnt tracking
1455     cstCnt       UINT8        -- number of consists in list
1456     cstList      ARRAY[] OF CONSIST
1457                                -- consist list.
1458                                If trnCstNo > 0 this shall be an
1459                                ordered list starting with trnCstNo = 1
1460                                (exactly the same as in structure
1461                                TRAIN_DIRECTORY).
1462                                If trnCstNo = 0 it is not mandatory to
1463                                list all consists (only consists which
1464                                should send CSTINFO telegram).
1465                                parameters 'trnCstNo' and 'cstOrient'
1466                                are optional and can be set to 0.
1467     trnTopoCnt   UINT32        -- trnTopoCnt value
1468                                trnCstNo > 0: actual value
1469                                trnCstNo = 0: set to 0
1470     safetyTrail  ETBCTRL_VDP  -- ETB-VDP trailer
1471                                parameter 'safeTopoCount' = 0
1472                                completely set to 0 = SDTv2 not used
1473 }
```



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Figure 11 – CSTINFOCTRL telegram

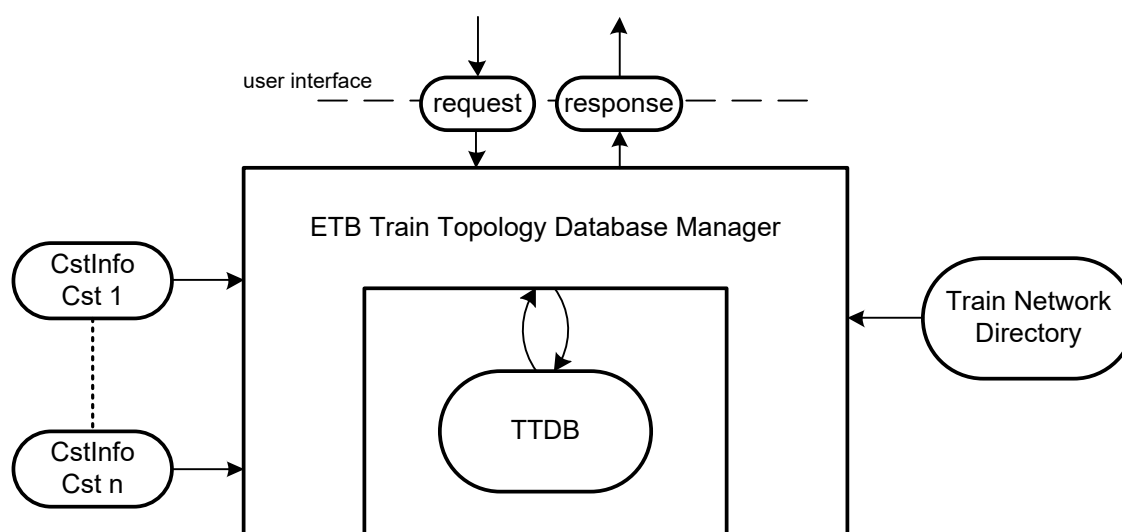
5.3 Train topology database

5.3.1 General

The train topology database (TTDB) is a repository for all the information related to the actual train composition and the actual ETB state.

An instance of the TTDB shall be available at least once in each consist.

NOTE In consists with multiple consist networks it might be an advantage to have multiple TTDB instances, one for each consist network



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Figure 12 – TTDB management block diagram

The TTDB is maintained by a TTDB Manager function as shown in Figure 12, which reads in consist information from other consists (provided by the CSTINFO telegrams) and the result from ETB train inauguration obtained from the ETBN (Train network directory as defined in IEC 61375-2-5) and stores this information to the TTDB. Towards the application services, it provides a user interface, which allows retrieving parts or all the information from the TTDB (see Annex E, Annex G and Annex H). The TTDB manager shall always keep the TTDB up to date.

The TTDB consists of four associated data blocks as it is depicted in Figure 13.

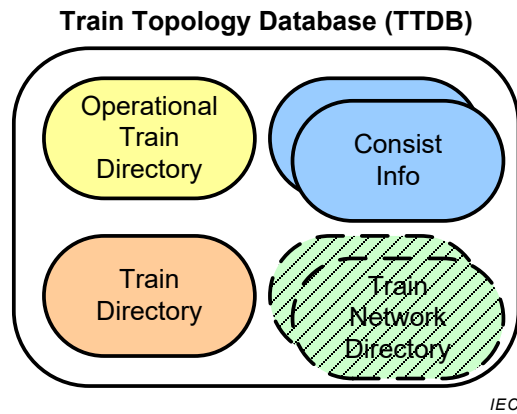


Figure 13 – TTDB Content

Consist Info

Contains the descriptions of each consist as they are distributed after ETB train inauguration within CSTINFO telegrams. This includes also a list of functions provided by the consist and all the consist related information which a TCN-DNS server needs for TCN-URI address resolution. This part is statically preconfigured for each consist. In trains with multiple ETBs, the consist info is available for each ETB and the content of the different consist info data blocks content can be different for each individual ETB (see 5.3.4 for details).

Closed trains are represented as consists in the consist info data block, and closed train consist info may be added optionally. Those entries are identifiable by the consist info class parameter (see 5.2.4).

Train Network Directory

Contains the description of the network topology of one ETB. This is the result of the ETB train inauguration as defined in IEC 61375-2-5. The train network directory is hallmarked by unique signature called etbTopoCnt. The TTDB may contain up to four train network directories representing the maximal four ETBs of the train network.

Train Directory

is (re-) computed each time there is a change in the train composition indicated by a change of the etbTopoCnt as defined in IEC 61375-2-5. The train directory provides an ordered list of all consists which have been discovered over the ETB the train directory is associated to.

Operational Train Directory

is (re-) computed each time there is a change in the train directory or upon a user request for leading (see 6.5) or for correction (see 6.6). This data block adds information about leading and correction to the TTDB and represents the operational train view as defined in 4.2.4.1. In trains with multiple ETBs only one operational train directory for all ETBs will be generated.

Each of these data blocks is protected by a signature, which allows checking the integrity of the stored data, see 5.3.3 for a detailed definition of these data blocks.

The TTDB shall support the storage of information for regular train compositions and, as an option, the storage of information for extended train compositions.

NOTE Differences between regular and extended train compositions are listed in IEC 61375-2-5.

5.3.2 Computation of the TTDB

5.3.2.1 General

The TTDB is computed during train composition discovery in several steps and by different functions as it is shown in Figure 14:

- Train network discovery (ETB inauguration), as defined in IEC 61375-2-5.
- Train directory computation on the base of the train network directory and the consist info.
- Operational train directory computation on the base of leading and correction information.

The different functions are defined in more detail in the following paragraphs.

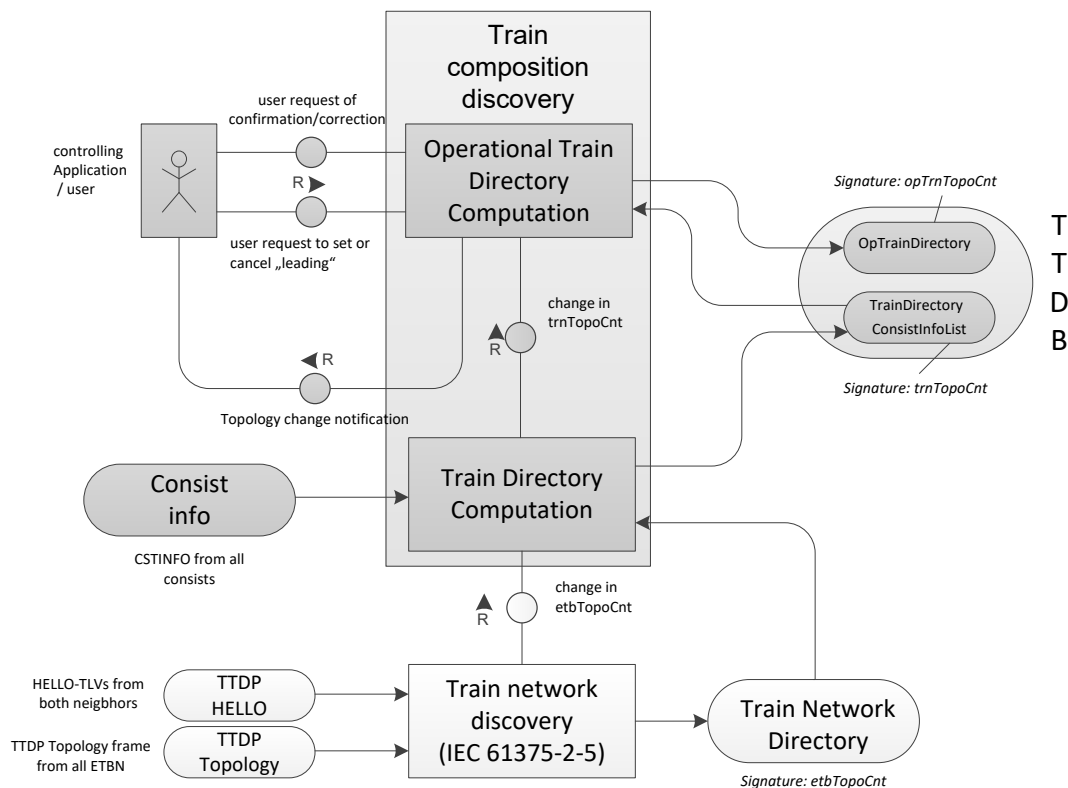


Figure 14 – TTDB computation block diagram

5.3.2.2 Train network discovery

Basis of the TTDB is the train network directory, which is computed in accordance with the algorithm defined in IEC 61375-2-5, and which represents the topology of the ETB as a sequence of ETBN belonging to consists. A discovered ETB network topology will be uniquely identified by its topography counter (etbTopoCnt).

5.3.2.3 Computation of the train directory

A (re-)computation of the train directory shall be executed each time there is a change of the etbTopoCnt.

During train directory computation, the TTDB shall be enriched by consist information collected from the consists in the train (CSTINFO telegrams).

The process of train directory computation is defined by the state diagram shown in Figure 15 and further described in Table 3 to Table 5.

NOTE 1 A recomputation of the train directory will be prevented if train inaugurations are inhibited as defined in IEC 61375-2-5.

For the optimization of CSTINFO and CSTINFOCTRL message exchange (network load reduction) a set of flags controlling the sending of CSTINFO and CSTINFOCTRL messages shall be supported, which are defined as:

```

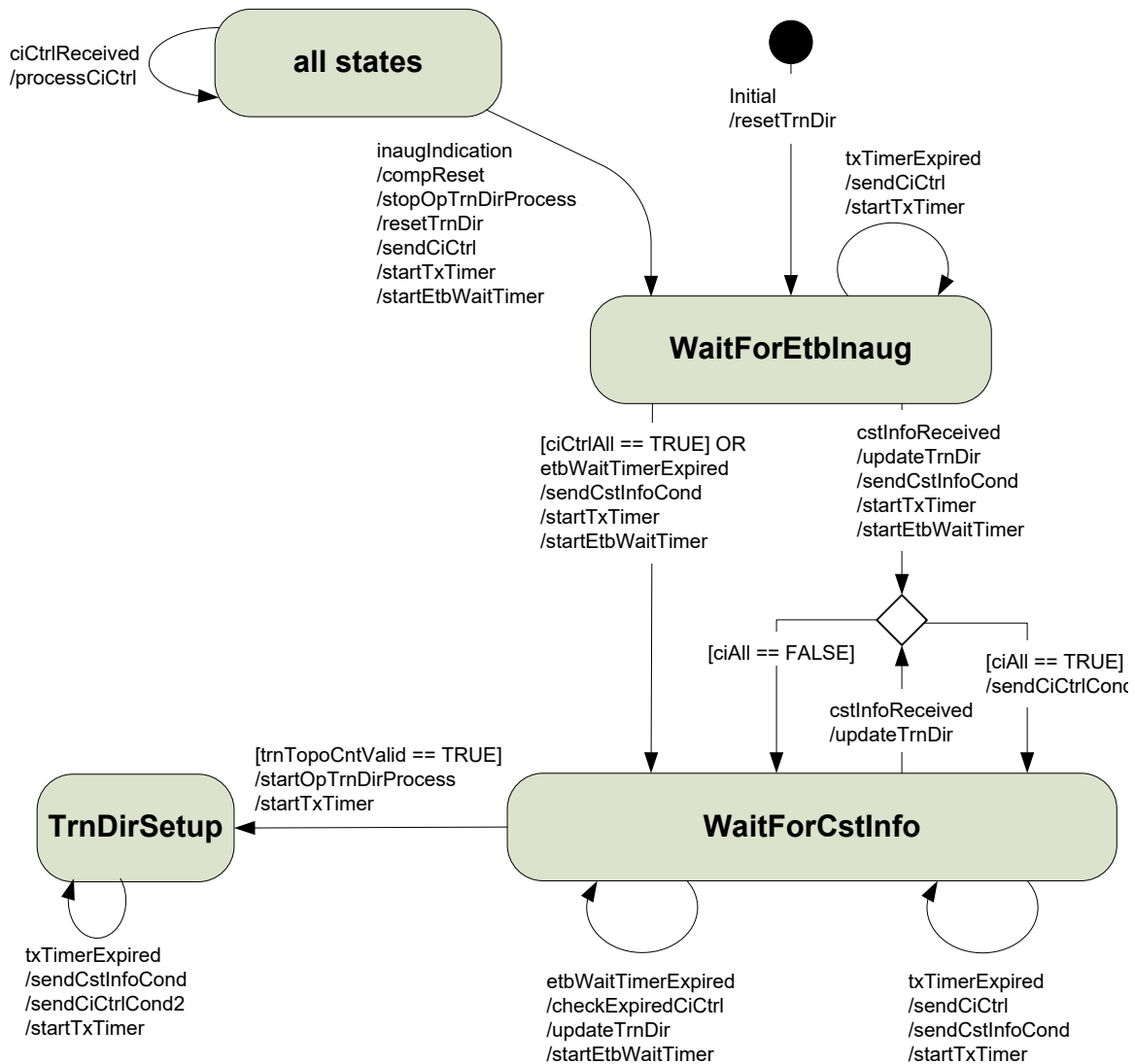
ciTxFlag    BOOLEAN    -- CSTINFO send control flag
FALSE: CSTINFO not to send
TRUE: CSTINFO to send

```

```

1532      cicTxCnt1      UINT8      -- CSTINFOCTRL send control flag (counter)
1533                               value range: 0..1
1534      cicTxCnt2      UINT8      -- CSTINFOCTRL send control flag (counter)
1535                               value range: 0..2

```



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Figure 15 – Train directory computation state diagram

NOTE 2 For some transitions in the UML state machine on Figure 15 a trigger is the reception of a CSTINFOCTRL packet. In those cases only the guards are indicated in the UML state machine transition.

Table 3 – Train directory computation – triggers

Trigger	Description
Initial	Power-up or reboot of ECSP
inaugIndication	Indication of a new train inauguration provided by the local ETBN in accordance to IEC 61375-2-5.
ciCtrlReceived	CSTINFOCTRL telegram has been received.
cstInfoReceived	CSTINFO telegram has been received.
etbWaitTimerExpired	CSTINFOCTRL wait timer expiration – indicating that some consist listed in Train Network Directory is not sending CSTINFOCTRL packets, i.e. ECSP in this consist is not operating correctly.
txTimerExpired	Timer for periodic transmission of CSTINFO and CSTINFOCTRL telegram has expired. Expiration of this timer indicates that previously transmitted CSTINFO or CSTINFOCTRL has not been received by all ECSP.

1540

Table 4 – Train directory computation – guards

Guard	Description
[trnTopoCntValid == TRUE]	CSTINFOCTRL has been received from all consists listed in the train directory with parameter 'cstTopoCnt' value != 0 and all consist from which CSTINFOCTRL has been received have identical trnTopoCnt value. NOTE 1 The trnTopoCnt value is known from the CSTINFOCTRL telegrams received with trnCstNo > 0. NOTE 2 This means that all active ECSP share the same input data for the calculation of Operational Train Directory.
[CiAll == TRUE]	CSTINFO message received from all consists listed in the train directory
[CiAll == FALSE]	CSTINFO message not (yet) received from all consists listed in the train directory
[CiCtrlAll == TRUE]	CSTINFOCTRL message received from all consists listed in the train directory
[CiCtrlAll == FALSE]	CSTINFOCTRL message not (yet) received from all consists listed in the train directory

1541

Table 5 – Train directory computation – actions

Action	Description
startEtbWaitTimer	(Re-)Start one-shot timer with a time value of 5,0 ± 0,2 s for regular train composition 40,0 ± 0,2 s for extended train composition Within this time CSTINFOCTRL telegrams from all consists listed in Train Directory should be received.
startTxTimer	(Re-)Start one-shot timer with a time value of 1,0 ± 0,1 s for regular train composition 8,0 ± 0,1 s for extended train composition This timer drives the periodic retransmission of CSTINFOCTRL and CSTINFO telegrams in case of some network failure. NOTE CSTINFO is retransmitted only if requested by some CSTINFOCTRL telegram.
resetTrnDir	Reset content of train directory: - train directory contains all consists identified by ETB inauguration (listed in Train Network Directory). - cstTopoCnt in all CONSIST structures are set to 0, except for own consist. - compute the trnTopoCnt Clear the consist info list except for the entry of the own consist Reset send control flags: ciTxFlag = FALSE cicTxCnt1 = 1 cicTxCnt2 = 0
updateTrnDir	Store CSTINFO in ConsistInfoList. Update train directory: - Update CONSIST structures in train directory with cstTopoCnt from received CSTINFO - Calculate new value of trnTopoCnt.

Action	Description
startOpTrnDirProcess	Start the operational train directory processing by triggering the event 'startOpTrnDirProcess' in the ETBCTRL processing state machine, see 6.4.5
stopOpTrnDirProcess	Stop the operational train directory processing by triggering the event 'stopOpTrnDirProcess' in the ETBCTRL processing state machine, see 6.4.5
sendCstInfoCond	Conditional sending of CSTINFO telegram: IF (ciTxFlag == TRUE) THEN send CSTINFO telegram; ciTxFlag = FALSE; END; NOTE The conditional sending of CSTINFO aims to reduce the network load
sendCiCtrl	Send CSTINFOCTRL telegram
sendCiCtrlCond1	Conditional sending of CSTINFOCTRL telegram: IF (cicTxCnt1 > 0) THEN send CSTINFOCTRL telegram; cicTxCnt1 = cicTxCnt1 – 1; END; NOTE The conditional sending of CSTINFOCTRL aims to reduce the network load
sendCiCtrlCond2	Conditional sending of CSTINFOCTRL telegram: IF (cicTxCnt2 > 0) THEN send CSTINFOCTRL telegram; cicTxCnt2 = cicTxCnt2 – 1; END; NOTE The conditional sending of CSTINFOCTRL aims to reduce the network load
processCiCtrl	Process received CSTINFOCTRL telegram. IF (CSTINFOCTRL parameter 'trnCstNo' > 0) THEN memorize the CSTINFOCTRL parameter 'trnTopoCnt'; memorize the time when CSTINFOCTRL has been received; END; IF ((CSTINFOCTRL parameter 'trnCstNo' > 0) AND (state == TrainDirSetup) AND (CSTINFOCTRL parameter 'trnTopoCnt' != trnTopoCnt value in local train directory)) THEN cicTxCnt2 = 2; END; IF (CSTINFOCTRL message does contain an entry of parameter 'cstTopoCnt' with a value == 0 for the local consist, which is the consist the receiving ECSP belongs to) THEN ciTxFlag = TRUE; END; NOTE This means that the sending ECSP has not received the CSTINFO of the local consist and is requesting now to (re)send this CSTINFO message.
checkExpiredCiCtr	Check for expired CSTINFOCTRL messages. For each consist from which the last received CSTINFOCTRL message is older than the value of etbWaitTimer: - Discard the CSTINFOCTRL message together with the memorized trnTopoCnt value. - Remove the consist info from the consist info list .