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Electronic railway equipment — Train communication network (TCN)

Part 2-3: TCN communication profile
(IEC 61375-2-3:2015)

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National foreword

This British Standard is the UK implementation of EN 61375-2-3:2015+A11:2017. It is identical to IEC 61375-2-3:2015, incorporating corrigenda July 2015 and October 2016. It supersedes BS EN 61375-2-3:2015 which is withdrawn.

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Text altered by IEC corrigendum October 2016 is indicated in the text by AC₂ AC₂.

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English Version

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(TCN) - Part 2-3: TCN communication profile
(IEC 61375-2-3:2015)

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(IEC 61375-2-3:2015)

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European foreword

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61131-3:2013	NOTE	Harmonized as EN 61131-3:2013 (not modified).
IEC 61375-3-4	NOTE	Harmonized as EN 61375-3-4.
IEC 61508-1:2010	NOTE	Harmonized as EN 61508-1:2010 (not modified).
IEC 61784-3-3:2010	NOTE	Harmonized as EN 61784-3-3:2010 (not modified).
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ISO/IEC 7498-1	NOTE	Harmonized as EN ISO/IEC 7498-1.

Foreword to amendment A11

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2020-02-01

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This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61375-1	-	Electronic railway equipment - Train communication network (TCN) - Part 1: General architecture	EN 61375-1	-
IEC 61375-2-1	-	Electronic railway equipment - Train communication network (TCN) - Part 2-1: Wire Train Bus (WTB)	EN 61375-2-1	-
IEC 61375-2-4	- ¹⁾	Electronic railway equipment - Train communication network (TCN) - Part 2-4: TCN Application profile	-	-
IEC 61375-2-5	-	Electronic railway equipment - Train communication network (TCN) - Part 2-5: Ethernet train backbone	EN 61375-2-5	-
IEC 62280	-	Railway applications - Communication, signalling and processing systems - Safety related communication in transmission systems	-	-
ISO/IEC 9646-6	1994	Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 6: Protocol profile test specification	-	-
ISO/IEC 9646-7	1995	Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 7: Implementation Conformance Statements	-	-

1) At draft stage.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO/IEC 17011	2004	Conformity assessment - General requirements for accreditation bodies accrediting conformity assessment bodies	EN ISO/IEC 17011	2004
ISO/IEC 17025	2005	General requirements for the competence of testing and calibration laboratories	EN ISO/IEC 17025	2005

Annex ZZ (informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers all relevant essential requirements as given in Annex III of the EC Directive 2008/57/EC (also named as New Approach Directive 2008/57/EC Rail Systems: Interoperability).

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZZ.1 relating to 'rolling stock - locomotives and passenger rolling stock' and Table ZZ.2 relating to the 'telematics applications for passenger services' of the rail system in the European Union, confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

**Table ZZ.1 – Correspondence between this European Standard, the RST LOC&PAS TSI
(published in the Official Journal L 356 on 12 December 2014, p. 228) and Directive 2008/57/EC**

Clauses of this European Standard	Chapter / § / points of RST LOC&PAS TSI	Essential Requirements (ER) of Directive 2008/57/EC	Comments
The whole standard is applicable.	4.2.4.9 Brake state and fault indication 4.2.5.2 Audible communication system 4.2.5.3 Passenger alarm 4.2.5.4 Communication devices for passengers 4.2.5.5 Exterior doors 4.2.12.2 General documentation: - description of computerised on board systems	2. Requirements specific to each sub-subsystem 2.4. Rolling Stock 2.4.1. Safety 2.4.2. Reliability and availability 2.4.3. Technical compatibility	The TSI does not impose any technical solution regarding physical interfaces between units. This standard offers a general multi-purpose solution for the digital communication network within railway vehicles and consists and it is relevant to equipment and vehicle interoperability.

**Table ZZ.2 – Correspondence between this European Standard, the TAP TSI
(published in the Official Journal L 123 on 12 May 2011, p. 11) and Directive 2008/57/EC**

Clauses of this European Standard	Chapter / § / points of TAP TSI	Essential Requirements (ER) of Directive 2008/57/EC	Comments
The whole standard is applicable	4.2.21. Networking and communication 4.2.21.1. General architecture	2. Requirements specific to each sub-subsystem 2.7. Telematics applications for freight and passengers 2.7.1. Technical compatibility 2.7.2. Reliability and availability	

WARNING: Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRONIC RAILWAY EQUIPMENT – TRAIN COMMUNICATION NETWORK (TCN) –

Part 2-3: TCN communication profile

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

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.

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.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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.

INTRODUCTION

The IEC 61375 standard series specifies a Train Communication Network for usage in railway vehicles (trains) mainly intended for the exchange of TCMS related information, but not restricted to it. The specification starts from the physical layer up to the application layer and it involves different communication technologies.

This part of IEC 61375 (IEC 61375-2-3) defines the communication profile of the Train Communication Network so as to achieve interoperability between Consists connected by Ethernet Train Backbones as defined in IEC 61375-2-5.

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

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

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

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 services (OMTS) related profiles as defined in the IEC 62580 series.

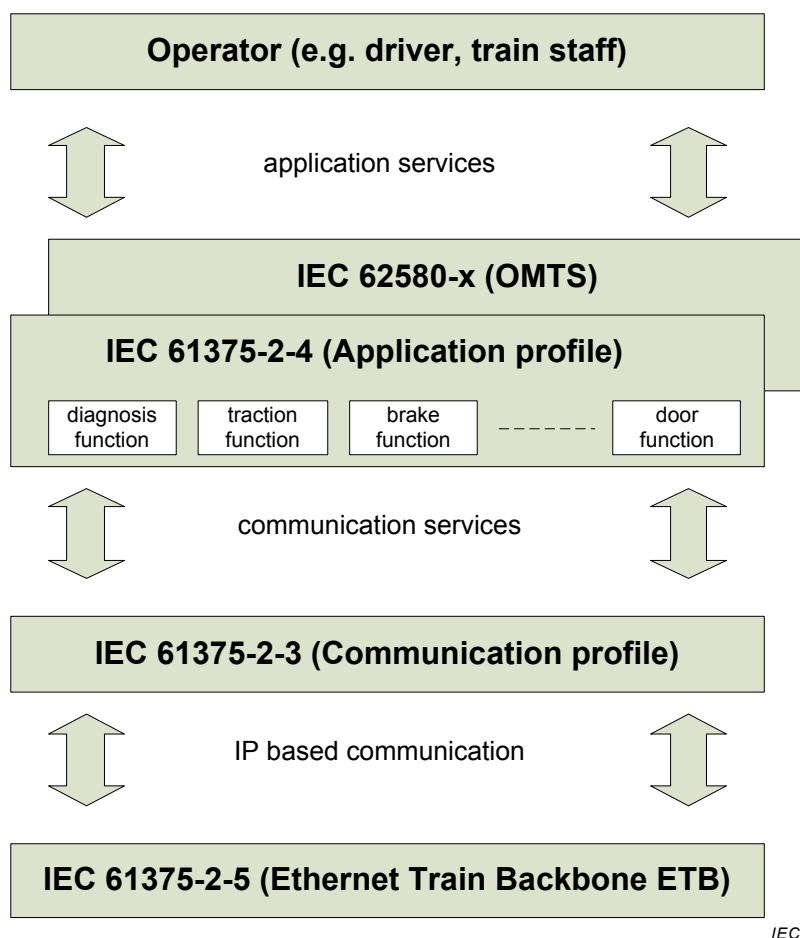


Figure 1 – IEC 61375-2-3 as connecting element between train backbone and application

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*

IEC 61375-2-1, *Electronic railway equipment – Train communication network (TCN) – Part 2-1: Wire Train Bus (WTB)*

IEC 61375-2-4, *Electronic railway equipment – Train communication network (TCN) – Part 2-4: Application Profile* (to be published)

IEC 61375-2-5, *Electronic railway equipment – Train communication network (TCN) – Part 2-5: Ethernet train backbone*

IEC 62280, *Railway applications – Communication, signalling and processing systems – Safety related communication in transmission systems*

ISO/IEC 9646-6:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 6: Protocol profile test specification*

ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements*

ISO/IEC 17011:2004, *Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

3 Terms, definitions, abbreviations, acronyms, and conventions

3.1 Terms and definitions

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

3.1.1

application layer

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

3.1.2

application layer interface

definition of the services offered by the application layer

3.1.3

application process

element within a real open system which performs the information processing for a particular application

3.1.4

big endian

definition where the most significant byte of multi byte data is stored in the lowest address memory location and sent first in the sequence of serialized transmissions

3.1.5

bridge

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

3.1.6

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.

3.1.7

closed train

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

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

3.1.8

closed train consist

consist within a closed train

3.1.9

communication devices

devices connected to Consist Network or Train Backbone with the ability to transport, source or sink data

3.1.10

composition

number, sequence, orientation and characteristics of the consists forming a train

3.1.11

configuration

definition of the topology of a network, the devices connected to it, their capabilities and the traffic they produce

3.1.12

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.

3.1.13

consist network

communication network interconnecting communication devices in one Consist

3.1.14

consist network address

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

3.1.15

consist sequence number

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

3.1.16

consumer

receiver of a message at the Transport Layer

3.1.17

destination device

receiver of a data packet

3.1.18

discovered vehicle/consist

vehicle/consist discovered during train inauguration

3.1.19

end device

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

3.1.20

Ethernet Train Backbone

train backbone based on switched Ethernet technology

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

3.1.21

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

3.1.22

function

application process which exchanges messages with another application process

3.1.23

gateway

connection between different communication technologies

3.1.24

group address

address of a multicast group to which a device belongs

3.1.25

integrity

property of a system to recognize and to reject wrong data in case of malfunction of its parts

3.1.26

leading vehicle

vehicle which controls the movements of the train

3.1.27

linear topology

topology where the nodes are connected in series, with two nodes each connected to only one other node and all others each connected to two other nodes (that is, connected in the shape of a line)

3.1.28

Local Area Network

LAN

part of a network characterized by a common medium access and address space

3.1.29

medium access control

MAC

sublayer of the Link Layer, which controls the access to the medium (arbitration, mastership transfer, polling)

3.1.30

medium

physical carrier of the signal: electrical wires, optical fibers, etc.

3.1.31

message

data item transmitted in one or several packets

3.1.32

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.

3.1.33

multimedia network

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

3.1.34

multimedia services

services which are used for multimedia

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

3.1.35

multiple unit

number of vehicles put together to form a unit for the conveyance of passengers and/or freight

Note 1 to entry: The driving cabs of the multiple unit can be located in special power vehicles (e.g. locomotives with only one cab) or in end vehicles fitted with driving cabs. Groups of vehicles of the multiple unit can be assembled into consists.

3.1.36

multiple unit train

train consisting of a set of closed trains, where the composition of the set may change during normal operation

3.1.37

network

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

3.1.38

network address

address which identifies a communication device on network layer

3.1.39

network device

components used to set up Consist Networks and Train Networks

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

3.1.40

network layer

layer in the OSI model responsible for routing between different busses

3.1.41

network management

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

3.1.42

node

device on the Train Backbone, which may act as a gateway between Train Backbone and Consist Network

3.1.43

operational network

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

3.1.44

operational train view

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

3.1.45

octet

byte

8-bit word stored in memory or transmitted as a unit

3.1.46

onboard multimedia and telematics subsystem

collection of train on-board services and functions for multimedia and telematics

Note 1 to entry: A definition of those services is given in IEC 62580.

3.1.47

operational services

all services which are needed to run a train safely

3.1.48

operational train direction

direction of train as seen by driver or train attendance

3.1.49

operational train directory

data structure describing the train composition as seen by driver or train attendance, including information about the leading vehicle and vehicle gaps

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

3.1.50

operator

enterprise or organization which is operating trains

3.1.51

packet

unit of a message (information, acknowledgement or control) transmitted by protocols on network or transport layer

3.1.52

PD-PDU

data unit for the transmission of process data

Note 1 to entry: There are two types of PD-PDUs. All types of PD-PDUs have the same PDU format. PD-PDU(data) is a PD-PDU containing user data and sent from a publisher to subscriber(s). This is used in push pattern and in pull pattern. PD-PDU(data) in pull pattern is also referred as PD-PDU(reply). PD-PDU(request) is a PD-PDU sent from a requester to publisher(s). This may or may not contain user data.

3.1.53

PD publisher

device which cyclically sends PD telegrams with a defined ComId to a defined address or address range

3.1.54

PD requester

device which requests a single PD telegram of a specified ComId to be sent to a specified address or address range

3.1.55

PD subscriber

device which receives PD telegrams with a defined ComId and a possible source address filter

3.1.56

producer

sender of a message at the Transport Layer

3.1.57

publisher

source of a dataset for broadcasting (see subscriber)

3.1.58

receiver

electronic device which may receive signals from the physical medium

3.1.59

redundancy group

group of devices, where only one device is active and the others are in standby

Note 1 to entry: If the active device fails, one of the standby devices takes over. Typically, a redundancy group comprises two devices.

3.1.60

regular transmission

data transmission of non safety related data

3.1.61

repeater

connection at the Physical Layer between bus segments, providing an extension of the bus beyond the limits permitted by passive means

Note 1 to entry: The connected segments operate at the same speed and with the same protocol. The delay introduced by a repeater is in the order of one bit duration.

3.1.62

residual error rate

probability of integrity breach (unrecognized wrong bit) per transmitted bit

3.1.63

ring topology

active network where each node is connected in series to two other nodes

Note 1 to entry: Ring may also be referred to as loop.

[SOURCE: IEC 61918:2013,3.1.63]

3.1.64

router

connection between two buses at the Network Layer, which forwards telegrams from one bus to another on the base of their network address

3.1.65

safe data transmission

data transmission of safety related data

3.1.66

service

capabilities and features of a sub-system (provided to a user)

3.1.67

sporadic data

transmission of data on a demand basis

3.1.68

subscriber

one of the sinks of a broadcast dataset (see publisher)

3.1.69

switch

MAC bridge

Note 1 to entry: As defined in IEEE 802.1D.

3.1.70

topology

possible cable interconnection and number of devices in a given network

3.1.71

topography counter

unique identifier of a train composition

3.1.72

train

composition of one or a set of Consists, where the configuration can change during normal operation

3.1.73

train communication network

data communication network for connecting programmable electronic equipment on-board rail vehicles

3.1.74

train communication system

train communication network plus its communication and application profile for the exchange of information trainwide

3.1.75

train control and monitoring system

collection of train on-board services and functions for the operation of a train.

Note 1 to entry: A definition of those services is given in IEC 61375-2-4.

3.1.76

train backbone

bus connecting the consists of a train

Note 1 to entry: Conforms to IEC 61375-2-1 (WTB) or IEC 61375-2-5 (ETB).

3.1.77

train backbone node

device on the train backbone which receives a train backbone node number during inauguration.

Note 1 to entry: A train backbone node can be used to connect an End Device or a Consist Network to the Train Backbone.

3.1.78

train backbone node number node address node number

number assigned to each train backbone node during inauguration, which indicates the position of the train backbone node on the train backbone

3.1.79

train backbone view

train seen as a sequence of consist networks determined by ETB inauguration

3.1.80

train directory

data structure describing the train composition after a train inauguration

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

3.1.81

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.

3.1.82

train network management

services of the network management for TCN

3.1.83

train directory computation

protocol to determine the actual train composition as a set of consists containing vehicles containing function devices

Note 1 to entry: Optional closed trains represented as consists can be detected and interpreted as a set of consists. Result of the train directory computation is the train directory data structure which is a part of the train topology database.

3.1.84

train reference direction

direction determined by inauguration

3.1.85

train topology database

data base collecting all the information about the actual train composition

Note 1 to entry: An instance of this database is computed within each consist of the train.

3.1.86

train view

train seen as sequence of consists determined by the ETB inauguration

3.1.87

transport layer

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

3.1.88

UIC vehicle identification number

12-digit number for the unique identification of vehicles

Note 1 to entry: As defined by the UIC.

3.1.89

unspecified PDU

TRDP PDU with ComId=0

Note 1 to entry: The user data content of an unspecified PDU is undetermined for the communication profile. Different PDUs and their content can be distinguished only at application level.

3.1.90

vehicle

single coach or locomotive

3.1.91

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 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 2 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.

3.2 Abbreviations and acronyms

ALG	Application Layer Gateway
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
CN	Consist Network
ComId	Communication Identifier
CRC	Cyclic Redundancy Check
CST	Consist
CSTINFO	Consist Information telegram
DC	Direct Current
DEV	Device
DNS	Domain Name System
DoS	Denial of Service
FCS	Frame Check Sequence
ECN	Ethernet Consist Network
ECSC	ETB Control Service Client
ECSP	ETB Control Service Provider
ED	End Device
ETB	Ethernet Train Backbone
ETBCTRL	ETB Control packet

ETBN	Ethernet Train Backbone Node
FCT	Function
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
LEN	Length
MAC	Medium Access Control
MC	Multicast
MD	Message Data
MD-PDU	Message Data Protocol Data Unit
MIB	Management Information Base
MTU	Maximal Transmission Unit
MVB	Multifunction Vehicle Bus
NAT	Network Address Translation
NOK	Not OK
OID	Object Identifier
OMTS	Onboard Multimedia and Telematic Subsystems
OSI	Open System Interconnection
PD	Process Data
PD-PDU	Process Data Protocol Data Unit
PICS	Protocol Implementation Conformance Statement
PROP	Properties
QoS	Quality of Service
RFC	Request For Comments
SDSINK	Safe Data Sink
SDSRC	Safe Data Source
SDTv2	Safe Data Transmission version 2
SID	Source Identifier
SIL	Safety Integrity Level
SMI	Safe Message Identifier
SNMP	Simple Network Management Protocol
SSC	Safety Sequence Counter
STC	Safe Topography Counter

TCN	Train Communication Network
TCMS	Train Control and Monitoring System
TCP	Transmittion Control Protocol
TP	Test Procedure
TSS&TP	Test Suite Structure and Test Purpose
TRDP	Train Real Time Data Protocol
TTDB	Train Topology Database
TTL	Time to Live
TTDP	Train Topology Discovery Protocol
UDP	User Datagram Protocol
UIC	Union Internationale des Chemins de Fer
UML	Unified Modeling Language
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
UUID	Universally Unique Identifier
UuT	Unit under Test
VDP	Vital Data Packet
VLAN	Virtual Local Area Network
WTB	Wire Train Bus
XML	Extended Markup Language
XSD	XML Schema Definition

3.3 Conventions

3.3.1 Base of numeric values

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

Analog and fractional values include a comma.

EXAMPLE The voltage is 20,0 V.

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

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

3.3.2 Character strings and citations

Character strings are placed within double quotes.

EXAMPLE "ComProfTestAppl".

Single quotes are used for citations (quotations).

EXAMPLE parameter 'etbTopoCnt'.

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

EXAMPLE telegram type 'Mn'.

3.3.3 Naming conventions

Keywords are written with a capital letter at the beginning.

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

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

Parameters are written with a capital letter at the beginning.

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

EXAMPLE 'etbTopoCnt'.

3.3.4 Diagram conventions

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

- UML state machines
- UML sequence diagram

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

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

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

3.3.5 Annotation of data structures

3.3.5.1 General

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

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

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

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

3.3.5.2 Additional data types

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

- (1) LABEL ::= ARRAY [16] OF CHAR
- (2) AntivalentType ::= ANTIVALENT8

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

3.3.5.3 Data type keywords

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

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)	

4 Architecture

4.1 General

This clause defines the train related communication architecture, which is the basis for the communication profile. The train related communication 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 in detail

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.

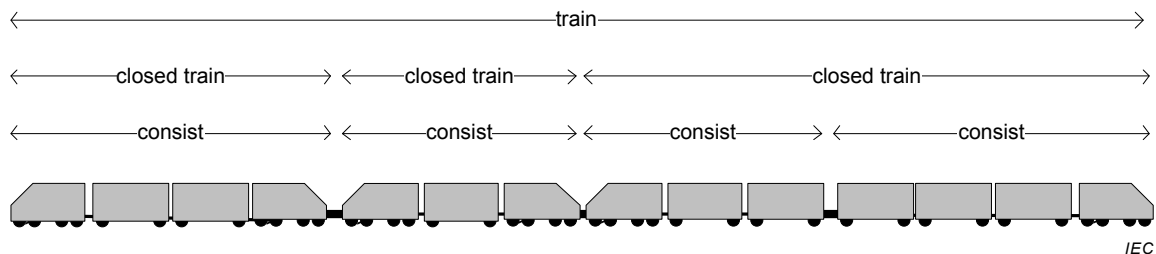


Figure 2 – Train structure in accordance to IEC 61375-1 (example)

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.

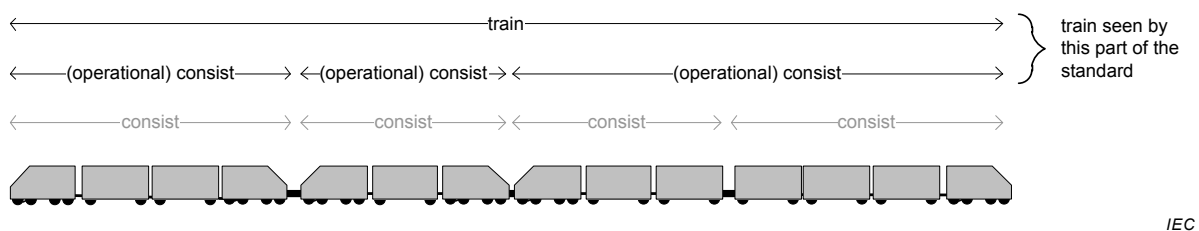


Figure 3 – Train structure seen from viewpoint of the communication profile (example)

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.

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 train may also contain 63 consists, or two trainsets with 32 and 31 vehicles form each one consist, in which case the train 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.

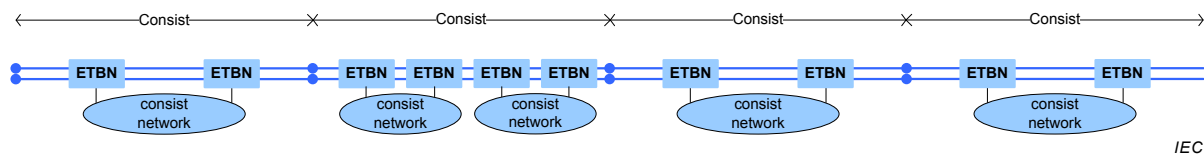


Figure 4 – Train network (example)

Furthermore, IEC 61375-1 allows applying up to 4 train backbones in parallel.

This communication profile defines the usage of the train backbones in the following way:

- One ETB (with subordinated consist networks) shall be used as operational network, supporting TCMS services.
- No, one or several ETBs (with subordinated consist networks) shall be used as multimedia network supporting OMTS services

The operational ETB may also be used for OMTS services.

NOTE 1 To have TCMS services and OMTS services sharing one (operational) ETB may be used for simple applications.

NOTE 2 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 much harder to fulfill 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 units).

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 share 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 backbone 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.

NOTE The impact of this requirement on the TTDB is defined in 5.3.4.2.

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.

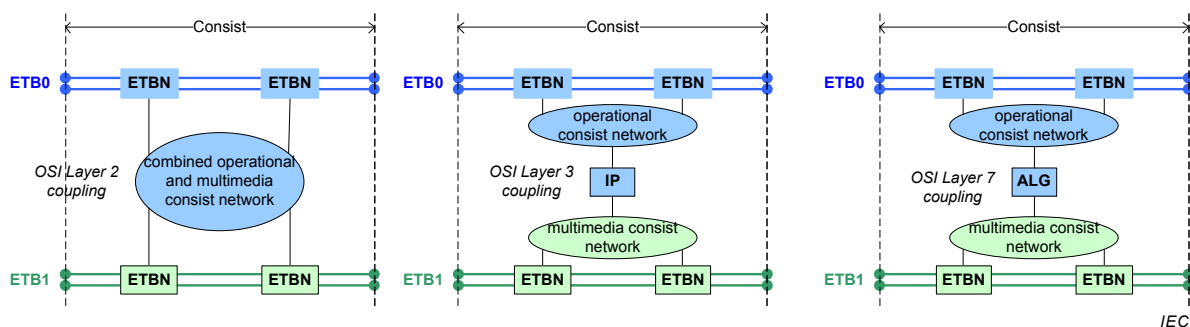


Figure 5 – Possible couplings of operational network and multimedia network

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 ETB (ETB0), and EDs connected to the multimedia consist network are said to be related to the multimedia ETB (ETB1).

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.

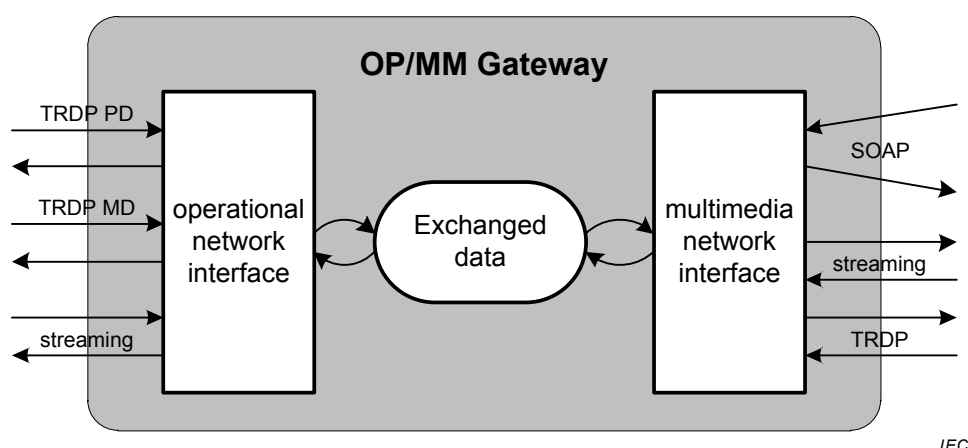
4.2.2.6.3 Data exchange between operational network and multimedia network

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) or direct exchange of TRDP data packets. 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

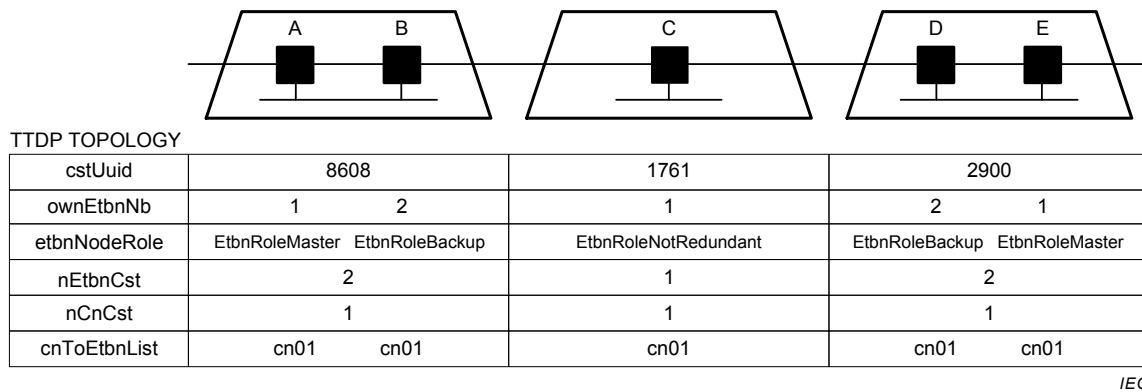
For applications of the multimedia network, it will be necessary to have the same operational train view (see 4.2.4.1) as for an application of the operational network, such as the sequence of consists and the position of the leading vehicle, in order to realize an unambiguous addressing scheme within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



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.

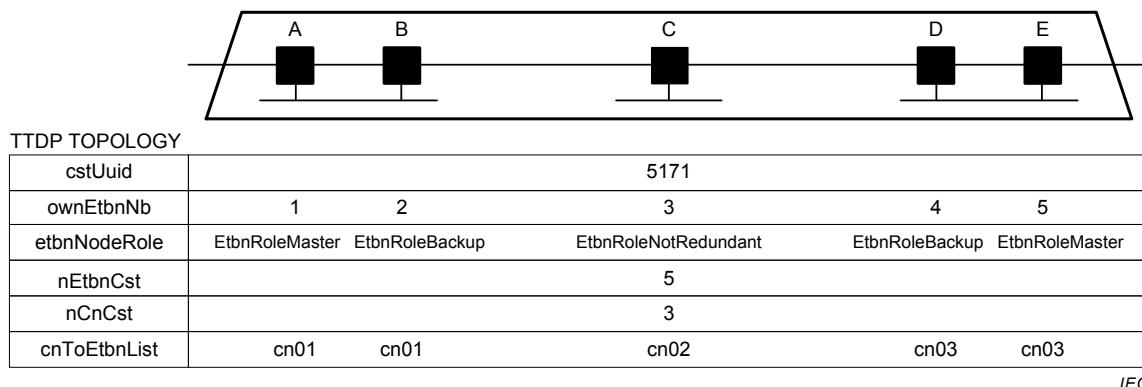


Figure 8 – Example: Closed Train

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 or more ETBs 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.

IEC 61375-1 specifies as well 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:

- b) If there was a previously leading vehicle, then this vehicle together with its previously operational train direction determines the operational train direction.
- c) If there were several previously leading vehicles, e.g. after a train lengthening, and all of these have the same viewing direction, then this viewing direction determines the operational train direction.
- d) If there are multiple consists in the train and a traction consist at one end, then this end defines the train head and traction consist includes vehicle 01 and determines the operational train direction.
- e) In all other cases, the operational train direction shall correspond to the ETB reference direction according to IEC 61375-2-5.

4.2.5 Consist and vehicle basic properties

4.2.5.1 General

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

- Static properties are features built into the vehicle or consist and thus only dependent on its class or design, e.g. “vehicle identifier”, “vehicle has first class seats”, “traction unit with electric drive”.
- Topological properties are properties, which present the physical configuration of train structure, e.g. vehicle sequence, vehicle orientation.
- Dynamic properties are properties which define a train assignment, e.g. “leading vehicle”, “vehicle sequence number” or “train reference direction”.

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

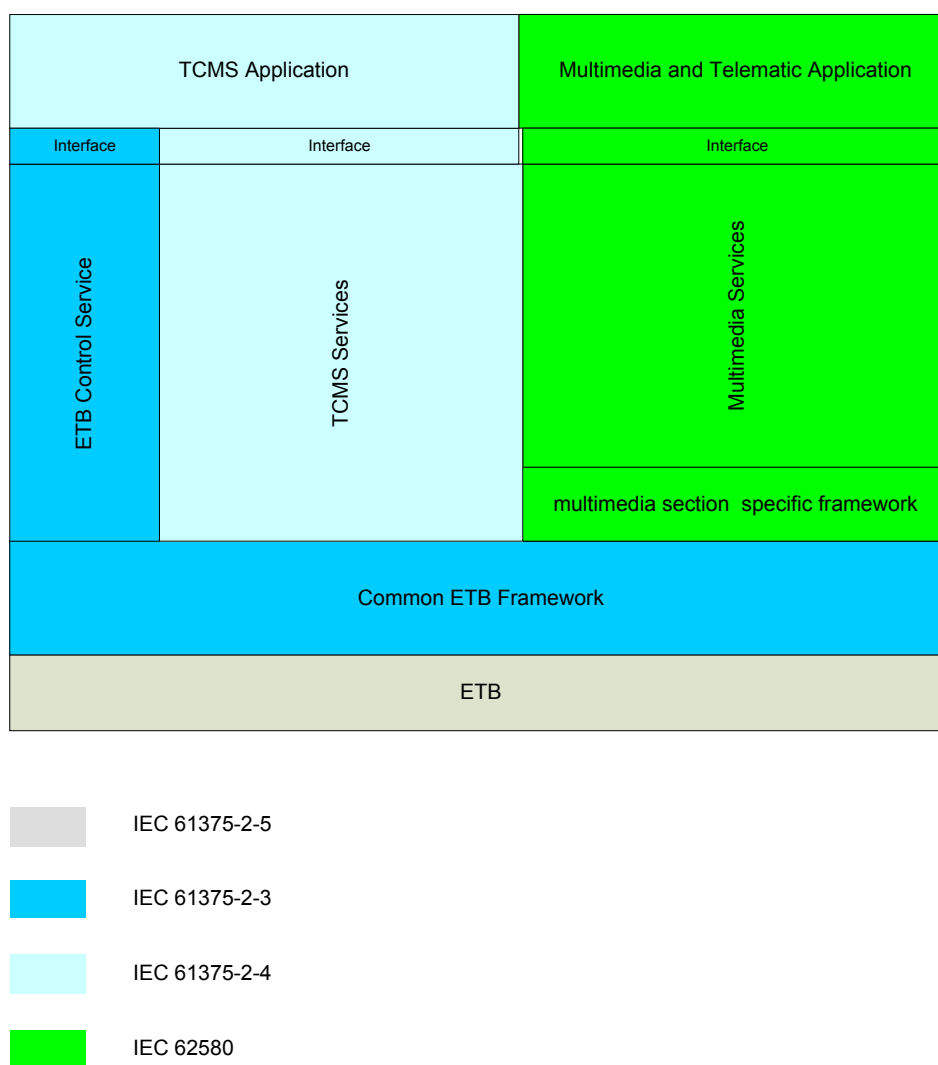
The logical train architecture defines a train as composed of services and the information exchanged between the services and between user and services.

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.



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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.

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

4.3.4 Service Provider

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

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

For redundant ECSP only one ECSP is actively providing the service.

5 Common ETB framework

5.1 General

5.1.1 Overview

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

- CSTINFO Telegram (see 5.2)
- Train topology database TTDB (see 5.3)
- Service addressing (see 5.4)
- TCN-DNS Server (see 5.5)
- Data exchange (see 5.6)
- Service discovery (see 5.6.4)
- Train Info service (see 5.8)

5.1.2 Interoperability

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

```
VERSION ::= RECORD
{
    mainVersion      UINT8      -- main version, incremented for
                                incompatible changes

                                value range: 1..255 (0 = reserved)
    subVersion       UINT8      -- sub version, incremented for
                                compatible changes
                                value range: 0..255
}
```

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

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

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

5.2 CSTINFO telegram

5.2.1 General

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

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

5.2.2 Closed train support (Option)

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

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

5.2.3 Protocol

The protocol for sending CSTINFO telegrams is defined in 5.3.2.

5.2.4 CSTINFO classes

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

- CSTINFO class 1: CSTINFO telegrams sent by consists which are no closed trains

- CSTINFO class 2: CSTINFO telegrams sent by closed trains
- CSTINFO class 3: CSTINFO telegrams sent by closed train consists

Consists which are no closed trains shall be able to receive and process CSTINFO classes 1 and 2, but need not be able to receive consist info class 3 telegrams.

Only CSTINFO class 2 telegrams shall provide a closed train consist list (array “cltrCstList” CSTINFO telegram). For CSTINFO classes 1 and 3 this array shall be omitted (parameter “cltrCstListCnt” set to 0, see 5.2.5).

5.2.5 CSTINFO Notification Message

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

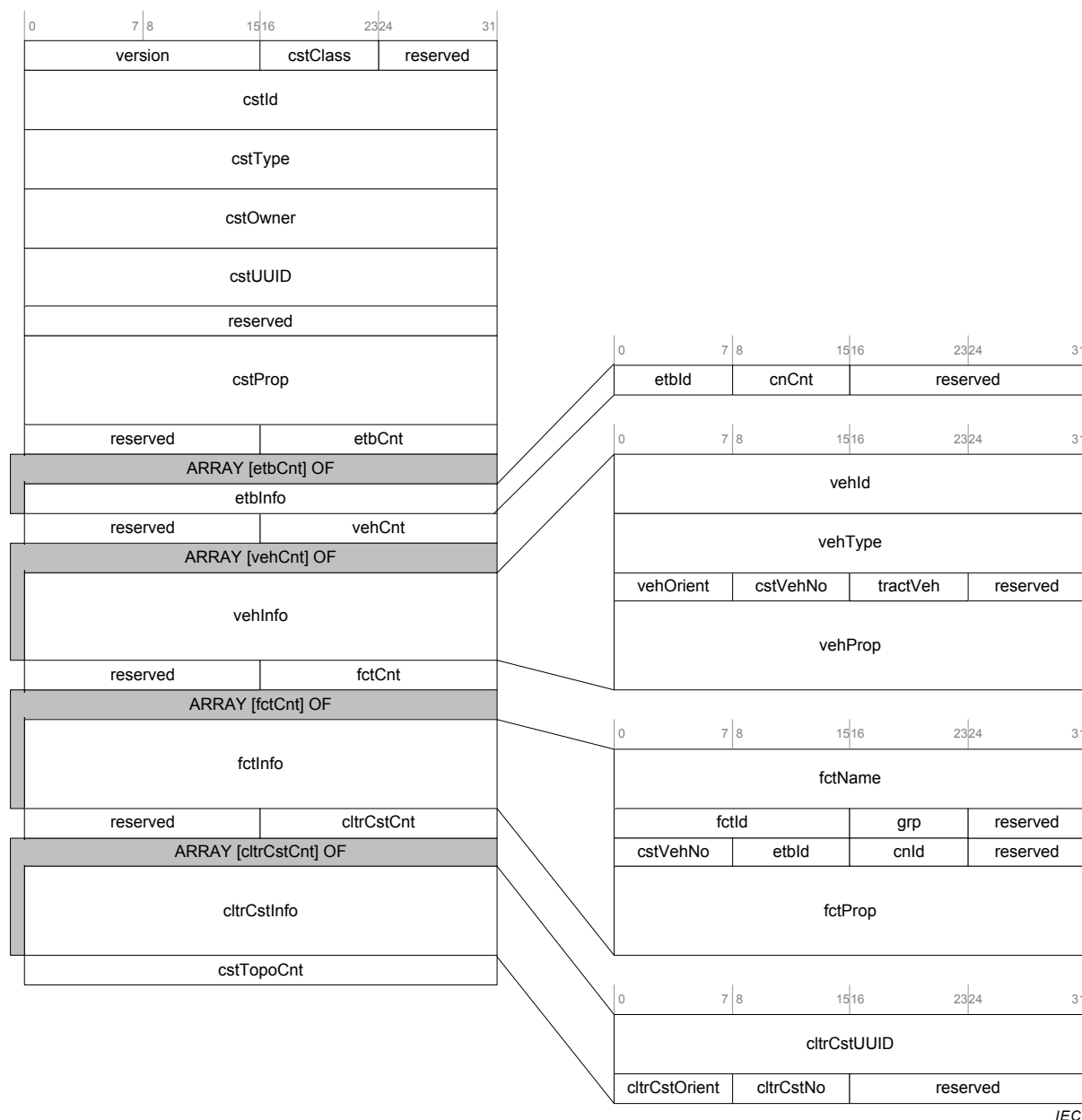
The CSTINFO size shall be restricted to the maximal DatasetLength parameter value of a MD-PDU as defined in Clause A.7.

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

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

```
CSTINFO ::= RECORD
{
  cstInfo      CONSIST_INFO  -- consist information as defined in
                               subclause 5.3.3.2.6
}
```

**Figure 10 – CSTINFO notification data**

5.2.6 CSTINFO Request

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

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

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

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

trnCstNo > 0

Used to request the sending of CSTINFO telegrams. The receiving ECSP shall memorize the parameter value.