IEC 61375-1

Edition 4.0 2026-03

INTERNATIONAL STANDARD

REDLINE VERSION

Electronic railway equipment - Train communication network (TCN) -
Part 1: General architecture

ICS 45.060.01

ISBN 978-2-8327-1132-3

IEC 61375-1:2026-03 RLV(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2026 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
2 Normative references 8
3 Terms, definitions, abbreviated terms, acronyms, and conventions 8
3.1 Terms and definitions 8
3.2 Abbreviations and acronyms 18
3.3 Conventions 19
~~3.3.1 Requirement conventions~~ .....
3.3.1 Base of numeric values 20
3.3.2 Naming conventions 20
3.3.3 State diagram conventions 20
4 Basic architecture 20
4.1 ~~Contents of this clause~~ General 20
4.2 ~~General~~Technology and components 21
4.2.1 Technology classes 21
4.2.2 Component types 21
4.3 Hierarchical structure 21
4.3.1 Network levels 21
4.3.2 Train backbone level 22
4.3.3 Consist network level 22
4.3.4 Interface between train backbone and consist network 23
4.3.5 End devices connected to train backbone 24
4.4 Network configurations 24
4.5 Train to ground connection (option) 25
5 Train backbone 26
5.1 ~~Contents of this clause~~ General 26
5.2 Train backbone topology 26
5.2.1 General 26
5.2.2 Train backbone based on bus technology 26
5.2.3 Train backbone based on switched technology 27
5.2.4 Train Backbone based on wireless technology 28
5.3 Train compositions 30
5.4 Train backbone node numbering 30
5.5 Train directions 31
5.5.1 Vehicle 31
5.5.2 Consist 31
5.5.3 Closed train 32
5.5.4 Train 32
5.6 Train inauguration 34
5.6.1 Objectives 34
5.6.2 Node sequence and orientation discovery 34
5.6.3 Train network directory 34
5.6.4 Train directory 34
5.6.5 Train inauguration control 38
5.6.6 Node states 40

5.6.7 Node roles 44
5.6.8 Performance 44
5.6.9 Independent consist orientation check (Option) 44
6 Consist network 45
6.1 ~~Contents of this clause~~General 45
6.2 Scope of standardization 45
6.3 Consist network topology 46
6.3.1 Consist network based on bus technology (MVB, ~~CANopen~~ CCN) 46
6.3.2 Consist network based on switched technology (ECN) 47
6.3.3 Consist network based on wireless technology (WLCN) 50
6.3.4 Sub-networks 50
6.3.5 Heterogeneous consist network 52
6.4 Gateway 52
6.4.1 General 52
6.4.2 Functional description 52
6.4.3 Application layer gateway 53
6.4.4 Gateway implemented by a router 55
6.4.5 Gateway implemented by a bridge 55
7 On-board data communication 56
7.1 General 56
7.2 Communication patterns 56
7.2.1 Purpose 56
7.2.2 Definitions 56
7.2.3 Push pattern 56
7.2.4 Pull pattern 58
7.2.5 Subscription pattern 59
7.3 Addressing 59
7.3.1 General 59
7.3.2 Network layer addressing 59
7.3.3 Application layer addressing 61
7.4 Availability of data communication 62
7.5 Data classes 62
7.5.1 General 62
7.5.2 Service parameters 62
7.5.3 TCN data class definition 64
7.6 Communication profile 65
7.7 Application profile 65
8 Cybersecurity 65
8.1 General 65
8.2 System under consideration 66
8.3 Lifecycle 66
8.3.1 General 66
8.3.2 Legacy systems 66
8.3.3 Protocol design 66
8.4 Guidelines 66
Annex A (informative) High-level train architecture 68
A.1 General 68
A.2 Architectural realms 68

A.3 On-board network structures 70
Bibliography 72

Figure 1 – Train backbone and consist network 21
Figure 2 – Example of consist with 2 consist networks 22
Figure 3 – End device connected to the train backbone (example) 24
Figure 4 – Communication between train and ground (example) 25
Figure 5 – Interfaces between consists 26
Figure 6 – Train backbone bus topology 27
Figure 7 – Train backbone switched topology (aggregated transmission media) 27
Figure 8 – Train backbone switched topology (segregated transmission media) 28
Figure 9 – Wireless train backbone mesh topology 28
Figure 10 – Wireless train backbone base station topology 29
Figure 11 – Wireless train backbone mesh topology for redundancy 29
Figure 12 – Wireless train backbone base station topology for redundancy 30
Figure 13 – Directions and orientation in a vehicle 31
Figure 14 – Directions and orientations in a consist (example) 32
Figure 15 – Directions and orientations in a closed train 32
Figure 16 – Directions and orientations in train (TCN directions) 33
Figure 17 – Structure of train ~~network~~ directory (example) 36
Figure 18 – Train inauguration block diagram 41
Figure 19 – Train inauguration state chart 43
Figure 20 – Independent orientation check with BEACON telegrams 44
Figure 21 – Consist network standard interfaces 46
Figure 22 – Consist network (bus technology) 46
~~Figure 23 – Local service ....~~
~~Figure 24 – Unconfirmed service ....~~
~~Figure 25 – Confirmed service ....~~
~~Figure 26 – Provider initiated services ....~~
Figure 23 – Consist switches 47
Figure 24 – Examples of consist network topologies (switched technology) 49
Figure 25 – End device connected to two consist switches 49
Figure 26 – Wireless consist network 50
Figure 27 – Sub-networks in a consist network 51
Figure 28 – Implementation example for two vehicle busses 52
Figure 29 – Example of heterogeneous train control network architecture 52
Figure 30 – Point to point communication pattern (push) 57
Figure 31 – Point to multi-point communication pattern (push) 57
Figure 32 – Point to point communication pattern (pull) 58
Figure 33 – Point to multi-point communication pattern (~~push~~pull) 58
Figure 34 – Subscription communication pattern 59
Figure A.1 – Example of architectural realm structure 69
Figure A.2 – Examples for network segregation of on-board physical networks 70

Table 1 – Train composition changes 30
Table 2 – Train ~~network~~ specific parameters (example) 37
Table 3 – Consist ~~network~~ specific parameters (example) 37
Table 4 – Vehicle specific parameters (example) 38
Table 5 – Device specific parameters (example) 38
Table 6 – Point to point (Push) 57
Table 7 – Point to multi-point (Push) 57
Table 8 – Point to point (Pull) 58
Table 9 – Point to multi-point (Pull) 59
Table 10 – Service parameters 62
Table 11 – Principal data classes 64

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

Electronic railway equipment - Train communication network (TCN) - Part 1: General architecture

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61375-1:2012. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61375-1 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Extension of train backbone topologies: aggregated and segregated topology;
b) Added independent consist orientation check with segregated train backbone topology;
c) Introduction of wireless technologies: wireless train backbone and wireless consist network;
d) Possibility of virtual networks;
e) Definition of data classes and protocol requirements suitable for the OMTS domain;
f) New clause about cybersecurity in train communication networks.

The text of this International Standard is based on the following documents:

Draft	Report on voting
9/3252/FDIS	9/3293/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of IEC 61375 series, 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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,
– withdrawn, or
– revised.

INTRODUCTION

IEC 61375-1 defines the general architecture of the Train Communication Network (TCN) to achieve compatibility between consist networks and train backbones defined by the IEC 61375 series.

The creation of this fourth edition of the standard has been motivated by advances in technology, namely in the fields of Ethernet communication, wireless communication, and cybersecurity, which made it necessary to adapt or to extend some sections of the TCN general architecture. These changes will then further on be reflected in the detailed technical specifications given in subsequent parts of the IEC 61375 series.

The TCN has a hierarchical structure with two levels of networks, a train backbone and a consist network:

a) for interconnecting vehicles in closed or open trains, this document specifies train backbones with different characteristics.

b) for connecting standard on-board equipment, this document specifies consist networks with different characteristics.

The general architecture of the TCN, which is defined in this document, ~~shall~~ does

c) establish the rules for interconnecting consist networks with train backbones, as
   1) identifying the interfaces;
   2) defining the principles of how train topology changes can be discovered;
   3) defining the basic communication services provided by train backbones to be used by consist networks;

d) establish basic rules for the train backbone and for the consist network;

e) establish rules for ~~communalities~~ commonalities in operation, as:
   1) patterns for the communication between users;
   2) addressing principles;
   3) data classes to be supported;

e) establish rules to support cybersecurity of the TCN.

1 Scope

This part of IEC 61375 applies to the architecture of data communication systems in open trains, i.e. it covers the architecture of a communication system for the data communication between vehicles of the said open trains, the data communication within the vehicles and the data communication from train to the ground.

The applicability of this part of IEC 61375 to the train network technologies allows for interoperability of individual vehicles within open trains in international traffic. The data communication systems inside vehicles are given as recommended solutions to cope with the said TCN. In any case, proof of compatibility between a proposed train backbone and a proposed consist network will have to be brought by the supplier.

This part of IEC 61375 ~~may~~ might be additionally applicable to closed trains and multiple unit trains when so agreed between purchaser and supplier.

NOTE 1 For definitions of open trains, multiple unit trains and closed trains, see Clause 3.

NOTE 2 Road vehicles such as buses and trolley buses are not considered in this part of IEC 61375.

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.~~

~~ISO/IEC 7498-1, *Information Technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*~~

~~ISO/IEC 8824-1:2002, *Information technology – Abstract Syntax Notation One (ASN.1): specification of basic notation*~~

~~ISO/IEC 9646-1:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts*~~

~~ISO/IEC 19501:2005, *Information technology – Open Distributed Processing – Unified Modeling Language (UML) Version 1.4.2*~~

~~UIC CODE 556, *Information transmission in the train (train-bus)*~~

There are no normative references in this document.

3 Terms, definitions, abbreviated terms, 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:

– IEC Electropedia: available at https://www.electropedia.org/

– ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
active train backbone node
train backbone node receiving a sequence number during train inauguration and forwarding user data packets between consist network and train backbone

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**~~
~~**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

[SOURCE: IEC 60050-811:2017, 811-37-05]

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~~ can receive the information and others not.

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

3.1.6
bus
<in a train communication network> communication medium which broadcasts the same information to all attached participants at nearly the same time, allowing all devices to obtain the same sight of its state, at least for the purpose of arbitration

3.1.7
closed train
train composed of one or a set of consists, where the train composition does not change during normal operation

EXAMPLE Metro, suburban train, or high-speed train unit.

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

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

3.1.8
communication device
device connected to the consist network or train backbone with the ability to transport, source or sink data

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

~~**3.1.10**~~
~~**composition**~~
~~number and characteristics of the vehicles 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; by extension, the operation of loading the devices with the configuration information before going to regular operation~~

3.1.9
consist
~~train set~~
~~rake of coaches~~
single vehicle or a group of vehicles which are not separated during normal operation~~, and which contains no, one or several consist networks~~

~~EXAMPLE The vehicles of a consist are steadily connected in a workshop, and automatic couplers are mounted at both ends of the consist to facilitate the coupling and de-coupling of complete consists in the workshop or during operation.~~

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

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

3.1.10
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]

3.1.11
consist network address
network address, which does not change after train inauguration and which is used to address communication device in the own consist network

3.1.12
consist sequence number
sequence number of the consist in the train as obtained during train inauguration

3.1.13
consist switch
~~consist network node~~
network component used in consist network based on switched technology~~ (ECN). See "switch" 3.1.58.~~

[SOURCE: IEC 60050-811:2017, 811-37-22]

~~**3.1.17**~~
~~**consumer**~~
~~receiver of a message at the transport layer (see: "producer" 3.1.47)~~

3.1.14
cybersecurity
<in railway application> set of activities and measures taken with the objective to identify, protect against, detect, respond to, and recover from unauthorized access or cyberattack which could lead to an accident, an unsafe situation, or railway application performance degradation

[SOURCE: CLC/TS 50701:2023, 3.1.32]

~~**3.1.18**~~
~~**destination device**~~
~~receiver of a data packet (see: "source device" 3.1.55)~~

3.1.15
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]

3.1.16
end node
node which terminates the train backbone

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

3.1.17
essential function
function or capability that is required to maintain health, safety, the environment and availability for the equipment under control

Note 1 to entry: Essential functions include, but are not limited to, the safety instrumented function (SIF), the control function and the ability of the operator to view and manipulate the equipment under control. The loss of essential functions is commonly termed loss of protection, loss of control and loss of view respectively. In some industries additional functions such as history can be considered essential.

[SOURCE: IEC 62443-4-2:2019, 3.1.20]

3.1.18
function
<in a train communication network> application process which exchanges messages with another application process

3.1.19
gateway
~~connection between different communication technologies~~
<in a train communication network> connection between different busses at the application layer requiring application-dependent data analysis and protocol conversion

3.1.20
group address
address of a multicast group to which a device belongs

[SOURCE: IEC 60050-811:2017, 811-37-45]

~~**3.1.24**~~
~~**inauguration**~~
~~operation executed in case of composition change, which gives all nodes of the train backbone their train backbone address, their orientation and information about all named nodes on the same backbone~~

3.1.21
integrity
<in a train communication network> property of a system to recognize and to reject wrong data in case of malfunction of its parts

3.1.22
intermediate node
node which establishes continuity between two bus sections connected to it, but does not terminate them

[SOURCE: IEC 60050-811:2017, 811-37-49]

~~**3.1.27**~~
~~**jumper cable**~~
~~cable connecting the trunk cables of two consecutive vehicles, possibly of a larger cross-section than the trunk cable, and which is plugged by hand in the case of the UIC-cable. There are generally two jumper cables between vehicles~~

3.1.23
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 (i.e. connected in the shape of a line)

[SOURCE: ~~IEC 61784-2~~ IEC 60050-811:2017, 811-37-51]

3.1.24
local area network
<in a train communication network> part of a network characterized by a common medium access and address space

[SOURCE: IEC 60050-811:2017, 811-37-60]

3.1.25
medium access control
<in a train communication network> sublayer of the link layer, which controls the access to the medium (arbitration, mastership transfer, polling)

3.1.26
medium
<in a train communication network> physical carrier of the signal: electrical wires, optical fibers, etc.

3.1.27
message
~~data item transmitted in one or several packets~~

<in transmission systems> information which is transmitted in one or several packets from a sender to one or more receivers

[SOURCE: IEC 60050-821:2017, 821-11-29]

~~**3.1.33**~~
~~**mobile train unit**~~
~~part of a train which shall be uniquely addressable from ground. A mobile train unit provides one active mobile communication gateway for train to ground communication.~~

3.1.28
multicast
transmission of the same message to a group of receivers, identified by their group address

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

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

3.1.29
multimedia data
data used for onboard multimedia and telematic services (OMTS), like video/audio streams or file transfer

3.1.30
multiple unit train
~~a train consisting of a set of closed trains, where the composition of the set may change during normal operation~~

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

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

3.1.31
network
<in a train communication network> set of possibly different communication systems which interchange information in a commonly agreed way

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

3.1.32
network address
address which identifies a communication device on network layer

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

3.1.33
network device
component used to set up consist networks and train networks

Note 1 to entry: These components ~~may~~ can 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.

[SOURCE: IEC 60050-811:2017, 811-37-70, modified – Note 1 to entry has been modified.]

3.1.34
network layer
layer in the OSI model responsible for routing between different busses

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

3.1.35
network management
<in a train communication network> operations necessary to remotely configure, monitor, diagnose and maintain the network

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

~~**3.1.41**~~
~~**node**~~
~~device on the train backbone, which may act as a gateway between train backbone and consist network~~

3.1.36
octet
byte
~~8-bit word stored in memory or transmitted as a unit~~

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

[SOURCE: IEC 60050-171:2019, 171-02-12, modified – removal of Note to entry.]

3.1.37
open train
train composed of one or a set of consists, where the configuration ~~may~~ can change during operation~~, as for instance locomotive hauled international UIC trains~~

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

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

3.1.38
operator
enterprise or organization which is operating trains

3.1.39
operational data
data critical for train operation (TCMS), like propulsion control, brake control, doors control, lighting control or heating, ventilation, and air conditioning control

3.1.40
packet
<in a train communication network> unit of a message (information, acknowledgement, or control) transmitted by protocols on network or transport layer

~~**3.1.46**~~
~~**passive train backbone node**~~
~~train backbone node which is in standby to an active train backbone node in a consist network~~

~~**3.1.47**~~
~~**producer**~~
~~sender of a message at the transport layer (see: "consumer" 3.1.17)~~

~~**3.1.48**~~
~~**publisher**~~
~~source of a dataset for broadcasting (see: "subscriber" 3.1.57)~~

3.1.41
realm
logical concept structuring train functions along coherent boundaries

3.1.42
receiver
<in a train communication network> electronic device which ~~may~~ can receive signals from the physical medium

3.1.43
repeater
< in a train communication network> 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.

[SOURCE: IEC 60050-811:2017, 811-37-90]

~~**3.1.51**~~
~~**residual error rate**~~
~~probability of integrity breach (unrecognized wrong bit) per transmitted bit~~

3.1.44
ring topology
active network where each node is connected in series to two other nodes

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

[SOURCE: ~~IEC 61918~~ IEC 60050-811:2017, 811-37-91]

3.1.45
router
<in a train communication network> connection between two busses at the network layer, which forwards datagrams from one bus to another on the base of their network address

3.1.46
safety integrity
ability of a safety-related system to achieve its required safety functions under all the stated conditions within a stated operational environment and within a stated duration

[SOURCE: IEC 60050-821:2017, 821-12-54]

3.1.47
service
<in a train communication network> capabilities and features of a sub-system (e.g. a communication layer) provided to a user

[SOURCE: IEC 60050-811:2017, 811-37-93]

~~**3.1.55**~~
~~**source device**~~
~~sender of a data packet (see: "destination device" 3.1.18)~~

~~**3.1.56**~~
~~**sporadic data**~~
~~transmission of data on a demand basis~~

~~**3.1.57**~~
~~**subscriber**~~
~~one of the sinks of a broadcast dataset (see: "publisher" 3.1.48)~~

3.1.48
system under consideration
<in a train communication network> collection of assets that are needed to provide and operate a railway application including any relevant network infrastructure assets

Note 1 to entry: In a cybersecurity context as defined in IEC 62443-3-2:2020, a system under consideration consists of one or more zones and related conduits. All assets within a system under consideration belong to either a zone or conduit.

3.1.49
switch
<in a train communication network> MAC bridge as defined in IEEE 802.1~~D~~Q

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

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

3.1.50
topography
data structure describing the nodes attached to the train backbone, including their address, orientation, position and node descriptor

[SOURCE: IEC 60050-811:2017, 811-37-105]

3.1.51
topology
possible cable interconnection and number of devices in a given network

[SOURCE: IEC 60050-811:2017, 811-37-106]

~~**3.1.61**~~
~~**topography counter**~~
~~counter in a node which is incremented at each new inauguration~~

3.1.52
train
~~composition of one or a set of consists, which can be operated as an autonomous unit, e.g. containing drives and at least one driver's cab. Trains can be categorized into open trains (see 3.1.43), closed trains (see 3.1.8) and multiple unit trains (see 3.1.35).~~

combination of rolling stock coupled together

Note 1 to entry: Rolling stock includes banking locomotives.

[SOURCE: IEC 60050-811:2017, 811-01-08]

3.1.53
train communication network
data communication network for connecting programmable electronic equipment on-board rail vehicles

[SOURCE: IEC 60050-811:2017, 811-37-108]

3.1.54
train backbone
train bus
bus connecting the ~~vehicles~~ consists of a train, in particular the wire train bus, and which conforms to the TCN protocols

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

3.1.55
train backbone node
node
~~device connected to the train backbone. A train backbone node can be used to connect end devices or consist networks to the train backbone. A train backbone node can be active (see 3.1.1) or passive (see 3.1.46).~~

<in a train communication network> device on the train backbone that acts as a gateway between the train backbone and the consist network

[SOURCE: IEC 60050-811:2017, 811-37-74, modified – "train backbone node" has been added as preferred term.]

3.1.56
train backbone node number
node address
node number
~~Each active train backbone node is assigned a number during inauguration, which indicates the position of the train backbone node on the train backbone.~~

unique number assigned to a node during train inauguration indicating the position of the train backbone node on the train backbone

Note 1 to entry: This number can be used as part of the train network address for addressing devices in the consist, the train backbone node belongs to, from any location in the train.

3.1.57
train composition
sequence, orientation and characteristics of consists which represent a train

3.1.58
train directory
data structure which describes the train composition and provides user information about the consists

3.1.59
train inauguration
operation executed in case of train composition change, which gives all nodes of the train backbone their train backbone node number, their orientation and information about all named nodes on the same backbone, and which determines the actual train composition

~~**3.1.68**~~
~~**train network management**~~
~~services of the network management for TCN~~

3.1.60
train network address
dynamic network address, which is used to address communication devices in other consist networks~~. This address can change after each inauguration.~~

Note 1 to entry: The train network address can change after each inauguration.

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

3.1.61
train network directory
data structure which describes the sequence of train backbone nodes, the sequence of consist networks and the orientation of the consists in which the nodes are located

3.1.62
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]

3.1.63
wireless access point
active network device, using a wireless network interface to offer access to the consist network

3.1.64
wireless end device
active end device, using a wireless network interface to exchange data within the consist network

3.2 Abbreviations and acronyms

~~ANSI~~	~~American National Standard Institute, a standardisation body in the United States~~
ALG	Application layer gateway
BER	Bit error rate~~, the rate of bit errors in a data stream, mainly caused by noise (random bit errors), but also caused by memory defects in data storing devices (systematic bit errors).~~
~~BR~~	~~Bit Rate, the rate of data throughput on the medium expressed in bits per second (bit/s) or in hertz (Hz), whichever is appropriate~~
CAN	Controller Area Network
CCN	CANOpen Consist Network
CCS	Command, control and signalling
CCU	Consist control unit
CN	Consist network
CPS	Communication protocol stack
~~CRC~~	~~Cyclic Redundancy Check, a data integrity check based on polynomial division~~
~~DIN~~	~~Deutsches Institut für Normung, the German national standardisation body~~
ECN	Ethernet Consist Network
ED	End device
~~EIA~~	~~Electronics Industries Association, a standardisation body in the United States~~
ETB	Ethernet train backbone
ETBN	Ethernet train backbone node
GCG	Ground communication gateway
HFR	Hazardous failure rate
HVAC	Heat, ventilation and air conditioning
~~IEC~~	~~International Electrotechnical Commission, Geneva~~
IEEE	Institute of Electrical and Electronics Engineers~~, New York~~
~~IETF~~	~~Internet Engineering Task Force~~
IP	Internet Protocols~~, as defined by the IETF~~
~~ISO~~	~~International Standard Organisation, Geneva~~
IT	Information technology
~~ITU~~	~~International Telecommunication Union, the international standardisation body for telecommunications based in Geneva~~
LAN	Local area network

MAC Medium Access Control~~, a sub-layer within the Link Layer ruling which device is entitled to send on the bus~~

MCG Mobile communication gateway

~~MTU Mobile Train Unit~~

MVB Multifunction vehicle bus

ND Network device

OMTN OnBoard Multimedia and Telematic Network

OMTS OnBoard Multimedia and Telematic Services

OSI Open System Interconnection~~, a universal communication model defined in ISO/IEC 7498-1~~

OT Operational technology

~~PCTR Protocol Conformance Test Report, defined in ISO/IEC 9646-1~~

~~PICS Protocol Implementation Conformance Statement, defined in ISO/IEC 9646-1~~

QoS Quality of service

RFC Request for comments~~, Internet Standard published by the IETF~~

RFID Radio frequency identification

SuC System under consideration

SW Software

TB Train backbone

TBN Train backbone node

TC Train connectivity

TCMS Train control and management system

TCN Train communication network~~, a set of communicating vehicle and Train Backbones~~

TPN Train passenger network

UIC International Union of Railways~~, the international railways operators association~~

UML Unified Modeling Language~~, defined in ISO/IEC 19501.~~

URI Uniform resource identifier~~, as defined by the IETF~~

VLAN Virtual local area network

WAP Wireless access point

WED Wireless end device

WiFi Wireless fidelity

WLCN Wireless consist network

WLTB Wireless train backbone

WLTBN Wireless train backbone node

WTB Wire train bus

3.3 Conventions

~~**3.3.1 Requirement conventions**~~

~~**Shall** is used to describe requirements.~~

~~**Should** is used to describe recommendations.~~

~~**May** is used to describe acceptable features.~~

~~**Could** is used to describe possible ways.~~

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.~~

All numeric values use a decimal representation unless otherwise noted.

Binary and hexadecimal values are represented using the ASN.1 (ISO/IEC 8824-1:2021) convention [4][1].

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

3.3.2 Naming conventions

~~If the keyword name is composed, the different parts of the name are united with a space.~~

~~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~~ joined without a space, and all parts are beginning with a capital letter.

EXAMPLE 1 "NumberOfConsists"

Function names are written with a lower-case first letter ~~at the beginning~~.

If the function name is composed, the different parts of the name are united without a space, and all parts except the first part are beginning with a capital letter.

EXAMPLE 2 "indicateTopoChange"

3.3.3 State diagram conventions

State diagrams are defined following the notation of UML state machines (ISO/IEC 19501:2005 [5]).

4 Basic architecture

4.1 ~~Contents of this clause~~ General

Clause 4 specifies the hierarchical network architecture of the train communication network together with the main characteristics of its parts and the interfaces between them.

Annex A describes the overall on-board IT/OT architecture to provide some background of the environment the TCN is embedded in. It also describes some potential network configurations.

[1] Numbers in square brackets refer to the Bibliography.