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INTERNATIONAL STANDARD

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

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

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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.

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

f) establish rules to support cybersecurity of the TCN.

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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 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

There are no normative references in this document.

3 Terms, definitions, abbreviated terms, acronyms, and conventions

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3.1 Terms and definitions

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

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

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

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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 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

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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]

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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]

3.1.9
consist
single vehicle or a group of vehicles which are not separated during normal 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

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

3.1.13
consist switch
network component used in consist network based on switched technology

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

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]

3.1.15
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]

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3.1.16
end node
node which terminates the train backbone

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

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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
<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]

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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]

3.1.23
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 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]

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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)

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

3.1.27
message
<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]

3.1.28
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

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3.1.30
multiple unit train
train comprising one or more train-units which can be controlled simultaneously from one cab and able to operate at normal speed in either direction without re-marshalling

[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 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.

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

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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]

3.1.36
octet
byte
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 can change during operation

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

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

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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

3.1.41
realm
logical concept structuring train functions along coherent boundaries

3.1.42
receiver
<in a train communication network> electronic device which 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

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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]

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

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

[SOURCE: 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]

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