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Second edition
2007-04

**Electric railway equipment –
Train bus –**

**Part 1:
Train communication network**



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**Electric railway equipment –
Train bus –**

**Part 1:
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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRIC RAILWAY EQUIPMENT –
TRAIN BUS –****Part 1: Train communication network****FOREWORD**

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

This second edition cancels and replaces the first edition published in 1999 and constitutes a technical revision.

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

- technical amendments concern Clauses 2, 3 and 4. Some inconsistencies between clauses have been solved, some parameters and values have been changed according to the suggestion of the experts of National Committees involved in the application of the standard;
- the pre-emphasis has been introduced for the MVB transmitted signal;

- Annex B has been superseded by IEC 61375-2.

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

FDIS	Report on voting
9/1013/FDIS	9/1033/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.

The following items are to be taken into consideration:

- in France the needs of data communication between equipment in vehicles and between vehicles are dealt with using products covered by other standards or technical specifications (many trains introduced in the last 10 years are equipped with data communication systems; care has been taken to make use as much as possible of different relevant industrial standards) incompatible with the provisions of this standard and making it inapplicable in that country;
- for instance, in modern rolling stock recently commissioned in France, technical specifications for train communication networks comply with IEC 61158-2 and EN 50170, which are the field bus international standards. On the other hand, token-passing bus access method has been used in technical specifications for data communication networks for the latest generation of high speed trains;
- in China, for closed trains and multiple units, the technical specifications of a train communication network may be based on an agreement between user and manufacturer alternatively to this standard.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site 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 standard may be issued at a later date.

INTRODUCTION

This part of IEC 61375 defines interfaces so as to achieve plug-in compatibility:

- a) between equipment located in different vehicles, and
- b) between equipment located within the same vehicle.

This standard defines these interfaces as connections to a data communication network, called the Train Communication Network (TCN).

The TCN has a hierarchical structure with two levels of busses, a Train Bus and a Vehicle Bus:

- a) for interconnecting vehicles in Open Trains (see definition) such as international UIC trains, this standard specifies a Train Bus called the Wire Train Bus (WTB);
- b) for connecting standard on-board equipment, this standard specifies a Vehicle Bus called the Multifunction Vehicle Bus (MVB).

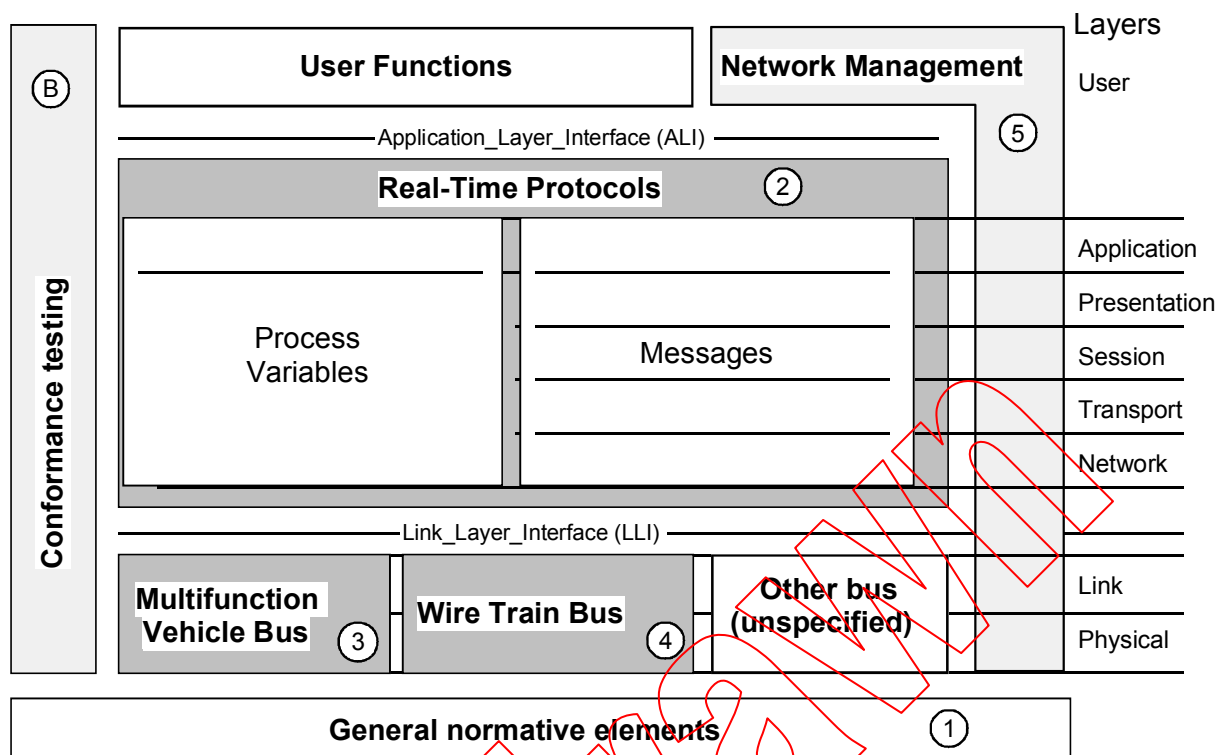
In the TCN architecture, all busses share the same Real-Time Protocols, which offer two communication services:

- a) Process Variables, a distributed, real-time database, periodically refreshed through broadcasting;
- b) messages, transmitted on demand either as:
 - unicast messages (point-to-point) or/and
 - multicast messages.

All busses in the TCN share a common Network Management, which allows debugging, commissioning and maintenance over the network.

Guidelines for conformance testing are included in this standard.

The TCN is structured similarly to the Open System Interconnection model defined in ISO/IEC 7498-1 (see Figure 1).



NOTE The circled numbers refer to the clauses and annexes of this standard.

Figure 1 – Layering of the TCN

This standard has been, for editorial reasons, divided into five clauses and two annexes:

Clause 1: General,

- Definitions and informative overview;

Clause 2: Real-Time Protocols,

- Variables: Link Layer Interface and Application Layer Interface;
- Messages: Link Layer Interface, Protocols, Application Layer Interface;
- Data Representation;

Clause 3: Multifunction Vehicle Bus,

- Physical Layer, Link Layer and Link Layer Management;

Clause 4: Wire Train Bus,

- Physical Layer, Link Layer and Link Layer Management;

Clause 5: Train Network Management,

- Configuration, supervision and control of the network;

Annex A: Tutorial on the Train Communication Network

Annex B: Guidelines for Conformance Test.

ELECTRIC RAILWAY EQUIPMENT – TRAIN BUS –

Part 1: Train communication network

1 General

1.1 Scope

This part of IEC 61375 applies to data communication in Open Trains, i.e. it covers data communication between vehicles of the said open trains and data communication within the vehicles of the said open trains.

The applicability of this standard to the train communication bus (WTB) allows for interoperability of individual vehicles within Open Trains in international traffic. The data communication bus inside vehicles (MVB) is given as recommended solution to cope with the said TCN. In any case, proof of compatibility between WTB and a proposed vehicle bus will have to be brought by the supplier.

This standard may be additionally applicable to closed trains and multiple unit trains when so agreed between purchaser and supplier.

NOTE 1 For a definition of Open Trains, Multiple Unit Trains and Closed Trains, see 1.3.

NOTE 2 Road vehicles such as buses and trolley buses are not considered in this standard.

1.2 Normative references

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

IEC 60096-1: *Radio-frequency cables – Part 1: General requirements and measuring methods*

IEC 60245-1, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 1: General requirements*

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60332-1-1, *Tests on electric and optical fibre cables under fire conditions – Part 1-1: Test for vertical flame propagation for a single insulated wire or cable – Apparatus*

IEC 60571, *Electronic equipment used on rail vehicles*

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60807 (all parts), *Rectangular connectors for frequencies below 3 MHz*

IEC 60870-5-1, *Telecontrol equipment and systems. Part 5: Transmission protocols - Section One: Transmission frame formats*

IEC 60874-10-1, *Connectors for optical fibres and cables – Part 10-1: Detail specification for fibre optic connector type BFOC/2,5 terminated to multimode fibre type A1*

IEC 60874-10-2, *Connectors for optical fibre and cables – Part 10-2: Detail specification for fibre optic connector BFOC/2,5 terminated to single-mode fibre type B1*

IEC 60874-10-3, *Connectors for optical fibre and cables – Part 10-3: Detail specification for fibre optic connector BFOC/2,5 terminated to single and multimode fibre*

ISO/IEC 8482, *Information technology – Telecommunications and information exchange between systems – Twisted pair multipoint interconnections*

ISO/IEC 8802-2, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical link control*

ISO/IEC 8824 (all parts), *Information technology – Abstract Syntax Notation One (ASN.1)*

ISO/IEC 8825 (all parts), *Information technology – ASN.1 encoding rules*

ISO/IEC 8859-1, *Information technology – 8-bit single-byte coded graphic character sets – Part 1: Latin alphabet No. 1*

ISO/IEC 9646 (all parts), *Information technology – Open Systems Interconnection – Conformance testing methodology and framework*

ISO/IEC 10646, *Information Technology – Universal Multiple Octet Coded Character Set (UCS)*

ISO/IEC 13239, *Information technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures*

ITU-T Recommendation V24, *List of definitions for interchange circuits between data terminal equipment (DTE) and data-circuit terminating equipment (DCE)*

ITU-T Recommendation Z.100, *Specification and Description Language (SDL)*

UIC 556 ORE B 108.3 Fiche No. 556, *Information transmission in the train (train-bus)*

UIC 557, *Diagnostics on passenger rolling stock*

IEEE 754, *Standard for Binary Floating-Point Arithmetic*

1.3 Terms and definitions

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

NOTE Keywords in this standard are written with the first letter of each word in upper case and, when they are composed of two or several words, these are joined by an underscore. This convention allows keywords to be tracked in the documents.

1.3.1 address

identifier of a communication partner, of which several types exist, depending on the layer.

1.3.2 agent

application process in a Station which accesses the local managed objects on behalf of the Manager

1.3.3**Aperiodic Data**

transmission of Process Data on a demand basis. This service is not used

1.3.4**Application Layer**

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

1.3.5**Application Layer Interface**

definition of the services offered by the Application Layer

1.3.6**Application Messages Adapter**

code directly called by the application implementing the Messages services

1.3.7**Application Messages Interface**

definition of the Messages services

1.3.8**Application Process**

communicating entity, implemented for instance by a task

1.3.9**Application Processor**

processor which runs a communicating Application Process

1.3.10**Application Supervision Interface**

definition of the Supervision services available in particular to the Agent

1.3.11**Application Variables Adapter**

code directly called by the application implementing the Variables services

1.3.12**Application Variables Interface**

definition of the Variables services

1.3.13**arbiter**

device, or common protocol followed by several devices, which selects one of several devices competing for mastership

1.3.14**Auxiliary Channel**

channel used for detecting additional Nodes

1.3.15**Basic Period**

bus activity is divided into periods. The shortest is the Basic Period, which consists of a Periodic Phase (for Periodic Data) and of a Sporadic Phase (for Message Data and Supervisory Data)

1.3.16

big-endian

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

1.3.17

bit-stuffing

method specified by ISO/IEC 13239 to prevent Frame Data from being misinterpreted as a Flag, consisting of inserting an additional "0" symbol after each string of five "1" symbols and removing this "0" at reception

1.3.18

bridge

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

1.3.19

broadcast

nearly simultaneous transmission of the same information to several destinations. Broadcast in the TCN is not considered reliable, i.e. some destinations may receive the information and others not

1.3.20

bus

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

1.3.21

Bus Administrator

device capable of becoming Master of the MVB

1.3.22

Bus Controller

processor or integrated circuit in charge of the Link Layer of communication

1.3.23

Bus Switch

switch or relay within a WTB Node which connects electrically the cable sections of the two directions

1.3.24

Caller

Application Process which initialises a message exchange

1.3.25

Check Sequence

method of error detection based on appending to the transmitted useful data a checksum or a cyclic redundancy check (CRC) calculated on the useful data

1.3.26

Check Variable

Process Variable of type antivalent boolean protecting another Process Variable

1.3.27

Check Offset

bit offset of a Check Variable within a Dataset

1.3.28**Closed Train**

train consisting of a set of vehicles, where the composition does not change during normal operation, for instance metro, suburban train, or high-speed train units

1.3.29**composition**

number and characteristics of the vehicles forming a train

1.3.30**configuration**

definition of the topology of a bus, 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

1.3.31**Connect Confirm**

response of the Consumer to the Connect Request of the Producer

1.3.32**Connect Request**

first packet of a message sent from Producer to Consumer

1.3.33**consistency**

Dataset consisting of several elements is consistent if all elements are read or written in one indivisible operation

1.3.34**Consumer**

receiver of a message at the Transport Layer (see: Producer)

1.3.35**continuity vehicle**

vehicle without an operational Train Bus Node, but carrying a section of the bus to connect passively the Train Bus of its adjacent vehicles.

1.3.36**conversation**

data exchange at the Application Layer, consisting of a Call Message and a Reply Message (the latter is missing in the multicast protocol). A conversation starts with the first Connect Request frame and ceases when the last acknowledgement for the Reply Message has been received or is no longer expected

1.3.37**datagram**

frame containing all information necessary to forward it to its final destination, without knowledge of previous frame's contents. Datagrams do not use a previous connection establishment and they are not acknowledged at the Link Layer

1.3.38**Dataset**

all Process Variables transmitted in one Process Data frame

**1.3.39
delimiter**

sequence of signals which includes code violation symbols (neither "1" nor "0") which is used to delimit the start (Start Delimiter) and the end (End Delimiter) of a frame, as defined for instance in IEC 61158-2

**1.3.40
Destination Device**

receiver of a frame at the Link Layer (see: Source Device)

**1.3.41
device**

unit connected to one or more busses

**1.3.42
Device Address**

Device Address identifies a device within a bus; On the MVB, the Device Address has 12 bits; On the WTB, the Device Address has 8 bits, the least significant 6 bits being the Node Address;

A device connected to several busses may have a different Device Address for each bus. Special devices such as repeaters only participate at the Physical Layer and have no Device Address

**1.3.43
Device Status**

16-bit word expressing the capabilities and status of an MVB device connection

**1.3.44
Direction 1**

one direction of a WTB Node

**1.3.45
Direction 2**

other direction of a WTB Node

**1.3.46
Electrical Middle Distance**

one of the media of the MVB

**1.3.47
Electrical Short Distance**

one of the media of the MVB

**1.3.48
End Delimiter**

sequence which ends a frame before the medium returns to idle

**1.3.49
End Node**

Node which terminates the two bus segments connected to it but does not establish continuity between them

**1.3.50
Event Round**

sequence of polls in which all events pending at the start are read

1.3.51**extension box**

wiring box where the trunk cable is interrupted and passively extended by an extension cable to connect a device

1.3.52**extension cable**

cable inserting a Node in a trunk cable, consisting of two separate twisted wire pairs per line, possibly of smaller cross-section than the trunk cable itself

1.3.53**field device**

device attaching simple sensors and actuators to the bus, outside a rack

1.3.54**final**

receiver of a packet (data or acknowledgement) at the Network Layer. When two devices communicate within the same bus, the final is located in the destination device (see: origin)

1.3.55**Flag**

sequence of "1" and "0" symbols which serves to delimit the beginning or the end of a frame. Flags which would appear in the transmitted data are modified by bit-stuffing, as defined for instance in ISO/IEC 13239

1.3.56**frame**

sequence of consecutive symbols sent in one time slot by a transmitter, between two slots where the line is idle.

1.3.57**Frame Check Sequence**

16-bit FCS specified in ISO/IEC 13239

1.3.58**Frame Data**

data transmitted between the Start Delimiter and the End Delimiter (on the MVB) or between the Preamble and the End Delimiter (on the WTB)

1.3.59**fritting**

electrical cleaning of oxidised contacts by applying a breakdown voltage over the contact

1.3.60**Function**

Application Process which exchanges messages with another Application Process

1.3.61**Function Directory**

directory which maps a Function Identifier to a Station Identifier and vice-versa

1.3.62**Function Identifier**

8-bit identifier of a Function

1.3.63

F code

in a Master Frame, indicates the request and the expected response Slave Frame size

1.3.64

gateway

connection between different busses at the Application Layer requiring application-dependent data analysis and protocol conversion

1.3.65

Group Address

address of a multicast group to which a Node belongs

1.3.66

Group Directory

directory which indicates to a Node to which multicast group it pertains

1.3.67

hamming distance

minimum number of bits of a given correct bit sequence, which, if inverted, create a false bit sequence indistinguishable from a correct one

1.3.68

HDLC

High-level Data Link Control, a set of standardised protocols, including ISO/IEC 13239 for data transmission

1.3.69

HDLC Data

data transmitted in an HDLC frame

1.3.70

Inauguration

operation executed in case of composition change, which gives all Nodes of the WTB their address relative to the Master, their orientation and the descriptor of all named Nodes on the same bus

1.3.71

Individual Period

interval between two successive transmissions of the same Process Data from the same source. The Individual Period is a power-of-2 multiple of the Basic Period

1.3.72

instance

a) one of several objects which share the same definition (object instance)

b) one of several (simultaneous or not) executions of the same program (process instance)

1.3.73

integrity

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

1.3.74

Intermediate Node

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

1.3.75**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

1.3.76**Line**

non-redundant bus. A dual-thread bus consists of two lines

1.3.77**Line Unit**

all circuits providing the electrical attachment to a line

1.3.78**Link Address**

address supplied to the Link Layer to identify to which Bus and to which Device Address a packet is sent or received

1.3.79**Link Control**

field in the HDLC frame which indicates the type of frame

1.3.80**Link Data**

data transported by the Link Layer, but not relevant to it

1.3.81**Link Header**

part of a Message Data frame relevant to the Link Layer

1.3.82**Link Layer**

layer in the OSI model establishing point-to-point and broadcast connections between devices attached to the same bus

1.3.83**Link Layer Interface**

interface between Link Layer and higher communication layers

1.3.84**Link Layer Management**

interface controlling the Link Layer for management purposes

1.3.85**little-endian**

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

1.3.86**local area network**

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

1.3.87**logical link control**

protocols and associated frame formats which serve to control the Link Layer

1.3.88

Logical Address

address which is not bound to a specific device (e.g. the Process Data address)

1.3.89

Logical Port

ports of a device used for the Process Data traffic and addressed by the Logical Address

1.3.90

Macro Cycle

number of Basic Periods corresponding to a Macro Period

1.3.91

Macro Period

longest Individual Period, after which the periodic traffic returns to the same pattern, counted in milliseconds

1.3.92

Main Channel

channel over which the main bus traffic is received

1.3.93

Management Message

message exchanged between a Manager and an Agent for Network Management.

1.3.94

Manager

Function in a Station which is dedicated to Network Management and which send management Call Messages through System Addresses

1.3.95

marshalling

allocation of application addresses or names to the Process Variables of a dataset, that, on the WTB, depends on the Node Type and Version

1.3.96

Master

device which spontaneously sends information on a bus to a number of slave devices. It may give a Slave the right to transmit for one Slave Frame only within a limited time

1.3.97

Master Frame

frame sent by a Master

1.3.98

Master Start Delimiter

Start Delimiter of a Master Frame

1.3.99

medium access control

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

1.3.100

medium dependent interface

mechanical and electrical interface between the transmission medium and a Medium Attachment Unit

1.3.101**medium**

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

1.3.102**Medium Attachment Unit**

device used as a coupler to the transmission medium

1.3.103**message**

data item transmitted in one or several packets

1.3.104**Messages**

transmission service of the TCN

1.3.105**Message Data**

data transmitted sporadically by the Link Layer in relation to message transmission; the corresponding Link Layer service

1.3.106**messenger**

communication stack caring for end-to-end message communication and interfacing to the application

1.3.107**multicast**

transmission of the same message to a group of Repliers, identified by their Group Address. The word "multicast" is used even if the group includes all Repliers

1.3.108**Multifunction Vehicle Bus****MVB**

Vehicle Bus to be used for connecting programmable stations and simple sensors/actors.

1.3.109**Multiple Unit Train**

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

1.3.110**network**

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

1.3.111**Network Address**

address which identifies a Function or a Station within the network. It can be either a User Address or a System Address

1.3.112**Network Header**

part of a Message Data frame relevant to the Network Layer

1.3.113

Network Layer

layer in the OSI model responsible for routing between different busses

1.3.114

Network Management

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

1.3.115

Node

device on the Wire Train Bus, which may act as a gateway between Train Bus and Vehicle Bus

1.3.116

Node Address

address of a Node on the Train Bus (6 bits). It is equal to the least significant 6 bits of the 8-bit Device Address on the WTB

1.3.117

Node Descriptor

24-bit data structure which indicates for a Node its Node Period and its Node Key

1.3.118

Node Directory

directory which maps the Node Address to the Device Address (one-to-one mapping in WTB)

1.3.119

Node Key

16-bit identifier selected by the application to identify a Node's type and version. The Master distributes it to all other Nodes after each composition change and before exchanging data

1.3.120

Node Period

on the WTB, desired Individual Period of a Node (identical to Individual Period except if overload occurs)

1.3.121

octet

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

1.3.122

Open Train

train consisting of a set of vehicles where the configuration may change during normal operation, for instance international UIC trains

1.3.123

Optical Glass Fibre

one of the media of the MVB

1.3.124

origin

sender of a packet (data or acknowledgement) at the Network Layer. When two devices communicate within the same bus, the Origin is located on the source device (see: final)

* IEC prescribes 'octet' instead of 'byte'

1.3.125**packet**

unit of a message (information, acknowledgement or control) transmitted in exactly one Message Data frame

1.3.126**period**

time unit after which a periodic pattern repeats itself

1.3.127**Periodic Data**

Process Data transmitted periodically, at an interval which is the Individual Period

1.3.128**Periodic List**

list of Nodes, addresses or devices to be polled in each period of a Macro Cycle

1.3.129**Periodic Phase**

phase during which the Master polls for Periodic Data according to its Periodic List

1.3.130**Physical Address**

Device Address on the MVB and the Node Address on the WTB which identify communicating devices on the same bus

1.3.131**Physical Port**

Port used for the Message Data or the Supervisory Data traffic and addressed by the Device Address

1.3.132**pitch**

distance between adjacent devices on the same electrical bus required to avoid clustering of bus loads

1.3.133**polling**

sending of a Master Frame in order to receive a Slave Frame

1.3.134**Port**

memory structure which contains data for transmission or reception, and in which a new value overwrites the former value (buffer, not queue). A Port provides means for simultaneous access by the bus and the application(s)

1.3.135**Port Index Table**

look-up table which deduces the memory address of a port from the Logical Address of the Process Data

1.3.136**Preamble**

sequence of signals heading a frame for the purpose of synchronising the receiver, used on the WTB

1.3.137

Presentation Layer

layer in the OSI model responsible for data representation and conversion

1.3.138

Process Data

source-addressed data broadcast periodically by the link layer in relation with Process Variables transmission; the corresponding Link Layer service

1.3.139

Process Variable

variable expressing the state of a process (e.g. speed, brake command)

1.3.140

Producer

sender of a message at the Transport Layer (see: Consumer)

1.3.141

Publisher

source of a Dataset for broadcasting (see: Subscriber)

1.3.142

PV Name

identifier of a Process Variable

1.3.143

PV Set

set of Process Variables belonging to the same Dataset

1.3.144

queue

memory storing an ordered set of frames in a first-in, first-out fashion

1.3.145

rack

equipment containing one or more devices, attached to the same segment

1.3.146

reassembly

act of regenerating a long message from several packets generated by segmentation

1.3.147

receiver

electronic device which may receive signals from the physical medium

1.3.148

Receive Queue

queue for receiving Message Data in a device

1.3.149

regular operation

normal bus activity as opposed to Inauguration (WTB) or configuration (MVB)

1.3.150

repeater

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

1.3.151**Replier**

Application Process which has been requested by the Caller to receive a Call Message and to reply with a Reply Message

1.3.152**residual error rate**

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

1.3.153**router**

connection between two busses at the Network Layer, which forwards datagrams from one bus to another on the base of their Network Address

1.3.154**scan**

polling of devices in a certain sequence for supervisory purposes

1.3.155**section**

part of a segment, which is passively connected to another section without terminator in between

1.3.156**segment**

piece of cable to which devices are attached, terminated at both ends by its characteristic impedance. Segments may consist of several sections (non-terminated) connected by connectors

1.3.157**segmentation**

division of a long message into several shorter frames for transmission

1.3.158**Send Queue**

queue for sending Message Data in a device

1.3.159**service**

capabilities and features of a sub-system (e.g. a communication layer) provided to a user

1.3.160**Session Header**

part of a Message Data frame relevant to the Session Layer

1.3.161**Session Layer**

OSI layer in charge of establishing and closing communication

1.3.162**Side A**

one side of a vehicle with respect to a WTB Node

1.3.163

Side B

other side of a vehicle with respect to a WTB Node

1.3.164

Slave

device which receives information from the bus or sends information on the bus in response to a request (also called a poll) from the Master

1.3.165

Slave Frame

frame sent by a Slave

1.3.166

Slave Start Delimiter

Start Delimiter of a Slave Frame on the MVB

1.3.167

Source Device

sender of a frame at the Link Layer (see: destination device)

1.3.168

sporadic transmission

transmission which is made upon demand, when an event external to the network requires it (also called aperiodic, event-driven, demand-driven transmission)

1.3.169

Sporadic Data

data frames transmitted on demand to carry Message Data or Supervisory Data

1.3.170

Sporadic Phase

second half of a Basic Period, dedicated to the demand-driven transmission of messages and bus management data

1.3.171

star coupler

device which takes the light of an optical fibre and redistributes it to several other fibres

1.3.172

Start Delimiter

delimiter which announces the beginning of a frame on the MVB

1.3.173

Station

device capable of message communication, by contrast to simple devices, and which supports an Agent Function

1.3.174

Station Directory

directory which maps a Station Identifier to a Link Address and vice-versa

1.3.175

Station Identifier

8-bit identifier of a Station

1.3.176**Station Status Word**

16-bit descriptor of the status and capabilities of a Station

1.3.177**Strong Master**

Strong Node is currently Master and will not relinquish mastership until demoted to Weak Node status

1.3.178**Strong Node**

Node selected by the application to become Strong Master. There may be only one Strong Master on a bus segment

1.3.179**stub**

T-connection branching from an electrical bus line (at the tap), connecting a device to the line

1.3.180**Subscriber**

one of the sinks of a broadcast Dataset (see: Publisher)

1.3.181**Supervisory Data**

data transmitted within one bus only for the purpose of Link Layer supervision (e.g. arbitration on the MVB or Inauguration on the WTB)

1.3.182**System Address**

Network Address of a Management Message exchanged between Manager and Agent, consisting of Node Address and Station Identifier

1.3.183**tap**

place where a segment is tapped. A tap is a three-way electrical fork

1.3.184**Telegram**

Master Frame and the corresponding Slave Frame, treated as a whole

1.3.185**terminator**

circuit which closes an electrical transmission line, ideally by its characteristic impedance

1.3.186**Terminator Switch**

switch which inserts the Terminator at the end of a segment on the WTB

1.3.187**Topography**

data structure describing the Nodes attached to the Train Bus, including their address, orientation, position and Node Descriptor

1.3.188**topology**

possible cable interconnection and number of devices a given network supports

1.3.189

Topography Counter

counter in a Node which is incremented at each new Inauguration

1.3.190

Traffic Store

shared memory accessed both by the network and the user, which contains the Process Data Port

1.3.191

Train Communication Network

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

1.3.192

Train Bus

bus connecting the vehicles of a train, in particular, the WTB, and which conforms to the TCN protocols

1.3.193

Train Network Management

services of the Network Management for TCN

1.3.194

transceiver

combination of a transmitter and of a receiver

1.3.195

transmitter

electronic device which can transmit a signal on the physical medium

1.3.196

Transport Data

data carried by the Transport Layer, but not relevant to it

1.3.197

Transport Header

part of a Message Data frame relevant to the Transport Layer

1.3.198

Transport Layer

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

1.3.199

trunk cable

cable which runs along the vehicles, as opposed to extension cable or jumper cable

1.3.200

User Address

Network Address of a User Message exchanged between Functions, consisting of Node Address (or Group Address) and Function Identifier

1.3.201

User Message

messages exchanged between user Functions

1.3.202**Variables**

transmission service of the TCN

1.3.203**Var_Offset**

bit offset of a Process Variable within a Dataset

1.3.204**Vehicle Bus**

bus connecting equipment within a vehicle or group of not separable vehicles, in particular, the MVB, and which conforms to the TCN protocols

1.3.205**Vehicle Descriptor**

application-dependent information about a particular vehicle, such as length and weight

1.3.206**Weak Master**

Weak Node is currently Master and which will relinquish mastership if it finds another, stronger Master

1.3.207**Weak Node**

Node which may take over the bus mastership spontaneously, but which releases it if it detects a stronger Node

1.3.208**Wire Train Bus (WTB)**

Train Bus for frequently coupled and uncoupled vehicles, such as international UIC trains

1.4 Abbreviations

ALI	Application Layer Interface, the definition of the semantics of all network services used by the application (a set of primitives, expressed as procedures, constants and data types)
AMA	Application Messages Adapter, the code directly called by the application which implements the Messages service
AMI	Application Messages Interface, the definition of the message services
ANSI	American National Standard Institute, a standardisation body in the United States
ASI	Application Supervision Interface, the definition of the Management services
ASN.1	Abstract Syntax Notation Number 1 on data presentation (ISO/IEC 8824)
AVA	Application Variables Adapter, the code directly called by the application implementing the Process Variable services
AVI	Application Variables Interface, the definition of the Process Variable services
BER	Basic Encoding Rules, a transfer syntax for ASN.1 data types (ISO/IEC 8825)
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
BT	Bit Time, the duration of the transmission of one bit, expressed in μ s

ITU	International Telecommunication Union, the international standardisation body for telecommunications based in Geneva
CRC	Cyclic Redundancy Check, a data integrity check based on polynomial division
DIN	Deutsches Institut für Normung, the German national standardisation body
EIA	Electronics Industries Association, a standardisation body in the United States
EMD	Electrical Middle Distance, one of the media of the MVB
ESD	Electrical Short Distance, one of the media of the MVB
EP	Electro-Pneumatic brake cable as described in UIC leaflet 648
ERRI	European Railways Research Institute, laboratory based in Utrecht, Netherlands
FCS	Frame Check Sequence, an error detection code appended to the transmitted data, as specified in ISO/IEC 13239
GCT	Guidelines for Conformance Test, the conformance testing specified in Annex B of this Standard
HDLC	High-level Data Link Control, a Link Layer protocol whose frame format is defined in ISO/IEC 13239
IEC	International Electrotechnical Commission, Geneva
IEEE	Institute of Electrical and Electronics Engineers, New York
ISO	International Standard Organisation, Geneva
LLC	Logical Link Control, a sub-layer within the Link Layer ruling the data exchange
LME	Layer Management Entity, the entity in charge of supervising a layer on behalf of Network Management
LMI	Layer Management Interface, the services provided by the LME
MAC	Medium Access Control, a sub-layer within the Link Layer ruling which device is entitled to send on the bus
MAU	Medium Attachment Unit, the part of a Node which interfaces electrically to the bus and which provides/accepts binary logic signals
MIB	Management Information Base, the set of all objects accessed by Network Management
MVB	Multifunction Vehicle Bus, a Vehicle Bus
NRZ	Non-Return to Zero, the simplest encoding scheme in which one bit is represented by one level for a "1" and the other level for a "0", or vice-versa, with a separate clocking
OGF	Optical Glass Fibre, one of the media of the MVB
ORE	Office de Recherches et d'Essais, a UIC laboratory based in Utrecht, Netherlands
OSI	Open System Interconnection, a universal communication model defined in the ISO/IEC 7498
PCTR	Protocol Conformance Test Report, defined in ISO/IEC 9646
PICS	Protocol Implementation Conformance Statement, defined in ISO/IEC 9646

PTA	Process Data to Traffic Store Adapter, the component which accesses one of the Traffic Stores
RIC	Regulation for the reciprocal use of coaches and vans in international traffic, edited by UIC.
RTP	Real-Time Protocols, the common communication protocols given in Clause 2 of this standard
SDL	Specification and Description Language, a specification language defined by ITU-T Z100 Annex D for communication protocols
TCN	Train Communication Network, a set of communicating vehicle and Train Busses
TNM	Train Network Management
UIC	International Union of Railways, the international railways operators association
WTB	Wire Train Bus

1.5 Conventions

1.5.1 Base of numeric values

This standard 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

1.5.2 Naming conventions

Keywords in the TCN specifications are written with a capital letter at the beginning.

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

When a data structure is associated with a keyword, its type consists of the same basic names separated by an underscore.

When the value corresponding to the keyword is transmitted in a message, the corresponding field has the same name as the type, but in lower case.

When the value is passed as parameter, the parameter name has the same name as the field in a message.

In the SDL diagrams, the corresponding variable has the same name as the type, but without underscores.

EXAMPLES

Topo Counter is a counter of the link layer;

It is of the type Topo_Counter, which is an UNSIGNED6.

When its value is transmitted in a message, the corresponding field is called 'topo_counter'.

When its value is transmitted across a procedural interface, the parameter is called 'topo_counter', its C-type is Type_Topo_Counter.

In the SDL diagrams, the variable representing the counter is called TopoCounter.

1.5.3 Time naming conventions

Time values beginning with a lower case (e.g. t mm) are measurable time intervals.

Time values beginning with an uppercase (e.g. T reply) are parameters or time-out values.

1.5.4 Procedural interface conventions

A procedural interface is defined by a set of service primitives, which represent an abstract, implementation-independent interaction between the service user and the service provider.

These primitives are expressed in this standard as procedures in the ANSI C syntax with typed parameters.

This ought to be considered as a semantic description only, which does not imply a particular implementation or language. Any interface which provides the same semantics is allowed.

Conformance to the syntax of this interface cannot be claimed. Implementations are free to change the procedure or parameters names, to add parameters or to split procedures, as long as the specified service is provided.

Interface procedures are defined in the ANSI C syntax using the Courier font.

Procedure names, variables and parameters appear in all lower case.

EXAMPLE lm_send_request

Constants and type definitions appear in all upper case.

EXAMPLE UNSIGNED32

The name of a procedure or of a type is prefixed:
for the Variables service by

- lp_ or LP_ Link Layer
- ap_ or AP_ Application Layer

for the Messages service by

- MD_ messages in general
- lm_ or LM_ Link Layer
- nm_ or NM_ Network Layer
- tm_ or TM_ Transport Layer
- sm_ or SM_ Session Layer
- am_ or AM_ Application Layer

Table 1 shows a template used for procedures and types.

Table 1 – Template for the specification of an interface procedure

Definition	<i>The service or data type is expressed here.</i> <i>In case of an indication procedure, the event which triggers the call is indicated here, beginning with "When"</i> <i>The name and parameters of the service procedure are defined here.</i> <i>In case of an indication procedure, the type of the procedure is specified.</i> <i>Input parameters, output parameters and return parameters are distinguished</i>	
Syntax	MD_RESULT lm_send_request (/* example */ unsigned, destination, UNSIGNED8 link_control, MD_PACKET * p_packet ENUM8 * status)	
Input	<i>Input parameters are supplied to the procedure, which is not allowed to modify them</i>	
	destination	The data type "unsigned" is compiler-dependent
	link_control	parameter passed by reference, not modified by the procedure. The data type is an 8-bit word
	p_packet	The "*" denotes a pointer to the p_packet data structure, which is of type MD_PACKET, defined elsewhere in this standard
Output	<i>Output parameters are expected to be modified by the call</i>	
	status	The type ENUM8 is an 8-bit enumeration type
Result	<i>The Result parameter is an optional output parameter which expresses success or failure of the call, but not necessarily of the service</i>	
	MD_RESULT	The Result parameter is of the type: AM_RESULT for the AMI, MD_RESULT for the LMI, LP_RESULT for the LPI, AP_RESULT for the AVI, The template specifies the error codes expected for each procedure individually. The Result parameter is not explicitly described if the only two values expected are: xx_OK = 0 successful completion; xx_FAILURE <> 0 some problem. The result can also be returned as an output parameter in the parameter list, depending on the implementation
Usage	The rules listed after the procedure template indicate how the procedure should be used. Although usage rules are not mandatory, not following them produces unpredictable results	
NOTE Data structures represented in this table are interface specifications which should not be confused with formats of the same data structures when transmitted over a bus, see 1.5.5.		

1.5.5 Specification of transmitted data

The format of transmitted data, single frames as well as whole messages, is specified in two forms:

- a graphical form, which is not normative, but shows the message structure at a glance.
- a textual form based on ASN.1, with encoding rules specified in 2.3.

EXAMPLE A graphical form of a message is shown in Table 2, the corresponding textual form is shown in Table 3.

Table 2 – Example of message structure

first transmitted octet								next transmitted octet								
bit->	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	snu	gni	node_id						station_id							
2	next_station_id								rsv1	Tvd	topo_counter					
4	tnm_key								sif_code (= 3)							
6	parameter 1															
8	parameter 2								parameter 3						par4	
^octet	parameter 5: ARRAY [n] OF (repeat following field (n) times)															
	parameter 5.1															
	parameter 5.2															
	parameter5.3: STRING32															
	(CHARACTER8)								last character or 0							

In the graphical form, one line is used for each word of 16 bits, but in Clause 4 (WTB), lines are 8-bit oriented.

Arrays of parameters are preceded by a repetition frame on the top and to its left.

Repetitions can be nested (see parameter 5.3 in Table 4).

If the size of a parameter may be longer than three words, three lines are allocated for it and the middle one has a shaded border.

Table 3 – Example of textual message form (corresponding to Table 2)

```

Call_Mgt_Message ::= RECORD
{
  snu                BOOLEAN1 (=1)      -- this '1' means that message
                                         uses system addressing
  gni                BOOLEAN1 (=0)      -- this '0' means that final
                                         is an individual device
  node_id            UNSIGNED6          -- 6-bit node address of final
  station_id         UNSIGNED8          -- 8-bit identifier of the
                                         station
  next_station_id    UNSIGNED8          -- 8-bit identifier of next
                                         station
  rsv1              BOOLEAN1 (=0)      -- this bit is always 0
  tvd               BOOLEAN1           -- this bit indicates if
                                         topography counter is valid
  topo_counter       UNSIGNED6          -- 6-bit topography counter
  tnm_key            UNSIGNED8,         -- announces a network
                                         management call message.
  sif_code           UNSIGNED8,         -- there is a different
                                         SIF_code for each
                                         Management Message
  parameter1         INTEGER16,        -- a 16-bit value. If the
                                         parameter has less than 16
                                         bits, the value is right-
                                         justified and sign-extended
                                         (e.g. one single octet is
                                         transmitted as the second
                                         octet).
  parameter2         INTEGER8,         -- this value is transmitted
                                         in the most significant
                                         part of a word.
  parameter3         UNSIGNED6         -- this value is transmitted
                                         in the least significant
                                         octet, but the lower two
                                         bits of that octet are
                                         reserved for parameter4.
  par4              ANTIVALENT2        -- parameter4 has two bits
  parameter5         ARRAY [n] OF     -- parameter5 represents a
  {                                     structured data to be
                                         repeated n times,
                                         containing:
  parameter5.1       INTEGER16        -- first parameter of the
                                         repeated field
  parameter5.2       UNIPOLAR4.16     -- second parameter of the
                                         repeated field
  parameter5.3       STRING32         -- third parameter is a string
                                         (array of up to 32 8-bit
                                         characters);
                                         - a string is closed by a
                                         '0' character, or by two
                                         such '0' characters to
                                         align on a 16-bit word
                                         boundary;
                                         - a void string consists of
                                         32 '0' characters;
                                         - the actual size of a
                                         string is deduced from the
                                         number of significant
                                         characters before the zero.
  },
}

```

Fields names begin with a lower case letter, their type begins with an upper case. Sometimes, the same type is used as a transmission format, in which case only the first letter is upper case, and as a C-type, in which case the whole type is in upper case.

EXAMPLE Am_Result (transmission format) and AM_RESULT (C-type of an interface procedure).

1.5.6 State diagram conventions

The transport protocol state machine is described as in ISO/IEC 8802-2 (Logical Link Layer) in the form of a table, which specifies the transitions between the possible states in which a state machine may be.

Transitions between states are governed by events, coming from the Network Layer (inbound packets), from the Session Layer (commands) or from time-outs.

An action depending on the event is executed before leaving the state. This action defines the next state.

Figure 2 shows an example of a state transition diagram.

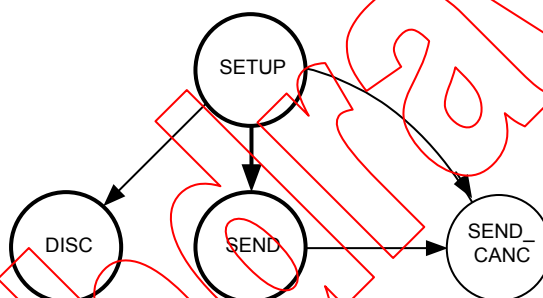


Figure 2 – State transition example

From “SETUP”, the machine may go to three different states, DISC, SEND or SEND_CANC.

The transition between these states are governed as Table 4 shows.

Table 4 – State transitions table

Current state	Event	Action(s)	Next state (if <> current)
SETUP	rcv_DR	close_send (DR_reason);	DISC
	rcv_CC AND (conn_ref = CC_conn_ref)	IF (eot) THEN close_send (AM_OK); ELSE credit:= CC_credit; send_not_yet:= credit; send_data_or_cancel; END;	DISC SEND or SEND_CANC
	TMO AND (rep_cnt = MAX_REP_CNT)	close_send (AM_CONN_TMO_ERR);	DISC

According to Table 4, there are three events which cause a transition from SETUP to the DISC state:

- 1) rcv_DR (received Disconnect_Request, a network event). The corresponding action consists in closing the connection (close_send) before going to state DISC;
- 2) another network event (received Connect_Confirm with correct reference), leading either to state DISC, SEND or SEND_CANC, depending on the outcome of the send_data or cancel procedure;
- 3) A time-out conditioned by the predicate (rep_cnt = MAX_REP_CNT), which also causes the closing of the connection.

1.6 General considerations

1.6.1 Interface between equipment

This standard defines the data communication interface of equipment located in a vehicle as a connection of devices to a Vehicle Bus, as shown in Figure 3.

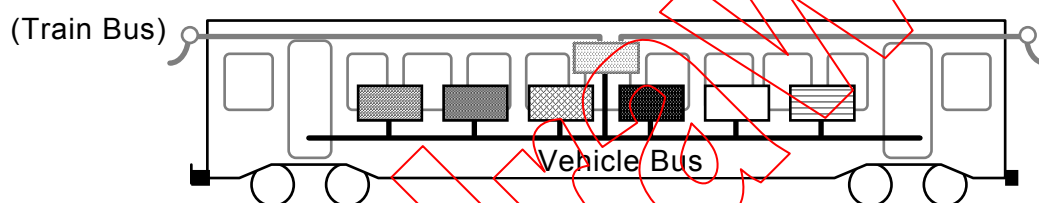


Figure 3 – Interfaces between equipment

As Vehicle Bus, Clause 3 of this standard specifies the Multifunction Vehicle Bus (MVB), a serial data communication bus designed primarily, but not exclusively, for interconnecting equipment where interoperability and interchangeability is needed.

1.6.2 Interface between vehicles

This standard defines the data communication interface between vehicles as the connection of Nodes located in vehicles to a Train Bus, as shown in Figure 4.

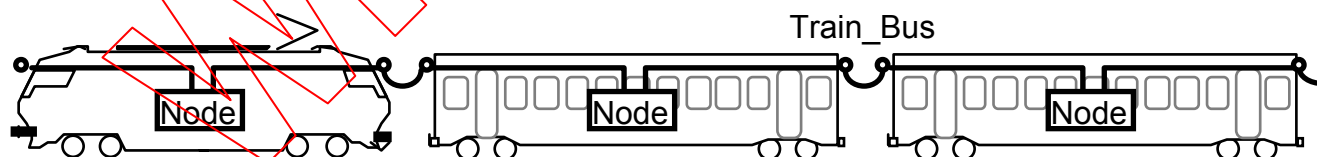


Figure 4 – Interfaces between vehicles

As Train Bus, Clause 4 of this standard specifies the Wire Train Bus (WTB), a serial data communication bus designed primarily, but not exclusively, for interconnecting vehicles of Open Trains.

NOTE For a definition of Open Trains, see 1.3.122

1.6.3 Real-Time Protocols

This standard defines the architecture of the TCN as a hierarchy consisting of two levels, a Train Bus and a Vehicle Bus, as shown in Figure 5.

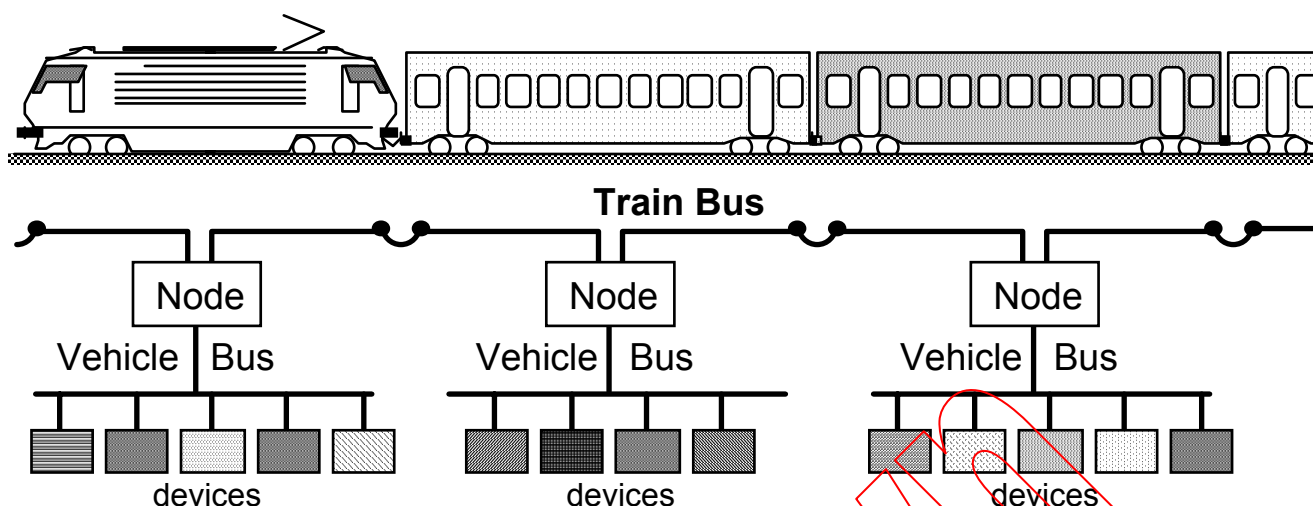


Figure 5 – Train Bus and Vehicle Bus

As communication protocols, Clause 2 of this standard specifies the Real-Time Protocols (RTP), used by all devices in the TCN to communicate over the MVB, the WTB or any other bus.

The RTP specify the Application Interface which the TCN provides, consisting of two basic services: Variables and Messages.

The RTP specify the transmission protocols which handle in particular routing, flow control and error recovery.

The RTP specify the interface which the busses are expected to provide to the transmission protocols, and in particular the two basic services:

- a) cyclic, source-addressed broadcast of Process Data; and
- b) sporadic, connectionless transmission of Message Data.

1.6.4 Network Management

As Network Management, Clause 5 of this standard specifies the TCN Network Management (TNM) as a collection of messages exchanged between Manager and Agent to provide the basic services.

1.6.5 Configurations

This standard can be used in parts or as a whole. For instance, it is possible to use:

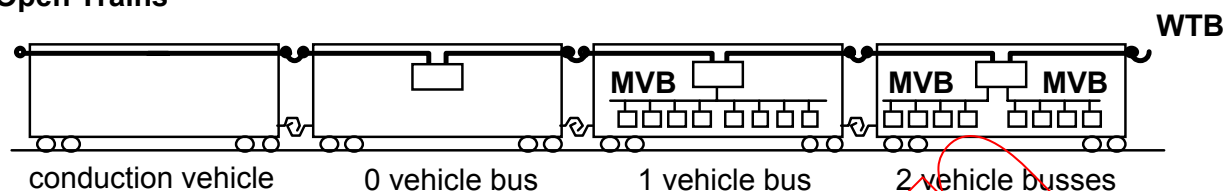
- a) the WTB without a vehicle bus or with another vehicle bus than MVB;
- b) the MVB without a train bus or with another Train Bus than the WTB;
- c) the RTP with other busses than the WTB or the MVB.

Figure 6 shows three configurations corresponding to three application domains:

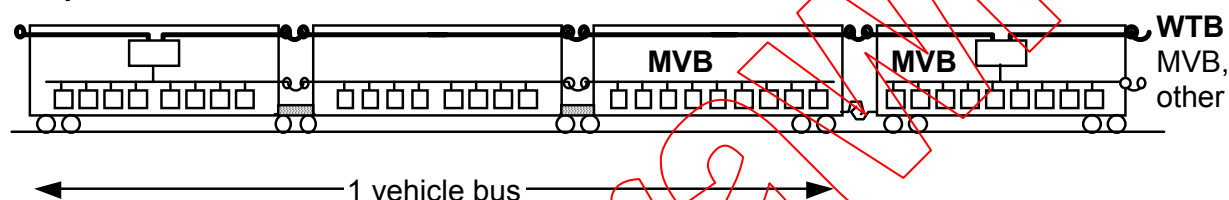
- a) the Open Trains configuration shows an Open Train, such as a UIC train, which require automatic configuration. The WTB is used as the standard Train Bus, supporting up to 32 Nodes. There may be 0, 1 or more Nodes per vehicle. To each Node, up to 15 Vehicle Busses (MVB or others) may be attached;

- b) the Multiple Unit Train configuration shows two connected closed trains. When these closed trains are coupled and uncoupled frequently, the WTB can be used as a standard Train Bus, but when configuration by other means is possible, other busses such as the MVB can be used instead. The Vehicle Bus can span several vehicles;
- c) the Closed Trains configuration shows a closed train, in which the MVB can be used both as Train Bus and as Vehicle Bus.

Open Trains



Multiple Unit Trains



Closed Trains

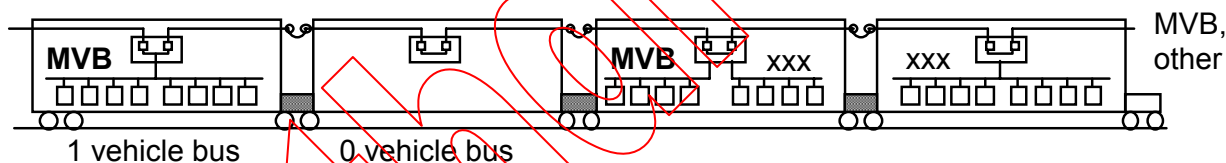


Figure 6 – TCN configurations

In all three configurations of Figure 6, the MVB is used to connect on-board equipment, but other busses may be used as Vehicle Bus.

1.6.6 Structure of a standard device

This subclause specifies permitted options in a TCN device. The options are described in the corresponding clauses and summarised in Figure 7.

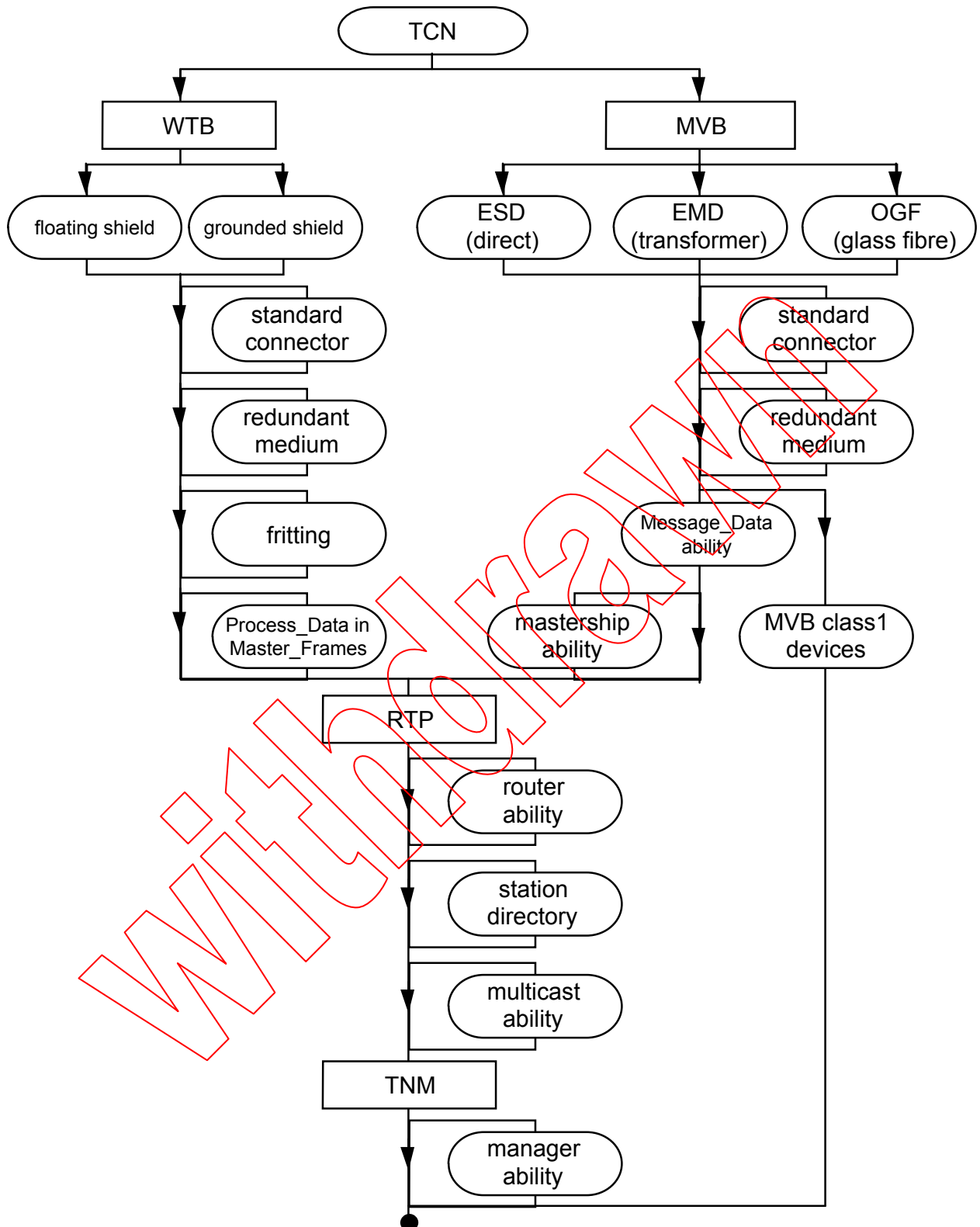


Figure 7 – TCN device configuration options

1.6.6.1 TCN device

A TCN compliant device shall implement at least one bus MAU for the MVB or for the WTB.

1.6.6.2 MVB options

The total number of TCN bus MAUs in a device shall not exceed 16.

An MVB MAU shall use one of the three standard media: ESD, EMD or OGF.

An MVB MAU may use a connector as specified in this standard.

An MVB MAU may use a redundant medium as specified in this standard.

An MVB MAU may include the Message Data transmission ability.

An MVB MAU may include the mastership ability.

1.6.6.3 WTB options

A WTB MAU shall be configurable for either a floating shield or a grounded shield.

A WTB MAU may use a connector as specified in this standard.

A WTB MAU may use a redundant medium as specified in this standard.

A WTB MAU may implement fritting as specified in this standard.

A WTB MAU may transfer Process Data in Master Frames as specified in this standard.

1.6.6.4 RTP options

A TCN device shall implement the Variables services.

A TCN device, except for MVB Class 1 device, shall implement the Messages services.

A TCN device may implement the router function if it has more than one MAU.

A TCN node may implement the node directory.

A TCN device may implement the station directory.

A TCN device may implement the multicast protocol.

1.6.6.5 TNM options

A TCN device shall implement the Agent function.

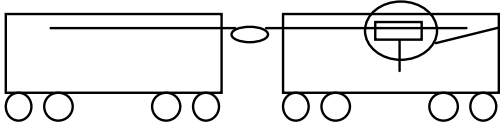
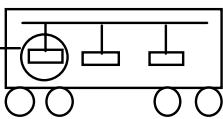
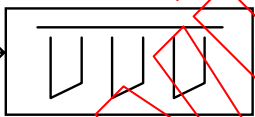
A TCN device may implement the Manager function.

1.7 Conformance Test

To claim conformance to the TCN standard, devices are expected to pass a suite of tests.

To ensure that interoperability is guaranteed according to Table 5, this standard comprises a set of Guidelines for Conformance Test, which are listed in Annex B.

Table 5 – Interoperability testing

	COVERED BY	
	IEC 61375	End USER
Level 1 Interface between vehicles (Train BUS) 	PROTOCOL PHYSIC/ELEC Node connector cable specification (Z: attenuation)	USER MESSAGES MECHANICAL (connectors/cables)
Level 2 Interface between equipment (Vehicle BUS) 	PROTOCOL PHYSIC/ELEC MECHANICAL (connectors/cables)	USER MESSAGES
Level 3 Interface between boards or Inter components 	Not covered	Not covered