



BSI Standards Publication

Electronic railway equipment — Train communication network (TCN)

Part 2-4: TCN application profile

National foreword

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRONIC RAILWAY EQUIPMENT –
TRAIN COMMUNICATION NETWORK (TCN) –****Part 2-4: TCN application profile**

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 61375-2-4, which is a technical specification, has been prepared by IEC technical committee 9: Electrical equipment and systems for railways, in collaboration with UIC.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
9/2093/DTS	9/2150A/RVC

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

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

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

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

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

INTRODUCTION

IEC TS 61375-2-4 defines the application profiles of the Train Communication Network in order to achieve communication between software applications throughout consist networks defined in IEC 61375-1 and the train backbone defined in IEC 61375-2-5.

This part of IEC 61375 defines the requirements for the applications communicating via the data transmission equipment of the consists throughout the consist networks and the train backbones.

The purpose of this part of IEC 61375 is to:

- fully document the communication requirements for all train applications, align them and set them out in standard form,
- provide guidelines for the technical solution of communication between software applications residing on the same or on different consists, which are part of a train, and which are connected to the consist networks and the train backbones in scope,
- define train applications for certain functionalities, which are in scope of this part of IEC 61375.

ELECTRONIC RAILWAY EQUIPMENT – TRAIN COMMUNICATION NETWORK (TCN) –

Part 2-4: TCN application profile

1 Scope

This part of IEC 61375 applies to the applications in trains, i.e. it covers the application profile for functions belonging to the Train Control and Monitoring System (TCMS). The application profile is based on the TCN communication system for the data communication between consists of the said trains. This document provides for a data interface with parameters and addressing of TCMS functions based on the communication profile laid out in IEC 61375-2-3.

This document is applicable in rolling stock requiring interoperable coupling and uncoupling. This part of IEC 61375 may be additionally applicable to closed trains and multiple unit trains when so agreed between purchaser and supplier.

The applicability of this part of IEC 61375 to the train communication network technologies as defined allows for interoperability of individual consists within trains.

The data communication systems inside consists are not covered by this document and are given only as example 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.

Special backup functions, which are used in cases when the train backbone is in a degraded condition are not in the scope of this document.

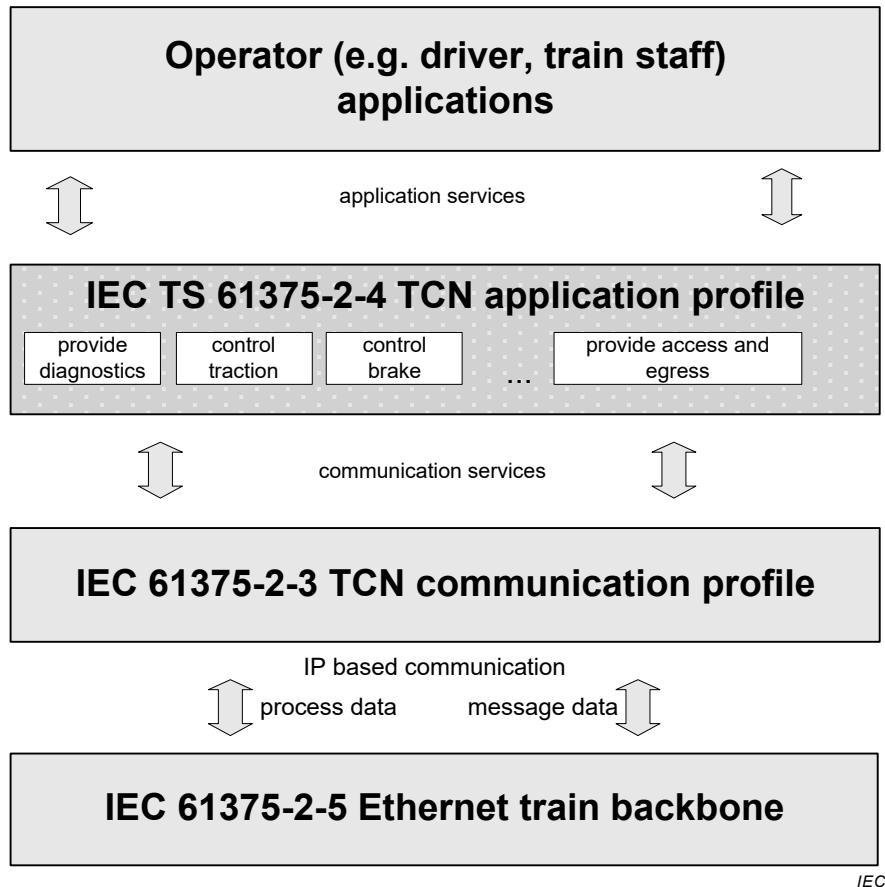


Figure 1 – IEC TS 61375-2-4 as a link between the functions and the applications

As illustrated in Figure 1 the purpose of this part of IEC 61375 is to create a general model that describes in a functional way the remote control of TCMS functions like “provide access and egress”. This document makes direct reference to IEC 61375-2-3, which covers data transmission on the Ethernet train backbone (ETB) and specifies the functions between the consists concerned (e.g. locomotives, multiple units and driving trailers) including the rules to set up the necessary data telegrams for transmission and process.

This document specifies the application profiles covering the train functions to:

- a) provide access and egress;
- b) control traction;
- c) control brake;
- d) provide diagnostics.

NOTE Functions b) to d) will be covered in a future revision of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 61375-1, *Electronic railway equipment – Train communication network (TCN) – Part 1: General architecture*

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

IEC 61375-2-3, *Electronic railway equipment – Train communication network (TCN) – Part 2-3: TCN communication profile*

3 Terms, definitions, abbreviated terms, acronyms and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61375-1 and the following apply.

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

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

3.1.1

all doors of consist CLOSED

each single door of the consist is closed

Note 1 to entry: This state is side selective.

3.1.2

all doors of consist LOCKED

each single door of the consist is locked

Note 1 to entry: This state is side selective.

3.1.3

all doors of train CLOSED

all doors of each consist are closed

Note 1 to entry: This state is side selective.

3.1.4

all doors of train LOCKED

all doors of each consist are locked

Note 1 to entry: This state is side selective.

3.1.5

application profile

defined standardized set of services or functions offered to the application processes for information exchange with specified data formats and data processing

3.1.6

CLOSE

action to juxtapose the door to its frame, to obstruct an entrance or opening

3.1.7

consist FAILURE

the consist is defined in failure state when the consist DCU control function or communication is in failure

Note 1 to entry: Failure detection may be realized by self-diagnostic of the consist DCU or by function supervision of consist DCU by the train DCU (e.g. process data sink time supervision).

3.1.8**door ATTENDED**

single door which remains active and open after the crew manipulator associated with it (e.g. square key) has remotely commanded all the other doors of the train to close

3.1.9**door CLOSED**

the door is defined closed when the door is adjacent to its frame and the mechanical locking device is not in effect, making possible the mechanical opening of the door itself

Note 1 to entry: In this condition it is possible to move the door electrically or pneumatically.

3.1.10**door OUT OF ORDER**

when at least one of the following conditions applies:

- a) the link to the remote control is failing;
- b) the door cannot be controlled locally

3.1.11**door ISOLATED**

when it is closed and mechanically locked by means of the appropriate mechanical closure device

Note 1 to entry: In this condition the door is permanently closed and locked and it cannot be moved in any way.

Note 2 to entry: In this condition the internal emergency handle and the outside one have no effect on the opening of the door.

3.1.12**ISOLATE door**

to close and mechanically lock the door and leave the door unable to execute any operation command

Note 1 to entry: ISOLATE door uses mechanical methods in case of door malfunction. For example the door isolation device is located on the door leaf, it is accessible from inside and /or outside via a square (or triangular) key lock.

3.1.13**door LOCKED**

the door is defined locked when the physical door is adjacent to its frame and the mechanical locking device is in effect, making it impossible to open the door mechanically

Note 1 to entry: In this condition it is impossible to move the door physically.

3.1.14**door OPENED**

the door is defined as opened when it is not adjacent to its frame and the entrance is not blocked

Note 1 to entry: In this condition it is ready to accept a closing command.

3.1.15**driving trailer**

vehicle with a driving cab at least at one end of the vehicle from which the traction and braking functions of a train can be controlled

3.1.16**functional address**

unique identification for a function

3.1.17**leading vehicle**

vehicle, which is elected by a communication service of IEC 61375-2-3 and which controls the movements of the train

3.1.18**locomotive**

motor vehicle, not forming part of a train-unit and not carrying a payload, intended to move other vehicles

[SOURCE: IEC 60050-811:2017, 811-02-06]

3.1.19**OPEN**

action to move the physical door and create an entrance

3.1.20**passenger coach**

passenger carrying vehicle without its own propulsion system

3.1.21**shoegear**

train equipment to transfer electric current from the third rail

Note 1 to entry: It is usually mounted on bogies.

3.1.22**traction unit**

vehicle with its own power equipment

3.1.23**vehicle**

single item of rolling stock

Note 1 to entry: Examples of a single item of rolling stock include a locomotive, a coach and a wagon.

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

3.2 Abbreviated terms and acronyms

ASC	Automatic Speed Control
ASN.1	Abstract Syntax Notation 1
DAC	Driver Activity Control
DB	Deutsche Bahn (German Railways)
DCU	Door Control Unit
DDU	Driver Display Unit
DMU	Diesel Multiple Unit
ED	End Device
EMU	Electric Multiple Unit
ENUM	Enumeration
ETB	Ethernet Train Backbone
ETCS	European Train Control System
FI	Function Interface
HMI	Human Machine Interface

HV	High Voltage
HVAC	Heating Ventilation and Air Conditioning
ID	Identification
IP	Internet Protocol
LV	Low Voltage
MD	Message Data
OSI	Open System Interconnection
NOTE A universal communication model is defined in ISO/IEC 7498.	
PD	Process Data
PDU	Protocol Data Unit
SNCF	Société Nationale des Chemins de fer Français (French National Railways)
TBN	Train Backbone Node
TCMS	Train Control and Monitoring System
TCN	Train Communication Network
TRDP	Train Real time Data Protocol
TTDB	Train Topology Data Base
UDP	User Datagram Protocol
UIC	Union Internationale des Chemins de Fer (International Union of Railways)
UML	Unified Modelling Language
WC	Water Closet
WSP	Wheel Slide Protection

3.3 Conventions

3.3.1 Base of numeric values

This document uses a decimal representation for all numeric values unless otherwise noted.

Analog and fractional values include a comma.

EXAMPLE The voltage is 20,0 V.

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

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

3.3.2 Naming conventions

Keywords are written with a capital letter at the beginning.

If the keyword name is composed of multiple words, the different words are united with a space and each word begins with a capital letter.

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

Parameters are written with a capital letter at the beginning.

If the parameter name is composed of different words, the different parts of the name are united without a space and each word begins with a capital letter.

EXAMPLE "NumberOfConsists".

3.3.3 State diagram conventions

State diagrams are according to the notation of UML state machines.

3.3.4 Elementary data types

Elementary data types are used as defined in IEC 61375-2-1.

3.3.5 Derived data types

Derived data types consist of elementary data types, like for instance enumerations and structures. Derived data types are implementation dependent; they are mainly user- or manufacturer specific data types.

The enumerated data type declarations (ENUM) constrain the value of any data element of that type to one of the values given.

4 Distributed train applications

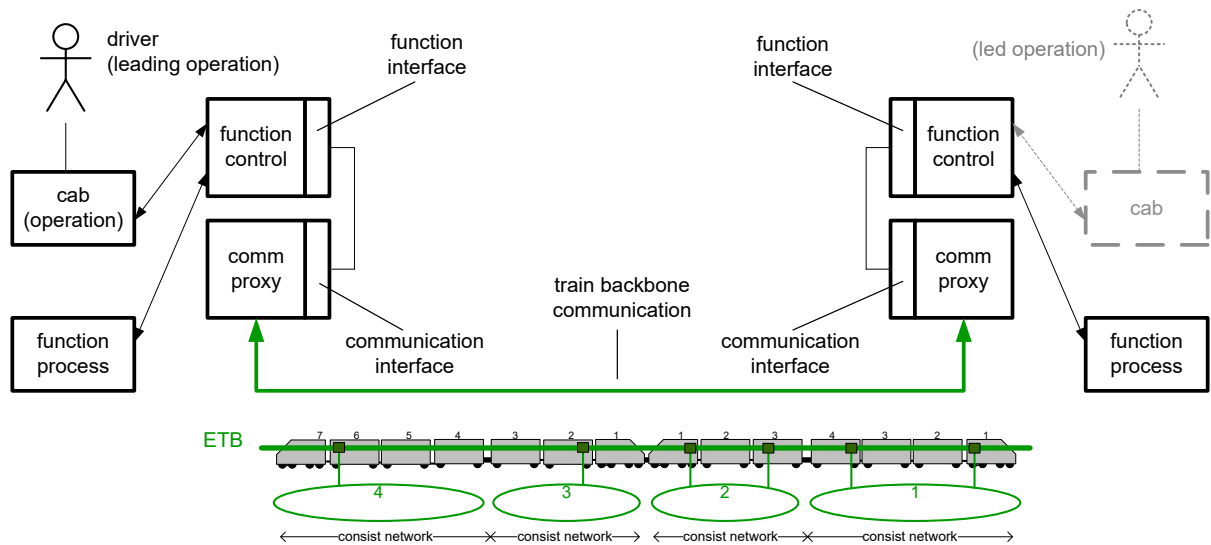
4.1 General

The technology of the various traction units within the various railway operators can be very different, considering, for example, the setting up of the traction power (contact breakers, switch gear, converters) and its control (relay logic, analogue and digital electronic equipment, microprocessors). A similar situation exists e.g. for doors providing external access to the train for the passengers.

4.2 Function interface for remote control

Because of the existing technical differences, there are also large differences in the input and output signals of the control equipment. Therefore it is not possible, in most cases, to use the signals transmitted over the train backbone to directly control the equipment or to obtain these signals directly from the control equipment. Consequently the remote function control process needs to communicate via a standardized function interface, which ensures the access to the remote door function process

Figure 2 shows as an example a common situation, when operating a train: One of the train's driver cabs on either end is the activated cab in the leading vehicle. In this cab the train driver is controlling the train's movement by actuating e.g. the traction lever. The command, generated by moving the traction lever on the driver's desk, sampled, and received by one traction function (called function control) and propagated throughout the train via the train backbone to all other traction functions via the comm proxy controlling locally the specific traction subsystems. These processes, which are controlling the traction subsystems in each consist or vehicle are called function process in Figure 2.



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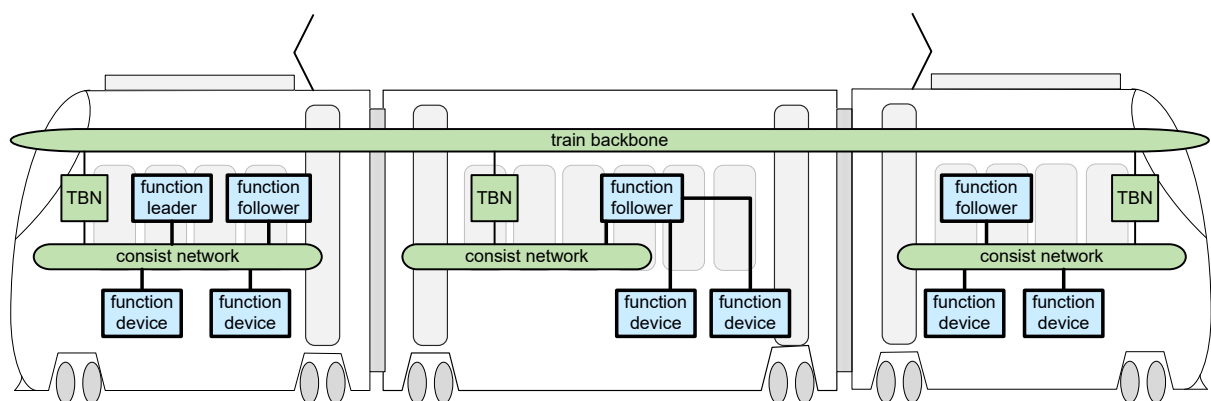
Figure 2 – Remote control of a process via the function interface

In Figure 2 the scenario is shown for the example of two driving cabs at each end of the train, one cab in leading operation and the other cab in unattended and led operation. For this remote control of functions, a set of signals, a so-called function interface, defines the necessary set of data for a function to fulfil its characteristic action in the intended manner. The way to transmit this set of signals via the ETB is defined as the communication interface for the train backbone communication defined in IEC 61375-2-3. These transmitted signals need to be translated in each consist in order to work with the actual control equipment of the related subsystems. Figure 2 shows this process, whereas the train backbone communication is the synonym for the data connections via the train backbone and the individual consist networks.

Like the presented remote traction control function in Figure 2 above, there are additional remote functions in a train, e.g. controlling doors, HVAC, exterior lighting, brakes. Thus a communication link is established between the application function processes according to rules laid out in this document.

4.3 General application architecture

The network architecture according to IEC 61375-1 defines the framework and constraints for distributed applications in a train. Figure 3 illustrates this architecture with a generic application.



IEC

Figure 3 – Architecture of a distributed application

A train is composed by consists. Each consist contains a consist network, which is connected via a train backbone node (TBN) to the train backbone, which provides the communication

infrastructure for the train wide communication. Train backbone, consist network, TBN are the basic components of the train communication network (TCN) according to IEC 61375 series.

The generic function is composed of:

- a) a function leader which is responsible to control the function by stimulation of the function followers (commands) and to receive the reactions from the function followers (status);
- b) one or more function follower(s), at most one per consist network, which is responsible to receive the commands from the function leader and to stimulate the function devices. The received reactions from the function devices are cumulated by the function follower and provided as function status of the consist to the function leader;
- c) one or more function device(s), which are receiving the commands from the function follower, execute the function operations and report the results to the function follower.

These parts of the application are distributed over the consists of the train. Different parts of the application in different consists can communicate only via the TCN.

For interoperability of consists only the communication between function leader and function follower is relevant. The interaction between function follower and function device is provided as information for better understanding of the behaviour of the application.

This technical specification does not require the consist network as communication infrastructure between function follower and function device. There may be any connection, e.g. wired by simple electric lines.

4.4 Architecture model

Figure 4 shows a graphical representation of the distributed application, which is used to model the communication flow (see 4.6).

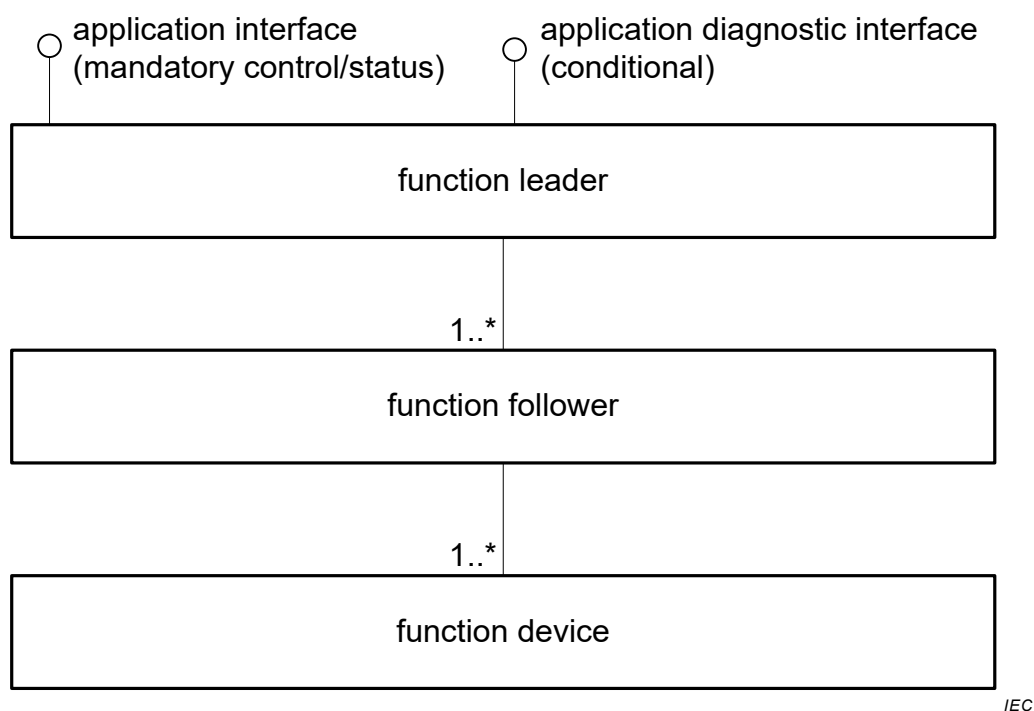


Figure 4 – Architecture model of a distributed application

The parts of the application need to cooperate to fulfil the requested function. Consequently these parts are source and sink of triggers, which stimulate this cooperation.

There shall be one Function Leader, which provides interfaces for the TCMS:

- a) an application interface to execute the control the operations and to get the status of the application;
- b) conditional an application diagnostic interface for additional information about the status of the application, if there is such information.

The function leader shall communicate with the function follower as agent for the consist. The function leader shall not assume a specific implementation of the parts of the application inside a consist.

NOTE There is no direct communication between the function leader and the function devices.

The function follower shall be responsible to control the application operation inside a consist. For interoperability the function follower shall not expose implementation details of the consist to the function leader.

4.5 Assignment of function leader and function follower

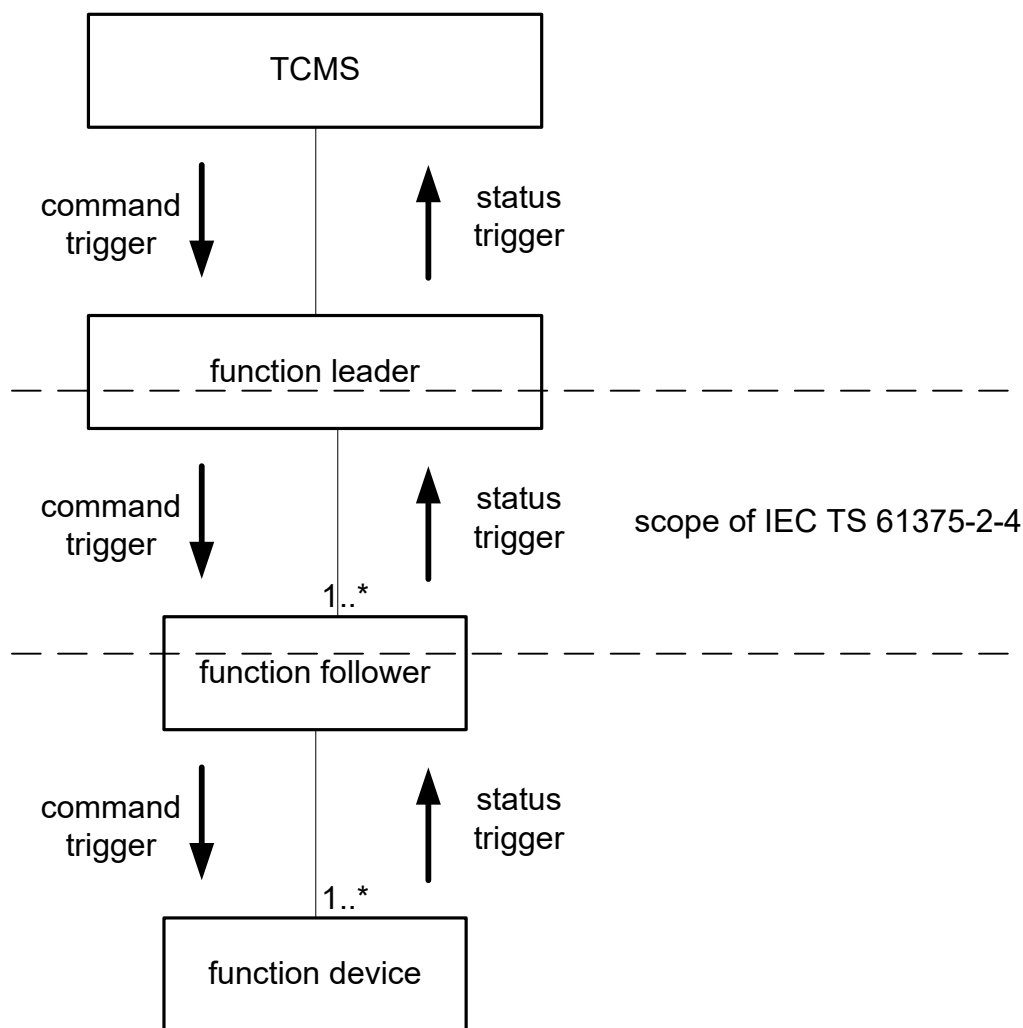
In order to communicate between e.g. a push button in the driver's cab, which calls "release all left doors" and the function "release door" in each consist, the following architecture is chosen (see 4.4): The function door control is split within a train into one train function leader and one or more function followers which are responsible to control the individual doors in each consist. The function leader is responsible for the communication with the subordinate function followers.

The roles function leader and function follower are implemented in function carriers inside the consists. Normally the function leader is located in the leading consist. If a train contains two consists at both ends, which can get leading, then there are two function carriers, which can host the function leader.

For each function a mechanism is needed, to assign the function leader and the function followers. This mechanism can be based on the dynamic properties (e.g. Leading) in the TTDB. This mechanism is defined in the description of the specific application profile.

4.6 Communication flow

Figure 5 illustrates this communication flow in the distributed application. Only the communication between function leader and function follower is in the scope of this document.



IEC

Figure 5 – Communication flow in the distributed application

To execute an application operation, the TCMS triggers the function leader with the appropriate command.

The function leader triggers all its function followers in the corresponding consists (networks) by sending the appropriate telegram.

Each function follower triggers the function device of the application by the appropriate command to perform the requested operation and receives the reaction (status) from the function device.

The function follower receives and cumulates the status from all its function devices and reports this cumulated status to the function leader.

The function leader receives and cumulates the status from all its function followers and reports this cumulated status to the TCMS.

5 Addressing and data format

5.1 General

According to 4.3, a function is distributed across the train. From an application point of view the function is treated as a unity, and the details of the communication are hidden. Figure 6

illustrates the principle of the parts (function instances) of a function group and the relations between the function instances. A function instance can be, e.g. a function leader or a function follower. The function instance relations begin and end at the function interfaces (FI) of the function instances.

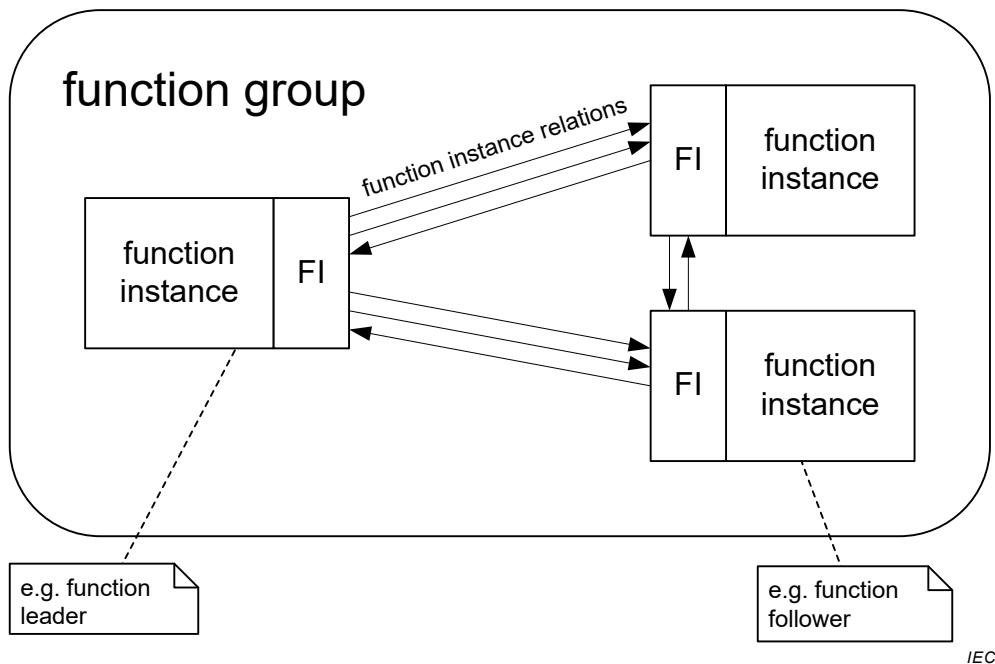


Figure 6 – Example function instances and their relations

Figure 7 shows the mapping of the function instance relations to the communication infrastructure. The function instance relations are supported by logical function channels, which hide the implementation of the data transfer.

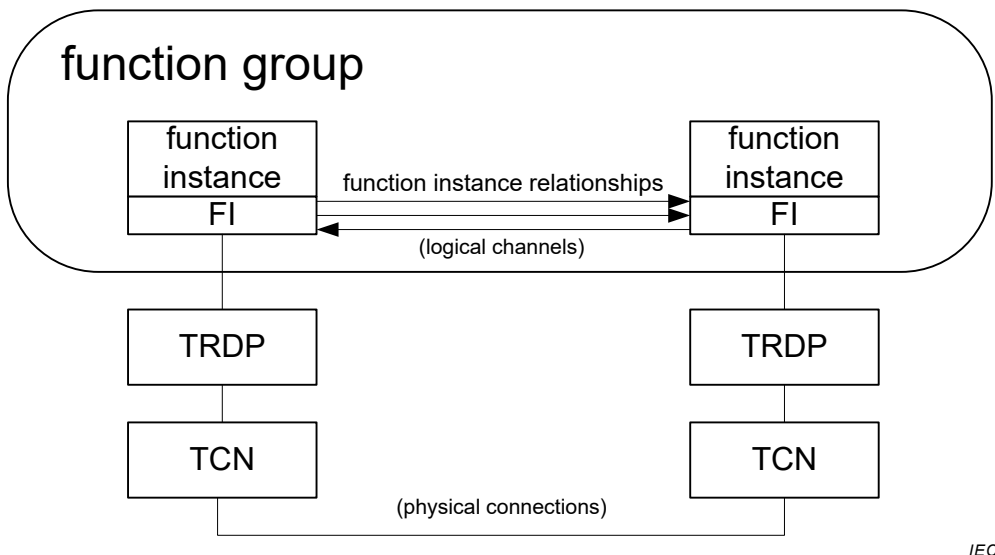


Figure 7 – Mapping of function instance relations to communication infrastructure

The channels permit the modelling of fine grained function instance relationships. To unambiguously identify a function channel, it is necessary to specify:

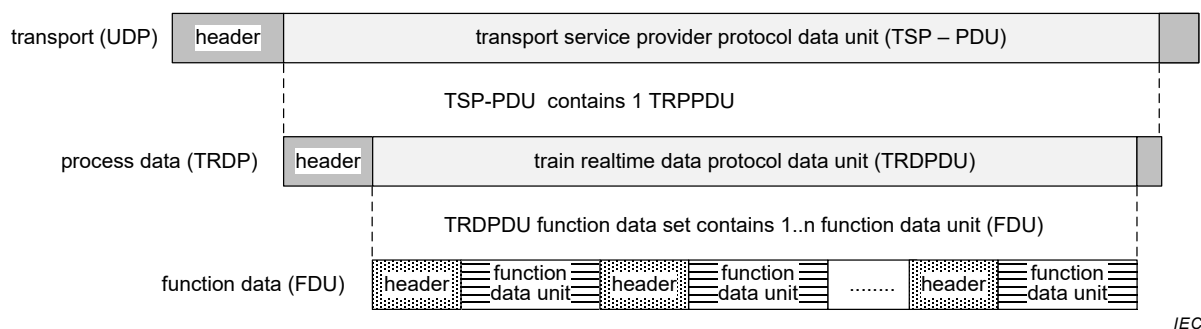
- the function group itself, (e.g. door control);
- the kind of function instance relation (e.g. function leader communicates with function follower);

- c) a specific function instance or a group of function instances (e.g. function instance in second vehicle or all function followers).

To locate the function instances in the train the static and dynamic properties stored in the TTDB are used. Since a train may be composed of closed trains or of consists with vehicles, it is possible to specify a function instance by its position in the train, closed train or consist. The needed information is stored in the TTDB also.

The function instances exchange their data via the function channels in function data units. Since the amount of data per function data unit is generally small compared with the overhead of TRDP, multiple function data units shall be packed in one TRDP telegram.

Figure 8 illustrates that the transport service provider protocol data unit (TSP-PDU) contains the process data in a train realtime data protocol data unit (TRDPDU), according to IEC 61375-2-3. This TRDPDU contains one or more function data units (FDU) in order to provide an efficient communication link between the function instances. One FDU contains the function specific signals for one function channel. Each header controls the handling according to the level of protocol and is precedes each of the data units.



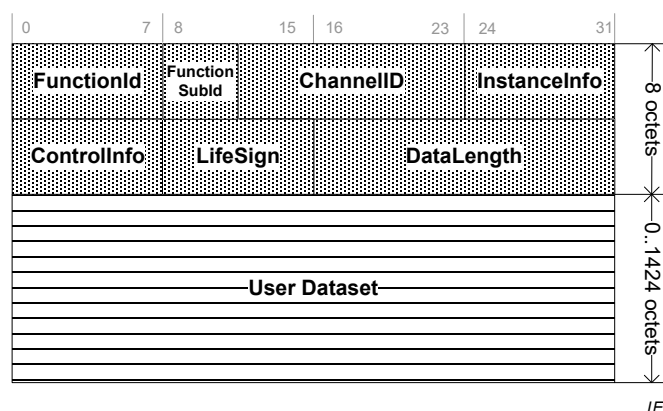
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Figure 8 – Function data units embedded in TRDP

5.2 Function data unit

5.2.1 General

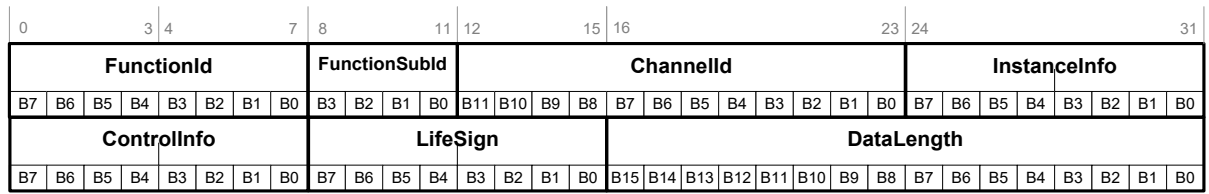
The function instances exchange their data via the function channels. Each function channel shall be associated with one function data unit. Figure 9 illustrates the structure of a function data unit.



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Figure 9 – Structure of function data unit

Figure 10 illustrates the structure of a function data unit header.



IEC

Figure 10 – Structure of function data unit header

```

STRUCT_FUNCTION_DATA_HEADER ::= STRUCT
{
    FunctionId      UNSIGNED8      -- function group identification
    FunctionSubId   UNSIGNED4      -- function sub-group identification
    ChannelId       UNSIGNED12     -- channel specification
    InstanceInfo    UNSIGNED8      -- additional function instance
                                   addressing info
    ControlInfo     BITSET8        -- control bits
    LifeSign        UNSIGNED8      -- sequence counter used as life sign
    DataLength      UNSIGNED16     -- length of data block
}

STRUCT_FUNCTION_DATA ::= STRUCT
{
    Header          STRUCT_FUNCTION_DATA_HEADER -- header information
    DataSet         UNSIGNED8[Header.DataLength] -- function data block
}

```

For specification of structures `STRUCT_FUNCTION_DATA` and `STRUCT_FUNCTION_DATA_HEADER` refer to 5.2.2 to 5.2.8.

5.2.2 Function identification

The function identification `FunctionId` shall identify the function group according to Table A.3 in Clause A.2. The function identification `FunctionSubId` shall identify the function sub-group within a function group according to Table A.4 in Clause A.2.

Example 1: `FunctionId` '92'H refers to External doors.

Example 2: `FunctionId` '22'H, `FunctionSubId` '2'H, `InstanceInfo` 1 refers to function instance class "AC_out" (main circuit breaker AC exterior section) in sub-function "Energy main circuit breaker" in function group "Power supply".

5.2.3 Channel identification

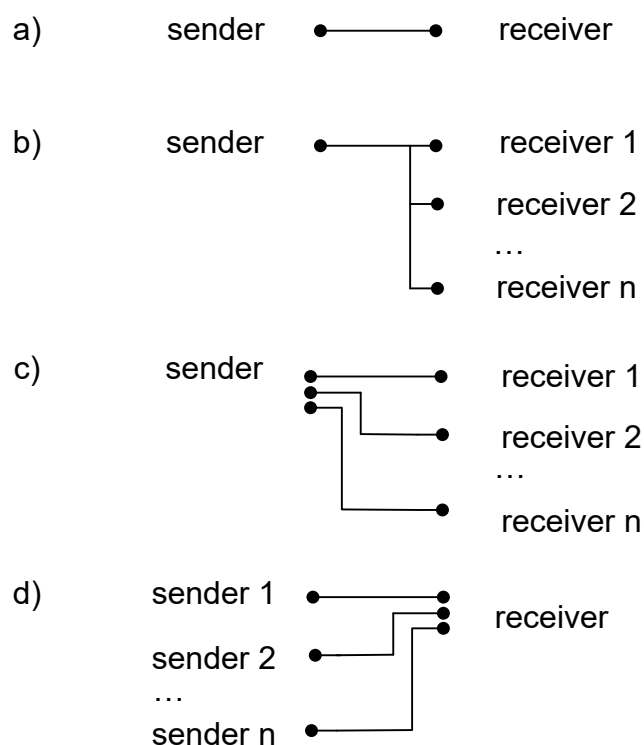
For one function / sub-function identification one or more channels may exist. One channel shall carry all signals of the same pair of sender and receiver.

The combination of function / sub-function identification and channel identification `ChannelId` shall uniquely identify a channel between function instances.

NOTE 1 The channel implicitly defines sender and receiver.

The channels shall support the following channel relations, see Figure 11:

- point-to-point;
- one-to-many, with same data for all receivers;
- one-to-many, with specific data for each receiver;
- many-to-one, with specific data from each sender.



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Figure 11 – Illustration of channel relations

To allocate the channels to the intended pairs of sender and receiver, they shall be assigned to channel groups according to Table 1:

Table 1 – Channel groups

Channel group	Sender level	Receiver level	Communication relation
A	train	closed train	function leader on train level to function follower on closed train level
B	closed train	vehicle	function leader on closed train level to function follower on vehicle level
C	train	vehicle	function leader on train level to function follower on vehicle level
D	train	train	function leaders on train level (e.g. function leadership negotiation)
E	closed train	closed train	function leaders on closed train level (e.g. function leadership negotiation)
F	closed train	closed train	from peer to peer in whole train
G	vehicle	vehicle	from peer to peer restricted to closed train boundaries
H	vehicle	vehicle	from peer to peer in whole train

NOTE Peer may be either a function leader or function follower.

For the channel groups A, B and C, the function leader resides on the superordinated level.

The impact of function communication depends on the used channel group. For example, in a multiple unit train, communication within channel group A will affect the whole train, but communication within channel group B will affect only one closed train of the multiple unit train.

Channel groups D and E are provided for function leader candidate to function leader candidate communication, e.g. negotiation of a function leader (see also 4.5).

Channel groups F, G and H are provided for peer-to-peer communication between function leaders on closed train level or between function followers on a vehicle level.

NOTE 2 The channel identification defines the hierarchical levels (train, closed train, vehicle) of sender and receiver. For example, the channel from sender exterior door function leader on train level to all receiver function follower on vehicle level.

The channels are unidirectional. The channel for the reverse communication direction shall be assigned to the same channel group.

Furthermore the channels shall be divided in two channel interoperability groups:

- e) interoperable channels;
- f) private channels.

The interoperable channels are used by the communication of applications defined by this document. These channels shall not be used for other purposes as assigned in this document.

The private channels can be used for communication of project or operator specific applications or for applications which have no need for interoperability, for example applications inside a closed train. These channels will never be assigned to the group of interoperable channels in the future.

5.2.4 Function instance information

The instance information InstanceInfo shall be interpreted depending on the control bit UserDatasetContent:

- a) UserDatasetContent = "Structure"
 - 1..127: the number of the function instance in the related counting area (see 5.2.9.1), counted according to the rules in 5.2.9.
 - 0: refers to all instances in the counting area.

The instance number identifies the affected instance either as sender or as receiver, depending on the direction of the associated channel.

- b) UserDatasetContent = "Array"
 - Number of used array elements

5.2.5 Function control information

The function control information ControlInfo is a bit set and shall be used according to Table 2.

Table 2 – Control information

Bit	Name	Value	Description
B0	UserDatasetContent	0 "Structure"	The data set contains a single data structure, field InstanceInfo is interpreted for a single data structure.
		1 "Array"	The data set contains an array of data structures, field InstanceInfo is interpreted for a data array.
B1	reserved	0	reserved for future use
		1	reserved for future use
B2	reserved	0	reserved for future use
		1	reserved for future use
B3	reserved	0	reserved for future use
		1	reserved for future use
B4	reserved	0	reserved for future use
		1	reserved for future use
B5	reserved	0	reserved for future use
		1	reserved for future use
B6	reserved	0	reserved for future use
		1	reserved for future use
B7	reserved	0	reserved for future use
		1	reserved for future use

5.2.6 Function life sign

The function life sign LifeSign is a counter, which shall be incremented each time, when the data set DataSet is forwarded to the communication protocol stack. The increment shall be done modulo 256.

5.2.7 Function data length

The function data length DataLength shall contain the length of the function data set (see 5.2.8). The length shall be counted in number of octets.

5.2.8 Function data set

The function data set contains the application data. The length of the function data set shall be a multiple of 2 (16-bit aligned).

The data structure "Structure" (control bit UserDatasetContent = 0) shall be used for point-to-point relations.

The data structure "Array" (control bit UserDatasetContent = 1) shall be used for one-to-many relations and for many-to-one relations. The number of receivers and senders resp. shall be determined by the information in the TTDB. Specific elements in the array shall be addressed by the field InstanceInfo.

5.2.9 Sequence numbers

5.2.9.1 General

Figure 12 illustrates an example train composition. In this example the train is composed by three closed trains, which are composed each by one or more consists, which are composed by one or more vehicles. The ETB reference direction is assumed from right to left.

NOTE 1 For definition of the reference directions, refer to IEC 61375-2-3.

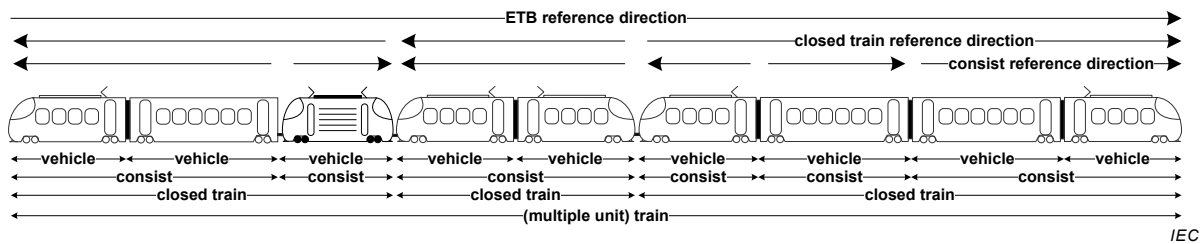


Figure 12 – Example train composition to illustrate sequence numbers

The train is structured by four hierarchical levels:

- a) (multiple unit) train;
- b) closed train;
- c) consist;
- d) vehicle.

Countable entities for sequence numbers are vehicles, consists and closed trains.

NOTE 2 Counting on the level of the complete train is pointless, because there is only one train.

Each countable entity can be counted in a counting area. Counting areas are on the level of consist, level of closed train and level of train.

NOTE 3 Counting on the level of vehicle is pointless, because there is only one vehicle.

Two kinds of sequence numbers for countable entities are defined:

- e) topological sequence numbers, base on the physical composition of the train;
- f) functional sequence numbers, based on static properties of vehicle, consist and closed train.

5.2.9.2 Topological sequence numbers

Topological sequence numbers depend only on the physical composition of the train and the superordinated counting area.

In the counting area train:

- a) the vehicles shall be counted ascending starting with 1 from the first vehicle in the train;
- b) the consists shall be counted ascending starting with 1 from the first consist in the train;
- c) the closed trains shall be counted ascending starting with 1 from the first closed in the train.

Figure 13 illustrates the sequence numbers for the entities vehicle, consist and closed train in the counting area train according to the example composition of Figure 12.

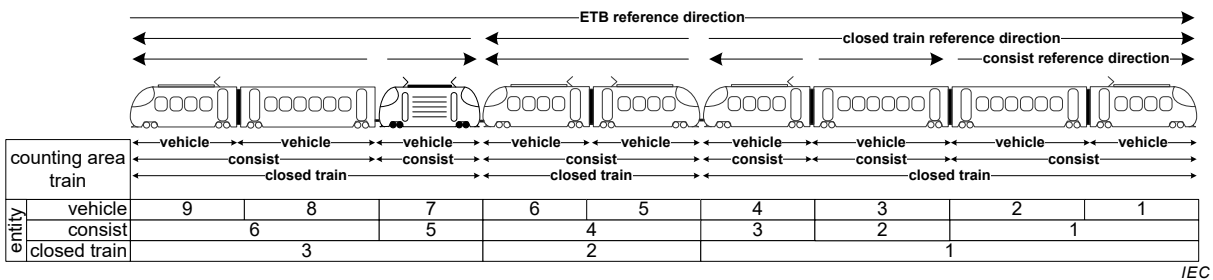


Figure 13 – Example sequence numbers in counting area train