BS EN 62580-1:2016

BSI Standards Publication

Electronic railway equipment — On-board multimedia and telematic subsystems for railways

Part 1: General architecture

bsi.

National foreword

This British Standard is the UK implementation of EN 62580-1:2016. It is identical to IEC 62580-1:2015.

The UK participation in its preparation was entrusted by Technical Committee GEL/9, Railway Electrotechnical Applications, to Panel GEL/9/-/4, Railway applications - Train communication network and multimedia systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Matériel électronique ferroviaire - Sous-systèmes ferroviaires multimédias et télématiques embarqués - Partie 1: Architecture générale (IEC 62580-1:2015)

Elektronische Betriebsmittel für Bahnen - Bordinterne Multimedia- und Telematik-Untersysteme für Bahnanwendungen - Teil 1: Allgemeine Architektur (IEC 62580-1:2015)

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

European foreword

The text of document 9/1990/FDIS, future edition 1 of IEC 62580-1, prepared by IEC/TC 9 "Electrical equipment and systems for railways" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62580-1:2016.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2017-05-11
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2019-11-11

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

For relationship with EU Directive 2008/57/EC amended by Commission Directive 2011/18/EU, see informative Annex ZZ, which is an integral part of this document.

Endorsement notice

The text of the International Standard IEC 62580-1:2015 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

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

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

Publication	Year	Title	EN/HD	Year
-	-	Railway applications - Classification system for railway vehicles - Part 4: Function groups	EN 15380-4	-
IEC 61375	Series	Electronic railway equipment - Train communication network (TCN)	EN 61375	Series
IEC 61375-2-3	-	Electronic railway equipment - Train communication network (TCN) - Part 2-3: TCN communication profile	EN 61375-2-3	-
IEC/TS 61375-2-4	-	Electronic railway equipment - Train communication network (TCN) - Part 2-4: TCN Application profile	-	-
IEC 61375-2-6 [1)]	-	Electronic railway equipment - Train communication network - Part 2-6: Onboard to ground communication	EN 61375-2-6 [1)]	-
IEC 62280	-	Railway applications - Communication, signalling and processing systems - Safety related communication in transmission systems	-	-
ISO/IEC 8824	series	Information technology - Abstract Syntax Notation One (ASN.1)	-	-
ISO/IEC 8825-1	-	Information technology - ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)	-	-
ISO/IEC 9646	series	Information technology - Open Systems Interconnection - Conformance testing methodology and framework	-	-
ISO/IEC/IEEE 42010	2011	Systems and software engineering - Architecture description	-	-

[1)] At draft stage.

Annex ZZ
(informative)

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

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

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

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

Clauses of this European Standard	Chapter / § / points / of RST LOC&PAS TSI	Essential Requirements (ER) of	Comments
The whole standard is applicable	4.2.5. Passenger-related items 4.2.12.2 General documentation: - description of computerised on-board systems	2. Requirements specific to each sub-subsystem 2.4. Rolling Stock 2.4.2. Reliability and availability 2.4.3. Technical compatibility	The TSI does not impose any technical solution regarding physical interfaces between units. The standard offers a general multi-purpose solution for the digital communication between applications and it is relevant to interoperability.

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

Clauses of this European Standard	Chapter / § / points / of TAP TSI	Essential Requirements (ER) of	Comments
The whole standard is applicable	4.2.21. Networking and communication 4.2.21.1. General architecture	2. Requirements specific to each sub-subsystem 2.4. Rolling Stock 2.4.2. Reliability and availability 2.4.3. Technical compatibility	

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

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRONIC RAILWAY EQUIPMENT – ON-BOARD MULTIMEDIA AND TELEMATIC SUBSYSTEMS FOR RAILWAYS –

Part 1: General architecture

FOREWORD

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International Standard IEC 62580-1 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

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

FDIS	Report on voting
9/1990/FDIS	9/2005/RVD

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

A list of all parts of IEC 62580 series, under the general title *Electronic railway equipment – On-board multimedia and telematic subsystems for railways*, 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 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.

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 62580-1 defines the general architecture of the On-board Multimedia and Telematic Subsystems (OMTS), so as to achieve compatibility between subsystems in the same vehicle and between subsystems on-board of different vehicles in the same train.

NOTE 1 The acronym OMTS replaces the previous OMMS (On-board MultiMedia Subsystem) definition, due to a change in the title of this standard.

The multimedia and telematic system is composed of but not limited to:

A Video surveillance/CCTV

B Driver and crew orientated services

C Passenger orientated services

D Train operator and maintainer orientated services

OMTSs installed in the same vehicle (consist) communicate by means of the consist network.

OMTSs, installed in different vehicle (consist) in the same train, communicate by means of the train network.

It is likely that each OMTS exchanges information with applications installed on-ground by means of a wireless communication gateway.

The on-board communication and the on-board to ground communication are specified by the IEC 61375 series.

NOTE 2 Board-to-ground communication is intended as a generic link, with no assumption on the underlying technology (radio, satellite or other).

As illustrated in Figure 1, the IEC 62580 series is structured as follows:

IEC 62580-1: General architecture

IEC 62580-2: Video surveillance/CCTV services

Driver and crew orientated services, passenger orientated services and train operator/maintainer orientated services are matters of standardisation which can be addressed in the future.

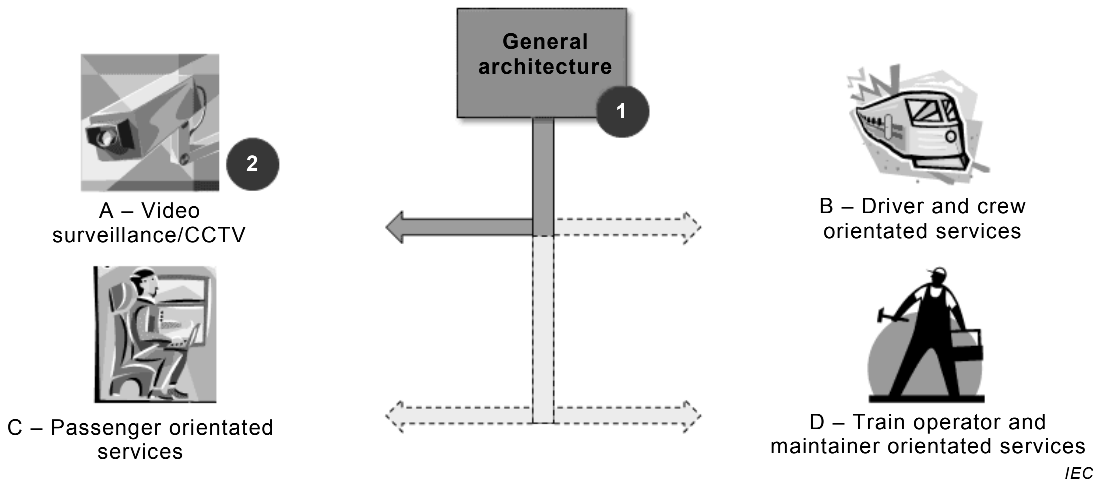

Figure 1 – OMTS categories and structure of the IEC 62580 series

ELECTRONIC RAILWAY EQUIPMENT – ON-BOARD MULTIMEDIA AND TELEMATIC SUBSYSTEMS FOR RAILWAYS –

Part 1: General architecture

1 Scope

This part of IEC 62580 specifies the general architecture of the On-board Multimedia and Telematic Subsystem, which includes four categories of multimedia and telematic subsystems identified as:

- A Video surveillance/CCTV
- B Driver and crew orientated services
- C Passenger orientated services
- D Train operator and maintainer orientated services

This part establishes:

- the boundary between the OMTS and the on-board communication system, as described by the IEC 61375 series
- the methodology to describe an OMTS in terms of abstract model
- the general principles and the basic requirements to specify the services provided/needed by each category
- the approach to ensure interoperability between services

This part gives guidelines for:

- OMTS classification
- functional breakdown structuring
- system breakdown structuring
- formal specification of an OMTS

This part is applicable to any type of train, e.g. open trains, multiple unit trains and closed trains.

NOTE The general architecture provides a common basis for the application categories defined in part 2 and possible future parts of this series of standards. Consequently, the approach is homogeneous for all multimedia and telematic subsystems addressed by this series of standards.

2 Normative references

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

IEC 61375 (all parts), *Electronic railway equipment – Train communication network (TCN)*

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

IEC 61375-2-4, *Electronic railway equipment – Train communication network (TCN) – Part 2-4: TCN application profile*[1]

IEC 61375-2-6, *Electronic railway equipment – Train communication network – Part 2-6: On-board to ground communication*

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

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

ISO/IEC 8825, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

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

ISO/IEC 42010:2011, *Systems and software engineering – Architecture description*

EN15380-4, *Railway applications – Classification system for railway vehicles – Part 4: Function groups*

3 Terms, definitions, abbreviations, acronyms, and conventions

3.1 Terms and definitions

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

3.1.1
communication
capability to transfer information between different parts of a system or subsystem

Note 1 to entry: Communication may refer to on-board, train-ground, train-train or ground-ground transmission.

3.1.2
entity
any concrete or abstract thing of interest

Note 1 to entry: While in general the word entity can be used to refer to anything, in the context of modelling it is reserved to refer to things in the universe of discourse being modelled (ISO/IEC 10746-2).

3.1.3
function
specific purpose or objective to be accomplished, which can be specified or described without reference to the physical means of achieving it

Note 1 to entry: A function transfers (considered as a black box) input parameters (material, energy, information) into aim related output parameters (material, energy, information).

3.1.4
Functional Breakdown Structure
FBS
hierarchical structure summarizing a set of functions leading to the same general focus or service, organized in function levels

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1 To be published.

3.1.5
function carriers
physical unit of observation to fulfil or partly fulfil one or more required functions

Note 1 to entry: Function carriers are considered as black box while describing the function.

3.1.6
function follower
application process which exchanges messages with the outside world only by means of a function leader

3.1.7
function leader
application process which manages exchanged messages with the outside world, routing them appropriately to and from the function follower(s) in a coordinated way

3.1.8
function level
hierarchy level to group functions of equal purpose. The first three levels are defined herein under:

1st level function
functional domain that encompasses a set of functions related to a same general focus or service for the considered (rolling stock) system

Note 1 to entry: Example for a 1st level function is:

– Provide appropriate conditions to passengers, train crew and payload.

2nd level function
related to a specific set of activities which contributes to the completion of the functional domain defined at the first level

Note 1 to entry: Examples for a 2nd level function are:

– Provide proper climate.

– Provide passenger information and entertainment.

Note 2 to entry: At this level, it is not said how a 2nd level function is to be implemented.

Note 3 to entry: A specific 2nd level function often is related to an engineering discipline and might be supported by one or a minimum number of subsystems.

Note 4 to entry: Each function at level 2 or level 3 has one or several transverse functions as sub-functions.

3rd level function
related to a specific activity within the related set of interconnected activities, it encompasses a set of tasks

Note 1 to entry: A function at least at level 3 should be supported as much as possible by one single subsystem.

Note 2 to entry: An example for 3rd level function is:

– Provide and support multimedia for passenger entertainment.

Note 3 to entry: Each function at level 2 or 3 has one or several transverse functions as sub-functions.

3.1.9
model
abstraction or representation of some aspect of a system.

3.1.10
multimedia
electronic production, coding/decoding, processing, delivery and consuming of information using a combination of one or more media including video, still images, audio, text in such a way that can be dynamically updated and/or interactively accessed

3.1.11
ontology
structure of concepts or entities within a domain, organized by relationships; a system model

Note 1 to entry: An ontology is a methodology which allows to specify knowledge within a specific domain in terms of concepts and the relationships which occur between them, so as to unambiguously define the meaning of each concept within a certain context. An ontology can be implemented using a semantic formal language which is machine-interpretable, building a model of the knowledge domain which can be automatically processed by computers.

3.1.12
operation
all functions which deal with the safety and regular exploitation of the transportation service

Note 1 to entry: Operational services are related to traction, braking and door management.

3.1.13
requirement
necessary condition or ability to constrain the solutions of a task or an aim

Note 1 to entry: A requirement describes for example, performance characteristics, operational conditions and quality attributes, expressed as measurable and testable technical parameters or indicators.

Note 2 to entry: Requirements are usually summarized in a specification.

Note 3 to entry: Beside requirements allocated to functions there are additional requirements allocated to other features (e.g. design, manufacturing).

The requirements are classified, but not only, into the following categories:

functional requirement
expresses the requirements on a certain functionality

Note 1 to entry: Functional requirements and use cases come from passenger/pay load and operator request rather than from integrator and supplier. They express the requirements on a certain functionality given in the FBS regarding interoperability (with other functions), operation, function/ behaviour, or functional architecture/design constraints.

The functional designation usually is additionally stated more precisely by detail properties, that provide more information referring to reliability, availability, performance, quality, documentation, input, output, real-time.

These higher-level functional goals pointed out for ambient conditions, design features and selected target groups/target objects are "requirements to a function".

system requirement
requirement on a subsystem or device

Note 1 to entry: Requirement on a subsystem or device regarding the requested technical compatibility, reliability, availability, maintainability, environmental impact/conditions (recyclables, emissions, EMC, climate, vibration), LCC, performance, quality, documentation, real-time behaviour, physical limits (dimension, weight), electrical interface (plugs, voltage, physical layer), or mechanical interface (fixing points, fixing method).

3.1.14
service
railways perform (transportation) services which are implemented by means of systems and subsystems

Note 1 to entry: In ICT, a service is a set of one or more functions provided by an application to another one.

Note 2 to entry: A service has some type of underlying computer system that supports the connection offered.

Note 3 to entry: A service provision is based on one or several functions each supported by a system (or subsystem). A service can also reuse other services. A service provider is able to perform a useful task for a service consumer, on request of the latter.

Note 4 to entry: The difference between service and function is blurry: in order to have the correct understanding, the following views are considered: behavioural, structural, external, internal. See Figure 7 for details.

3.1.15
service follower
application process which exchanges messages in a coordinated way with another application process in a SOA environment

3.1.16
service leader
application process in a SOA environment which manages exchanged messages in a coordinated way with other service follower(s)

3.1.17
Service Oriented Architecture
SOA
essentially a collection of services. These services communicate with each other. The communication can involve either simple data passing or it could involve two or more services coordinating some activity. Some means of connecting services to each other is needed

3.1.18
system
set of components organized to accomplish a specific function or set of functions

3.1.19
System Breakdown Structure
SBS
hierarchy of elements which can represent the structure of a system at different levels of detail. Structure here means the organisation of relations among the system constituents

3.1.20
subsystem
part of a larger system and set of elements, a coherent and somewhat independent component of a larger system

Note 1 to entry: A subsystem is a system itself. Therefore, a subsystem can be divided into further subsystems.

Note 2 to entry: A subsystem can be described in terms of functional blocks and interfaces. In a simple case, the functional blocks only exchange data. Often they need a more complex interaction in terms of services.

Note 3 to entry: A (sub)system is generally defined with a view to achieve a given objective.

3.1.21
telematic
applications which allow to seamlessly use remote objects, information or services, accessing them by means of a suitable communication system

Note 1 to entry: Telematics is the science of sending, receiving and storing information via telecommunication devices.

3.1.22
transverse function
function destined for the use together with several level 2 and level 3 functions of the Functional Breakdown Structure (FBS) at the same time

Note 1 to entry: The transverse functions are not part of the FBS but are implicit, for example ”provide diagnosis” or “communicate with train bus”.

3.1.23
Web Services
the most likely connection technology of service-oriented architectures, they essentially use XML to create a robust connection

3.2 Abbreviations and acronyms

3G	Third Generation
ASN.1	Abstract Syntax Notation One
ATP	Automatic Train Protection
BD	Blue-ray Disk
CCTV	Closed Circuit Television
CMD	China locomotive remote Monitoring and Diagnosis system
CN	Consist Network
CRH	China Railway High-speed
DOO	Driver Only Operation
DPWS	Device Profile for Web Services
DVD	Digital Versatile Disk
ECN	Ethernet Consist Network
ETB	Ethernet Train Backbone
ETBN	Ethernet Train Backbone Node
FBS	Functional Breakdown Structure
GCG	Ground Communication Gateway
GMTS	Ground Multimedia and Telematic Subsystem
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HMI	Human Machine Interface
ICT	Information and Communication Technology
IEF	Information Exchange Format
IT	Information Technology
LCD	Liquid Cristal Display
LDP	Locomotive on-board general Data monitoring
MCG	Mobile Communication Gateway
MP3	Moving Picture Expert Group-1/2 Audio Layer 3
NOC	Network Operation Centre
OASIS	Organization for the Advancement of Structured Information Standards
OMMS	On board MultiMedia Subsystem
OMTS	On board Multimedia and Telematic Subsystem
OWL	Ontology Web Language
PA	Public Address
PDA	Personal Digital Assistant
PIS	Passenger Information System
RDF	Resource Description Framework
RM	Reference Model
SBS	System Breakdown Structure

SOA	Service Oriented Architecture
SysML	System Modelling Language
TCMS	Train Control and Monitoring System
UML	Unified Modelling Language
UMTS	Universal Mobile Telecommunications System
URI	Uniform Resource Identifier
UTC	Coordinated Universal Time
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WS	Web Service
WSDL	Web Service Description Language
WTB	Wired Train Bus
XML	eXtensible Mark-up Language

3.3 Conventions

State diagrams are defined following the notation of UML 2.0 state machines.

4 Architecture

4.1 General

Consistently with the scope of this standard (see Clause 1), the General architecture at the basis of On-board MultiMedia Subsystems (OMTS) is specified in terms of services (see Figure 2).

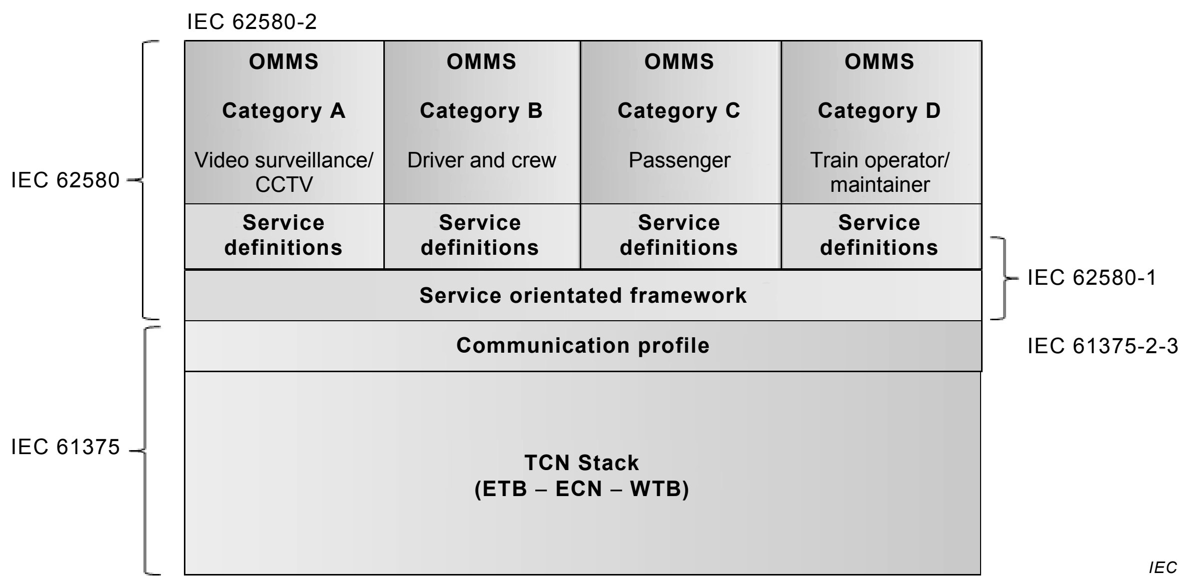

Figure 2 – Overview of the generic OMTS architecture

The main benefit of the service approach is to decouple applications from communication aspects, so as to ensure that applications compliant with IEC 62580 series are compatible with the protocols compliant with IEC 61375 series irrespective of possible amendments of the two series of standards.

NOTE 1 WTB is not well suitable for supporting a service oriented application interface, due to bandwidth limitation.

NOTE 2 Even if this standard is focused on on-board multimedia applications, it is well understood that many OMTSs can also have components on ground (see also 4.3.2).

Services provide access to functions and offer them through a standard interface, according to a general model for each subsystem, but shall not go into the details of implementation of the functions and of the subsystems themselves.

This standard defines an application profile for On-board Multimedia Subsystems (see also 4.3 for more details).

This standard specifies how to define an on-board multimedia application in terms of specific services and the messages they can produce/consume. This specification assumes that a communication mechanism is in place, allowing to transfer messages between services, as needed. Consequently this standard covers no specification of the communication mechanism, assuming that it is specified by IEC 61375 series. Obviously some minimum requirements of the OMTS services shall be fulfilled by such mechanism.

Based on an abstract model of the application, the application profile defines functions relevant for interoperability and maps them to a number of reusable services, which represent the application interface.

As the standard deals with services, it appears a logical choice to found it on a well-established architecture specifically based on services, as it is the Service Oriented Architecture (SOA). According to SOA, the interaction between applications happens by means of services, provided by the participating subsystems and their components. Several SOA specifications and implementations are available. In order to take into account performance and complexity concerns, a simplified protocol should be considered, which is suitable for implementation on embedded systems.

The services to be specified can be defined considering an abstract model of the subsystem, so as to have a generally applicable definition which is not tied to any specific implementation. Moreover, the identified services shall be relevant for subsystem interoperability.

Two levels of interoperability are considered:

Interoperability between subsystems – this is the case when a subsystem is considered as a black box, without any assumption about how it is broken down into components and how they work together in order to provide the needed functionality. In this case services are defined at subsystem level and the scope is limited to interoperability between subsystems: e.g. a passenger information system on train A can exchange messages with a passenger information system on train B; in this case, the functional model only exposes external interfaces and data.

Interoperability between components – this is the case when a subsystems is broken down into a few basic components: in such case services and interfaces between the components are defined as well and interoperability between components can be achieved as well: e.g. a public display system (text and graphic message system) from manufacturer A and an announcement generator (e.g. next station and connection announcement) from manufacturer B can work together to set up a passenger information system. This approach implies to define also internal interfaces between functional blocks (components).

Clearly, the level of detail of the subsystem abstract model is different.

It is important that the model will clearly specify which functions are involved and which information they exchange. Moreover it is essential to clarify how information shall be used (produced/consumed) by the functions. The interaction mechanisms and information flow should be described by formal methods, e.g. using UML 2.0 diagrams.

This standard specifies a general mechanism which allows subsystems and components to provide and/or consume services.

In order to do this:

- services shall exchange messages;
- a common definition of contents shall be agreed and defined.

For each of the four identified subsystem categories, coding shall be XML and the XML contents to be exchanged shall be defined by means of a suitable XML Schema.

The details of the application profile for each subsystem category (service definitions) are defined in other parts of this standard.

Finally, information needs to be addressed, in a unique and formal way. This is needed in order to refer to functions without knowing which devices are carrying them and which are the physical addresses of such devices. Each service shall be identified by means of a URI (Uniform Resource Identifier), which may be based on a Fully Qualified Domain Name.

NOTE 3 The details of the logical addressing mechanism are specified in IEC 61375-2-3.

4.2 Improvements on XML

4.2.1 Encoding

XML is widespread in the internet domain. So many peripherals using this protocol are already available. However XML as a transfer syntax is inefficient because of its character-based encoding. It might pose a problem on the train network because of the limited bandwidth of the train backbone.

Several methods can be devised to compress the data. For example ASN.1 (ISO/IEC 8824) encoding methods could be used. ASN.1 binary encodings are used in wireless telecom communications. The first step would be to transform XML message to/from ASN.1 message using the rules specified in ISO/IEC 8825 for ASN.1 coding.

A preliminary study has shown that using ASN.1, a reduction of the data volume in the magnitude order of 99 % can be expected.

4.2.2 Ontology

Definition of multimedia services, based on XML and XML schema only, will leave some problems unsolved:

- how to describe not only the syntax of contents but also its meaning (semantics);
- how to express data in a non-ambiguous form which can turn them into well-defined information;
- how to allow automatic elaboration of information based on its meaning;
- how to ensure consistency between information defined in different applications (developed differently in time and space).

A more complete and self-consistent representation of information can be offered by means of ontology. See 4.5.6.3.

The specification of the ontology is not covered by the IEC 62580 series.

4.3 Boundary

4.3.1 General

Distributed application processes need to interact using a communication stack to participate in a communication network, which can include different bearers, technologies and interfaces.

In order to provide a uniform, complete interface to all applications, a middleware layer should be added in between, which decouples applications from the communication layers and their technical solutions, and offers complementary services as well.

In other words, the middleware as defined hereinafter separates the world of final user applications, which deal with information, from the world of communication, which deals with transferring data in the form of bits and packets.

For even a more general approach, the interface layer between applications and the communication stack are split into two sub-layers, which are located on top of the communication stack (layer 7):

- an application independent communication profile
- a communication independent application profile

NOTE These two layers are dealt with in detail in IEC 61375-2-3 and future IEC 61375-2-4.

In general terms, the communication profile maps the communication services, that is the capability to transfer data between nodes with mechanisms depending on the envisaged data classes. This is independent from data contents and from application issues (see 4.5.4).

The application profile is a sub-layer complementary to the previous one which accommodates the communication functionality to the needs of a specific application category.

The application profile and communication profile together constitute a middleware.

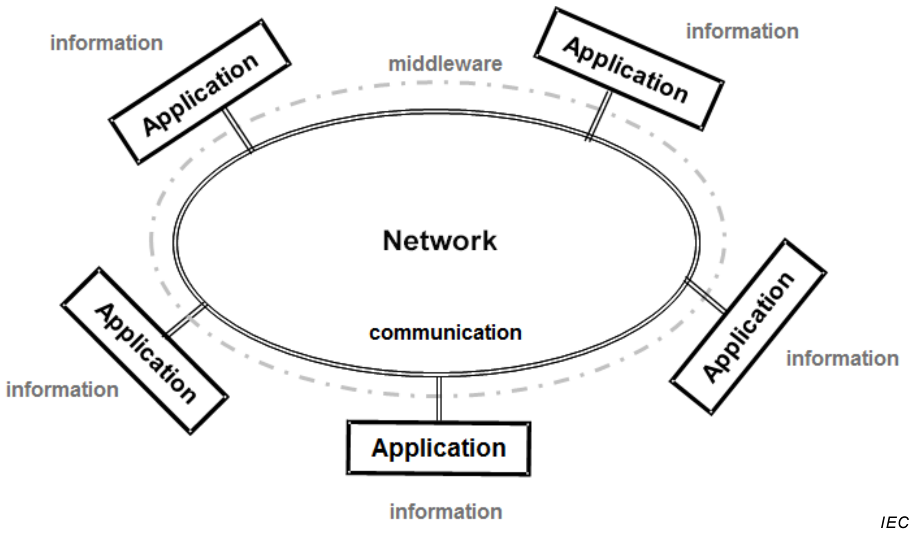

Figure 3 – Middleware concept

The middleware achieves the scope of decoupling the applications implementing the needed functionality, from the communication mechanisms providing data transfer services (Figure 3).

4.3.2 Boundary between IEC 62580 series and IEC 61375 series

The IEC 62580 series of international standards deals with interoperability between multimedia subsystems at application level, defining how applications exchange information using a logic channel. Therefore, IEC 62580 specifies an information stack, which allows OMTS applications to communicate with each other on the (virtual) logic channel.

It is assumed that a communication network is available to applications and that this is the network specified in the IEC 61375 standard series.

In order to achieve this, the communication stack shall provide the communication services required by the information stack and finally, through it, by the OMTS applications, see the IEC 61375/IEC 62580 interface in Figure 4.

A detailed description of such an interface and of the layering of the communication stack is covered by IEC 61375-2-3.

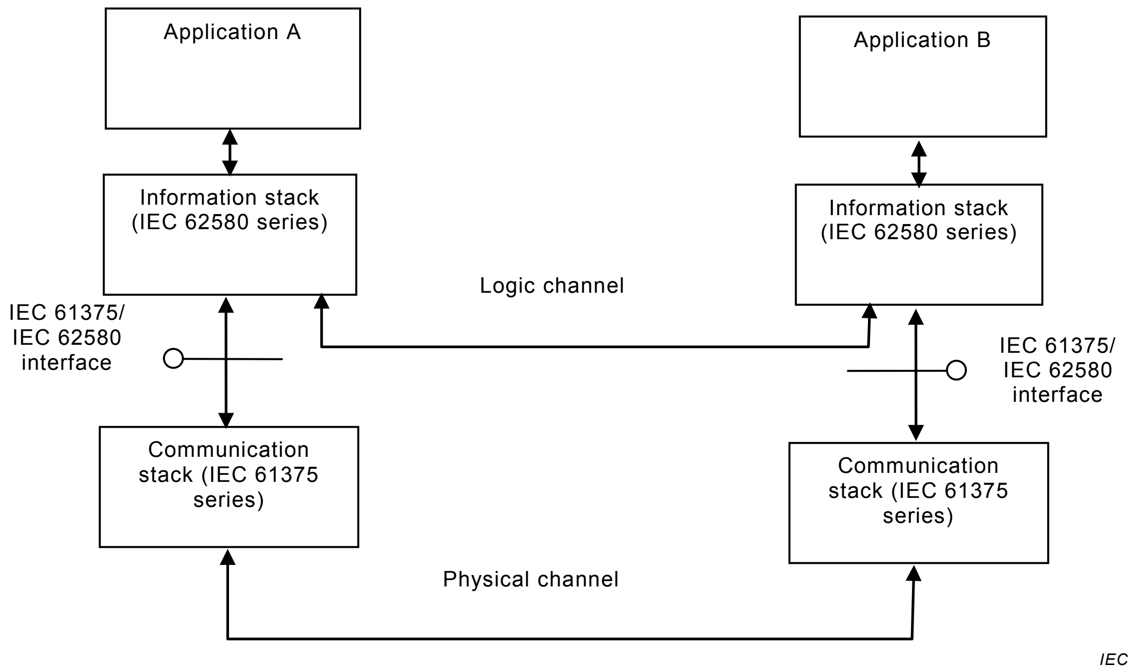

Figure 4 – Relationship between IEC 61375 and IEC 62580

As is often the case, multimedia applications can be split into an on-board part and a ground part, as they need information available from ground systems and/or transfer on-board information to ground.

In such cases, it is assumed that the on board communication network includes a link to the ground network, so as to properly connect all needed parts of multimedia applications.

In the IEC 61375 series, the board-to-ground radio link is specified in IEC 61375-2-6. By means of a Mobile Communication Gateway (MCG), communication is achieved between on-board applications and ground applications. The ground counterpart of the MCG is the GCG (Ground Communication Gateway).

Figure 5 illustrates the communication arrangements between the train and the ground.

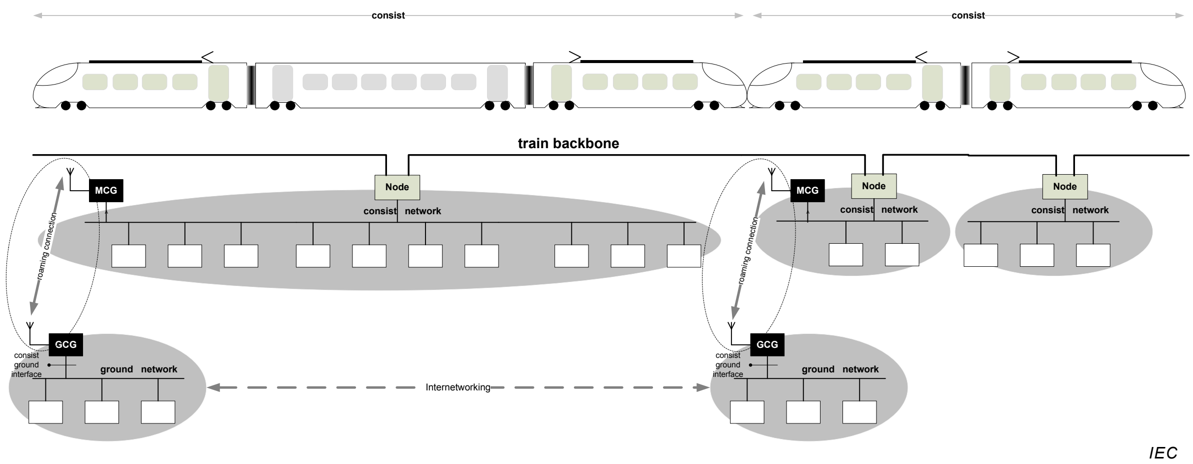

Figure 5 – ETB on-board network and board-ground link through MCG-GCG pairs

4.4 OMTS abstract model

4.4.1 General

Each category of OMTS should be described using a single model which is able to express the basic behaviour of the subsystem. Details which are too close to product implementation or can put unneeded constraints on future evolution of OMTS should be avoided.

The OMTS should be specified by an abstract model based on functional breakdown of the main OMTS function, the interactions and behaviour of the functions obtained from the breakdown, their interfaces and the related offered and/or requested services.

This concept is illustrated by Figure 6.

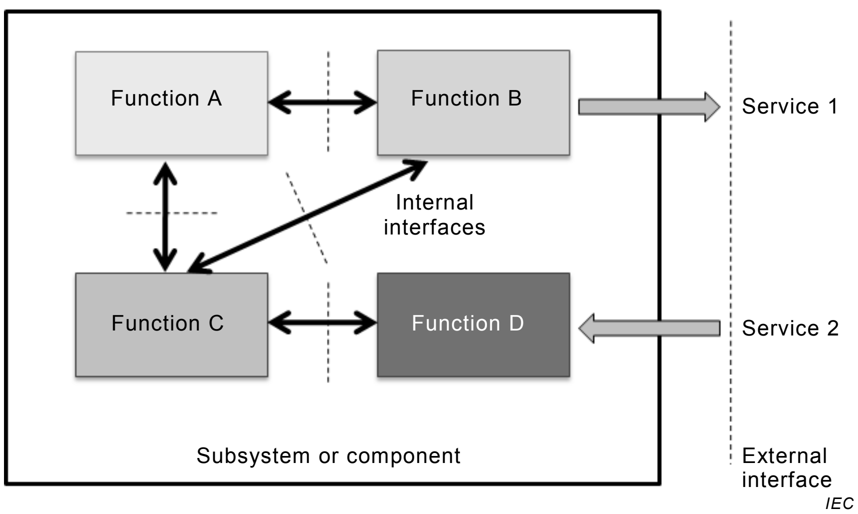

Figure 6 – Concept of abstract model

The concepts used in the OMTS abstract model according to Figure 6 and the relationships between them are captured in the conceptual model depicted in Figure 7. The most general relationships are listed in Table 1.

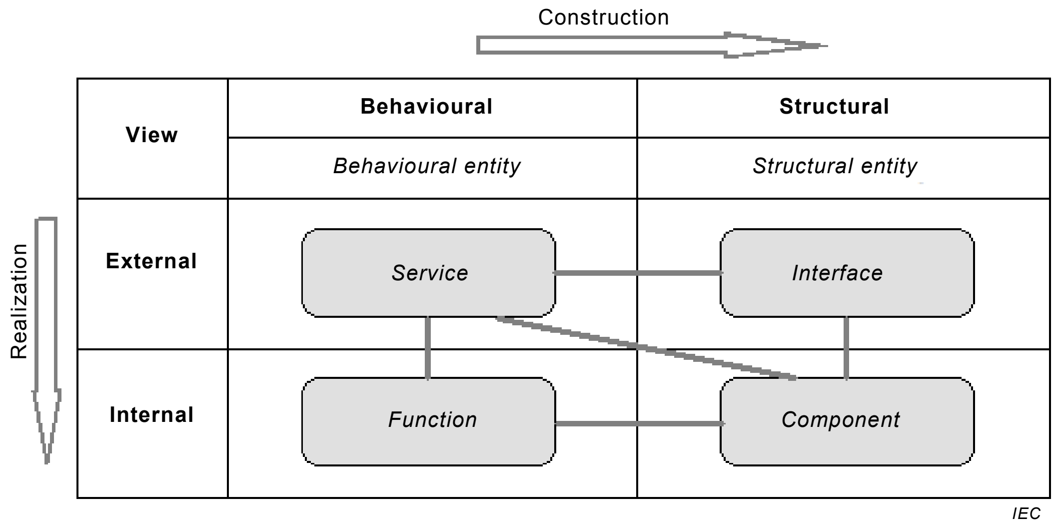

Figure 7 – Conceptual model

Table 1 – Relationships in the conceptual model

Service	has	Interface
Service	is realized by is used by	Function
Service	is used by	Component
Interface	is assigned to	Service
Interface	composes is used by	Component
Function	realizes uses	Service
Function	is assigned from	Component
Component	uses	Service
Component	is composed of uses	Interface
Component	is assigned to	Function

As shown in Figure 7, different views on the system can be taken focusing thus on different entities. External view (black box) corresponds to service specification whereas the internal view (white box)corresponds to service realization. Behavioural view, telling what the system does, is of prime importance in requirement phase; the structure of the system, telling what the system is made of, is constructed based on behavioural entities.

To summarize: a service is a unit of functionality that a system exposes to its environment, an interface is a point of access where one or more services are made available to the environment, a function is a behaviour entity that groups behaviour which can be performed by a component, a component is the entity that is capable of performing behaviour. The functions shall be those of FBS.

The actors of OMTS use cases may be the entities from business domain (person's roles, organizational units). This domain is the uppermost one covered by enterprise architecture (EA). Usually there are other two domains under EA called application and technology or infrastructure domains. The standards mentioned in 4.5.1 address enterprise architecture and this architecture is considered an “umbrella” architecture. The conceptual model depicted in

Figure 7 can be applied in all EA domains but things which are behind the concepts may be different. For instance a component in the business domain may be among others person’s role or organizational unit, in the application domain subsystem or application, and in the technology domain device or system software.

EXAMPLE: The business function "maintenance" is performed by some organizational unit which is supported by IT applications accessible via their service interfaces. These applications use other services from the application domain and the services from the infrastructure domain, e.g. communication services.

4.4.2 Methodology

This subclause specifies the approach to be used by IEC 62580-2 and by possible future parts of IEC 62580 to define an abstract model for the different multimedia categories (Figure 8).

Figure 8 – Principle of abstract model definition

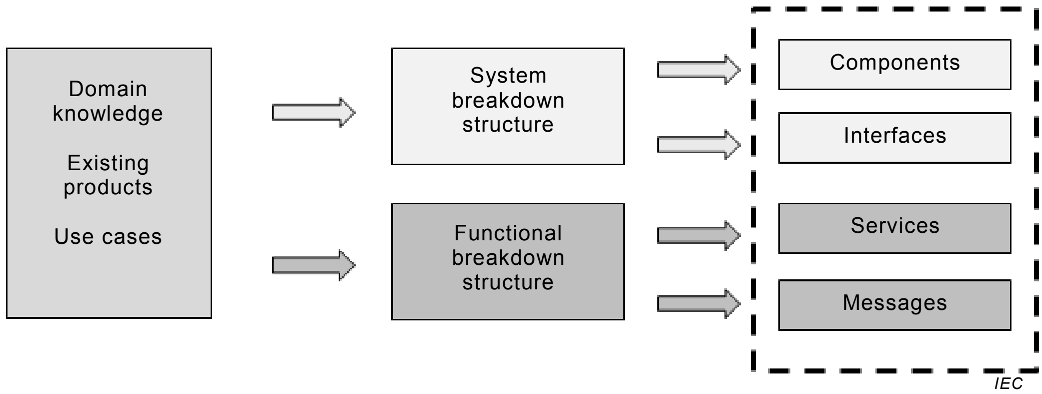

Figure 9 – Methodology for abstract model definition

For each of the four multimedia subsystem categories, taken into consideration in this standard series, existing knowledge is the starting point for the abstraction process.

This knowledge is mainly based on existing products and use cases and is expressed in textual form using human language.

From this knowledge, system’s requirements and functional requirement should be captured.

This activity shall be performed by means of system breakdown structure (see 4.4.3) and functional breakdown structure (see 4.4.4).

The system breakdown structure leads to the definition of the components (elements) and interfaces of the system, while the functional breakdown structure leads to the services offered and/or required by the functions and the relevant messages and their patterns exchanged over the relevant interfaces.

This is illustrated in Figure 9.

4.4.3 System breakdown structure

In order to identify and define the OMTS components and interfaces, a system breakdown structure of the relevant subsystem shall be executed.

A block diagram can well represent the intermediate results of this phase, nevertheless a formal method should be used, SySML is recommended.

NOTE SysML is a general purpose modelling language for systems engineering applications. It supports the specification, analysis, design, verification and validation of a broad range of systems and systems-of-systems. SysML is derived from the Unified Modelling Language™ (UML™), the industry standard for modelling software-intensive systems, so SysML is frequently implemented as a plugin for popular UML modelling tools. Moreover, the SysML open source specification is publicly available and has been adopted by the Object Management Group (OMG).

This approach is better detailed in Clause B.3.

4.4.4 Functional breakdown structure

In order to identify and define the OMTS services and exchanged messages, a functional breakdown structure of the subsystem shall be executed.

UML 2.0 diagrams should be used to describe the functional behaviour of the OMTS subsystem or component.

This aspect is better detailed in Clause B.2.

4.5 General principles and basic requirements for OMTS services

4.5.1 Service oriented paradigm

ISO/IEC 42010:2011 defines architecture as: “The fundamental organization of a system embodied in its components, their relationships to each other and to the environment, and the principles guiding its design and evolution”.

Considering the definition above and the service orientation paradigm, the guiding principles are the following:

- services share a formal contract
- services are loosely coupled
- services abstract underlying logic
- services are composable
- services are reusable
- services are autonomous
- services are stateless
- services are discoverable

The following Figure 10 shows the general SOA approach.

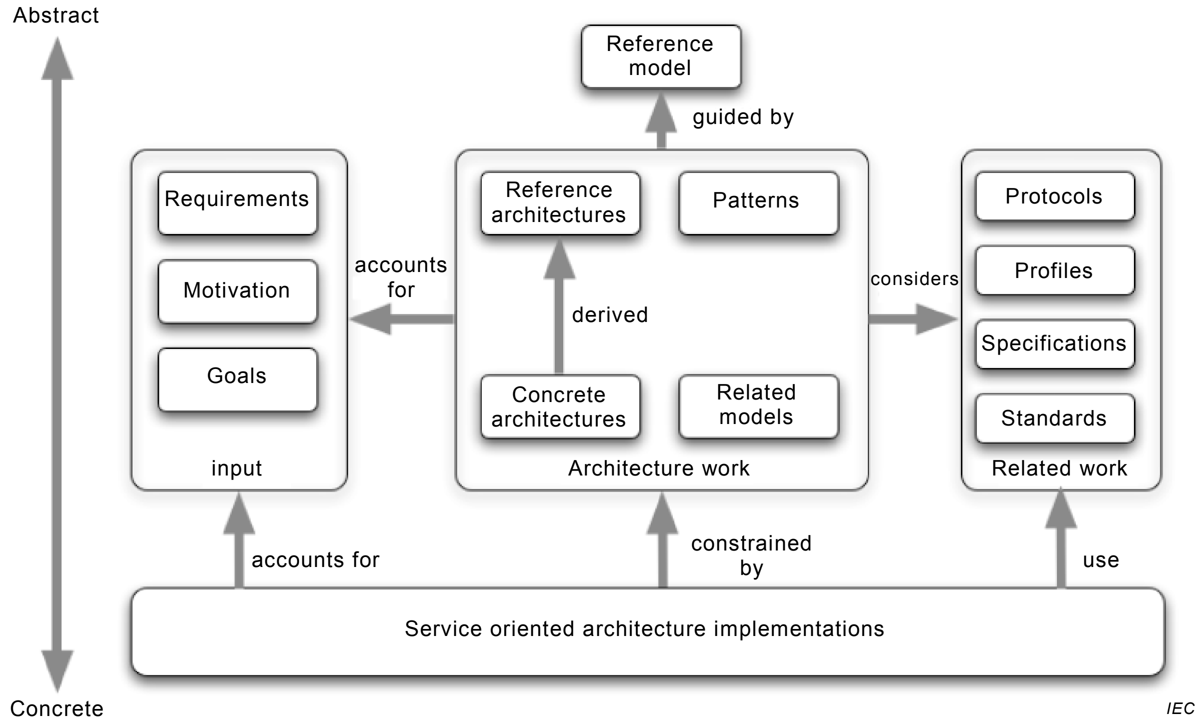

Figure 10 – SOA approach

A reference model and reference architecture for SOA were elaborated by OASIS and The Open Group. The evolving specifications of these bodies are written from different perspectives and provide different depths of detail for the perspectives on which they focus. They complement each other.

The OASIS Reference Model for SOA (SOA RM) is the most abstract of the specifications positioned. It is used for understanding core SOA concepts.

The Open Group SOA ontology extends, refines, and formalizes some of the core concepts of the SOA RM. It is used for understanding the core SOA concepts.

The OASIS Reference Architecture Foundation for SOA is an abstract, foundation reference architecture addressing the ecosystem viewpoint for building and interacting within the SOA paradigm. It is used for understanding the different elements of SOA, the completeness of SOA architectures and implementations, and considerations for cross-ownership boundaries where there is no single authoritative entity for SOA.

The Open Group SOA Reference Architecture is a layered architecture from consumer and provider perspective with cross-cutting concerns describing the architectural building blocks and principles that support the realizations of SOA. It is used for understanding the different elements of SOA, deployment of SOA in enterprise, basis for an industry or organizational reference architecture, implication of architectural decisions, and positioning of vendor products in a SOA context.

The reference architecture for the domain addressed by this Part 1 embodies design and technology choices.

An example of consistent SOA solution is the Device Profile for Web Services (DPWS – OASIS standard) which addresses the field of industrial automation and fulfils the needs and constraints of embedded systems. It specifies how to:

- Send secure messages to and from a Web service

- Dynamically discover a Web service
- Describe a Web service
- Subscribe to, and receive events from, a Web service

The arrangements of clients and devices (hosting services) are shown in the following Figure 11.

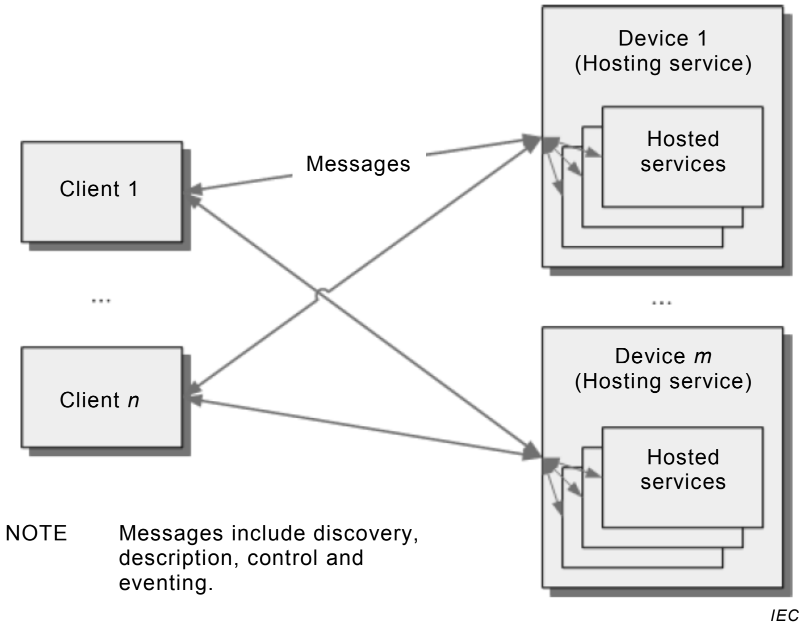

Figure 11 – Clients and devices arrangements

This profile is supported by the set of Web Service (WS-*) specifications, e.g. WS-Addressing, WS-Discovery, WS-Security.

The document WS-Dynamic Discovery (see section Bibliography) covers:

- Service management
- Service directory
- Service publishing
- Service discovery
- Service subscription

4.5.2 Service concept

The OMTS architecture has the scope to allow application-level interoperable interfacing between different multimedia subsystems.

The interface between functions is based on the concept of services: each multimedia/telematic subsystem can be seen as a set of cooperating services, producing and/or consuming messages.

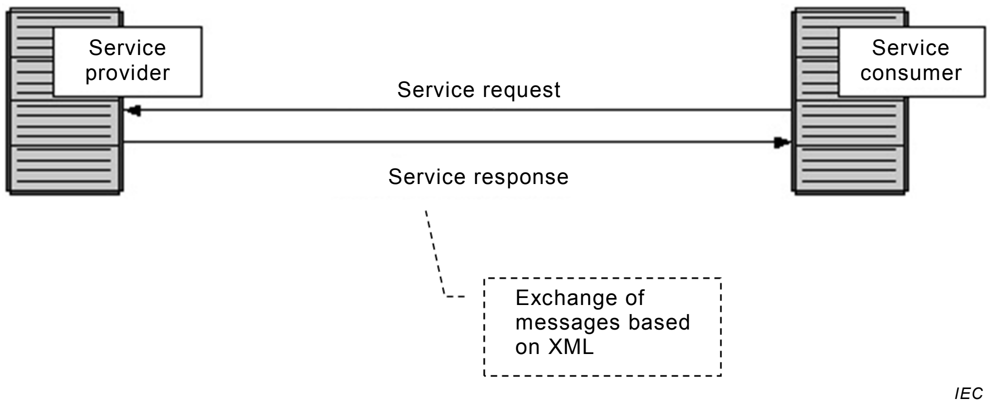

Figure 12 – Service concept

Figure 12 illustrates a basic service-oriented architecture. It shows a service consumer at the right sending a service request message to a service provider at the left. The service provider returns a response message to the service consumer. The request and subsequent response connections are defined in some way that is understandable to both the service consumer and service provider. A service provider can also be a service consumer.

Figure 12 illustrates the message exchange patterns in the case of request/response. Other message exchange patterns can be used, e.g. event notification where, after request, the response is sent more than one time when the relevant event happens.

In order to specify it with sufficient detail for the scope of this standard, the interface has to fulfil two main requirements:

a) The interface shall be able to manage services.

b) The interface shall be able to define the messages to be exchanged between the services.

The following subclauses specify how the OMTS standard interface shall be built in order to fulfil such requirements.

4.5.3 Services versus functions

The concept "function" is not explicitly defined either in the Reference Model (RM) or in the Reference Architecture (RA). Hence there is no defined relation between "service" and "function". Based on functions provided by the system the service exposes an interface to the outside world.

EN 15380-4 defines the functions and their groups which cover the complete functionality of railway vehicles. Some of these functions could be services, others, for instance, the capabilities are only accessed by services without public visibility (e.g. GetStatus – capabilities are operations in the service interface specification in WSDL language).

We will use in our architecture, design and other models/diagrams the Service only and we will reference the functions in the FBS when we will be describing the functionality provided by the Service.

4.5.4 OMTS service based interface

The OMTS architecture is a Service Oriented Architecture (SOA).

Services allow to describe interfaces at application-level (see Figure 13).

This subclause defines a minimal service interface which is able to:

- Describe a service
- Send secure messages to and from a service
- Dynamically discover a service
- Subscribe to, and receive events from, a service

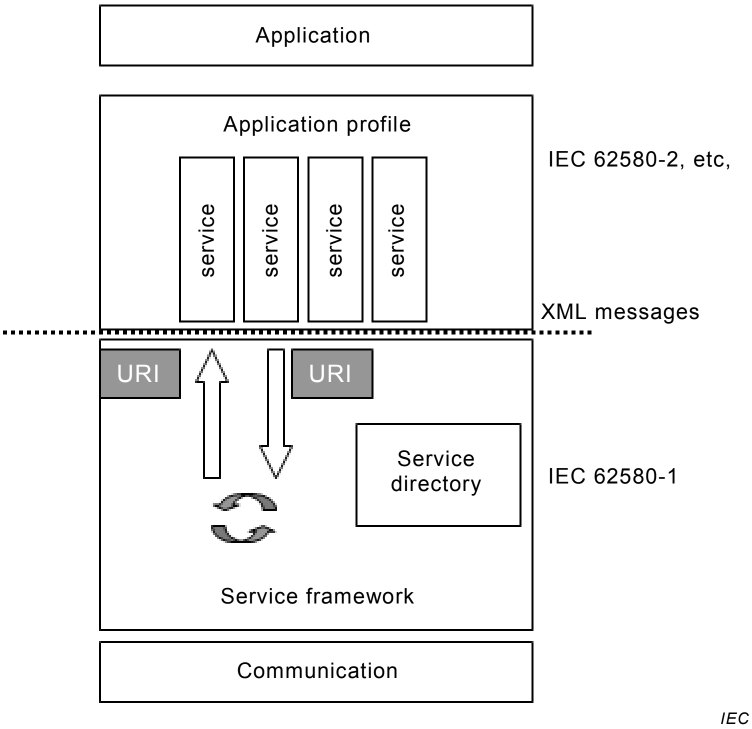

Figure 13 – Block diagram of the service based interface

The specified service oriented architecture shall be suitable for implementation on board trains and within embedded systems.

In order to ensure interoperability, a common mechanism implementing the SOA architecture in a suitable way for OMTS is needed.

NOTE For example, a solution is specified in Devices Profile for Web Services (DPWS) Version 1.1 – OASIS Standard – 1 July 2009. Several DPWS implementations are available, which offer more details, support and tools (e.g. WS4D, SOA4D). To achieve interoperability, a more detailed and restrictive specification of DPWS is needed. However it is not possible at the moment to achieve more detailed specifications as further feedback from companies which will start using the standard is needed.

As is common practice in SOA, messages exchanged between services are formatted in XML language. Apart from this, the service framework makes no assumption on the message nature. Message details and contents are the subject of 4.5.6.

The service framework shall be used for the OMTS external interfaces and for the defined internal interfaces between its components, as they are specified in the subsystem abstract model.

The interface between the service framework and the communication stack (IEC 61375) shall comply with the requirements of IEC 61375-2-3.

The service URI shall be compatible with the requirements of IEC 61375-2-3.

4.5.5 OMTS services

Each category of On-board Multimedia Subsystems (OMTS) shall specify a set of services which are identified according to the following criteria:

– they are essential to represent the subsystem abstract model;
– they are relevant for subsystems/components interoperability within such category.

The relevant services shall be specified according to rules defined in 4.5.4.

Services interact each other and with other services by means of message exchange.

For each service, the service messages that it can produce/consume need to be specified.

The service message format is specified in the next subclause.

4.5.6 OMTS service messages

4.5.6.1 General

This subclause specifies service messages in general: however only messages relevant for interoperability need to be standardized. Such messages depend on the specific category taken into consideration and are defined in Part 2 and possible future parts of this standard.

Service messages shall be formatted according to XML.

Messages shall be specified for each defined interface of the OMTS subsystem.

Messages shall be defined for each service, in order to allow proper communication of the data needed by the functions underneath, which have to properly operate and synchronise with other functions.

One of the following two Information Exchange Formats shall be used in order to define message contents:

– Information Exchange Format 1 – based on XML, XML schema and Namespaces
– Information Exchange Format 2 – based on a semantic formal language

They correspond to two different levels of OMTS service interface (see 4.5.6.4).

4.5.6.2 Information Exchange Format 1

When Information Exchange Format 1 is chosen, an XML schema can define the needed contents for messages related to a specific multimedia category, specified in Part 2 and possible future parts of this standard.

Consistency between data defined for different subsystems should be verified by means of formal methods.

4.5.6.3 Information Exchange Format 2

When Information Exchange Format 2 is chosen, data are expressed by means of a formal semantic language, e.g. Ontology Web Language (OWL) representing a common ontology.

The ontology may be used as a reference in order to define the contents of messages, for interfaces implemented according to the Information Exchange Format 2 (IEF2).

Contents may be defined using a semantic formal language based on XML (e.g. using the OWL language). Therefore, IEF2 differs from IEF1 as:

a) Messages are still encoded in XML, but following a semantic language.
b) Messages embed their meaning (ontology references) within their contents.

The principle is reported in Figure 14 and a brief introduction to ontology is included as Annex E.

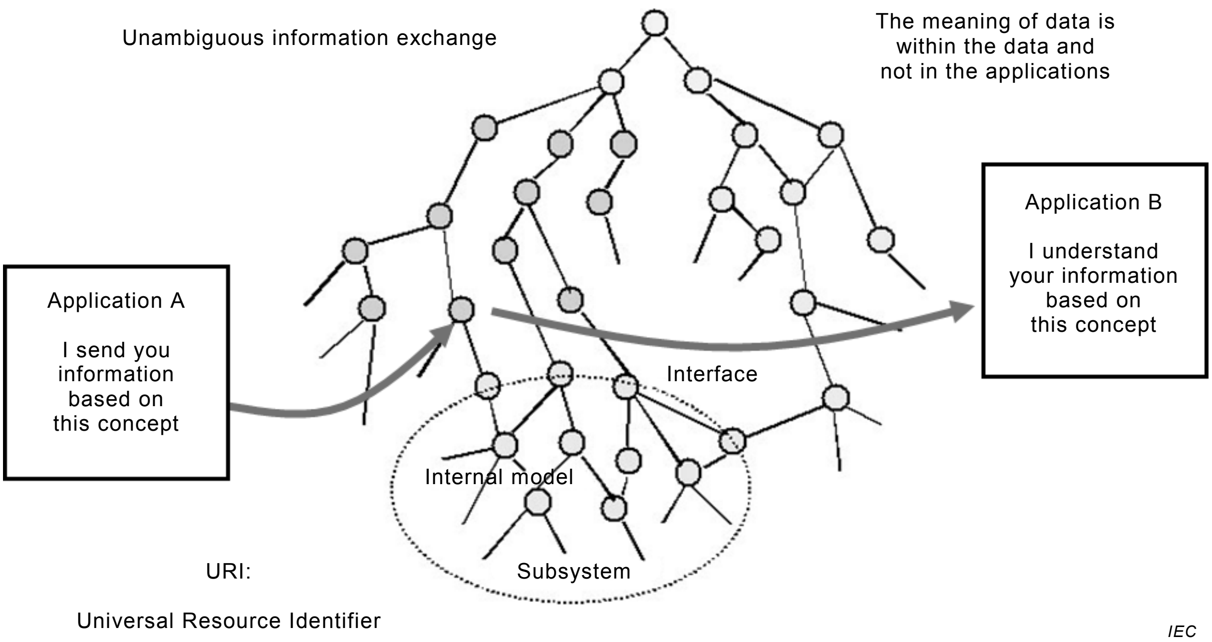

Figure 14 – Principle of the ontology based Information Exchange Format 2

Some documents introducing the ontology concept are listed in the Bibliography.

4.5.6.4 Compatibility

Referring to Figure 15,

IEF 2 messages shall be ignored by IEF 1 interfaces.

IEF 1 messages shall be understood by IEF 2 interfaces.

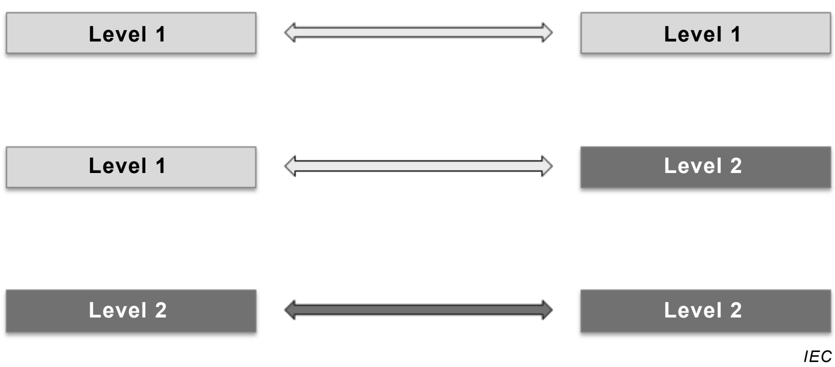

Figure 15 – Compatibility map

Therefore, Level 1 and Level 2 subsystems are able to understand each other based on IEF1 messages, possibly with performance reduction for the Level 2 subsystems.

NOTE The service message format can be an input for other application profiles, as those specified in future IEC 61375-2-4.

4.5.7 OMTS common services

4.5.7.1 General

Some services having general validity and wide usage can be identified, which are better specified independently from any specific OMTS category. Some services can even be specified or used by other subsystems (e.g. TCMS).

Examples of such services are:

- Security support services (authentication, data integrity)
- Position service (informing about the position of the train)
- Time service (giving the current UTC information)
- Topology service (giving information about the current train composition)

The details of some common services are provided by the application profile, as defined in future IEC 61375-2-4.

4.5.7.2 OMTS security services

In general, OMTS applications can communicate using open or closed communication systems, according to the definitions given by IEC 62280.

The communication systems described by IEC 61375 may be classified as open or closed communication systems according to their implementation. In order to classify the IEC 61375 communication system, it is necessary to apply the general criteria defined by IEC 62280. Particularly IEC 61375-2-3 and IEC 61375-2-6 are providing details on the security capability respectively of the communication profile layer and of the communication between board and ground.

When the OMTS application is implemented according to DPWS specification, some security capabilities are already provided by WS-Security. Nevertheless conformity to IEC 62280 shall be evaluated.

4.6 OMTS interoperability

4.6.1 General

In order to complete the general architecture, this subclause describes the coordination mechanism between subsystems of the same category, when they need to participate in the same network.

This is the case either when two consists, both equipped with such subsystems, are coupled together to become part of the same train or when a consist is accessed from ground.

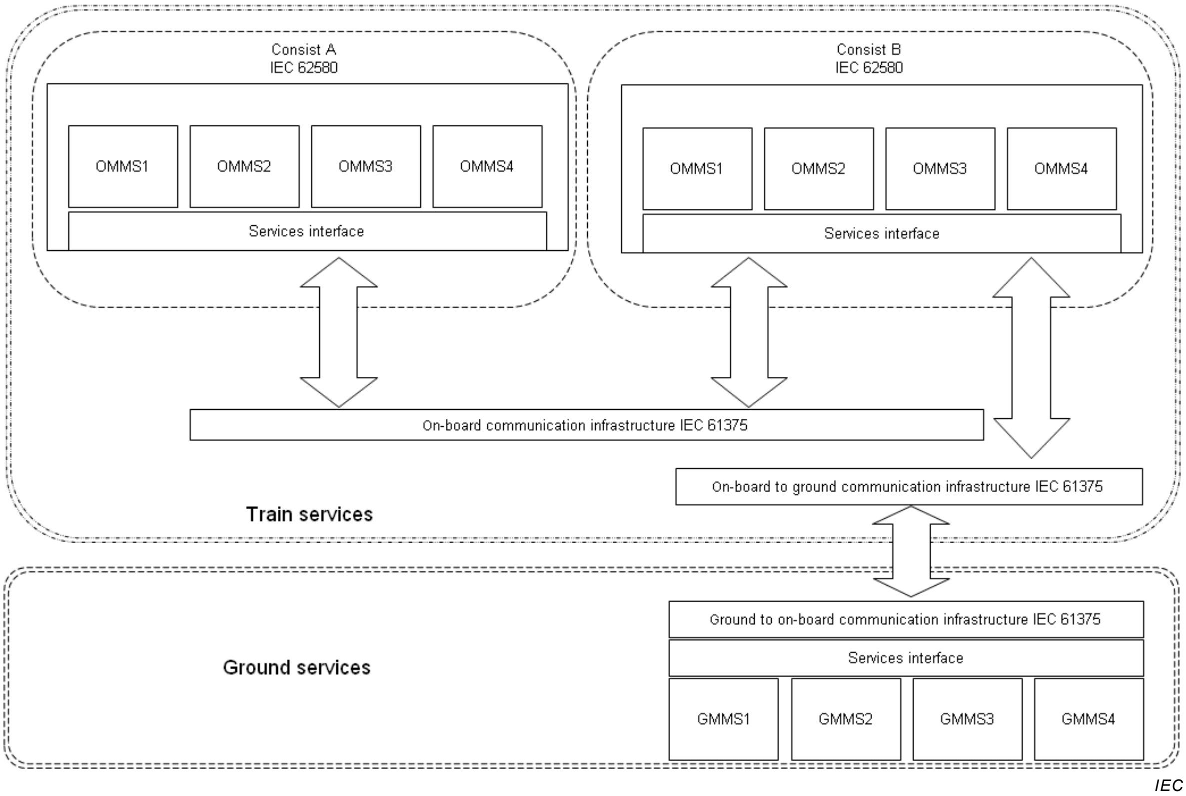

Figure 16 – Service interfaces

With reference to Figure 16, main concepts and mechanisms are listed herein and defined:

- Interoperability key concept
- Subsystems grouping and application leader election

Each consist is a cluster of subsystems connected by the network; the subsystems need to be grouped either statically (e.g. MVB or ECN environment) for fixed configuration or dynamically (e.g. WTB or ETB environment) in order to perform a set of functions or services. The subsystems could play either the role of "function follower" or "function leader", the role needs to be managed according to the redundancy rules requested for that function/service and a subsystem application leader election mechanism shall be implemented.

In the same way a service could be elected service leader.

4.6.2 Subsystem logical structure

According to SBS (with reference to Figure 17), any subsystem shall be broken down into a number of components, suitably interfaced between them and with the external world.

When considering a specific subsystem category (as detailed in Part 2 and possible future parts of this standard series), the abstraction process allows to have a general standard model of the subsystem, which can be mapped to any real product and implementation.

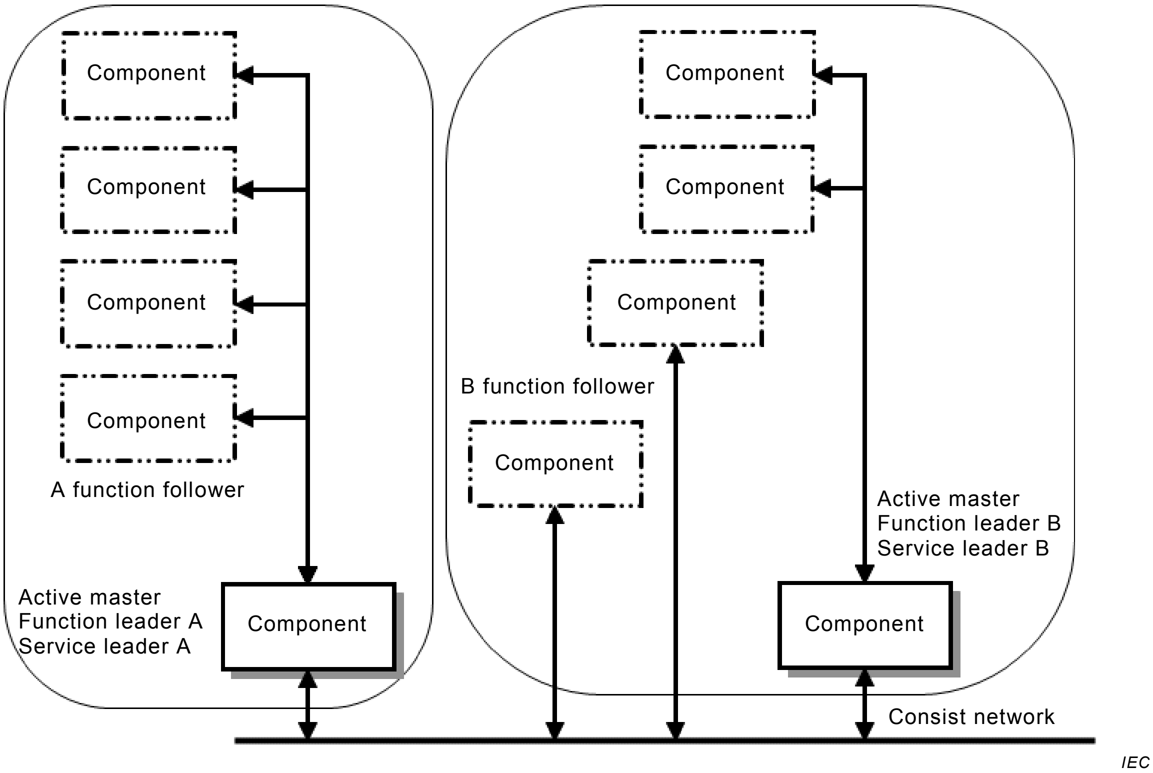

Figure 17 – Subsystem breakdown structure

For each service if a service leader has been elected it shall be responsible for communication between the subsystem and the external world.

Of course, this means that a service leader shall provide one or more services which enable information exchange with other related subsystems (normally located outside the consist, e.g. in another consist or on the ground).

4.6.3 Subsystem coupling

When two subsystems are coupled, so that they are part of the same network, a re-configuration step is needed in order to have the subsystems working as a single subsystem (if possible) (see Figure 18).

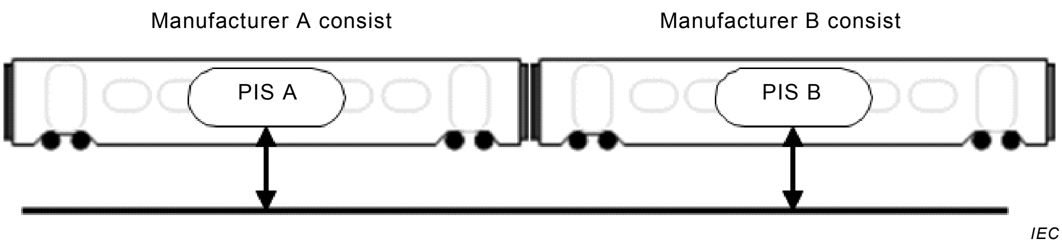

Figure 18 – Coupling of two consists and related subsystems

In order to achieve such a result, function and service should negotiate leadership and are impacted by any network configuration changes. The leadership negotiation mechanism brings to the election of a single leader for each function or service. The results of functions mapping and arbitration in consist networks is shown in Figure 19 and the results of service mapping and arbitration in consist networks is shown in Figure 20.

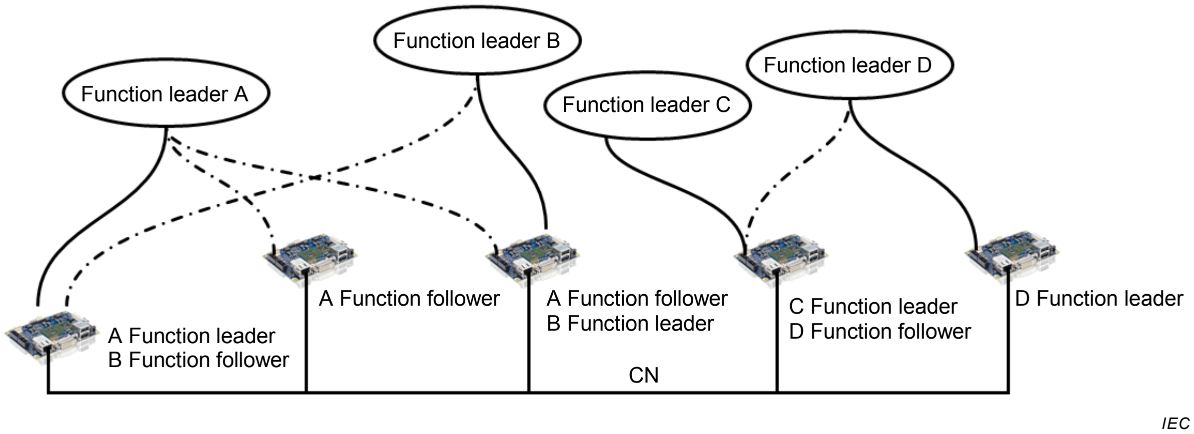

Figure 19 – Function mapping and role arbitration

Through the service discovery mechanism, each service leader will become aware that a service leader from a subsystem of the same category is now available in the network. The mastership of the function and service role arbitration requires a negotiation process between the function and service leaders as modelled in Figure 21.

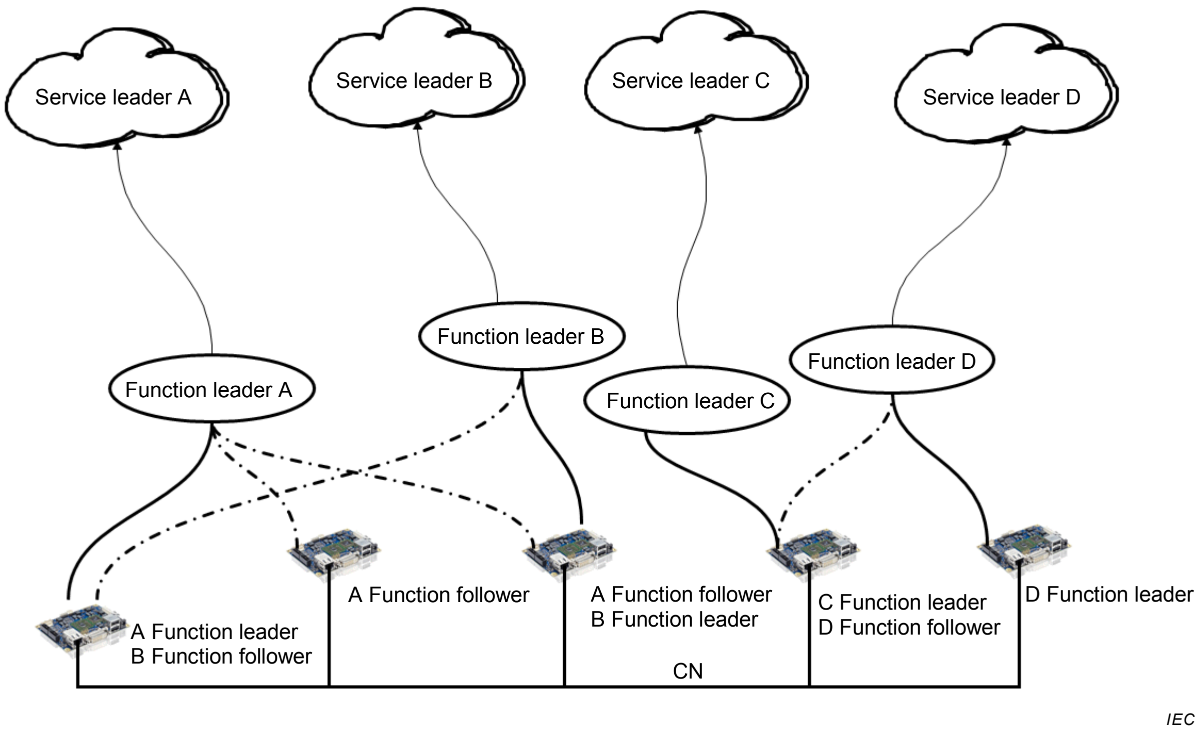

Figure 20 – Function and service mapping on consist network

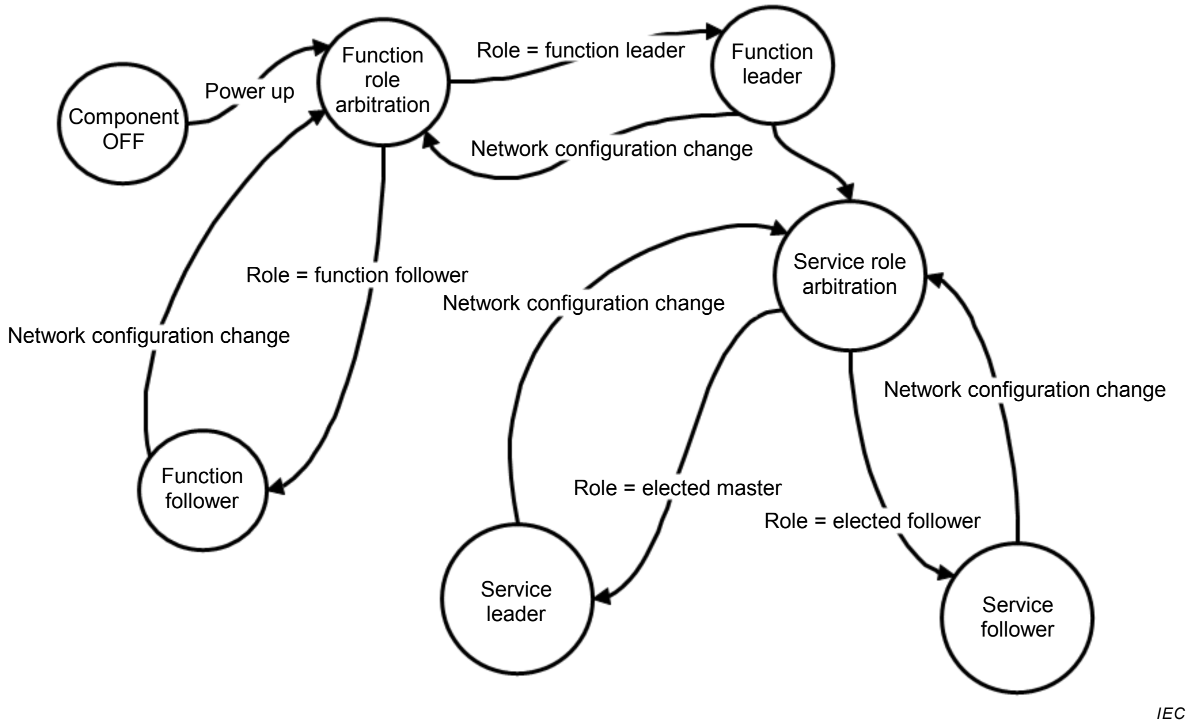

Figure 21 – Function and service role arbitration

4.6.4 Function role arbitration

In case two or more subsystems are coupled together, each having its own function leader, a mechanism is needed in order to allow them to agree and choose one of them as function leader, while the other ones will become function follower.

The rules which will drive the function leader election are the following:

a) Checking the respective logical consist number from the train topology, the function leader which is part of the consist with the lower number will become function leader.

Some alternate solutions or special cases are possible:

b) The function leader which is part of the consist where the MCG is located will become function leader.
c) The function leader which is already active, as a result from coupling with other consists, will keep the status of function leader.

The SBSs in Figure 22 and Figure 23 show the points of view of the component, function and services across the layers of IEC 61375 and IEC 62580. In Figure 22, the two consists are uncoupled and each one is connected to the ground services in independent way. The mastership shall be managed at consist level.

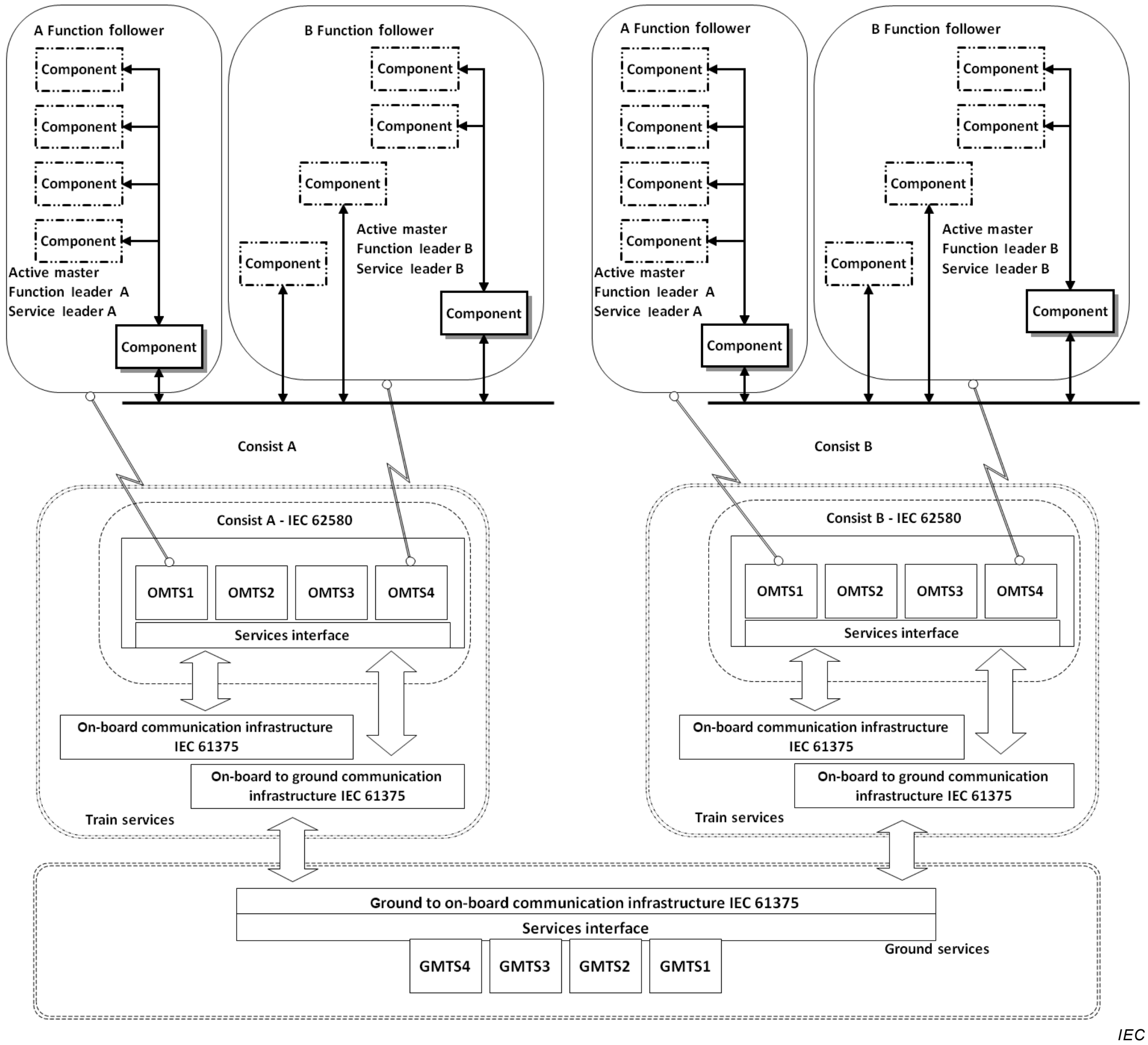

Figure 22 – Uncoupled functional breakdown structure

4.6.5 Service role arbitration

In Figure 23 the two consists are coupled and the mastership is managed in order to define the various service leaders. From the ground side there is a single consist formed by “Consist A + Consist B”.

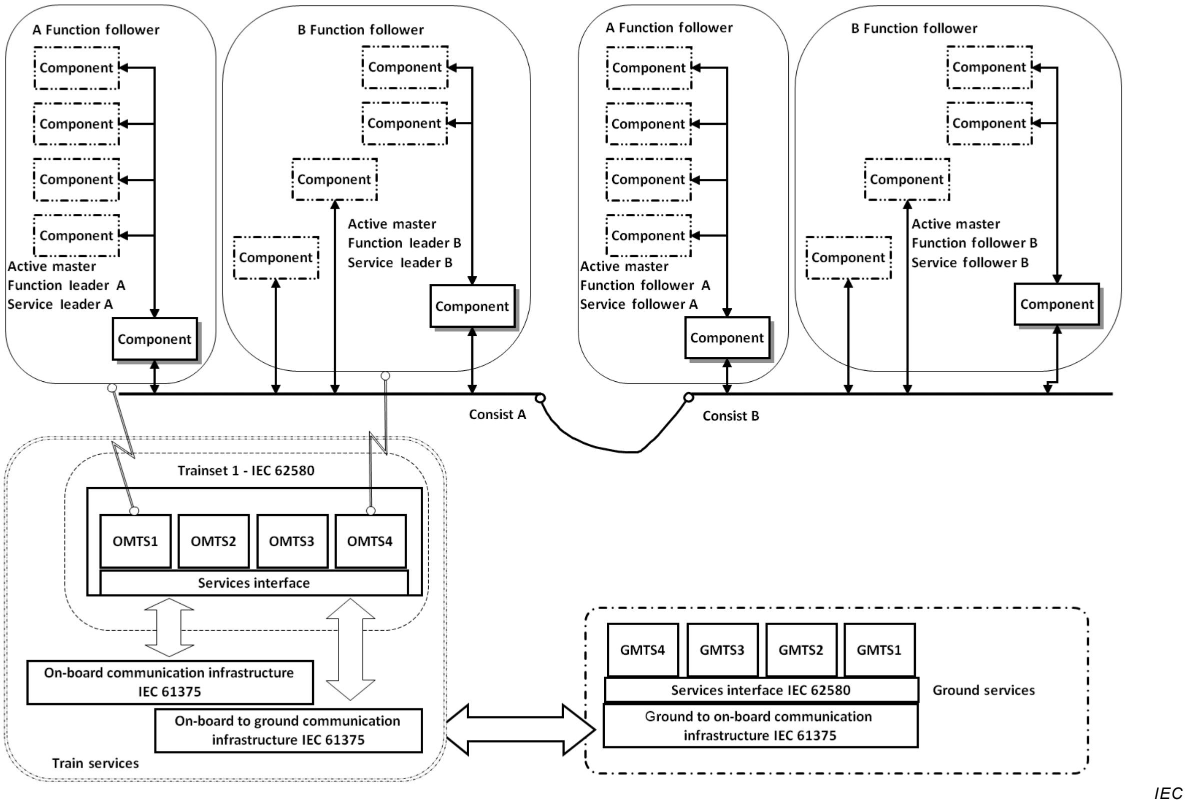

Figure 23 – Coupled functional breakdown structure

During the mastership process two possibilities can occur:

a) None of the service leaders includes the capability to release leadership.

b) One or more of the service leaders includes the capability to release leadership.

In case a), subsystem functional coupling is not possible and the two subsystems will go on working independently, each leader controlling its own components as in the uncoupled case.

In case b), one of the two service leaders will release the leadership and will act as a service follower, allowing its components to receive and react to messages coming from the other service leader.

Figure 24 shows the on board service space resulting from the mastership process.

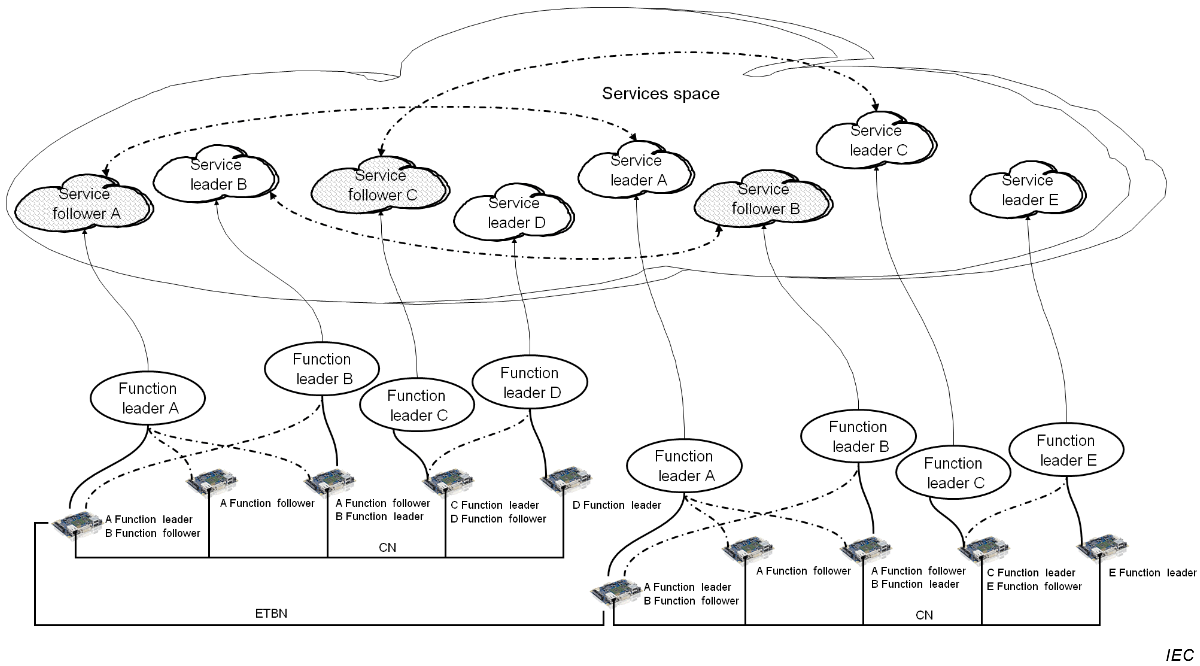

Figure 24 – Service space

In case the components associated to the service follower are not compliant with this standard, the service follower needs to relay messages (possibly translating them) coming from the service leader.

NOTE Consist coupling normally occurs through the related ETB switches and train backbone. For the purpose of this standard, this can be considered as transparent.

4.6.6 System uncoupling

When a service follower will detect that the current service leader is no more part of the network, it will try to start a role arbitration procedure with the other service followers.

If no other leader is present in the network, it will become the service leader.

4.6.7 Interaction between on-board services and ground services

The FBS of each subsystem shall be defined taking into consideration the need to have function carriers located on the ground, rather than on board.

At service level, this shall be handled transparently, as each service will interact with other services, with no need to be aware of where they are physically located.

Figure 25 shows the relationship between the on board service space resulting from the mastership process and the ground service space. On the vehicle, an OMTS on-board to ground communication interface (OMTS-IF) is used to access the subsystems inside that consist. Such interface is responsible for caching data retrieved from the subsystems, routing request to the subsystems, embed adapters for legacy subsystems, i.e. subsystems that have a proprietary interface and do not implement the OMTS interface. Subsystems that should be integrated natively, i.e. without an adapter, need to implement the OMTS-IF interface.

The board-to-ground communication interface is described in IEC 61375-2-6.

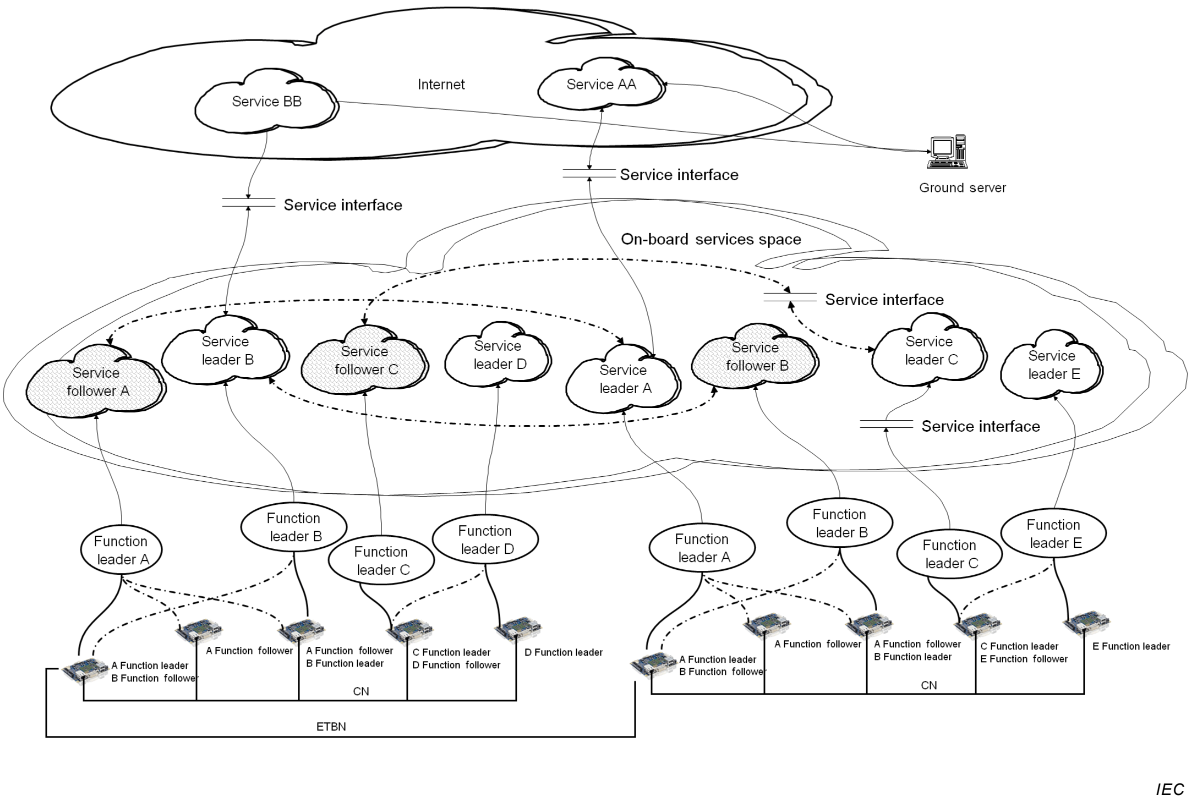

Figure 25 – Interaction between on-board services and ground services

The service leader will be in charge of handling board-ground messages.

5 Use cases

Some use cases relevant to the OMTS are reported in Annex D.

6 Conformity statement

Conformity test statement or methods shall be defined in Part 2 and possible future parts of this standard, according to the methodology described in ISO 9646 and referred to the messages exchanged on the OMTS external interfaces.

Annex A
(informative)

OMTS classification

A.1 Identification of On-board Multimedia and Telematic Subsystems and Services

For the purposes of this standard, the following criteria apply:

a) On-board Multimedia and Telematic Subsystems (OMTS) are non-operational subsystems, in the sense that the lack or failure of their services cannot in general prevent the train from performing its operational mission.
b) OMTSs are ICT applications. Therefore Services have to be intended as “ICT services” which are related to the implementation of functions relevant to an OMTS subsystem. They can be better organized according to a Service Oriented Architecture and implemented as Web Services.
c) OMTS can include one or more subsystems. The 4 OMTS categories defined in this standard series are subsystems.
d) OMTSs are defined by means of functional blocks which provide or use services.

OMTSs are not limited to entertainment and audio-video only, even if this is the common understanding of many people. Due to such misunderstanding, they consider strange or inappropriate to include under the OMTS denomination also services relevant to the driver, crew, operator or maintainer.

OMTSs deal with electronic production, coding/decoding, processing and exchange of information which is not directly relevant for train operation.

A service is to be classified as OMTS service if its own provision of the discrete (sub)function is classified in the multimedia and telematic domain, independently from the nature of the function carrier and the (sub)systems that provide or use such service; e.g. an OMTS function can be implemented as part of a TCMS (Train Control and Monitoring System) (sub)system.

EXAMPLE Request for access ramp from a handicapped passenger.

As a consequence of the above statements, services can be considered in the scope of IEC 62580 series when they can be qualified as non-operational Multimedia and Telematic services (in a broad sense), while Operational and Communication services are out of scope.

A.2 OMTS category A: Video surveillance and CCTV services (IEC 62580-2)

The Video surveillance/CCTV (Closed Circuit TV) is an OMTS subsystem (category A) providing services focused on the surveillance and the security of the train and passengers. It uses video/audio capture, processing, encryption, recording, transmission and display functions to realize each service.

The Video surveillance/CCTV services can include (list is not exhaustive):

– Rear-view mirror: live videos from rear cameras are used to help the driver during normal manoeuvring.
– Exterior look: live video from external cameras on the sides of the vehicle and betting on the doors, help the driver during the opening and closing of doors in the station.

- Incident management: continuing video recording from forward cameras are used by train operator, infrastructure and other companies to aid the management and identification of responsibilities of accident.
- Passenger alarm: through the emergency buttons on the vehicle, passengers can alert the crew. Internal cameras video can be:
  - recorded a few seconds/minutes before and after the alarm, to be used by operators or the police,
  - displayed to train operators to help them in the management of the alarm.
- Motion detection alarm: motion detection can be useful to help operators and the police in identifying intruders inside the vehicle. Video from on-board cameras can be recorded a few seconds before and after the alarm happens.
- Image recognition alarm: image recognition algorithms can be used to detect suspicious objects (e.g. luggage unattended). Video from on board cameras can be recorded a few seconds before and after the alarm happens.
- Interior look: continuing video recording from interior cameras are used by train operator and police for surveillance and security issues (according to privacy rules).
- Interior listening: remote activation of interphones can be used to monitoring audio of the passenger compartment. Audio, heard in real time or recorded, can be used by train operators and police for surveillance and security issues (according to privacy rules).
- Retrieving of encrypted video recorded clips by Authorized Body (surveillance and security issues according to privacy rules).

A.3 OMTS category B: Driver and crew orientated services

The services providing communication between the train driver and the ground centre do not include services requiring safe communication, e.g. the communication relevant to ERTMS or to equivalent train control systems.

The train driver and crew orientated services can include the following examples (list is not exhaustive):

- Services providing communication between the train driver and the ground centre: exchange of driver advisory information, amendments to the electronic route book
- Energy management: green driving style, energy monitoring for saving purposes
- Fuel management (diesel traction unit): green driving style, fuel consumption monitoring for saving purposes
- Incident management and recovery: considering information exchange only
- Services using audio communication: e.g. cab to cab calls
- Services using handheld devices with wireless access: e.g. electronic ticketing
- Services using HMI and console: programming, controlling and monitoring on board audio/video systems
- Services providing communication between the crew and the ground centre.

In terms of information, the following items represent important, even if not exhaustive, examples:

Information for the crew

- due to delayed connections
- due to security / safety related issues (terror warnings, accidents)
  - which cannot be published by PIS
  - which can be forwarded to PIS
- train behaviour, e.g. air conditioning failure, technical anomalies

- information flow control to crew´s end devices (PDA, mobile phones)
- recognition and authorisation of crew´s end devices
- communication control to the relevant crew members (in case of multi train unit for different directions)
- handling of missing / stolen / absent end devices
- administration of user´s classes
- implementation of bidirectional traffic / decision for one-way traffic
- implementation of crew intercom systems (e.g. via Voice over WLAN per end device)
- implementation of train-external communication (via mobile communication gateway)
- integration of crew´s end devices for e.g. passenger seat reservation (clearing or booking instance, ticketing, internet billing, internet accessing)
- functionality of crew´s end device for an active intervention on the train´s system (e.g. control of air conditioning, audio/video-system, lighting system)
- definition of a border of functionality to enter PIS-relevant data (e.g. short messages to be displayed)
- definition of a border of functionality to view CCTV-relevant data – interface to IEC 62580-2 has to be defined
- functionality to display how crowded a train is
- possibility of ordering snacks or beverages

Information to the driver:

- train behaviour, e.g. air conditioning failure, technical anomalies
- requirements for forwarding to maintenance introduction
- handling of information coming from TCMS and/or non-operational relevant systems
- administration of user´s classes
- recognition and authorisation of drivers´ end devices
- implementation of bidirectional traffic / decision for one-way traffic
- integration into existing communication devices (e.g. HMI)
- integration of additional services, e.g. driver´s assistance service

A.4 OMTS category C: Passenger orientated services

Passenger orientated services can be divided into:

- Passenger information services
- Passenger entertainment services

The passenger information subsystems provide to the passengers services like text, audio / video information related to the train operation. It also covers the passenger and crew communication.

Passenger information services include (list is not exhaustive):

- Interior / exterior signs: announcements triggered automatically (by location) or statically (by crew) may provide some useful information to passengers like: train and car number, starting and terminal station, next stop, current stop, time, special messages and indication of exit side.

- Public address: announcements triggered automatically (by location) or statically (by crew) may provide some useful information to passengers as the current station, the next station and other operational information.
- Passenger Emergency Intercom: the passengers can start emergency communication, with on-board or ground crew, using emergency interphones on the vehicle.
- Passenger announcements: on-board or ground crew can diffuse some communication to a part or all vehicles of the train.
- Incident management Information to the passengers related to unexpected events
- Seat reservation: passengers and crew shall be able to know if a place is booked about track section. The crew shall be able to see more details to verify the passenger ticket.

The passenger entertainment area is focused on providing the passengers with video/audio entertainment and communication services, including (list is not exhaustive):

- Personal Audio: passengers shall be able to listen music through earphones, to select their favourite channel and adjust the volume. The crew shall be able to select different programs for each vehicle.
- Passenger Audio/Video advertisement: provides a combination of information and entertainment. The crew shall be able to select different programs for each vehicle.
- Internet access: passengers with their own internet enabled device may access the Internet (electronic mail, browsing web sites, etc.). The crew shall be able to choose different bandwidth options for each vehicle.
- Video on demand/selection from a list of programs: passengers shall be able to select and view a specific video, on demand. The crew shall be able to select different programs for each vehicle.
- Background audio program: through internal loudspeakers background music is played for passengers (muted during PA announcements). The crew shall be able to select different programs for each vehicle. Allowed audio sources can be MP3 and other digital formats, public analogue or digital radio and other supports (e.g. DVD, BD, etc.).
- Travelling information: additional route information (speed, temperature, remaining travel time, timetable, connections) and service offers (restaurant, bar) can be proposed to passengers. The crew shall be able to add manually some information for each vehicle.

A.5 OMTS category D: Train operator and maintainer orientated services

Nowadays the train operator and the maintainer may be from different companies. Some services on board can be remotely invoked by the train operator and/or the maintainer from ground.

Some of the services can require interaction between the personnel on board and the train operator/ maintainer on ground.

The services relevant to monitoring, diagnosis and maintenance should have interfaces in order to be invoked also by personnel on board, e.g. when the train is stopped in the depot.

Example of the train operator and maintainer orientated services can be the following (list is not exhaustive):

- Remote monitoring and diagnosis: including telemetry
- Remote maintenance: including access to the technical documentation and maintenance procedures. Spare parts management
- Fleet management: quality of services monitoring and management, incident management and recovery (traffic management is not included)
- Energy management: energy consumption measuring and transmission to ground, green driving style, energy monitoring for saving purposes

– Fuel management (diesel traction unit): fuel consumption and transmission to ground, fuel consumption monitoring for saving purposes, fuel and lubricant life cycle management

The following function/services are listed as a non-exhaustive examples:

Maintainer orientated service

- Accreditation of the maintainer (the maintainer may be the manufacturer, the operator or a third party).
- Decision of forwarding the traffic to the service yard / the depot
- Handling of software updates for executable files
- Handling of software updates for non-executable files
- Recognition and authorisation of maintainers´ end devices
- Handling of traffic according to different access points for maintenance (e.g. PIS-network, gateways, wireless interface)
- Handling of service application
  - From back-office
  - From local device
  - Definition of service end point (gateway, application)
- Version management
- Usage of proprietary software vs. standardisation (e.g. vnc client or vpn tunnel)
- Integration of existing software structures in the background / back-office
- Usage of end devices for enabling a software download
- Integration of software download in existing train maintenance concepts

Train operator orientated service

- Strong differentiation between maintainer and operator orientated service is required, as there are concurring value flows (e.g. passenger counting systems based revenues)
- Definition of the train operator´s role (to distinguish between himself and ordered 3rd party applications)
- Decision of forwarding the traffic to the service yard / the depot
- Handling of software updates for executable files (interface to TCMS-relevant systems necessary)
- Handling of software updates for non-executable files (e.g. time schedule updates, reservation data for PIS)
- Definition of temporarily available users (e.g. inspectors)
- Display service of current train state to train operator´s network operation centre (NOC)
- Definition of the possibility of interaction from NOC to train (e.g. announcements)
- Handling of train delay and train connection related issues
- Definition of interfaces to train operator´s and third party applications´ data services
- Definition of ownership and responsibility for data transport services (in order to handle responsibility for a possibly delayed / cancelled transmission)
- Definition of border/interface related to the train to ground communication specified in IEC 61375-2-6
- Border to third party ground-situated services (e.g. video content management, advertisements).

Annex B
(informative)

FBS, SBS and common structure guidelines

B.1 Introduction

This informative annex provides guidelines to the application of the Functional Breakdown Structure (FBS) and the System Breakdown Structure (SBS) to the categories of the OMTS. It is based on the existing drafts of the EN 15380 series prepared by the CENELEC TC 256.

Finally some guidelines related to the structure of Part 2 and possible other future parts of this standard series are presented in Clause B.4.

B.2 Functional breakdown structure

B.2.1 General

The Functional Breakdown Structure (FBS) is used by all parties involved in the rolling stock product definition phase and the following processes to structure the functional requirements and use cases according to a standardized list of functions. It starts with the concept and spreads across the whole product life cycle. During this period the level of detail of the structure could be adapted according to the project progress. This means that functions in a product concept catalogue are mainly described by requirements. The transfer into implementable hardware and software elements takes place later.

The Functional Breakdown Structure (FBS) and the System Breakdown Structure complement each other. While the SBS, consisting of the standardized list of subsystems and devices, is used for structuring system requirements and related use cases, the FBS standard describes the functions of a vehicle and is used to get a correlation between functional requirement and the structure of functions even as for the related use cases. These structures (SBS and FBS) describe different views on the rolling stock.

B.2.2 Functional structure – Function levels

Functions are grouped into levels regardless of their vehicle specific technical realization. Hence the function groups and function descriptions were developed without considering how each function may be achieved in practice.

The hierarchy of the functional groups serves as a guideline when creating functional structures. Functions are realised at the technical level as hardware and software within hierarchically structured units. Although the units interact at the functional level, they may be spatially separated from one another.

Expanding the functions, elementary functions and characteristic features is possible within the scope of this standard. Whether it is necessary to make use of this option will depend on the specific application being considered.

Changes of the existing functional levels should be avoided.

Functional units can be associated with several functions. A single function can be distributed over several functional units.

EN 15380-4 uses the following key terms, which are defined in Clause 3 of this standard:

- Function
- Functional Breakdown Structure (FBS)
- Function level: level to group functions of equal purpose
- 1st level function (functional domain)
- 2nd level function (main function)
- 3rd level function (subfunction)

The following list enumerates some of the 1st level functions defined for rolling stocks:

a) Carry and protect passenger, train, crew and load
b) Provide appropriate conditions to passenger, train crew and payload
c) Provide access and loading
d) Connect vehicles and/or consists
e) Provide energy
f) Accelerate, maintain speed, brake and stop
g) Provide train communication, monitoring and control
h) Support and guide the train on the track
i) Integrate the vehicle into the complete system railway
j) Provide multimedia services to passenger, driver, crew, operator and maintainer

B.2.3 Subordinate level functions

For 1st level functions, listed in item j) of B.2.2, the corresponding sub-functions are defined comprehensively at 2nd, 3rd and 4th level for all functional multimedia categories.

B.2.4 OMTS breakdown example

Table B.1 shows how the OMTS can be allocated into the FBS. This is only an example so it is not mandatory and exhaustive. The actual breakdown structure is shown in each relevant OMTS category defined in this standard.

Table B.1 – Example of FBS

2nd level function		3rd level function		4th level function	
1	Provide Video surveillance and CCTV	1.1	Provide external view	1.1.1	Provide live video of the side of the vehicle and betting on the doors from on-board external cameras
				1.1.2	Provide live video of front view from on-board cameras
		1.2	Provide incident management	1.2.1	Provide means to the passenger to alert the crew
				1.2.2	Provide means to the passenger to force the video recording
		1.3	Provide video recording of trains interiors	1.3.1	Provide continuous video recording from interior cameras
				1.3.2	Provide motion detection alarm and consequently recording
		1.4	Retrieving of encrypted video recorded clips	1.4.1	Provide authentication and authorized to grant access to the recorded video files
				1.4.2	Provide search and display of granted video files
2	Provide driver and crew orientated services	2.1	Provide driver orientated	2.1.1	Provide audio communication between the train driver and the ground centre

2nd level function		3rd level function		4th level function	
			services	2.1.1	Provide information to assist the driver (e.g. optimal speed for energy saving)
				2.1.3	Provide information on time table and amendment of train route
		2.2	Provide crew orientated services	2.2.1	Provide electronic ticketing
				2.2.2	Provide access to time table and other relevant information for connecting transport systems (e.g. busses, boats, planes)
				2.2.3	Provide audio communication between the crew and the ground centre
3	Provide passenger orientated services	3.1	Provide passenger information	3.1.1	Provide visual information with interior / exterior signs
				3.1.2	Provide seat reservation information
				3.1.3	Provide audio information by public address
				3.1.4	Provide passenger emergency Intercom
		3.2	Provide passenger entertainment	3.2.1	Passenger audio/video advertisement
				3.2.2	Provide video on-demand
				3,2,3	Provide personal audio program
				3,2,4	Travelling information
				3.2.5	Provide internet connection
4	Provide train operator and maintainer orientated services	4.1	Provide services to the operator	4.1.1	Provide services for fleet management in terms of quality of services monitoring and management
				4.1.2	Provide services for iIncident management and recovery
				4.1.3	Provide energy measurement for billing
				4.1.4	Provide energy saving services
		4.2	Provide services to the maintainer	4.2.1	Remote monitoring and diagnosis
				4.2.2	Provide telemetry
				4.2.3	Provide access to technical documentation and maintenance procedures
				4.2.4	Provide services for spare parts management

B.3 System breakdown structure

The system requirements are presented and specified for each relevant category of OMTS on the base of the System Breakdown Structure.

The following three levels are considered:

At level 1 the structure includes main systems, the relevant main system for OMTS according to the four categories.

At level 2 there are the subsystems of each main category.

At level 3 there are the various devices of the relevant OMTS subsystem.

B.4 Guidelines common to all service categories

B.4.1 Basic structure common to all parts

The following basic structure is recommended for Part 2 and possible future parts of this standard:

- Scope (definition of category)
- Requirements
  - Interoperability objectives should be exposed
- System breakdown structure
- Functional breakdown structure
- Abstract model
  - Components
  - Interfaces (for each component)
  - Services (for each interface)
  - Messages (for each service)
- Options
- Conformance testing

B.4.2 Common guidelines

Service definition should follow the methodology described in 4.4.2.

For better description and easier implementation, services description should be divided into two parts:

a) Formalism readable by train experts, not necessarily communication language experts

b) Formalism in an annex describing the protocol as a direct mapping of what will be exchanged by the devices and the interaction between them

Abstract Syntax Notation One (ASN.1) is a standard and flexible notation that describes rules and structures for representing, encoding, transmitting, and decoding data in telecommunications and computer networking. The formal rules enable representation of objects that are independent of machine-specific encoding techniques.

ASN.1 formal notation is the nearest from WSDL, and quite readable. SBS and FBS can also be described by ASN.1 Specification in ASN.1 are directly machine processable to generate a schema and integrate in the service oriented architecture (it will be also possible to import in ontology later).

An example is given in Annex C.

Annex C
(informative)

Example of formal specification

C.1 Example of formal specification

This example shows how to use formal languages in order to specify the abstract model of a simplified door subsystem.

C.2 Scope

The scope of this annex is to manage some display inside a car. The passenger can have some interaction with an input device.

C.3 Requirements

When there is no passenger action, some default information about the journey (provided by the operator to the “operation management”) is displayed on the screen. The display itself is managed by the “terminal management” (see Figure C.1).

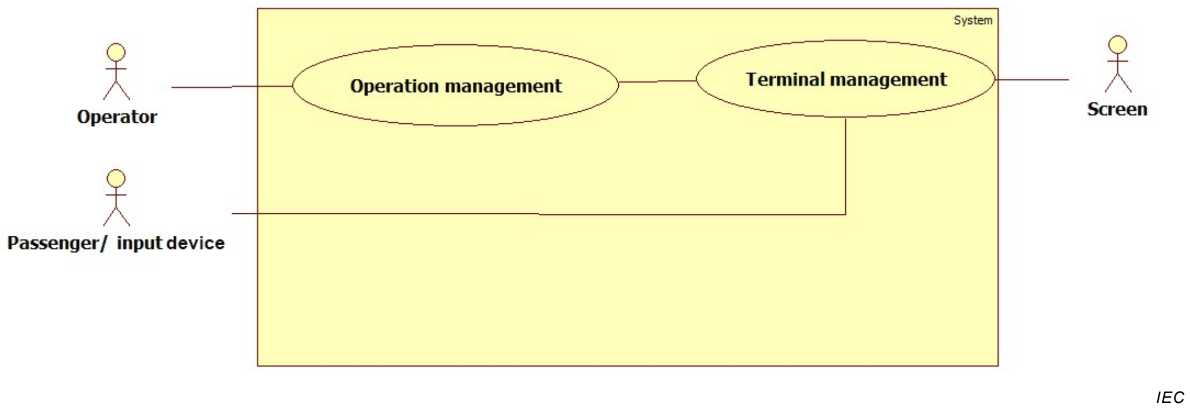

Figure C.1 – Display management

Through some input managed by the “terminal management” the passenger can modify the information displayed on the screen.

The passenger, using an input device can directly interact with the terminal, requesting the display of specific information.

NOTE For a real display terminal description this clause would also contain a lot of other electrical and mechanical constraints.

C.4 System Break Down Structure

Our current car system is composed of two subsystems (see Figure C.2):

- another OMTS system
- the terminal

The terminal system has three components:

- The screen which displays information
- The input device to interact with the passenger
- The power to put the terminal on or off

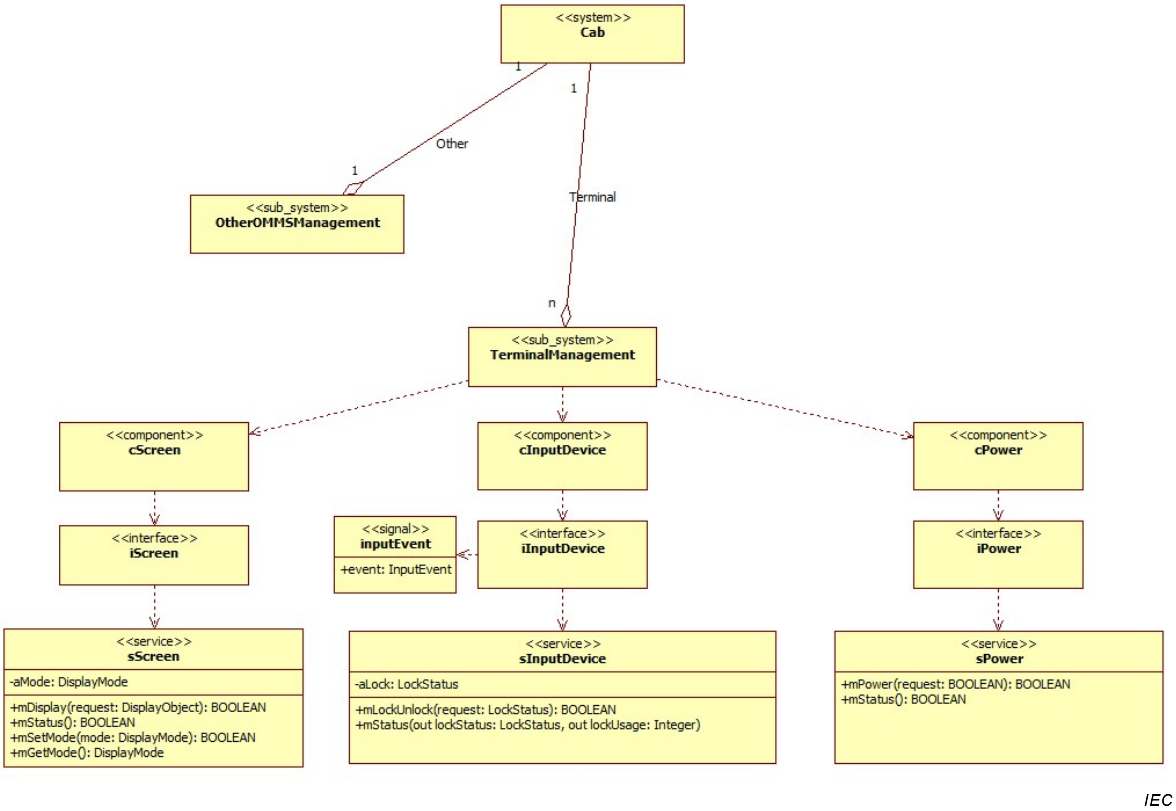

Figure C.2 – Display system breakdown structure

C.5 Function Break Down Structure

A real document should describe all functions. The following example describes the exchange for a standard display.

The power is switched on, the terminal is configured in the appropriate mode for displaying the information, and the information is displayed (see Figure C.3).

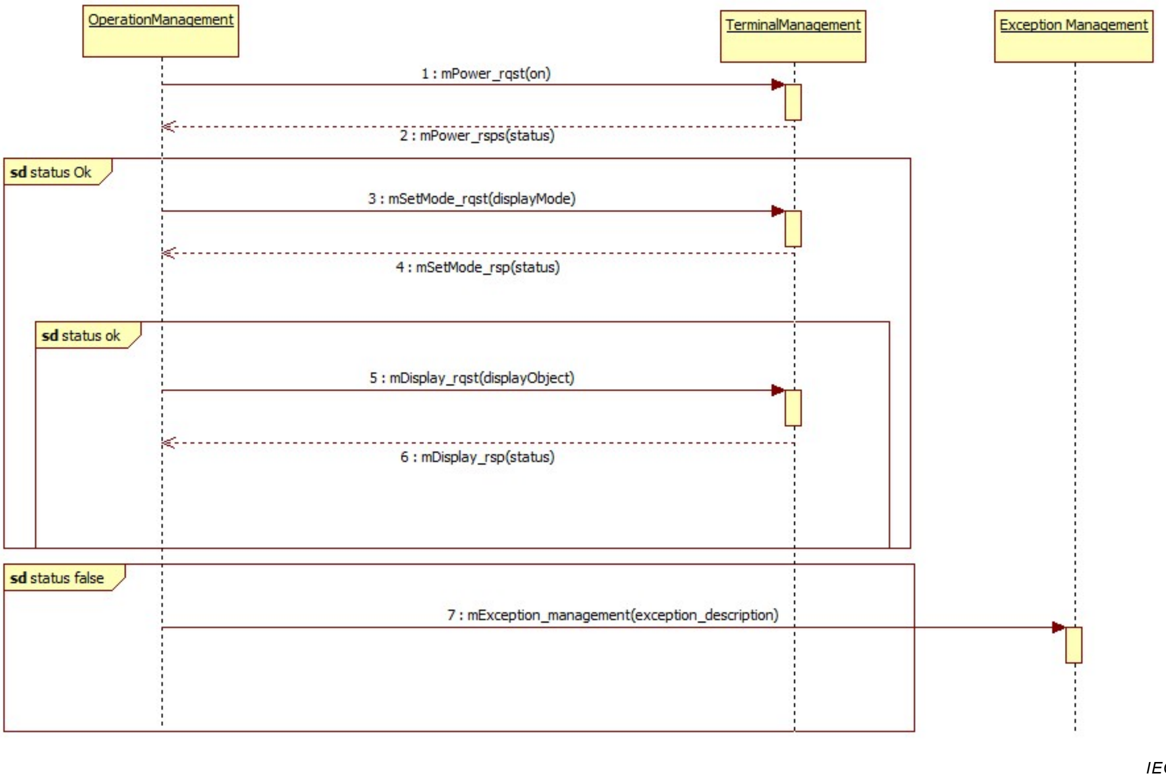

Figure C.3 – Display functional breakdown structure

C.6 Description of the abstract model using ASN.1

```
TrainGrammar
DEFINITIONS EXPLICIT TAGS ::=
BEGIN

    Root ::= Cab;

    ---
    --- Status for response
    ---
    LockStatus ::= ENUMERATED {lock(1), unlock(2)};

    --
    -- DisplayMode is to be defined
    --
    DisplayMode ::= ANY;

    --
    --  Cab : Cab is the whole system and it is composed of many subsystem
    --        which could be also subdivided in subsystems
    --
    Cab ::= CHOICE
    {
        terminalManagement  TerminalManagement,
        otherOMMSManagement OtherOMMSManagement -- any other subsystem
    };

    --
    -- TerminalManagement system
    -- TerminalManagement system  is composed of three components the screen,
    --                              an inputDevice and the power
```

```
--
TerminalManagement ::= CHOICE
{
    cScreen      Screen,
    cInputDevice InputDevice,
    cPower       Power
};

--
-- Screen : the first component of the terminal
--
Screen ::= CHOICE
{
    --
    -- iScreen : the first interface for the screen manage display and mode
    --
    iScreen
        CHOICE
        {
            --
            -- first service for system TerminalManagement/ component Screen
            --
            sScreen CHOICE
            {
                --
                -- mDisplay : display something on the screen
                --
                mDisplay
                    Terminalmanagement_cScreen_iScreen_sScreen_mDisplay,
                --
                -- mStatus : get status of the screen
                --
                mStatus Terminalmanagement_cScreen_iScreen_sScreen_mStatus,
                --
                -- mSetMode : configure the screen for the folowing displays
                --
                mSetMode
                    Terminalmanagement_cScreen_iScreen_sScreen_mSetMode,
                --
                -- mGetMode : get current mode of screen
                --
                mGetMode
                    Terminalmanagement_cScreen_iScreen_sScreen_mGetMode
            }
        }
};

--
-- InputDevice : the second component of terminal manaagement
--
InputDevice ::= CHOICE
{
    --
    -- iInputDevice : interaction with the passenger
    --
    iInputDevice
        CHOICE
        {
            --
            -- sInputDevice : service for input device
            --
            sInputDevice
                CHOICE
                {
```

```
                    --
                    -- mLockUnlock : lock or unlock input device usage
                    --
                    mLockUnlock

            Terminalmanagement_cInputDevice_iInputDevice_sInputDevice_mLockUnlock,
                    --
                    -- mStatus : get status of input device
                    --
                    mStatus
             Terminalmanagement_cInputDevice_iInputDevice_sInputDevice_mStatus
                 }
        }
};

--
-- Power : third component of TerminalManagement
--
Power ::= CHOICE
{

    --
    -- iPower : interface for power
    --
    iPower CHOICE
    {

        --
        -- sPower : sevice for power
        --
        sPower CHOICE
        {
            --
            -- mPower : power on or off the power of the terminal
            --
            mPower  TerminalManagement_cPower_iPower_sPower_mPower,
            --
            -- mStatus : return the status of power : on or off
            --
            mStatus TerminalManagement_cPower_iPower_sPower_mStatus
        }
    }
};

--
-- mDisplay : display some display object
--
TerminalManagement_cScreen_iScreen_sScreen_mDisplay ::= CHOICE
{

    -- the request
    request  DisplayObject,

    -- indicate success
    response BOOLEAN,

    -- error case
    error    ListErrorElem
};

--
-- mStatus : indicates if screen is operational
--
TerminalManagement_cScreen_iScreen_sScreen_mStatus ::= CHOICE
```

```
{

    -- the request
    request  NULL,

    -- indicate success
    response BOOLEAN
};

--
-- mSetMode : configure the mode of screen
--
TerminalManagement_cScreen_iScreen_sScreen_mSetMode ::= CHOICE
{

    -- the request
    request  DisplayMode,

    -- indicate success
    response BOOLEAN,

    -- error case
    error    ListErrorElem
};

--
-- mGetMode : get current mode of the screen
--
TerminalManagement_cScreen_iScreen_sScreen_mGetMode ::= CHOICE
{

    -- the request
    request  NULL,

    -- indicate success
    response DisplayMode
};

--
-- mLockUnlock : lock or unlock the input device
--
TerminalManagement_cInputDevice_iInputDevice_sInputDevice_mLockUnlock ::= CHOICE
{

    -- the request
    request  LockStatus,

    -- indicate success
    response BOOLEAN,

    -- error case
    error    ListErrorElem
};

--
-- mStatus : get status of the input device
--
TerminalManagement_cInputDevice_iInputDevice_sInputDevice_mStatus ::= CHOICE
{

    -- the request
    request  NULL,

    -- give status
```

```
        response SEQUENCE
        {

            -- indicates if locked or not
            lockStatus LockStatus,

            -- number of times the input device was used
            lockUsage  INTEGER
        }
    };

    --
    -- mPower : power on or off the power in the door
    --
    TerminalManagement_cPower_iPower_sPower_mPower ::= CHOICE
    {

        -- true to put power on / false to put it off
        request  BOOLEAN,

        -- response
        response BOOLEAN,

        -- error case
        error    ListErrorElem
    };

    --
    -- mStatus : return the status of power on or off
    --
    TerminalManagement_cPower_iPower_sPower_mStatus ::= CHOICE
    {

        -- request
        request  NULL,

        -- response
        response BOOLEAN -- true if power is on
    };

END
```

Annex WSDL Coding

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<wsdl:definitions xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
      xmlns:tns="http://www.example.org/Display/"
      xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
      xmlns:xsd="http://www.w3.org/2001/XMLSchema" name="Display"
      xmlns:wse="http://schemas.xmlsoap.org/ws/2004/08/eventing"
      targetNamespace="http://www.example.org/Display/">
      <wsdl:types>
            <xsd:schema targetNamespace="http://www.example.org/Display/">

                  <xsd:element name="DisplayObjectElem" type="tns:DisplayObjectType" />
                  <xsd:element name="ListErrorElem" type="tns:ListErrorType" />
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                                          type="tns:LockStatusResponseType" />
                  <xsd:element name="EBoolElem" type="xsd:boolean" />
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                  <xsd:element name="ComplexElem" type="tns:ComplexType" />

                  <xsd:simpleType name="LockStatusType">
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                              <xsd:enumeration value="lock" />
                              <xsd:enumeration value="unlock" />
                        </xsd:restriction>
                  </xsd:simpleType>

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                              <xsd:element name="lockStatus" type="tns:LockStatusType" />

                              <xsd:element name="lockUsage" type="xsd:int" />
                        </xsd:sequence>
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                              <xsd:extension base="xsd:string" />
                        </xsd:simpleContent>
                  </xsd:complexType>

                  <xsd:complexType name="NULL">
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                  </xsd:complexType>
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                              <xsd:element name="index" type="xsd:int" />
                              <xsd:element name="descriptif" type="tns:ListErrorType" />

                        </xsd:choice>
                  </xsd:complexType>
                  <xsd:complexType name="ListErrorType">
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                        </xsd:sequence>
                  </xsd:complexType>
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                        <xsd:simpleType name="TestCounterStart">
                              <xsd:restriction base="xsd:int" />
                        </xsd:simpleType>
                  </xsd:element>

                  <xsd:element name="DisplayModeElem" type="tns:DisplayModeType" />
```

```
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            </xsd:simpleType>
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                  <xsd:restriction base="xsd:int"></xsd:restriction>
            </xsd:simpleType>
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      <wsdl:part name="re_mPower" element="tns:EBoolElem" />
</wsdl:message>
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      <wsdl:part name="rs_mPower" element="tns:EBoolElem" />
</wsdl:message>
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</wsdl:message>
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      <wsdl:part name="e_mSetMode" element="tns:ListErrorElem" />
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      <wsdl:part name="re_mSetMode" element="tns:DisplayModeElem" />
</wsdl:message>
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      <wsdl:part name="re_mPower" element="tns:EBoolElem" />
</wsdl:message>
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      <wsdl:part name="re_mStatus" element="tns:NULLElem" />
</wsdl:message>
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      <wsdl:part name="re_mStatus" element="tns:NULLElem" />
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      <wsdl:part name="rs_mStatus" element="tns:EBoolElem" />
</wsdl:message>
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</wsdl:message>
<wsdl:message name="mGetModeResponse2">
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</wsdl:message>
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      <wsdl:part name="re_mLockUnlock" element="tns:LockStatusElem" />
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```

```
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      <wsdl:part name="e_mLockUnlock" element="tns:ListErrorElem" />
</wsdl:message>
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</wsdl:message>
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</wsdl:message>
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</wsdl:message>
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      </wsdl:operation>
      <wsdl:operation name="mStatus">
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            <wsdl:output message="tns:ScreenStatusResponse" />
      </wsdl:operation>
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            <wsdl:fault name="fault" message="tns:mSetModeFault" />
      </wsdl:operation>
      <wsdl:operation name="mGetMode">
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      </wsdl:operation>
</wsdl:portType>
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            <wsdl:input message="tns:mLockUnlockRequest" />
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      </wsdl:operation>
      <wsdl:operation name="mStatus">
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      </wsdl:operation>
</wsdl:portType>
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      <wsdl:operation name="mPower">
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      </wsdl:operation>
      <wsdl:operation name="mStatus">
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      </wsdl:operation>
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```

```
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            transport="http://schemas.xmlsoap.org/soap/http" />
        <wsdl:operation name="mDisplay">
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            <wsdl:output>
                <soap:body use="literal" />
            </wsdl:output>
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            </wsdl:input>
            <wsdl:output>
                <soap:body use="literal" />
            </wsdl:output>
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                <soap:fault use="literal" name="fault" />
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            </wsdl:output>
        </wsdl:operation>
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            </wsdl:input>
            <wsdl:output>
                <soap:body use="literal" />
            </wsdl:output>
        </wsdl:operation>
        <wsdl:operation name="mStatus">
            <soap:operation soapAction="http://www.example.org/Display/mStatus" />
            <wsdl:input>
```

```
                <soap:body use="literal" />
            </wsdl:input>
            <wsdl:output>
                <soap:body use="literal" />
            </wsdl:output>
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            </wsdl:input>
            <wsdl:output>
                <soap:body use="literal" />
            </wsdl:output>
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            </wsdl:fault>
        </wsdl:operation>
        <wsdl:operation name="mStatus">
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                soapAction="http://www.example.org/Display/mStatus" />
            <wsdl:input>
                <soap:body use="literal" />
            </wsdl:input>
            <wsdl:output>
                <soap:body use="literal" />
            </wsdl:output>
        </wsdl:operation>
    </wsdl:binding>
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    </wsdl:service>
    <wsdl:service name="cPower_iPower">
        <wsdl:port name="sPower" binding="tns:powerBinding">
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        </wsdl:port>
    </wsdl:service>
    <wsdl:service name="cInputDevice_iInputDevice">
        <wsdl:port name="sInputDevice" binding="tns:inputDeviceBinding">
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        </wsdl:port>
    </wsdl:service>
</wsdl:definitions>
```

Annex D
(informative)

Use cases

D.1 General

Three use cases are hereinafter reported which were prepared by the Japanese, the Chinese and the Italian National Committees.

D.2 Use cases of on-board multimedia applications in Japan

D.2.1 General

The following use cases are reported:

- Passenger Information System
- On board Video Surveillance System
- Driver Only Operation (DOO) CCTV

D.2.2 Passenger Information System

The Passenger Information System performs the following functions:

- Dual screen (LCD 15", 17" or 19" x 2) displays, one display for video advertisement and another for train and passenger information
- Spot communication via IEEE 802.11b/g, WiMAX or EHF (Extremely High Frequency) wave for advertisement update
- Real-time communication via dedicated train radio system or 3G mobile phone service for train and passenger Information

The following Figure D.1 shows the system structure.

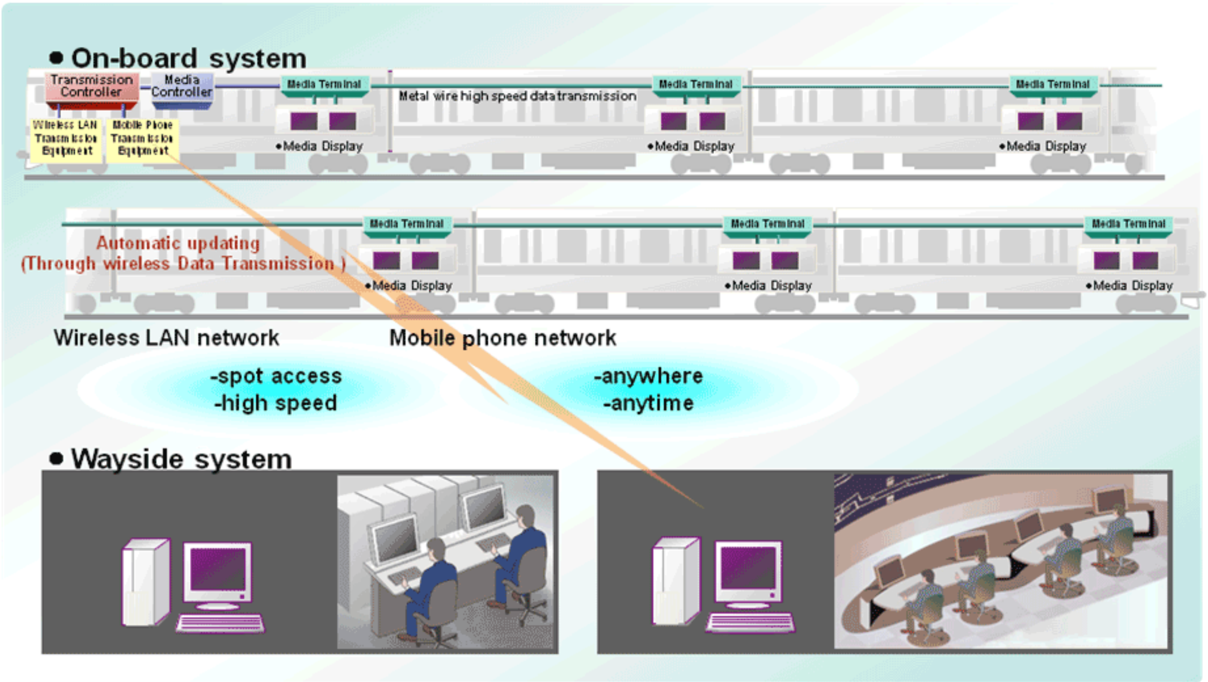


Figure D.1 – Passenger information system structure

The following Table D.1 reports the application on Japanese trains between 2001 and 2010 (the list is not exhaustive).

Table D.1 – PIS applications in Japan

LCD dimension	Number of fleets	Number of cars	LCD sets
15 inch	4	1 624	26 896
17 inch	4	1 252	19 328
19 inch	1	273	3 276
Totals	9	3 149	49 500

D.2.3 On board Video Surveillance System

The On-board Video Surveillance System performs the following functions:

- monitoring doorways and gangways,
- recording video pictures around doorways and gangways.

The following Figure D.2 shows the system structure.

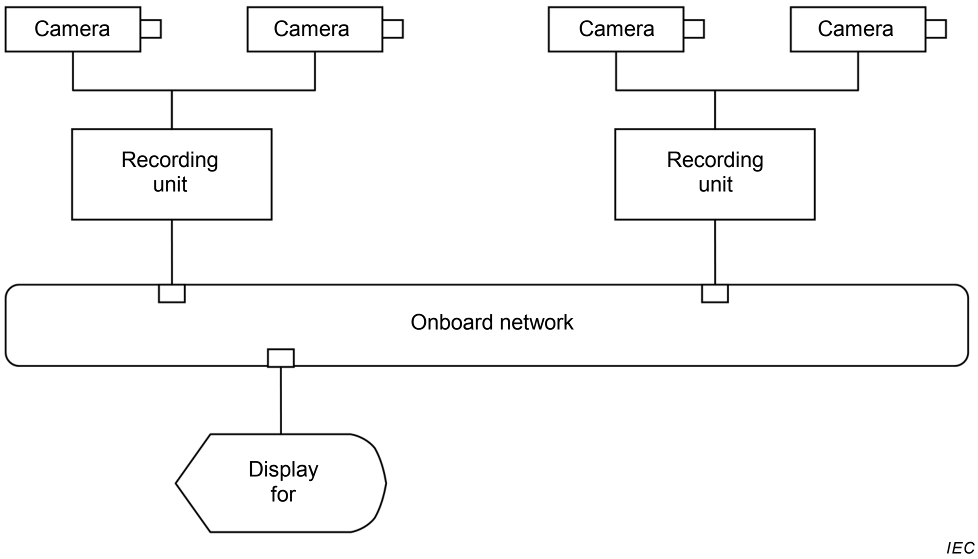


Figure D.2 – On board video surveillance system structure

D.2.4 Driver Only Operation (DOO) CCTV

The Driver Only Operation CCTV System performs the following functions:

- assist a driver in door opening,
- assist a driver in door closing,

displaying passengers passing through platform doors.

The following Figure D.3 shows the system structure.

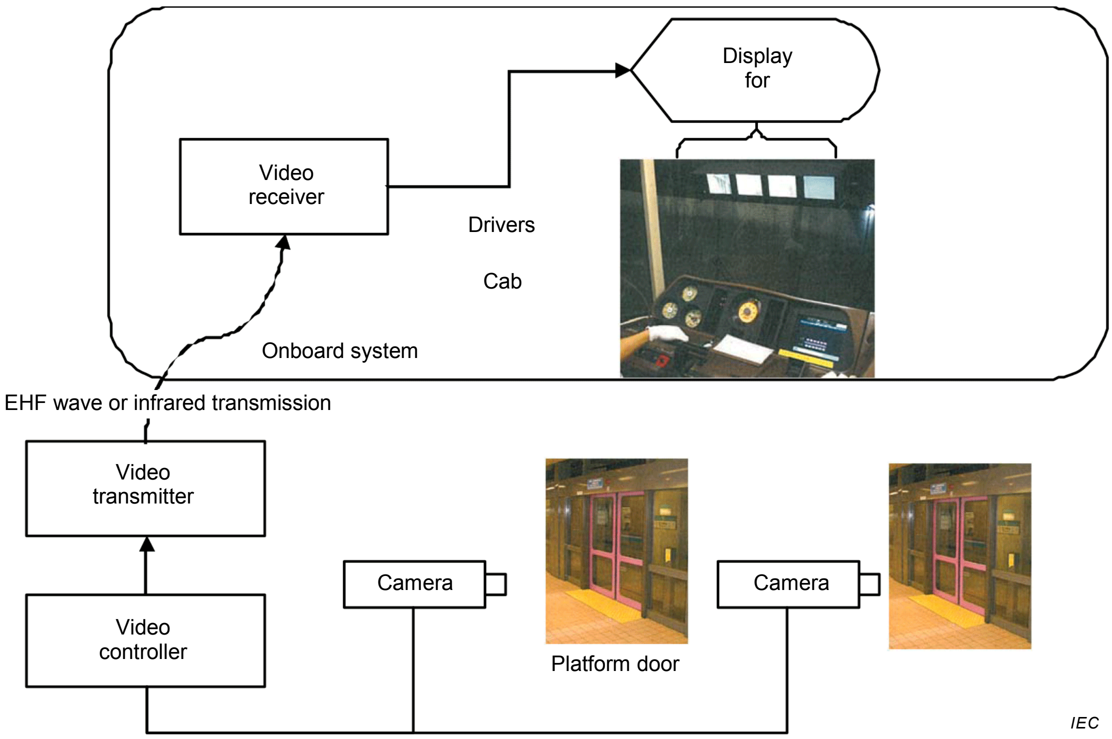


Figure D.3 – Driver Only Operation CCTV System structure

D.3 The China locomotive remote monitoring and diagnosis system

The use case presented hereinafter is the CMD, the China locomotive remote Monitoring and Diagnosis system which is used by:

- the ministry of railways,
- the railway bureaus,
- the railway operators,
- the maintenance centrals,
- the locomotive's drivers,
- the manufacturers.

The following Figure D.4 shows the structure of the system.

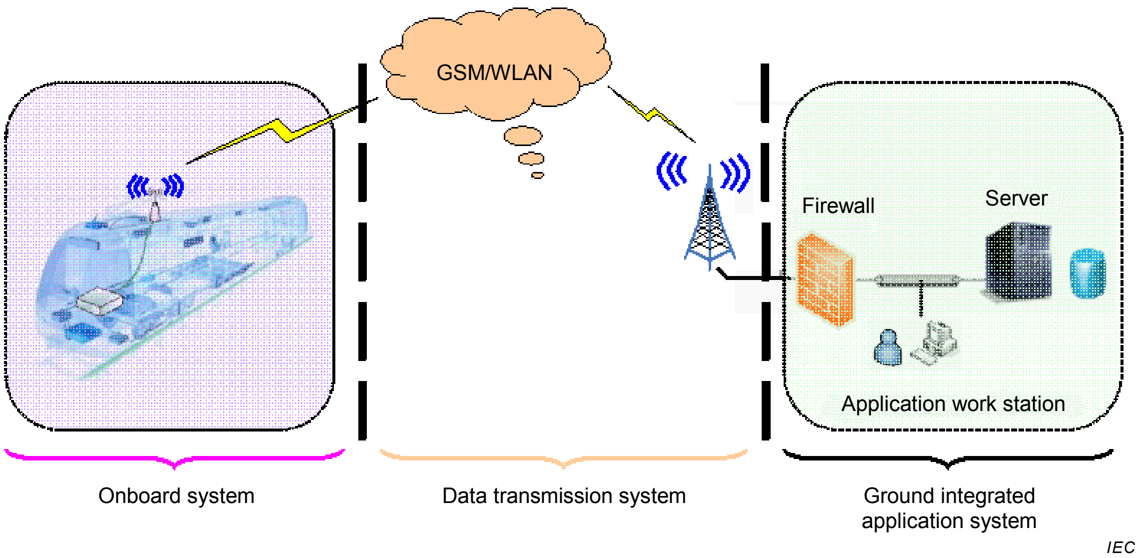


Figure D.4 – China locomotive remote monitoring and diagnosis system structure

The following Figure D.5 shows the detail of the CMD system which is installed on board a locomotive.

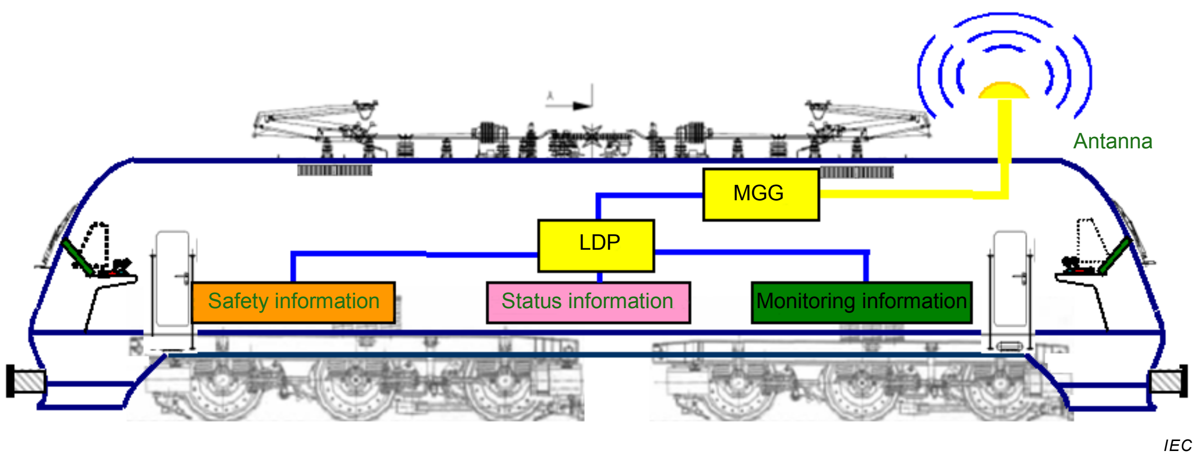


Figure D.5 – CMD system structure

LDP stands for Locomotive on-board general Data monitoring.

MCG stands for Mobile Communication Gateway.

The following information is managed by the CMD:

- Safety information: Information related to the operation safety (e.g. from ATP equipments).
- Status information: Information related to the status and fault data of traction, braking, networks, auxiliary power systems, etc.
- Monitoring information: Mainly referring to integrated monitoring subsystem, such as:
  - CCTV system
  - axle temperature monitoring equipments
  - pantograph detecting equipment
  - track detecting equipments, etc.

The information are collected and recorded on board on LDP and, while in port, the recorded data of the whole course tracking are downloaded to the ground integrated application systems automatically according to the schema shown in Figure D.6.

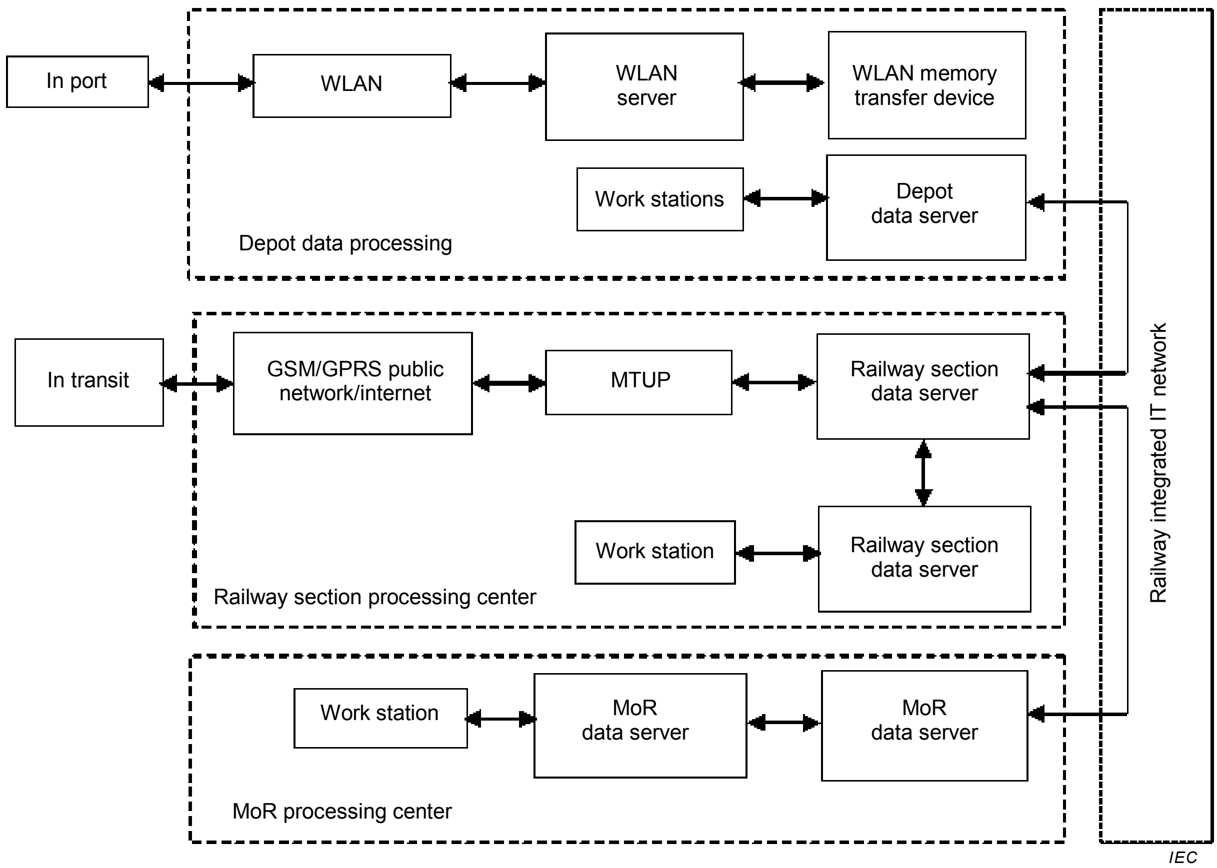


Figure D.6 – Data flow of the remote monitoring and diagnosis system

All the downloaded data are transmitted among Ministry of Railways (MoR), railway bureaus, and locomotive terminals by means of the integrated IT networks shown by Figure D.7.

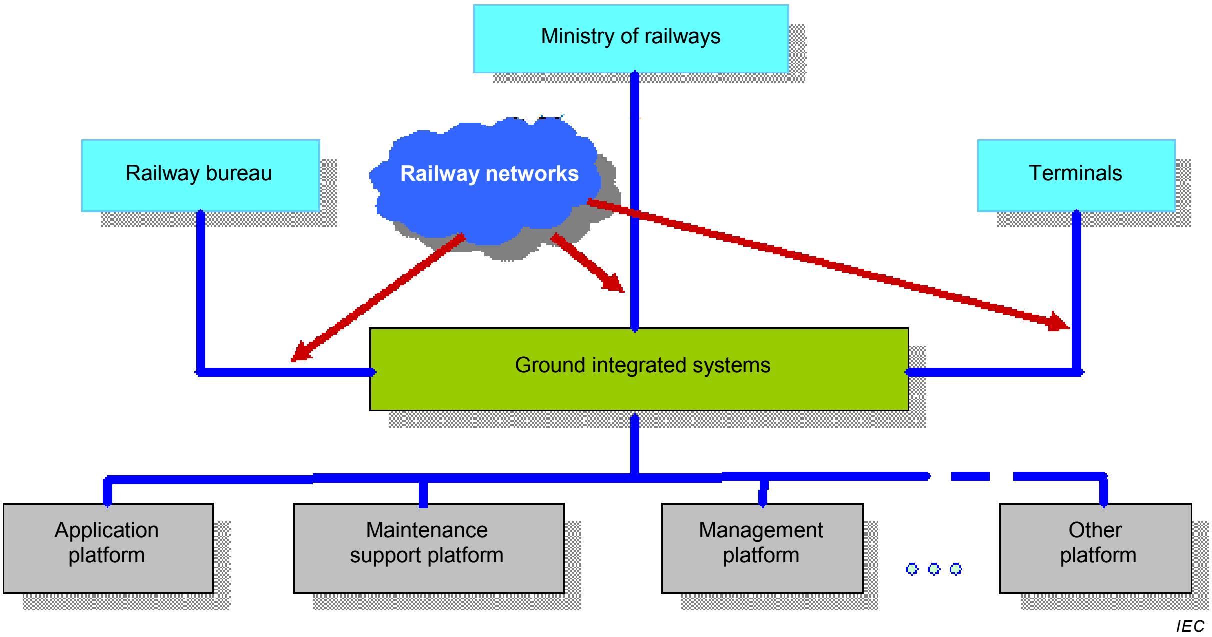


Figure D.7 – Integrated IT network structure

CMD is applied in China:

- in 12 railway bureaus, such as Shenyang, Guangzhou, etc, the MTUP, server, application work stations, and ground system software have been equipped.
- in the main depots of locomotive, AP, application work stations and ground system software have been equipped.
- On nearly 3 000 locomotive units and CRH units, including the HX serials, SS serials, DF serials, etc., which have been equipped with CMD on board equipment.

NOTE HX, SS and DF are locomotives produced in China.

D.4 Passenger orientated services – The Italian high speed train Frecciarossa use case

After two years of research and design efforts the FS-Telecom Italia project is on the home stretch. From December 2010 the Frecciarossa passengers are able to enjoy internet access with their own devices. The Frecciarossa turns into a mobile office, with reliable and good quality radio mobile internet connection.

The radio mobile cellular network coverage is ensured on the Italian high speed rail networks as shown by the following Figure D.8:

Figure D.8 – Radio mobile cellular network coverage

The radio mobile cellular network was specially tuned to support high speed UMTS users.

This was obtained by an ad hoc positioning of the ground cells.

The geometry of the ground cells and their positions with respect to the rail track play an important role on the quality of the coverage, see the following Figure D.9.

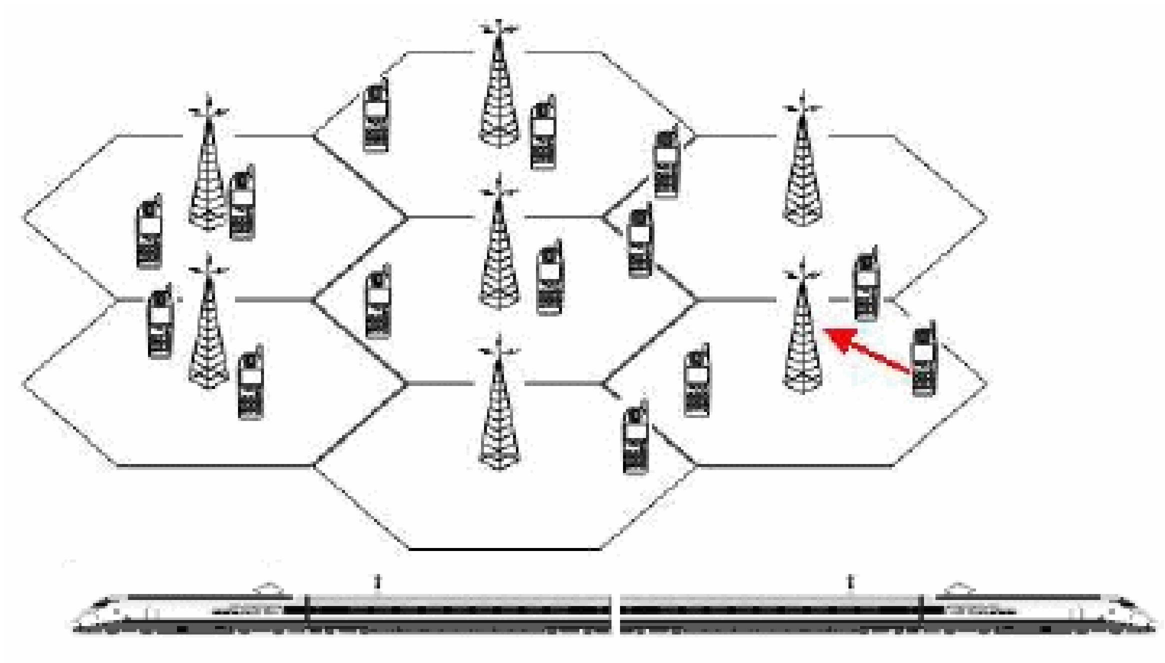


Figure D.9 – Geometry of the ground cells

The network structure is shown in the following Figure D.10.

NOTE SDH (Synchronous Digital Hierarchy), PDH (Plesiochronous Digital Hierarchy), STM-1 (Synchronous Transport Module level-1), WDM (Wavelength Division Multiplexing) are telecommunication protocols or technologies;BS = Base Station, RNC = Radio Network Controller, MSC = Mobile Switching Center, VLR = Visitor Location Register.

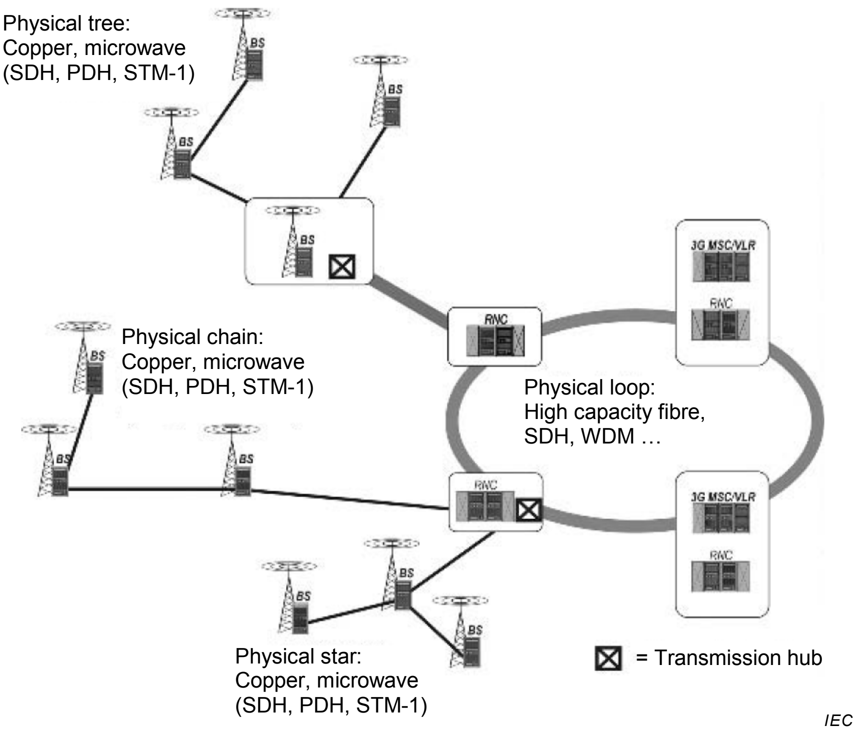


Figure D.10 – Mobile network structure

Figure D.11 shows the download and upload performance obtained by Frecciarossa along the track between the Milano station and Bologna station.

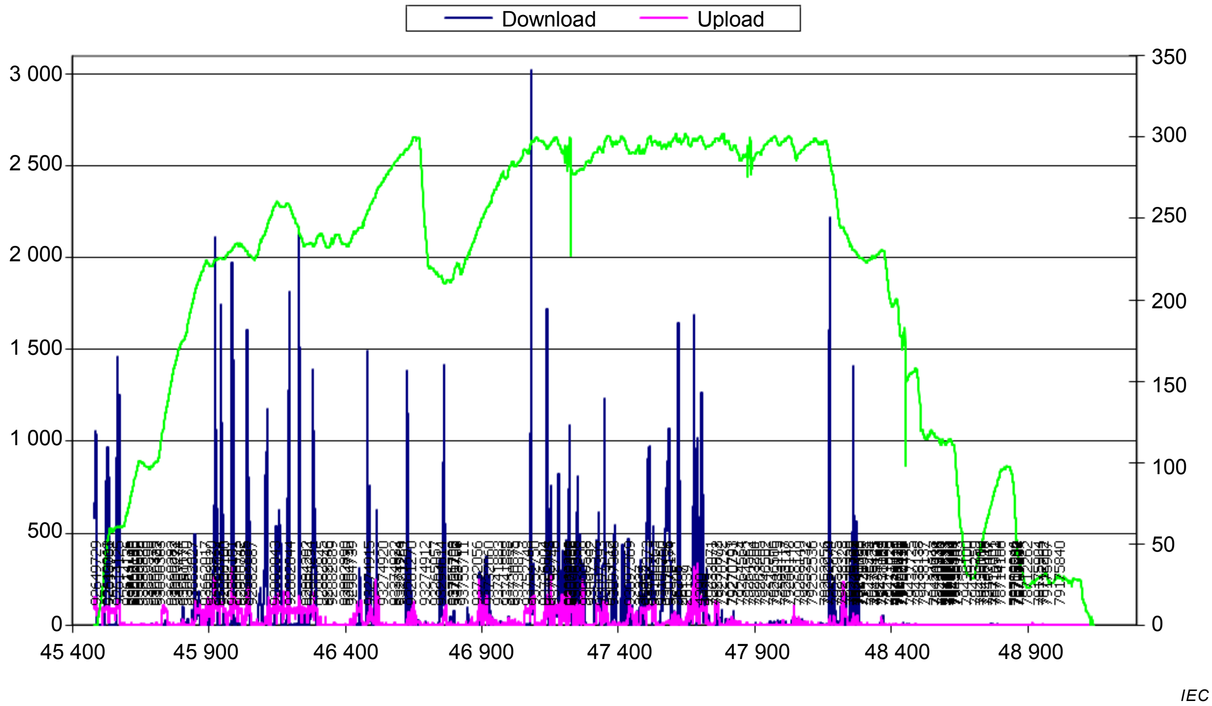


Figure D.11 – Download and upload performance

The Frecciarossa is equipped with on-board WiFi and UMTS communication infrastructure as shown in Figure D.12 and Figure D.13.

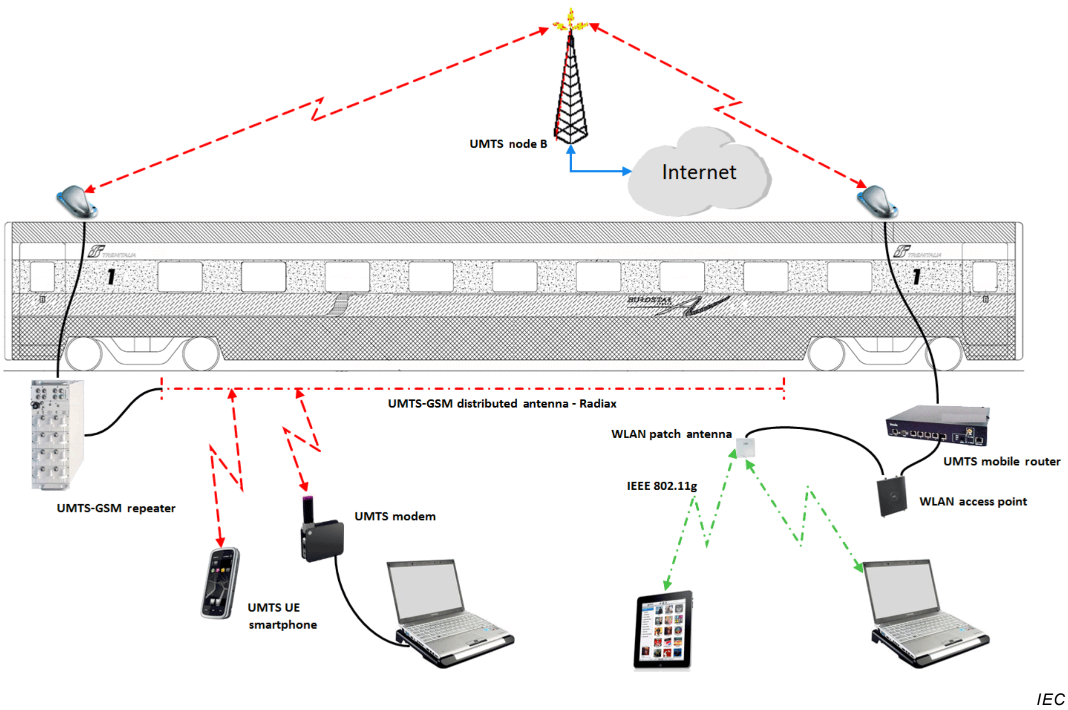
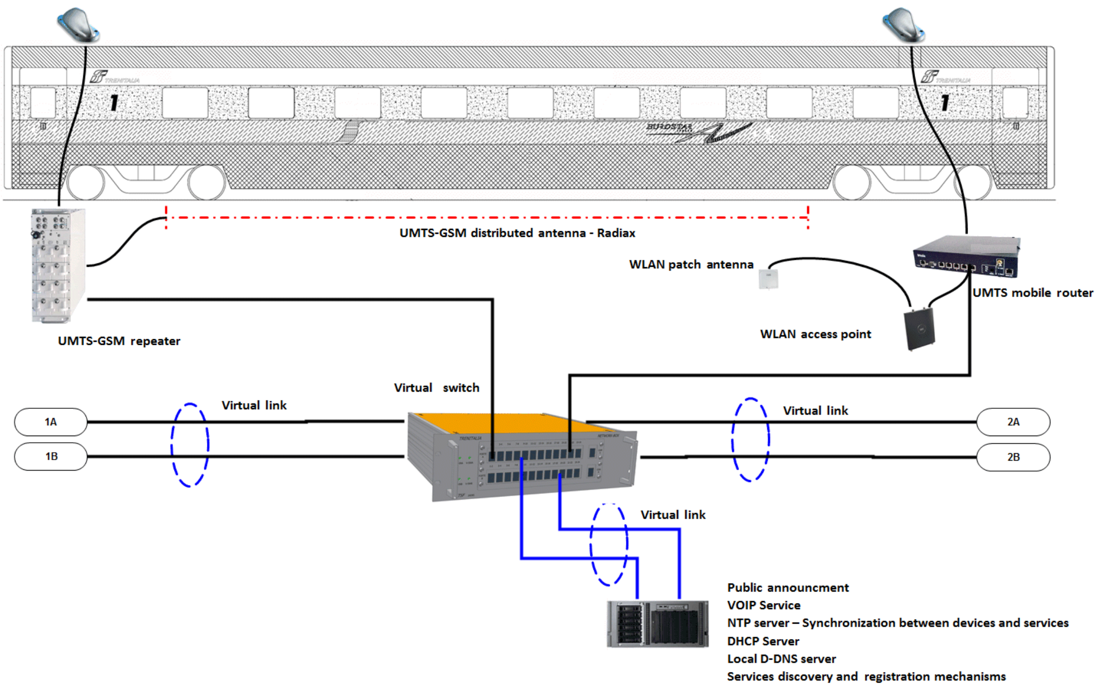


Figure D.12 – On-board WiFi and UMTS communication

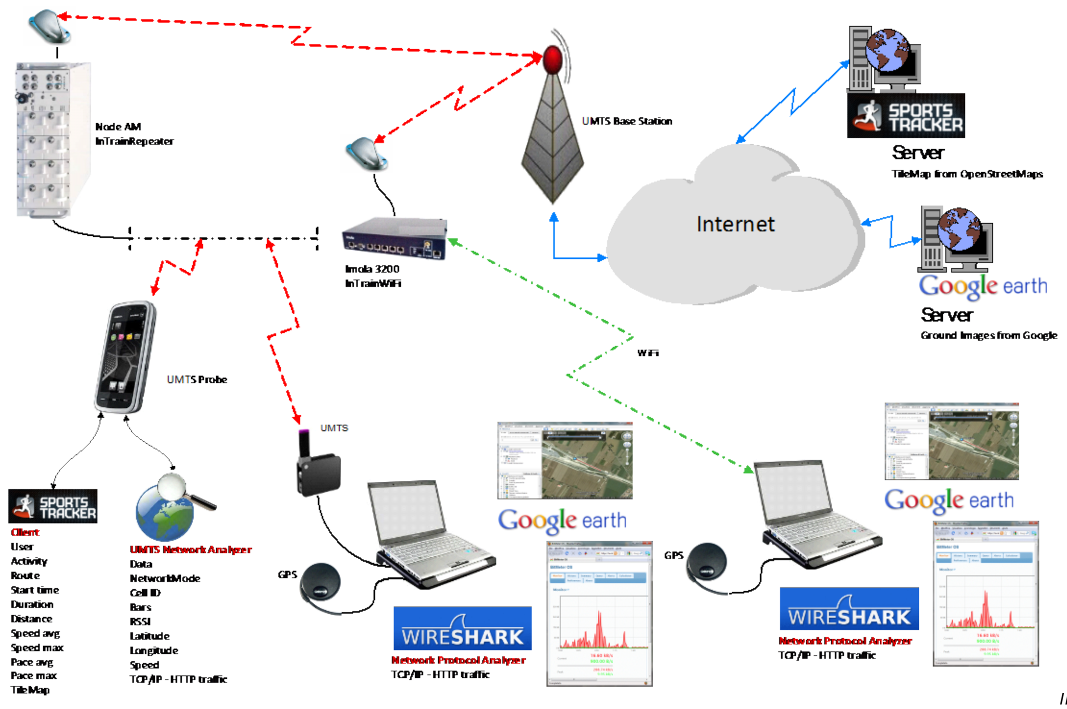


IEC

Figure D.13 – On-board back bone and wireless board to ground communication

NOTE VOIP (Voice Over IP), NTP (Network Time Protocol), DHCP (Dynamic Host Configuration Protocol), D-DNS (Dynamic Domain Name Server).

The performance were tested using the test arrangement shown in Figure D.14. The UMTS probe is based on SymPA v1.0 developed by University of Málaga, Spain.



IEC

Figure D.14 – Performance test arrangement

Annex E
(informative)

Introduction to ontology

The traditional approach to distributed applications design is to define in advance a set of common rules related to interpretation of exchanged message, to be strictly followed by the designers of the different components, so as to achieve the needed level of interoperability. Such an approach implies problems due to possible different interpretation of the specifications, with consequent misunderstanding of message meaning and difficult to diagnose application misbehaviour. Moreover, updating and upgrading of the application becomes a complex and expensive task (see Figure E.1).

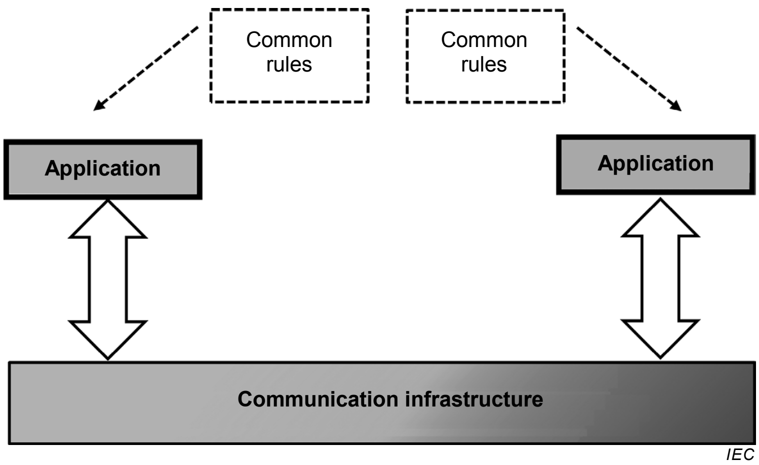


Figure E.1 – Traditional approach

The ontology based approach relies on a common ontology, which can be referenced at run-time in order to get the meaning of information messages exchanged between application services (see Figure E.2).

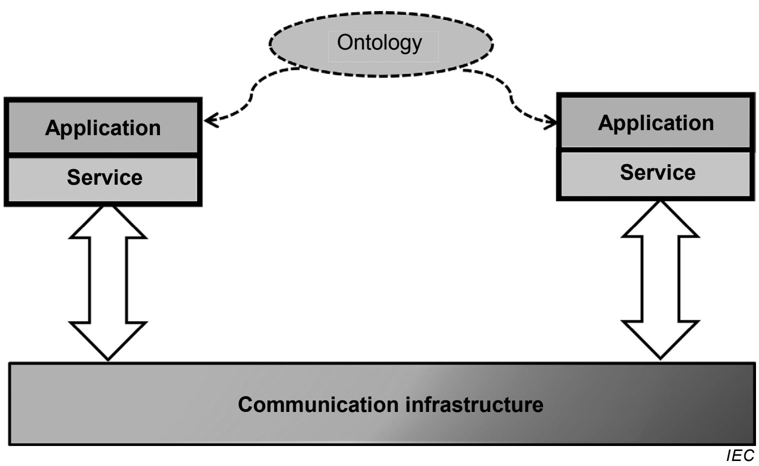


Figure E.2 – Ontology based approach

Such an approach brings a number of benefits in terms of (see Figure E.3):

– Possibility to dynamically upgrade the ontology and therefore extend the application functionality

– Scale up application complexity without exponential growth of integration problems
– Ensure unambiguous interpretation of message meaning and consistency between all defined concepts (with automatic check of it)
– Facilitate elaboration of information using inference techniques, rather than specialised algorithms

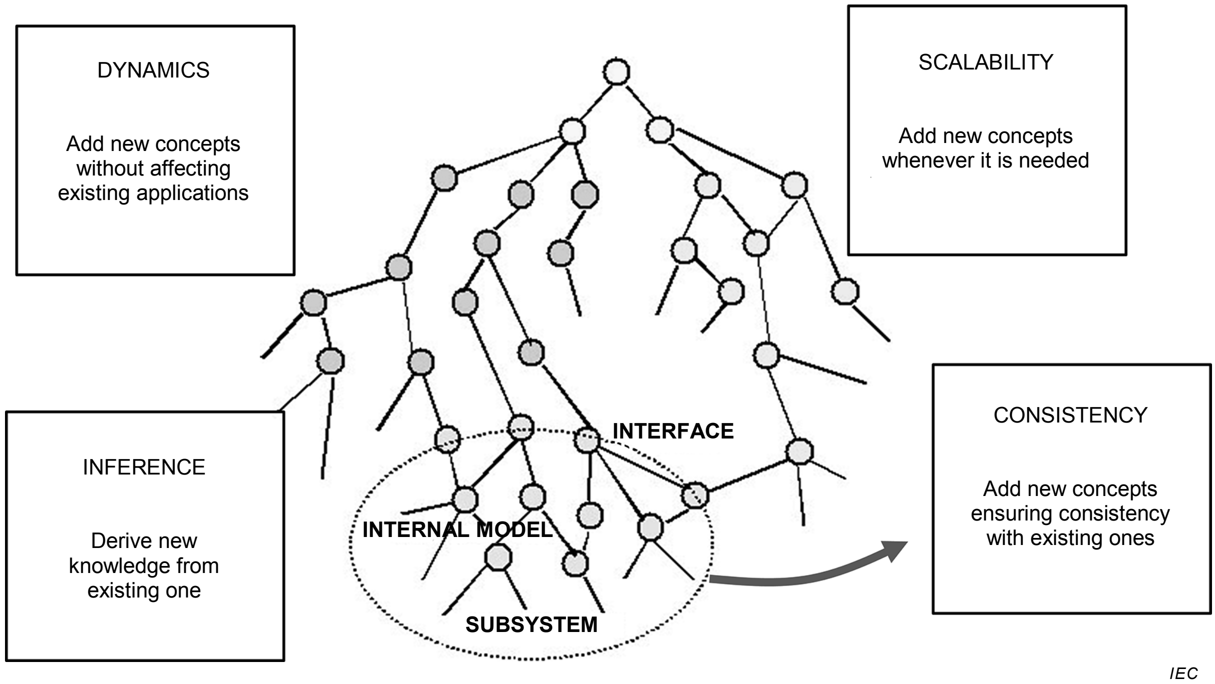


Figure E.3 – Benefits of ontology based approach

The ontology is a hierarchical definition of concepts and their relations, representing a model of a well-defined knowledge domain. It allows to add to data its related context, turning it into really understandable information. In other words, ontology allows to exchange semantically enriched information.

As ontology development in ICT started more than 20 years ago, today there are consolidated languages and use-proven tools which can properly support such technology.

OWL (Ontology Web Language) is one of the most important and widespread languages, well supported by a specific tool, Protégé, developed by Stanford University.

Protégé is a free, open source ontology editor and knowledge-base framework. Protégé ontologies can be exported into a variety of formats including RDF(S), OWL, and XML schema. Therefore, such a tool can be recommended also to generate reliable consistency-checked XML schemas (level 1 – see 4.5.6.2), thus simplifying possible future updates (see Figure E.4).

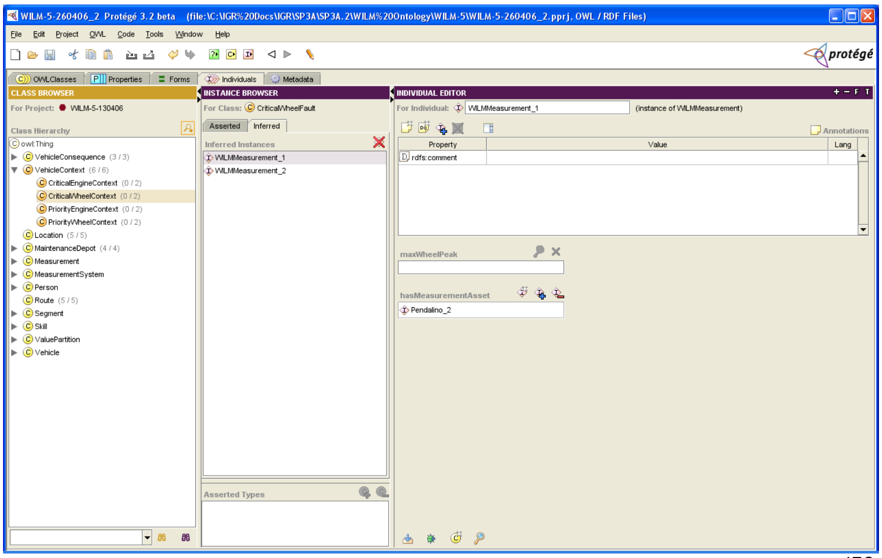


Figure E.4 – Screen shot of Protégé interface

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- *SOA Reference Architecture*, https://www2.opengroup.org/ogsys/catalog/C119
- *ArchiMate® 2.0 Specification*, https://www2.opengroup.org/ogsys/catalog/C118
- http://www.service-architecture.com/web-services/articles/service-oriented_architecture_soa_definition.html
- http://docs.oasis-open.org/ws-dd/discovery/1.1/os/wsdd-discovery-1.1-spec-os.pdf

For an introduction to DPWS and its standardization status:

- *Device Profile for Web Services Version 1.1,* OASIS Standard, 1 July 2009
- *Web Services Discovery and Web Services Devices Profile,* Toby Nixon Co-Chair, OASIS WS-DD TC
- *Web Services Dynamic Discovery (WS-Discovery) Version 1.1*, OASIS Standard, 1 July 2009

For an example of DPWS limited implementation:

- *Introducing Devices Profile for Web Services*, Copyright © 2007 Microsoft Corporation
- *DPWS CORE Version 2.1 User Guide Version 0.9,* March 31, 2009

For an introduction to semantic technologies:

- *Ontology Engineering Manual – InteGRail project,* R. Lewis (UoB), M. Pirker (Siemens), April 2006
- *Predictive maintenance of railway subsystems using an Ontology based modelling approach,* Paper presented at WCRR2011, Paolo Umiliacchi, 23 May 2011
- *Efficient data integration in the railway domain through an ontology-based methodology,* Elsevier publication, Dr. S. Verstichel et al., 2011

Other useful documents:

CEN/TS 15531-1, *Public transport – Service interface for real-time information relating to public transport operations – Part 1: Context and framework*

CEN/TS 15531-2, *Public transport – Service interface for real-time information relating to public transport operations – Part 2: Communications infrastructure*

CEN/TS 15531-3, *Public transport – Service interface for real-time information relating to public transport operations – Part 3: Functional service interfaces (describes individual services and data they work with)*

IEEE 802.11b/g, *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*

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