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BSI Standards Publication

Railway applications — Urban guided transport management and command/control systems

Part 1: System principles and fundamental concepts

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National foreword

This British Standard is the UK implementation of EN 62290-1:2014. It is identical to IEC 62290-1:2014. It supersedes BS EN 62290-1:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/9, Railway Electrotechnical Applications.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Foreword

The text of document 9/1913/FDIS, future edition 2 of IEC 62290-1, 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 62290-1:2014.

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)	2015-05-14
– latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-08-14

This document supersedes EN 62290-1:2006.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62290-1:2014 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
IEC 62236	series	Railway applications - Electromagnetic compatibility	-	-
IEC 62278	-	Railway applications - Specification and demonstration of reliability, availability, maintainability and safety (RAMS)	-	-
IEC 62279	-	Railway applications - Communications, signalling and processing systems - Software for railway control and protection systems	-	-
IEC 62280	-	Railway applications - Communication, signalling and processing systems - Safety related communication in transmission systems	-	-
IEC 62290-2	-	Railway applications - Urban guided transport management and command/control systems - Part 2: Functional requirements specification	EN 62290-2	-
IEC 62425	-	Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling	-	-

CONTENTS

INTRODUCTION

IEC 62290 standard series specifies the functional, system and interface requirements for the command, control, and management systems intended to be used on urban, guided passenger transport lines and networks. This series does not apply to lines that are operated under specific railway regulations, unless otherwise specified by the authority having jurisdiction.

These systems are designated here as Urban Guided Transport Management and Command/Control Systems (UGTMS). UGTMS cover a wide range of operations needs from non-automated (GOA1) to unattended (GOA4) operation. A line may be equipped with UGTMS on its full length or only partly equipped.

This series does not specifically address security issues. However, aspects of safety requirements may apply to ensuring security within the urban guided transit system.

The main objective of this series is to achieve interoperability, interchangeability and compatibility.

This series is a recommendation for those transport authorities wishing to introduce interoperable, interchangeable and compatible equipment.

It is the responsibility of the transport authority concerned in accordance with the authority having jurisdiction to decide on how to apply this series and to take into account their particular needs.

IEC 62290 series is also intended to support applications for upgrading existing signalling and command control systems. In this case, interchangeability and compatibility could be ensured only for the additional UGTMS equipment. Checking the possibility for upgrading existing equipment and the level of interoperability is the responsibility of the transport authority concerned.

Application of the series should take into account the differences between the various networks operated in different nations. Those differences include operational and regulatory requirements as well as different safety cultures.

This series defines a catalogue of UGTMS requirements split into mandatory and optional functions. The functions used are based on the given grade of automation. By fulfilling the requirements, a supplier can create one or more generic applications including all mandatory functions and all or a subset of optional functions. A generic application will achieve interoperability within the defined specific application conditions. Customising a generic application will create a specific application taking into account of local conditions like track layout and headway requirements. It is the choice of supplier and transport authority to add additional functions to a generic or specific application. These additional functions are not described in this series.

According to IEC 62278, it is the responsibility of the transport authority, in agreement with the authority having jurisdiction, to decide, taking into account their risk acceptance principles to conduct specific hazard and risk analysis for each specific application. The safety levels for the functions of each specific application have to be determined by a specific risk analysis.

Terms such as "safety related command", "safety conditions", "safe station departure" are mentioned without having performed any hazard analysis.

Standard series IEC 62290 is intended to consist of four parts:

– Part 1 “System principles and fundamental concepts” provides an introduction to the standard and deals with the main concepts, the system definition, the principles and the

main basic functions of UGTMS (Urban Guided Transport Management and Command/Control Systems).

The three other parts correspond to the three steps (see Figure 1) required in the process of specifying UGTMS and are to be used accordingly.

– Part 2 “Functional requirements specification” specifies the functional requirements associated to the basic functions provided by Part 1, within the system boundaries and interfaces as defined in Figure 3 of Part 1.

  The FRS (Functional Requirements Specification) identifies and defines the functions that are necessary to operate an urban guided transport system. Two types of functions are distinguished for a given grade of automation: mandatory functions (e.g. train detection) and optional functions (e.g. interfaces to passenger information and passenger surveillance systems). Requirements of functions have the same allocation, unless they are marked otherwise.

– Part 3 (under consideration) “System requirements specifications” deals with the architecture of the system and the allocation of the requirements and functions identified in part 2 to architecture constituents.

  The SRS (System Requirements Specification) specifies the architecture of a UGTMS system, with mandatory and optional constituents.

– Part 4 (under consideration) “Interface specifications” deals with the definition of the interfaces, as well as the data exchanged by them (FIS and FFFIS), for the interoperable and interchangeable constituents identified in part 3.

  For interfaces between UGTMS constituents, the logical interface or FIS (Functional Interface Specification) and/or the physical and logical interface or FFFIS (Form Fit Functional Interface Specification) will be considered.

NOTE The specific structures of part 3 and part 4 will be established following completion of part 2 to accommodate optional and mandatory constituents, and to reflect local conditions. In principle, only one FIS or/and FFFIS will be defined for the same interface. However, when justified in some cases, several FIS or several FFFIS will be defined for the same interface.

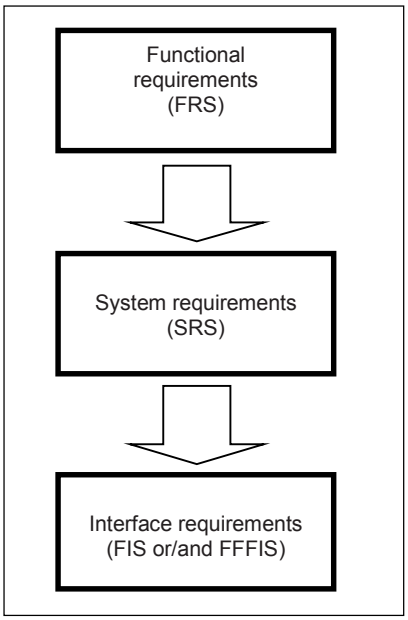

Figure 1 – The three-step process followed by the UGTMS standard

Requirements are those necessary to fulfil all operational needs for safe and orderly operation requested by transport authorities without regard to technical solutions.

The chosen level of detail in describing requirements enables customers as well as authorities having jurisdiction to be assured that generic applications delivered by different suppliers will cover at least the same functionality as specified in this part of IEC 62290.

Requirements which are established by this series are indicated clearly with a requirement identification number related to the function to be covered.

RAILWAY APPLICATIONS – URBAN GUIDED TRANSPORT MANAGEMENT AND COMMAND/CONTROL SYSTEMS –

Part 1: System principles and fundamental concepts

1 Scope

This part of IEC 62290 provides an introduction to the standard and deals with the main concepts, the system definition, the principles and the basic functions of UGTMSs (Urban Guided Transport Management and Command/Control Systems) for use in urban guided passenger transport lines and networks. This part of IEC 62290 is applicable for new lines or for upgrading existing signalling and command control systems.

This part of IEC 62290 is applicable to applications using:

- continuous data transmission,
- continuous supervision of train movements by train protection profile,
- localisation of trains by external wayside equipment or reporting trains.

This standard is not applicable to existing command and control systems or projects in progress prior to the effective date of this standard.

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 62236 (all parts), *Railway applications – Electromagnetic compatibility*

IEC 62278, *Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*

IEC 62279, *Railway applications – Communications, signalling and processing systems – Software for railway control and protection systems*

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

IEC 62290-2, *Railway applications – Urban guided transport management and command/control systems – Part 2: Functional requirements specification*

IEC 62425, *Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling*

3 Terms, definitions and abbreviations

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

3.1 Terms and definitions

3.1.1
additional function
function to be adapted to the specific requirements of each transport authority (due to local rules or specific needs of the transport authority)

Note 1 to entry: The components affected by this function are not necessarily interchangeable nor interoperable.

3.1.2
automatic mode
operation in semi-automated train operation (GOA2), driverless train operation (GOA3), unattended train operation (GOA4)

3.1.3
command
order used to perform a function in a system

Note 1 to entry: This order can originate from

– a system operator,

– an external system,

– inside UGTMS;

this order can be sent:

– to an external system,

– inside UGTMS.

3.1.4
commercial speed
nominal average speed of passenger service trains between two terminus stations of the line (dwell times at stations taken into account)

Note 1 to entry: Commercial speed is equal to the length between two terminus stations divided by the nominal journey time.

3.1.5
compatibility
capability of the UGTMS system to co-exist with other systems in the same transport network without any interference

3.1.6
constituent
any elementary component, group of components, subassembly or complete assembly of equipment incorporated or intended to be incorporated into UGTMS

3.1.7
control
process to keep the output of the system within defined parameters using commands for non-safety related control or safety related control

Note 1 to entry: An example of non-safety related control is the process of commanding acceleration or braking to maintain speed at x km/h ± y km/h. An example of safety related control is the process of commanding the emergency brakes if the speed exceeds the predefined speed limit.

3.1.8
driving on sight
manual driving carried out at a speed that allows the driver to stop the train before reaching any obstacle on the track

3.1.9
emergency brake
brake or combination of brakes which ensures that the train will stop with the brake rate agreed between authority having jurisdiction, transport authority and train manufacturer

3.1.10
generic application
application which contains all mandatory and all or a subset of optional functions, with predefined configurability and customisable for different specific applications

3.1.11
generic product
product independent of applications, fulfilling predefined boundary conditions, interfaces and functionality (black box)

EXAMPLES: point machines, axle counters, real-time operating systems, fail-safe computer platforms without application software.

3.1.12
grade of automation
automation level of train operation, in which Urban Guided Transport (UGT) can be operated, resulting from sharing responsibility for given basic functions of train operation between operations staff and system

3.1.13
interchangeability
capability of system components identified in this standard to be procured from any number of suppliers and replaced without any substantial change in functionality or performance

Note 1 to entry: It also allows the system to adapt to technology evolutions without significant modification to its architecture.

3.1.14
interlocking
interdependent liaison between the control levers or the electrical control circuits of different apparatus such as points, signals, which makes it impossible to place them in positions which are unsafe

Note 1 to entry: In English, the term “interlocking” refers also to the place where interlocking is achieved.

Note 2 to entry: In French, the term “enclenchement” refers also to the individual locking of an apparatus such as a pair of points.

Note 3 to entry: For the purposes of this standard the term “interlocking” also refers to an apparatus ensuring the interlocking functionality.

[SOURCE: IEC 60050-821:1998, 821-05-02]

3.1.15
interoperability
ability of a transport network to operate trains and infrastructures to provide, accept and use services so exchanged without any substantial change in functionality or performance

Note 1 to entry: This ability rests on all the regulatory, technical and operational conditions which must be met in order to satisfy all the defined requirements applicable to the given grade of automation, irrespective of which supplier provides which components or systems.

3.1.16
management
in UGTMS, it is the process by which:

– to conduct scheduled, efficient and reliable train services

– to handle degraded modes and abnormal situations

3.1.17
mandatory function
function compulsory for any UGTMS application depending on the GOA and has to be developed in compliance with the UGTMS requirements in order to obtain interchangeable and interoperable components

Note 1 to entry: Requirements of mandatory functions are also mandatory unless they are marked as optional.

3.1.18
mission
mission of a train
non-safety related instruction for guiding a train for a journey from one defined location (e.g. terminal station, transfer track) to another defined location including intermediate stops for passenger transfer and possibly needed actions of a train (e.g. turn back) including time constraints

3.1.19
movement authority
permission for a train to run, within the constraints of the infrastructure, up to a specific location

3.1.20
non-operative UGTMS trains
non-UGTMS equipped trains and trains with inoperative UGTMS onboard equipment

3.1.21
operations control centre
OCC
centre from which operation of the line or the network is supervised and managed

3.1.22
operations control HMI
external central Human Machine Interface (HMI) (at Operations Control Centre OCC) and/or local Human Machine Interface (HMI) (if any)

3.1.23
operations staff
staff authorised to perform tasks concerning train operation or direct service to passengers

3.1.24
optional function
function not compulsory for a defined grade of automation

Note 1 to entry: For a specific UGTMS application the transport authority has to decide if it uses it or not; if yes, this function shall be compliant with the UGTMS requirements, in order to obtain interchangeable and interoperable components.

3.1.25
reporting train
UGTMS-equipped train able to report its location and other relevant information

3.1.26
route
predetermined path for a traffic movement

[SOURCE: IEC 60050-821:1998, 821-01-22]

3.1.27
safe places
areas within the network of an operator where evacuation of passengers can be performed, depending on current operational conditions, with a minimum of risks to the passengers (e.g. stations, refuges on the line)

3.1.28
service brake
braking applied by the driver or the train UGTMS onboard equipment to control train speed

Note 1 to entry: This takes into account passengers comfort, economic and environmental considerations.

3.1.29
signal
– conventional visual or acoustic indication, generally concerning the movements of railway vehicles and transmitted to the staff entrusted to observe it
– apparatus by means of which a conventional indication is given

[SOURCE: IEC 60050-821:1998, 821-02-01]

3.1.30
specific application
application designed for a particular realisation based on a customised generic application

3.1.31
spot transmission
track to train transmission that can only take place when the train passes the information point

3.1.32
station
place where trains stop to allow passengers to embark and disembark

3.1.33
supervise
to monitor the performance and the status of a system and initiate control when necessary

3.1.34
train detection
safe recognition of the presence or absence of any trains on a defined section of the track or at a given point

3.1.35
train integrity
state of the train being complete (no car unduly separated from the train)

3.1.36
train stop
device located adjacent to a running rail which is so positioned that if the signal with which it is associated is displaying danger it actuates the braking system of a train which passes this signal; alternatively, when a line speed restriction exists, it may be used independently of a signal

[SOURCE: IEC 60050-821:1998, 821-08-10]

3.1.37
transfer track
transition area between unequipped part of a network and UGTMS territory

3.1.38
transport authority
entity which is responsible for safe and orderly operation of a transport system

3.1.39
UGTMS onboard equipment
UGTMS equipment installed on the train

3.1.40
UGTMS operations control equipment
UGTMS equipment performing centralised command/control, management and supervising functions and providing interface for HMI

3.1.41
UGTMS wayside equipment
equipment not on board trains, set either at trackside locations or elsewhere along the line or in the network

3.1.42
zone of protection
zone where no train is allowed to run, as a response to various kinds of incidents except identified hazardous situations for which trains can leave the zone

3.2 Abbreviations

AC	Alternating Current
CCTV	Closed Circuit TeleVision
DC	Direct Current
DCS	Data Communication System
FFFIS	Form-Fit Functional Interface Specification
FIS	Functional Interface Specification
FPA	Flank Protection Area
FRS	Functional Requirements Specification
GOA	Grade Of Automation
HMI	Human Machine Interface
HVAC	Heating Ventilation and Air Conditioning
M	Mandatory
O	Optional
OCC	Operations Control Centre
OVL	Overlap
RAMS	Reliability, Availability, Maintainability and Safety
RD	Route Destination
REQ	Requirement
RO	Route Origin
SRS	System Requirements Specification
UGT	Urban Guided Transport
UGTMS	Urban Guided Transport Management and Command/Control System
UGTMS OB	Onboard UGTMS equipment
UGTMS WS	Wayside UGTMS equipment

4 Concepts

4.1 Urban guided transport (UGT)

4.1.1 General

UGT is defined as a public transportation system in an urban environment with self-propelled vehicles and operated on a guideway, which is segregated from general road and pedestrian traffic.

Railway infrastructures which are part of a railway network operated under specific railway regulations are excluded, unless otherwise specified by the authority having jurisdiction.

Trains of transport undertakings (e.g. underground/metro, tram, regional and suburban operators) are included even if they are operated under specific railway regulations, when they are designated to operate on UGTMS infrastructure. In this case, trains of different transport undertakings shall fulfil the conditions of interoperability and the requirements given by specific regulations.

4.1.2 Operations

Operation is considered as the totality of all means to effect the transportation of passengers, including the training of operations staff and maintenance of installations and rolling stock.

Train operations include command and control of routes, passenger transfer, driving of trains and also shunting.

4.1.3 Operational facilities

Operational facilities are all those installations and equipment which serve operations such as (an example of track layout is shown in Figure 2):

– electrotechnical installations (like traction power supply, lighting equipment, communication equipment, command and control system, management system, maintenance system, etc.);
– guideway for movement of trains (points, derailers, crossings, crossings with movable frogs, level crossings, flood gates, platform tracks, tracks between stations, etc.). Platform tracks and tracks between stations might be used for one way or bi-directional operation;
– stations are places where passengers transfer between the wayside and a train is achieved. A station comprises waiting area(s) (with optionally, installations for passenger service and ticketing) and passenger transfer area(s) as interface between platform and train;
– sidings are considered as a place for storing rolling stock and turn back of trains. Sidings are normally not used for passenger transport;
– depots which are used for maintenance and storage of rolling stock and normally not used for passenger transport.

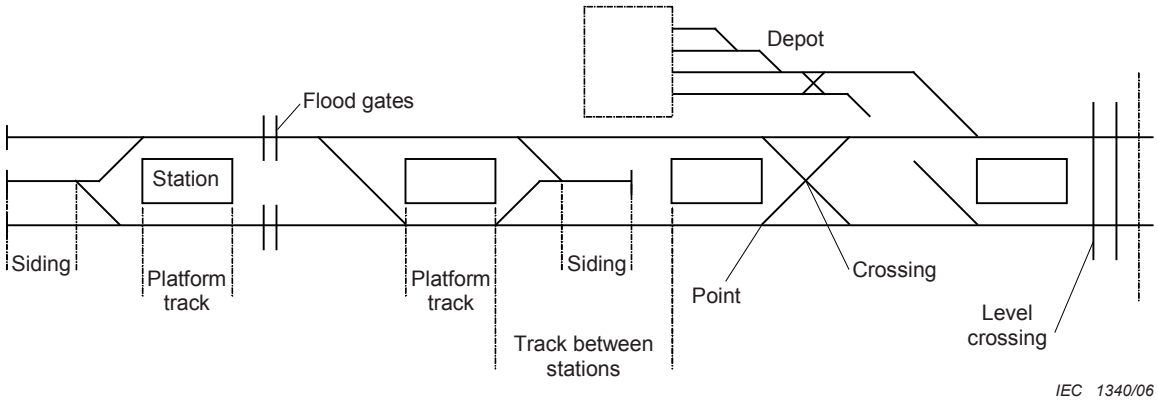

Figure 2 – Example of track layout

4.1.4 Rolling stock

Rolling stock is considered as a guided vehicle which may operate as a single unit or as a composition of units. A unit may consist of one or more cars, which cannot be uncoupled during train operation.

Trains are units of rolling stock operating as passenger or non-passenger trains consisting of one or more units. If a train consists of more than one unit it can be split during train operation.

4.1.5 Staff

Operations staff are notably persons who are involved directly in the process of passenger transportation (like drivers, operators in OCC, supervisors on platforms or in OCC).

Maintenance staff are persons who are involved in maintenance of infrastructure and rolling stock.

Rescue staff are persons who are involved in rescue of persons notably located inside stations and rolling stock.

4.1.6 Passengers

Passengers are users of the transportation system, noted that there are specific passenger needs for handicapped passengers, passengers with reduced mobility, children and passengers with luggage.

4.2 Grade of automation

4.2.1 Descriptions

4.2.1.1 General

UGT can be operated at different grades of automation defined below. The definition of grades of automation arises from apportioning responsibility for given basic functions of train operation between operations staff and system.

The mandatory basic functions of train operation for a given grade of automation on a line or network are defined in the following subclauses and Table 1.

Non-mandatory basic functions of train operation for a given grade of automation may also be realised by the system.

The grade of automation will influence the requirements of operation, operational facilities, rolling stock, staff. The requirements shall take into account the behaviour of passengers.

Table 1 – Grades of automation

Basic functions of train operation		On-sight train operation	Non-automated train operation	Semi-automated train operation	Driverless train operation	Unattended train operation
		GOA0	GOA1	GOA2	GOA3	GOA4
Ensure safe movement of trains	Ensure safe route	x (points command/control in system)	system	system	system	system
	Ensure safe separation of trains	x	system	system	system	system
	Ensure safe speed	x	x (partly supervised by system)	system	system	system
Drive train	Control acceleration and braking	x	x	system	system	system
Supervise guideway	Prevent collision with obstacles	x	x	x	system	system
	Prevent collision with persons on tracks	x	x	x	system	system
Supervise passenger transfer	Control passengers doors	x	x	x	x	system
	Prevent injuries to persons between cars or between platform and train	x	x	x	x	system
	Ensure safe starting conditions	x	x	x	x	system
Operate a train	Put in or take out of operation	x	x	x	x	system
	Supervise the status of the train	x	x	x	x	system
Ensure detection and management of emergency situations	Detect fire/smoke and detect derailment, detect loss of train integrity, manage passenger requests (call/evacuation, supervision)	x	x	x	x	system and/or staff in OCC
NOTE x = responsibility of operations staff (may be realised by UGTMS system) system = shall be realised by UGTMS system						

4.2.1.2 Grade of automation 0 (GOA0): On-sight train operation

In this grade of automation, the driver has full responsibility and no system is required to supervise his activities. However, points and single tracks can be partially supervised by the system.

4.2.1.3 Grade of automation 1 (GOA1): Non-automated train operation

In this grade of automation, the driver is in the front cabin of the train observing the guideway and stops the train in the case of a hazardous situation. Acceleration and braking are commanded by the driver in compliance with wayside signals or cab-signal. The system supervises the activities of the driver. This supervision may be done at specific locations, be semi-continuous or continuous, notably in respect of the signals and the speed. Safe departure of the train from the station, including door closing, is the responsibility of the operations staff.

4.2.1.4 Grade of automation 2 (GOA2): Semi-automated train operation

In this grade of automation, the driver is in the front cabin of the train observing the guideway and stops the train in the case of a hazardous situation. Acceleration and braking is automated and the speed is supervised continuously by the system. Safe departure of the train from the station is the responsibility of the operations staff (door opening and closing may be done automatically).

4.2.1.5 Grade of automation 3 (GOA3): Driverless train operation

In this grade of automation, additional measures are needed compared to GOA2 because there is no driver in the front cabin of the train to observe the guideway and stop the train in case of a hazardous situation.

In this grade of automation, a member of the operations staff is necessary onboard. Safe departure of the train from the station, including door closing, can be the responsibility of the operations staff or may be done automatically.

4.2.1.6 Grade of automation 4 (GOA4): Unattended train operation

In this grade of automation, additional measures are needed compared to GOA3 because there are no onboard operations staff.

Safe departure of the train from the station, including door closing, has to be done automatically.

More specifically, the system supports detection and management of hazardous conditions and emergency situations such as the evacuation of passengers. Some hazardous conditions or emergency situations, such as derailment or the detection of smoke or fire, may require staff interventions.

4.2.2 Implementation of grades of automation

Different grades of automation may be used with the same train at different areas of the same line.

The functions for different grades of automation have to be realised in an upgradeable way by technical subsystems implemented on a common core architecture. UGTMS will address basic functions identified in Table 1.

4.2.3 Grades of automation covered by UGTMS

UGTMS shall support GOA1, GOA2, GOA3 and GOA4.

GOA0 is not covered by the UGTMS standard but may be used as a degraded grade in a UGTMS environment.

4.3 Operation management and supervision

Operation management and supervision functions are described in 6.2.

4.4 Interoperability, interchangeability, compatibility and adaptability

4.4.1 General

A generic application of UGTMS shall be specified in such a manner as to optimise at the same time **interchangeability, interoperability, compatibility** and **adaptability**.

4.4.2 Interoperability

4.4.2.1 Interoperability in a given grade of automation

In order to achieve interoperability within a given grade of automation, the onboard and wayside equipment shall take into account the goals summarised below:

a) a train with a UGTMS system provided by supplier X can operate on a track equipped with UGTMS wayside equipment supplied by Y;

b) a train with a UGTMS system provided by supplier X can be coupled with a train equipped with a UGTMS system provided by supplier Y (provided rolling stock can be coupled);

c) UGTMS wayside equipment provided by supplier X and UGTMS wayside equipment provided by supplier Y or Z on two adjacent portions of track can be interfaced with a common OCC supplied by X, Y or Z;

d) a train with a UGTMS system provided by X, Y or Z can pass track boundaries X/Y, Y/Z and X/Z without any operational or technical disturbance.

4.4.2.2 Interoperability with different grades of automation

When the grades of automation are different between the wayside equipment and the onboard equipment, the UGTMS system shall be able to operate at the highest available common grade.

4.4.2.3 Mixed operation

UGTMS shall not negatively affect the operation of non-UGTMS equipped trains. To ensure the safe movement of non-UGTMS equipped trains, an additional system is necessary which is outside UGTMS. If mixed operation is required, UGTMS shall interface to this additional system.

4.4.3 Interchangeability

Interchangeability means that it is possible to replace any UGTMS constituent supplied by one industry provider by a constituent supplied by another industry provider but designed according to the same FFFIS and FIS specifications.

4.4.4 Compatibility

Compatibility means that there is no undesired interaction between the UGTMS system and the existing infrastructure, trains and equipment. This characteristic is notably required for ease of migration towards UGTMS.

4.4.5 Adaptability

Adaptability means that the system allows, as far as possible, line extension and/or throughput increase and/or rolling stock fleet evolution.

5 System environment and boundaries

UGTMS is an integrated train command, control and management system providing the functions described in Clause 6. The system environment is shown in Figure 3. UGTMS shall have capability to interface with all identified subsystems, if provided.

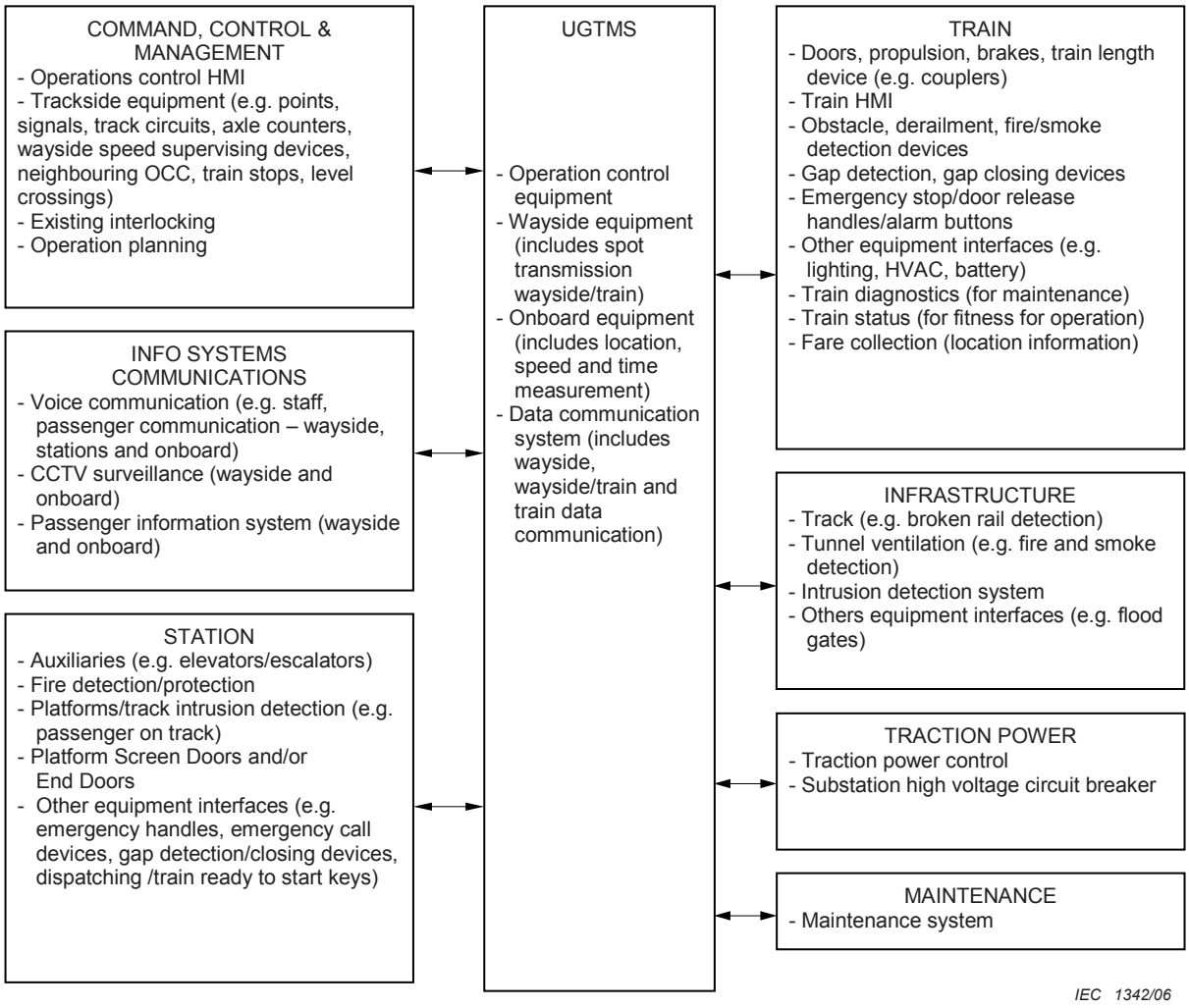

Figure 3 – System environment

The basic system environment shows the general approach of the UGTMS system with its system boundaries and required external interfaces.

The basic UGTMS constituents which are designated to solve the required functionality are:

– UGTMS operations control equipment which is in charge of operation management and supervision for a whole line or network. UGTMS equipment of the OCC provides the interface to the operators' HMI (external central HMI) for the whole UGTMS functionality and optionally for the non-UGTMS constituents;

– UGTMS wayside equipment (UGTMS WS) which is in charge of ensuring train operation in a certain area of the line. In the case of using an existing interlocking UGTMS WS

provides the interface to use those functionalities which are provided by the existing interlocking;

– UGTMS onboard equipment (UGTMS OB) which is in charge of ensuring train operation related to one specific train;

– the data communication system provides the data exchange between UGTMS constituents. UGTMS is independent of data transmission media, especially between wayside data communication and UGTMS OB (line cable, radio, etc.). Due to the fact that communication techniques are very versatile, it is required that DCS be transparent, therefore UGTMS has to define a standard interface with the communication system.

The shown basic system environment includes all external system elements for all grades of automation. For a given grade of automation only a subset of the external system elements may be present.

6 General requirements and description of the basic functions

6.1 General requirements

6.1.1 System approach

This standard enables the design of generic applications achieving interoperability and interchangeability, compatibility and adaptability. Generic applications of UGTMS shall contain all mandatory and a subset of optional functions featuring predefined configurability. A generic application can be designed to contain generic products. A generic application can be customised for different specific applications. A generic application is only valid within its defined borders.

A specific application of UGTMS is designed for only one particular installation and can be based on a customised generic application. A specific application may contain additional specific functions, which are not defined in this standard. The specific application takes into account the local conditions like track layout, headway requirements as well as climate and environmental conditions.

A generic product can be designed for use in different applications. A generic product is independent from generic or specific applications.

6.1.2 RAMS requirements

RAMS requirements of the UGTMS system shall conform to IEC 62278.

Safety requirements of the UGTMS system shall conform to IEC 62425, IEC 62279 and IEC 62280.

6.1.3 Electromagnetic compatibility

The UGTMS system shall conform to the IEC 62236 series with regard to electromagnetic compatibility.

6.1.4 Energy saving

The UGTMS system shall contribute to the energy efficient operation of trains.

6.1.5 Local conditions

6.1.5.1 Consideration for local climate and natural features

Requirements for local climate, natural features and environmental conditions shall be specified in each specific application.

6.1.5.2 Respect for local conditions

The functional requirements for a UGTMS system will be affected by local conditions. Accordingly, the application of the UGTMS standard shall take into account the local conditions, such as laws, regulations, cultures, customs, technologies and economical circumstances.

6.1.6 Intermodality between networks

The UGTMS system shall facilitate easy passenger exchange between networks, lines and sections of line.

6.1.7 Interoperability between neighbouring UGTMS fitted networks

UGTMS trains entering a UGTMS network from a neighbouring UGTMS network, or from a neighbouring non-UGTMS network, shall be capable of operating at the highest available grade of automation common to the wayside and onboard UGTMS equipment in the network being entered.

For non-UGTMS trains entering a UGTMS network, train protection for the non-UGTMS-equipped train shall be provided by equipment external to UGTMS as defined in 4.4.2.3.

Train operations for UGTMS trains or non-UGTMS trains entering a non-UGTMS network are not covered by this standard.

UGTMS related operational and technological conditions for the interoperability between networks shall be agreed between the related transport authorities when defining their specific applications.

6.1.8 Measures to ensure the movement of passengers with reduced mobility

UGTMS shall take into account the safe movement of disabled passengers and/or passengers with reduced mobility.

6.1.9 Nominal mode, degraded modes, emergency situation

UGTMS shall take into account failures or incidents and ensure degraded mode and emergency situation management. The UGTMS system shall also provide assistance to the operator towards recovering from most degraded situations.

6.1.10 Basic system performances

The following items shall be considered as basic criteria for UGTMS:

– safety;
– availability;
– technical and operational fall-back modes;
– maintainability;
– reliability;
– adaptability;
– testability;
– maximum speed;
– headway;
– journey time;
– commercial speed;

– stopping accuracy;
– required reaction times.

These parameters shall be specified by the transport authority, which has to define the contribution of the UGTMS system to performances in comparison with theoretical best performances allowed by each specific application of rolling stock and the characteristics and layout of tracks.

6.1.11 Requirements for upgrading GOA

The UGTMS system shall allow GOA upgrading up to GOA4. UGTMS shall allow the achievement of this goal by the use of one or several different generic applications, depending on the specific application required by the transport authority.

6.1.12 Requirements for adding new parts of line

The UGTMS system shall allow extensions of lines and modifications of track layout.

6.2 Description of the basic functions

6.2.1 General

Depending on GOA, the functions described below, whether required or not, are specified in detail in IEC 62290-2 (Functional requirements specification).

6.2.2 Basic functions for train operation

6.2.2.1 General

The following described basic functions are used to realise the train operation in a certain area on a given network of tracks with respect to required travel direction, train destination and allowed speed. The safe movement of trains is the basic required functionality irrespective of the grade of automation.

In GOA3 and GOA4, with no driver in the front cabin or no operations staff on the train, additional system functions are needed to substitute the staff ensuring safe train operations in addition to safe train movement.

6.2.2.2 Ensure safe movement of trains

6.2.2.2.1 General

To ensure the safe movement of trains the following functions are required:

– ensure safe route;
– ensure safe separation of trains;
– ensure safe speed;
– authorise train movement.

For UGTMS ensuring safe separation of trains and ensuring safe speed requires the use of data communication between wayside and onboard equipment .

6.2.2.2.2 Ensure safe route

In order to prevent train collision and derailment, a route is to be considered as safe, if all requested elements of the guideway are locked in the required position to avoid concurrent use by another train.

6.2.2.2.3 Ensure safe separation of trains

Safe train separation shall be provided between all trains operating in UGTMS territory. In the UGTMS territory, UGTMS ensures the separation of equipped trains from non-equipped trains, or trains with failed UGTMS equipment, provided that those trains are detected by a secondary detection system. Safe train separation shall be based upon the principle of an instantaneous stop of the preceding train. In order to prevent collisions between following trains, safe separation shall be provided in such a way that a safe braking distance between trains is maintained at all times.

6.2.2.2.4 Ensure safe speed

In order to prevent derailment and collisions, UGTMS shall ensure that under no circumstances will the train's actual speed exceed the most restrictive speed limit. This includes the determination of permitted speed, and the supervision of train movement.

6.2.2.2.5 Authorise train movement

This function authorises the movements of the train if all safety conditions are fulfilled.

6.2.2.3 Drive train

For GOA2 or above, UGTMS shall provide for the starting, stopping, and speed control of the train as its travels along the track so that the speed, acceleration, deceleration, and jerk rate are within passenger comfort limits and the train speed is below the speed limit imposed by the safety system.

For GOA1, these functions are the responsibility of the train driver.

6.2.2.4 Supervise guideway

6.2.2.4.1 General

Supervising the guideway in GOA1 and GOA2 is part of the responsibility of the train driver. In higher grades of automation the following basic functions have to be realised by the UGTMS system through interfaces to external systems:

– prevent collision with obstacles;
– prevent collision with persons on tracks.

6.2.2.4.2 Prevent collision with obstacles

This basic function shall be realised by various measures and rules to prevent collision with obstacles on the track. Interfaces to external devices are necessary to remove the authorisation of train movement.

6.2.2.4.3 Prevent collisions with persons on tracks

This basic functionality shall be realised by various measures and rules to prevent collisions with persons on tracks. Interfaces to external devices are necessary to remove the authorisation of train movement.

6.2.2.5 Supervise passenger transfer

6.2.2.5.1 General

Ensuring safe passenger transfer through the following functions is a mandatory system requirement for GOA4. For lower grades of automation these functions may be in whole or in part the responsibility of the train driver or operations staff on the platform in combination with the system:

– control doors,
– prevent injuries to persons between cars or between platform and train,
– ensure starting conditions.

6.2.2.5.2 Control doors

UGTMS shall ensure that all operational and safety related preconditions for opening and closing doors are fulfilled. This function concerns train doors and if they are used platform doors and emergency doors.

6.2.2.5.3 Prevent injuries to persons between cars or between platform and train

This basic function is intended to prevent hazards or avoid accidents associated with the gap between cars or between platform and train. This function may require interfaces to an external device.

6.2.2.5.4 Ensure starting conditions

For authorising station departure, UGTMS shall ensure, that

– necessary operational preconditions, and
– safety preconditions

for a train to leave the station are fulfilled.

6.2.2.6 Operate a train

6.2.2.6.1 General

This basic function includes:

– put in or take out of operation;
– manage driving modes;
– manage movement of trains between two operational stops;
– change the travel direction;
– couple and split a train;
– supervise the status of the train.

6.2.2.6.2 Put in or take out of operation

Put in or take out of operation is intended to awake trains, including a self-check of the train, on every location within the UGTMS domain (main line, sidings and depots), respective to setting the train in operation for a specific or a certain number of train journeys. It is also intended to set trains to sleep on every location within the UGTMS domain (main line and sidings) respective to setting the train out of operation.

6.2.2.6.3 Manage driving modes

This basic function is intended to manage driving modes of the train during train services between various manual modes and from and to automatic mode for operational or fall-back reasons.

6.2.2.6.4 Manage movement of trains between two operational stops

This basic function is intended to manage train movements when operational disturbances have led to an unscheduled stop outside stations.

6.2.2.6.5 Change the travel direction

This basic function is intended to realise a turn-back in platform tracks, in sidings, in depots or under specific conditions on tracks between stations.

6.2.2.6.6 Couple and split a train

This basic function is intended to couple and split trains for operational reasons in platform tracks or in sidings, or for recovering trains on tracks between stations in automatic or manual modes.

6.2.2.6.7 Supervise the status of the train

This basic function is intended to supervise the status of the train related to issues of availability and safety during operation.

6.2.2.7 Ensure detection and management of emergency situations

This basic function is intended to supervise the status of the train related to safety of passengers in trains during operation by providing interfaces to

– detect fire/smoke;
– detect derailment;
– detect loss of train integrity;
– manage passenger requests (call/evacuation, supervision).

6.2.3 Basic functions for operation management and supervision

6.2.3.1 Manage the daily timetable

This basic function includes:

– import timetables;
– select the timetable;
– modify the operational timetable.

6.2.3.2 Manage the train service

6.2.3.2.1 General

This basic function includes:

– manage train missions;
– set routes automatically;
– regulate trains;
– ensure connecting services;
– manage operational disturbances;
– dispatch trains.

6.2.3.2.2 Manage train missions

This basic function is intended to create and modify missions to organise train trips and distribute them to trains.

6.2.3.2.3 Set routes automatically

This basic function is intended to set routes automatically based on operational conditions (e.g. timetable, train position, train list, cycle, etc.).

6.2.3.2.4 Regulate trains

This basic function is intended to avoid bunching of trains and to reduce delays to trains in the case of disturbances.

6.2.3.2.5 Ensure connecting services

This basic function is intended to ensure connecting services between a UGTMS line and other public transport services (e.g. bus, tram, underground lines, etc.).

6.2.3.2.6 Manage operational disturbances

This basic function is intended to propose a catalogue of measures and assist the resolution of operational disturbances (e.g. blockage of a track by a failed train).

6.2.3.2.7 Dispatch trains

This basic function is intended to harmonise the starting of trains in stations on the whole line and to ensure connecting services, by assigning varying dwell times determined by the train regulation system.

6.2.3.3 Supervise train operations

6.2.3.3.1 General

This basic function includes:

– supervise train tracking;
– supervise trains and wayside equipment;
– supervise passengers.

6.2.3.3.2 Supervise train tracking

This basic function is intended to monitor trains in the network automatically using train identification and status (including delay information) to recognise deviations from normal operation as soon as possible.

6.2.3.3.3 Supervise trains and wayside equipment

This basic function is intended to monitor the technical equipment of trains and wayside equipment to recognise as soon as possible technical failures, which could lead to an operational disturbance.

6.2.3.3.4 Supervise passengers

This basic function is intended to supervise passengers (e.g. on platforms, in access to platforms and in the train, etc.) by CCTV surveillance system or other devices. UGTMS has to provide an interface.

6.2.3.4 Control traction power

This basic function is intended to switch on and off traction power in the operation area by the operator or automatically on given sections or on all sections.

This function of traction power control is optionally inside UGTMS. If it is outside UGTMS, there is an interface. For the purposes of this standard, traction power control is considered external to UGTMS, with interfaces to UGTMS. A given UGTMS implementation of UGTMS may integrate other traction power control functions, but such integrated functions are not covered by this standard.

This basic function includes regenerative braking control.

6.2.3.5 Provide the operator interface

6.2.3.5.1 General

This basic function is to accept the operators' commands and to display the status of the system to the operators. HMI are outside UGTMS but UGTMS provides interfaces.

6.2.3.5.2 Provide interface to the operations control HMI

This basic function is intended to provide the interface between UGTMS and the external central HMI (OCC) and/or local HMI (if any).

6.2.3.5.3 Provide interface to the train HMI

This basic function is intended to provide the interface between UGTMS and the external train HMI operated and observed by onboard staff.

6.2.3.6 Provide interface with the communication system for passengers and staff

This basic function is intended to provide the interface in order to communicate with passengers and staff (voice communication via radio, telephone).

6.2.3.7 Provide interface with the passenger information system

This basic function is to provide information to passengers on the line (including onboard trains) or in the network in normal operation and in cases of perturbations by announcements or visible measures. UGTMS provides the interface with the external passenger information system.

6.2.3.8 Provide interface with passenger surveillance systems

This basic function is to provide an interface to the CCTV surveillance system or other devices, on platforms at stations and onboard trains.

6.2.3.9 Support maintenance

This basic function is to support maintenance of infrastructure and trains in cases of recognised failures and planned maintenance. UGTMS provides the interface with the external maintenance management system.

6.2.3.10 Manage rolling stock and staff resources

This basic function is to manage the rolling stock fleet and assign staff needed to fulfil the requirements of train operation.

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