

English Version

**Railway applications - Urban guided transport management and  
command/control systems - Part 1: System principles and  
fundamental concepts  
(IEC 62290-1:2025)**

Applications ferroviaires - Systèmes de contrôle/commande  
et de gestion des transports guidés urbains - Partie 1:  
Principes système et concepts fondamentaux  
(IEC 62290-1:2025)

Bahnanwendungen - Betriebsleit- und  
Zugsicherungssysteme für den städtischen  
schienengebundenen Personennahverkehr - Teil 1:  
Systemgrundsätze und grundlegende Konzepte  
(IEC 62290-1:2025)

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

## EN IEC 62290-1:2025 (E)

### European foreword

The text of document 9/3166/FDIS, future edition 3 of IEC 62290-1, prepared by TC 9 "Electrical equipment and systems for railways" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62290-1:2025.

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) 2026-05-31
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2028-05-31

This document supersedes EN 62290-1:2014 and all of its amendments and corrigenda (if any).

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

This document has been prepared under a standardization request addressed to CENELEC by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

### Endorsement notice

The text of the International Standard IEC 62290-1:2025 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 are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where 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](http://www.cenelec.eu).

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 62236	series	Railway applications - Electromagnetic compatibility	EN 50121	series
IEC 62278	-	Railway applications - Specification and demonstration of reliability, availability, maintainability and safety (RAMS)	EN 50126	-
IEC 62279	-	Railway applications - Communications, signalling and processing systems - Software for railway control and protection systems	EN 50128	-
IEC 62280	-	Railway applications - Communication, signalling and processing systems - Safety related communication in transmission systems	EN 50159	-
IEC 62290-2	-	Railway applications - Urban guided transport management and command/control systems - Part 2: Functional requirements specification	EN IEC 62290-2	-
IEC 62425	-	Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling	EN 50129	-



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# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Railway applications – Urban guided transport management and  
command/control systems –  
Part 1: System principles and fundamental concepts**

**Applications ferroviaires – Systèmes de contrôle/commande et de gestion des  
transports guidés urbains –  
Partie 1: Principes système et concepts fondamentaux**

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DỰ ÁN TIÊU CHUẨN TC2545



## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

#### Part 1: System principles and fundamental concepts

#### FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 62290-1 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways. It is an International Standard.

This third edition cancels and replaces the second edition published in 2014. This edition constitutes a technical revision.

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

- a) Figure 3, giving the system environment of UGTMS, has been amended to reflect the adaptation of it;
- b) external equipment for which no requirement is described in the IEC 62290 series has been removed;

- c) new external equipment having such requirements (like the washing machine) has been added.

The text of this International Standard is based on the following documents:

Draft	Report on voting
9/3166/FDIS	9/3197/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

A list of all parts of IEC 62290 series, under the general title *Railway applications – Urban guided transport management and command/control systems*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.



## INTRODUCTION

The IEC 62290 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.

These systems are designated herein 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.

The IEC 62290 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 objectives of this series are as follows:

- to provide a baseline system description and functional requirements specification for a transport authority to use in a request for proposal,
- to provide recommendations for those transport authorities wishing to acquire an interoperable or interchangeable system.

It is the responsibility of the transport authority concerned to decide on how to apply the IEC 62290 series and to take into account their particular needs.

The 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.

The IEC 62290 series defines a catalogue of UGTMS requirements split into mandatory and optional functions. The functions used are based on the given grade of automation. Most of the functions characterized as mandatory are considered with no condition. Some specific functions have a condition to be mandatory (this condition being generally related to the use of an external equipment by UGTMS). 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 the IEC 62290 series.

According to IEC 62278, it is the responsibility of the transport authority 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 are 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.

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

- IEC 62290-1, "System principles and fundamental concepts", provides an introduction to the IEC 62290 series and deals with the main concepts, the system definition, the principles and the main basic functions of UGTMS.

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

- IEC 62290-2, "Functional requirements specification", specifies the functional requirements associated to the basic functions provided by IEC 62290-1, within the system boundaries and interfaces as defined in Figure 3.

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. manage stabling). Requirements of functions have the same allocation, unless they are marked otherwise.

- IEC 62290-3, "System requirements specification", deals with the architecture of the system and the allocation of the requirements and functions identified in IEC 62290-2 to UGTMS equipment.

The SRS (system requirements specification) specifies the architecture of a UGTMS system, with mandatory and optional UGTMS equipment.

- IEC 62290-4<sup>1</sup>, "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 UGTMS equipment identified in IEC 62290-3.

For interfaces between UGTMS equipment, the logical interface or FIS (functional interface specification) or the physical and logical interface or FFFIS (form fit functional interface specification) will be considered.

NOTE The specific structure of IEC 62290-4 will be established to accommodate optional and mandatory UGTMS equipment, and to reflect local conditions. In principle, only one FIS or FFFIS will be defined for the same interface. However, when justified in some cases, several FISs or several FFFISs will be defined for the same interface.

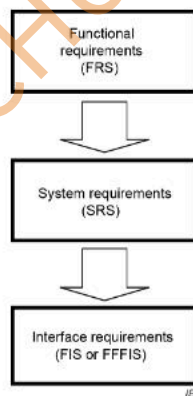


Figure 1 – Three-step process followed by the UGTMS series

<sup>1</sup> Under consideration.

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 transport authorities to be assured that generic applications delivered by different suppliers will cover at least the same functionality as specified in this document.

Requirements which are established by the IEC 62290 series are indicated clearly with a requirement identification number related to the function to be covered.

DỰ ÁN TIÊU CHUẨN TC2545

## 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 IEC 62290 series and deals with the main concepts, the system definition, the principles and the basic functions of UGTMS (urban guided transport management and command/control systems) for use in urban guided passenger transport lines and networks. This document is applicable for new lines or resignalling of existing lines.

This document is applicable to applications using

- continuous data transmission,
- continuous supervision of train movements by train protection profile, and
- localisation of trains by onboard UGTMS equipment (reporting trains), and optionally by external wayside (and optionally onboard) device.

#### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 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 abbreviated terms

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

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

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

#### 3.1 Terms and definitions

##### 3.1.1

##### **adaptability**

capacity of the system to allow evolution of train fleet or guideway

##### 3.1.2

##### **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 the additional function are not necessarily interchangeable nor interoperable.

##### 3.1.3

##### **automatic driving mode**

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

##### 3.1.4

##### **command, <in signalling>**

order used to perform a function in a system

Note 1 to entry: This order can originate from

- a system operator,
- an external system, or
- inside UGTMS;

This order can be sent:

- to an external system, or
- inside UGTMS.

[SOURCE: IEC 60050-821:2017, 821-01-50, modified – In the Note 1 to entry, "the system itself" has been replaced with "UGTMS".]

##### 3.1.5

##### **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.

[SOURCE: IEC 60050-821:2017, 821-01-51]

##### 3.1.6

##### **compatibility**

<for UGTMS system> capability of the UGTMS system to co-exist with other systems in the same transport network without any interference



**3.1.7****control, <in signalling>**

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  $x \text{ km/h} \pm y \text{ km/h}$ . An example of safety-related control is the process of commanding the emergency brakes if the speed exceeds the predefined speed limit.

[SOURCE: IEC 60050-821:2017, 821-01-28]

**3.1.8****driving on sight****on sight train operation**

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

[SOURCE: IEC 60050-821:2017, 821-02-127, modified – The word “driver” has been replaced with “train operator”.]

**3.1.9****dwell time**

time during which a train is berthed in a station served by the mission

**3.1.10****emergency brake**

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

[SOURCE: IEC 60050-811:2017, 811-06-11, modified – “the authority having jurisdiction, the transport authority and the train manufacturer” has been replaced with “the transport authority and the train manufacturer”.]

**3.1.11****generic application**

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

[SOURCE: IEC 60050-821:2017, 821-01-56, modified – “functions” has been removed after “mandatory”.]

**3.1.12****generic product**

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

EXAMPLE Point machines, axle counters, real-time operating systems, fail-safe computer platforms without application software.

[SOURCE: IEC 60050-821:2017, 821-01-57, modified – In the example, “Examples include” has been removed, and “and fail-safe” has been replaced by “fail-safe”.]



### 3.1.13

#### **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

[SOURCE: IEC 60050-821:2017, 821-01-58, modified – “between the” has been replaced by “between”, “the urban guided transport management and command/control” and “(UGTMS)” have been removed and the Note 1 to entry has been omitted.]

### 3.1.14

#### **headway**

minimum time interval between consecutive trains allowed by the signalling system

[SOURCE: IEC 60050-821:2017, 821-02-54, modified – The word “signal” deleted from term.]

### 3.1.15

#### **interchangeability, <of system components>**

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

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

[SOURCE: IEC 60050-821:2017, 821-01-60, modified – “identified in this document” has been added and in the Note 1 to entry, “be adapted” has been replaced by “adapt”.]

### 3.1.16

#### **interlocking, <in railway signalling>**

interdependent liaison between the control levers or the electrical control circuits of different apparatus such as points and 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 document, the term “interlocking” also refers to an apparatus ensuring the interlocking functionality.

[SOURCE: IEC 60050-821:2017, 821-05-02, modified – Note 3 to entry added, and the words “a pair of” added in Note 2 to entry.]

### 3.1.17

#### **interoperability**

#### **interoperability of a transport network**

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: The interoperability rests on all the regulatory, technical and operational conditions which are 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.

[SOURCE: IEC 60050-821:2017, 821-01-61, modified – “exchanged in such as way that there is no” has been replaced with “so exchanged without any” and in the Note 1 to entry “This ability depends” has been replaced with “The interoperability rests” and “must be” has been replaced with “are”.]

**3.1.26**

**operations control HMI**

external central human machine interface (HMI) (at operations control centre, OCC) and external local human machine interface, if any, located in decentralized operations control rooms

[SOURCE: IEC 60050-821:2017, 821-01-65, modified – “external” has been added twice, “the operations control centre, OCC” has been replaced with “operations control centre, OCC”, “and/or” replaced by “and”, “(if any)” by “, if any” and “located in decentralized operations control rooms” has been added.]

**3.1.27**

**operations staff**

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

[SOURCE: IEC 60050-821:2017, 821-01-66]

**3.1.28**

**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, it means this function is compliant with the UGTMS requirements, in order to obtain interchangeable and interoperable components.

**3.1.29**

**reporting train**

UGTMS train able to report its location and other relevant information

**3.1.30**

**rollaway**

unintended movement of the train in either a forward or reverse direction

**3.1.31**

**route, <in signalling>**

predetermined path for a traffic movement

[SOURCE: IEC 60050-821:2017, 821-01-22]

**3.1.32**

**safe braking model**

analytical representation of a train's performance while decelerating to a complete stop, allowing for a combination of worst-case influencing factors and failure scenarios

**3.1.33**

**safe place**

area 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

EXAMPLE Stations, refuges on the line.

**3.1.34**

**safety-related command**

operator triggered command whose execution has an impact on safety

**3.1.35****service brake**

braking applied by the train operator or the UGTMS onboard equipment to control train speed

Note 1 to entry: The service brake takes into account passengers' comfort, economic and environmental considerations.

**3.1.36****signal, <in railway signalling>**

visual or acoustic indication transmitted to the staff entrusted to observe it, generally concerning the movements of railway vehicles, or apparatus by means of which an indication is given

[SOURCE: IEC 60050-821:2017, 821-02-01, modified – Definition rephrased with "visual or acoustic indication transmitted to the staff entrusted to observe it, generally concerning the movements of railway vehicles, or apparatus by means of which an indication is given" and Note 1 to entry has been omitted.]

**3.1.37****specific application**

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

[SOURCE: IEC 60050-821:2017, 821-01-74]

**3.1.38****spot transmission**

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

[SOURCE: IEC 60050-821:2017, 821-03-50]

**3.1.39****station**

place where trains stop to allow passengers to embark and disembark

**3.1.40****supervise**

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

[SOURCE: IEC 60050-821:2017, 821-01-75]

**3.1.41****train detection**

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

[SOURCE: IEC 60050-821:2017, 821-03-51]

**3.1.42****train integrity**

state of the train being complete

Note 1 to entry: "Complete" means that no car is unduly separated from the train.

[SOURCE: IEC 60050-821:2017, 821-03-52, modified – "(no car unduly separated from the train)" has been deleted, to create instead the Note 1 to entry.]

**3.1.43**

**train HMI**

external HMI, located onboard trains in train operator's cabin or at train attendant's place

Note 1 to entry: The external train HMI comprises all means intended for manual, visual and audible interactions with operational staff onboard the train.

**3.1.44**

**train operator**

operations staff who is onboard and is in charge of driving the train, or able to drive it for degraded situations

**3.1.45**

**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

Note 1 to entry: Alternatively, when a line speed restriction exists, the train stop can be used independently of a signal.

[SOURCE: IEC 60050-821:2017, 821-08-10, modified – "Alternatively," has been added in Note 1 to entry.]

**3.1.46**

**transfer track**

transition area between unequipped part of a network and UGTMS territory

**3.1.47**

**transport authority**

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

[SOURCE: IEC 60050-821:2017, 821-01-77]

**3.1.48**

**UGTMS onboard equipment**

UGTMS equipment installed on the train

**3.1.49**

**UGTMS operations control equipment**

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

**3.1.50**

**UGTMS train**

UGTMS equipped train

**3.1.51**

**UGTMS wayside equipment**

equipment set either at trackside locations or elsewhere along the line, which is not part of UGTMS operations control equipment

**3.1.52**

**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

[SOURCE: IEC 60050-821:2017, 821-01-79, modified – "in which" has been replaced with "where", "incident" with "incidents" and "are permitted to" with "can".]

### 3.2 Abbreviated terms

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

## 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.

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 trains.

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



#### 4.1.3 Operational facilities

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

- electrotechnical installations (traction power supply, lighting equipment, communication equipment, command and control system, management system, maintenance system, etc.);
- guideway for movement of trains (points, derailleurs, crossings, crossings with movable frogs, 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, which 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, which are tracks that can be used for the turn back or storing of trains; sidings are normally not used for passenger transport;
- depots, which are used for maintenance and storage of trains and normally not used for passenger transport.

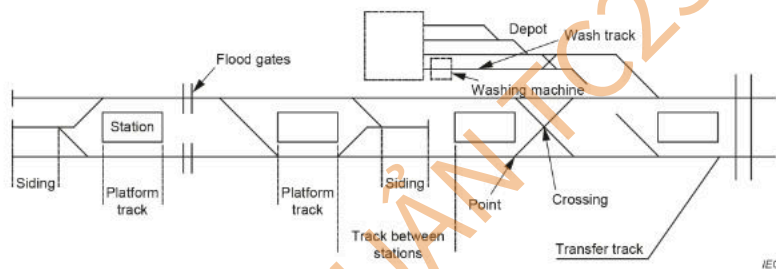


Figure 2 – Example of track layout

#### 4.1.4 Train

Train is defined as a guided vehicle which may operate as a single unit or as a composition of units (for passenger service, or for other purpose). A unit is made of one or more cars. The composition of a unit will not be changed during train operation.

The coupling and the uncoupling of trains can be done during train operation.

#### 4.1.5 Staff

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

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

Rescue staff are persons who are involved in rescue of persons in particular located inside stations and trains.

#### 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 in 4.2.1.2 to 4.2.1.6. 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 4.2.1.2 to 4.2.1.6 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, trains and staff. The requirements shall take into account the behaviour of passengers.

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Table 1 – Grades of automation

Basic functions of train operation		On-sight train operation GOA0	Non-automated train operation GOA1	Semi-automated train operation GOA2	Driverless train operation GOA3	Unattended train operation 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	System	System	System	System
Drive train	Control acceleration and braking	x	x	System	System	System
	Prevent collision with obstacles	x	x	x	System	System
	Prevent collision with persons on tracks	x	x	x	System	System
Supervise passenger transfer	Control doors	x	x	x	x	System
	Prevent injuries to persons between cars or between platform and train	x	x	x	x	System
	Ensure train departure	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 staff in OCC
<b>Key</b>						
x responsibility of operations staff (may be realised by UGTMS system)						
System shall be realised by UGTMS system						

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

In this grade of automation, the train operator is driving on sight. The train operator has full responsibility and no system is required to supervise the train operator's 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 train operator 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 train operator in compliance with information displayed in the cab or from wayside signals. The system continuously supervises the movement of the train. 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 train operator 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 train operator 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 series 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 UGTMS onboard, operations control 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 trains 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 UGTMS wayside equipment, UGTMS operations control equipment and the UGTMS onboard equipment, the UGTMS system shall be able to operate at the highest available common grade.

###### **4.4.2.3 Mixed operation**

If mixed operation is requested, UGTMS shall allow the operation of non-UGTMS trains.

To ensure safe movement of non-UGTMS trains:

- UGTMS will receive inputs from wayside train detection devices, and control wayside signals,
- optionally, this function can be performed by an external system (e.g. external interlocking), with UGTMS receiving status from the external system.

##### **4.4.3 Interchangeability**

Interchangeability means that it is possible to replace a constituent of UGTMS architecture supplied by one industry provider with one 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, throughput increase and evolution of train fleet.

### 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 external systems, if provided.

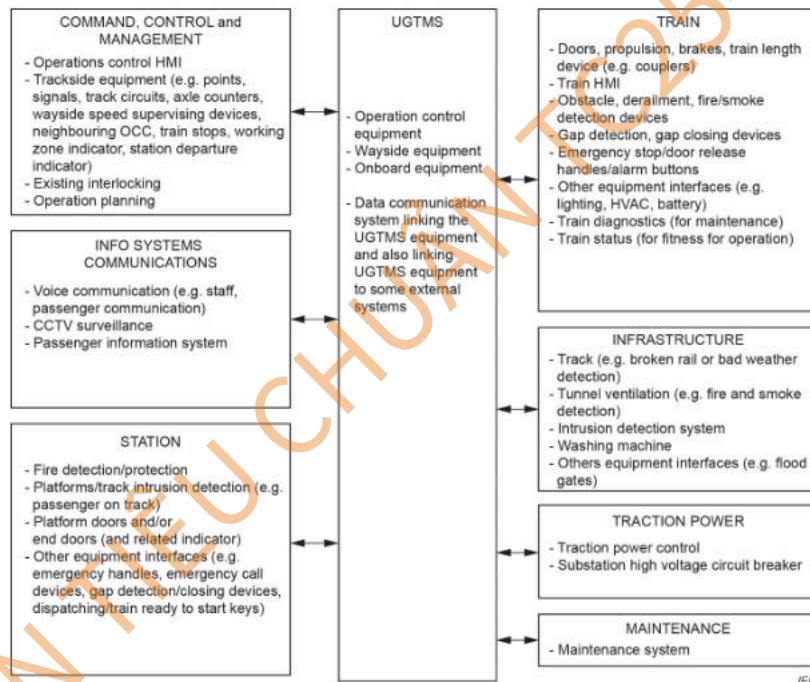


Figure 3 – System environment

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

**NOTE** Some external systems have not been retained in the environment of UGTMS as the interface with such systems is seen as not relevant for this document (e.g. fare collection, auxiliaries like escalators), or it is seen as site-specific (e.g. level crossings which follow different principles and generally work independently).



UGTMS consists of the following:

- UGTMS operations control equipment which is in charge of operation management and supervision for a whole line or network; UGTMS operations control equipment 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 which is in charge of ensuring train operation in a certain area of the line; in the case of using an existing interlocking, UGTMS wayside equipment has an interface to this external interlocking to receive status from the interlocking logic and to send commands (e.g. overrides) to it;
- UGTMS onboard equipment which is in charge of ensuring train operation related to one specific train.

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

The basic system environment shown in Figure 3 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 document 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 document. 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 series shall take into account the local conditions, such as laws, regulations, cultures, customs, technologies and economic 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 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 UGTMS onboard equipment and the other UGTMS equipment in the network being entered.

For non-UGTMS trains entering a UGTMS network, train protection for the non-UGTMS train shall be provided by UGTMS or 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 document.

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 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 type of train 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 scalable and configurable generic applications, in order to respond to transport authority requirements.

#### **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 in 6.2.2 and 6.2.3, 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 basic functions described in 6.2.2.2 to 6.2.2.7 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 train operator 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 UGTMS 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. 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. In the UGTMS territory, if UGTMS has to ensure safe separation of trains for non-equipped trains, or trains with failed UGTMS onboard equipment, a secondary detection system has to be provided to detect these trains.

**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 it 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 operator.

#### **6.2.2.4 Supervise guideway**

##### **6.2.2.4.1 General**

As indicated in Table 1, supervising the guideway in GOA1 and GOA2 is the responsibility of the train operator, but this function may be supplied by the system. 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 in whole or in part be the responsibility of the train operator 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 train departure**

For authorising station departure, UGTMS shall ensure the following conditions are fulfilled for a train to leave the station:

- necessary operational preconditions;
- safety preconditions.

**6.2.2.6 Operate a train****6.2.2.6.1 General**

This basic function includes the following:

- put in or take out of operation;
- manage driving modes;
- manage movement of trains between two operational stops;
- change the travel direction;
- couple and uncouple 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, at stabling areas 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 at stabling areas within the UGTMS domain (main line, sidings and depots) 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 driving modes and automatic driving modes for operational or fall-back reasons.

**6.2.2.6.4 Manage movement of trains after unexpected 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 uncouple a train**

This basic function is intended to couple and uncouple trains for operational reasons in platform tracks or in sidings, or for recovering trains on tracks between stations in automatic or manual driving 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 the following functions:

- detect onboard 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 the following:

- 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 the following:

- 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 journeys 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 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).

##### **6.2.3.2.6 Dispatch trains for energy saving**

This basic function is intended to harmonise the starting of trains in stations on the whole line, 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 the following:

- 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 basic function includes regenerative braking control.

The traction power control system is considered as external to UGTMS, with an interface to UGTMS.

#### **6.2.3.5 Manage the interface with the HMI**

##### **6.2.3.5.1 General**

This basic function is to provide information or receive commands via interfaces to external HMI. The use of information provided by UGTMS to these external HMI (for being displayed or recorded for instance) is outside UGTMS.

##### **6.2.3.5.2 Manage the interface with the operations control HMI**

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

##### **6.2.3.5.3 Manage the interface with 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 trains and staff resources**

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

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