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Intelligent transport systems (ITS) — Guidance protocol via personal ITS station for advisory safety systems

Part 2: Road guidance protocol (RGP) requirements and specification

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National foreword

This British Standard is the UK implementation of ISO 13184-2:2016.

The UK participation in its preparation was entrusted to Technical Committee EPL/278, Intelligent transport systems.

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

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INTERNATIONAL STANDARD

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Intelligent transport systems (ITS) — Guidance protocol via personal ITS station for advisory safety systems —

Part 2: Road guidance protocol (RGP) requirements and specification

Systèmes intelligents de transport — Protocole d'orientation par station ITS personnelle pour systèmes à avis de sécurité —

Partie 2: Spécifications et exigences du protocole d'orientation routière

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

ISO 13184 consists of the following parts, under the general title *Intelligent transport systems (ITS) — Guidance protocol via personal ITS station for advisory safety systems*:

— *Part 1: General information and use cases definition*

— *Part 2: Road guidance protocol (RGP) requirements and specification*

Additional part dealing with road guidance protocol (RGP) conformance test specification is under preparation.

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Introduction

This part of ISO 13184 specifies the use cases implementation of a real-time decision support system for guidance information, designed to enhance mobility and vehicle safety and to provide a parking guide service using the Personal ITS Station (P-ITS-S). The purpose of the system is to transmit guidance or warning messages to drivers and pedestrians in real-time, enhance the user's convenience and avoid congestion in parking facilities by preventing accidents and enabling easy parking.

This part of ISO 13184 implements the road guidance protocol (RGP) requirements (derived from the use cases defined in ISO 13184–1) based on the Data eXchange Message (DXM) at the application level regarding the safety warning and parking guide services between the Roadside ITS Station (R-ITS-S) installed at the roadside and the user's Personal ITS Station (P-ITS-S), e.g. Nomadic Device.

This part of ISO 13184 covers subjects related to traffic safety, including pedestrians besides vehicle drivers. Therefore, this DXM implementation describes how the safety-related services are provided using the P-ITS-S.

This system is based on the following assumptions.

— Based on the fact that the P-ITS-S has limited resources considers these limitations.

— Use cases related to the safety warning and parking guide service can be classified in various ways. These use cases can be added or deleted frequently depending on the specific circumstances of roads and parking spaces. Therefore, the DXM implementation design needs to be flexible and extendable, which enables to add or delete the use cases conveniently.

— The DXM implementation of road guidance contains data elements to configure the message transmitted between the ITS Stations.

— The major use cases include safety warnings at roads and parking guide services to be used between the R-ITS-S and the P-ITS-S.

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Intelligent transport systems (ITS) — Guidance protocol via personal ITS station for advisory safety systems —

Part 2: Road guidance protocol (RGP) requirements and specification

Systèmes intelligents de transport -- Protocole d'orientation par station ITS personnelle pour systèmes à avis de sécurité -- Partie 2

1 Scope

This part of ISO 13184 specifies the road guidance use cases on the DXM to provide the real-time decision support system to drivers or pedestrians using P-ITS-S. The road guidance protocol (RGP) is an instantiation of the data exchange message (DXM), which represents a generic message to exchange data between ITS stations.

The RGP defines an interoperable service protocol between P-ITS-S and R-ITS-S for exchanging data elements. This part of ISO 13184 specifies the following:

— Reference architecture for real-time decision support system.

  This reference architecture provides a general structure for the real-time decision support system and the method of message exchange between the P-ITS-S and the R-ITS-S. This reference architecture is used to build the interconnections between the P-ITS-S and the R-ITS-S.

— Technique of application protocol design for various use cases on a P-ITS-S.

  This technique adopts a flexible and extendable protocol design. In many cases, the application protocol for the ITS is designed to provide a set of messages that is dependent on the use cases and the message exchange method. However, it is not easy to enumerate all use cases for some applications. The use cases can be changed or enhanced frequently. For this type of application, the protocol design, depending on the use cases, is not appropriate. This part of ISO 13184 provides a general technique of designing the road guidance application protocol based on the use cases.

— Primitive data element.

  The primitive data element will be commonly used to configure the safety warning and parking guide service in the form of speed, location and time.

— Use cases at the road and parking spaces for warning and parking guide.

  This part of ISO 13184 describes the use cases applicable to the communication services between the P-ITS-S and the R-ITS-S for the purposes of providing safety warning and parking guidance.

ISO 13184 (all parts) have been aligned according to the requirements specified in ISO 21217, ISO/TS 17419 and ISO/TS 17423.

This part of ISO 13184 only specifies the RGP messages based on the DXM definition (see Annex B and Annex C) at real-time. The content of the RGP messages are based on the definition of road guidance use cases as documented in ISO 13184–1.

This part of ISO 13184 implements ITS-SU objects, which is a general reference to ITS application objects, ITS message sets and other objects which may require globally unique identification and registration.

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The management of ITS-SU objects is many-fold, e.g. specified in ISO 24102–4, ISO 24102–5, ISO 24102–6, ISO 24102–7, ISO 24102–8 and ISO 24102–9, and in CEN/ISO/TS 17423. This part of ISO 13184 implements authorized and controlled operation of ITS-SU objects, which requires considerations of ITS-SU object identifiers, i.e. ITS-AID, ITS-MsgSetID, ITS-SUID, ITS-SCUID, addresses and protocol identifiers used in the communication protocol stack of an ITS-S, and others.

NOTE The accuracy of the navigation and positioning system as input to the Road Guidance application is important for road guidance but is not part of the ISO 13184 series. Detailed information about crossroads is needed for implementation of Road Guidance applications.

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.

ISO/TS 17419, *Intelligent transport systems — Cooperative systems — Classification and management of ITS applications in a global context*

ISO/TS 17423, *Intelligent transport systems — Cooperative systems — ITS application requirements and objectives for selection of communication profiles*

ISO 21217, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 17419, ISO/TS 17423, ISO 21217 and the following apply.

3.1
FA-SAP
service access point between facilities and application layer

3.2
GPS coordinates
collection of GPS position and time

3.3
GPS position
collection of GPS latitude, longitude and altitude

3.4
ITS-S capability (ITS-S capabilities)
uniquely addressable protocol functionality

3.5
ITS station
ITS-S
entity in a communication network, comprised of application, facilities, networking and access layer components specified in ISO 21217 that operate within a bounded secure management domain

3.6
ITS-S application process
ITS-S AP
element in an ITS station that performs information processing for a particular application, and uses ITS-S services to transmit and receive information

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3.7
ITS-S application process provisioner
ITS-S APP
functionality in an ITS-SU offering *ITS-S application processes* (3.6) for download and installation to other ITS-Ss

3.8
personal ITS station
P-ITS-S
implementation of an ITS station as personal ITS subsystem

Note 1 to entry: P-ITS-S is used to send the information of each user (drivers and pedestrians) to the roadside ITS station, and receives the safety warning and parking guide service and transfers them to the users.

3.9
roadside ITS station
R-ITS-S
system that receives and processes vehicular and pedestrian information within a certain zone and determines the situation, in order to provide the safety warning and parking guide service to vehicles and pedestrians

Note 1 to entry: The system is installed at the roadside.

3.10
sensor
device designed to collect general information (e.g., road surface state, potential hazard vehicle's speed) within the server's zone

3.11
WGS-84 coordinate system
WGS-84 is the reference system used in the satellite-based positioning system NAVSTAR Global Positioning System (GPS)

Note 1 to entry: The World Geodetic System (WGS) is a standard for use in cartography, geodesy, and navigation. The latest revision is WGS-84.

4 Abbreviated terms

ADU	application data unit
AP	application process
ASN.1	abstract syntax notation one
BT	Bluetooth
C	conditional
C-ITS-S	central–intelligent transport system–station
CRC	cyclic redundancy check
Cvt	convention (M, O, C)
DER	distinguished encoding rules
DTC	diagnostic trouble code
DXM	data exchange message
FA-SAP	facility application–service access point
GPS	global positioning system
HTML	hypertext mark-up language
ITS	intelligent transport systems
ITS-AID	intelligent transport systems–application identifier
ITS-MsgSetID	intelligent transport systems–message set identifier

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ITS-S	intelligent transport systems–station
ITS-SU	intelligent transport systems–station unit
ITS-SCUID	intelligent transport systems–station communication unit identifier
ITS-SUID	intelligent transport systems–station unit identifier
ITS-S AP	intelligent transport systems–ITS-S application process
ITS-S APP	intelligent transport systems–ITS-S application process provisioner
L2CAP	logical link control and adaptation protocol
M	mandatory
ND	nomadic device
O	optional
OBEX	object exchange
OSI	open systems interconnection
PER	packed encoding rules
P-ITS-S	personal–intelligent transport system-station
R-ITS-S	roadside–intelligent transport system-station
RGP	road guidance protocol
SDP	service discovery protocol
SGML	standard generalized mark-up language
UCDF	use case description format
UGP	unified gateway protocol
VIN	vehicle identification number
V-ITS-SG	vehicle–intelligent transport system-station gateway
WGS-84	World Geodetic System 1984

5 Conventions

This part of ISO 13184 is based on the conventions discussed in the OSI Service Conventions (ISO/IEC 10731) as they apply for communication services. The vehicle data transfer protocol is applicable to OSI layers 5, 6 and 7.

6 Road guidance implementation overview

The Road Guidance will be implemented in Data eXchange Message (DXM) which is another way of transmitting data. Other standards directly define ASN.1 elements for every parameter (see ETSI EN 302 637–2, SAE J2735 or ETSI/TS 101 539–1). However, DXM defines data parameters, its types, units, etc. DXM defines flexible messages because every message consists of a message ID (iTSmsID) and a list of registered value identifiers (rvIds) referencing data parameters. New messages can be defined by adding rvIds to the list, new data parameters can be defined by referring data types.

The road guidance DXM implementation considers conditions such as limited resources because the user receives the service from a P-ITS-S. It is undesirable that all use cases be implemented and installed in a light-weight nomadic device, as elements of the road environment, such as crossroads and the parking environment, are very diverse in their forms. In addition, the service environment at crossroads and parking spaces varies, depending on the time and the area, and undergoes a relatively large number of changes. Therefore, use cases may need to be added/modified/deleted. As a result, the nomadic device can work as an obstacle to smooth service provisioning and service expansion, as it has the burden of updating the use cases manually according to its necessity. This part of ISO 13184 proposes a light-weight P-ITS-S that can resolve these challenges.

The DXM handler allows sending of information between two ITS stations [i.e. a personal ITS station sends its user type (pedestrian, vehicle, etc.) and GPS position to a roadside ITS station; a roadside ITS station sends a collision possible message, including its position to the personal ITS station]. The DXM

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handler is an ITS-S facilities layer ITS-S capability and an ITS-S application process (see Figure 1). The relation between the APPs on a personal ITS station or the application on a roadside ITS station and a DXM handler is realized through FA-SAP (API). FA-SAP primitives defined in ISO/TS 17429 can be used for this purpose. APPs request the use of the DXM ITS-S capability at time of flow registration. DXM ITS-S capability formats the packets based on RGP defined use cases. As per conformance with ISO/TS 17419 and ISO/TS 17423, add in the overview the process by which a road guidance application (ITS-S application process) gets installed in an ITS station and registered with the ITS station management entity, together with its communication requirements, defined for each type of messages exchanged between the Personal ITS-S, Roadside ITS-S and Central ITS-S should be prepared by ITS-S application process(s) (ITS-S AP).

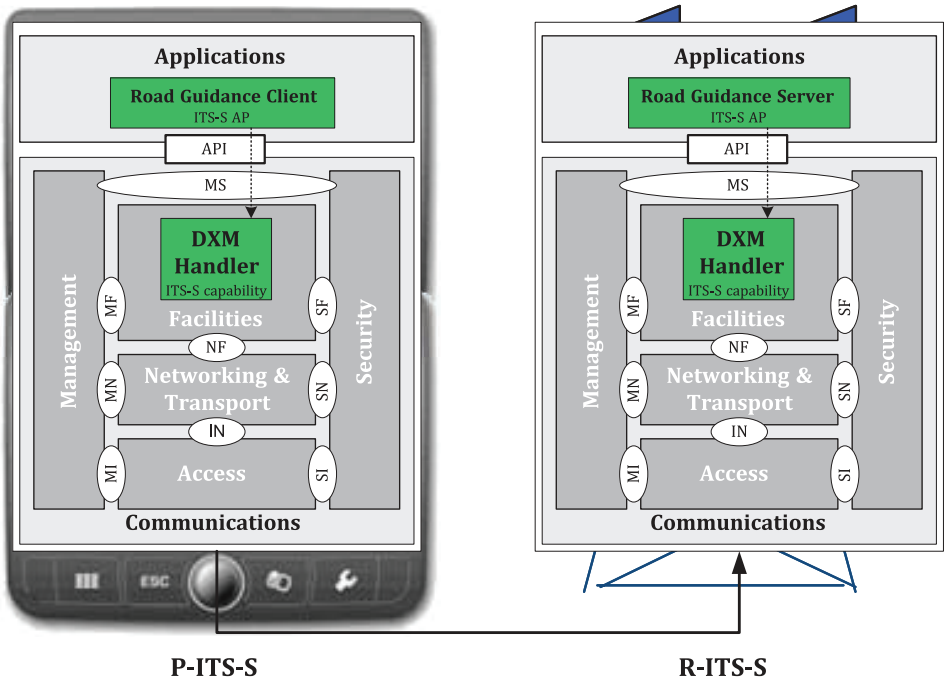

Figure 1 — Communication flow

Figure 2 shows the communication of the road guidance implementation using the DXMessage, i.e. the P-ITS-S starts with "App" handling only messages from and to the R-ITS-Ss. The P-ITS-S is pre-loaded with the DXM configuration using case(s)-specific configuration information from the C-ITS-S (1) to support road guidance messages and data parameters.

After a road user (vehicle, pedestrian) enters a road guidance zone of an R-ITS-S (3), the P-ITS-S immediately reports its position and motion parameters with the necessary message to the R-ITS-S (4). If a situation occurs in the road guidance zone, which matches a supported use case, the R-ITS-S notifies the situation (i.e. safety warning, parking guidance) information to the P-ITS-S (5). The P-ITS-S shows the situation on the display and/or does some acoustic signals. On leaving the road guidance zone, the P-ITS-S stops the communication to the R-ITS-S (6).

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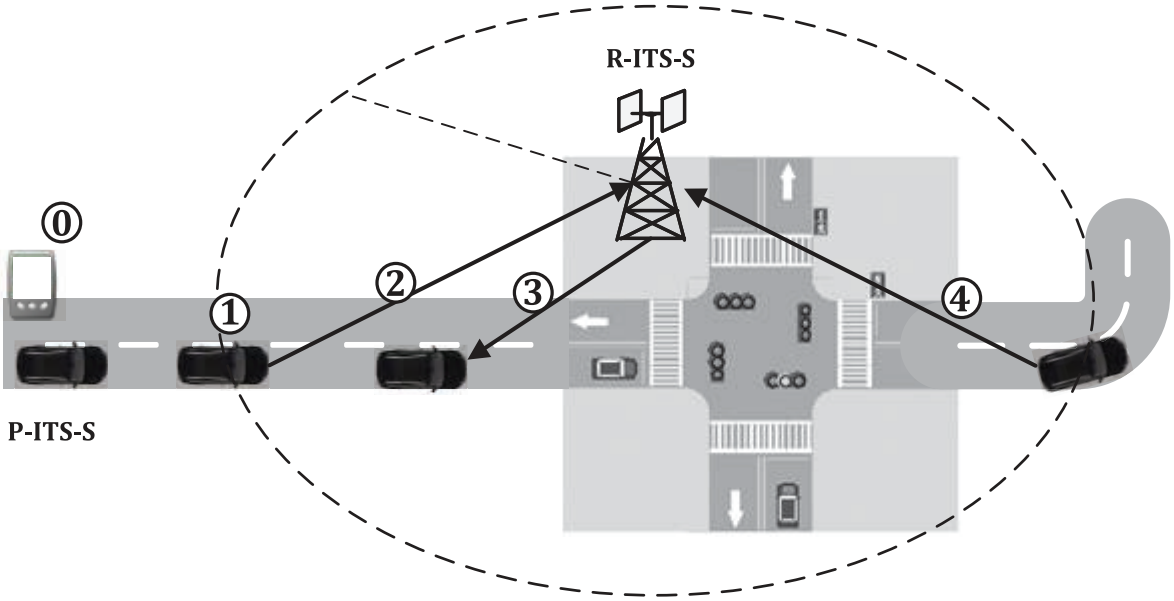

Key

0 update configuration by download

1 road guidance zone

2 sending position and motion information to R-ITS-S

3 sending problem notification

4 sending stop notification/leaving road guidance zone

Figure 2 — Road guidance protocol message exchange scenario

Independent from the P-ITS-S to C-ITS-S/R-ITS-S communication, new messages and their parameters have to be communicated from the C-ITS-Ss to all R-ITS-Ss. In addition, the applications have to be modified and provided in the App Store to support all use cases.

The use case implementation of the RGP is defined in Clause 7.

On the P-ITS-S, a Road Guidance Client ITS-S application process uses the DXM Handler ITS-S capability to communicate to R-ITS-Ss. It uses a broadcast to send its road user type, GPS coordinates and additional data to inform surrounding R-ITS-Ss that it is interested in messages concerning its position (see Figure 3). So the P-ITS-S is added to the list of interested stations of the R-ITS-S.

If an R-ITS-S recognized problems in its communication area, it sends DXM containing the problem information to all list members of interested stations.

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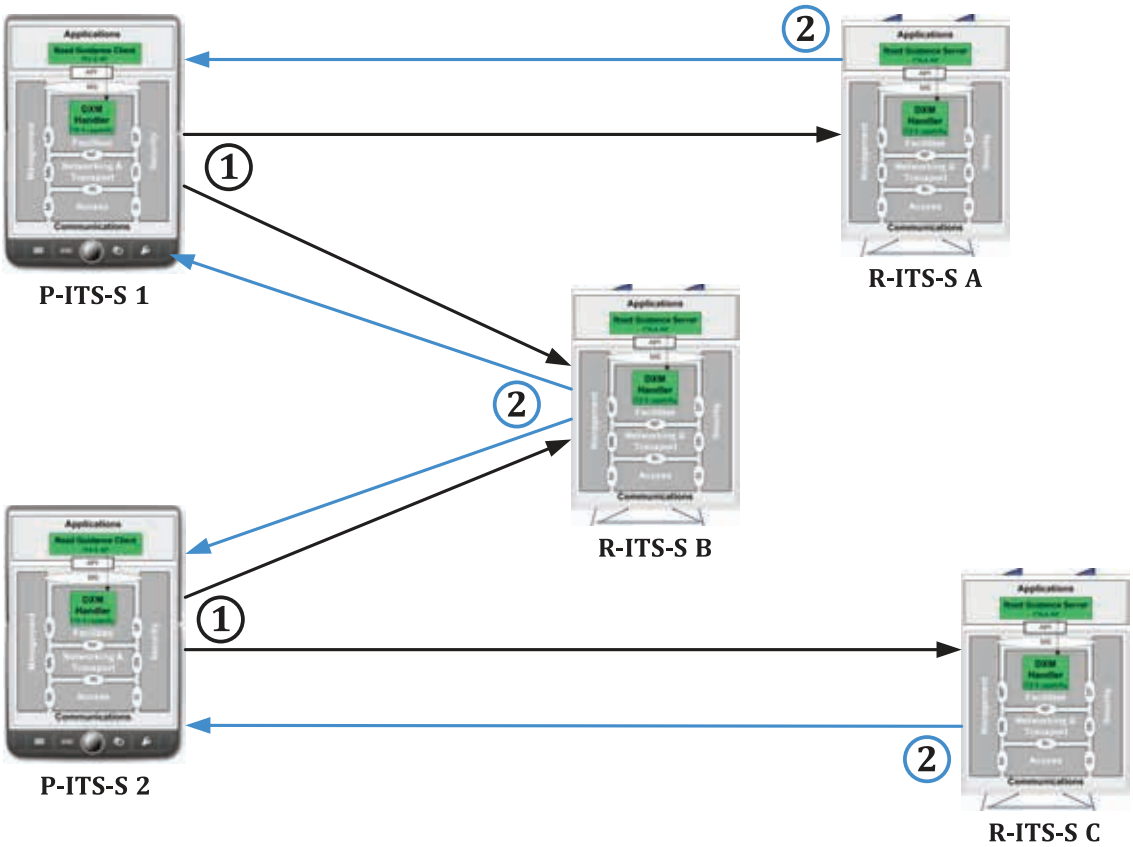

Key

1 P-ITS-S sends a broadcast — to inform all possible R-ITS-Ss: "I am interested"

2 R-ITS-Ss send possible problems to all interested stations

Figure 3 — Communication between P-ITS-Ss and R-ITS-Ss

Every RGP message is encoded as DXM. The DXM will be transmitted with an Application Data Unit (ADU) by the road guidance Application Process (AP) using the ITS-S layer facilities.

7 Use cases implementation into the road guidance protocol

7.1 Use case clusters overview

Table 1 provides an overview of the different use cases. The use cases are grouped into use case clusters.

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Table 1 — Overview of use case clusters and associated use cases

# Title of use case cluster	Brief description
1 Crossroads with a traffic signal	This cluster is separated into five use cases by taking the signal violating vehicle as a risk factor. A vehicle at a crossroad is controlled by the signalling system of the traffic signal. The use cases presented in this cluster are designed to provide a service for smooth crossroad traffic control while complying with the signalling system and protecting pedestrians on a pedestrian crossing. UC 1.1 — Vehicle violates a signal without stopping UC 1.2 — Violating vehicle is inside the crossroad UC 1.3 — Guiding the pedestrian on a pedestrian crossing UC 1.4 — Pedestrians violate the traffic signal on a pedestrian crossing UC 1.5 — The traffic is bumper-to-bumper on the crossroad
2 Crossroads	This use case considers the scenario that the crossroad is not equipped with a traffic signal, which may cause the traffic congestion if several vehicles enter into the crossroad simultaneously. This use case is designed to provide smooth traffic flow by preventing heavy traffic congestion or reducing waiting time. UC 2.1 — Crossroads without a traffic signal
3 Parking space	This cluster describes two use cases for the parking guide. UC 3.1 — Parking guide when the vehicle enters a parking area UC 3.2 — Searching the path and parking space on demand The parking path guide in the parking space use case refers to simple transmission of the path to the user's personal ITS station, not to the vehicle navigation system. When a vehicle enters into the parking space, it is difficult for the vehicle driver to check how many parking lots are available at which space. Therefore, if the parking space is full or if a parking space is available but cannot be identified conveniently, the driver will waste time to park the vehicle or even unable to find a parking space for the vehicle. In addition, the driver may not be able to park the vehicle at the convenient space.
4 Risky environment alarm	This cluster describes two use cases that consider the frequent accidents area at the curved road. UC 4.1 — Vehicle strays into the path of an oncoming vehicle UC 4.2 — Vehicle approaches the curved road with excessive speed The cluster considers the oncoming vehicle and speed limit regulation. The use cases focus on reducing and preventing the accident which can be caused by the geometric structure of the road. The following two use cases consider the speed limit of the vehicles with some special cases that contain school zone and severe weather condition. UC 4.3 — Risky environments alarm in severe weather condition UC 4.4 — Risky environments alarm in the areas of speed limit enforcement The use cases help safe driving by informing of the presence of the school zone and the severe weather condition.

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Table 1 *(continued)*

# Title of use case cluster	Brief description
	The following two use cases consider temporary road occupation scenarios and the situation of an emergency vehicle to establish a clear path. UC 4.5 — Vehicle approaches a temporary road occupation This use case addresses the situation when a vehicle approaches a temporary road occupation such as the road construction, accident/disabled vehicles or obstacles on the road. By informing the status of temporary road occupation, the road congestion will be prevented. UC 4.6 — Emergency vehicle approaches on one's route This use case addresses the situation when an emergency vehicle is moving to establish a clear path. This cluster handles the safety messaging procedure when an emergency vehicle is approaching. By announcing the emergency vehicle approaching information, an emergency vehicle can achieve a clear path.

7.2 Use cases implementation

7.2.1 UC cluster 1 — Crossroads with a traffic signal

7.2.1.1 UC 1.1 — Vehicle violates a signal without stopping

Table 2 defines the use case handling when a vehicle violates a stop signal at the crossroads.

Table 2 — Definition of UC 1.1 — Vehicle violates a signal without stopping

Use Case	**Cluster**	**1 — Crossroads with a traffic signal**		When a vehicle enters a crossroad and cannot stop on the stop line due to the long braking distance and velocity of the vehicle, the warning message is sent to all vehicles and pedestrians. If the vehicle is able to stop on the line, the warning message may disappear.
	Name	**UC 1.1 — Vehicle violates a signal without stopping**		
	Occurrence area	Crossroads with a traffic signal.		
	Road user situation	Accessing the crossroads.		
	Provisioning phase	a) The vehicle accesses the crossroads. b) Forecasts that the vehicle can violate the signal when entering into the crossroads. c) Sends the information message with handling of risk factors as soon as any vehicle poses a risk. d) Sends the release message when the vehicle arrives at the stop line.		
	P-ITS-S control	The following references are related to "Provisioning phase": to c) Caution/Warning message. to d) Release message.		
	Hindrance factor	Signals of the traffic signal should be known in advance to forecast the signal.		
	Requirements	When the user receives the information message, the user must pay attention to it.		
	Reference	Signal violation forecasting of this system is closely related to the driver's response time and braking distance. Therefore, environmental circumstances such as the vehicle type and the state of the road surface may be considered as the major factors to apply this service.		
	Clause	**Name**	**Exe**	**Description**

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Table 2 *(continued)*

Messages	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.4	`collision-possible`	R	Send notification message to indicate a vehicle possibly violating a crossing signal, including crossing position and blocked lanes. Send updated message if blocked lanes have changed its status.
	9.15	`release`	R	Release message if problem no longer occurs.

7.2.1.2 UC 1.2 — Violating vehicle is inside the crossroad

Table 3 defines the use case handling procedure when a vehicle violates the stop signal and locates inside the crossroad. This situation is similar to the use case shown in 7.2.1.1. However, unlike 7.2.1.1, this use case considers the handling procedure when a vehicle has already violated the traffic signal.

Table 3 — Definition of UC 1.2 — Violating vehicle is inside the crossroad

Use Case	**Cluster**	**1 — Crossroads with a traffic signal**		If a vehicle crosses over the stop line and enters inside the crossroad, or the vehicle has violated the stop line and keeps moving even with the stop signal, the warning message is sent to the surrounding vehicles. The warning message is also sent to pedestrians who have received a clear signal at the pedestrian crossing.
	Name	**UC 1.2 — Violating vehicle is inside the crossroad**		
	Occurrence area	Crossroads with a traffic signal.		
	Road user situation	The clear signal is on.		
	Provisioning phase	a) Checks whether a vehicle violates the signal at the crossroad when the traffic signal has changed. b) Generates a caution message that the vehicle violating the traffic signal has been detected. As soon as the signal has changed, the vehicle in violation of the signal is identified and the caution message is sent to the surrounding vehicles and pedestrian which receives the clear signal. c) Generates a release message if the vehicle that has violated the traffic signal exits the crossroad.		
	P-ITS-S control	The following references are related to “Provisioning phase”: to c) Caution/Warning message. to d) Release message.		
	Hindrance factor	Vehicle making a right turn.		
	Requirements	Pay attention to the warning message.		
	Reference	The vehicle attempts to make a right turn and the vehicle in violation of the traffic signal cannot be clearly identified.		
	Clause	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.

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Table 3 *(continued)*

Messages	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.5	`vehi-cle-blocks-road`	R	Send notification message to indicate a vehicle blocks a crossing road, including crossing position and blocked lanes. Send updated message if blocked lanes have been changed.
	9.15	`release`	R	Release message if problem no longer occurs.

7.2.1.3 UC 1.3 — Guiding the pedestrian on a pedestrian crossing

Table 4 defines the use case handling procedure if the remaining time of clear signal is short when the pedestrians cross the pedestrian crossing.

Table 4 — Definition of UC 1.3 — Guiding the pedestrian on a pedestrian crossing

Use Case	**Cluster**	**1 — Crossroads with a traffic signal**	If a pedestrian accesses the pedestrian crossing, the remaining time of the clear signal is compared with the average walking time, and the guide message is sent. In addition, if the signalling time at a pedestrian crossing is short, the remaining time of clear signal is notified to the pedestrian at the pedestrian crossing.	
	Name	**UC 1.3 — Guiding the pedestrian on a pedestrian crossing**		
	Occurrence area	Crosswalks with a traffic signal.		
	Road user situation	Remaining clear signal time needed.		
	Provisioning phase	a) Checks the remaining time of clear signal. b) Checks the average walking time. c) Generates a guide message that the remaining time of clear signal is notified to the pedestrian. The remaining time of the clear signal is compared with the average walking time, and the guide message is sent. In addition, if the signalling time at a pedestrian crossing is short, the remaining time of clear signal is notified to the pedestrian at the pedestrian crossing.		
	P-ITS-S control	The following references are related to “Provisioning phase”: to b) Caution/Warning message. to c) Guide message.		
	Hindrance factor	Not applicable.		
	Requirements	Pay attention to the guide message.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	No messages can be defined to solve use case			

7.2.1.4 UC 1.4 — Pedestrians violate the traffic signal on a pedestrian crossing

Table 5 defines the use case handling procedure if pedestrians violate a traffic signal on the pedestrian crossing.

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Table 5 — Definition of UC 1.4 — Pedestrians violate the traffic signal on a pedestrian crossing

Use Case	**Cluster**	**1 — Crossroads with a traffic signal**		If a pedestrian enters into the pedestrian crossing even though the traffic signal indicates "Stop" or the traffic signal is changing during a pedestrian crossing, the warning message is sent to the surrounding vehicles.
	Name	**UC 1.4 — Pedestrians violate the traffic signal on a pedestrian crossing**		
	Occurrence area	Crosswalks with a traffic signal.		
	Road user situation	Vehicle accesses the crossroads.		
	Provisioning phase	a) Check the existence of pedestrians after the green signal is expired in the pedestrian crossing immediately. b) Generates warning message which indicates the pedestrians are existing. c) Releases the warning message if the pedestrians exit the pedestrian crossing.		
Use Case	**P-ITS-S control**	The following references are related to "Provisioning phase": to b) Caution/Warning message. to c) Release message.		
	Hindrance factor	Not applicable.		
	Requirements	Pay attention to the warning message.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.6	`pedestrian-blocks-road`	R	Send notification message to indicate (a) pedestrians block(s) a crossing road, including crossing position and blocked lanes. Send updated message if blocked lanes have been changed.
	9.15	`release`	R	Release message if problem no longer occurs.

7.2.1.5 UC 1.5 — Traffic is bumper-to-bumper on the crossroad

Table 6 defines the use case handling procedure for protecting traffic congestion and improving traffic flow if vehicles try to enter into crossroads when the traffic is bumper-to-bumper.

Table 6 — Definition of UC 1.5 — The traffic is bumper-to-bumper on the crossroad

	Cluster	**1 — Crossroads with a traffic signal**	If traffic is congested and expected to affect vehicles, a guidance message will be announced to affected vehicles to enable them to seek alternative routes that may help improve the overall traffic situation. Clear signal should be changed to red, yellow, and green and absent traffic signals (see EN 12795).
	Name	**UC 1.5 — The traffic is bumper-to-bumper on the crossroad**	
	Occurrence area	Crossroads with a traffic signal.	
	Road user situation	Receiving a clear signal.	

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Table 6 *(continued)*

Use Case	**Provisioning phase**	a) Check the traffic congestion along the road and crossroad. b) Generates a guide message if the traffic is bumper-to-bumper immediately. c) Release the guide message if the traffic is smooth.		
	P-ITS-S control	The following references are related to "Provisioning phase": to b) Guide message. to c) Release message.		
	Hindrance factor	Vehicles which neglect the guide message and enter into the crossroad.		
	Requirements	If vehicles receive the guide message, the vehicles do not enter into the crossroad even though the traffic signal is clear.		
	Reference	Detecting of bumper-to-bumper status refers the share of roads and the speed of vehicles.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.7	`bumper-to-bumper`	R	Send notification message to indicate the traffic is bumper-to-bumper in the crossroads, including crossing position and blocked lanes. Send updated message if blocked lanes have been changed.
	9.15	`release`	R	Release message if problem no longer occurs.

7.2.2 UC cluster 2 — Crossroads

7.2.2.1 UC 2.1 — Crossroads without a traffic signal

Table 7 defines the use case handling procedure of the vehicles at the crossroads without a traffic signal.

Table 7 — Definition of UC 2.1 — Crossroads without a traffic signal

Use Case	**Cluster**	**2 — Crossroads**	When several vehicles enter a crossroad simultaneously, information as to which vehicle gets priority is announced to affected vehicles based on the traffic regulations, which enables the traffic flow smoothly by minimizing the waiting time and making the vehicles move consecutively. In addition, to announce the priority, the warning message where the vehicle which violates the regulation is approaching is also notified.
	Name	**UC 2.1 — Crossroads without a traffic signal**	
	Occurrence area	Crossroads without a traffic signal.	
	Road user situation	Approaching the crossroad without a traffic signal.	
	Provisioning phase	a) Checks the vehicle speed and distance between the vehicle and crossroad. b) Checks the priority and announces the priority information immediately as the vehicles cross the crossing. c) Driver receives the message. d) Pass the crossroad following the priority.	

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Table 7 *(continued)*

	P-ITS-S control	The following references are related to "Provisioning phase": to c) Guide message.		
	Hindrance factor	The vehicle which neglects the priority.		
	Requirements	Pass the crossroads depending on the priority information, and follow the updated information if the priority is changing.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.8	`crossing-priority`	R	Send notification message to indicate the crossing priority to the vehicle, including crossing position and priority. If another vehicle passes the crossing, update the priority.

7.2.3 UC cluster 3 — Parking space

7.2.3.1 UC 3.1 — Parking guide when the vehicle enters a parking area

Table 8 defines the use case handling procedure of parking guidance using the parking guide service. Using this use case, the driver can select the preferred parking space, so the vehicle is guided to the parking space.

Table 8 — Definition of UC 3.1 — Parking guide when the vehicle enters a parking area

Use Case	**Cluster**	**3 — Parking space**	When vehicles approach the parking space, available parking spaces depending on the driver's types (handicapped, inexperienced, etc.) and vehicle types (passenger vehicles, small vehicles, SUVs, buses, etc.) are identified and notified to the driver. After the driver chooses the preferred space among the notified spaces by the guidance, the information regarding the movement path to the designated space is sent to the personal ITS station. The service will be terminated when the driver finds the target parking space and parks the vehicle according to the guided path.
	Name	**UC 3.1 — Parking guide when the vehicle enters a parking area**	
	Occurrence area	Street, parking area.	
	Road user situation	Driving to the designated parking space.	
	Provisioning phase	a) Checks the available parking spaces; chooses the algorithm for selecting the optimal space and announce the route for the specific space. b) Sends guide messages to the driver. c) Completes parking.	
	P-ITS-S control	The following references are related to "Provisioning phase": to b) Guide message.	
	Hindrance factor	Sensors for notifying the empty parking space have to be working properly. Well defined path calculation algorithm for parking has to be established.	

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Table 8 *(continued)*

	Requirements	Pay attention to the selection of preferred space among the notified spaces.		
	Reference	Not applicable.		
Messages	**Chapter**	**Name**	**Exe**	**Description**
	9.16	`search-parking-space`	P/V	Request R-ITS-S to search a parking space with the given requirements.
	9.17	`guide-parking-space`	R/C	Guide the P-ITS-S to the parking space with way-points and navigation hints.

7.2.3.2 UC 3.2 — Searching the path and parking space on demand

Table 9 defines the use case handling procedure of parking guidance when some obstacles hinder normal movement of the vehicle on the movement path or parking space while the vehicle is travelling to the parking space under the guidance of the personal ITS station.

Table 9 — Definition of UC 3.2 — Searching the path and parking space on demand

Use Case	**Cluster**	**3 — Parking space**	If any vehicle or obstacle blocks the movement path due to abnormal situation in a parking space or if any other factor disturbs normal parking at the designated space, the new parking space and movement path will be sent to the personal ITS station on demand and sent to the personal ITS station, so that the driver can avoid the hindrance.	
	Name	**UC 3.2 — Searching the path and parking space on demand**		
	Occurrence area	Street, parking area.		
	Road user situation	Driving to the designated parking space.		
	Provisioning phase	a) Moves to the designated parking space. b) Checks the obstacle blocking the path of the vehicle. c) Searches a new route and parking slot. d) Introduces the new route and parking slot. e) Completes parking.		
	P-ITS-S control	The following references are related to “Provisioning phase”: to d) Guide message.		
	Hindrance factor	Hinder the driving route and parking position.		
	Requirements	Pay attention to the guide message for new parking slot.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.16	`search-parking-space`	P/V	Request R-ITS-S to search a parking space with the given requirements.
	9.17	`guide-parking-space`	R/C	Guide the P-ITS-S to the parking space with waypoints and navigation hints.

7.2.4 UC cluster 4 — Risky environment alarm

7.2.4.1 UC 4.1 — Vehicle strays into the path of an oncoming vehicle

Table 10 defines the use case handling procedure of warning alarm when there is an oncoming vehicle which strays into the path. Using this use case, the vehicle can pass the curved road in safety by preventing a collision.

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Table 10 — Definition of UC 4.1 — Vehicle strays into the path of an oncoming vehicle

Use Case	**Cluster**	**4 — Risky environment alarm**	When vehicles approach a curved road and an oncoming vehicle strays into its path, the warning message is sent to the vehicle. If a driver receives the warning message, he/she can avoid a collision by driving the vehicle to the outside lane or reducing the vehicle speed. The service will be terminated when the driver passes through the curved road.	
	Name	**UC 4.1 — Vehicle strays into the path of an oncoming vehicle**		
	Occurrence area	Curved road.		
	Road user situation	Approaching the curved road.		
	Provisioning phase	a) Checks whether a vehicle approaches the curved road. b) Checks whether there's an oncoming vehicle which strays into the path. c) Generates the caution message that the vehicle strays into the path of an oncoming vehicle has been detected, Guide to drive outside lane and reduce the vehicle speed. d) Sends message which advise to move the vehicle to the outside lane or reduce the vehicle speed.		
	P-ITS-S control	The following references are related to "Provisioning phase": to b) Caution/Warning message.		
	Hindrance factor	Oncoming vehicle is out of control.		
	Requirements	Pay attention to the guide message for existence of the oncoming vehicle.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.9	`oncoming-vehicle`	R	Send notification message to indicate an oncoming vehicle.
	9.15	`release`	R	Release message if problem no longer occurs.

7.2.4.2 UC 4.2 — Vehicle approaches the curved road with excessive speed

Table 11 defines the use case handling procedure of warning alarm when a vehicle approaches the curved road and violates the speed limit regulation. Using this use case, the vehicle speed is predetermined and makes the vehicle pass the curved road smoothly.

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Table 11 — Definition of UC 4.2 — Vehicle approaches the curved road with excessive speed

Use Case	**Cluster**	**4 — Risky environment alarm**		When vehicles approach a curved road and approaching vehicles violate the speed limit, the warning message is sent to the corresponding vehicle. If a driver receives the warning message, he/she can reduce the vehicle speed, which enables to drive the curved road following by the speed limit regulation. This results in smooth and safe driving in the curved road. The service will be terminated when the driver pass through the curved road.
	Name	**UC 4.2 — Vehicle approaches the curved road with excessive speed**		
Use Case	**Occurrence area**	Curved road.		
	Road user situation	Approaching the curved road.		
	Provisioning phase	a) Checks whether a vehicle violates the speed limit regulation when the vehicle approaches the curved road. b) Generates and sends alarm message to the vehicle. Guide to reduce the vehicle speed. c) Generates a release message when the vehicle's speed reaches the regulation speed.		
	P-ITS-S control	The following references are related to "Provisioning phase": to b) Caution/Warning message.		
	Hindrance factor	Not applicable.		
	Requirements	Pay attention to the speed limit alarm message.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.10	`overspeed`	R	Send notification message to indicate the driver that he is driving too fast. This notification message is generated immediately until the driver reduces the speed or the end of the curve is reached.

7.2.4.3 UC 4.3 — Risky environments alarm in severe weather condition

Table 12 defines the use case handling procedure of warning alarm when the unexpected weather condition occurs. Using this use case, the bad weather condition such as heavy rain, thick fog or freezing road information is sent to a driver in advance, which enables to drive in safety.

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Table 12 — Definition of UC 4.3 — Risky environments alarm in severe weather condition

Use Case	**Cluster**	**4 — Risky environment alarm**		When vehicles approach an accident zone in bad weather conditions, the warning message is sent to the vehicle depending on the road and weather condition. If a driver receives the warning message, he/she can recognize the risky environments and prevent the accident by reducing the vehicle's speed or by establishing a safety distance more clearly. The service will be terminated when the driver passes through the designated areas.
	Name	**UC 4.3 — Risky environments alarm in severe weather condition**		
	Occurrence area	Areas of frequent accidents.		
	Road user situation	Approaching the unknown areas with bad road condition.		
Use Case	**Provisioning phase**	a) Checks whether a vehicle approaches the frequent accident zones due to the bad weather conditions. b) Checks the on-road and weather conditions. c) Generates and sends a caution message to the vehicle that it may skid on the ice or it has poor visibility. Guide to reduce the vehicle speed. d) Generates a release message when the vehicle passes through the designated zones.		
	P-ITS-S control	The following references are related to "Provisioning phase": to b) Caution/Warning message.		
	Hindrance factor	Not applicable.		
	Requirements	Pay attention to the guide message for road and weather conditions.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.11	`bad-weather`	R	Send notification message to indicate bad weather.
	9.15	`release`	R	Release message if problem no longer occurs.

7.2.4.4 UC 4.4 — Risky environments alarm in the areas of speed limit enforcement

Table 13 defines the use case handling procedure of warning alarm when a vehicle approaches the area of speed limit enforcement. Using this use case, the area of speed limit enforcement such as school zone and temporary speed limit reducing is informed to a driver in advance, which enables to drive in safety and prevent accidents.

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Table 13 — Definition of UC 4.4 — Risky environments alarm in the areas of speed limit enforcement

Use Case	**Cluster**	**4 — Risky environment alarm**	When vehicles approach an area where a speed limit is enforced, the warning message is sent to the approaching vehicles. If a driver receives the warning message, he/she can prepare to reduce the speed of vehicle and prevent the accident. The service will be terminated when the driver passes through the designated areas.	
	Name	**UC 4.4 — Risky environments alarm in the areas of speed limit enforcement**		
	Occurrence area	Areas of speed limit enforcement.		
	Road user situation	Approaching to the areas of speed limit enforcement.		
	Provisioning phase	a) Checks whether a vehicle approaches to the areas of speed limit enforcement. b) Generates and sends a caution message which indicates the speed limit zone ahead. Guide to reduce the vehicle speed. c) Generates a release message when the vehicle passes through the designated zones.		
Use Case	**P-ITS-S control**	The following references are related to "Provisioning phase": to b) Caution/Warning message.		
	Hindrance factor	Not applicable.		
	Requirements	Pay attention to the guide message for indicating the speed limit zone.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.12	`speed-limit`	R	Send notification message to indicate driving too fast in a speed enforcement area.
	9.15	`release`	R	Release message if problem no longer occurs.

7.2.4.5 UC 4.5 — Vehicle approaches a temporary road occupation

Table 14 defines the use case handling procedure of warning alarm when the temporary road occupation occurs. Using this use case, the temporary road condition such as the road construction ahead, accident ahead or disabled vehicle ahead information is announced to the following vehicles, which enable to drive in safety.

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Table 14 — Definition of UC 4.5 — Vehicle approaches a temporary road occupation

Use Case	**Cluster**	**4 — Risky environment alarm**	When an unexpected situation related to road conditions occurs, the warning message is sent to affected vehicles. The message announces information about ongoing road constructions, accidents and disabled vehicles ahead, etc. If a driver receives the warning message, he/she can perceive the road status and prevent the congestion/accident by reducing the vehicle speed or shifting the driving lane. The service will be terminated when the driver passes through the designated areas.	
	Name	**UC 4.5 — Vehicle approaches a temporary road occupation**		
	Occurrence area	Congested area.		
	Road user situation	Approaching to the congested unknown areas.		
	Provisioning phase	a) Checks whether a vehicle approaches to the congested unknown area. b) Checks the road conditions such as reported accidents, road construction information and presence of disabled vehicle. c) Generates and sends a guide message to the vehicle depending on the remaining time to be cleared. Guide to avoid road congestion. d) Generates a release message when the occupation is cleared.		
	P-ITS-S control	The following references are related to “Provisioning phase”: to b) Caution/Warning message.		
	Hindrance factor	Not applicable.		
Use Case	**Requirements**	Pay attention to the guide message for the reason of the temporary road occupation.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.13	`road-occupation`	R	Send notification message to indicate a road occupation.
	9.15	`release`	R	Release message if problem no longer occurs.

7.2.4.6 UC 4.6 — Emergency vehicle approaches on one’s route

Table 15 defines the use case handling procedure of warning alarm when an emergency vehicle approaches on one’s route. Using this use case, the vehicle ensures the path of emergency vehicle by following the warning message.

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Table 15 — Definition of UC 4.6 — Emergency vehicle approaches on one's route

Use Case	**Cluster**	**4 — Risky environment alarm**	When an emergency vehicle approaches, the warning message is sent to vehicles on its route. If a driver receives the warning message, he/she can prepare to clear the path for the emergency vehicle. This use case enables an emergency vehicle to drive clearly by informing emergency vehicle approaching information in advance. The Service will be terminated after an emergency vehicle passes along the driver's vehicle.	
	Name	**UC 4.6 — Emergency vehicle approaches on one's route**		
	Occurrence area	Road.		
	Road user situation	Approaching the emergency vehicle to one's route.		
	Provisioning phase	a) Checks whether an emergency vehicle approaches to one's route. b) Generates and sends a guide message for the designated path to be cleared. Guide for fire lane to be cleared. c) Generates a release message when the emergency vehicle passes along one's route.		
	P-ITS-S control	The following references are related to "Provisioning phase": to b) Caution/Warning message.		
	Hindrance factor	Not applicable.		
	Requirements	Pay attention to the guide message whether the emergency vehicle has passed along or not.		
	Reference	Not applicable.		
Messages	**Clause**	**Name**	**Exe**	**Description**
	9.2	`notify-on-position`	P/V	Send P-ITS-S position, motion parameter and vehicle size to the road side server (R-ITS-S) on entering R-ITS-Ss communication area. After the first contact, send only the P-ITS-S position in a predefined time interval.
	9.3	`stop-notify`	P/V	Stop the communication to the R-ITS-S.
	9.14	`emergency-vehicle`	R	Send notification message to indicate an/some emergency vehicle(s) on the road.
	9.15	`release`	R	Release message if problem no longer occurs.

8 RGP messages

8.1 Overview

Figure 4 shows an overview of the RGP messages.

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