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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

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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).

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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.

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.

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.

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

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

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

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).

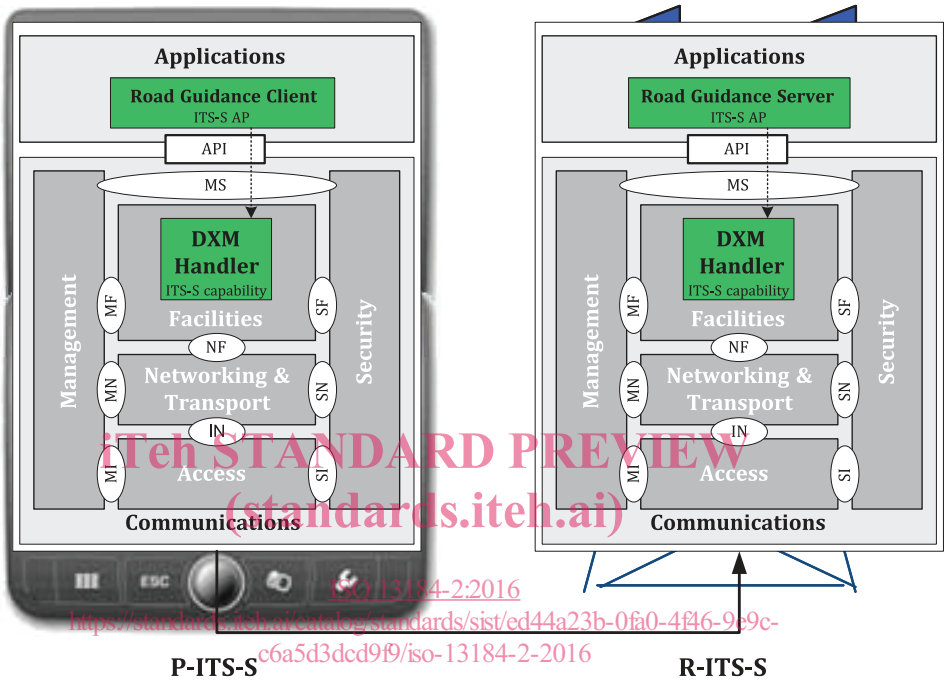
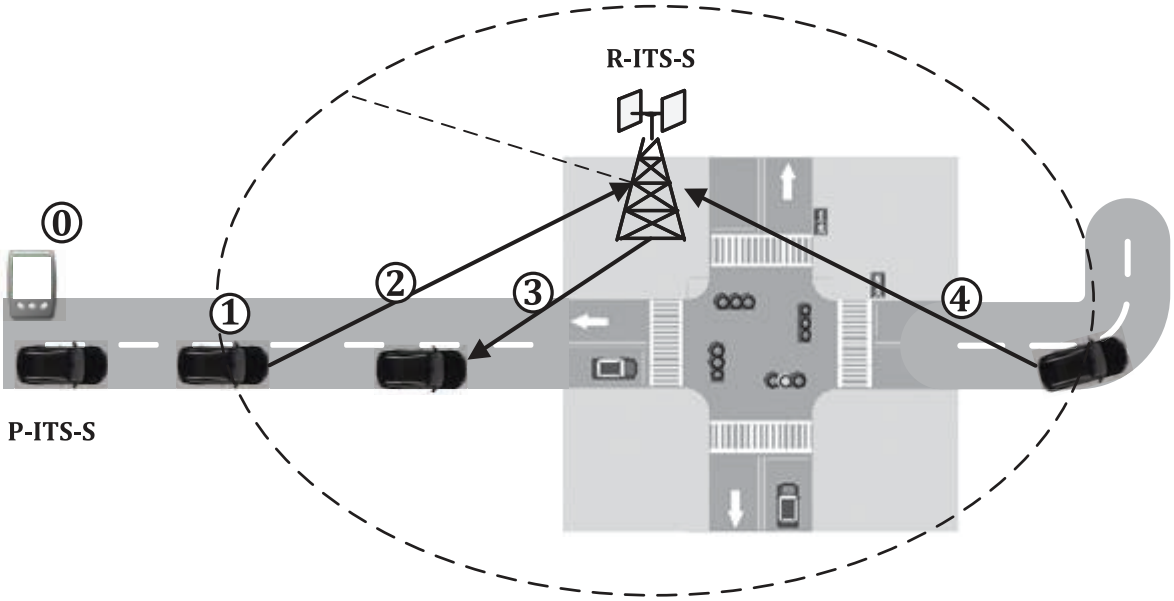


Figure 1 — Communication flow

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).



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

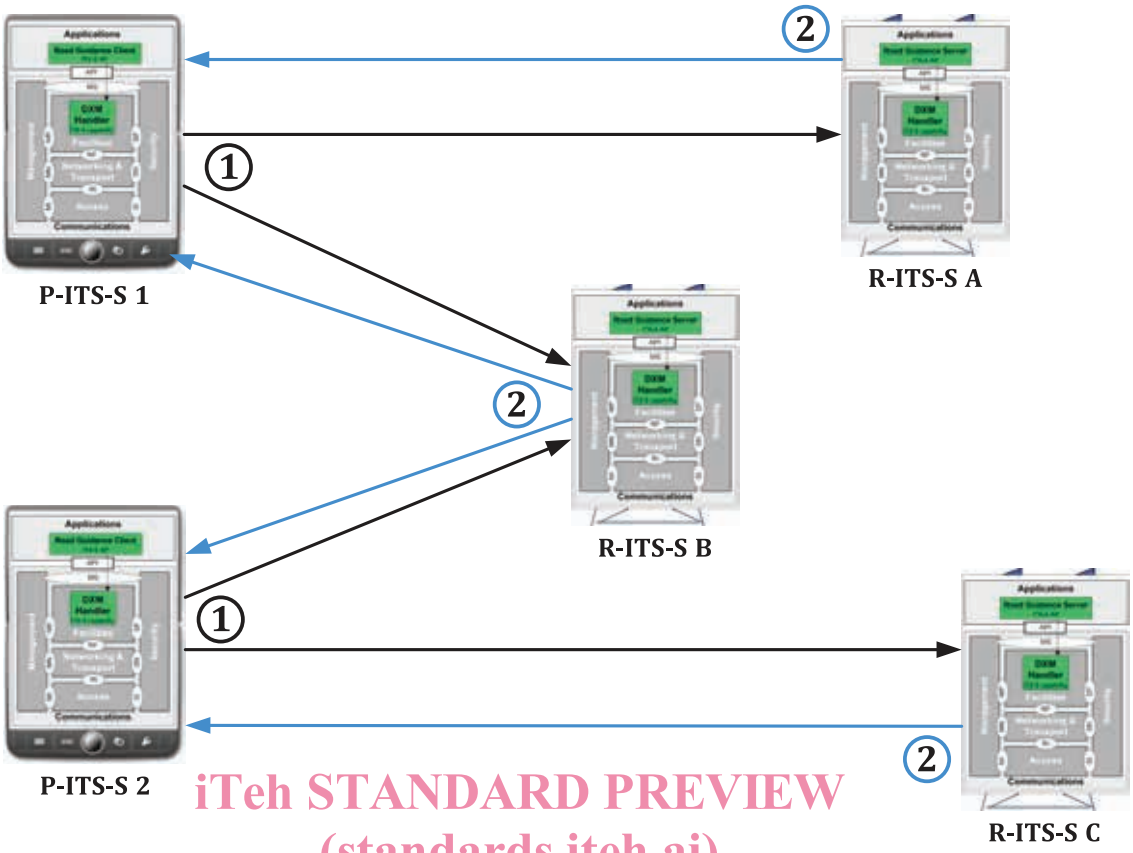
Figure 2 — Road guidance protocol message exchange scenario

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.



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.

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.

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**