

PD ISO/TS 19091:2017



BSI Standards Publication

**Intelligent transport systems  
— Cooperative ITS — Using  
V2I and I2V communications  
for applications related to  
signalized intersections**

### **National foreword**

This Published Document is the UK implementation of ISO/TS 19091:2017.

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.

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

© The British Standards Institution 2017.  
Published by BSI Standards Limited 2017

ISBN 978 0 580 92102 5

ICS 03.220.20; 35.240.60

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2017.

### **Amendments/corrigenda issued since publication**

Date	Text affected
------	---------------

---

---

---

**Intelligent transport systems —  
Cooperative ITS — Using V2I and I2V  
communications for applications  
related to signalized intersections**

*Systèmes intelligents de transport — Coopérative ITS — Utilisation  
de communications V2I et I2V pour des applications relatives aux  
intersections signalées*





**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
copyright@iso.org  
www.iso.org

# Contents

Page

<b>Foreword</b> .....	<b>vi</b>
<b>Introduction</b> .....	<b>vii</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>2</b>
<b>4 Abbreviated terms</b> .....	<b>9</b>
<b>5 General description (informative)</b> .....	<b>11</b>
5.1 Overview.....	11
5.2 Functional model.....	11
5.2.1 Description.....	11
5.2.2 Architecture.....	13
5.2.3 Message interactions.....	15
5.2.4 Common operational assumptions.....	15
5.3 Safety use cases.....	16
5.3.1 Intent.....	16
5.3.2 Additional assumptions.....	17
5.3.3 Architecture implications.....	17
5.4 Mobility/sustainability use cases.....	17
5.4.1 Intent.....	17
5.4.2 Additional assumptions.....	18
5.4.3 Architecture implications.....	18
5.5 Priority/pre-emption use cases.....	18
5.5.1 Intent.....	18
5.5.2 Additional assumptions.....	20
5.5.3 Architecture implications.....	20
5.5.4 Public transport signal priority application.....	21
5.5.5 Freight vehicle signal priority application.....	22
5.5.6 Emergency (public safety) vehicle pre-emption application.....	23
<b>6 Function description (informative)</b> .....	<b>24</b>
6.1 Public safety vehicle.....	24
6.1.1 Broadcast public safety vehicle information.....	24
6.1.2 Broadcast emergency response indication.....	24
6.2 Signal pre-emption.....	24
6.2.1 Signal pre-empt request (normal power).....	25
6.2.2 Signal pre-empt request (high power).....	25
6.2.3 Request signal pre-empt — Message identifier.....	25
6.2.4 Request signal pre-empt — Intersection identifier.....	25
6.2.5 Request signal pre-empt — Approach lane.....	25
6.2.6 Request signal pre-empt — Egress lane.....	26
6.2.7 Request signal pre-empt — Vehicle class.....	26
6.2.8 Request signal pre-empt — Time of service.....	26
6.2.9 Request signal pre-empt — Vehicle identity.....	26
6.2.10 Request signal pre-empt — Vehicle location and speed.....	26
6.2.11 Request signal pre-empt — Cancellation.....	26
6.2.12 Request signal pre-empt — Transaction identifier.....	27
6.2.13 Request signal pre-empt — Duration.....	27
6.3 Public transport and commercial vehicle.....	27
6.3.1 Broadcast priority requesting vehicle information.....	27
6.4 Signal priority requirements.....	27
6.4.1 Signal priority request.....	27
6.4.2 Request signal priority — Message identifier.....	27
6.4.3 Request signal priority — Intersection identifier.....	28

6.4.4	Request signal priority — Approach lane	28
6.4.5	Request signal priority — Egress lane	28
6.4.6	Request signal priority — Vehicle class	28
6.4.7	Request signal priority — Time of service	28
6.4.8	Request signal priority — Vehicle identity	28
6.4.9	Request signal priority — Vehicle location and speed	29
6.4.10	Request signal priority — Service information	29
6.4.11	Request signal priority cancellation	29
6.4.12	Request signal priority — Priority request level	29
6.4.13	Request signal priority — Transaction identifier	29
6.4.14	Request signal priority — Duration	29
6.4.15	Request signal priority — Transit schedule	29
6.5	Broadcast area's geometrics	30
6.5.1	Broadcast roadway geometrics	30
6.5.2	Broadcast roadway geometrics — Message identifier	30
6.5.3	Broadcast intersection — Identifier	30
6.5.4	Broadcast intersection — Reference point	30
6.5.5	Broadcast intersection — Lane/approach default width	30
6.5.6	Broadcast intersection — Egress lanes/approach	30
6.5.7	Broadcast intersection — Ingress lanes/approach	31
6.5.8	Broadcast intersection — Lane/approach number	31
6.5.9	Broadcast intersection — Lane/approach centerline coordinates	31
6.5.10	Broadcast intersection — Vehicle lane/approach manoeuvres	31
6.5.11	Broadcast intersection — Pedestrian crossing lane/approach manoeuvres	32
6.5.12	Broadcast intersection — Special lane/approach manoeuvres	32
6.5.13	Broadcast intersection — Version identifier	32
6.5.14	Broadcast intersection — Crossings	32
6.5.15	Broadcast intersection — Lane/approach width	33
6.5.16	Broadcast intersection — Node lane/approach width	33
6.5.17	Broadcast intersection — Egress connection	33
6.5.18	Broadcast intersection — Traffic control	33
6.5.19	Broadcast intersection — Traffic control by lane/approach	33
6.5.20	Broadcast road conditions	33
6.5.21	Broadcast intersection — Signal group	34
6.6	Broadcast GNSS augmentation details	34
6.6.1	Broadcast GNSS augmentations	34
6.6.2	Broadcast GNSS augmentation detail — NMEA	34
6.6.3	Broadcast GNSS augmentation detail — RTCM	34
6.7	Signalized intersection requirements	34
6.7.1	Broadcast signal phase and timing information	34
6.7.2	Broadcast signal phase and timing — Message identifier	35
6.7.3	Broadcast signal phase and timing — Intersection identifier	35
6.7.4	Broadcast signal phase and timing — Intersection status	35
6.7.5	Broadcast signal phase and timing — Timestamp	35
6.7.6	Broadcast manoeuvre — Signal group	35
6.7.7	Broadcast manoeuvre — Manoeuvre state	35
6.7.8	Broadcast manoeuvre — Vehicular state	35
6.7.9	Broadcast manoeuvre — Pedestrian state	35
6.7.10	Broadcast manoeuvre — Special state	36
6.7.11	Broadcast manoeuvre — Time of change — Minimum	36
6.7.12	Broadcast manoeuvre — Time of change — Maximum	36
6.7.13	Broadcast manoeuvre — Succeeding signal indications	36
6.7.14	Broadcast manoeuvre — Succeeding signal indication time of change	37
6.7.15	Broadcast manoeuvre pending manoeuvre start time	37
6.7.16	Broadcast manoeuvre — Pedestrian detect	37
6.7.17	Broadcast manoeuvre — Pedestrian call	37
6.7.18	Broadcast manoeuvre — Optimal speed information	38
6.7.19	Broadcast manoeuvre — Signal progression information	38

6.7.20	Broadcast manoeuvre — Egress lane queue .....	38
6.7.21	Broadcast manoeuvre — Egress lane storage availability .....	38
6.7.22	Broadcast manoeuvre — Wait indication .....	38
6.8	Broadcast cross traffic sensor information .....	38
6.9	Broadcast vulnerable road user sensor information .....	38
6.10	Broadcast dilemma zone violation warning .....	38
6.11	Broadcast signal preferential treatment status .....	38
6.11.1	Broadcast preferential treatment — Signal status message .....	39
6.11.2	Broadcast preferential treatment — Message identifier .....	39
6.11.3	Broadcast preferential treatment — Intersection identifier .....	39
6.11.4	Broadcast preferential treatment — Intersection status .....	39
6.11.5	Broadcast preferential treatment — Prioritization request status .....	39
6.11.6	Broadcast preferential treatment — Vehicle source .....	39
6.11.7	Broadcast preferential treatment — Transaction identifier .....	40
6.12	Message identifier .....	40
6.13	System performance requirements .....	40
6.13.1	Broadcast intersection — Computed lane/approach .....	40
6.14	Transmission rates — Signal preferential treatment .....	40
6.14.1	Maximum transmission rate — Request signal preferential treatment .....	40
6.14.2	Maximum response time — Request signal preferential treatment .....	40
6.14.3	Minimum transmission rate — Signal status message .....	40
6.14.4	Minimum transmission period — Signal status message .....	41
6.15	Transmission rate requirements — Broadcast roadway geometrics information .....	41
6.15.1	Minimum transmission rate — Broadcast roadway geometrics information .....	41
6.15.2	Maximum transmission rate — Broadcast roadway geometrics information .....	41
6.15.3	Default transmission rate — Broadcast roadway geometrics information .....	41
6.16	Transmission rate requirements — GNSS augmentations detail broadcasts .....	41
6.16.1	Minimum transmission rate — GNSS augmentation details broadcasts .....	41
6.16.2	Default transmission rate — GNSS augmentation details broadcasts .....	41
6.17	Transmission rate requirements — Broadcast signal phase and timing information .....	41
6.17.1	Minimum transmission rate — Broadcast signal phase and timing information .....	42
6.17.2	Maximum transmission rate — Broadcast signal phase and timing information .....	42
6.17.3	Default transmission rate — Broadcast signal phase and timing information .....	42
6.18	Transmission rate requirements — Broadcast cross traffic sensor information .....	42
6.18.1	Minimum transmission rate — Broadcast cross traffic sensor information .....	42
6.18.2	Maximum transmission rate — Broadcast cross traffic sensor information .....	42
6.18.3	Default transmission rate — Broadcast cross traffic sensor information .....	42
6.19	Transmission rate requirements — Broadcast vulnerable road user sensor information .....	42
6.19.1	Transmission rate — Broadcast vulnerable road user sensor information .....	42
6.19.2	Maximum transmission rate — Broadcast vulnerable road user sensor information .....	43
6.19.3	Default transmission rate — Broadcast vulnerable road user sensor information .....	43
<b>7</b>	<b>Messages .....</b>	<b>43</b>
<b>8</b>	<b>Conformance .....</b>	<b>43</b>
	<b>Annex A (informative) Use cases .....</b>	<b>44</b>
	<b>Annex B (informative) Use case to requirements traceability .....</b>	<b>102</b>
	<b>Annex C (informative) Requirements traceability matrix .....</b>	<b>119</b>
	<b>Annex D (normative) Extension procedures .....</b>	<b>133</b>
	<b>Annex E (normative) Profile A for J2735™ .....</b>	<b>134</b>
	<b>Annex F (normative) Profile B for J2735™ .....</b>	<b>138</b>
	<b>Annex G (normative) Profile C for J2735™ .....</b>	<b>162</b>
	<b>Bibliography .....</b>	<b>211</b>

## 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](http://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](http://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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

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

## Introduction

Cooperative-ITS (C-ITS) is a promising and remarkable advancement of intelligent transport systems (ITS). Numerous cooperative applications are specified that open up new possibilities to make traffic safer, more efficient, and smarter. Technologies are developed and improved to realize and support those new services and applications. To enable those applications, information needs to be reliably communicated between the stationary infrastructure and mobile vehicles.

This document describes the use cases for several applications that address safety, mobility, and ecological sustainability. Each use case has information needs that communication between vehicles and the infrastructure facilitate. It then identifies the information needs for the applications and the requirements to satisfy them. In turn, it maps the requirements into data frames and data elements to fulfil the requirements within the specified message set.

ISO 22951 has a relationship to this document. PRESTO addresses its user needs through the implementation of a specific system architecture similar to that described in NTCIP 1211. This architecture includes traffic signals, message signs, routing systems, human machine interfaces, and fixed detection locations. Many of PRESTO's data value details are "left undefined to allow for discretionary definition by each country." The PRESTO architecture detects priority requesting vehicles by installing specific detection equipment at these locations.

This document uses a similar set of user needs to develop the message set between vehicles and the roadside equipment they interface. This document does not address the system architecture other than data needed to fulfil the user needs that will be managed elsewhere in the architecture. It details data values and structures in order to define the interface between these two devices. Routing information is supported in the architecture through other mechanisms and is not a need supported by the vehicle to roadside equipment information flows. The user needs also provide for priority by approach, a preconfigured strategy, and ingress/egress lane requests. This document is based on vehicles periodically broadcasting their location and trajectory information to other vehicles and the roadside infrastructure. This document compliments ISO 22951 as it provides for vehicle location and request information directly from connected vehicles rather than the detection of the vehicles from other fixed sensing equipment. It does not address the architecture data flows and operations that are detailed within ISO 22951. In other terms, this document provides a connected vehicle alternative for request and status communication without impacting the back office or local intersection operations of priority management.



# Intelligent transport systems — Cooperative ITS — Using V2I and I2V communications for applications related to signalized intersections

## 1 Scope

This document defines the message, data structures, and data elements to support exchanges between the roadside equipment and vehicles to address applications to improve safety, mobility and environmental efficiency. In order to verify that the defined messages will satisfy these applications, a systems engineering process has been employed that traces use cases to requirements and requirements to messages and data concepts.

This document consists of a single document that contains the base specification and a series of annexes. The base specification lists the derived information requirements (labelled informative) and references to other standards for message definitions where available. [Annex A](#) contains descriptions of the use cases addressed by this document. [Annex B](#) and [Annex C](#) contain traceability matrices that relate use cases to requirements and requirements to the message definitions (i.e. data frames and data elements). The next annexes list the base message requirements and application-oriented specific requirements (requirements traceability matrix) that map to the message and data concepts to be implemented. As such, an implementation consists of the base plus an additional group of extensions within this document.

Details on information requirements, for other than SPaT, MAP, SSM, and SRM messages are provided in other International Standards. The focus of this document is to specify the details of the SPaT, MAP, SSM, and SRM supporting the use cases defined in this document. Adoption of these messages varies by region and their adoption may occur over a significant time period.

This document covers the interface between roadside equipment and vehicles. Applications, their internal algorithms, and the logical distribution of application functionality over any specific system architecture are outside the scope of this document.

## 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.

ISO 22951, *Data dictionary and message sets for preemption and prioritization signal systems for emergency and public transport vehicles (PRESTO)*

ISO 26684, *Intelligent transport systems (ITS) — Cooperative intersection signal information and violation warning systems (CIWS) — Performance requirements and test procedures*

SAE J2735<sup>TM</sup>:2016, *Dedicated Short Range Communications (DSRC) Message Set Dictionary*

EN 302 637-2 V1.3.2, *Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service*

ARIB STD-T109, *700 MHz Band Intelligent Transport Systems*

ITS FORUM RC-010, *700 MHz Band Intelligent Transport Systems — Extended Functions Guideline, published on March 15, 2012*

ETSI/TS 102 894-2 V1.2.2, *Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer; common data dictionary*