



C-ITS Infrastructure Mobile ITS-G5 System Profile

C-Roads Platform

Working Group 2 Technical Aspects

Taskforce 3 Infrastructure Communication

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Publication History

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1 Introduction

1.1 C-Roads platform for harmonisation of C-ITS deployment

The C-Roads Platform is a joint initiative of European Member States and road operators for testing and implementing C-ITS services in light of cross-border harmonisation and interoperability. Through the C-Roads Platform, authorities and road operators join together to harmonise the deployment activities of cooperative intelligent transport systems (C-ITS) across Europe. The goal is to achieve the deployment of interoperable cross-border C-ITS services for road users.

C-ITS enables vehicles to interact directly with each other and the surrounding road infrastructure. In road transport, C-ITS typically involves vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. In order to enable an efficient and undisturbed exchange of information within these services as well as a cross-border implementation, harmonised C-ITS specifications are indispensable. The approach starts from a functional perspective, then requirements applicable to all implementations and then towards technology specifications of currently validated implementations (ITS-G5 for short range communication, IP based for long range cellular). In order to meet these challenges, the C-ROADS platform is divided into five Working Groups. The first Working Group is concerned with organisational tasks, the second with Technical Aspects and the third with Evaluation and Assessment. The fourth Working Group is about Urban C-ITS Harmonisation and Working Group 5 is about Digital Transport Infrastructure (DTI).

The C-Roads Platform is steered by the C-Roads Steering Committee which is composed by Member State representatives. With the support of the Supporting Secretariat, decisions for achieving the goal of the implementation of interoperable end-user services are taken. In this respect specifications, plans and reports, which are proposed and recommended by specific Working Groups, are approved. Within WG2 these specifications are harmonized in 5 Task Forces and derived from pilot activities and the basis for further pilot and implementation activities. This especially goes with technical decisions, which influence deployment and procurement decisions at pilot sites.

The Working Groups are installed as decision support for the Steering Committee to ensure proper decisions towards interoperable deployments. Individual experts participating in the single pilots work together in these Working Groups to prepare proposals and recommendations. Also, members of the single pilot activities as well as of the C-Roads-Working Groups actively contribute to the work of the EU-C-ITS-Platform.



Figure 1 : Overview of C-Roads coverage

1.2 Story board C-Roads C-ITS deployment documentation

This document is part of the C-Roads C-ITS Deployment Documentation and Requirements. The complete set of documents is much related to a common project life cycle of a system implementation. As a guide to the C-Roads Documentation, a story board based on such a project life cycle is provided in this section, with emphasis on role of this document C-ITS Infrastructure Mobile ITS-G5 System Profile. The story board should be read from left to right and shows the different stages of the project life cycle and how each C-Roads Documentation is related to it, thereby can be supportive to road authorities and other stakeholders.

A complete description of the story board of a C-ITS implementation project, the different stages and the related C-Roads documents is given in *Introduction to the C-Roads WG2 Deployment Documentation and Requirements* [35]. This document describes the stages in section 1.4. Starting with stage 3, rather generic requirements and the required governance are specified - those are applicable for all services, use cases and scenarios in a similar way. On stage 4a and 4b, the more detailed specifications are relevant - including service specific security requirements. Both levels, generic and specific requirements, have impact on the test cases derived on stage 5. Figure 2 shows where the present document takes place in the whole document architecture.

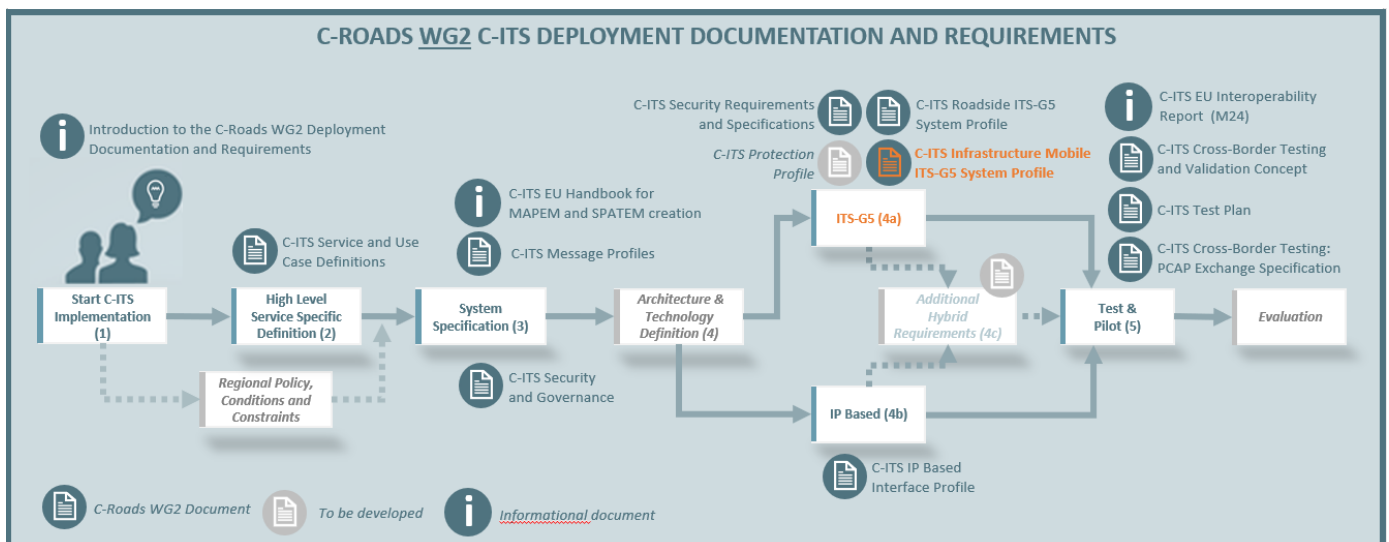


Figure 2 : Highlight of WG2 document in complete story board

1.3 Scope of this document

This document defines the C-ITS Infrastructure Mobile ITS-G5 station profile as part of the C-Roads Project. This profile defines the requirement related to the features of a mobile C-ITS station belonging to a special organisation. This includes all ITS-G5 stations that can potentially be used as mobile stations (e.g. trailers, (aftermarket) vehicle stations).

This document describes the common requirements of all infrastructure mobile C-ITS stations to realize interoperability with other C-ITS sub-systems as defined in EN 302 665 [12]. The functional requirements of mobile ITS stations are out of the scope of this document.

For a better readability, the terms “mobile ITS station” is used to describe an “C-ITS Infrastructure mobile ITS station”.

The scope of this document excludes the potential interaction between the infrastructure mobile ITS station and the infrastructure, other than the ITS-G5 exchanges with R-ITS-S. This concerns for instance a cellular connection that may link the mobile ITS station directly to the TCC.

This profile does not include the usage of C-ITS messages by trailers. The subject is still pending and might impact the present document.

1.4 Organisation of the document

Standards are developed in a neutral and open way such that they include different options to allow diversion and future options to extend the standards later. To realize Interoperability among sub-systems many of these options need to be made specific. Profiles therefore describe the selected options and include additional specifications when required to ensure the expected interoperability.

Since the requirements of the ITS sub-systems are very similar, this C-ITS Infrastructure Mobile ITS-G5 System Profile uses the C2C-CC BSP [2] as a basis from content and structure point of view.

- § 2 contains the provisions notations and verbal forms used in the present document.
- The architecture of a mobile ITS station and the supported use cases are described in § 3.
- The 4th chapter consists of the technical requirements defining the mobile ITS-S profile. It consists of:
 - Positioning and timing
 - System behaviour
 - Access Layer
 - Network and Transport Layer
 - Facility Layer
 - Security
- The list of parameters used in the requirements, their value and description are gathered in § 5

1.5 Acronyms and Definitions

1.5.1 Acronyms

AT	Authorisation Ticket
BSP	Basic System Profile
BTP	Basic Transport Protocol
C-ITS	Cooperative Intelligent Transport Systems
C2C-CC	Car2Car Communication Consortium
CA	Cooperative Awareness
CAM	Cooperative Awareness Message
CCH	Control Channel; Channel with 5900 MHz carrier centre frequency (IEEE channel 180), also known as Service Channel 0 (renamed to SCH0)
DCC	Decentralised Congestion Control
DENM	Decentralized Environmental Notification Message
DSRC	Dedicated Short Range Communications
GBC	Geo Broadcast
GN	Geo Networking

GNSS	Global Navigation Satellite System
ITS	Intelligent Transport Systems
ITS-G5	ITS-G5 is a European standard for ad-hoc short-range communication of vehicles among each other (V2V) and with Road ITS Stations (V2I). The ITS-G5 Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band is given in ETSI EN 302 663. ITS-G5 is a profile of the amendment IEEE 802.11p, which has been incorporated into the main IEEE 802.11 standard, and an IEEE 802.2 LLC. It uses the 5.9 GHz frequency band to support safety- and non-safety ITS applications.
ITS-S	Intelligent Transport Systems Station
IVI	Infrastructure to Vehicle Information
IVIM	Infrastructure to Vehicle Information Message
LLC	Logical Link Control
MAPEM	MAP (topology) Extended Message
NH	Next Header
HLN	Hazardous Location Notification
R-ITS-S	Roadside ITS Station (RSU or ITS-S R in the French Terminology); also called infrastructure roadside system in this document
RSP	Roadside ITS-G5 System Profile (short also Roadside System Profile)
RWW	Roadworks Warning
SCF	Store Carry Forward
SCH0	Control Channel; Channel with 5900 MHz carrier centre frequency (IEEE channel 180), also known as Service Channel 0
SHB	Single-Hop Broadcast
SPATEM	Signal Phase and Timing Extended Message
SREM	Signal Request Extended Message
SSEM	Signal request Status Extended Message
TAI	International Atomic Time
TC	Traffic Class
TCC	Traffic Control Centre
WGS	World Geodetic System
WM	Winter Maintenance

1.5.2 Definitions

Term	Definition
<i>ITS-S Application</i>	Uses one or more Facilities Layer Service with different parameters, depending on the situation, to provide an ITS service to the user.
<i>Use case scenario</i>	Denotes a more specific way to execute an ITS-S application, e. g. the stand-alone mode of Roadworks Warning in case of safety trailers failing to connect to the centre. As another example, in the C-ITS Corridor terminology, “TCC-triggered RWW” denotes a use case scenario to implement RWW application based on TCC data only.
<i>Facilities Layer Service</i>	In this document, the term service is derived from the term ITS-S service as defined in ETSI EN 302 665 [12]. It describes a communication functionality offered by an ITS-S to an ITS-S application.
<i>C-ITS time</i>	The number of elapsed International Atomic Time (TAI) milliseconds since 2004-01-01 00:00:00.000 Coordinated Universal Time (UTC)+0 as defined in [EN 302 636-4-1]. Timestamps as defined in [TS 102 894-2] follow this time format (Copied as it is from RS_BSP_193)
<i>Station clock</i>	A clock representing C-ITS time in a mobile ITS station (Copied as it is from RS_BSP_430)
<i>Vehicle states</i>	Absolute position, heading and velocity of the mobile ITS station at a certain point in time (Copied as it is from RS_BSP_428)
<i>Regular driving dynamics</i>	<p>A vehicle is considered to be under regular driving dynamics when:</p> <ul style="list-style-type: none"> • it has passed its initial start-up phase; • it is being used as envisaged by the manufacturer; • the normal control of the vehicle is possible (e. g. it is not directly involved in an accident, road surface allows normal tire grip); • it is located on a surface without movement in respect to the reference coordinate system, except for minimal effects like continental drift; • the vehicle lateral acceleration is $< 1,9 \text{ m/s}^2$; • the vehicle longitudinal acceleration is $> -2,4 \text{ m/s}^2$ (deceleration); • the vehicle longitudinal acceleration is $< 2,5 \text{ m/s}^2$; • vehicle speed is \leq minimum of (130 km/h, legal maximal speed of the vehicle). <p>(Inspired from RS_BSP_449 with modifications)</p> <p>Note: These conditions describe the operational environment. They might be subject to acceptance testing and do not need to be observed during runtime of the ITS-S.</p>
<i>Sky obstruction</i>	The fraction of hemisphere values that are obstructed for Galileo or other Global Navigation Satellite Systems (GNSS) satellites due to mountains, buildings, trees, etc. (Copied as it is from RS_BSP_211)

<i>Open sky conditions</i>	Conditions given when the sky is less than 20 % obstructed. (Copied as it is from RS_BSP_533)
<i>Minimum confidence</i>	<p>This concept is used to determine if the mobile ITS station has enough confidence in its data information to use them for C-ITS application.</p> <p>The minimum confidence is reached when:</p> <ul style="list-style-type: none"> - PosConfidenceEllipse.semiMajorConfidence is different than “unavailable” or “outOfRange” - PosConfidenceEllipse.semiMinorConfidence is different than “unavailable” or “outOfRange” - HeadingConfidence is different than “unavailable” <p>Other confidence elements are tolerated as “unavailable” at the date of preparation of this document: PosConfidenceEllipse.semiMajorOrientation AltitudeConfidence SpeedConfidence (Inspired from RS_BSP_535 with modifications)</p>
<i>Confidence interval</i>	The estimated value plus/minus the confidence value. (Copied as it is from RS_BSP_500)
<i>Confidence area</i>	For the horizontal position, a confidence area is used instead of a single confidence interval. The confidence area is specified by an ellipse (centred at the estimated horizontal position) described via a major axis, minor axis and orientation of the major axis relative to the north of the reference coordinate system. (Copied as it is from RS_BSP_200)
<i>Infrastructure Mobile ITS-S</i>	ITS station embedded in a moving vehicle, implementing the infrastructure mobile ITS system profile. For a better readability, “mobile ITS station” per default instead of “Infrastructure mobile ITS station”.
<i>BSP_AT_Change</i>	AT change strategy defined in the C2C-CC BSP [2]
<i>Aftermarket device / station</i>	C-ITS devices / stations that are sold and installed after the primary item (vehicle, trailer ...) they are fitted into/unto has been purchased. Aftermarket devices are not part of the primary item itself at the time of purchase and are usually not connected to all the systems and internal interfaces of said item.

2 Provisions

2.1 Verbal forms of the expression of provisions

In this document, the following verbal forms are used to indicate requirements:

Shall / Shall not

Recommendations shall be indicated by the verbal forms:

Should / Should not

Permissions shall be indicated by the verbal forms:

May / May not

Possibility and capability shall be indicated by the verbal forms:

Can / Cannot

Inevitability used to describe behaviour of systems beyond of the scope of this deliverable shall be indicated by:

Will / Will not

Facts shall be indicated by the verbal forms:

Is / Is not

2.2 Provisions from referenced documents

Unless otherwise specified in the present document, the normative requirements included in the referenced documents supporting the required functionality of the ITS system shall apply. The verbal forms for the definition of provisions of referenced documents are defined either inside the document or generally by the SDO (standardisation organisation) or the organisation providing them. For example, normative requirements in ETSI documents are indicated by the verbal form “shall”.

2.3 Notation used to identify requirements

Interoperability between C2C and C-Roads Platform is a key aspect for the writing of the MSP requirements. Thus, the requirements follow the following formalism:

Req_ID	<i>UniqueRequirementID (RequirementVersion)</i>
Requirement	Content of the requirement. Principal verb like “shall” or “should” are written in bold .
Origin	<i>BSPCopyPaste</i>
Interop issue	<i>InteroperabilityComment</i>

With:

- *UniqueRequirementID*

Initiated with RS_MSP_001 for the first requirement and incremented for each additional requirement. Each requirement has a unique ID.

- *RequirementVersion*

Initiated with the value 1.

If the requirement evolves, *RequirementVersion* is incremented. To limit versioning, the version only evolves when the document is in a release: for draft and non-official releases, revision marks are sufficient.

- *BSPCopyPaste*

The BSP requirement that may have inspired the MSP requirement. The possible values are:

- “RS_BSP_XXX as it is” if the requirement originates from the BSP and is exactly copied.
- “RS_BSP_XXX with modification” if the BSP requirement is not exactly copied.
- “RS_RSP_XXX as it is” if the requirement originates from the RSP and is exactly copied.
- “N/A” if the MSP requirement is not inspired from the BSP

- *InteroperabilityComment*

Summarises the conclusion on the interoperability reflexions with the BSP. The possible values are:

- “N/A” if the requirement is equivalent to the BSP one.
- Otherwise, write a short description of the deviation from C2C and an analysis of the impact on interoperability.

2.4 Standards evolution

The standards chosen as specifications in this deliverable are evolving standards. This document selects specific versions of the underlying existing standards for concrete implementation. The list of relevant standards and their version is described in chapter 6.

2.5 Terms from Definitions

Predefined terms listed in chapter 1.5.2 Definitions are put in [] and italic, e.g. [*Station clock*]

3 Features of the C-ITS Infrastructure Mobile ITS-G5 system profile

This document is one of the documents of stage 4 in the C-Roads workflow (see chapter 1.2 above). This workflow reflects how information flows through the C-ITS station architecture. It starts with an application (referred to as “Service”), which is described in the stage 2 documents. In order to perform its function, the application decides to send out messages and in order to do so, it invokes a Service Access Point (SAP) of a Facility Layer Service. The term SAP is taken from the Open Systems Interconnection (OSI) reference model for the interfaces between layers, many people today would probably rather call it an API. The Facility Layer Service performs its task according to its specification and uses SAPs of underlying layers (transport, network, access) for doing so. The corresponding specifications are not developed in C-Roads, standards are used for this instead, e. g. ETSI 302 637-3 and ISO 103 301 for the Facility Layer services.

The C-ITS Infrastructure Mobile ITS-G5 System Profile, referred as MSP, defines a common base for the ITS-G5 communication between non-user vehicle (road operator, emergency, law enforcement vehicles) and other ITS stations. The communication directions derived from this is also known as V2X (Vehicle-to-everything).

The profile provides descriptions, definitions and rules for all layers (Applications, Facilities, Networking & Transport and Access) of the ETSI ITS station reference architecture/ITS-S host. Security is also included. The understanding of the core mobile system components is depicted in Table 1:

Table 1 C-ITS Infrastructure Mobile ITS-G5 system components

Layer	Component		Tasks	Com- ponent
Applications	Operational Specifications		Service definitions, transmission principles, and triggering conditions.	Management & Security
Facilities	Positioning & Time (incl. minimum data quality requirements)		Relevance Checking, trace and pathHistory filling.	
	Data and Message Content	CAM, DENM, SREM, SSEM	Vehicle & infrastructure data provider.	
		IVIM, SPATEM, MAPEM, etc.	Received event mapping	
Transport & Network	Transport	Basic transport protocol (BTP)	End-to-end, connection-less transport service	
	Network	Geo-Based Addressing	Future use	
		Geo-Routing Protocol	Future use	
Access	ETSI ITS-G5 European Profile Standard		Congestion Control	
IEEE 802.11p				

3.1 Architecture

The standards profile distinguishes between two types of interoperability:

- Inter-sub-system interoperability (interoperability of different ITS subsystems), i.e. sub-systems implementing the standards profile can communicate/understand each other,
- Intra-sub-system interoperability (interoperability of components within one ITS subsystem), i.e., the sub-system consists of completely interchangeable components.

Each type of interoperability provides benefits for the system but comes with a certain effort to achieve this interoperability.

Inter-sub-system interoperability requires a precise definition of the external interfaces but can leave room for different implementations within the sub-system, which encourages innovation and competitive differentiation.

Intra-sub-system interoperability requires a much higher degree of standardisation within the sub-system and allows customers to select among the best suppliers for each individual component within the sub-system.

The C-ITS infrastructure Mobile ITS-G5 system profile contributes to the realisation of the objective of the C-ROADS Platform to develop, share, and publish common communication profiles. This standard profile aims for inter-sub-system interoperability between infrastructure and vehicles, and not for intra-sub-system interoperability.

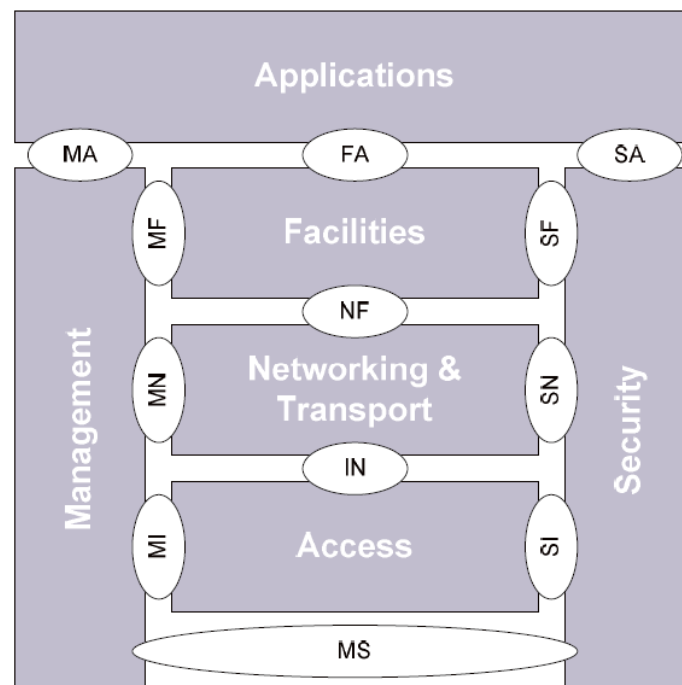


Figure 3 The ITS-Station layered architecture/ITS-S host (ETSI EN 302 665 [12])

3.2 Set of supported applications

As mentioned in section 1.3, this document does not describe the functional requirements of the mobile ITS stations. However, the use cases implemented by the station requires a minimum set of supported messages and low layer capabilities.

At the date of writing this document, the following use cases have been defined for infrastructure mobile ITS stations:

- HLN-EPVA, HLN-ERVI
- SI-EVP, SI-TLP
- HLN-PTVC, HLN-PTVS
- RWW-RM, RWW-WM

All mobile ITS-S may manage all use cases described in “Service and Use Case Definitions” [37] on the reception side.

There is another application based on CAM messages and it is called Coexistence (ITS-G5 – CEN-DSRC). Coexistence differentiates itself from the other ITS-S applications. It is used to ensure the stable operation of the ITS ecosystem and is therefore called a system ITS-S application. The other ITS-S applications are of functional nature.

Some of these use cases are overlapping with the C2C-CC BSP. The C-ROADS specification for these use cases focusses on aftermarket devices.

/!\ At the publication date of this document, the use cases based on SREM and SSEM are not fully specified. This version of the document will therefore not include specificities concerning those types of messages.

Another open topic is the applicability of this profile regarding moving trailers.

4 Technical requirements of the Infrastructure mobile ITS-G5 System Profile

This section provides the technical requirements defining the C-ITS Infrastructure Mobile ITS-G5 System Profile. The requirements are grouped into the following sub sections:

- Positioning and timing;
- System behaviour;
- Access Layer;
- Network and Transport Layer;
- Facility Layer;
- Security.

Where applicable, standards or reference documents essential for specifying these requirements are provided within the sub-sections. Most of these standards or documents are published (or within the publishing process) at ETSI, CEN, or ISO. Furthermore, the document “Message Profiles” [4] is essential to achieve interoperability between the various implementations of the C-ITS Infrastructure Mobile ITS-G5 systems system profile as it fills gaps currently not addressed by CEN and ETSI.

4.1 Positioning and timing

Any numeric values (except the confidence level of 95%) provided in this and further sub-sections are reflecting the current possibilities as provided by the GNSS sub-system. Values provided here have to be seen as targeted values. Hence, these values should be deemed as suggestions and are subject to change.

<i>Req_ID</i>	RS_MSP_001(1)
<i>Requirement</i>	Timestamps in messages generated by mobile ITS stations shall be based on the [Station clock] NOTE: This includes the C-ITS payload and the Geo Networking layer.
<i>Origin</i>	RS_BSP_432 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_002(1)
<i>Requirement</i>	The difference between [Station clock] and [C-ITS time] shall be estimated. This difference shall not exceed <i>pPotiMaxTimeDiff</i> . If the difference exceeds this value, the ITS-S shall not transmit C-ITS messages. NOTE: A precise timestamp is needed not only for time synchronisation but is also an indicator that the system works properly.
<i>Origin</i>	RS_BSP_207 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_003(1)
<i>Requirement</i>	After a synchronisation of the [<i>Station clock</i>] on the [<i>C-ITS time</i>], the station clock may remain valid for at least 6 minutes when no external time synchronisation signals are available.
<i>Origin</i>	RS_BSP_518 with modification
<i>Interop issue</i>	No impact: "Shall" in the BSP. Impacts only the performance of the station.

<i>Req_ID</i>	RS_MSP_005(1)
<i>Requirement</i>	At system start-up, the mobile ITS station may report a stored heading value as the initial start-up value.
<i>Origin</i>	RS_BSP_445 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_006(1)
<i>Requirement</i>	<p>If the clock has been valid within the last 7 days and if a full system reset has not been performed, the [<i>Station clock</i>] should become valid (see RS_MSP_002) within 1 min after an external synchronisation signal is available.</p> <p>Otherwise, the clock may become valid within 15 min after an external synchronisation signal is available.</p> <p>Note: '7 days' shall point out the assumption, that a vehicle is used at least once a week. Besides this, the number '7' does not have a certain technical background.</p>
<i>Origin</i>	RS_BSP_516 with modification
<i>Interop issue</i>	No impact: "Shall" in the BSP. Impacts only the performance of the station.

<i>Req_ID</i>	RS_MSP_007(1)
<i>Requirement</i>	The [<i>Vehicle states</i>] shall be consistent. Therefore, heading and velocity shall refer to the same moment in time as the absolute position (e. g. GenerationDeltaTime in CAMs).
<i>Origin</i>	RS_BSP_190 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_008(1)
<i>Requirement</i>	Traces and path history data shall be generated only when [<i>Minimum confidence</i>] is available and RS_MSP_002 is respected.
<i>Origin</i>	RS_BSP_215 as it is (mentioned requirements might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_009(1)
<i>Requirement</i>	<p>The mobile ITS-S reference coordinate systems shall follow EN 302 890-2 [39].</p> <p>NOTE: This includes World Geodetic System 84 (WGS84) as coordinate system for the [Vehicle states]</p> <p>NOTE2: as specified in the standard, the altitude information is interpreted as height above WGS84 Ellipsoid</p>
<i>Origin</i>	RS_BSP_191 ; RS_BSP_198 as they are
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_010(1)
<i>Requirement</i>	<p>In nominal cases, the mobile ITS station shall interpret 'heading' as the orientation of the horizontal velocity vector with regards to the WGS84 north as defined in in TS 102 894-2 [15].</p> <p>In particular cases (e.g., an emergency vehicle in intervention), the heading for the DENM may be latched, implying that heading is no more aligned with velocity vector.</p> <p>The starting point of the velocity vector shall be the C-ITS vehicle reference point, as defined in B.19 'referencePosition' in [EN 302 637-2].</p>
<i>Origin</i>	RS_BSP_192 with modification
<i>Interop issue</i>	May impact: contrary to C2C, the heading is not ALWAYS the direction of the vehicle

<i>Req_ID</i>	RS_MSP_011(1)
<i>Requirement</i>	When information from some sensors used for estimating [Vehicle states] (e. g. GNSS or vehicle sensors) is not available, the vehicle states estimation (e.g. by means of extrapolation) should be continued. In this case, RS_MSP_112 is still applicable.
<i>Origin</i>	RS_BSP_195 with modification
<i>Interop issue</i>	No impact: "Shall" in BSP. If not implemented, no accurate position available, thus no transmission.

<i>Req_ID</i>	RS_MSP_012(1)
<i>Requirement</i>	When active, a mobile ITS station shall update the [Vehicle states] with a frequency of at least the pPotiUpdateRate
<i>Origin</i>	RS_BSP_197 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_013(1)
<i>Requirement</i>	<p>The mobile ITS station shall set the VehicleWidth in CAMs it originates to the value of the width without mirrors and the VehicleLengthValue to the length potentially attached extensions like a trailer, crane or snow plough.</p> <p>Note: 'without mirrors' is to follow the concept of EN 302 890-2 [39].</p>
<i>Origin</i>	RS_BSP_534 with modification
<i>Interop issue</i>	No impact: We follow the CAM standard.

<i>Req_ID</i>	RS_MSP_112(1)
<i>Requirement</i>	<p>The accuracy estimations shall yield valid 95 % confidence information. This means that the true value is inside the [<i>Confidence interval</i>] or [<i>Confidence area</i>] for at least 95 % of the data points in a given statistical population.</p> <p>Note: Some GNSS chips do not provide the area, wherein 95% of the sampling values are, but a radius of a circle of equal probability (CEP) that includes 50% of the samples. Then a conversion is necessary. If the values are normally distributed, the conversion factor from 50% to 95% is 2.1 – this means, the major and minor axis (or simply the radius) of the 50% area need to be multiplied by 2.1 to get the axis length for the area of 95%.</p>
<i>Origin</i>	RS_BSP_431 with modification
<i>Interop issue</i>	No impact: Same as BSP with an additional explanation how to convert CEP to 95%

<i>Req_ID</i>	RS_MSP_014(1)
<i>Requirement</i>	<p>The mobile ITS station shall use a coordinate system compliant to ISO 8855 [28], section 2.13.</p> <p>NOTE: In detail this means that the X and Y axes are parallel to the ground plane, the Z axis is aligned vertically upwards, the Y axis points to the left of the vehicle's forward direction, and the X axis points towards vehicle's forward driving direction.</p>
<i>Origin</i>	RS_BSP_321 as it is
<i>Interop issue</i>	N/A

The further definition of requirements for confidence values is still work in progress for (aftermarket) mobile ITS stations. The following requirements from the BSP are recommended, but aftermarket devices might not be always able to fulfil these requirements:

- 538
- 202
- 205
- 209
- 448
- 457
- 529
- 530

Work will continue to come up with proper values for aftermarket devices for at least requirements 205 (horizontal / vertical position confidence under open sky conditions), 448 (speed confidence) and 457 (heading confidence), but only after early implementers can reflect on the results of their products.

4.2 System behaviour

<i>Req_ID</i>	RS_MSP_015(1)
<i>Requirement</i>	The mobile ITS station shall operate the Cooperative Awareness Basic Service when it is participating in public traffic, unless the mobile ITS station is explicitly deactivated. Note: 'Participating in public traffic' includes 'being on public roads under [<i>Regular driving dynamics</i>]', but is not limited to public roads only.
<i>Origin</i>	RS_BSP_214 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_016(1)
<i>Requirement</i>	Mobile ITS Station may transmit protected zone information as described in TS 102 792 [14].
<i>Origin</i>	N/A
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_017(2)
<i>Requirement</i>	The mobile ITS station shall allow the occupant to deactivate the C-ITS station at any time. If it is not possible to deactivate the C-ITS station, the responsible party needs to ensure that privacy of the driver is respected.
<i>Origin</i>	RS_BSP_501 with modification
<i>Interop issue</i>	No impact: rephrasing of BSP but content remains the same.

<i>Req_ID</i>	RS_MSP_018(1)
<i>Requirement</i>	For all CAMs and DENMs that originate from a mobile ITS station, the time interval given by the moment in time when the message is sent from the originating station minus the moment in time the information in the message refers to, shall be in the range of 0 ms to +100 ms plus additional delays due to DCC mechanisms. Note: The moment in time the information refers to is represented by a timestamp in the message. This timestamp is represented in a CAM by the <i>GenerationDeltaTime</i> and in a DENM by the <i>DetectionTime</i> . Note: The moment in time when the message is sent and the moment in time the information in the message refers to may be measured by different station clocks. Therefore, the allowed time difference between the [<i>Station clock</i>] and [<i>C-ITS time</i>] shall be taken into account when determining the time interval.
<i>Origin</i>	RS_BSP_404 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_019(1)
<i>Requirement</i>	The mobile ITS-S shall handle CAM transmissions so that no outdated messages (i. e. a newer CAM is available) are transmitted even if decentralized congestion control is applied.
<i>Origin</i>	RS_BSP_242 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_021(1)
<i>Requirement</i>	The mobile ITS station shall only operate the Decentralized Environmental Notification Basic Service if also operating the Cooperative Awareness Basic Service.
<i>Origin</i>	RS_BSP_531 as it is
<i>Interop issue</i>	N/A

4.3 Access Layer

4.3.1 General

The access layer comprises of the two lowest layers in the protocol stack; physical (PHY) and data link layers, where the latter is further subdivided into medium access control (MAC) and logical link control (LLC). All of them are specified in ETSI EN 302 663 [11]. PHY and MAC are derived from IEEE 802.11-2016 [24] with the MIB parameter **dot11OCBAActivated** set to true enabling a new capability namely “communicating outside the context of a basic service set (BSS)”. ETSI EN 302 663 [11] mandates the use of IEEE 802.2 LLC with the mode of operation set to Type 1 – unacknowledged connectionless. Further, ETSI EN 302 663 [11] requires decentralised congestion control (DCC) methods to avoid unstable network behaviour and channel congestion. ETSI TS 102 792 [14] specifies amongst other things minimum duty cycles for different DCC profiles to ensure interoperability with CEN DSRC (European electronic toll collection at 5.8 GHz). ETSI EN 302 571 [21] specifies the frequency channels for radio equipment in the 5 855 MHz to 5 925 MHz frequency band. Further, it specifies output power for the different frequency channels and spectrum masks.

4.3.2 List of relevant documents

Table 2 Relevant documents for the access layer

Document	Title	Short Description
ETSI EN 302 571 [21]	Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU	Specification of frequency channels for 5 855 MHz to 5 925 MHz, with corresponding spectrum mask and output power.
ETSI EN 302 663 [11]	Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band	Specifies the whole access layer with PHY, MAC, and LLC, for 5 855 MHz to 5 925 MHz. Requirements on DCC [17] and co-existence with CEN DSRC.
ETSI TS 102 792 [14]	Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication	Specifies requirements to ensure coexistence between ITS stations using the frequency bands ITS-

	(CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range.	G5A/B/D and CEN DSRC using the TTT band.
ETSI TS 102 687 [17]	Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part	Specifies the DCC operation responsible for maintaining network stability, throughput efficiency and fair resource allocation to ITS-S using ITS-G5 access technology.
IEEE 802.11	Wireless LAN	Set of media access control and physical layer specifications for implementing wireless local area network (WLAN) communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands.

4.3.3 ETSI EN 302 571

<i>Req_ID</i>	RS_MSP_022(1)
<i>Requirement</i>	The mobile ITS-S access layer shall be compliant with the EN 302 571 [21].
<i>Origin</i>	RS_BSP_433 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_023(1)
<i>Requirement</i>	<p>The nominal RF output power shall be within the range of 17 dBm (e.i.r.p.) to 33 dBm (e.i.r.p.). The target nominal RF output power is 23 dBm (e.i.r.p.).</p> <p>Note: Adjustable RF output power is required by RS_MSP_025 and RS_MSP_032</p> <p>Note: The maximum RF output power is regulated by [ETSI EN 302 571].</p> <p>Note: The maximum allowed total transmit power (mean e.i.r.p.) is 33 dBm with a transmit power control (TPC) range of at least 30 dB (see also: [ECID 2020/1426]). The maximum power spectral density is 23 dBm/MHz</p>
<i>Origin</i>	RS_BSP_226 as it is (mentioned requirements might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_025(1)
<i>Requirement</i>	<p>The mobile ITS station shall support per-packet transmission power control.</p> <p>Note: PTx may depend on the current DCC state (i.e. relaxed, active or restrictive) and traffic class (i.e. TC ID 0, TC ID 1, etc.) as specified in the Roadside ITS-G5 System Profile [38].</p>
<i>Origin</i>	RS_BSP_245 as it is
<i>Interop issue</i>	N/A

4.3.4 ETSI EN 302 663

<i>Req_ID</i>	RS_MSP_027(1)
<i>Requirement</i>	Mobile ITS station's access layer shall be compliant with ETSI EN 302 663 [11].
<i>Origin</i>	RS_BSP_434 with modification
<i>Interop issue</i>	No impact: BSP and MSP do not refer to the same version of the standard. EN 302 663 v 1.3.1 includes requirements that were previously contained in the harmonized standard EN 302 571 v1.2.1

<i>Req_ID</i>	RS_MSP_026(1)
<i>Requirement</i>	When transmitting CAM, DENM and/or SREM, the mobile ITS-S shall use the control channel (CCH)
<i>Origin</i>	RS_BSP_225 with modification
<i>Interop issue</i>	No impact: MSP do not use the C2C use case documents.

<i>Req_ID</i>	RS_MSP_028(1)
<i>Requirement</i>	Mobile ITS station shall use a default transfer rate of 6Mbit/s (QPSK 1/2) for the transfer of messages on CCH channel (cf. RS_MSP_026)
<i>Origin</i>	RS_BSP_228 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_111(1)
<i>Requirement</i>	Mobile ITS station shall , at a minimum, be able to generate and transmit the number of messages as determined by the value of the highest CAM generation rate (i.e. 10 Hz) increased by the minimum required DENM generation rate derived from the use cases implemented on transmission side.
<i>Origin</i>	RS_BSP_243 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_114(1)
<i>Requirement</i>	Mobile ITS station shall support the broadcast mode as defined in ETSI EN 302 663 [11].
<i>Origin</i>	
<i>Interop issue</i>	N/A

4.3.5 ETSI TS 102 792

<i>Req_ID</i>	RS_MSP_029(1)
<i>Requirement</i>	<p>Where the mobile ITS station is not equipped with a CEN-DSRC radio detector as described in clause 5.2.5 of TS 102 792 [14], it shall maintain a list of protected zone positions as described in clause 5.5.1 of TS 102 792 [14]. This list shall be composed of:</p> <ul style="list-style-type: none"> - a set of protection zones as listed in the 'latest version' (available when the vehicle is developed) of the protected zone database. The mobile ITS station may include update mechanisms of the database; - a set of protected zones as identified by the reception of CEN-DSRC mitigation CAMs as described in clauses 5.2.5 and 5.2.2.3 of TS 102 792 [14]; - a temporarily protected zone as identified by the reception of CEN-DSRC mitigation CAMs as described in clause 5.2.2.2 of TS 102 792 [14].
<i>Origin</i>	RS_BSP_458 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_030(1)
<i>Requirement</i>	Where the mobile ITS station is equipped with a CEN-DSRC radio detector, mitigation shall be applied as described in clause 5.2.5 of TS 102 792 [14] and the mobile ITS station shall generate CAMs in accordance with clause 5.5.1 of TS 102 792 [14].
<i>Origin</i>	RS_BSP_459 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_031(1)
<i>Requirement</i>	<p>Where the mobile ITS station is not equipped with a CEN-DSRC radio detector, mitigation shall be applied in accordance with TS 102 792 [14] on the basis of the list defined in RS_MSP_029 and received CAMs from other road users which have implemented RS_MSP_030.</p> <p>Note: Clarification of clause 5.2.5 of [TS 102 792]: A mobile C-ITS station should mitigate each time to the nearest tolling station centre position. Where several positions are given in the same area, the mobile C-ITS station should respond to each centre position, possibly in a sequence. Protected zones with identical protectedZone ID may be seen as a single station. Where the protected zone database and the CEN-DSRC mitigation CAMs contain a valid protected zone with the identical protectedZone ID, mitigation shall be based only on the CEN-DSRC mitigation CAM content.</p>
<i>Origin</i>	BSP_460 as it is (mentioned requirements might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_032(2)
<i>Requirement</i>	The mobile ITS station shall reduce its transmission power to $PToll = pDccMaxPToll$ as soon as the protected zone is entered and without changing any other DCC transmission parameters as per RS_MSP_036 . TC ID 0 messages are excluded from this restriction. Note: Coexistence mode A is advised.
<i>Origin</i>	RS_BSP_246 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_033(1)
<i>Requirement</i>	The mobile ITS station may implement an additional filtering of received messages that also affects GeoBroadcast forwarding in situations of high message loads. NOTE: In case of severe traffic congestion or other extreme vehicular network scenarios the DENM load might increase abruptly. In such cases, mobile ITS-S are explicitly allowed to forgo the forwarding of foreign DENM messages
<i>Origin</i>	RS_BSP_241 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_034(1)
<i>Requirement</i>	If the mobile ITS Station transmits protected zones, the following requirements of Roadside ITS-G5 System Profile [38] shall be applicable: <ul style="list-style-type: none"> - RS_RSP_100 - RS_RSP_104 - RS_RSP_107
<i>Origin</i>	N/A
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_035(1)
<i>Requirement</i>	If the mobile ITS Station transmits protected zone data, it shall transmit CAMs containing Protected Zone data according to the message format specified by ETSI EN 302 637-2 [9]. NOTE 1: The data elements specific for the Coexistence [<i>ITS-S Application</i>] are located in the highFrequencyContainer and the data frame BasicVehicleContainerHighFrequency. NOTE 2: A CAM may as well contain other data elements not related to Coexistence.
<i>Origin</i>	N/A
<i>Interop issue</i>	N/A

4.3.6 ETSI TS 102 687

Req_ID	RS_MSP_036(1)
Requirement	<p>If the reactive DCC algorithm outlined in clause 5.3 of TS 102 687 [17] is implemented, the settings of Table A.1 and/or Table A.2 in TS 102 687 [17] shall be used.</p> <p>Additional bursts are allowed for TC ID 0 messages with RBurst = 20 messages/s, with a maximum duration of TBurst = 1 s. The time period in between these bursts should be at least TBurstPeriod = 10 s. The limits given in TS 102 687 [17]. still apply.</p> <p>Note: Table A.1 in TS 102 687 [17] is based on CAM and Decentralised Environmental Notification Message (DENM) dissemination for use cases defined in [37] with an average T_{on} of 1000 µs and Table A.2 for T_{on} of 500 µs.</p>
Origin	RS_BSP_238 with modification
Interop issue	No impact: BSP only allows Table A.2. This is justified by the facts that vehicle transmissions are predominantly CAMs which are relatively short compared to DENMs by infrastructure. The usage of different parameters does not impact interoperability. Large scale deployment also not impacted as most vehicles will follow similar requirement in the BSP.

Req_ID	RS_MSP_037(1)
Requirement	<p>If the mobile ITS station uses the reactive DCC algorithm outlined in clause 5.3 of TS 102 687 [17], the following smoothing function of Channel Busy Ratio (CBR) values shall be performed:</p> $\text{CBR_now} = (\text{CBR}(n) + \text{CBR}(n-1)) / 2.$ <p>Note: Where 'n' and 'n-1' are the current and previous CBR sampling periods respectively.</p> <p>Note: CBR assessment is a mandatory feature outlined in Clause 4.2.10 of ETSI EN 302 571 [21]</p>
Origin	RS_BSP_240 as it is
Interop issue	N/A

Req_ID	RS_MSP_038(1)
Requirement	DCC techniques shall be applied according with ETSI TS 102 687 [17].
Origin	RS_BSP_436 as it is
Interop issue	N/A

4.4 Network and Transport Layer

4.4.1 General

The relevant standards are listed in Table 3 below. The specification of the Geo Networking protocol is split into two parts, media-independent and media-dependent. Purpose of the split was to allow for more than one access technology other than ITS-G5. However, so far, a specification for another access technology-specific extension other than ITS-G5 does not exist. Mobile ITS station does not include the features specified in the media dependent standard. Transport layer requirements are considered in this section.

4.4.2 List of relevant documents

Table 3 Relevant documents for the network and transport layer

Document	Title	Short Description
ETSI EN 302 636-4-1 [7]	Vehicular Communication; Geonetworking; Part 4 Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality	Defines common media-independent functionality of Geo Networking
ETSI EN 302 636-5-1 [8]	Vehicular Communication; Geonetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocols	Defines the Basic Transport Protocol (what data is to be provided by higher layer to networking layer)
ETSI EN 302 931 [6]	Vehicular Communications; Geographical Area Definition	Defines geographical areas so that different shapes can be used as destinations for the messages from higher layers.

4.4.3 ETSI EN 302 636-4-1 Geo Networking media-independent

Req_ID	RS_MSP_040(1)
Requirement	The networking protocol of mobile ITS-S shall comply with GeoNetworking (GN) according to ETSI EN 302 636-4-1 [7]
Origin	RS_BSP_437 as it is
Interop issue	N/A

Req_ID	RS_MSP_041(1)
Requirement	All default constants and parameters of the mobile ITS profile not defined or overwritten in the current document shall be set as specified in Annex H of ETSI EN 302 636-4-1 [7].
Origin	RS_BSP_250 as it is
Interop issue	N/A

Req_ID	RS_MSP_042(1)
Requirement	GN shall be used with itsGnSecurity set to pGnSecurity
Origin	RS_BSP_251 as it is (mentioned parameters might differ from BSP)
Interop issue	N/A

Req_ID	RS_MSP_043(1)
Requirement	GN shall be used with itsGnMaxGeoAreaSize and shall be set to pGnMaxAreaSize.
Origin	RS_BSP_255 as it is (mentioned parameters might differ from BSP)
Interop issue	N/A

<i>Req_ID</i>	RS_MSP_112(1)
<i>Requirement</i>	The mobile ITS station should omit forwarding of a packet if the distance between its own location and the centre of the destination area exceeds <i>pGnMaxAcceptDistance</i> .
<i>Origin</i>	RS_BSP_515 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_044(1)
<i>Requirement</i>	For all GN packets a mobile ITS station originates, the optional 'Repetition interval' parameter of EN 302 636-4-1 [7] shall not be set. Note: This means, packet repetition is not performed at GN layer in a mobile ITS station and the corresponding steps for repetition in the packet-handling procedures described in clause 10.3 of EN 302 636-4-1 [7] are not executed. Furthermore, the 'maximum repetition time' parameter of the service primitive GN-DATA.request and the GN protocol constant <i>itsGnMinPacketRepetitionInterval</i> do not apply to a mobile ITS station.
<i>Origin</i>	RS_BSP_416 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_045(1)
<i>Requirement</i>	If [Itss_WithPrivacy] according to TS 102 941 [32] applies, then GN shall be used with <i>itsGnLocalAddrConfMethod</i> set to <i>pGnAddrConfMode</i> . If [Itss_NoPrivacy] applies, <i>itsGnLocalAddrConfMethod</i> may be set to AUTO(0).
<i>Origin</i>	RS_BSP_252 with modification (mentioned parameters might differ from BSP)
<i>Interop issue</i>	No impact. Privacy is mandatory for C2C vehicles. Privacy is not an interop issue.

<i>Req_ID</i>	RS_MSP_046(1)
<i>Requirement</i>	GN shall be used with its <i>GnIfType</i> set to <i>pGnInterfaceType</i> .
<i>Origin</i>	RS_BSP_414 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_047(1)
<i>Requirement</i>	The mobile ITS station shall use Single Hop Broadcast (SHB) packet transport type as defined in EN 302 636-4-1 [7] on all CAM packets it originates. Note: this requirement is coming from in CAM standard [9], already applicable.
<i>Origin</i>	RS_BSP_256 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_048(1)
<i>Requirement</i>	The mobile ITS station shall use the GBC packet transport type as defined in EN 302 636-4-1 [7] on all DENM packets it originates. Note: this requirement is coming from in DENM standard [10], already applicable.
<i>Origin</i>	RS_BSP_257 as it is
<i>Interop issue</i>	N/A

Note: This profile covers the handling of SHB (via **RS_MSP_047**) and GBC (via **RS_MSP_048**) packets. While it does not cover the handling of other GN packet types defined in EN 302 636-4-1 [7], it does not prevent their implementation

4.4.3.1 Basic Header Fields

<i>Req_ID</i>	RS_MSP_049(1)
<i>Requirement</i>	The LifeTime (LT) field of all SHB packets shall be set to 1 second. Note: this implies that the sub-field base and sub-field multiplier are both set to 1.
<i>Origin</i>	RS_BSP_258 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_050(1)
<i>Requirement</i>	The mobile ITS station shall set the LifeTime field of all GBC packets to the minimum value of ValidityDuration and RepetitionDuration, where ValidityDuration and RepetitionDuration are defined in the Roadside ITS-G5 System Profile [38]. The value of the LifeTime field shall not exceed the itsGnMaxPacketLifetime, as specified in Annex H to EN 302 636-4-1 [7]. Note: this assures the coherence between application and network timing parameters.
<i>Origin</i>	RS_BSP_259 as it is
<i>Interop issue</i>	N/A

4.4.3.2 Common Header Fields

<i>Req_ID</i>	RS_MSP_051(1)
<i>Requirement</i>	Mobile ITS-S shall not implement store carry forward. Consequently, the SCF bit in the Traffic Class (TC) field shall be set to pGnGbcScf.
<i>Origin</i>	RS_BSP_260 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_052(1)
<i>Requirement</i>	Mobile ITS-S shall not offload packets to another channel. Consequently, the channel offload bit of the TC (Traffic Class) field shall be set to pGnChannelOffLoad for all message types.
<i>Origin</i>	RS_BSP_262 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_053(1)
<i>Requirement</i>	The traffic class ID for message sets shall be set as defined in the Roadside ITS-G5 System Profile [38].
<i>Origin</i>	RS_BSP_235 ; RS_BSP_292 with modification
<i>Interop issue</i>	No impact, same usage of TC for DENMs and CAMs in BSP and MSP

<i>Req_ID</i>	RS_MSP_054(1)
<i>Requirement</i>	The mobile ITS station shall set the itsGnIsMobile bit of the Flags field to pGnIsMobile.
<i>Origin</i>	RS_BSP_264 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_055(1)
<i>Requirement</i>	<p>The mobile ITS station may set the optional GN-DATA.request parameter 'Maximum hop limit' for GBC packets as follows:</p> <ul style="list-style-type: none"> - 0, if the destination area is a circle with radius <= 100 m; - 1 if the destination area is a circle with radius <= 200 m; - 2, if the destination area is a circle with radius <= 500 m; <p>For circular destination areas with higher radius, Maximum hop limit is increased by one for any additional 250 m radius length.</p> <p>Note: If that parameter is not set, the default <i>itsGnDefaultHopLimit</i> 10 automatically applies</p>
<i>Origin</i>	RS_BSP_265 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_056(1)
<i>Requirement</i>	<p>The multi-hop operation mode shall be supported by the Mobile C-ITS station by implementing the forwarding algorithm specified in the Annexes D, E.3 and F.3 of ETSI EN 302 636-4-1 [7].</p> <p>Note: on the transmission side, the default parameter <i>itsGnDefaultHopLimit</i> of the standard is used (cf. RS_MSP_041)</p>
<i>Origin</i>	RS_BSP_266 as it is
<i>Interop issue</i>	N/A

4.4.3.3 Duplicate Packet Detection

<i>Req_ID</i>	RS_MSP_057(1)
<i>Requirement</i>	Mobile ITS station shall use duplicate packet detection on the networking and transport layer. For the detection of duplicated packets, the algorithm specified in Annex A.2 of the EN 302 636-4-1 [7] shall be used.
<i>Origin</i>	RS_BSP_268 as it is
<i>Interop issue</i>	N/A

4.4.4 ETSI EN 102 636-4-2 Geo Networking media-dependent

4.4.4.1 Forward

<i>Req_ID</i>	RS_MSP_058(1)
<i>Requirement</i>	The mobile ITS station shall forward packets using background access category (AC_BK), see TS 102 636-4-2 [26]. Note: In case of forwarded packets, the TC indicated in the GN Common Header is preserved and not used for DCC queue assignment. The media dependent part of the network layer is defining the access category to be used by the access layer.
<i>Origin</i>	RS_BSP_267
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_059(1)
<i>Requirement</i>	GeoNetworking Frames sent by mobile ITS-S shall use the EtherType value pGnEtherType as specified in TS 102 636-4-2 [26] and as listed by the IEEE Registration Authority at http://standards.ieee.org/develop/regauth/ethertype/eth.txt
<i>Origin</i>	RS_BSP_270 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

4.4.5 ETSI EN 302 636-5-1 Basic Transport Protocol

<i>Req_ID</i>	RS_MSP_060(1)
<i>Requirement</i>	Mobile ITS-S shall implement the Basic Transport Protocol EN 302 636-5-1 [8]
<i>Origin</i>	RS_BSP_438 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_113(1)
<i>Requirement</i>	Mobile ITS-S shall employ BTP-B headers. Consequently, the GeoNetworking common header shall use a value of pGnBtpNh for the NH field.
<i>Origin</i>	RS_BSP_273 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_061(1)
<i>Requirement</i>	Mobile ITS-S shall set the destination port info field to the value pBtpDestPortInfo.
<i>Origin</i>	RS_BSP_274 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_062(1)
<i>Requirement</i>	Mobile ITS-S shall set the destination port depending on the message set as specified in the TS 103 248 [22].
<i>Origin</i>	RS_BSP_275 ; RS_BSP_276 as they are
<i>Interop issue</i>	N/A

4.4.6 ETSI EN 302 931 Geographical area definition

<i>Req_ID</i>	RS_MSP_063(1)
<i>Requirement</i>	The mobile ITS-S shall at least support circular, rectangular and ellipsoidal geographical areas as defined in the EN 302 931 [6]. Each [<i>ITS-S Application</i>] shall specify one of the above geographical area types and indicated through the GeoNetworking header as specified in EN 302 636-4-1 [7].
<i>Origin</i>	RS_BSP_279 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_064(1)
<i>Requirement</i>	<p>When a mobile ITS-S calculates the distance between two positions using GNSS coordinates (e. g. for PathDeltaPoints or in cases of circular relevance area), it may use the great-circle method.</p> <p>Note: In this case, care shall be taken to avoid large rounding errors on low-precision floating point systems; these can be avoided, e. g., with the haversine formula. In case the relevance area is an ellipse or a rectangle, then the cartesian coordinates of the area centre and of the current position need to be calculated for assessing whether to hop the packet as specified in EN 302 636-4-1 [7]; for this purpose, it is recommended to use the Local Tangent Plane method, or another method delivering the same accuracy.</p>
<i>Origin</i>	RS_BSP_280 with modification
<i>Interop issue</i>	No impact. Shall in BSP. No impact on interop but needs to be considered when determining the confidence of the provided information.

4.5 Facility Layer

4.5.1 List of relevant documents

The relevant standards for the facility layer are listed in Table 4 below.

Table 4 Relevant documents for the facility layer

Document	Title	Short Description
ETSI EN 302 637-3 [10]	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3 Specifications of Decentralized Environmental Notification Basic Service	Defines event/triggered DEN message as second core message for many ITS-S applications
ETSI TS 102 894-2 [15]	Intelligent Transport Systems (ITS); Users and applications requirements; Applications and facilities layer common data dictionary	Definition and specifications on the common data container at the applications and facility layer. The common data container includes the definition, syntax and semantic specifications of all the data elements/data frames used in the applications and facilities layer messages
C-ROADS C-ITS Message Profiles [4]	C-ITS Message Profiles and Parameters	Functional and operational specifications of infrastructure day-1 ITS-S applications
ISO 8855 [28]	Road vehicles – Vehicle dynamics and road-holding ability - Vocabulary	Reference Coordinates System
EN 302 637-2 [9]	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service	Defines CAM as core message for many ITS-S applications, plus sending rules

4.5.2 Traces

<i>Req_ID</i>	RS_MSP_065(1)
<i>Requirement</i>	For the creation for traces and path histories, road operators should use design method one as specified in Appendix A.5 to SAE J2945/1 [39]. For existing systems, equidistant points may be used instead of design method one. Note: The minimum length, maximum length and the other requirements concerning traces and pathHistories are applicable, regardless of the method being used.
<i>Origin</i>	N/A
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_066(1)
<i>Requirement</i>	<p>If Design Method One is used by the mobile ITS station for trace/pathHistory creation, the station shall use this generation method with the following settings:</p> <ul style="list-style-type: none"> - Instead of the maximum value 15 in step number 9, the parameter vMaxPHistPoints shall apply; - $K_PHALLOWABLEERROR_M = pTraceAllowableError$, where $PH_ActualError < K_PHALLOWABLEERROR_M$; - $K_PH_CHORDLENGTHTHRESHOLD = pTraceMaxDeltaDistance$, maximum distance between two successive concise path points.; - $K_PH_MAXESTIMATEDRADIUS = REarthMeridian$; - $K_PHSMALLDELTA\Phi_R = pTraceDeltaPhi$; - $REarthMeridian = pTraceEarthMeridian$ (according to the IUGG), used for great-circle or orthodromic distance calculation: $PH_ActualChordLength = REarthMeridian * \cos^{-1}[\cos(lat_1) \cos(lat_2) \cos(long_1 - long_2) + \sin(lat_1) \sin(lat_2)]$
<i>Origin</i>	RS_BSP_318 with modification
<i>Interop issue</i>	No impact: usage of the Design Method One is mandatory in BSP and not in MSP.

4.5.3 ETSI EN 302 637-2

CAM transmission requirements in case of transmission of protected zone information by the mobile ITS stations are defined in chapter 4.3.5.

<i>Req_ID</i>	RS_MSP_067(1)
<i>Requirement</i>	The mobile ITS station's Cooperative Awareness service shall be compliant with EN 302 637-2 [9].
<i>Origin</i>	RS_BSP_439 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_068(1)
<i>Requirement</i>	A mobile ITS station shall transmit CAMs as long as position and time information are available and within the limits specified in RS_MSP_008 .
<i>Origin</i>	RS_BSP_291 as it is (mentioned requirements might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_069(1)
<i>Requirement</i>	The parameter T_GenCam_Dcc (see ETSI EN 302 637-2 [9]) shall be set to the value of the minimum time between two transmissions, T_{off} , as given by DCC mechanisms in RS_MSP_036 . Note: this means that the CAM transmission frequency is bounded by the DCC constraints.
<i>Origin</i>	RS_BSP_293 as it is (mentioned requirements might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_070(1)
<i>Requirement</i>	The adjustable N_GenCam parameter (see ETSI EN 302 637-2 [9]) specified in the CAM Generation Frequency Management shall be set to pCamGenNumber for the mobile ITS station.
<i>Origin</i>	RS_BSP_297 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_071(1)
<i>Requirement</i>	The path history field in the CAM low-frequency container shall contain a PathHistory data element covering a minimum distance of <i>pCamTraceMinLength</i> . An exception to the minimum covered distance by PathHistory shall be made only if: <ul style="list-style-type: none"> - the vehicle has not yet physically covered the distance with its current AT (e. g. after vehicle start-up or right after AT change when driving); or - the maximum number of PathPoints is used, but the overall length covered by the PathHistory still does not reach <i>pCamTraceMinLength</i>.
<i>Origin</i>	RS_BSP_285 with modification (mentioned parameters might differ from BSP)
<i>Interop issue</i>	May impact: The difference with BSP is that MSP do not require the usage of Design Method One. Thus, the impact is the same as the one of RS_MSP_066 .

<i>Req_ID</i>	RS_MSP_072(1)
<i>Requirement</i>	The PathHistory in CAMs originated by mobile ITS stations shall cover at most <i>pCamTraceMaxLength</i> .
<i>Origin</i>	RS_BSP_286 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_073(1)
<i>Requirement</i>	The PathHistory in CAMs originated by mobile ITS stations shall consist of at most <i>pCamTraceMaxPoints</i> path points. Note: Regardless of the value of <i>pCamTraceMaxPoints</i> , the system is expected to be able to process PathHistory in received CAMs with up to 23 path points (see RS_MSP_067). Handling of the PathHistory in received CAMs with more than 23 path points is considered optional.
<i>Origin</i>	RS_BSP_512 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_073(1)
<i>Requirement</i>	The PathHistory in CAMs shall include PathDeltaTime in every PathPoint. It shall describe a list of actually travelled geographical locations leading to the current vehicle position, sorted by the time the positions were reached by the vehicle, with the first point being the closest in time to the current time.
<i>Origin</i>	RS_BSP_287 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_074(1)
<i>Requirement</i>	Where the mobile ITS station does not move, i.e. PathPoint position information does not change, the PathDeltaTime of the first PathPoint shall still be updated with every CAM.
<i>Origin</i>	RS_BSP_288 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_075(1)
<i>Requirement</i>	Where the mobile ITS station does not move, i.e. PathPoint position information does not change, for a duration longer than the maximum value of PathDeltaTime (specified in [TS 102 894-2]) the PathDeltaTime of the first PathPoint in the CAM shall be fixed to the maximum value.
<i>Origin</i>	RS_BSP_289 as it is
<i>Interop issue</i>	N/A

4.5.4 ETSI EN 302 637-3

<i>Req_ID</i>	RS_MSP_076(1)
<i>Requirement</i>	Mobile ITS station Decentralized Environmental Notification service shall be compliant to ETSI EN 302 637-3 [10].
<i>Origin</i>	RS_BSP_440 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_077(1)
<i>Requirement</i>	Mobile ITS station shall implement the DENM repetition as specified in the DEN basic service specification EN 302 637-3 [10]. Note: this is specified as it is realised at the facility level and not the Geonet one (see RS_MSP_044(1))
<i>Origin</i>	RS_BSP_301 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_078(1)
<i>Requirement</i>	<p>The path history field in the DEN messages shall contain trace-data elements covering a minimum distance of <i>pDenmTraceMinLength</i>.</p> <p>An exception to the minimum covered distance by traces shall be made only if:</p> <ul style="list-style-type: none"> - the vehicle has not yet physically covered the distance with its current AT (e. g. after vehicle startup or right after AT change when driving); or - the maximum number of PathPoints is used, but the overall length covered by the PathHistory still does not reach <i>pDenmTraceMinLength</i>.
<i>Origin</i>	RS_BSP_302 with modification (mentioned parameters might differ from BSP)
<i>Interop issue</i>	No impact: usage of the Design Method One is mandatory in BSP and not in MSP.

<i>Req_ID</i>	RS_MSP_079(1)
<i>Requirement</i>	The traces in the DENMs originated by mobile ITS stations shall cover at most <i>pDenmTraceMaxLength</i> .
<i>Origin</i>	RS_BSP_303 as it is. (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_080(1)
<i>Requirement</i>	<p>The PathDeltaTime data elements of the PathPoints in the first DENM traces element shall be updated only if the DENM is updated.</p> <p>Note: At the date of preparation of this document, it applies to all transmitted DENM as all use cases implemented (see chapter 3.2) imply a continuous refreshment of the message. (see Service and use case [37])</p> <p>Note: RS_MSP_085 and RS_MSP_086 describe the handling of pathHistory creation for static use cases (e. g. RWW-ROVI).</p>
<i>Origin</i>	RS_BSP_305 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_081(1)
<i>Requirement</i>	<p>The traces in the DENMs originated by mobile ITS stations shall consist of at most <i>pDenmTraceMaxPoints</i> path points.</p> <p>Note: Regardless of the value of <i>pDenmTraceMaxPoints</i>, the system is expected to be able to process traces in received DENMs with up to 40 path points (see RS_MSP_076).</p>
<i>Origin</i>	RS_BSP_513 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_082(1)
<i>Requirement</i>	<p>The usage of traces by Mobile ITS station shall be:</p> <p>The first trace element shall describe a time-ordered list of actually travelled geographical locations leading to the event position, as specified in RS_MSP_073</p> <p>Note: reverse movement completes this requirement. (cf. RS_MSP_083)</p>
<i>Origin</i>	RS_BSP_304 as it is (mentioned requirements might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_083(1)
<i>Requirement</i>	<p>In order for the traces to represent the “locations leading to the event” as mentioned in RS_MSP_082, mobile ITS stations that are allowed to enter a state of reverse movement according to traffic regulation, shall, when moving in reverse:</p> <p>Delete the last created points to avoid the description of back and forth travels in the trace. Thus, the first point of the trace shall have an <u>up-to-date</u> pathDeltaTime.</p> <p>Note: Requirements concerning the length of the trace are still applicable. Thus, memory of more than 40 last positions may be necessary when removing points due to backward movement.</p>
<i>Origin</i>	N/A
<i>Interop issue</i>	May impact: C2C needs to be informed.

<i>Req_ID</i>	RS_MSP_085(1)
<i>Requirement</i>	Where the event-detecting vehicle does not move, i.e. PathPoint position information does not change, the PathDeltaTime of the first PathPoint of the first DENM traces element shall still be updated with every update of the event.
<i>Origin</i>	RS_BSP_306 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_086(1)
<i>Requirement</i>	Where the mobile ITS station does not move, i.e. PathPoint position information does not change, for a duration longer than the maximum value of PathDeltaTime (specified in TS 102 894-2 [15]), the PathDeltaTime of the first PathPoint in the first DENM trace element shall be fixed to the maximum value.
<i>Origin</i>	RS_BSP_307 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_087(1)
<i>Requirement</i>	Additional PathHistory elements may be present in the DENM traces. However, unlike the first element, these shall describe alternative routes to the event location. These routes may or may not be available at the time of detecting the event. In this case, PathPoints shall be position-ordered and shall not include the PathDeltaTime.
<i>Origin</i>	RS_BSP_308 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_088(1)
<i>Requirement</i>	'Keep alive forwarding' as described in chapter 6.1.4.2 of the DENM standard EN 302 637-3 [10] shall not be used.
<i>Origin</i>	RS_BSP_536 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_089(1)
<i>Requirement</i>	The following statement of Annex B item B.1 of EN 302 637-3 [10] shall not be implemented for GN forwarding: "For the forwarding vehicle C-ITS station, the stationID shall be set to the station ID of the forwarding vehicle C-ITS station, if the DENM is forwarded."
<i>Origin</i>	RS_BSP_536 with modification
<i>Interop issue</i>	No impact: the note of RS_BSP_536 is a requirement and thus mentioned here.

<i>Req_ID</i>	RS_MSP_090(1)
<i>Requirement</i>	For all GN packets, a mobile ITS station originates, the time interval given by the moment in time when the message is sent from the originating station minus the moment in time the source position vector refers to, shall be in the range of 0 ms to +100 ms plus additional delays due to DCC mechanisms. Note: The moment in time when the message is sent and the moment in time the source position vector refers to may be measured by different station clocks. Therefore, the allowed time difference between the [<i>Station clock</i>] and [<i>C-ITS time</i>] in accordance to RS_MSP_002 shall be taken into account when determining the time interval.
<i>Origin</i>	RS_BSP_537 as it is
<i>Interop issue</i>	N/A

4.5.5 TS19091 [27]

This part will be filled in future release. (SREM/SSEM)

4.6 Security

To avoid redundancy, and increase stability between C-Roads documents, the requirements of this part mostly refer to C_Roads_WG2_TF1_Security_requirements [36]

Req_ID	RS_MSP_091
Requirement	<p>The mobile ITS station shall respect the following requirements extracted from [36]:</p> <ul style="list-style-type: none"> - RS_SEC_011 (RS_BSP_178) depending on [Itss_WithPrivacy] according to TS 102 941 [32] - RS_SEC_019 (RS_BSP_160) - RS_SEC_020 (RS_BSP_407 & 170) - RS_SEC_021 (RS_BSP_182) depending on [Itss_WithPrivacy] according to TS 102 941 [32] - RS_SEC_022 (RS_BSP_163) - RS_SEC_023 (RS_BSP_164) - RS_SEC_032 (RS_BSP_184) <p>NOTE: as the requirements RS_SEC_XXX do not have versioning, the applicable version of the mentioned document in § 6 is critical.</p>
Origin	RS_BSP_178 ; RS_BSP_160 ; RS_BSP_407 ; RS_BSP_170 ; RS_BSP_182 ; RS_BSP_163 ; RS_BSP_164 ; RS_BSP_184 with modification
Interop issue	No impact: only privacy modification which does not impact the interoperability.

Req_ID	RS_MSP_092(1)
Requirement	<p>The mobile ITS station shall check the <i>generationTime</i> in the security header against the reception time and accept only CAMs in the last time of <i>pSecCamPastToleranceTime</i> and other messages within the last time of <i>pSecMessagePastToleranceTime</i>. Message types shall be differentiated using the indicated ITS-AID in the security header.</p>
Origin	RS_BSP_168 as it is (mentioned parameters might differ from BSP)
Interop issue	N/A

Req_ID	RS_MSP_093(1)
Requirement	<p>The mobile ITS station shall check the <i>generationTime</i> in the security header against the reception time and accept only messages from up to <i>pSecMessageFutureToleranceTime</i> in the future.</p>
Origin	RS_BSP_532 as it is (mentioned parameters might differ from BSP)
Interop issue	N/A

Req_ID	RS_MSP_094(1)
Requirement	<p>The mobile ITS station shall check the distance from the originator position – in the security header, if available – and shall forward only messages with a distance from the originator of <i>pSecMaxAcceptDistance</i> or less. Additionally, the mobile ITS station may also forgo forwarding messages with a distance between <i>pSecMinAcceptDistance</i> and <i>pSecMaxAcceptDistance</i>.</p> <p>Note: 6 km = 6 hops x 1 000 m.</p>
Origin	RS_BSP_169 as it is (mentioned parameters might differ from BSP)
Interop issue	N/A

<i>Req_ID</i>	RS_MSP_095(1)
<i>Requirement</i>	<p>The security services in the following list shall be supported by mobile ITS-S. They are described in [36] and are applicable to all C-ITS stations:</p> <ul style="list-style-type: none"> - Obtain and update authorization tickets - Obtain, update and publish enrolment credentials - Update local authorization status repository
<i>Origin</i>	RS_BSP_328 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_096(1)
<i>Requirement</i>	The GN Source Address shall be constructed according to chapter 6 GeoNetworking address in [EN 302 636-4-1], with field M (bit 0) to <i>pSecGnSourceAddressType</i> .
<i>Origin</i>	RS_BSP_401 as it is (mentioned parameters might differ from BSP)
<i>Interop issue</i>	N/A

4.6.1 AT changeover

<i>Req_ID</i>	RS_MSP_097(1)
<i>Requirement</i>	<p>If [Itss_WithPrivacy] according to TS 102 941 [32] applies, then:</p> <p>When an AT changeover happens:</p> <ul style="list-style-type: none"> - All addresses and identifiers transmitted through short-range communication shall be changed and the GBC sequence number shall be set to 0, or a different random value. - The internal storage used for generation of Traces and EventHistory of the DENMs shall be erased. - All active DENM transmissions shall be stopped. DENM transmission can be restarted after the AT changeover has been done and if the triggering conditions are satisfied again. (Note: This implies that the triggering condition logic is restarted.) - The internal storage used for generation of the PathHistory of CAMs shall be erased. <p>Note: Erasing of data is done to ensure that no old data is transmitted in messages after the AT changeover.</p> <p>Note: Identity management is defined in chapter 6.5 of [TS 102 940].</p>
<i>Origin</i>	RS_BSP_182 with modification
<i>Interop issue</i>	No impact: privacy is not mandatory contrary to C2C

<i>Req_ID</i>	RS_MSP_098(1)
<i>Requirement</i>	<p>If [Itss_WithPrivacy] according to TS 102 941 [32] applies, then:</p> <p>If the mobile ITS station detects a collision of the least significant 32 bit of the 'Certificate digest' / 'hashedId8' with the 'Certificate digest' / 'hashedId8' of another C-ITS station, it shall initiate a change of its authorization ticket. This only applies if all the following conditions are valid:</p> <ul style="list-style-type: none"> - the certificate corresponding to the other 'Certificate digest' / 'hashedId8' is valid; - the message used to provide the certificate has a valid signature; - the change to the current AT has not been triggered by a collision.
<i>Origin</i>	RS_BSP_181 with modification
<i>Interop issue</i>	No impact: privacy is not mandatory contrary to C2C

<i>Req_ID</i>	RS_MSP_099(1)
<i>Requirement</i>	<p>As mentioned in C-Roads Security Requirements [36], the AT changeover and privacy policy is defined by each member state under the restriction of the CP.</p> <p>The AT changeover should be implemented as proposed by the BSP (<i>BSP_AT_Change</i>).</p>
<i>Origin</i>	N/A
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_100(1)
<i>Requirement</i>	<p>If <i>BSP_AT_Change</i> is implemented, all distances in the requirements from RS_MSP_101 to RS_MSP_105 shall be travel distances with a relative uncertainty of less than 5 %.</p> <p>Note: The travel distance is understood as the length of the path followed or to be followed by the vehicle and not the straight-line distance between 2 points.</p>
<i>Origin</i>	RS_BSP_519 as it is (mentioned requirements might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_101(1)
<i>Requirement</i>	<p>If <i>BSP_AT_Change</i> is implemented, when the engine control is activated after it has been deactivated for at least <i>pSecAtRestartTime</i>, the mobile ITS station shall perform an AT changeover.</p> <p>Note: When the engine control is activated after it has been deactivated for less than <i>pSecAtRestartTime</i>, the mobile ITS station may perform an AT changeover.</p> <p>Note: Conditions for the next AT changeover are given in RS_MSP_102</p>
<i>Origin</i>	RS_BSP_520 as it is (mentioned parameters and requirements might differ from BSP)
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_102(1)
<i>Requirement</i>	If <i>BSP_AT_Change</i> is implemented, and after the RS_MSP_101 has been satisfied a mobile ITS station shall perform the AT changeover after the vehicle has driven a distance equal to a current random value in the range of [800 m; 1 500 m].
<i>Origin</i>	RS_BSP_521 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_103(1)
<i>Requirement</i>	If <i>BSP_AT_Change</i> is implemented, and after the RS_MSP_102 has been satisfied, a mobile ITS station shall perform the AT changeover after the vehicle has driven at least 800 m from the location of that AT changeover plus an additional time interval equal to a current random value in the range [120 s; 360 s].
<i>Origin</i>	RS_BSP_522 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_104(1)
<i>Requirement</i>	If <i>BSP_AT_Change</i> is implemented, and after the RS_MSP_103 has been satisfied, a mobile ITS station shall perform the AT changeover after the vehicle has driven a random distance in the range of [10 000 m; 20 000 m] with respect to the location of the last AT changeover.
<i>Origin</i>	RS_BSP_523 as it is
<i>Interop issue</i>	N/A

<i>Req_ID</i>	RS_MSP_105(1)
<i>Requirement</i>	If <i>BSP_AT_Change</i> is implemented, and after the RS_MSP_104 has been satisfied, a mobile ITS station shall perform further AT changeovers every time the vehicle has driven a random distance in the range of [25 000 m; 35 000 m] from the location of the last AT changeover
<i>Origin</i>	RS_BSP_524 as it is
<i>Interop issue</i>	N/A

The Figure 4 provides a summary of the described AT changeover procedure when the *BSP_AT_Change* is implemented.

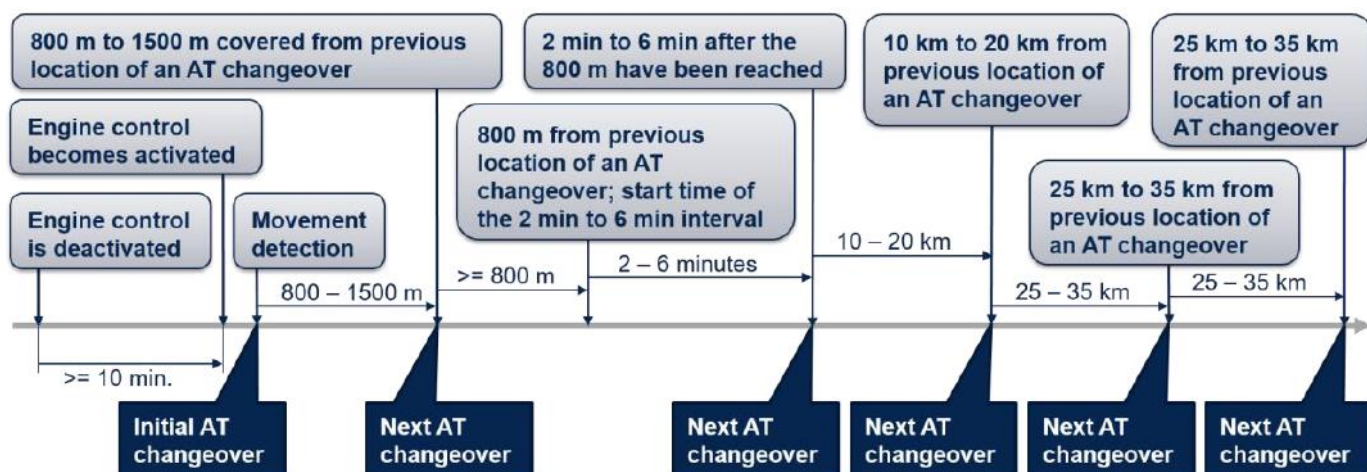


Figure 4: AT changeovers and related events over time

Req_ID	RS_MSP_106(1)
Requirement	<p>If <i>BSP_AT_Change</i> is implemented, a mobile ITS station shall only sign a message when it is in possession of at least 56 valid ATs and corresponding private keys at the point in time of signing that message.</p> <p>Note: If this requirement cannot be met due to connectivity or CCMS service availability problems, the C-ITS station might operate in degraded mode, as defined by the single OEM.</p>
Origin	RS_BSP_526 as it is
Interop issue	N/A

Req_ID	RS_MSP_107(1)
Requirement	<p>If <i>BSP_AT_Change</i> is implemented, a mobile ITS station shall select the next AT randomly with equal probability and without replacement, from the available and valid ATs.</p> <p>Note: this means that after use of one AT, that this AT is not immediately available but can be kept for later selection see RS_MSP_108.</p>
Origin	RS_BSP_527 as it is
Interop issue	N/A

Req_ID	RS_MSP_108(1)
Requirement	<p>If <i>BSP_AT_Change</i> is implemented, a mobile ITS station shall re-start the random selection procedure of RS_MSP_107 when all ATs have been selected an equal number of times.</p> <p>Note: this means that all valid ATs are available again for the procedure of RS_MSP_107.</p>
Origin	RS_BSP_528 as it is
Interop issue	N/A

<i>Req_ID</i>	RS_MSP_109(1)
<i>Requirement</i>	<p>A mobile ITS station should, if possible, be securely linked to one specific vehicle. Where the mobile ITS station is powered, it should verify that it is operating in the vehicle with which it has been securely linked. If such correct functioning condition cannot be verified, the mobile ITS station should be deactivated, preventing it from sending messages (i.e. deactivate at least the radio transmission level of the mobile ITS station).</p> <p>Note: Securely linked means paired in the factory or in an authorized repair shop.</p> <p>Note : This requirement is part of the security objective that an ITS Station is correctly mounted and protected against theft. Other method to achieve this goal might also be feasible.</p>
<i>Origin</i>	RS_BSP_158 with modification
<i>Interop issue</i>	No impact: "Shall in BSP. Improves the security if done, but difficult to realise on aftermarket vehicles.

<i>Req_ID</i>	RS_MSP_110(1)
<i>Requirement</i>	The mobile ITS station shall provide the received valid SSP and ITS-AID as part of the valid certificate to the FAC layer ([EN 302 636-5-1] annex A Parameter 'permissions').
<i>Origin</i>	RS_BSP_447 as it is
<i>Interop issue</i>	N/A

5 Parameter settings

To easily track the differences and similarities between MSP and BSP parameters, the naming of the BSP is followed.

Parameters with (*) indicates that the MSP differs from the BSP referenced for the said parameter.

Parameter	Value	Unit	Description	Min. Value	Max. Value	Source Document
pAIDataRateCch	6	Mbit/s	Default data rate for Control Channel (CCH), which is also called Service Channel 0 (SCH0)	3	27	[EN 302 663] [IEEE 802.11]
pBtpDestPortInfo	0	n/a	Value for the destination port information	0	65 535	[EN 302 636-5-1]
pCamGenNumber	3	n/a	Number of consecutive generated CAMs without time restrictions	0	3	[EN 302 637-2]
pCamTraceMaxLength (*)	900	m	Maximal length of a trace in CAMs	--	--	--
pCamTraceMinLength	200	m	Minimal length of a trace in CAMs	--	--	--
pCamTraceMaxPoints	23	n/a	Maximum allowed number of trace points in CAMs	n/a	n/a	[EN 302 637-2]
pDccMaxPToll	10	dBm	Value for transmission power inside protected zones	--	--	[TS 102 792] Version 1.2.1
pDenmTraceMaxLength (*)	1100	m	Maximum length of a trace in DENMs	--	--	--
pDenmTraceMinLength	600	m	Minimum length of a trace in DENMs	--	--	--
pDenmTraceMaxPoints	40	n/a	Maximum allowed number of trace points in DENMs	n/a	n/a	[EN 302 637-3]
pGnAddrConfMode	ANONYMOUS (2)	n/a	Configuration method for GeoNetworking (GN) address	0	2	[EN 302 636-4-1]
pGnBtpNh	2	n/a	Value for the Next Header (NH) field of GN common header.	0	3	[EN 302 636-4-1]
pGnChannelOffLoad	0	n/a	Value for the channel offload field	0	1	[EN 302 636-4-1]
pGnEtherType	0x8947	--	Value for the EtherType to use	--	--	--
pGnGbcScf	0	n/a	Value for the store-carry-forward field in cases of GBC	0	1	[EN 302 636-4-1]
pGnInterfaceType	ITS-G5 (1)	n/a	Interface type to be used by GN	0	1	[EN 302 636-4-1]
pGnIsMobile	1	n/a	Defines whether C-ITS station is mobile or not	0	1	[EN 302 636-4-1]
pGnMaxAreaSize	80	km ²	Supported area to cover	1	625	[EN 302 636-4-1]
pGnMaxAcceptDistance	10	km	Maximum distance between forwarder and centre of the destination	--	--	--

Parameter	Value	Unit	Description	Min. Value	Max. Value	Source Document
			area of a packet			
pGnSecurity	ENABLE D(1)	n/a	Defines use of GN security headers	0	1	[EN 302 636-4-1]
pPotiMaxTimeDiff	20	ms	Maximum time difference between station clock and C-ITS time	--	--	--
pPotiUpdateRate	10	Hz	Update rate for position and time information	--	--	--
pSecCamPastToleranceTime	2	s	Maximum absolute time difference between the time in the security header of the Cooperative Awareness Message (CAM) and station clock to accept the CAM	--	--	--
pSecGnSourceAddress Type	0	n/a	Value for the M field of the GN address (configuration type of the address)	0	1	[EN 302 636-4-1]
pSecMaxAcceptDistance	10	km	Maximum distance between originator and receiver to accept messages	--	--	--
pSecMinAcceptDistance	6	km	The lower bound of <i>pSecMaxAcceptDistance</i>	--	--	--
pSecMessageFutureToleranceTime	220	ms	Maximum absolute time difference between timestamp in security header and station clock to accept messages from the future	--	--	--
pSecMessagePastToleranceTime	10	min	Maximum absolute time difference between the time in security header of message (other than CAM) and station clock to accept the message	--	--	--
pSecAtRestartTime	10	min	Time between consecutive restarts in which the authorization ticket shall not be changed	--	--	--
pSecRestartDelay	1	min	Grace period for AT change after turning on ignition terminal	--	--	--
pTraceAllowableError	0,47	m	Parameter for calculation of path history; see [SAE J2945/1] for further details	--	--	--
pTraceDeltaPhi	1	°	Parameter for calculation of path history; see [SAE J2945/1] for further details	--	--	--
pTraceEarthMeridian	6 378,137	km	Earth mean radius (according to International Union of Geodesy and Geophysics (IUGG)). Used for calculation of traces; see [SAE J2945/1] for further details	--	--	--
pTraceMaxDeltaDistance	22,5	m	Parameter for calculation of traces, see [SAE J2945/1] for further details.	--	--	--

6 References

All normative references within a standard referenced here are automatically included and will not be listed separately.

Only if a normative reference is out of date because a newer version of the reference standard is supported, the newer reference is listed and marked accordingly.

Table 5 Table of normative key references

#	Reference
[17]	ETSI TS 102 687 V1.2.1 (2018-04) - Intelligent Transport Systems (ITS); Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part
[21]	ETSI EN 302 571 V2.1.1 (2017-02) - Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
[30]	ETSI TS 102 965 v2.1.1 (2021-11) - Intelligent Transport Systems (ITS); Application Object Identifier (ITS-AID); Registration; Release 2
[31]	ETSI TS 102 940 v2.1.1 (2021-07) - Intelligent Transport Systems (ITS); Security; ITS communications security architecture and security management; Release 2
[32]	ETSI TS 102 941 v1.4.1 (2021-01) - Intelligent Transport Systems (ITS); Security; Trust and Privacy Management
[33]	ETSI TS 103 097 v2.1.1 (2021-10) - Intelligent Transport Systems (ITS); Security; Security header and certificate formats; Release 2
[2]	Vehicle C-ITS station profile version 1.6.1
[7]	ETSI EN 302 636-4-1 V1.4.1 (2020-01) Intelligent Transport Systems (ITS); Vehicular Communication; Geonetworking; Part 4 Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality
[8]	ETSI EN 302 636-5-1 V2.2.1 (2019-05) Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol
[11]	ETSI EN 302 663 V1.3.1 (2020-01) Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band
[39]	ETSI EN 302 890-2 V2.1.1 (2020-03) Intelligent Transport Systems (ITS); Facilities Layer function; Part 2: Position and Time management (PoTi); Release 2

Table 6 Table of additional normative references

#	Reference
[4]	C-ITS Message Profiles_R2.0.3
[6]	ETSI EN 302 931 V1.1.1 (2011-07) Vehicular Communications; Geographical Area Definition.
[9]	ETSI EN 302 637-2 V1.4.1 (2019-04) Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service
[10]	ETSI EN 302 637-3 v1.3.1 (2019-04) Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service
[12]	ETSI EN 302 665 V1.1.1 (2010-09) Intelligent Transport Systems (ITS); Communications Architecture
[14]	ETSI TS 102 792 V1.2.1 (2015-06) Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency rang.
[15]	ETSI TS 102 894-2 V1.3.1 (2018-08) - Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary
[22]	ETSI TS 103 248 V1.3.1 (2019-04) - Intelligent Transport Systems (ITS); GeoNetworking; Port Numbers for the Basic Transport Protocol (BTP)
[24]	IEEE Std. 802.11-2016. IEEE Standard for Information technology — Telecommunications and information exchange between systems, local and metropolitan area networks — Specific requirements, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
[26]	ETSI TS 102 636-4-2 V1.4.1 (2021-02) Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 2: Media-dependent functionalities for ITS-G5
[27]	ISO/TS 19091:2019 Intelligent transport systems -- Cooperative ITS -- Using V2I and I2V communications for applications related to signalized intersections
[28]	ISO 8855:2011 Road vehicles -- Vehicle dynamics and road-holding ability -- Vocabulary
[35]	C_Roads_WG2_Introduction to the C-Roads WG2 Deployment Documentation and Requirements_R2.0.0
[36]	C_Roads_WG2_TF1_Security_requirements_R1.8.0
[37]	C_Roads_WG2_TF2_Service and Use Case Definitions 2.0.0

[38]	Roadside ITS-G5 System Profile_2.0.3
[39]	SAE J2945:2020, On-Board System Requirements for V2V Safety Communications