Basic System Profile

CAR 2 CAR Communication Consortium

About the C2C-CC

Enhancing road safety and traffic efficiency by means of Cooperative Intelligent Transport Systems and Services (C-ITS) is the dedicated goal of the CAR 2 CAR Communication Consortium. The industrial driven, non-commercial association was founded in 2002 by vehicle manufacturers affiliated with the idea of cooperative road traffic based on Vehicle-to-Vehicle Communications (V2V) and supported by Vehicle-to-Infrastructure Communications (V2I). Today, the Consortium comprises 88 members, with 18 vehicle manufacturers, 39 equipment suppliers and 31 research organisations.
Over the years, the CAR 2 CAR Communication Consortium has evolved to be one of the key players in preparing the initial deployment of C-ITS in Europe and the subsequent innovation phases. CAR 2 CAR members focus on wireless V2V communication applications based on ITS-G5 and concentrate all efforts on creating standards to ensure the interoperability of cooperative systems, spanning all vehicle classes across borders and brands. As a key contributor, the CAR 2 CAR Communication Consortium works in close cooperation with the European and international standardisation organisations such as ETSI and CEN.

Document information

Number:	2037	**Version:**	1.2.0	**Date:**	24.11.2016
Title:	CAR 2 CAR Communication Consortium Basic System Profile			**Document Type:**	
Release	1.2.0				12 Sept. 2017
Release Status:	-				
Status:	Final Draft				

Table 1: Document information

Changes since last version

Title:			CAR 2 CAR Communication Consortium Basic System Profile		
Explanatory notes:					
1	0	24.11.2016	Split former BSP into single documents for objectives, features and requirements as part of CAR 2 CAR Release 1.2.0	Henrik Antoni, Thomas Biehle, Robert Pflug	
Issue	Rev.	Date	Changes	Edited by	Approved

Table 2: Change history

Open Issues

The document should be handled as a working draft.

Technical specifications to be added:

- Wireless Performance
- Positioning Performance
- Protection Profile

RS_BSP_152: Definitions of terms, as used up to now in the BSP (derived from ETSI), does not completely match to the definition of terms as defined by release management (derived from AUTOSAR). Shall and should are the same, but the others differs.

RS_BSP_200: Change the term "navigation coordinate north" to the defined north reference (given in RS_BSP_191) or rephrase it to "reference coordinate system north".

RS_BSP_150: The abbreviation "CA" is used with two different meanings. Please see also RS_BSP_180.

Chapter Security: Please clarify: What is a pseudonym, a pseudonymID, a pseudonym certificate, a certificate, and a Long Term Certificates? How they are related?

Please double check the security requirements, if the terms are used in the right way.

RS_BSP_168: Currently this requirement is optional due to “should”. Is this intended?

RS_BSP_163: Rephrase to "The C2C-CC basic system shall do a cryptographic verification of the message’s signature."?

RS_BSP_160: Create a Feature like "The C2C basic system shall use certificates and signatures to ensure authentication of message originator." out of this requirement?

RS_BSP_407: Defintion of “authorization ticket (pseudonym certificate)“ is missing.

RS_BSP_178: Is a minimum preload time required?

RS_BSP_403: Definition of „interval“ is missing.

RS_BSP_410: Definition of “ride“ is missing. Maybe replace this by “being not stationary“?

RS_BSP_179: Are there any rules for reusing pseudonyms? Maybe not two time in row the same pseudonym?

RS_BSP_402: Unknown definition of overlapping period

RS_BSP_181: When shall the change be done? Immediately or after the current validity of the pseudonym is expired (see RS_BSP_410)?

RS_BSP_186: Is it intended that encryption is only applied in one direction?

RS_BSP_328: Definition for "authorization tickets", "enrolment credentials" and "authorization status repository" are missing. Maybe link to external definitions, if existing.

RS_BSP_342: Currently this requirement has a NOTE-nature. May merge it with the requirement RS_BSP_341?

RS_BSP_190: What are the limits of “same“, especially for the moment in time?

RS_BSP_194: We have a requirement, that the time of the station clock shall be synchronized to ITS time (see RS_BSP_206). Beside that RS_BSP_432 defines, that the time stamps in message shall base on station clock. As a result, this requirement is duplicated to them. Maybe move the NOTE.

RS_BSP_431:

- Is this requirement clear for everybody? What is the detailed meaning of this requirement? Does the accuracy estimation shall only provide values which fits a defined confidence interval with a confidence level of 95 %? In that case: what shall be done, if it cannot provide such values? Does it have any impacts to GeoNetworking?

- What „accuracy“ is ment? Accuracy in general or a certain one like position, speed or heading accuracy?

RS_BSP_208: This requirement has a NOTE-nature, so change it into a NOTE and append on RS_BSP_207.

RS_BSP_226: section 8.4.1 refers to “C2C-CC Whitepaper Minimum communication performance” which currently not exists (see open issues).

RS_BSP_433, 434, 435, 436, 437, 438, 439, 440: Which parts of this standards are really required?

RS_BSP_398: Clarify „at least“, may remove it. The new requirement would be “The C2C-CC basic system shall support broadcast mode”.

RS_BSP_235: Clarify „at least“, may remove “at least”.

RS_BSP_239: Which of the parameters are still necessary? Thus none of them is transfered into chapter "Parameter settings".

RS_BSP_240: Does this requirement contains the whole specification for the channel load measurements? In this case the reference to [14] can be removed.

RS_BSP_241: The whole requirement is a NOTE, remove it.

Chapter Networking and Transport Layer: In the former BSP we had also no reference for the media dependent part. Don’t we need that part?

RS_BSP_258: Parameter vGNSHBLifeTime results of the two parameters pGnShbLifeTimeMultiplier and pGnShbLifeTimeBase. For this reason, we can remove vGNSHBLifeTime.

RS_BSP_269: Clarify may. Currently it is left open to the implementer whether the system sends beacons or not.

RS_BSP_280: This requirement has a NOTE-nature. So mark it as NOTE and append it to another requirement or rewrite it to a true requirement.

RS_BSP_288: The definition of “does not move, i.e. PathPoint position information does not change” can be replace by “being stationary”. Thus the requirements should be changed to:

"In cases where the C2C-CC basic system is stationary, the PathDeltaTime of the first PathPoint shall still be updated with every CAM."

RS_BSP_289: What is „a long time“? Proposal: When the C2C-CC basic system is stationary for a duration longer than the maximum value of PathDeltaTime (specified in [8]) the PathDeltaTime of the first PathPoint in the CAM shall be fixed to the maximum value.

RS_BSP_290: We already claimed compliance to 302 637-2 in RS_BSP_439. Do we still need the second sentance?

RS_BSP_293: The parameter T_{TX} is not defined in Table 9 (refers in original BSP to Table “Parameters Settings for Day One”).

Is something get lost while rewriting the tables (RS_BSP_238 and RS_BSP_239) in the former BSP versions? Does the parameter now refers to table “DCC Parameters for Day One” (Table 8) (which contains this parameter)?

RS_BSP_294, 295, 296: The parameters are not part of 302 637-2. The standard already contains similar requirements.

RS_BSP_306: The definition of “does not move, i.e. PathPoint position information does not change” can be replace by “being stationary”. Thus the requirements should be changed to:

"In cases where the event detecting C2C-CC basic system is stationary, the PathDeltaTime of the first PathPoint of the first DENM traces element shall still be updated with every DEN_Update."

RS_BSP_307: What is „a long time“? Proposal: When the C2C-CC basic system is stationary for a duration longer than the maximum value of PathDeltaTime (specified in [8])

the PathDeltaTime of the first PathPoint in the first DENM trace element shall be fixed to the maximum value.

RS_BSP_315: Is it intended to exclude future triggering conditions or applications? If it is intended, then how do we ensure, that only TC-compliant applications request DENMs?

RS_BSP_309: Value set for traffic classes are already part of TCs. This requirment can be removed.

RS_BSP_318: In [VSC-A] parameter K_PH_CHORDLENGTHTHRESHOLD is defined as the maximum distance between **two successive** concise path points.

RS_BSP_202: What means “confidence value” in this sentences? Please clarify the requirement and maybe rephrase the requirement.

Was something like the following intended: Vehicle states shall be provided within the confidence interval limits (see RS_BSP_???) for a confidence level of 95 % for each scenario listed in RS_BSP_209. This implies that in an assessment test (which can be offline) a statistic averaging over all states and scenarios is not appropriate.

Please double check the use of "confidence values" and may replace them by "confidence level or interval".

RS_BSP_205: Does the horizontal and vertical interval have to be valid for the same time or are they considered separately?

RS_BSP_205: In Feature RS_BSP_189 we claim that the system shall be able to determine also velocity and heading. But we do not define confidence intervals for both, only for the position. Is this intended?

In Triggering Conditions we claim to obtain the velocity from vehicle bus, not from GNSS. Is this also a requirement for the C2C-CC basic system?

RS_BSP_209: What is the meaning of "c" column “Acceptance”? Is this the allowed confidence interval for the horizontal position? What is about the vertical position?

RS_BSP_214: A definition of „safety-related context“ is missing. That is not clear.

RS_BSP_246: Why does the system rely on beaconing when the CEN/DSRC system is transmitting CAMs with protect communication zones? I do not get this? (Stefan Begerad)

RS_BSP_250: Does this requirement only holds true for Network and Transport Layer or does it also account for other layers? I can imagine, that it also account for other Layers. In this case, this requirement shall be more general. (Stefan Begerad)

RS_BSP_256: This requirement is somehow redundant to the SHB requirement of section 5.3.4.1 in ETSI EN 302 637-2 CA Basic Service. Are you aware of that? (Stefan Begerad)

RS_BSP_257: This requirement is somehow redundant to the SHB requirement of section 5.4.2.2 in ETSI EN 302 637-3 DEN Basic Service. Are you aware of that? (Stefan Begerad)

RS_BSP_273: This requirement is somehow redundant to the SHB requirement of section 5.4.2.2 in ETSI EN 302 637-3 DEN Basic Service. Are you aware of that? (Stefan Begerad)

Table of contents

List of figures

Es konnten keine Einträge für ein Abbildungsverzeichnis gefunden werden.

List of tables

1 Introduction

Other (informational) **RS_BSP_147**

The European architecture for Cooperative Intelligent Transport System (C-ITS), outlined in EN 302 665, defines four ITS sub-systems; vehicle, roadside, personal, and central. For all of that sub-systems a common ITS-S reference architecture is described, which offers different implementation options. Each option is further defined by one or more standards, contributed by different Standards Developing Organizations (SDOs).

For interoperability, each sub-system requires a specific set of standards, called system profile, defining in which way possible options are implemented. Thus the system profile describes external interfaces matching those of other sub-systems where communication is intended.

Interoperability again can be distinguished between two types:

- Inter-sub-system interoperability i.e. sub-systems implementing the system profile can communicate/understand each other
- Intra-sub-system interoperability (interoperability of components within an 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 standardization within the sub-system, and allows customers to select among the best suppliers for each individual component within the sub-system. If intra-sub-system interoperability is not achieved, customers can only order complete sub-systems.

Given the C2C-CC plans of a fast and wide deployment, it is important to start the internal development and purchasing processes within the different OEMs as soon as possible. Given this timeframe, the C2C-CC aims for inter-sub-system interoperability, and not for intra-sub-system interoperability.

2 Scope

Other (informational) **RS_BSP_146**

The present document provides all requirements related to the features of a C2C-CC basic system (see [C2C-CC Features]) to enable Inter-sub-system interoperability.

In terms of C2C-CC each requirement details a feature (which again details an objective) and provides its implementation details. Requirements itself are not further detailed by C2C-CC, thus requirements are the lowest level of specification provided by C2C-CC. As lowest layer of specification requirements are basis for testing, which follows the backward link: If all requirements of a feature are tested, the featured can be assumed as “tested” and if all features of an objective are assumed as “tested” the objective itself can be assumed as “tested”.

In some cases requirements are written in a way which let the implementation open, for example if they refer very specific parts of a vehicle. Those requirements have to be further detailed by anybody implementing that requirement. Beside this special requirements all other requirements can be further detailed too.

3 Conventions to be used

3.1 Modal verbs terminology

Other (informational) **RS_BSP_152**

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 behavior of systems beyond of scope of this deliverable shall be indicated by:

- Will
- Will not

Facts shall be indicated by the verbal forms:

- Is
- Is not

3.2 Item identification

Other (informational) **RS_BSP_421**

Each item of this document has its unique identifier starting with “RS_BSP_” as prefix. For any review annotations, remarks and/or questions please refer to this unique ID rather than chapter or page numbers!

3.3 Provisions from referenced documents

Other (informational) **RS_BSP_153**

Unless otherwise specified in the present document, the normative requirements included in the referenced documents supporting the required functionality of the C2C-CC basic 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 or the organization providing them. For example normative requirements in ETSI documents are indicated by the verbal form “shall”.

When the requirements defined in the standards published by the various organizations stand in conflict, or contradict the requirements specified inside this document, the ones specified inside this document shall always outweigh the requirements included inside the referenced documents.

3.4 Requirements quality

Other (informational) **RS_BSP_424**

All Requirements shall have the following properties:

- Redundancy
  Requirements shall not be repeated within one requirement or in other requirements
- Clearness
  All requirements shall allow one possibility of interpretation only. Only technical terms of the glossary may be used. Furthermore, it must be clear from the requirement, what object the statement is a requirement on.

  Examples:

  - The <...> module shall/should/may ...
  - The <...> module's environment shall ...
  - The <...> configuration shall...
  - The function <...> shall ...
  - The hardware shall ...
- Atomicity
  Each Requirement shall only contain one requirement. A Requirement is atomic if it cannot be split up in further requirements.
- Testability
  Requirements shall be testable by analysis, review or test.
- Traceability
  The source and status of a requirement shall be visible at all times.
- Formulation

  All requirements shall be formulated so that they can be interpreted without the surrounding context (for example: “the function Xyz…" instead of "this function…").

4 References

4.1 Normative references

Definition **RS_BSP_427**

[C2C-CC Features]	CAR 2 CAR Communication Consortium Features
[EN 302 571]	EN 302 571 V1.2.1: Intelligent Transport Systems (ITS); Radio communications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive.
[EN 302 636-4-1]	EN 302 636-4-1 V1.2.1: 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.
[EN 302 636-5-1]	EN 302 636-5-1 V1.2.1: Intelligent Transport Systems (ITS);Vehicular Communication; Geonetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocols.
[EN 302 637-2]	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.
[EN 302 637-3]	EN 302 637-3 V1.2.2: Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.
[EN 302 663]	EN 302 663 V1.2.0: Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band.
[EN 302 665]	EN 302 665 V1.1.1: Intelligent Transport System (ITS); Communications Architecture
[EN 302 931]	EN 302 931 V1.1.1: Vehicular Communications; Geographical Area Definition.
[TS 102 687]	TS 102 687 V1.1.1: Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part.
[TS 102 724]	TS 102 724 V1.1.1: Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band.
[TS 102 792]	TS 102 792 V1.1.1: 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.
[TS 102 894-2]	TS 102 894-2 V1.1.1: Intelligent Transport Systems (ITS); Users and applications requirements; Applications and facilities layer common data dictionary.
[TS 103 097]	TS 103 097 V1.2.1: Intelligent Transport Systems (ITS); Security;

	Security Header and Certificate Formats.
[VSC-A]	„VSC-A Final Report,“ [Online]. Available: http://www.nhtsa.gov/DOT/NHTSA/NVS/Crash%20Avoidance/Technical%20Publications/2011/811492B.pdf.
[ISO 8855]	ISO 8855: Road vehicles - Vehicle dynamics and road-holding ability - Vocabulary, ISO, 2011

Table 3: Normative references

4.2 Informative references

Other (informational) **RS_BSP_151**

[14] C2C-CC White Paper Decentralized Congestion Control (DCC) for Day One.

[17] C2C-CC White Paper Information quality/event detection.

Table 4: Informative references

5 Definitions and abbreviations

5.1 Definitions

Definition **RS_BSP_149**

A *C2C-CC basic system* is a C-ITS vehicle sub-system as outlined in [C2C-CC Features].

Definition **RS_BSP_428**

Vehicle states comprises as absolute position, time, heading and velocity.

Definition **RS_BSP_193**

ITS time is defined as a time based on TAI (Temps Atomique International, International Atomic Time), a high-precision atomic coordinate time standard. Epoch of this time is set to 1.1.2004, 00:00 UTC, timestamps (as defined in [TS 102 894-2]) are counted as milliseconds since epoch.

Definition **RS_BSP_429**

Information provided with a confidence level of 95 % means that the true value (e.g., position of a reference measurement system) is inside the range specified by the estimated value plus/minus the confidence interval in 95% of the datasets in a given statistic base.

Definition **RS_BSP_200**

For horizontal positions a confidence area is used instead of a single confidence interval. The confidence area is described as ellipse specified via a major axis, minor axis and orientation of the major axis relative to navigation coordinate north. Positions provided with this confidence area means that "the true position is inside the confidence area centered around the estimated position in 90 % of the datasets in a given statistical base" (for a confidence level of 90 %).

NOTE: Only 90 % (instead of 95 %) have to be in the confidence area, to take into account the 2 dimensional extension of a confidence area, compared to a confidence interval.

Definition **RS_BSP_211**

Sky obstruction is defined as the fraction of the half-hemisphere values that are obstructed for GNSS satellites due to mountains, buildings, trees, etc.

Definition **RS_BSP_430**

The *station clock* is defined as a clock representing ITS time (see RS_BSP_193) in a C2C-CC basic system.

5.2 Abbreviations

Other (informational) **RS_BSP_150**

BSP	Basic System Profile
BTP	Basic Transport Protocol
C2C-CC	Car2Car Communications Consortium
CA	Cooperative Awareness / Certification Authority

CAM	Cooperative Awareness Message
C-ITS	Cooperative Intelligent Transport System
CL	Channel Load
CS	Charging Spot
DCC	Decentralized Congestion Control
DENM	Decentralized event notification message
DP	DCC profile
DPID	DCC profile identifier
EV	Electric Vehicle
GBC	GeoBroadcast
GN	GeoNetworking
GNSS	Global Navigation Satellite System
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transport System
LT	Lifetime
LTC	Long-Term Certificate
MAC	Medium Access Control
OEM	Original Equipment Manufacturer
PAI	Position Accuracy Indicator
PC	Pseudonym Certificate
PKI	Public key infrastructure
POI	Point of Interest
QPSK	Quadrature phase-shift keying
SCF	Store Carry Forward
SDO	Standards Developing Organization
SHB	Single Hop Broadcast
TAI	Temps Atomique International
TAL	Trust Assurance Level
TC	Traffic class
UTC	Coordinated Universal Time
WG	Working Group
WGS	World Geodetic System

Table 5: Abbreviations

6 Requirements specifications

6.1 Security

Requirement **RS_BSP_158**

The C2C-CC basic system shall be designed in a way that the system will only send messages from the dedicated vehicle.

Details:

Tested by:

Requirement **RS_BSP_168**

The C2C-CC basic system should check the timestamp in the security envelope compared to the reception time and accept only CAMs in the last time of *pSecCamToleranceTime* and other messages within the last time of *pSecMessageToleranceTime*.

NOTE: Due to the tolerance of the ITS station times, the C2C-CC basic system can accept messages 2 * *pPotiMaxTimeDiff* in the future (due to clock allowed deviation).

Details:

Tested by:

Requirement **RS_BSP_169**

The C2C-CC basic system shall check the distance from the sender position - in the security envelope, if available - and forward only messages with a distance from the sender of equal or less than *pSecMaxAcceptDistance*.

NOTE: 6 km = 6 hops * 1000 meter.

Details:

Tested by:

Requirement **RS_BSP_163**

The “verification” of a message shall comprise at least cryptographic verification of the message’s signature.

Details:

Tested by:

Requirement **RS_BSP_164**

The C2C-CC basic system shall only forward verified messages in the ITS-G5 network.

Details:

Tested by:

Requirement **RS_BSP_160**

The C2C-CC basic system shall use one end-to-end security envelope per message according to [TS 103 097].

Details:

Tested by:

Requirement **RS_BSP_406**

The end-to-end security envelope shall be generated according to the security profiles specified in clause 7.1, 7.2, and 7.3 in [TS 103 097], depending on whether a CAM, DENM or other message is processed.

Details:

Tested by:

Requirement **RS_BSP_407**

The signature in the end-to-end security envelope shall be generated using a private key corresponding to a valid authorization ticket (pseudonym certificate) according to clause 7.4.1 in [TS 103 097].

Details:

Tested by:

Requirement **RS_BSP_170**

The C2C-CC basic system shall use for sending messages digital signatures and certificates based on ECDSA-256 using the elliptic curve NIST P-256 algorithm as defined in [TS 103 097].

Details:

Tested by:

Requirement **RS_BSP_173**

The C2C-CC basic system shall support key origin authentication via the creation of a signature over internally generated public key(s), where public keys for LTCs shall be signed with the module private key and public keys for PCs shall be signed with a previously registered LTC private key.

Details:

Tested by:

Requirement **RS_BSP_174**

The C2C-CC basic system shall support key origin authentication for the new (long-term or pseudonym) public keys that are provided in certificate signing requests.

Details:

Tested by:

Requirement **RS_BSP_178**

Pseudonym preloading in the vehicle shall not exceed *pSecMaxPreloadTime*, i.e. all certificates in a vehicle shall have a validity range that spans at most *pSecMaxPreloadTime* altogether.

Details:

Tested by:

Requirement **RS_BSP_180**

The pseudonym validity periods shall be defined by the Pseudonym CA in conformance to the rules of the Root CA.

Details:

Tested by:

Requirement **RS_BSP_411**

In case that an C2C-CC basic system has no valid pseudonym certificates for signing messages, it shall stop transmitting messages that use the security profiles specified in [TS 103 097], clause 7.1, clause 7.2, and clause 7.3.

Details:

Tested by:

Requirement **RS_BSP_403**

The maximum amount of pseudonyms in an interval shall be *pSecMaxPseudonymNumber*.

NOTE: In case of *pSecMaxPseudonymNumber* = 20: For each year about 1040 pseudonyms are necessary. Within the overlapping phase, the number of valid pseudonyms could be up to 40.

Details:

Tested by:

Requirement **RS_BSP_412**

The driver shall be informed in advance about the expiration of the pseudonym certificates.

Details:

Tested by:

Requirement **RS_BSP_413**

The driver shall be informed in advance about the expiration of the Long Term Certificates.

Details:

Tested by:

Requirement **RS_BSP_410**

The C2C-CC basic system shall change the pseudonym during the ride in the interval of *pSecPseudonymChangeMinInterval* up to *pSecPseudonymChangeMaxInterval* randomly.

NOTE: Both limits might change in the future.

Details:

Tested by:

Requirement **RS_BSP_177**

The pseudonym used by the C2C-CC basic system shall change every time when the vehicle's ignition is switched on except if the system gets restarted within a period of *pSecRestartBlockingTime*, the pseudonym shall not be changed.

Details:

Tested by:

Requirement **RS_BSP_409**

The pseudonym change after turning on ignition shall be performed within a grace period of *pSecRestartDelay*.

Details:

Tested by:

Requirement **RS_BSP_179**

Pseudonyms may be reused within their validity period.

Details:

Tested by:

Requirement **RS_BSP_402**

The pseudonym validity periods shall not be longer than one week + overlapping period.

Details:

Tested by:

Requirement **RS_BSP_181**

If the C2C-CC basic system detects a collision of the least significant 32 bit of the pseudonym identifier of type HashedId8 with the pseudonym identifier of another ITS station (or C2C-CC basic system), it shall change the pseudonym if the certificate corresponding to the other pseudonym ID is valid.

Details:

Tested by:

Requirement **RS_BSP_182**

All addresses and identifiers of other layers transmitted over the ITS G5 wireless channel (such as StationId in CAM/DENM, GeoNetworking Source Address, MAC Source Address), shall be changed when the security entity changes its pseudonym.

Details:

Tested by:

Requirement **RS_BSP_185**

Facilities layer shall clear the own station's path history cache (used to fill into new messages) when the security entity changes its pseudonym identity.

Details:

Tested by:

Requirement **RS_BSP_184**

Applications shall be able to block the pseudonym change indefinitely, if the vehicle is stationary. In other cases, applications shall only be able to block it for at most *pSecChangeBlockingMaxTime*.

Exception:

- Validity of the pseudonym expired
- Collision of pseudonym identifiers

Details:

Tested by:

Requirement **RS_BSP_186**

The communication with the PKI shall be authenticated and encrypted end-to-end from the ITS--S to the certificate authority.

Details:

Tested by:

Requirement **RS_BSP_161**

The basic C2C-CC system shall employ the security envelope on its Network layer according to [EN 302 636-4-1].

The security envelope covers GN Common and Extended Headers, GN Basic Header is not content of the envelope.

Details:

Tested by:

Requirement **RS_BSP_401**

The GN Source Address shall be constructed as follows:

- Set the field M (bit 0) to *pSecGnSourceAddressType*.
- Set the field ST (bits 1 to 5) to the station type of the ITS-S. The station type in the GN source address shall be identical to the station type in CAMs/DENMs.
- Set all bits of the field SCC (bits 6 to 15) to *pSecGnScc*.
- Set the field MID (bits 16 to 63) to the value of the MAC address.

Details:

Tested by:

Requirement **RS_BSP_183**

All identifiers according to RS_BSP_182 (MAC Source Address, StationId in CAM/DENM, GN Source Address) shall be derived from the pseudonym ID. The required number of least significant bytes of the pseudonym ID shall be used as respective identifier.

Details:

Tested by:

Requirement **RS_BSP_328**

The security services in Table 6 shall be supported, but are defined by the manufacturer.

Obtain and update authorization tickets
Obtain, update and publish enrolment credentials
Update local authorization status repository

Table 6: Manufacturer dependent security service

Details:

Tested by:

Requirement **RS_BSP_341**

The minimal acceptable trust level for ITS station implementations is *pSecMinTal*.

Details:

Tested by:

Requirement **RS_BSP_342**

Each TAL is mapped to a subject assurance representation according to [TS 103 097] as specified in Table 7.

TAL	Subject assurance
0	0x00
1	0x20
2	0x40
3	0x60
4	0x80

Table 7: Mapping between TAL and subject assurance representations

Details:

Tested by:

6.2 Position and Timing

Requirement **RS_BSP_190**

The vehicle states (see RS_BSP_428) shall be consistent. Vehicle state values are consistent if they refer to the same position and time instant.

Details:

Tested by:

Requirement **RS_BSP_191**

The C2C-CC basic system shall use WGS84 as reference coordinate system as defined in [TS 102 894-2].

Altitude information shall be interpreted as height above WGS84 Ellipsoid.

NOTE: Alternative altitude interpretations using Geoid definitions (e.g. relative to mean sea level) shall not be used.

Details:

Tested by:

Requirement **RS_BSP_192**

The C2C-CC basic system shall interpret “heading” as the direction of the horizontal velocity vector. The starting point of the velocity vector shall be the ITS Vehicle Reference Point as defined in [EN 302 637-2] B.19.

NOTE: Alternative heading interpretations referring to the vehicle body orientation shall not be used.

NOTE: This definition implies that straight backward driving results in 180° difference between heading and vehicle body orientation.

Details:

Tested by:

Requirement **RS_BSP_194**

ITS-S time shall be the basis for all time stamps in all transmitted messages of the C2C-CC basic system.

NOTE: This implies that timestamps in GeoNetworking header use the same clock and time base as timestamps in CAM/DENM/... payloads.

Details:

Tested by:

Requirement **RS_BSP_195**

When some sensors used for estimating vehicle states (see RS_BSP_428, e.g. GNSS and vehicle sensors) are not available, the vehicle states estimation shall be continued (e.g. by means of extrapolation). The confidence intervals of all vehicle states shall be calculated considering the actual status of the sensors used.

Details:

Tested by:

Requirement **RS_BSP_197**

A C2C-CC basic system shall update the vehicle states (see RS_BSP_428) at least with a frequency of *pPotiUpdateRate* when it is active.

Details:

Tested by:

Requirement **RS_BSP_431**

The accuracy estimation shall yield valid 95 % confidence value, according to definition in RS_BSP_429.

Details:

Tested by:

Requirement **RS_BSP_432**

Timestamps in messages shall be based on station clock (see RSP_BSP_430).

Details:

Tested by:

Requirement **RS_BSP_207**

The difference between station clock (see RSP_BSP_430) and time base shall be estimated. If the maximum difference of |Station clock time - time base| = > *pPotiMaxTimeDiff*, it does not allow the (ITS) system to be active.

Details:

Tested by:

Requirement **RS_BSP_208**

A precise timestamp is needed not only for time synchronization but also implies that system states are valid at precisely that point in time, i.e., that the vehicle states (see RS_BSP_428) stay consistent.

Details:

Tested by:

6.3 System behavior

Requirement **RS_BSP_214**

The C2C-CC basic system shall operate the Cooperative Awareness Basic Service when it is in a safety-related context.

Note: Operation of the Cooperative Awareness Basic Service includes the transmission of cooperative awareness messages (CAMs) if all conditions for CAM generation are fulfilled.

Details:

Tested by:

Requirement **RS_BSP_215**

Traces and path history data shall only be generated when position confidence and ITS time information are available as specified in RS_BSP_205 and RS_BSP_206.

Details:

Tested by:

Requirement **RS_BSP_216**

By default, a C2C basic system shall be considered to be within the safety-related context, as long as the vehicle is participating in public traffic under normal driving conditions.

In some specific situations, the safety-related context may be deactivated for the C2C basic system under a deactivation condition. This condition has to be verified by a vehicle occupant or an in-vehicle system.

Details:

Tested by:

Requirement **RS_BSP_404**

For all messages a C2C-CC basic system sends, the moment in time when the message is sent on a communication channel in relaxed congestion status, minus the moment in time when the information in the message was obtained, shall be in the range of 0 milliseconds to +160 milliseconds.

Note 1: A measurement of the moment in time when a message is sent and the time-stamp inside the message will not always refer to the same clock (typically ITS Time and ITS Station time, respectively), which needs to be taken into account when the time difference is determined.

Note 2: This requirement should be tested with applications, where the fulfillment of the triggering conditions is not dependent on timers or durations.

Note 3: The time stamps inside the messages are represented in a CAM by GenerationDeltaTime and in a DENM by DetectionTime.

Note 4: The 160 milliseconds comes together from (100 + 60) milliseconds:

- In DP1 mode (normal operation) up to 10 messages/second can be generated, so it is common sense to be able to send at least 10 messages/second. That means that the system

as a whole must guarantee a traversal time lower than 100 milliseconds in order to support this generation rate, otherwise overlaps and messages drops will occur.

- Under relaxed channel condition you still have the 60 milliseconds T_{off} time which could additionally delay a message.

Note 5: The information of a DENM is obtained, when the last necessary trigger applies and is evaluated to be valid.

Details:

Tested by:

6.4 Access Layer

Requirement **RS_BSP_433**

The C2C-CC basic system's access layer shall be compliant to [EN 302 571].

Details:

Tested by:

Requirement **RS_BSP_225**

The C2C-CC basic system shall use the control channel G5-CCH to send the messages it generates.

Details:

Tested by:

Requirement **RS_BSP_226**

RF output power of the C2C-CC basic system shall be adjustable such that the communication performance specified in sub-section 8.4.1 is achieved.

NOTE: The maximum of 33 dBm defined in [EN 302 571] is not mandatory. It is expected that this value will only occur when using directional antenna(s).

Details:

Tested by:

Requirement **RS_BSP_434**

The C2C-CC basic system's access layer shall be compliant to [EN 302 663].

Details:

Tested by:

Requirement **RS_BSP_228**

The C2C-CC basic system shall use a transfer rate of *pAlDataRateCch* on G5-CCH.

Details:

Tested by:

Requirement **RS_BSP_397**

The C2C-CC basic system shall also support *pAlDataRateCchLow* and *pAlDataRateCchHigh* transfer rates on G5-CCH (for future use).

Details:

Tested by:

Requirement **RS_BSP_398**

The C2C-CC basic system shall support at least the broadcast mode.

Details:

Tested by:

Requirement **RS_BSP_232**

The C2C-CC basic system shall use the *Detect and Avoid* method, specified in [TS 102 792], based on the tolling zone announcement messages.

NOTE: Other methods beside *Detect and Avoid* can also be supported.

Details:

Tested by:

Requirement **RS_BSP_435**

The C2C-CC basic system's access layer shall be compliant to [TS 102 724].

Details:

Tested by:

Requirement **RS_BSP_235**

The C2C-CC basic system shall support at least the following DCC-Profiles defined inside [TS 102 724]: DP0, DP1, DP2 and DP3.

These four DCC-Profiles shall use the following DCC-Profile Identification (DPID) values:

- DP0, used only for DENMs with TC = 0
- DP1: used for DENMs with TC = 1
- DP2: used for CAMs with TC = *pCamTrafficClass*
- DP3: used for forwarded DENMs and other low priority messages

Details:

Tested by:

Requirement **RS_BSP_436**

The C2C-CC basic system's DCC mechanism shall be compliant to [14].

Details:

Tested by:

Requirement **RS_BSP_238**

The C2C-CC basic system shall use the DCC Mechanism summarized in Table 8. The DCC Mechanism is located at the DCC Access Sub-layer.

NOTE: The initial specification results of [14].

DCC States	ChannelLoad (CL) [%]	Transmission Interval T_{TX} [ms]	Message Rate R [Hz]
Relaxed	0% ≤ CL< 19%	60	16,7
Active_1	19% ≤ CL < 27%	100	10

Active_2	27% ≤ CL < 35%	180	5,6
Active_3	35% ≤ CL < 43%	260	3,8
Active_4	43% ≤ CL < 51%	340	2,9
Active_5	51% ≤ CL < 59%	420	2,4
Restricted	CL ≥ 59%	460	2,2

Table 8: DCC Parameters for Day One

Details:

Tested by:

Requirement **RS_BSP_239**

The C2C-CC Basic System shall implement the DCC State Machine in such a way that the parameters in that table can be modified in later releases of C2C-CC.

Table 9 lists the parameters that may be subject to change (i.e., through optimization) in future revisions of the DCC Mechanism.

Parameter	Meaning	Default
P_{Tx}	Transmission power	There is no default value set in this document. For each system the default TX power will depend on what is needed to fulfill the minimum communication range requirement
P_{Toll}	Transmission power across all states and DPs when in *toll communication mode* (see NOTE 3 in [14])	P_{Toll} = 10 dBm
T_{up}	Time of sustained channel load that triggers transition to a more restrictive state	T_{up} = 5 s Tup= NDL_timeUp in [TS 102 687]
T_{down}	Time of sustained channel load that triggers transition to a less restrictive state	T_{down} = 1 s Tdown = NDL_timeDown in [TS 102 687]
T_{TX_MAX}	Maximum transmission interval for all states	T_{TX_MAX} = 460 ms
T_{TX_MIN}	Minimum transmission interval for DP1-DP3 NOTE: minimum transmission interval for DP0 is 50 ms	T_{TX_MIN} = 60 ms
R_{Burst}	Maximum message rate of message bursts (additionaly to rate of DP1-DP3)	R_{Burst} = 20 messages per second

T_{Burst}	Time period over which message burst is measured T_{Burst} seconds is allowed very $T_{WaitBurst}$ seconds.	T_{Burst} = 1 second
$T_{BurstPeriod}$	Time period in which one burst is allowed.	$T_{BurstPeriod}$ = 10 seconds
$R_{max\_relaxed}$	Maximum message rate in *relaxed* state	$R_{max\_relaxed}$=36,7messages/second
$R_{max\_active,k}$	Maximum message rate in *active* sub-states	The inverse of the transmission interval for each CL value. *k*=1..*n*
$R_{max\_restrictive}$	Maximum message rate in *restrictive* sub-states	See Table 8.
CL_{max}	Transition threshold between *active* and *restrictive* states	CL_{max} = *59%*
CL_{min}	Transition threshold between *relaxed* and *active* states	CL_{min} = *19%*
CL_{active_k} ,*k*= *1…n*	Transition threshold between active states	CL_{active_k} , *k= 1…n*
t_j , *j=1..m*	*relaxed* (sub-)states transmission interval values as per Table 8	*m* = 1, see Table 8
t_k , *k=1..n*	*active* (sub-)states transmission interval values as per Table 8	*n* = 5, see Table 8
t_l , *l=1..q*	*restrictive* (sub-)states transmission interval values as per Table 8	*q* = 1, see Table 8
n	Number of *active* sub-states	*n*=5
q	Number of *restrictive (*sub-)states	*n*=1
m	Number of *relaxed (*sub-)states	*m=1*
MCS	Modulation an Coding Scheme	6 Mbps QPSK ½ as per [EN 302 571] for all states and DP values in Table 8
α ,β,γ	Channel Load smoothing parameters	Default values are *α=β*=0.5, γ=0 see Section 1.3 of [14].
$S_{th,}$ $N_{p,}$ T_{m} , T_p	Channel Load estimation parameters	Default values are T_m= 100 ms, T_p = 8 µs, N_p =12 500, and S_{th} = -85 dBm see Section 1.3 of [14].

Table 9: Parameters Settings for Day One

Details:

Tested by:

Requirement **RS_BSP_240**

The C2C-CC basic system shall use the channel load measurement mechanism specified in [14]. In particular:

- The DCC-CCA *Threshold* (S_{th}) shall be set to *pDccCcaThresh*.
- The channel load, *channelLoad*(S_{th}), shall be calculated as the number of channel probe samples for which the received signal strength was larger than Sth (i.e., when the channel is "busy") divided by the total number of samples that were probed. In formal terms
- The probing sample duration T_p shall be set to *pDccProbingDuration*, i.e., one data symbol.
- The channel load measurement, i.e. *channelLoad*(S_{th}),value shall be provided by the MAC layer synchronously every Measuring interval T_m, with T_m= *pDccMeasuringInterval.*
- The minimum receiver sensitivity for the modulation and coding schemes supported shall be *pDccMinSensitivity*. This includes a sensitivity variation margin (factoring in temperature, production, implementation and aging losses) of *pDCCSensitivityMargin*.
- The DCC Mechanism shall perform a smoothing of the reported channel load values The following filter shall be used to smooth out the channel load value (i.e., CL in Table 8) that is used to control the state transitions in DCC:
  CL_{now} = a**channelLoad*(S_{th})(t)+ß*CL(t-1)+y*CL(t-2), where a=ß=0.5, and y=0

Details:

Tested by:

Requirement **RS_BSP_241**

NOTE: The C2C-CC basic system should manage its limited hardware and software resources at its disposal, and it may perform traffic shaping or selective forwarding following the best effort principle.

NOTE: Traffic shaping is especially relevant for relayed DENM messages sent on DP3, as it is anticipated that in some situations – such as severe traffic congestion or other extreme vehicular network scenarios – the DENM load might increase abruptly. In such cases, C2C-CC basic systems are explicitly allowed to forgo the forwarding of foreign DENM messages.

Details:

Tested by:

Requirement **RS_BSP_242**

The C2C-CC basic system shall manage CAM generation such that no CAM messages shall be dropped; in other words, CAMs shall be generated at the rate at which they are forwarded to MAC layer. CAM messages shall not be held in the *DCC_Access queues* but forwarded directly to MAC layer.

Details:

Tested by:

Requirement **RS_BSP_243**

The C2C-CC basic system 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) and, if detection algorithms are used, then increased by the minimum required DENM generation rate derived from those triggering conditions.

Details:

Tested by:

Requirement **RS_BSP_244**

The C2C-CC basic system shall abide by the following maximum message rates:

- For the relaxed state: the sum of all messages sent on DP1, DP2 and DP3 while in relaxed state shall not surpass $R_{max\_relaxed}$ = 16.7 messages per second. Message bursts are allowed for DP0 with R_{Burst} = 20 messages per second, with a maximum duration of T_{Burst} = 1 seconds, and may only take place every $T_{BurstPeriod}$ = 10 seconds. Thus, adding DP0 messages, the maximum message rate amounts to $R_{max\_relaxed}$ = 36.7 messages per second.
- For active states: the maximum message rate for each state is given as *R* in Table 8
- For the restrictive state the maximum message rate per C2C-CC basic system station is set to 2.2 messages per second, i.e., the inverse of T_{TX_MAX} = 460 ms.

Details:

Tested by:

Requirement **RS_BSP_245**

The C2C-CC basic system shall support per-packet transmission power control.

NOTE: P_{Tx} may depend on the current state (i.e., relaxed, active or restrictive) and on DCC_Profile (i.e, DP0, DP1, etc).

Details:

Tested by:

Requirement **RS_BSP_246**

The C2C-CC basis system shall reduce its transmission power to P_{Toll} = *pDccPToll* as soon as the *protected communication zone* is entered, and without changing any other DCC transmission parameters as per Table 8. DP0 messages are excluded from this restriction.

NOTE: A C2C-CC basic system may rely on beaconing or other mechanism to detect a *victim CEN/DSRC system* (e.g., a toll gantry).

Details:

Tested by:

6.5 Network and Transport Layer

Requirement **RS_BSP_437**

The C2C-CC basic system's media-independent part of GeoNetworking shall be compliant to [EN 302 636-4-1].

Details:

Tested by:

Requirement **RS_BSP_250**

All default constants and parameters of the C2C-CC basic system profile not defined or overwritten in the current document shall be set as specified in Annex G of [EN 302 636-4-1].

Details:

Tested by:

Requirement **RS_BSP_251**

GN shall only be used with itsGnSecurity set to *pGnSecurity*.

Details:

Tested by:

Requirement **RS_BSP_252**

GN shall only be used with itsGnLocalAddrConfMethod set to *pGnAddrConfMode*.

Details:

Tested by:

Requirement **RS_BSP_255**

GN parameter itsGnMaxGeoAreaSize shall be set to *pGnMaxAreaSize*.

Details:

Tested by:

Requirement **RS_BSP_416**

Packet repetition shall not be performed by GN and the corresponding steps in the packet handling procedures in [EN 302 636-4-1] (clause 9.3) shall not be executed.

The parameter 'Maximum repetition time' of the service primitive GN-DATA.request is not applicable. Also, the GN protocol constant itsGnMinPacketRepetitionInterval is not applicable.

Details:

Tested by:

Requirement **RS_BSP_414**

GN shall only be used with itsGnIfType set to *pGnInterfaceType*.

Details:

Tested by:

Requirement **RS_BSP_415**

itsGnMinPacketRepetitionInterval is not applicable (N/A).

Details:

Tested by:

Requirement **RS_BSP_256**

The C2C-CC basic system shall use a Single Hop Broadcasting (SHB) header on all CAM packets it sends.

Consequently, the GeoNetworking common header shall use a value of *pGnShbHtField* for the HT field, and a value of *pGnShbHstField* for the HST field when transmitting SHB packets.

Details:

Tested by:

Requirement **RS_BSP_257**

The C2C-CC basic system shall use GeoBroadcast (GBC) headers on all DENM packets it sends.

Consequently, The GeoNetworking common header shall use a value of *pGnGbcHtField* for the HT field when transmitting DENM packets.

For the HST field only the following values shall be used (see [EN 302 636-4-1]):

- 0 for circular areas,
- 1 for rectangular areas, and
- 2 for ellipsoidal areas.

Details:

Tested by:

Requirement **RS_BSP_258**

The C2C-CC basic system shall set the LifeTime field of all SHB packets to vGNSHBLifeTime. Consequently, the multiplier bit of the LT field shall be set to *pGnShbLifeTimeMultiplier* and the base bit of the LT field shall be set to *pGnShbLifeTimeBase*.

Details:

Tested by:

Requirement **RS_BSP_259**

The C2C-CC basic system shall set the LifeTime field of all GBC packets to the minimum of ValidityDuration and RepetitionInterval (LifeTime=min(ValidityDuration, RepetitionInterval)), where ValidityDuration and RepetitionInterval are defined inside [17]. The value of the LifeTime field shall not exceed the itsGnMaxPacketLifetime, specified in [EN 302 636-4-1], Annex G.

Details:

Tested by:

Requirement **RS_BSP_260**

The C2C-CC basic system shall buffer GBC packets when no neighbours are available (store-carry-forward). Consequently, the SCF bit of the TC (Traffic Class) field of GBC packets shall be set to *pGnGbcScf*.

Details:

Tested by:

Requirement **RS_BSP_262**

The C2C-CC basic system is not required to offload packets to another channel. Consequently, the channel offload bit of the TC (Traffic Class) field should be set to *pGnChannelOffLoad*.

Details:

Tested by:

Requirement **RS_BSP_263**

The C2C-CC basic system shall only use the DCC profiles specified in RS_BSP_235. Consequently, the DCC Profile ID bits of the TC (Traffic Class) field shall only use the DPID values defined in RS_BSP_235.

Details:

Tested by:

Requirement **RS_BSP_264**

The C2C-CC basic system shall set the itsGnIsMobile bit of the Flags field to *pGnIsMobile*.

Details:

Tested by:

Requirement **RS_BSP_265**

The C2C-CC basic system shall set the GN Hoplimit parameter as follows:

- 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
- 3 otherwise

Details:

Tested by:

Requirement **RS_BSP_266**

The C2C-CC basic system shall support multi-hop operation mode. The C2C-CC basic system shall implement the forwarding algorithm specified [EN 302 636-4-1] Annex E.3.

Details:

Tested by:

Requirement **RS_BSP_267**

When forwarding packets, the C2C-CC basic system shall use the DCC profile DP3 as defined in [TS 102 724] and profiled in RS_BSP_235.

Details:

Tested by:

Requirement **RS_BSP_268**

The C2C-CC basic system shall use duplicate packet detection on the networking and transport layer. Consequently, the algorithm specified in [EN 302 636-4-1] Annex A.2 and A.3 shall be used for detecting duplicate packets.

Details:

Tested by:

Requirement **RS_BSP_269**

The C2C-CC basic system may only send beacons with the Position Accuracy Indicator (PAI) set to *pGnPai*.

Details:

Tested by:

Requirement **RS_BSP_270**

All GeoNetworking frames sent by the C2C-CC basic system shall use the EtherType value *pGnEtherType* as listed by the IEEE Registration Authority at http://standards.ieee.org/develop/regauth/ethertype/eth.txt

Details:

Detailed by:
Tested by:

Requirement **RS_BSP_438**

The C2C-CC basic system's Basic Transport Protocol shall be compliant to [EN 302 636-5-1].

Details:
Tested by:

Requirement **RS_BSP_273**

The C2C-CC basic system shall employ BTP-B headers. Consequently, the GeoNetworking common header shall use a value of *pGnBtpNh* for the NH field.

Details:
Tested by:

Requirement **RS_BSP_274**

The C2C-CC basic system shall set the destination port info field to the value *pBtpDestPortInfo*.

Details:
Tested by:

Requirement **RS_BSP_275**

Inside the BTP-B header, the C2C-CC basic system shall set the destination port to the value *pBtpCamPort* for CAMs.

Details:
Tested by:

Requirement **RS_BSP_276**

Inside the BTP-B header, the C2C-CC basic system shall set the destination port to the value *pBtpDenmPort* for DENMs.

Details:
Tested by:

Requirement **RS_BSP_279**

The C2C-CC basic system shall support circular, rectangular and ellipsoidal geographical areas as defined in [EN 302 931]. Each use case defined in [17] must specify one of the above geographical area types and indicated through the GeoNetworking header as specified in [EN 302 636-4-1].

Details:
Tested by:

Requirement **RS_BSP_280**

When a C2C-CC basic system calculates the distance between two positions using GNSS coordinates (e.g. for PathDeltaPoints or in case of circular relevance area), it is recommended that the great-circle or orthodromic distance method is used. Thereby, 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 center and of the current position need to be calculated for assessing whether to hop the packet as specified in [EN 302 931]; for this purpose it is recommended to use the Local Tangent Plane method, or another method delivering the same accuracy.

Details:

Tested by:

6.6 Facility Layer

Requirement **RS_BSP_439**

The C2C-CC basic system's CA basic service shall be compliant to [EN 302 637-2].

Details:

Tested by:

Requirement **RS_BSP_285**

The path history field inside the CAM low frequency container shall be generated according to the method specified in RS_BSP_318 and shall contain a PathHistory data element covering a minimum distance of *pCamTraceMinLength* (K_PHDISTANCE_M parameter in [VSC-A], Appendix B-2).

An exception to the minimum covered distance by PathHistory shall be only made if either of the following conditions is fulfilled:

- The vehicle has not yet physically covered the distance with its current pseudonym (e.g., after vehicle startup or right after pseudonym change when driving)
- The maximum number of PathPoints is used while the overall length covered by the PathHistory still does not reach *pCamTraceMinLength*.
  NOTE: This may happen, when the road topology contains curves with small radius. In this case, the inter distance between concecutive PathPoints is reduced.

Only in the above two cases the vehicle may send PathHistory information covering a distance below *pCamTraceMinLength*.

Details:

Tested by:

Requirement **RS_BSP_286**

The PathHistory in CAMs shall cover at most *pCamTraceMaxLength*.

Details:

Tested by:

Requirement **RS_BSP_287**

The PathHistory in CAMs shall include PathDeltaTime in every PathPoint. Therefore, the PathHistory shall describe a time-ordered list of actually travelled geographical locations leading to the current vehicle position.

Details:

Tested by:

Requirement **RS_BSP_288**

In cases where the vehicle does not move, i.e. PathPoint position information does not change, the PathDeltaTime of the first PathPoint shall still be updated with every CAM.

Details:

Tested by:

Requirement **RS_BSP_289**

When standing for a long time, the PathDeltaTime of the first PathPoint shall be fixed to the maximum value specified in [TS 102 894-2]. Therefore, PathPoints do not “fall out” of the PathHistory when standing for a long time.

Details:

Tested by:

Requirement **RS_BSP_290**

The CA basic service shall be active as long as C2C basic system is in the safety-related context as specified RS_BSP_216. As long as the CA basic service is active, CAMs shall be generated according to the generation rules defined in [EN 302 637-2].

Details:

Tested by:

Requirement **RS_BSP_291**

A C2C-CC basic system shall transmit CAM messages as long as position and time information are available and within the specified limits in RS_BSP_205 and RS_BSP_206.

Details:

Tested by:

Requirement **RS_BSP_292**

The traffic class value for CAM messages shall be set to *pCamTrafficClass*.

Details:

Tested by:

Requirement **RS_BSP_293**

The parameter T_GenCam_Dcc (see [EN 302 637-2]) shall be set to the value of the transmission interval, T_{TX}, as given by the DCC Mechanism (see Table 9).

Details:

Tested by:

Requirement **RS_BSP_294**

The MAX_DANGLE representing the delta angle (in degrees) between two generation rules checks shall use a value of pCamMaxDAngle.

Details:

Tested by:

Requirement **RS_BSP_295**

The MAX_DDISTANCE representing the delta distance (in meters) between two generation rules checks shall use a value of *pCamMaxDDistance*.

Details:

Tested by:

Requirement **RS_BSP_296**

The MAX_DSPEED representing the delta speed between two generation rules checks shall use a value of *pCamMaxDSpeed*.

Details:

Tested by:

Requirement **RS_BSP_297**

The adjustable N_GenCam parameter (see [EN 302 637-2]) specified in the CAM Generation Frequency Management shall be set to *pCamGenNumber* for the C2C-CC basic system.

Details:

Tested by:

Requirement **RS_BSP_440**

The C2C-CC basic system's DEN basic service shall be compliant to [EN 302 637-3].

Details:

Tested by:

Requirement **RS_BSP_301**

The DENM repetition shall be done by the DEN basic service as specified in [EN 302 637-3].

Details:

Tested by:

Requirement **RS_BSP_302**

The path history field inside the DEN messages shall be generated according to the method specified RS_BSP_318 and shall contain Trace data elements covering a minimum distance of *pDenmTraceMinLength* (K_PHDISTANCE_M parameter in [VSC-A], Appendix B-2).

An exception to the minimum covered distance by Traces shall be only made if either of the following conditions is fulfilled:

- The vehicle has not yet physically covered the distance with its current pseudonym (e.g., after vehicle startup or right after pseudonym change when driving)
- The maximum number of PathPoints is used while the overall length covered by the PathHistory still does not reach *pDenmTraceMinLength*.
  NOTE: This may happen, when the road topology contains curves with small radius. In this case, the inter distance between consecutive PathPoints is reduced.

Only in the above two cases the vehicle may send Traces information covering a distance below *pDenmTraceMinLength*.

Details:

Tested by:

Requirement **RS_BSP_303**

The Traces in the DENMs shall cover at most *pDenmTraceMaxLength*.

Details:

Tested by:

Requirement **RS_BSP_304**

The C2C-CC basic system shall use the DENM traces as follow: The PathDeltaTime shall be sent in every PathPoint in the first DENM traces element. Therefore, the first element of the traces shall describe a time-ordered list of actually travelled geographical locations leading to the event position. In its simplest form this is the same as the PathHistory at that time instant, which is recommended to be used.

Details:

Tested by:

Requirement **RS_BSP_305**

The PathDeltaTime data elements of the PathPoints in the first DENM traces element shall only be updated if the DENM is updated. Furthermore, the cases in which DENM Updates are triggered shall be specified on a case-by-case basis in the corresponding Triggering Conditions, see [17].

Details:

Tested by:

Requirement **RS_BSP_306**

In cases 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 DEN_Update.

NOTE: This is only the case for stationary events where the detecting vehicle is identical to the event, e.g. a stationary vehicle warning. For dynamic events, e.g. dangerous situations, or events, where the event is not identical to the vehicle, e.g. adverse weather warning, this is not the case.

Details:

Tested by:

Requirement **RS_BSP_307**

When standing for a long time, the PathDeltaTime of the first PathPoint of the first DENM traces element shall be fixed to the maximum value specified in [TS 102 894-2]. Therefore, PathPoints do not “fall out” of the first DENM traces element when standing for a long time.

Details:

Tested by:

Requirement **RS_BSP_308**

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 the alternative routes, the PathPoints shall be position-ordered (i.e. shortest-path routes) and they shall not include the PathDeltaTime.

Details:

Tested by:

Requirement **RS_BSP_315**

The C2C-CC basic system shall only generate DENMs as described in [17].

Details:

Tested by:

Requirement **RS_BSP_309**

The traffic class value for DENM messages shall be as set as defined in Table 10.

Use Case (DENM cause codes)	Traffic Class
Emergency Vehicle Warning (95)	1
Dangerous Situation (99)	
Emergency Brake Light (Sub cause code 1)	0
Pre-Crash (Sub cause code 2)	0
Automatic Emergency Breaking (Sub-cause code 5)	0
Other Sub use cases	1
Stationary Vehicle Warning, V2X Rescue Signal (94, 91)	1
Traffic Jam Ahead Warning (27)	1
Collision Risk - Exchange of IRCs (97)	0
Adverse Weather Conditions (6, 17, 18, 19)	1

Table 10: Mapping of Use Cases to Traffic Classes

Details:

Tested by:

Requirement **RS_BSP_313**

The data elements which constitute the content of the CAM and DENM shall be compliant to [TS 102 894-2] and use the coordinate system specified in RS_BSP_321.

Details:

Tested by:

Requirement **RS_BSP_318**

The traces and path histories used by the C2C-CC basic system shall be generated using the Design Method One as specified in [VSC-A] Appendix B-2. The C2C-CC basic system shall use this generation method with the following settings:

- K_PHALLOWABLEERROR_M = *pTraceAllowableError*, where PH_ActualError < K_PHALLOWABLEERROR_M
- Maximum distance between concise path points, K_PH_CHORDLENGTHTHRESHOLD = *pTraceMaxDeltaDistance*
- K_PH_MAXESTIMATEDRADIUS = REarthMeridian
- K_PHSMALLDELTAPHI_R = *pTraceDeltaPhi*
- REarthMeridian = *pTraceEarthMeridian* (according to IUGG - International Union of Geodesy and Geophysics), used for great-circle or orthodromic distance calculation:

$$PH\_ActualChordLength = REarthMeridian * \cos^{-1}[$$
$$\cos(lat_1)\cos(lat_2)\cos(long_1 - long_2) + \sin(lat_1)\sin(lat_2)]$$

Details:

Tested by:

Requirement **RS_BSP_321**

The C2C-CC basic system shall use a coordinate system compliant to [ISO 8855], section 2.13.

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.

Details:

Tested by:

6.7 Hardware related requirements

Requirement **RS_BSP_202**

The 95 % confidence value (see RS_BSP_429) shall be valid in each scenario listed in RS_BSP_209. This implies that in a confidence value assessment test (which can be offline) a statistic averaging over all states and scenarios is not appropriate.

Instead, a sliding window containing the vehicle states (see RS_BSP_428) of the last *pPotiWindowTime* seconds shall be used as the statistic base.

NOTE: the proposed confidence validation mechanism using the sliding window is typically performed off-line, as post-processing of collected test data. It is not required that the C2C-CC basic system performs confidence validation on-line, i.e. while in safety-related context.

NOTE: the exact value of *pPotiWindowTime* will be defined in WG Conformance Assessment based on Best Practice experience. First considerations and tests suggest a value in the range 20...120 seconds, see [7].

NOTE: The sliding window approach has the following advantages over separate statistics for each scenario:

- Transitions between scenarios are included.
- Confidence is valid "now" instead of "over lifetime". "Error bursts" (many invalid confidence values in a short timeframe) are not allowed.
  - This enhances the usefulness of the confidence value for applications.
  - This requires a fast detection of accuracy degradation inside POTI.
- The precise definition of test data has no effect on confidence validation parameters. Requirement however is: Test data contains all scenarios listed in section RS_BSP_209.
- No further statistic calculations needed. Coverage of all relevant states is given by the scenarios. Coverage of the relevant time will be ensured by the definition of test data in WG Conformance Assessment.
- The interval length is similar to typical (environment and driving condition) scenario lengths (city tunnel, standing at traffic light, driving maneuvers …).

5 % of the interval is similar to typical short term effects (driving under a bridge, …).

Details:

Tested by:

Requirement **RS_BSP_205**

Under optimal GNSS conditions and normal driving dynamics, the confidence values shall be equal to or lower than the following values in at least 95 % of datasets:

- horizontal position confidence of 5 m
- vertical position confidence of 15 m

In other scenarios, the requirement degradations in RS_BSP_209 apply. This requirement ensures the usefulness of information sent.

NOTE: Altitude Accuracy will be quantized quite roughly for CAM/DENM, e.g. “within 1/2/5/10/20/50/100/200 m”.

Details:

Tested by:

Requirement **RS_BSP_206**

The station clock (see RS_BSP_430) shall be within *pPotiMaxTimeDiff* to ITS time, i.e. Delta t = |station clock time – ITS time| < *pPotiMaxTimeDiff*.

Details:

Tested by:

Requirement **RS_BSP_209**

A C2C-CC basic system shall be able to provide useful vehicle state estimations (see RS_BSP_428) also in challenging scenarios. To account for inevitable degradations, required confidence values are defined for different scenarios in the following Table 11.

NOTE: One possibility to conduct these tests is a HiL testbed. Thereby, the C2C-CC (by way of the WG Conformance Assessment) could collect and administer a test database to which C2C-CC members can contribute and access data. This would allow members to test their systems across a large set of scenarios, without the need to physically collect all the data in the field, thus saving costs.

NOTE: The definition of “sky obstruction” is provided in RS_BSP_211.

ID	Scenario	Definition	Acceptance
Environment conditions			
S1	Open sky	Sky is less than 20% obstructed, with vehicle moving with normal driving dynamics, normal road conditions	C < 5m
S2	Tunnel	No GNSS Satellite is visible for at least 30 s and 250 m (v_{min}=30 km/h), GNSS signal reflection at entrance and end of tunnel	C < 15m
S3	Parking house	No direct visible GNSS Satellites, but connection by reflexions, T > 60 s, v_{max} < 20 km/h, minimum 2 x 90 ° curves and s > 100 m, 2 ramps in the entrance and exit area	
S4	Half open sky	Sky is at least 40 % obstructed (obstruction concentrated on one side of the car) for more than 30 s, Driving conditions as S1	C < 7m
S5	Forest	Sky is obstructed by trees higher that the antenna for more than 30 s Driving conditions as S1	C < 10m

S6	Mountains (Valley)	Sky is at least 50 % obstructed by high mountain(s) , Driving conditions as S1	C < 10m
S7	City	In a 300 s drive, the sky was at least 40 % obstructed (short periods of less than 40 % obstructions allowed), frequent GNSS signal reflection at buildings, including short losses of GNSS signal (i.e. less than 4 satellites) Driving conditions as S1	C < 14m
S8	Mild Urban	Sky is 20 – 40 % obstructed, t > 60 s, s > 400 m, Driving conditions as S1 with stops, trees and/or buildings, as well as alleys	
Driving conditions under open sky			
S9	Dynamic driving	Testdrive with longitudinal accelerations of more than -6 m/s² and lateral accelerations of > (±) 5 m/s²	C < 7m
S10	Static	Vehicle standing still for 30 min	C < 5m
S11	Rough road	Testdrive on dirt road with pot holes, v= 20 - 50 km/h	C < 10m
S12	Icy road	Testdrive with longitudinal accelerations of more than -0.5 m/s² and lateral accelerations of > (±) 0.5 m/s² , μ < 0.15,	C < 7m
S13	High speed	V=v_{max} of target vehicle on dry road for 30 s	C < 6m

Table 11: Scenarios

Details:

Tested by:

Requirement **RS_BSP_210**

Specific values and criteria for acceptance in each of the test scenario definitions (including standstill, see RS_BSP_209) shall be specified by C2C-CC WG Compliance Assessment.

Details:

Tested by:

7 Parameter settings

Definition **RS_BSP_443**

Parameter	Value	Unit	Description	Min. Value	Max. Value	Source Document
pAlDataRateCch	6	Mbit/s	Default data rate for CCH.	???	???	???
pAlDataRateCchHigh	12	Mbit/s	Optional higher data rate for CCH than the default one.	???	???	???
pAlDataRateCchLow	3	Mbit/s	Optional lower data rate for CCH than the default one.	???	???	???
pBtpCamPort	2001	n/a	Well-known destination port for CAMs.	0	65535	[EN 302 636-5-1]
pBtpDenmPort	2002	n/a	Well-known destination port for DENMs.	0	65535	[EN 302 636-5-1]
pBtpDestPortInfo	0	n/a	Value for the destination port information.	0	65535	[EN 302 636-5-1]
pCamGenNumber	0	n/a	Number of consecutive generated CAMs without time restrictions.	0	3	[EN 302 637-2]
pCamMaxDAngle	4	°	Heading variation (compared to the latest CAM), which requires generation of a new CAM.	???	???	???
pCamMaxDDistance	4	m	Distance variation (since the position of the latest CAM), which requires generation of a new CAM.	???	???	???
pCamMaxDSpeed	0.5	m/s	Speed variation (compared to the latest CAM), which requires generation of a new CAM.	???	???	???
pCamTraceMaxLength	500	m	Maximal length of a trace in CAMs.	???	???	???
pCamTraceMinLe	200	m	Minimal length of a	???	???	???

ngth			trace in CAMs.			
pCamTrafficClass	2	n/a	Traffic class value CAMs are send with.	0	255	???
pDccCcaThresh	-85	dBm	???	???	???	???
pDccMeasuringInterval	100	ms	Value for the interval in which the channel load is provided.	???	???	???
pDccMinSensitivity	-88	dBm	Value for minimum receiver sensitivity.	???	???	???
pDccProbingDuration	8	µs	Value for the probing sample duration	???	???	???
pDccPToll	10	dBm	Value for transmission power inside protected communication zones.	???	???	???
pDCCSensitivityMargin	3	dB	Value for margin of paremter pDccMinSensitivity.	???	???	???
pDenmTraceMaxLength	1000	m	Maximal length of a trace in DENMs.	???	???	???
pDenmTraceMinLength	600	m	Minimal length of a trace in DENMs.	???	???	???
pGnAddrConfMode	ANONYMOUS (2)	n/a	Configuration method for GN address.	0	2	[EN 302 636-4-1]
pGnBtpNh	2	n/a	Value for the 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.	???	???	???
pGnGbcHtField	4	n/a	Value for the HeaderType field in case of GBC.	0	15	[EN 302 636-4-1]
pGnGbcScf	1	n/a	Value for the store-carry-forward field in case 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 ITS-S is mobile or	0	1	[EN 302 636-4-1]

			not.			
pGnMaxAreaSize	80	km²	Supported area to cover.	21474 83648	21474 83647	[EN 302 636-4-1]
pGnPai	1	n/a	Value for the Position Accuracy Indicator field.	0	1	[EN 302 636-4-1]
pGnSecurity	ENABLED (1)	n/a	Defines use of GN security headers.	0	1	[EN 302 636-4-1]
pGnShbHstField	0	n/a	Value for the HeaderSubType field in case of SHB.	0	15	[EN 302 636-4-1]
pGnShbHtField	5	n/a	Value for the HeaderType field in case of SHB.	0	15	[EN 302 636-4-1]
pGnShbLifeTime	1	s	Value for the LifeTime field in case of SHB.	???	???	???
pGnShbLifeTimeBase	1	n/a	Value for the LifeTimeBase field in case of SHB.	0	3	[EN 302 636-4-1]
pGnShbLifeTimeMultiplier	1	n/a	Value for the LifeTimeMultiplier field in case of SHB.	0	63	[EN 302 636-4-1]
pPotiMaxTimeDiff	20	ms	Maximum time difference between station clock and reference time.	???	???	???
pPotiWindowTime	???	s	Size of PoTi sliding window in seconds.	20	120	???
pPotiUpdateRate	10	Hz	Update rate for position and time information.	???	???	???
pSecCamToleranceTime	2	s	Maximum time deviation between time in CAM and station clock to accept the CAM.	???	???	???
pSecChangeBlockingMaxTime	15	min	Maximum time a pseudonym change can be blocked, if C2C-CC basic system is moving.	???	???	???
pSecGnScc	0	n/a	Value for the SCC field of the GN address.	0	1023	[EN 302 636-4-1]

pSecGnSourceAddressType	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	6	km	Maximum distance between sender and receiver to accept messages.	???	???	???
pSecMaxPreloadTime	3	year	Maximum time for preloading certificates.	???	???	???
pSecMaxPseudonymNumber	20	pseudonym	Maximum amount of pseudonyms at once, whereof the C2C-CC basic system can choose.	???	???	???
pSecMessageToleranceTime	10	min	Maximum time deviation between time in message (other to CAM) and station clock to accept the message.	???	???	???
pSecMinTal	2	TAL level	Value for minimum TAL for an ITS-S.	???	???	???
pSecPseudonymChangeMaxInterval	30	min	Maximum validity of the current pseudonym.	???	???	???
pSecPseudonymChangeMinInterval	10	min	Minimum validity of the current pseudonym.	???	???	???
pSecRestartBlockingTime	10	min	Time between consecutive restarts in which the pseudonym shall not be changed.	???	???	???
pSecRestartDelay	1	min	Grace period for pseudonym change after turning on ignition terminal.	???	???	???
pTraceAllowableError	0.47	m	Parameter for calculation of traces, see [VSC-A] for further details.	???	???	???
pTraceDeltaPhi	1	°	Parameter for calculation of traces, see [VSC-A] for further details.	???	???	???

pTraceEarthMeridian	6378.137	km	Earth mean radius (according to IUGG - International Union of Geodesy and Geophysics). Used for calculation of traces, see [VSC-A] for further details.	???	???	???
pTraceMaxDeltaDistance	22.5	m	Parameter for calculation of traces, see [VSC-A] for further details.	???	???	???

Table 12: Parameter settings for all requirements