C2C-CC Basic System Profile

CAR 2 CAR Communication Consortium

Partners of the C2C-CC

Document information

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Table 1: Document information

Changes since last version

Title:			CAR 2 CAR Communication Consortium Draft C2C-CC Basic System Standards Profile		
Explanatory notes:					
1	1	01.12.2015	Reworked according to Change Management process and released as part of CAR 2 CAR Release 1.1.0	Volkswagen AG	
	1.0.4	31.01.2014	Review and finalized v1.0	Buburuzan	
	1.0.4	29.01.2014	Amendment structure	Van der Kluit	
	1.0.3	15.01.2014	Editorial corrections	Van der Kluit	
	1.0.2	14.01.2014	Editorial corrections	Van der Kluit	
	1.0.1	10.01.2014	Integrated new POTI input from Continental	Van der Kluit	
	1.0	12.12.2013	Version for publication	Van der Kluit / Buburuzan	
0	1	30.07.2010	Document template	name	name
Issue	**Rev.**	**Date**	**Changes**	**Edited by**	**Approved**

Table 2: Change history

Open Issues

The document should be handled as a working draft.

Roadmap:

- next intermediate release in 06/2016 (V1.2.0 -beta)
- next major release (V1.2) 12/2016

Document structure:

- document will be split into different documents (HW, SW, System & Parameter)

Technical specifications to be added:

- Wireless Performance
- Positioning Performance
- Protection Profile

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1 Scope

Other (informational) **RS_BSP_146**

This standards profile document, identifies a minimum set of standards and fills the missing gaps necessary for implementing an interoperable vehicle ITS-Station, aimed for the Day-1 deployment on the European market.

The C2C-CC basic system is defined as a specific type of ITS-Station and it is described throughout this document. The C2C-CC basic system shall support a variable number of cooperative intelligent transport system (C-ITS) applications, aimed at increasing road traffic safety and at improving the overall traffic efficiency and reducing CO2 emissions.

Since the standards profiled here offer several implementation options, this document selects only the options needed for the Day-1 deployment on the European market. The document takes into account requirements such as security, information quality, and efficient use of spectrum in the 5.9 GHz range.

2 Introduction

Other (informational) **RS_BSP_147**

The European ITS-Station architecture, outlined in EN 302 665, defines four ITS sub-systems; vehicle, roadside, personal, and central. For interoperability, each sub-system requires a specific standards profile, with external interfaces matching those of other sub-systems where communication is intended. Herein, the standards profile for the vehicle ITS sub-system is defined.

Several standards developing organizations (SDOs) such as ETSI, CEN, ISO, IEEE and SAE are actively contributing with standards in the field of Cooperative ITS (C-ITS). These efforts are driven by different stakeholders, with partially overlapping, and partially diverging strategic interests. The C2C-CC has consolidated and communicated its understanding of the core vehicle system components in a C2C-CC basic system overview as depicted in Figure 1.

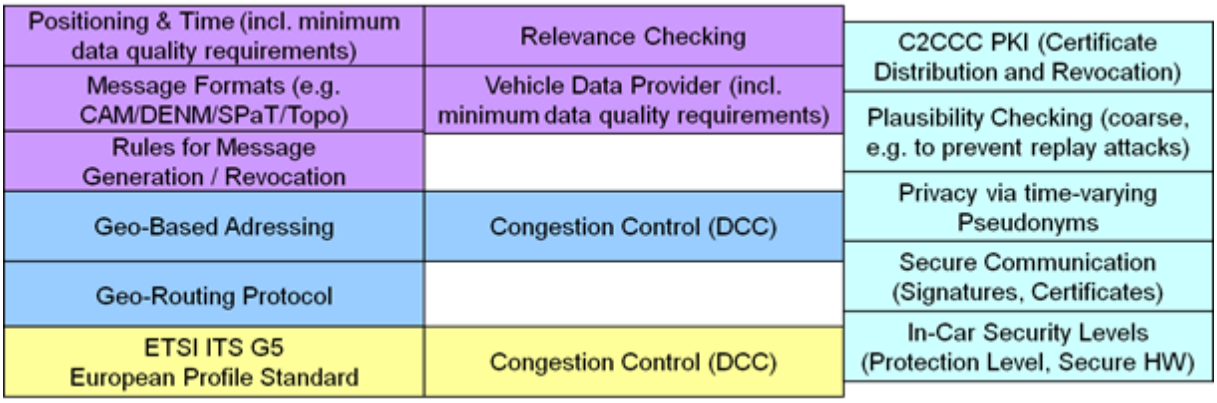

Figure 1: C2C-CC basic system components

This basic system is a vehicle ITS sub-system enabling a set of day one use cases (listed in Table 6 in section 6.1).

An extended version of the basic system is shown in Figure 2. The extension supports multi-channel, multi-interface operation, service management and IP-based addressing. The current document focuses only on the architecture specified in Figure 1.

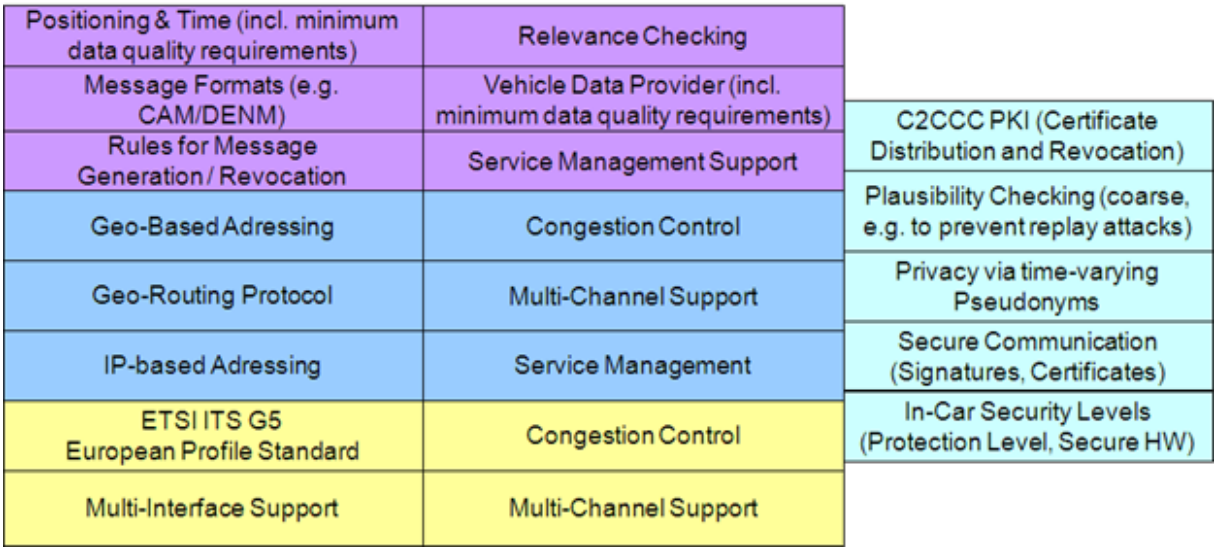

Figure 2: C2C-CC Extended Basic System Components

The standards profile for the vehicle ITS sub-system can serve as basis for discussion and orientation for the definition of standards profiles for personal and roadside ITS sub-systems in joint efforts with other stakeholders. Because of very similar system requirements, it can

be expected that many of the standards in the present document are also used when developing the standards profiles of the roadside and the personal ITS sub-system.

3 Definitions and abbreviations

3.1 Definitions

Other (informational)

RS_BSP_149

Car2Car basic system	The vehicle ITS subsystem outlined in this document, supporting the day one use-cases defined in clause 6.1

Table 3: Definitions

3.2 Abbreviations

Other (informational) **RS_BSP_150**

BSS	Basic service set
BTP	Basic Transport Protocol [1]
C2C-CC	Car2Car communications Consortium
CA	Cooperative awareness
CAM	Cooperative awareness message [2]
CS	Charging Spot
DCC	Decentralized Congestion Control
DENM	Decentralized event notification message [3]
DP	DCC profile
DPID	DCC profile identifier
DSRC	Dedicated Short Range communications
EDCA	Enhanced distributed channel access
EV	Electric Vehicle
GLOSA	Green Light Optimized Speed Advisory
GBC	GeoBroadcast
GN	GeoNetworking
GPS	Global positioning system
HSM	Hardware security module
HST	Header Sub-type
HT	Header Type
ITS	Intelligent Transport Systems
LF	Low frequency
LLC	Logical Link Control
LT	Lifetime
LTCA	Long-Term Certificate Authority
MAC	Medium Access Control
MHP	Maximum Hop limit
NDL	Network Design limits
NH	Next Hop
PCA	Pseudonym Certificate Authority
PHY	Physical layer
PKI	Public key infrastructure
POI	Point of Interest
PTD	Probe Traffic Data
SCF	Store Carry Forward

SHB	Single Hop Broadcast
SPAT	Signal Phase and Timing
TAL	Trust Assurance Level
TC	Traffic class

Table 4: Abbreviations

4 References

Other (informational) **RS_BSP_151**

[1] EN 302 636-5-1 V1.2.0: Vehicular Communication; Geonetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocols.

[2] EN 302 637-2 V1.3.0: Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service.

[3] EN 302 637-3 V1.2.0: Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service.

[4] TS 103 097 V1.2.1: Security Header and Certificate Formats.

[5] EN 302 636-4-1 V1.2.0: Vehicular Communication; Geonetworking; Part 4 Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality.

[6] C2C-CC Protection profile.

[7] White Paper on Positioning and Timing.

[8] TS 102 894-2 V1.1.1: Intelligent Transport Systems (ITS); Users and applications requirements; Applications and facilities layer common data dictionary.

[9] EN 302 663 V1.2.0: Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band.

[10] TS 102 724 V1.1.1: Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band.

[11] 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.

[12] 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.

[13] C2C-CC Minimum communication performance.

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

[15] TS 102 687 V1.1.1: Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part.

[16] EN 302 931 V1.1.1: Vehicular Communications; Geographical Area Definition.

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

[18] „VSC-A Final Report,“ [Online]. Available: http://www.nhtsa.gov/DOT/NHTSA/NVS/Crash%20Avoidance/Technical%20Publications/2011/811492B.pdf.

[19] ISO, ISO 8855: Road vehicles - Vehicle dynamics and road-holding ability - Vocabulary, ISO, 2011.

[20] TS 102 940 V1.1.1: ITS Communications Security Architecture and Security Management.

[21] TS 102 941 V1.1.1: Trust and Privacy Management.

[22] C2C-CC PKI Memo v1.7.

[23] C2C-CC White Paper Trust Evaluation and Trust Assurance for Security of C2X Stations.

[24] C2C-CC WhitePaper IVS.

[25] CEN ISO TS 19091-3.

[26] C2C-CC White Paper Channel Usage.

Table 5: References

5 Provisions

5.1 Verbal forms for the expression of provisions

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

5.2 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 (standardization organization) 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. For this version of the document only chapters 6 and 7 provide mandatory requirements, chapter 8 being in this version of the document only informative in nature.

6 Features of the Car2Car basic system

Other (informational) **RS_BSP_154**

The standards profile distinguishes between two types of interoperability:

- Inter-sub-system interoperability i.e. sub-systems implementing the standards 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 basic system standards profile aims for inter-sub-system interoperability, and not for intra-sub-system interoperability.

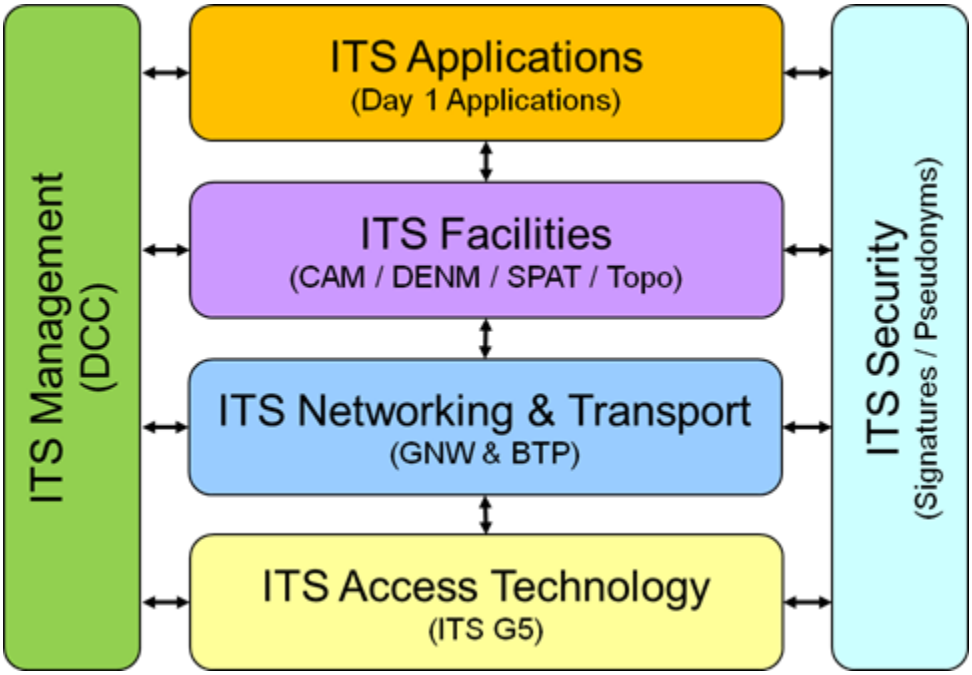

Figure 3: The ITS-Station layered architecture

The C2C-CC basic system shall contain, but is not limited to the following elements:

- The C2C-CC basic system shall be able to communicate over the ITS-G5A channel as profiled in section 7.1.
- The C2C-CC basic system shall implement GeoNetworking and Basic Transport Protocol as profiled in section 7.2.
- The C2C-CC basic system shall be based on the co-operative awareness and de-centralized environmental notification basic services as profiled in section 7.3.
- The C2C-CC basic system shall implement security methods, as profiled in section 7.4.

- The C2C-CC basic system shall support the minimum performance requirements and display the system behavior specified in section 6.2.2 and 0.
- The C2C-CC basic system could support any of the day one use cases specified in section 6.1.

6.1 List of supported applications

Other (informational) **RS_BSP_155**

The main purpose of this C2C-CC basic system standards profile document is to ensure interoperability among vehicle ITS-Stations for safety related functions. According to the C2C-CC contract, this document focuses on specifying the C2C-CC basic system on the vehicle ITS station transmitting side. Moreover, this profile document shall be oriented towards ensuring the fulfilment of the requirements of the use cases from the safety domain specified in Table 6.

Additionally, chapter 8 of this document includes a set of additional requirements that might be supported by the C2C-CC basic system at a later point in time and with a future revision of this document.

The use cases listed in Table 6 do not constitute a mandatory set of applications to be implemented as part of a C2C-CC basic system and only a subset of them might be supported by a specific implementation of the C2C-CC basic system.

Use Case	Specification status
Emergency Vehicle Warning	V3.3.0
Dangerous Situation	V3.3.0
• Emergency Brake Light	
• Pre-Crash	
• Automatic Emergency Breaking	
Stationary Vehicle Warning, V2X Rescue Signal	V3.2.0
Traffic Jam Ahead Warning	V3.3.0
Collision Risk (Exchange of IRCs)	V3.2.0
Adverse Weather Conditions	V3.2.0

Table 6: Day-1 vehicle-to-vehicle use cases

In order to ensure interoperability on the receiving side, the C2C-CC basic system might also support the use cases listed in Table 7, a detailed description of these use cases being available in chapter 8.1.1 of this document.

Use Case	Specification status
In-Vehicle Signage	V1.0
Green Light Optimal Speed Advisory	TBD
Road Work Warning	V2.0
Probe Traffic Data	TBD
Hazardous Location Warning	TBD

Table 7: Day-1 infrastructure-to-vehicle use cases

6.2 C2C-CC Basic System requirements

Other (informational) **RS_BSP_156**

This section defines the main characteristics of the C2C-CC basic system. They are to be included in all car-to-car system instantiations, which implement the C2C-CC basic system profile.

6.2.1 Security

6.2.1.1 Security principle

Objective **RS_BSP_157**

The C2C CC basic system shall provide services for integrity and authenticity protection.

NOTE: The integrity of the in vehicle network should be protected against unwanted actions emitted by the C2X CC basic system. This protection is out of scope of this document.

Details:

Detailed by:

Tested by:

Objective **RS_BSP_408**

The C2C CC basic system shall provide measures to protect the privacy of the driver/vehicle.

Details:

Detailed by:

Tested by:

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:

Detailed by:

Tested by:

Requirement **RS_BSP_159**

The C2C-CC basic system shall be designed in a way that position and time information is checked for plausibility.

Details:

Detailed by:

Tested by:

6.2.1.2 Security envelope

Requirement **RS_BSP_160**

The C2C-CC basic system shall use one end-to-end security envelope per message according to ETSI TS 103 097 [4].

Details:

Detailed by:

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 ETSI TS 103 097 [4], depending on whether a CAM, DENM or other message is processed.

Details:

Detailed by:

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 ETSI TS 103 097 [4].

Details:

Detailed by:

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 [5].

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

Details:

Detailed by:

Tested by:

6.2.1.3 Verification pattern

Requirement **RS_BSP_163**

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

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_164**

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

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_168**

The CAR 2 CAR basic system should check the timestamp in the security envelope compared to the reception time and accept only CAMs in the last 2 seconds and other messages within the last 10 minutes.

NOTE: Due to the tolerance of the ITS station times, the CAR 2 CAR basic system can accept messages 40 ms in the future.

Details:

Detailed by:

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 6 km.

NOTE: 6 km = 6 hops * 1000 meter.

Details:

Detailed by:

Tested by:

6.2.1.4 Cryptographic algorithms

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 ETSI TS 103 097 [4].

Details:

Detailed by:

Tested by:

6.2.1.5 Storage and usage of credentials

Requirement **RS_BSP_173**

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:

Detailed by:

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:

Detailed by:

Tested by:

6.2.1.6 Pseudonym update requirements

Requirement **RS_BSP_176**

The basic C2C-CC system shall change pseudonyms.

Details:

Detailed by:

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 10min, the pseudonym shall not be changed.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_409**

The pseudonym change after turning on ignition shall be performed within a grace period of 1 minute.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_410**

The C2C basic system shall change the pseudonym during the ride in the interval of 10 min. up to 30 min. randomly.

NOTE: the values 10 and 30 minutes might change in the future.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_178**

Pseudonym preloading in the vehicle shall not exceed 3 years, i.e. all certificates in a vehicle shall have a validity range that spans at most 3 years altogether.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_179**

Pseudonyms may be reused within their validity period.

Details:

Detailed by:

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:

Detailed by:

Tested by:

Requirement **RS_BSP_402**

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

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_403**

The maximum amount of pseudonyms in an interval shall be 20 pseudonyms.

NOTE: Therefore, for each year about 1040 pseudonyms are necessary. Within the overlapping phase, the number of valid pseudonyms could be up to 40.

Details:

Detailed by:

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:

Detailed by:

Tested by:

Requirement **RS_BSP_411**

In case that an ITS station has no valid pseudonym certificates for signing messages, it shall stop transmitting messages that use the security profiles specified in ETSI TS 103 097 [4], clause 7.1, clause 7.2, and clause 7.3.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_412**

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

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_413**

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

Details:

Detailed by:

Tested by:

6.2.1.7 Requirements on other layers

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:

Detailed by:

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:

Detailed by:

Tested by:

Requirement **RS_BSP_401**

The GN Source Address shall be constructed as follows:

- Set the field M (bit 0) to 0.
- 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 0.
- Set the field MID (bits 16 to 63) to the value of the MAC address.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_184**

Safety critical 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 15 minutes.

Exception:

- Validity of the pseudonym expired
- Collision of pseudonym identifiers

Details:

Detailed by:

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:

Detailed by:

Tested by:

6.2.1.8 Interface to Certificate Authority

Requirement **RS_BSP_186**

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

Details:

Detailed by:

Tested by:

Objective **RS_BSP_405**

The C2C-CC basic system shall support services for confidentiality within the communication with the PKI entities.

Details:

Detailed by:

Tested by:

6.2.2 Positioning and timing

Other (informational) **RS_BSP_187**

The requirements introduced in this subsection are based on the assumptions and motivation introduced and explained in [7].

6.2.2.1 General

Other (informational) **RS_BSP_188**

NOTE: Any numeric values (except the confidence level of 95%) provided in this and further sub-sections are merely initial values based on experience, and may be used as a *start point* for Compliance Assessment activities. Hence, these values should be deemed as suggestions and are subject to change.

Objective **RS_BSP_189**

A C2C-CC basic system shall be able to estimate the vehicle states absolute position, heading, velocity and time reliably under all driving conditions. The vehicle state estimation shall include confidence values according to the definition in RS_BSP_199, for position, heading and velocity, as a standardized description of the estimation accuracy.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_190**

The vehicle states, i.e. position, time, heading and velocity, shall be consistent. Vehicle state values are consistent if they refer to the same position and time instant.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_191**

WGS 84 shall be used as the reference coordinate system as defined in the Common Data Dictionary [8].

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:

Detailed by:

Tested by:

Requirement **RS_BSP_192**

Heading shall be interpreted 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 CAM specification B.19 [2].

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:

Detailed by:

Tested by:

Requirement **RS_BSP_193**

The basis for the ITS-S time shall be TAI (Temps Atomique International, In-ternational Atomic Time), a high-precision atomic coordinate time standard. Timestamps shall be counted in milliseconds with epoch set to 1.1.2004, 00:00 UTC [8]

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_194**

The ITS-S time shall be the basis for all time stamps in all transmitted messages.

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

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_195**

When some sensors used (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:

Detailed by:

Tested by:

6.2.2.2 Data frequency

Requirement **RS_BSP_197**

A C2C-CC basic system shall update the vehicle states at least 10 times/second when it is active.

Details:

Detailed by:

Tested by:

6.2.2.3 Confidence validation

Other (informational) **RS_BSP_198**

This section deals with the validation of the accuracy estimation.

Requirement **RS_BSP_199**

The accuracy estimation shall yield valid 95% confidence values, according to the following definition:

A system providing state information with a 95% confidence level shall be interpreted as meaning that “the true state value (e.g., the *position of a reference measurement system*) is inside the range specified by the estimated state value plus/minus the confidence value in 95% of the datasets in a given statistic base”.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_200**

In case of the vehicle state horizontal position, this confidence is formulated as an elliptical confidence area specified via a major axis, minor axis and orientation of the major axis relative to navigation coordinate north. A system providing this confidence area shall be interpreted as meaning that "the true position is inside the confidence area centered around the estimated state in 90% of the datasets in a given statistical base".

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

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_202**

The 95% confidence value shall be valid in each scenario listed in section 6.2.2.6. 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 of the last T_Test 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 T_Test 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 POTI Whitepaper.

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 6.2.2.6.
- 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:

Detailed by:

Tested by:

6.2.2.4 Position, Velocity and Heading confidence values

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 6.2.2.6 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:

Detailed by:

Tested by:

6.2.2.5 Timing accuracy

Requirement **RS_BSP_206**

The clock representing the time base in an ITS-S shall be called the *Station clock*. The *Station clock* shall be within 20 ms of the time base (see RS_BSP_193), i.e. Delta t = |*Station clock* time - time base| < 20 ms. Timestamps in messages shall be based on the *Station clock*.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_207**

The difference between *Station clock* and time base shall be estimated. If the maximum difference of |*Station clock* time - time base| = >20 ms, it does not allow the (ITS) system to be active.

Details:

Detailed by:

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 stay consistent.

Details:

Detailed by:

Tested by:

6.2.2.6 Confidence requirements dependent on scenarios

Requirement **RS_BSP_209**

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

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.

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 (=vmin=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, vmax < 20km/h, minimum 2 x 90° curves and s > 100m, 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 > 400m, 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 > (±) 5m/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 > (±)0.5m/s² , μ<0.15,	C < 7m
S13	High speed	V=v_max of target vehicle on dry road for 30 s	C < 6m

Table 8: Scenarios

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_210**

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

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_211**

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

Details:

Detailed by:

Tested by:

6.2.3 System behaviour

Requirement **RS_BSP_214**

The C2C-CC basic system shall transmit cooperative awareness messages (CAMs) when it is in a safety-related context as described below taking into account the requirements set by DCC.

Details:

Detailed by:

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 sub-section 6.2.2.

Details:

Detailed by:

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 it is active.

In some specific situations, the safety related context may be deactivated for the C2C basic system under a deactivation condition. The conditions, under which a deactivation is accepted, shall imply that the vehicle is not participating in traffic. This condition has to be verified by a vehicle occupant or an in-vehicle system.

Note 1: At the time of writing of this document, the deactivation may be based on external or internal information; examples of such information might be signaling from an ITS application provider, such as a wireless charging station or a car park offering such services, via 802.11p or other access technology, detection based on in-vehicle sensor(s) etc.

Note 2: At the time of writing this specification it is neither feasible nor desired to provide a complete list of situations, in which a deactivation of the C2C System is allowed. However the safety of the users shall be ensured at all times. Further specification is left open for the OEMs.

Note 3: An example of a possible situation, where the safety related context of a C2C basic system might be lifted is given below, for the sole purpose of facilitating understanding. The safety related context of the C2C-CC basic system might for example be lifted when an electric or hybrid vehicle equipped with a C2C-CC basic system is preparing for and/or is under charge at a charging spot (CS) located outside the road. An example of the deactivation process could be the receipt of a CS POI notification from the road side (via 11p or via other wireless networks), followed by the driver's confirmation for the need of EV charging at a specific CS.

Details:

Detailed by:

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 Toff 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:

Detailed by:

Tested by:

7 List of relevant standards and whitepapers

Other (informational) **RS_BSP_218**

This chapter lists the set of documents essential for specifying the C2C-CC basic system. Most of these documents are published (or under the publishing process) at ETSI or CEN. In addition to the ETSI and CEN documents, a number of C2C-CC white papers are also included. The C2C-CC white papers are essential to achieve interoperability between the various implementations of the C2C-CC basic system since they fill in the gaps currently not addressed by the ETSI and CEN documents. The C2C-CC white papers describe the agreed solutions between the members of the C2C-CC and are to be considered in the same way as the standards developed by ETSI and CEN. In the case of conflict between requirements of the C2C-CC white papers and standards developed by ETSI and CEN the C2C-CC white papers outweigh the ETSI and CEN documents.

7.1 Access layer

Other (informational) **RS_BSP_219**

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). The PHY, MAC and LLC, are all specified in EN 302 663 [9]. The PHY and MAC are derived from IEEE 802.11 with the MIB parameter dot11OCBActivated set to true enabling a new capability namely “communicating outside the context of a basic service set (BSS)”, i.e., IEEE 802.11p. EN 302 663 [9] mandates the use of IEEE 802.2 LLC with the mode of operation set to Type 1 – unacknowledged connectionless. Further, EN 302 663 [9] requires decentralized congestion control (DCC) methods to avoid unstable network behaviour and channel congestion. TS 102 724 [10] and TS 102 792 [11] 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). EN 302 571 [12] 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.

7.1.1 List of relevant documents

Other (informational) **RS_BSP_221**

Document	Title	Version	Short Description
EN 302 571 [12]	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	V1.2.1 (2013-09)	Specification of frequency channels for 5 855 MHz to 5 925 MHz, with corresponding spectrum mask and output power.
EN 302 663 [9]	Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band	V1.2.1 (2013-07)	Specifies the whole access layer with PHY, MAC, and LLC, for 5 855 MHz to 5 925 MHz. Requirements on DCC (TS 102 687) and co-existence with CEN DSRC (TS 102 724).

TS 102 724 [10]	Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band	V1.1.1 (2012-10)	Channelization concept with implications on transceivers. Specifies minimum duty cycles for DCC profiles to ensure interoperability with CEN DSRC at 5.8 GHz. Related to the white paper C2C-CC channel usage.
TS 102 792 [11]	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 range	V1.1.1 (2012-10)	Specifies multiple techniques to mitigate interference between CEN DSRC equipment and ITS stations operaint in the 5Ghz frequency range.
White Paper [13]	“Minimum communication performance” C2C-CC White Paper”	Not Required in v1.0	Agreement within C2C-CC on minimum communication performance for the C2C-CC basic system.
White Paper [14]	“Distributed Congestion Control (DCC) for Day One” C2C-CC White Paper	1.0	Agreement within C2C-CC on the DCC algorithm used by the C2C-CC Basic System.

Table 9: Relevant documents for the access layer

7.1.2 EN 302 571

Other (informational) **RS_BSP_222**

Title

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 Directive 2014/53/EU [12]

Purpose

Specifies normative requirements for 5 855 MHz to 5 925 MHz.

Note: Always the actual version applies

Status

Public version EN 302 571 V1.2.1 (under R&TTE Directive)

A revised version is currently being processed in ETSI ERM TG37 that is going to be approved on a TC level to cover the Directive 2014/53/EU (Radio Equipment Directive, RED).

Relevance

Suppliers of radio equipment and system integrators

7.1.2.1 Main Specifications

Other (informational) **RS_BSP_223**

EN 302571 specifies the technical (mandatory) requirements of ITS-G5.

- Carrier frequencies
  - Control channel: G5-CCH; Center Frequency: 5 900 MHz

    - Service Channel: G5-SCH1; Center Frequency: 5 880 MHz
    - Bandwidth (10 MHz)
    - Carrier frequency accuracy (± 20 ppm)
- RF output power limits
    - Maximum RF output power (33 dBm e.i.r.p.)
    - Maximum power spectral density (23 dBm e.i.r.p.):
    - Transmit power control (range 3 dBm to 33 dBm e.i.r.p.)
- Transmitter unwanted emissions inside/outside ITS band
- Receiver spurious emissions
- Receiver selectivity (adjacent/alternate channel rejection, blocking)
- Receiver sensitivity (minimum -85 dBm for BPSK)

Furthermore EN 302 571 references ETSI TS 102 687 (Decentralized congestion control, DCC) and ETSI TS 102 792 (Interference mitigation for tolling systems) as mandatory mechanisms.

7.1.2.2 C2C-CC Profile Settings

7.1.2.2.1 Control Channel

Requirement **RS_BSP_225**

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

Details:

Detailed by:

Tested by:

7.1.2.3 RF Output Power

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 [12] is not mandatory. It is expected that this value will only occur when using directional antenna(s).

Details:

Detailed by:

Tested by:

7.1.3 EN 302 663 (former ES 202 663)

Other (informational) **RS_BSP_227**

Title

Intelligent Transport Systems (ITS); Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band [9]

Purpose

Specifies the access layer technology including PHY, MAC and LLC, all parts being based on IEEE standards. Requires DCC and mitigation techniques to co-exist with CEN DSRC.

Status

EN 302 663 V.1.2.0 is available.

Relevance

Suppliers of radio equipment

7.1.3.1 Main Specifications

Other (informational) **RS_BSP_229**

- ITS-G5A frequency band: 5 875 MHz to 5 905 MHz
- Specifies PHY, MAC and LLC, i.e., complete access layer

7.1.3.2 C2C-CC Profile Settings

Requirement **RS_BSP_228**

The C2C-CC basic system shall use a transfer rate of 6 Mbit/s on G5-CCH.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_397**

The C2C-CC basic system shall also support 3 Mbit/s and 12 Mbit/s transfer rates on G5-CCH (for future use).

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_398**

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

Details:

Detailed by:

Tested by:

7.1.4 TS 102 792

Other (informational) **RS_BSP_230**

Title

Intelligent Transport Systems (ITS); Mitigation techniques to avoid interference between Europe-an CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range

Purpose

Specifies multiple techniques to mitigate interference between CEN DSRC equipment and ITS stations operating in the 5 GHz frequency range.

Status

Public version TS 102 792 V1.1.1 [11]

Relevance

Suppliers of radio equipment

7.1.4.1 Main Specifications

Other (informational) **RS_BSP_231**

TS 102 792 specifies three different tolling station detection techniques namely;

- Use of a hardware detector
- Software based detection
- No detection, but this imposes a limit on the output power of max. 10dBm

7.1.4.2 C2C-CC Profile Settings

Requirement **RS_BSP_232**

The C2C-CC basic system shall use at least the detect-and-avoid method based on the tolling zone announcement messages.

Details:

Detailed by:

Tested by:

7.1.5 TS 102 724

Other (informational) **RS_BSP_233**

Title

Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band, Channel specifications 5 GHz [10]

Purpose

Describes the channelization concept with implications on transceivers. Related to the white paper: C2C-CC channel usage.

Status

Public version TS 102 724 V1.1.1 (2012-10)

Relevance

Device management

7.1.5.1 Main Specifications

Other (informational) **RS_BSP_234**

- Transceiver configurations T1 … T3
- DCC Profiles (DP)

7.1.5.2 C2C-CC Profile Settings

Requirement **RS_BSP_235**

The C2C-CC Basic System shall support at least the following DCC-Profiles defined inside TS 102 724 [10]: 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 = 2
- DP3: used for forwarded DENMs and other low priority messages

Details:

Detailed by:

Tested by:

7.1.6 C2C-CC Whitepaper Decentralized Congestion Control (DCC) for Day One

Other (informational) **RS_BSP_236**

Title

C2C-CC Decentralized Congestion Control (DCC) for Day One.

Purpose

Describes the congestion control mechanisms to be used by the C2C-CC basic system profile.

Status

Final Draft v1.0

Relevance

Device management

7.1.6.1 Main Specifications

Other (informational) **RS_BSP_237**

- The congestion Control mechanism to be used by the C2C-CC basic system.

7.1.6.2 C2C-CC Profile Settings

Requirement **RS_BSP_238**

The C2C-CC Basic System shall use the DCC Mechanism specified in [14] and summarized in Table 10. The DCC Mechanism is located at the DCC Access Sub-layer.

DCC States	*ChannelLoad,CL (%)*	*Transmission Interval, TTX [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 10: DCC Parameters for Day One

Details:

Detailed by:

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 modified in later releases of C2C-CC.

Table 11 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 [15]
T_{down}	Time of sustained channel load that triggers transition to a less restrictive state	T_{down} = 1 s Tdown = NDL_timeDown in [15]
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 4.
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 4	*m* = 1, see Table 4
t_k , *k=1..n*	*active* (sub-)states transmission interval values as per Table 4	*n* = 5, see Table 4
t_l , *l=1..q*	*restrictive* (sub-)states transmission interval values as per Table 4	*q* = 1, see Table 4
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 [12] for all states and DP values in Table 4

α, β, γ	Channel Load smoothing parameters	Default values are $\alpha=\beta=0.5$, $\gamma=0$ 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 11: Parameters Settings for Day One

Details:

Detailed by:

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 -85 dBm
- 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 S_{th} (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 8 µs, 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= 100 ms
- The minimum receiver sensitivity for the modulation and coding schemes supported shall be -88 dBm. This includes a sensitivity variation margin (factoring in temperature, production, implementation and aging losses) of 3 dB
- 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 1) 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:

Detailed by:

Tested by:

Other (informational) **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.

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:

Detailed by:

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:

Detailed by:

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 10
- 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:

Detailed by:

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:

Detailed by:

Tested by:

Requirement **RS_BSP_246**

The C2C-CC basis system shall reduce its transmission power to P_{Toll} = 10 dBm as soon as the *protected communication zone* is entered, and without changing any other DCC transmission parameters as per Table 10. 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:

Detailed by:

Tested by:

7.2 Networking and Transport layer

7.2.1 List of relevant documents

Other (informational) **RS_BSP_247**

The relevant standards are listed in Table 12 below. The specification of the GeoNetworking protocol is split into two parts, media-independent and media-dependent. Purpose of the split was to allow for more than one access technology than ITS-G5. However, so far, a specification for another access technology-specific extension than ITS-G5 does not exist. The C2C-CC basic system does not include the features specified in the media dependant standard.

Document	Title	Version	Purpose
EN 302 636-4-1 [5]	Vehicular Communication; Geonetworking; Part 4 Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality	1.2.0 (2013-10)	Defines common media-independent functionality of GeoNetworking
EN 302 636-5-1 [1]	Vehicular Communication; Geonetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocols	01.02.2000 (2013-10)	Defines the Basic Transport Protocol (what data is to be provided by higher layer to networking layer)
EN 302 931 [16]	Vehicular Communications; Geographical Area Definition	01.01.2001	Defines geographical areas so that different shapes can be used as destinations for the messages from higher layers.

Table 12: Relevant documents for the transport and network layers

7.2.2 EN 302 636-4-1 Geo Networking media-independent

Other (informational) **RS_BSP_248**

Title

Vehicular Communication; GeoNetworking; Part 4 Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality [5]

Purpose

It defines common media-independent functionality of GeoNetworking

Status

EN 302 636-4-1 is available.

Relevance

Suppliers of protocol stacks.

7.2.2.1 Main Specifications

Other (informational) **RS_BSP_249**

- Geo Networking-specific data structure
- Geo Networking packet structure and formats

- Geo Networking protocol operations
- Duplicate packet detection
- Position vector update
- Forwarding algorithms

7.2.2.2 C2C-CC Profile Settings

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 [5].

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_251**

GN shall only be used with itsGnSecurity = ENABLED (1).

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_252**

GN shall only be used with itsGnLocalAddrConfMethod = ANONYMOUS (2).

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_255**

The C2C-CC basic system shall support geo-areas areas of up to 80 km2. In consequence, the itsGnMaxGeoAreaSize shall have a value of 80.

Details:

Detailed by:

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 parameters 'Maximum repetition time' and 'Maximum hop limit' of the service primitive GN-DATA.request are not applicable. Also, the GN protocol constant itsGnMinPacketRepetitionInterval is not applicable.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_414**

GN shall only be used with itsGnIfType = ITS-G5 (1).

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_415**

itsGnMinPacketRepetitionInterval is not applicable (N/A).

Details:

Detailed by:

Tested by:

7.2.2.2.1 Employed GeoNetworking headers

Requirement **RS_BSP_256**

The C2C-CC basic system shall use a Single Hop Broadcasting (SHB) header on all CAM packets it sends according to section 7.3.2.

Consequently, the GeoNetworking common header shall use a value of 5 for the HT field, and a value of 0 for the HST field when transmitting SHB packets.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_257**

The C2C-CC basic system shall use GeoBroadcast (GBC) headers on all DENM packets it sends according to section 7.3.3.

Consequently, The GeoNetworking common header shall use a value of 4 for the HT field when transmitting DENM packets.

For the HST field only the following values shall be used:

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

Details:

Detailed by:

Tested by:

7.2.2.2.2 Basic Header Fields

Requirement **RS_BSP_258**

The C2C-CC basic system shall set the LifeTime field of all SHB packets to 1 second. Consequently, the multiplier bit of the LT field shall be set to 1 and the base bit of the LT field shall be set to 1.

Details:

Detailed by:

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 Annex G of [5].

Details:

Detailed by:

Tested by:

7.2.2.2.3 Common Header Fields

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 1.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_261**

The C2C-CC basic system shall have at least a buffer size of 1024 Kilobytes, as specified in Annex G of [5].

Details:

Detailed by:

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 0.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_263**

The C2C-CC basic system shall only use the DCC profiles specified in 7.1.5.2. Consequently, the DCC Profile ID bits of the TC (Traffic Class) field shall only use the DPID values defined in 7.1.5.2.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_264**

The C2C-CC basic system shall set the itsGnIsMobile bit of the Flags field to 1.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_265**

The C2C-CC basic system shall set the Maximum Hop Limit (MHL) field to 10.

Details:

Detailed by:

Tested by:

7.2.2.2.4 Multi-Hop support

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 in the Annex E.3 [5].

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_267**

When forwarding packets, the C2C-CC basic system shall use the DCC profile DP3 as defined in [10] and profiled in 7.1.5.2.

Details:

Detailed by:

Tested by:

7.2.2.2.5 Duplicate Packet Detection

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 A.2 and A.3 of EN 302 636-4-1 [5] shall be used for detecting duplicate packets.

Details:

Detailed by:

Tested by:

7.2.2.2.6 Beaconing Support

Requirement **RS_BSP_269**

C2C-CC basic system may only send beacons with the Position Accuracy Indicator (PAI) set to 1.

Details:

Detailed by:

Tested by:

7.2.2.3 Ethertype

Requirement **RS_BSP_270**

All GeoNetworking frames sent by the C2C-CC basic system shall use the EtherType value 0x8947 as listed by the IEEE Registration Authority at http://standards.ieee.org/develop/regauth/ethertype/eth.txt

Details:

Detailed by:

Tested by:

7.2.3 EN 302 636-5-1 Basic Transport Protocol

Other (informational) **RS_BSP_271**

Title

Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol **[1]**

Purpose

It specifies a simple, low overhead, connectionless transport protocol for GeoNetworking

Status

EN 302 636-5-1 is published.

Relevance

Suppliers of hardware and protocol stack.

7.2.3.1 Main Specifications

Other (informational) **RS_BSP_272**

- BTP packet structure
- BTP headers
- Protocol operations

7.2.3.2 C2C-CC Profile Settings

Requirement **RS_BSP_273**

The C2C-CC basic system shall employ BTP-B headers. Consequently, the GeoNetworking common header shall use a value of 2 for the NH field.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_274**

The C2C-CC basic system shall set the destination port info field to the value 0.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_275**

Inside the BTP-B header, the C2C-CC basic system shall set the destination port to the value 2001 for CAMs.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_276**

Inside the BTP-B header, the C2C-CC basic system shall set the destination port to the value 2002 for DENMs.

Details:

Detailed by:

Tested by:

7.2.4 EN 302 931 Geographical area definition

Other (informational) **RS_BSP_277**

Title

Intelligent Transport Systems (ITS); Vehicular Communications; Geographical Area Definition **[16]**

Purpose

It specifies geometric shapes and elementary geometry operations for use in other standards, such as Geo Networking.

Status

EN 302 931 is published.

Relevance

Suppliers of hardware and protocol stack.

7.2.4.1 Main Specifications

Other (informational) **RS_BSP_278**

- Geographical areas
  - Circular area
  - Rectangular area
  - Elliptical area

Elementary geometry

- Geometric function F to determine spatial characteristics of a point P(x,y)

7.2.4.2 C2C-CC Profile Settings

Requirement **RS_BSP_279**

The C2C-CC basic system shall support circular, rectangular and ellipsoidal geographical areas. Each use case defined by the C2C-CC triggering conditions and data quality document (7.3.5) of the C2C-CC APP WG must specify one of the above geographical area types and indicated through the GeoNetworking header as specified in EN 302 636-4-1 [5].

Details:

Detailed by:

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 [16]; for this purpose it is recommended to use the Local Tangent Plane method, or another method delivering the same accuracy.

Details:

Detailed by:

Tested by:

7.3 Facility Layer

7.3.1 List of relevant documents

Other (informational) **RS_BSP_281**

The relevant standards for the facilities layer are listed in Table 13 below.

Document	Title	Version	Purpose

EN 302 637-2 [2]	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service	V1.3.0 (2013-08)	Defines CAM as core message for many use cases, plus sending rules.
EN 302 637-3 [3]	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service	V1.2.0 (2013-08)	Defines event-triggered DEN message as second core message for many use cases.
TS 102 894-2 [8]	Intelligent Transport Systems (ITS); Users and applications requirements; Applications and facilities layer common data dictionary	V1.1.1 (2013-08)	Definition and specifications on the common data container at the applications and facilities 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.
White paper [17]	C2C-CC Information quality/event detection white C2C-CC White Paper		Minimum information quality to be provided, plus rules for triggering DEN messages (“triggering conditions”)
VCS-A [18]	Vehicle Safety Communications – Applications; VSC-A; Final Report: Appendix B-2; Path History Reference Design and Test Results	V21-10-2010	Path History methods, constants and variables.
ISO 8855 [19]	Road vehicles - Vehicle dynamics and road-holding ability - Vocabulary	V2011-12-15	Reference Coordinates System

Table 13: Relevant documents for the facilities layer

7.3.2 EN 302 637-2 Co-operative Awareness Basic Service

Other (informational) **RS_BSP_282**

Title

Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service **[2]**

Purpose

Specifications of Cooperative Awareness basic service in support of day one use cases.

Status

EN 302 637-2 is available.

Relevance

The CA basic service is a core component of the C2C-CC basic system.

7.3.2.1 Main Specifications

Other (informational) **RS_BSP_283**

EN 302 637-2 **[2]** specifies:

- Syntax and semantic of Cooperative Awareness Message (CAM),
- The generation rules of CAM,
- CAM protocol operation.

7.3.2.2 C2C-CC Profile Settings

Requirement **RS_BSP_285**

The path history field inside the CAM low frequency (LF) container shall be generated according to the method specified in 7.3.6.2 and shall contain a PathHistory data element covering a distance of at least 200 m (K_PHDISTANCE_M parameter).

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 200m.

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 the 200 m lower limit.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_286**

The PathHistory in CAMs shall cover at most 500 m.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_287**

A C2C-CC basic system shall send PathDeltaTime in every PathPoint of the PathHistory. Therefore, the PathHistory shall describe a time-ordered list of actually travelled geographical locations leading to the current vehicle position.

Details:

Detailed by:

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:

Detailed by:

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 [8]. Therefore, PathPoints do not “fall out” of the PathHistory when standing for a long time.

Details:

Detailed by:

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 in section 0. As long as the CA basic service is active, CAMs shall be generated according to the generation rules defined in EN 302 637-2 [2].

Details:

Detailed by:

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 limits specified in section 6.2.2.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_292**

The traffic class value for CAM messages shall be set to 2.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_293**

The parameter T_GenCam_Dcc shall be set to the value of the transmission interval, T_{TX}, as given by the DCC Mechanism (see Table 11).

Details:

Detailed by:

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 4°.

Details:

Detailed by:

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 4 m.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_296**

The MAX_DSPEED representing the delta speed between two generation rules checks shall use a value of 0.5 m/s.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_297**

The adjustable N_GenCam parameter specified in the CAM Generation Frequency Management shall be set to 0 for the C2C-CC Basic System.

Details:

Detailed by:

Tested by:

7.3.3 EN 302 637-3 Decentralized Environmental Notification Basic Service

Other (informational) **RS_BSP_300**

Title

Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service **[3]**

Purpose

Specifications of the Decentralized Environmental Notification basic service in support of day one use cases.

Status

EN 302 637-3 is available.

Relevance

The DEN basic service is a core component of the C2C-CC basic system.

7.3.3.1 Main Specifications

Other (informational) **RS_BSP_299**

EN 302 637–3 **[3]** specifies:

- Syntax and semantic of Decentralized Environmental Notification Message (DENM),
- Interaction between Applications and DEN basic service.
- DENM protocol operation.

7.3.3.2 C2C-CC Profile Settings

Requirement **RS_BSP_301**

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

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_302**

The path history field inside the DEN messages shall be generated according to the method specified in 7.3.6.2 and shall contain Trace data elements covering a distance of at least 600 m (K_PHDISTANCE_M parameter).

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 200m.

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 the 600 m lower limit.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_303**

The Traces in the DENMs shall cover at most 1000 m.

Details:

Detailed by:

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:

Detailed by:

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 [17].

Details:

Detailed by:

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:

Detailed by:

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 [8]. Therefore, PathPoints do not “fall out” of the first DENM traces element when standing for a long time.

Details:

Detailed by:

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:

Detailed by:

Tested by:

Requirement **RS_BSP_309**

The traffic class value for DENM messages shall be as set as defined in Table 14.

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 14: Mapping of Use Cases to Traffic Classes

Details:

Detailed by:

Tested by:

7.3.4 TS 102 894-2 Common Data Dictionary

Other (informational) **RS_BSP_310**

Title

Intelligent Transport Systems (ITS); Users and applications requirements; Applications and facilities layer common data dictionary **[8]**

Purpose

It defines the common data elements to be used in CAM and DENM.

Status

The document was approved by ETSI TC ITS in August 2013.

Relevance

Data dictionary is mandatory for the CAM and DENM construction.

7.3.4.1 Main Specifications

Other (informational) **RS_BSP_311**

The standard specifies:

- Definitions of common data elements being used in CAM and in DENM.
- ASN.1 presentation of common data elements.

7.3.4.2 C2C-CC Profile Settings

Requirement **RS_BSP_313**

The data elements which constitute the content of the CAM and DENM shall be compliant to TS 102 894-2 [8] and use the coordinate system specified in section 7.3.7.

Details:

Detailed by:

Tested by:

7.3.5 C2C-CC White Paper Triggering conditions and data quality white paper

Other (informational) **RS_BSP_312**

Title

Triggering conditions and data quality **[17]**

Purpose

Definition of conditions under which DENM transmission should be initiated by applications.

Data quality requirements

Status

Drafts.

Relevance

To ensure a C2C-CC basic system common behaviour of the DENM transmission for the day one use cases.

7.3.5.1 Main Specifications

Other (informational) **RS_BSP_314**

The white paper specifies:

- DENM triggering conditions for each day 1 use case.
- DENM data elements value setting rules.
- Requirements of data quality for CAM, DENM.

7.3.5.2 C2C-CC Profile Settings

Requirement **RS_BSP_315**

The C2C-CC basic system shall only generate DENMs as described in the C2C-CC triggering conditions white paper [17].

Details:

Detailed by:

Tested by:

7.3.6 VSC-A Appendix B-2 Path History Reference Design and Test Results

Other (informational) **RS_BSP_316**

Title

Vehicle Safety Communications – Applications; VSC-A; Final Report: Appendix B-2:Path History Reference Design and Test Results

Purpose

Defines the different Methods for creating Traces and Path Histories.

Status

Published

Relevance

To allow for a unified way to build-up Path-History and Traces inside the CAMs and DENMs.

7.3.6.1 Main Specifications

Other (informational) **RS_BSP_317**

- The rules for generating PathHistory and Trace data elements.

7.3.6.2 C2C-CC Profile Settings

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 the VSC-A Final Report [18]: Appendix B-2. The C2C-CC basic system shall use this generation method with the following settings:

- K_PHALLOWABLEERROR_M = 0,47 m, where PH_ActualError < K_PHALLOWABLEERROR_M
- Maximum distance between concise path points, K_PH_CHORDLENGTHTHRESHOLD = 22,5 m
- K_PH_MAXESTIMATEDRADIUS = REarthMeridian
- K_PHSMALLDELTAPHI_R = 1 degree
- REarthMeridian = 6378.137 km (according to IUGG - International Union of Geodesy and Geophysics), used for great-circle or orthodromic distance calculation:

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

Details:

Detailed by:

Tested by:

7.3.7 ISO 8855 Road vehicles - Vehicle dynamics and road-holding ability ? Vocabulary

Other (informational) **RS_BSP_319**

Title

International Standard ISO 8855; Road vehicles - Vehicle dynamics and road-holding ability – Vocabulary **[19]**

Purpose

Defines the different automotive coordinate systems and many other variables and constants.

Status

Published

Relevance

To allow a unified coordinates system inside the data elements used by CAMs and DENMs.

7.3.7.1 Main Specifications

Other (informational) **RS_BSP_320**

- The coordinate system

7.3.7.2 C2C-CC Profile Settings

Requirement **RS_BSP_321**

The C2C-CC basic system shall use the coordinate system defined inside section 2.13 of [19], with the X and Y axes parallel to the ground plane, the Z axis aligned vertically upwards, the Y axis pointing to the left of the vehicle's forward direction, and the X axis pointing towards vehicle's forward driving direction.

Details:

Detailed by:

Tested by:

7.4 Security

7.4.1 List of relevant documents

Other (informational) **RS_BSP_322**

The relevant security standards are listed in the Table 15.

Document	Title	Version	Purpose
TS 102 940 [20]	ITS Communications Security Architecture and Security Management	1.1.1 (2012-06)	Overview on ITS Security Architecture
TS 102 941 [21]	Trust and Privacy Management	1.1.1 (2012-06)	
TS 103 097 [4]	Security Header and Certificate Formats	1.2.1	EU standard for ITS message security headers
White Paper [22]	C2CCC PKI Memo	1.7	Composition of PKI, definition of related processes.
White Paper [23]	C2CCC Trust Evaluation and Trust Assurance for Security of C2XC Stations	1.0	Definition of in-vehicle security mechanisms in several trust and assurance levels, minimum security requirements for use-cases

Table 15: Relevant documents for the security functions

7.4.2 TS 102 940 Security Architecture and Security Management

Other (informational) **RS_BSP_323**

Title

ITS Communications Security Architecture and Security Management Purpose [20]

Purpose

The standard provides a definition of the basic security architecture based on different possible use cases and general scenarios.

Status

The standard is published.

Relevance

It provides an overview over the basic security services provided in a vehicle.

7.4.2.1 Main Specifications

Other (informational) **RS_BSP_324**

The standard specifies a number of basic security services which are typically provided to support the C2C communication.

7.4.2.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_325**

Not all specified security services are required to be implemented. Additionally for some services, the implementation is defined internally by the manufacturer.

Requirement **RS_BSP_328**

The security services in Table 16 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 16: Manufacturer dependent security service

Details:

Detailed by:

Tested by:

7.4.3 TS 102 941 Trust and Privacy Management

Other (informational) **RS_BSP_330**

Purpose

The standard mainly details some of the functionality of the Enrolment Authority (LTCA) and the Authorization Authority (PCA). **[21]**

Status

The standard is published (version 1.1.1). It is currently under revision to adapt to TS 103 097.

Relevance

The processes defined in the standard are relevant. The binding to IEEE 1609.2, and therefore a large portion of the standard, is not applicable.

7.4.3.1 Main Specifications

Other (informational) **RS_BSP_331**

The contents of the messages exchanged with the PKI (LTCA/PCA) are specified on a high level.

7.4.3.2 C2C-CC Profile Settings

7.4.4 TS 103 097 Security Header and Certificate Formats

Other (informational) **RS_BSP_333**

Title

Security Header and Certificate Formats [4]

Purpose

Defines the security header and the certificate format used by the inter-vehicle communication

Status

The standard is published. A new work item for revising the standard towards ASN.1 has been started. However, this profile mandates v 1.2.1 for C2C-CC day 1.

Relevance

The specified security header and certificate format shall be the only deployed header specification to ensure interoperability between different manufacturers.

7.4.4.1 Main Specifications

Other (informational) **RS_BSP_335**

There are three main parts of the specification:

- The security headers
- The certificate format
- Security profiles for messages and specific certificates

7.4.4.2 C2C-CC Profile Settings

7.4.5 C2C-CC Whitepaper PKI Memo

Other (informational) **RS_BSP_336**

Title

Public Key Infrastructure Memo **[22]**

Purpose

The general architecture of a PKI suitable for C2C applications is specified.

Status

Available for C2C-CC internal members.

Relevance

The PKI is a core component of the security architecture.

7.4.5.1 Main Specifications

Other (informational) **RS_BSP_337**

The PKI architecture - divided in Long-Term Certificate Authority (LTCA) and Pseudonym Certificate Authority (PCA) - is specified. Based on the architecture, operational usages of certificates, processes for updating certificates and the revocation of certificates are specified.

7.4.5.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_338**

The TS 102 940 standard and the PKI memo use different wordings. Therefore, a mapping is provided in Table 17.

TS 102 940	PKI Memo
Enrolment Authority	Long-Term Certificate Authority (LTCA)
Enrolment Credentials	Long-Term Certificate (LTC)
Authorization Authority	Pseudonym Certificate Authority (PCA)
Authorization Ticket	Pseudonym Certificate (PC)

Table 17: Mapping between TS 102 940 and PKI Memo wordings

7.4.6 C2C-CC Whitepaper Trust Evaluation and Trust Assurance for Security of C2X Stations

Other (informational) **RS_BSP_339**

Title

Trust Evaluation and Trust Assurance for Security of C2X Stations [23]

Purpose

The security model of the C2C security is based on a hierarchical trust model. The whitepaper defines the requirements for C2C stations to be trustworthy.

Status

Available for C2C-CC internal members. A protection profile for testing the defined assurance levels is under preparation.

Relevance

The deployed hardware in the C2C stations is one of the trust anchors of the security architecture.

7.4.6.1 Main Specifications

Other (informational) **RS_BSP_340**

The document specifies 5 trust assurance levels, TAL 0 to TAL 4. TAL 0 means no required software or hardware protection and TAL 4 is the highest trust assurance level. It furthermore gives some basic advice on the implementation of a security evaluation and certification scheme.

7.4.6.2 C2C-CC Profile Settings

Requirement **RS_BSP_341**

The minimal acceptable trust level for ITS station implementations is TAL 2.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_342**

Each TAL is mapped to a subject assurance representation according to TS 103 097 as specified in Table 18

TAL	Subject assurance
0	0x00
1	0x20
2	0x40

3	0x60
4	0x80

Table 18: Mapping between TAL and subject assurance representations

Details:

Detailed by:

Tested by:

7.5 Cross-layer and management

Other (informational) **RS_BSP_343**

Document Title	Version	Purpose
C2C-CC Positioning and Timing Whitepaper [7]	V2.0	Positioning and Timing requirements

Table 19: Cross-layer and management

7.5.1 C2C-CC Whitepaper Positioning and Timing

Other (informational) **RS_BSP_344**

Title

C2CCC Whitepaper on Positioning and Timing **[7]**

Purpose

The C2CCC Whitepaper on Positioning and Timing describes the positioning and timing requirements and baseline information required by the C2C-CC basic system

Status

Draft version 6.0 published internally. A new version, on which the profile document is based on, will be uploaded in CW6/2014.

7.5.1.1 Main Specifications

Other (informational) **RS_BSP_345**

The whitepaper specifies the minimum positioning and timing performance requirements of the C2C-CC basic system. These requirements have been already included in sub-section 6.2.2 of this document and are not listed again here.

8 Amendments

Other (informational) **RS_BSP_346**

This chapter is not normative in nature and it only lists a set of possible amendments to the existing C2C-CC basic system profile. These amendments are designed to extend the C2C-CC basic system profile, basically providing additional requirements to the ones already specified inside chapters 6 and 7 of this document. As a rule, none of the requirements specified in this chapter shall overwrite, replace or negate any of the requirements already specified in chapters 6 and 7 of this document. When the different amendments are completed and the above two conditions are met, the amendments could be integrated at the right place inside chapters 6 and 7 when a new version of the whole document will be compiled.

8.1 Amendment A: Infrastructure-based applications

8.1.1 Infrastructure-based Information

Other (informational) **RS_BSP_347**

Besides the exchange of information between C2C-CC basic systems among each other, additional relevant safety and traffic management related information can be obtained from other ITS-Stations in order to further improve the safety and traffic efficiency. This chapter provides an overview of the Use-Cases and the information the C2C-CC basic system may expect to receive from and provide to other sources.

In this chapter the different aspects related to information exchange initiated by Infrastructure based ITS-Stations as managed by Road Operators or Traffic controllers are described. This includes the communication behavioural expectations from the source ITS Stations are described. Only those expectations are described here, which are not already covered by other parts of this document. The intend of this chapter is to cover those elements of importance which are relevant to booth the receiving C2C-CC basic system and the ITS System as a hole. In Table 20 you can find a list of the covered Use-Cases and Services.

Use Case	Specification status
In-Vehicle Signage	V1.0
Signal Phase and Time (SPAT) and MAP	In progress – Audi + Volvo + NPRA + Siemens
Road Work Warning	In progress – VW + BASt
Probe Traffic Data (PTD)	In progress
Hazardous Location Warning	Not yet started

Table 20: Day-1 Infrastructure-to-Vehicle Use Cases

8.1.2 List of relevant documents

Other (informational) **RS_BSP_348**

The relevant infrastructure based information standards are listed below.

Document	Title	Version	Purpose
C2C-CC White Paper SPAT/MAP	C2C-CC White paper SPAT/MAP	0	Specification of Cooperative traffic light services in support of day one use cases.
C2C-CC White paper IVS [24]	C2C-CC White paper IVS		Short range communication of safety related traffic signs at critical road locations i.e. traffic, hazard or accident

			hotspots.
C2C-CC Whitepaper VMS (Road Variable Message Signs)	C2C-CC Whitepaper VMS (Road Variable Message Signs)		
C2C-CC White paper Road Works Warning.			
C2C-CC White paper probe traffic data			
C2C-CC White paper hazardous location warning.			

Table 21: Relevant documents for the infrastructure based use-cases

8.1.3 C2C-CC White paper IVS

Other (informational) **RS_BSP_349**

Title

C2C-CC White paper IVS [24]

Purpose

Short range communication of safety related traffic signs at critical road locations i.e. traffic, hazard or accident hotspots.

Max. 3 signs per message

Status

The current state of IVS is described in the C2C-CC IVS Whitepaper including Appendix 1 as the list of supported traffic signs.

The C2C-CC IVS white paper which will be transferred to the Basic Signage of an IVI

Relevance

TBD

8.1.3.1 Main specifications

Other (informational) **RS_BSP_350**

Message requirements

- Traffic sign coding (C2C-CC Appendix 1 list) [24]
- Location Position WGS84 (ETRS89), heading, relevance area
- Validity: time + area (= trace points)

Potential solutions

- G5A I2V via local (autonomous) or strategic IRS,
- DENM (Loc Container, Cause Code 90, Alacarte Container: C2C-sign list, max. 3 signs per Loc, sign configuration)
- Sent when valid (incl. time of validity)
- Validity area = trace (before and after sign loc)

8.1.3.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_351**

The message format of IVS messages will be compliant to ISO/CEN specifications.

Other (informational) **RS_BSP_352**

The itsGnIsMobile bit of the Flags field to 0.

Other (informational) **RS_BSP_353**

The roadside systems will transmit IVS messages on the control channel.

Other (informational) **RS_BSP_354**

A a roadside system will transmit IVS messages over geoNetworking/BTP stack.

The addressing mode shall be geoBroadcasting.

Other (informational) **RS_BSP_355**

A C2C-CC basic vehicle system shall receive IVS messages triggered in accordance with the rules specified in CEN/ISO document.

Other (informational) **RS_BSP_356**

The processing of IVS messages at the receiver's Facilities Layer is not mandatory.

8.1.4 VMS (Road Variable Message Signs)

Other (informational) **RS_BSP_357**

Title

VMS (Road Variable Message Signs)

Purpose

Transmission of messages visualized on Road Variable Message Signs (i.e. signs, free text) coherently with the displayed information.

Status

First draft of VMS white paper for December 2013

Relevance

TBD

8.1.4.1 Main specifications

Other (informational) **RS_BSP_358**

Potential solutions

- New IVI message vs DENM
- CEN/ISO IVI Application Data Unit

IVI data structure requirements

- General
  - Information related to correspondent lane (lane description)
  - More than one sign/ lane supported
  - Communication technology independent
  - Information aggregation (Day2)
  - Versioning (Day2)
- Message coding
  - Signs (common catalogue)
  - Free text (separate container for free text; multi-language support only in case of ‘coded’ text)
- Message validity

    - Time (message validity)
    - Space
- Location information
    - Position, heading,trace points (clear definition of location information: i.e. number of trace points, heading, resolution)
    - Support multiple location information containers
- Support all technologies/layouts used in VMS (e.g. lane-control systems, text and pictogram VMS, rotating prism VMS)

8.1.4.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_359**

The message format of IVI VMS messages will be compliant to ISO/CEN specifications.

Other (informational) **RS_BSP_360**

The itsGnIsMobile bit of the Flags field to 0.

Other (informational) **RS_BSP_362**

The roadside systems will transmit IVS messages on the **control channel**.

Other (informational) **RS_BSP_361**

A roadside system will transmit IVS messages over geoNetworking/BTP stack.

Other (informational) **RS_BSP_363**

A roadside system will send IV VMS messages triggered in accordance with the rules specified in CEN/ISO document.

Other (informational) **RS_BSP_364**

The processing of IVI VMS messages at the receiver's Facilities Layer is not mandatory.

8.1.5 C2C-CC Whitepaper on MAP/SPAT

Other (informational) **RS_BSP_365**

Title

Intelligent transport systems — Cooperative Systems — SPAT (Signal Phase and Timing) message , MAP (Intersection topology) message

Purpose

Specification of Cooperative traffic light services in support of day one use cases.

Status

The document is in drafting status.

Relevance

The SPAT (Signal Phase and Timing) enables infrastructure based safety application and intersection manoeuvres for vehicles.

The MAP (road topology) is the essential part for executing lane based safety application within intersection and on highways (roadwork warning).

8.1.5.1 Main specifications

Other (informational) **RS_BSP_366**

[25] specifies:

- Syntax and semantic of SPAT(Signal phase and Timing) and MAP(road topology). The message set definition is based on the internationally harmonized SAEJ2735 standard between USA, EU, JP).
- Definition of SAE J2735 SPAT/MAP message set for European usage (especially ITS-G5).
- Protocol amendments to SAEJ2735 for European usage (ITS-G5).
- Interaction between vehicles and traffic light controller.

8.1.5.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_367**

Below the expectation from the vehicle side on messages transmitted by roadside systems is described.

Requirement **RS_BSP_368**

The **message format** of SPAT& MAP messages will be compliant to ISO/CEN specifications. Roadside systems will transmit SPAT& MAP messages on the **control channel**.

Details:

Detailed by:

Tested by:

Other (informational) **RS_BSP_369**

The itsGnIsMobile bit of the Flags field to 0.

Requirement **RS_BSP_370**

A a roadside system will transmit SPAT& MAP messages over **geoNetworking/BTP** stack.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_371**

Inside the BTP-B header, the destination port for MAP is 2003 and for SPAT 2004.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_372**

SPAT& MAP messages will be triggered in **accordance** with the rules specified in CEN/ISO document [25].

Details:

Detailed by:

Tested by:

Other (informational) **RS_BSP_373**

The processing of SPAT & MAP messages at the receiver's Facilities Layer is not mandatory

8.1.6 C2C-CC White paper Road Works Warning

Other (informational) **RS_BSP_374**

Title

C2C-CC White paper Road Works Warning.

Purpose

TBD

Status

TBD

Relevance

TBD

8.1.6.1 Main specifications

Other (informational) **RS_BSP_375**

tbd

8.1.6.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_376**

tbd

8.1.7 C2C-CC White paper Probe Traffic Data

Other (informational) **RS_BSP_377**

Title

C2C-CC White paper probe traffic data

Purpose

TBD

Status

TBD

Relevance

TBD

8.1.7.1 Main specifications

Other (informational) **RS_BSP_378**

tbd

8.1.7.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_379**

tbd

8.1.8 C2C-CC White paper Hazardous Location Warning

Other (informational) **RS_BSP_382**

Title

C2C-CC White paper hazardous location warning.

Purpose

TBD

Status

TBD

Relevance

TBD

8.1.8.1 Main specifications

Other (informational) **RS_BSP_380**

tbd

8.1.8.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_381**

tbd

8.2 Amendment B: Extended channel usage support

Other (informational) **RS_BSP_383**

Document Title	Version	Purpose
C2C-CC Positioning and Timing Whitepaper [7]	V2.0	Positioning and Timing requirements

Table 22: Amendment B

8.2.1 C2C-CC Whitepaper Channel Usage

Other (informational) **RS_BSP_384**

Title

Position Paper on CAR 2 CAR Communication Consortium Position Paper on ETSI ITS G5 Channel Usage, v1.05, Date: 26.06.2014 **[26]**

Purpose

The position paper describes the C2CCC proposal and guideline of channel usage for car-to-car- and car-to-infrastructure communication. The ETSI standards as of today do not define a mapping of applications to channels. For interoperability, a clear mapping must be agreed so that a sender is not transmitting information on channel “A”, while the intended receiver is listening on channel “B”.

Status

Version 1.0 published internally

Relevance

System developers

8.2.1.1 Main specifications

Other (informational) **RS_BSP_385**

The whitepaper specifies mapping of messages to different communication channels, depending on channel load

8.2.1.2 C2C-CC Profile Expectations

Other (informational) **RS_BSP_386**

Message Type	First Hop Mapping	Further Hops Mapping Low channel load	Further Hops Mapping High channel load
CAM	Control Channel		
DENM	Control Channel	Control Channel	Service Channel

SPAT	Control Channel
MAP	Control Channel
IVI	Control Channel

Table 23: Message Type

The mapping distinguishes between “Low channel load” and “High channel load” conditions and the following assertion hold for the start of deployment

The channel load is envisaged to remain as low as long as

- Penetration rate is less than 10% (number of cars expected in first years after introduction). %.
- CAM rate up to 10Hz with DCC
- Received packet rate £ 400 packets/second *

This stringent assignment of all messages to the Control Channel at the start enables single-transmitter-single-receiver solutions for the Basic System, representing the most simple, easiest-to-implement, and most cost effective option.

8.3 Amendment C: C2C protection profile

8.3.1 C2C-CC White Paper Protection profile

Other (informational) **RS_BSP_387**

Title

C2C-CC Protection profile **[6]**

Purpose

TBD

Status

TBD

Relevance

TBD

8.3.1.1 Main specifications

Other (informational) **RS_BSP_388**

tbd

8.3.1.2 C2C-CC Profile Settings

Other (informational) **RS_BSP_389**

tbd

8.4 Amendment D: Wireless performance

8.4.1 C2C-CC Whitepaper Minimum communication performance

Other (informational) **RS_BSP_390**

Title

C2CCC Whitepaper minimum communication performance

Purpose

Describes the use case scenarios, the antenna requirements, and the communication performance requirements.

Status

TBD

Relevance

Suppliers of automotive antennas and systems …. TBD

8.5 Amendment E: Cross-layer interfaces

Other (informational) **RS_BSP_391**

tbd

8.6 Amendment F: Protected zones mitigation

8.6.1 Mitigation information message for protected communication zones

Other (informational) **RS_BSP_392**

Title

Mitigation information message for protected communication zones.

Purpose

Definition of protected communication zones for support of coexistence to national installed systems (e.g. CEN-DSRC tolling e.g FR, IT, AT) for day one.

Status

Draft for dayone amendment to CAM[2] Specification and CDD[5] ongoing.

Relevance

The mitigation of interferences to national installed systems is a core feature for coexistence for day one deployment.

8.6.1.1 Main specifications

Other (informational) **RS_BSP_393**

See CAM **[2]** message and CDD **[8]** common data dictionary.

8.6.1.2 C2C-CC Profile Settings

Requirement **RS_BSP_394**

The message format for mitigation is defined within the CAM message set [2]

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_395**

The roadside systems will transmit CAM including protected zone to vehicles before entering the protected communication zone on the control channel.

Details:

Detailed by:

Tested by:

Requirement **RS_BSP_396**

A vehicle travelling within the protected communication zone is not allowed to transmit with more power than 10 dBm.

Details:

Detailed by:

Tested by: