Cellular V2X Plugtests;
3rd C-V2X Plugtests;

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Copyright Notification

No part may be reproduced except as authorized by written permission.
The copyright and the foregoing restriction extend to reproduction in all media.

© European Telecommunications Standards Institute 2022.
All rights reserved.

DECT™, **PLUGTESTS**™, **UMTS**™, **TIPHON**™, the TIPHON logo and the ETSI logo are Trade Marks of ETSI registered for the benefit of its Members.
3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.
LTE™ is a Trade Mark of ETSI currently being registered
for the benefit of its Members and of the 3GPP Organizational Partners.

Contents

Intellectual Property Rights.....5

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document. Foreword.....5

Conformance testing aims to assess standard compliancy of implementations by checking individual requirements of a single protocol layer against a protocol simulator. But interoperability testing aims to test the interoperability of complete implementations in real conditions, thus exercising the complete system in communication operation to verify their correct behaviour.1 ..... Scope 6

2 References 6
2.1 Normative references 6

3 Abbreviations 7

4 Conventions.....7
4.1 Interoperability test process.....7
4.1.1 Introduction.....7
4.1.2 The test description proforma.....8
4.2 Tooling.....8
4.3 Test Description naming convention.....9
4.4 Test Summary.....9
4.6 DENM Relevance Area – GN Destination Area.....9

5 Test Bed Architecture 10

6 Basic Configuration 10
6.1 GN.....10
6.2 BTP Port Mapping 11
6.3 Geographic Parameters.....11
6.3.1 Single hop messaging (GEO_CFG_01) 11
6.3.2 Distribution within Destination Area (GEO_CFG_02).....12
6.3.3 Distribution within Destination Area (GEO_CFG_02_B) 12
6.7.4 Distribution within Destination Area – with originator disappearance (GEO_CFG_03).....13
6.3.4 Receivers being outside of Destination Area (GEO_CFG_04) 14
6.3.5 First receiver appears in Destination Area (GEO_CFG_05) 14
6.3.6 New receivers appears in Destination Area (GEO_CFG_06).....15
6.3.7 Source moving at constant 90 km/h speed (GEO_CFG_17). Note: requires 10 Hz position server rate 16
6.3.8 Source moving at constant 3 m/s^2 acceleration (GEO_CFG_18). Note: requires 10 Hz position server rate).....16
6.5 CPS parameters.....17
6.6 CAM frequency 17
6.7 Determination of destination position for geo unicast tests 18
6.8 Security Settings 18
6.9 SCF Bit Settings.....18

7 GN Scenarios.....18
7.1 GN Beaconing 18
7.1.1 Detection of neighbour.....18
7.2 CAM message transmission.....19
7.2.1 Exchange of CAM messages.....19
7.3 DENM message transmission.....20
7.3.1 EUT inside DENM Relevance area (no duplicate checking).....20
7.3.2 Duplicate Packet Detection (checking the re-broadcasting limit within the DENM relevance area).....20
7.3.3 EUT outside DENM Relevance area 22

7.3.4 EUT receiving a cached DENM message 23

8 Facility Scenarios....24
8.1 CAM message transmission....24
8.1.1 Exchange of CAM messages....24
8.1.2 Testing of CAM generation frequency management 25
8.2 DENM message transmission....28
8.2.1 EUT driving into DENM Relevance area within the DENM lifetime 28
8.2.2 EUT driving into DENM Relevance area after the DENM lifetime 30
8.2.3 Keeping DENM information alive after removal of the source (optional feature)....30
8.3 SPAT/MAP message transmission....32
8.3.1 Exchange of MAP messages 32
8.3.2 Exchange of SPAT messages 33
8.3.2 Exchange of SPAT and MAP messages related each other....33

Change History 35

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for ETSI members and non-members, and can be found in ETSI SR 000 314: "Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document. Foreword

Major TC ITS standards have been recently published, enabling ITS component vendors to design implementations compliant with stable specifications. Ongoing EU projects, like for instance DRIVE-C2X, are using TC ITS standards to develop cooperative system frameworks, as well as to use the cooperative systems in field operational tests to assess the benefit of this technology.

ETSI STF and TTF have already produced conformance test specifications and are currently developing a conformance test platform for the assessment of the cooperative systems component compliancy.

ETSI experience with other similar communication technologies (e.g. mobile communicaton systems) shows that compliant systems are not necessarly interoperabable. Furthermore, the tests carried out during the interoperability event are using pragmatical test methods, which are perfectly matching the test needs for prototype ITS implementations.

Conformance testing aims to assess standard compliancy of implementations by checking individual requirements of a single protocol layer against a protocol simulator. But interoperability testing aims to test the interoperability of complete implementations in real conditions, thus exercising the complete system in communication operation to verify their correct behaviour.1 Scope

This document forms the guidelines to lead the technical organization of the 3rd CV2X Plugtests event, in Klettwizt, Germany, from 28th March to 1st April 2022. This document is intended to be upgraded for future interoperability events.

This document describes:

- The testbed architecture showing which ITS systems and components are involved and how they are going to interwork
- The configurations used during test sessions, including the parameter values of the different layers
- The interoperability test descriptions, which are describing the scenarios, which the participants will follow to perform the tests.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references,only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 302 636-4-1 (V1.4.1): "Intelligent Transport System (ITS); Vehicular communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to multipoint communications; Sub-part 1: Media independent functionalities".

[2] ETSI EN 302 636-5-1 (V2.2.1): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol".

[3] ETSI EN 302 637-2 (V1.4.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".

[4] ETSI EN 302 637-3 (V1.3.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

[5] ETSI EG 202 798 (V1.1.1): "Intelligent Transport Systems (ITS); Testing; Framework for conformance and interoperability testing".

[6] ETSI TS 102 940 (v1.4.1): "ITS Security; ITS communications security architecture and security management".

[7] ETSI TS 102 941 (v1.4.1): "ITS Security; Trust and Privacy Management".

[8] ETSI TS 103 097 (v1.4.1): "ITS Security; Security header and certificate formats".

[9] ETSI TS 103 301 (v1.3.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services"

[10] CEN ISO/TS 19091: "Intelligent transport systems - Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CAM	Cooperative Awareness Message
CPS	Central Position Server
DENM	Decentralized Environmental Notification Message
EUT	Equipment Under Test
GPSD	Daemon that receives data from a GPS receiver. It provides a unified interface to receivers of different types, and allows concurrent access by multiple applications
GN	GeoNetworking
GVL	Geographical Virtual Link
ITS-S	ITS Station. Can be either RIS or VIS. This acronym is used when the role of the ITS Station is not relevant for the scope of the test. Note: When the role is relevant for the test, then RIS or VIS is used.
RIS	ITS Roadside Station
TVL	Topological Virtual Link
VIS	ITS Vehicle Station

4 Conventions

4.1 Interoperability test process

4.1.1 Introduction

The goal of interoperability test is to check that devices resulting from protocol implementations are able to work together and provide the functionalities provided by the protocols. As necessary, one message may be checked during a test, when a successful functional verification may result from an incorrect behaviour for instance. Detailled protocol checks are part of the conformance testing process and are thus avoided during the Interoperablity tests.

The test session will be mainly executed between two devices from different vendors. For some test purposes, it may be necessary to have more than two devices involved. Each device can play different roles (VIS, RIS) during the test sessions. The information about the test configuration like the number of devices or the roles required are indicated in the test description tables below.

4.1.2 The test description proforma

The test descriptions are provided in proforma tables following the the format described in [5]. The following different test events are considered furing the test execution:

- A **stimulus** corresponds to an event that enforces an EUT to proceed with a specific protocol action, like sending a message for instance.
- A **verify** consists of verifying that the EUT behaves according to the expected behaviour (for instance the EUT behaviour shows that it receives the expected message).
- A **configure** corresponds to an action to modify the EUT configuration.
- A **check** ensures the receipt of protocol messages on reference points, with valid content. This "check" event type corresponds to the interoperability testing with conformance check method.

See the test description tables applying to the CMS interoperability testing below.

For the execution of the interoperability test sessions, the following conventions apply:

- Every ‘Check’ step of a test description should be perfomed using a trace created by a monitor tool (see clause ‘Tooling’ below) and may be skipped due to time restricitions.
- The GPS trace defines the speed of the vehicles. It is assumed that the implementations use dynamically this data in their Facility and GN layer implementations
- Use of triggers for the GN scenarios: The GN scenarios use CAM, DENM triggers to keep as much as possible the notion of an integrated end – 2 end test
- The UC scenarios focus on information fields and values which are relevant for the given functions. By sending pre-defining CAM and DENM messages the correct decoding and interpretation is tested. Also, clarification will be gained on how and with which values to use CAM and DENM parameters (such as cause code and sub cause codes) are used.

4.2 Tooling

- Message monitoring solutions (sniffer devices) are provided during the Plugtests event, to log and decode messages
- All log filers created by the sniffer device can be consulted by participants for debugging purposes
- Except for the “check” events, the the verification of the message conformity is not part of the Interoperability test process
- Participant may also use their own tool for logging and analyzing messages for the “check” purposes

4.3 Test Description naming convention

Table 1: TD naming convention

TD/<root>/<gr>/<nn>		
<root> = root	CN	Connectivity
	GN	Geo Networking
	CAM	Cooperative Avareness Message
	DENM	Decentralized Event Notification Message
	SPAT_MAP	Signal Phase And Timing and Map topology
	UC	Use Case specific
<gr> = group	BEA	Beaconing
	GBC	Geo Broadcast
	SHB	Single Hop Broadcast
<nn> = sequential number		01 to 99

4.4 Test Summary

Table 2: GN Tests

1	TD_GN_BEA_01	Detection of neighbour
2	TD_GN_SHB_01	Broadcasting of CAM messages is correctly handled
3	TD_GN_GBC_01	DENM message is processed inside its Destination Area
4	TD_GN_GBC_02	Number of re-broadcasts is correctly handled during DENM flooding
5	TD_GN_GBC_03	DENM message is not processed outside its Destination Area
6	TD_GN_GBC_04	Geo-broadcast message caching is correctly implemented

Table 3: CAM and DENM Tests

7	TD_CAM_05	CAM messages and their mandatory data elements are interoperable
8	TD_CAM_08	CAM generation frequency of stationary vehicle is T_GenCamMax
9	TD_CAM_09	CAM generation interval equals T_GenCam_Dcc while position difference with respect to previous CAM exceeds 4 m (speed is constant)
10	TD_CAM_10	CAM generation frequency corresponds to the position difference based dynamic trigger
11	TD_CAM_11	CAM generation interval equals T_GenCam_Dcc while speed difference with respect to previous CAM exceeds 0.5 m/s (acceleration is constant)
12	TD_CAM_12	CAM generation frequency corresponds to the speed difference based dynamic trigger
13	TD_DENM_01	DENM re-transmissions are correctly received within the DENM lifetime
14	TD_DENM_02	DENM re-transmissions are not received after the DENM lifetime
15	TD_DENM_03	Keeping DENM information alive after removal of the source (optional)

Table 4: SPAT and MAP Tests

16	TD_SPAT_MAP_01	Exchange of MAP messages
17	TD_SPAT_MAP_02	Exchange of SPAT messages
18	TD_SPAT_MAP_03	Exchange of SPAT and MAP messages related each other

4.6 DENM Relevance Area – GN Destination Area

The test configurations (see clause 6.7) define GN Destination Areas. However, the test descriptions (see clause 7 and 8) use , where applicable, in their test objectives the term of DENM Relevance Area. For the purpose of this document it is assumed that the DENM Relevance area is equal to the GN Destination Area.

5 Test Bed Architecture

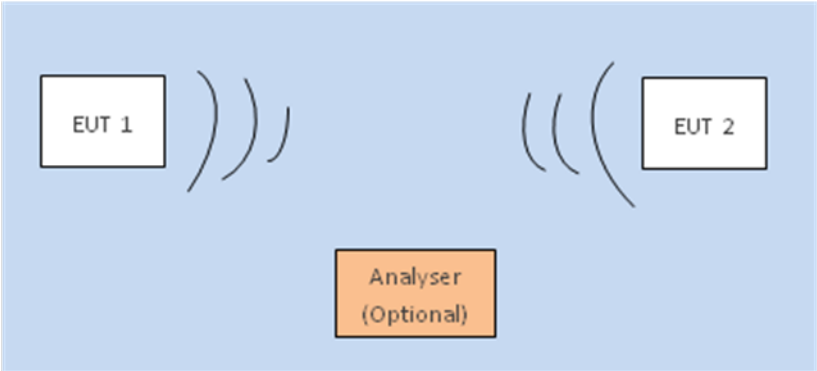

Figure 1: Basic Face 2 Face Configuration

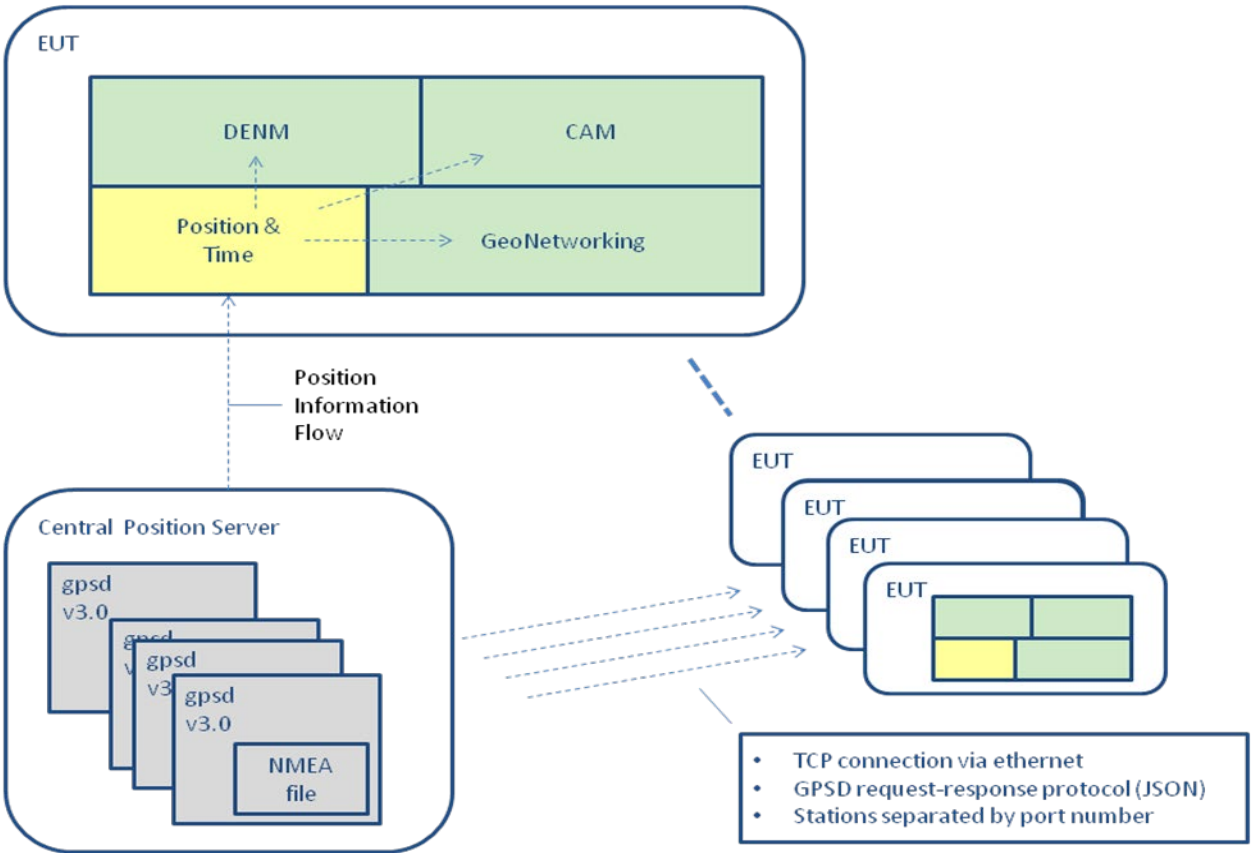

Figure 2: Central Position Server

6 Basic Configuration

6.1 GN

Unless specified differently, the devices shall be in auto-address configuration mode (MIB attribute itsGnLocalAddrConfMethod is set to AUTO (0)).

6.2 BTP Port Mapping

BTP - A shall not be used.

BTP - B shall be used with the following mapping:

Table 4: BTP Port Mapping

	Dst port
CAM	2001
DENM	2002
MAPEM	2003
SPATEM	2004

6.3 Geographic Parameters

This section defines the different test configurations GEO_CFG_nn. Each test configuration describes

- geo positions (Please note that the geo positions are for information only. The geo positions used for testing are provided by the GPSD)
- destination area (where applicable). Please refer to clause 4.6 on definition of DENM Relevance Area and GN Destination Area
- geo configuration

The GPSD may vary any of the input coordinates within approximately ± 5 meters: this shall not cause any difference with the expected test results. Such variation may reflect the slight change in each real position measurement data.

6.3.1 Single hop messaging (GEO_CFG_01)

Table 5: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.5338016	13.9264149
Receiver	1942	51.5338398	13.9271539

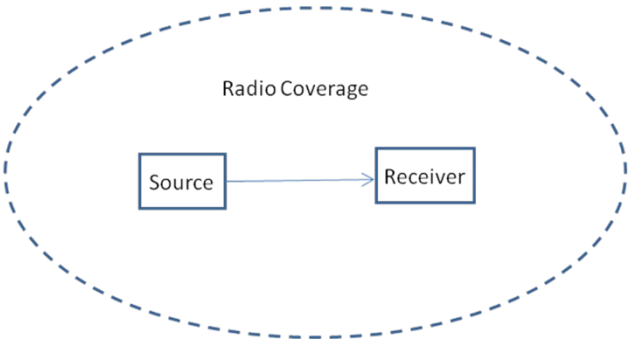

Figure 3: GEO_CFG_01

6.3.2 Distribution within Destination Area (GEO_CFG_02)

Table 6: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.5338016	13.9264149
Receiver	1942	51.5338398	13.9271539

Table 7: Destination Area

Destination area midpoint Lat – relative to originator	Destination area midpoint Lon – relative to originator	Destination area shape	Length of the long semi-axis	Length of the short semi-axis	Azimuth angle of the long semi-axis
-0.0001	-0.0001	Ellipse	200 m	100 m	90 degrees

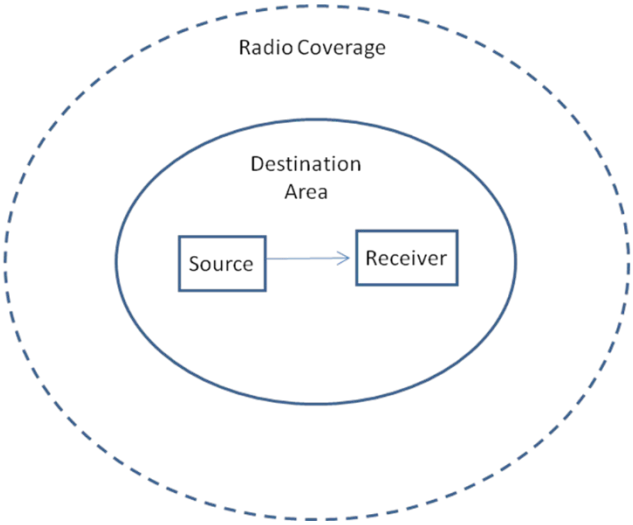

Figure 4: GEO_CFG_02

6.3.3 Distribution within Destination Area (GEO_CFG_02_B)

Table 8: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.5338016	13.9264149
Receiver 1	1942	51.5338398	13.9271539
Receiver 2	1943	51.5336806	13.9271792

Table 9: Destination Area

Destination area midpoint Lat – relative to originator	Destination area midpoint Lon – relative to originator	Destination area shape	Length of the long semi-axis	Length of the short semi-axis	Azimuth angle of the long semi-axis
-0.0001	-0.0001	Ellipse	200 m	100 m	90 degrees

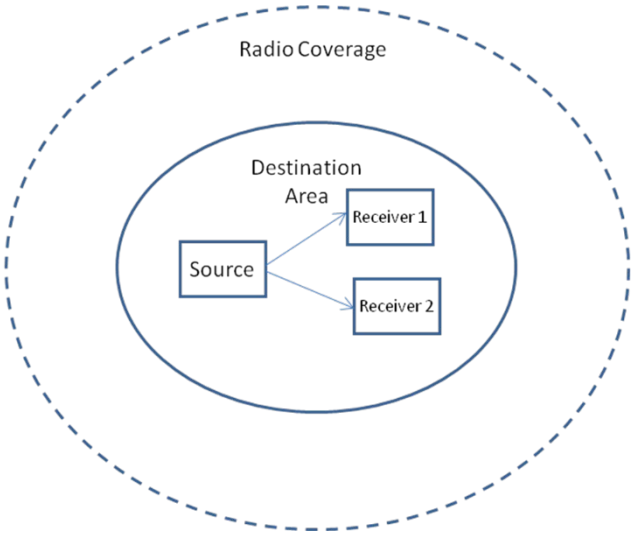

Figure 5: GEO_CFG_02_B

6.7.4 Distribution within Destination Area – with originator disappearance (GEO_CFG_03)

Table 5: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.5338016	13.9264149
Neighbour 1	1942	51.5338398	13.9271539
Neighbour 2	1943	51.5336806	13.9271792

Table 6: Destination Area

Destination area midpoint Lat – relative to originator	Destination area midpoint Lon – relative to originator	Destination area shape	Length of the long semi-axis	Length of the short semi-axis	Azimuth angle of the long semi-axis
-0.0001	-0.0001	Ellipse	200 m	100 m	90 degrees

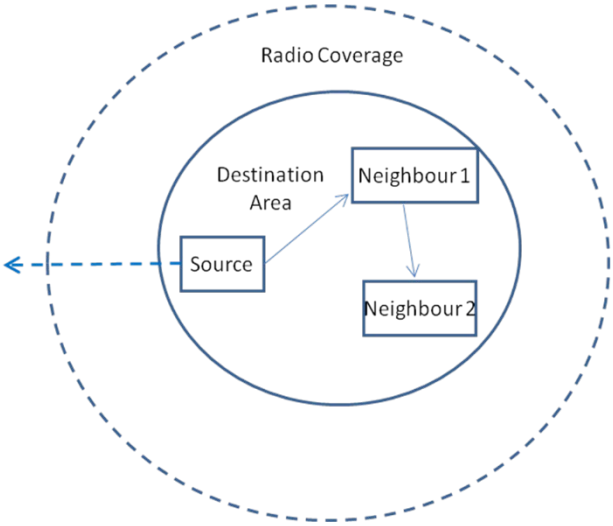

Figure 6: GEO_CFG_03

Note: The absence of the source will be achieved through link attenuation, without a change in its geographic coordinates.

6.3.4 Receivers being outside of Destination Area (GEO_CFG_04)

Table 7: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.5338016	13.9264149
Receiver	1944	51.5340933	13.9286331

Table 8: Destination Area

Destination area midpoint Lat – relative to originator	Destination area midpoint Lon – relative to originator	Destination area shape	Length of the long semi-axis	Length of the short semi-axis	Azimuth angle of the long semi-axis
0	0	Ellipse	100 m	20 m	0 degrees

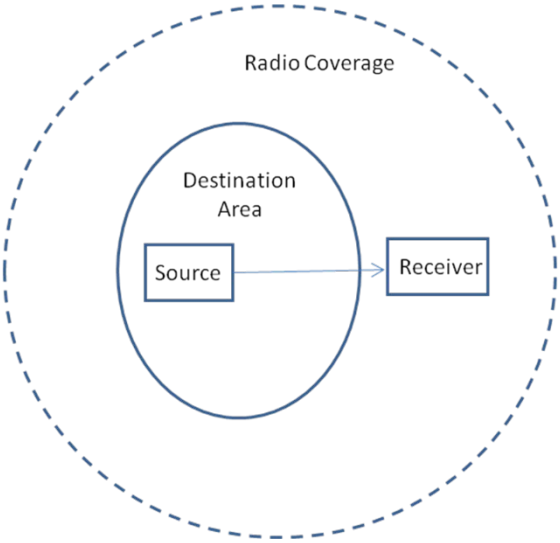

Figure 7: GEO_CFG_04

6.3.5 First receiver appears in Destination Area (GEO_CFG_05)

Table 9: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.5338016	13.9264149
Receiver	1942	51.5338398	13.9271539

Table 10: Destination Area

Destination area midpoint Lat – relative to originator	Destination area midpoint Lon – relative to originator	Destination area shape	Length of the long semi-axis	Length of the short semi-axis	Azimuth angle of the long semi-axis
-0.0001	-0.0001	Ellipse	200 m	100 m	90 degrees

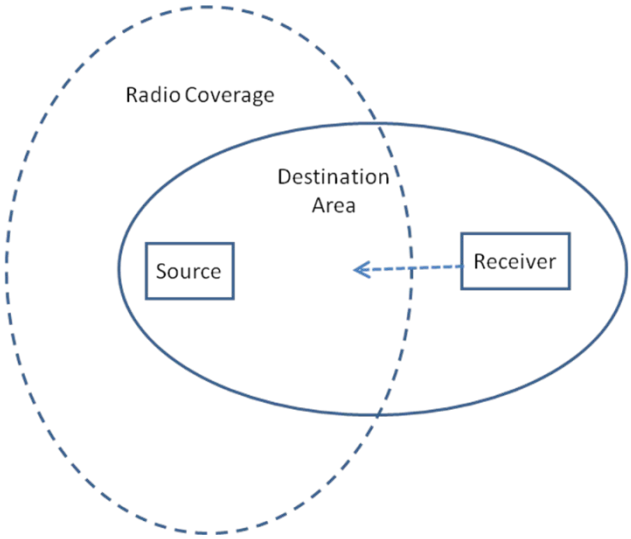

Figure 8: GEO_CFG_05

Note: The appearance of the receiver will be achieved through link attenuation, without a change in its geographic coordinates.

6.3.6 New receivers appears in Destination Area (GEO_CFG_06)

Table 16: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.5338016	13.9264149
Neighbour	1942	51.5338398	13.9271539
Receiver	1943	51.5336806	13.9271792

Table 17: Destination Area

Destination area midpoint Lat – relative to originator	Destination area midpoint Lon – relative to originator	Destination area shape	Length of the long semi-axis	Length of the short semi-axis	Azimuth angle of the long semi-axis
-0.0001	-0.0001	Ellipse	200 m	100 m	90 degrees

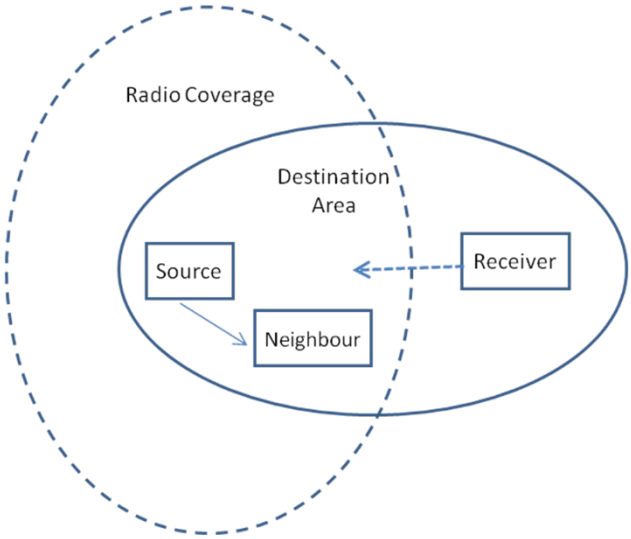

Figure 9: GEO_CFG_06

Note: The appearance of the receiver will be achieved through link attenuation, without a change in its geographic coordinates

6.3.7 Source moving at constant 90 km/h speed (GEO_CFG_17). Note: requires 10 Hz position server rate

Table 18: Geo Positions

Role		GPSD port	Lat	Lon
Source	Start position (0m)	1953	51.5336321	13.9289402
	0.1 seconds later (2.5m)		51.5336287	13.9289075
	0.2 seconds later (5m)		51.5336237	13.9288671
	10 seconds later (250m)		51.533411	13.9253874
Receiver		1942	51.5338398	13.9271539

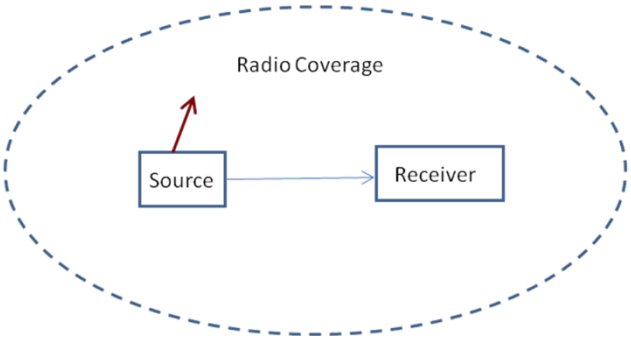

Figure 10: GEO_CFG_17

6.3.8 Source moving at constant 3 m/s^2 acceleration (GEO_CFG_18). Note: requires 10 Hz position server rate)

Table 19: Geo Positions

Role		GPSD port	Lat	Lon
Source	Start position (0m)	1954	51.5336922	13.9282656
	1 seconds later (1.5 m)		51.5336915	13.928242
	2 seconds later (6 m)		51.533685	13.9281803
	10 seconds later (150m)		51.5335208	13.926119
Receiver		1942	51.5338398	13.9271539

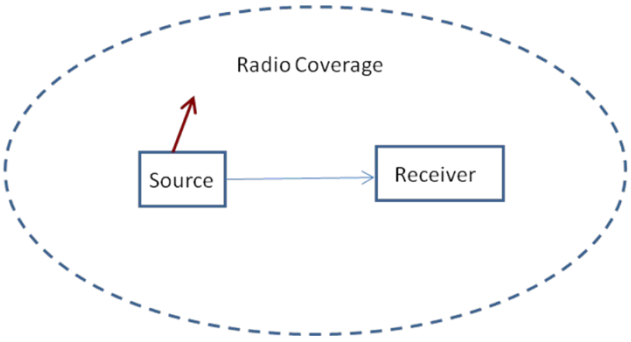

Figure 10: GEO_CFG_18

6.5 CPS parameters

Table 20: CPS Parameters

CFG	TD ID	Role	Test Session 1 CPS IP@:port	Motion Path
GEO_CFG_01	TD_GN_BEA_01 TD_GN_SHB_01 TD_CAM_05 TD_CAM_08 TD_SPAT_MAP_01 TD_SPAT_MAP_02 TD_SPAT_MAP_03	Source	1941	
		Receiver	1942	
GEO_CFG_02	TD_GN_GBC_01	Source	1941	
		Receiver	1942	
GEO_CFG_02_B	TD_GN_GBC_02	Source	1941	
		Receiver 1	1942	
		Receiver 2	1943	
GEO_CFG_03	TD_DENM_03	Source	1941	
		Neighbour 1	1942	
		Neighbour 2	1943	
GEO_CFG_04	TD_GN_GBC_03	Source	1941	
		Receiver	1942	
GEO_CFG_05	TD_GN_GBC_04	Source	1941	
		Receiver	1942	
GEO_CFG_06	TD_DENM_01 TD_DENM_02	Source	1941	
		Neighbor	1942	
		Receiver	1943	
GEO_CFG_17	TD_CAM_09 TD_CAM_10	Source	1953**	YES, requires 10 Hz position update
		Receiver	1942	
GEO_CFG_18	TD_CAM_11 TD_CAM_12	Source	1954**	YES, requires 10 Hz position update
		Receiver	1942	

* - port provides motion path, ** - port provides motion path with 10Hz update rate

6.6 CAM frequency

CAM generation frequency shall be controlled according to clause 6.1.3 of [3].

6.7 Determination of destination position for geo unicast tests

Accordingly to the GN specification, the source can send a packet only if it knows the position of the destination.

Otherwise, LS service is initiated. If LS service is not supported there are 2 possibilites to overcome this issue:

- use the SAP between GN and upper layer and pass the position of the destination via the GN-DATA.request primitive

- use the destination device and trigger it to send a periodic TSB (so that the Source can get the position of the Destination device). The TSB is sent via the Forwarder device.

6.8 Security Settings

All messages exchanges shall be secured according to [6], [7] and [8].

6.9 SCF Bit Settings

Unless explicitly defined, the SCF (Store Carry & Forward) bit in the TrafficClass field is set to 1 (enabled).

7 GN Scenarios

For all the tests defined in this chapter the settings apply as defined in clauses '6.8 Security Settings' and '6.9 SCF Bit Settings'.

7.1 GN Beaconing

7.1.1 Detection of neighbour

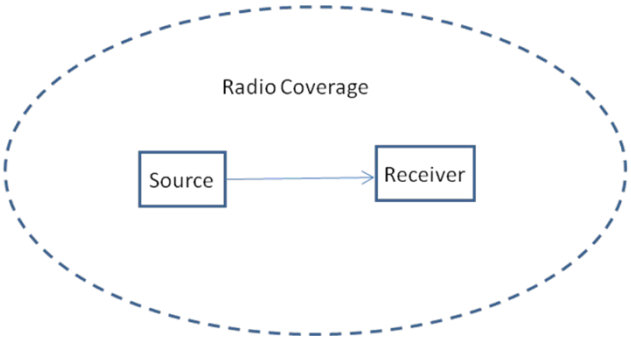

Figure 12: GEO_CFG_01

Interoperability Test Description			
Identifier:	TD_GN_BEA_01		
Objective:	Detection of neighbour		
Configuration:	GEO_CFG_01		
References:	[1] 9.2.3, 9.8.6 and 9.4		
Pre-test conditions:	• 2 ITS-S devices (1 Source, 1 Receiver) • Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source ITS-S sends beacons
	2	verify	Receiver ITS-S detects its neighbour

Interoperability Test Description			
	3	check	Received beacon contains Position Vector indicating geographical position (Longitude/Latitude) according to the provided position feed input

7.2 CAM message transmission

7.2.1 Exchange of CAM messages

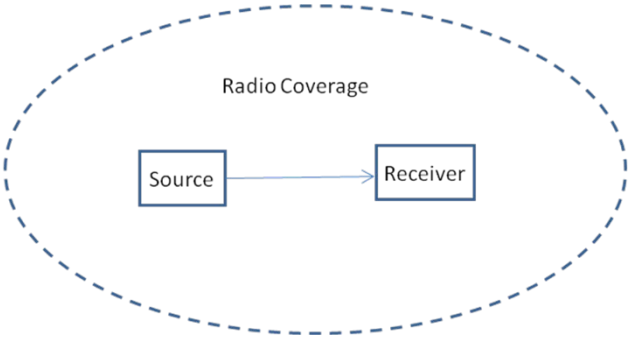

Figure 13: GEO_CFG_01

Interoperability Test Description			
Identifier:	TD_GN_SHB_01		
Objective:	Broadcasting of CAM messages is correctly handled		
Configuration:	GEO_CFG_01		
References:	[1] 9.8.2 and 9.4 [3] 7		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Each ITS-S device has sent at least 1 beacon		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a CAM message
	2	verify	Receiver devices receive a Single Hop Broadcast (SHB) packet containing CAM message.
	3	check	Received SHB packet is carried by a link layer packet containing the link layer destination address indicating broadcast MAC address
	4	verify	Receiver passes received CAM message to its Facility layer
	5	verify	Steps 2 to 4 are repeated within the CAM messaging frequency range

7.3 DENM message transmission

7.3.1 EUT inside DENM Relevance area (no duplicate checking)

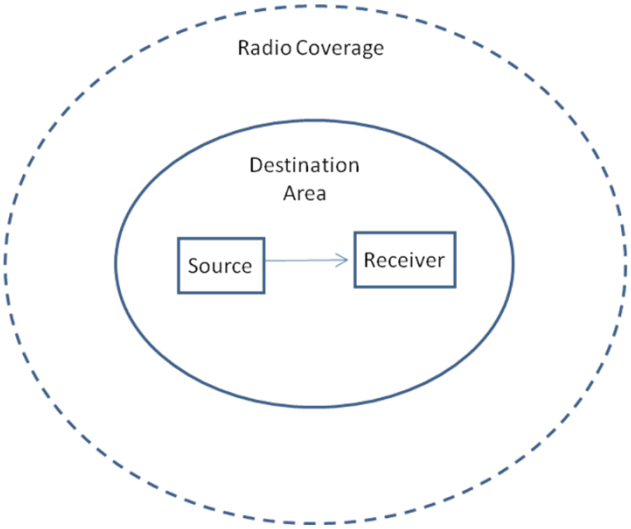

Figure 14: GEO_CFG_02

Interoperability Test Description			
Identifier:	TD_GN_GBC_01		
Objective:	DENM message is processed inside its Destination Area		
Configuration:	GEO_CFG_02		
References:	[1] 9.8.58.5 and 9.4 [4] 6.1.3.2		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Prepare the DEN message so that the destination area is as defined in the geo configuration Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Each ITS-S device has sent at least 1 beacon or 1 CAM		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	verify	Receiver devices receive a GeoBroadcast packet containing DENM message
	3	check	Received GeoBroadcast packet is carried by a link layer packet containing the link layer destination address indicating broadcast MAC address
	4	verify	Receiver passes DENM message to its Facility layer

7.3.2 Duplicate Packet Detection (checking the re-broadcasting limit within the DENM relevance area)

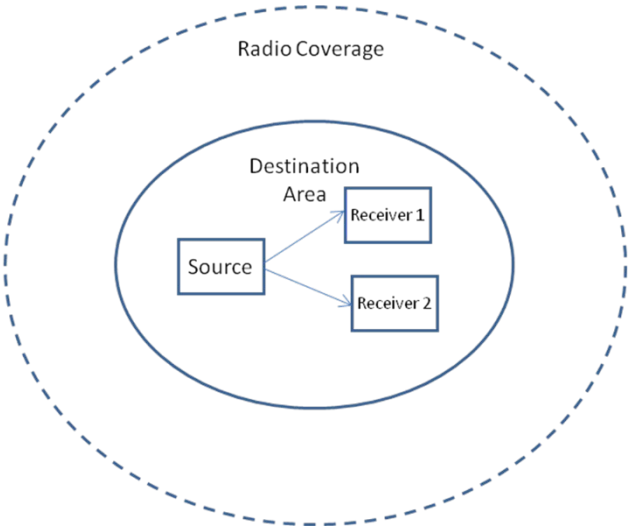

Figure 15: GEO_CFG_02_B

Interoperability Test Description			
Identifier:	TD_GN_GBC_02		
Objective:	Number of re-broadcasts is correctly handled during DENM flooding		
Configuration:	GEO_CFG_02_B		
References:	[1] 9.8.5 and 9.4 [4] 6.1.3.2		
Pre-test conditions:	3 ITS-S devices (1 Source, 2 Receivers) Prepare the DEN message so that the destination area is as defined in the geo configuration - and validityDuration > 1 minute · Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Each ITS-S device has sent at least 1 beacon or 1 CAM		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	verify	Receiver devices receive several GeoBroadcast packet containing DENM message. The number of received GeoBroadcast packets equals 1 (Source broadcast) + the number of receiver devices minus 1 (received re-broadcasts).
	3	verify	Receiver passes only a single DENM message to its Facility layer

7.3.3 EUT outside DENM Relevance area

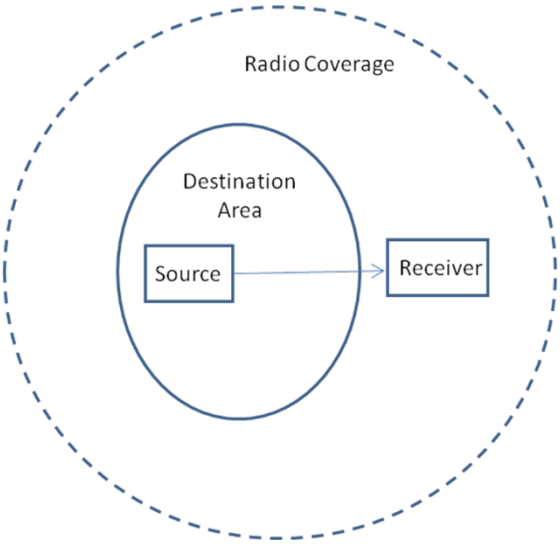

Figure 16: GEO_CFG_04

Interoperability Test Description			
Identifier:	TD_GN_GBC_03		
Objective:	DENM message is not processed outside its Destination Area		
Configuration:	GEO_CFG_04		
References:	[1] 9.8.5 and 9.4 [4] 6.1.3.2		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Prepare the DEN message so that the destination area is as defined in the geo configuration Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Each ITS-S device has sent at least 1 beacon or 1 CAM		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	verify	Receiver devices receive a GeoBroadcast packet containing DENM message
	3	check	Received GeoBroadcast packet is carried by a link layer packet containing the link layer destination address indicating broadcast MAC address
	4	verify	Receiver does not pass any DENM message to its Facility layer

7.3.4 EUT receiving a cached DENM message

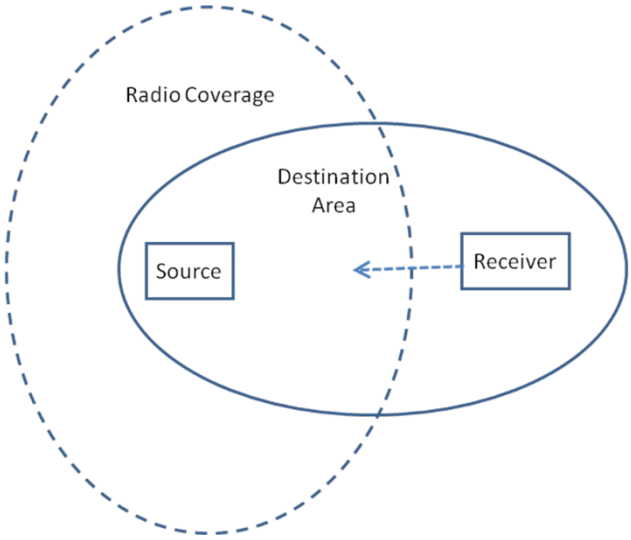

Figure 17: GEO_CFG_05

Interoperability Test Description			
Identifier:	TD_GN_GBC_04		
Objective:	Geo-broadcast message caching is correctly implemented		
Configuration:	GEO_CFG_05		
References:	[1] 9.8.5 and 9.4 [4] 6.1.3.2, 7.1.2		
Pre-test conditions:	• ITS-S devices (Source and Receiver) connected through antenna cable with controllable link attenuator on it • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • Set SCF bit to 1 • Prepare the DEN message so that the destination area is as defined in the geo configuration ○ and validityDuration set to 6 seconds • Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration • Source and Receiver are off-link		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	stimulus	Lower the attenuation on the connection, so that the two devices are on-link
	3	verify	Receiver devices receives buffered GeoBroadcasts containing the DENM message

Note: Formula to calculate the total number of packets: f = 1.1 Hz equals T = 900 ms; min(validityDuration, repetitionDuration) / 900 ms ~ 5 ; total number of packets = 5 + initial packet sent at t_0 = 6 packets

8 Facility Scenarios

For all the tests defined in this chapter the settings apply as defined in clauses '6.11 Security Settings' and '6.12 SCF Bit Settings'.

8.1 CAM message transmission

The following configuration applies to all tests in this chapter.

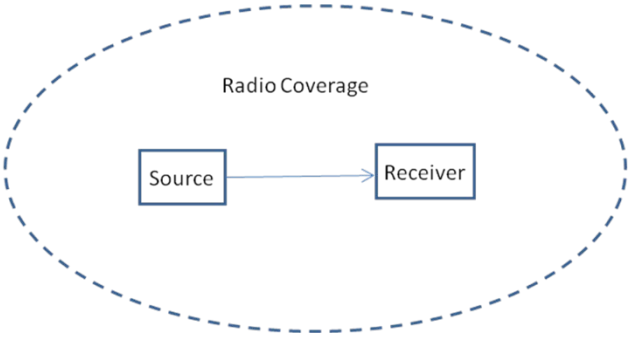

Figure 19: GEO_CFG_01

8.1.1 Exchange of CAM messages

Interoperability Test Description			
Identifier:	TD_CAM_05		
Objective:	CAM messages and their mandatory data elements are interoperable		
Configuration:	GEO_CFG_01		
References:	[1] 9.8.5 and 9.4 [3] 7		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure a CAM message without any optional data elements		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a CAM message
	2	verify	Receiver devices process the CAM as a valid message
	3	verify	Steps 2 to 3 are repeated at the CAM frequency of 1 Hz

8.1.2 Testing of CAM generation frequency management

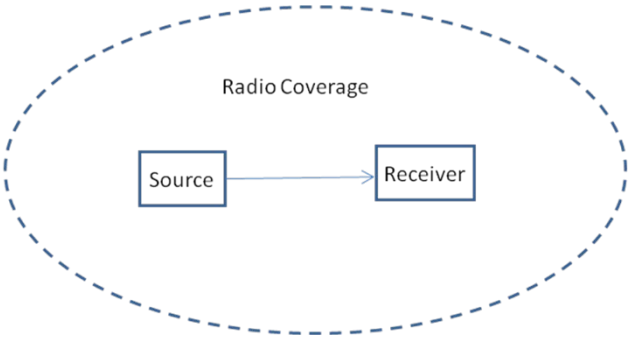

Figure 20: GEO_CFG_01

Interoperability Test Description			
Identifier:	TD_CAM_08		
Objective:	CAM generation frequency of stationary vehicle is T_GenCamMax		
Configuration:	GEO_CFG_01		
References:	[1] 9.8.5 and 9.4 [3] 6.1.3		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure *T_GenCam_Dcc* parameter to a value of 0.5 s		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Wait until Source is sending some CAM messages
	2	verify	Elapsed time between consecutively received CAM messages is 1 s (*T_GenCamMax* value)

Note: In the test 'stationary vehicle' is written in order to ensure a setup where the lowest T_GenCamMax sending frequency is used.

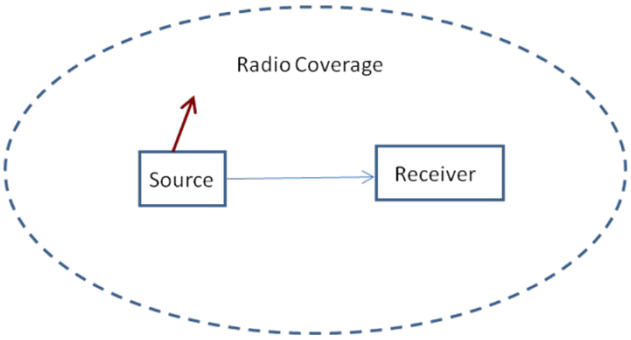

Figure 21: GEO_CFG_17

Interoperability Test Description			
Identifier:	TD_CAM_09		
Objective:	CAM generation interval equals T_GenCam_Dcc while position difference with respect to previous CAM exceeds 4 m (speed is constant)		
Configuration:	GEO_CFG_17		
References:	[1] 9.8.5 and 9.4 [3] 6.1.3		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure *T_GenCam_Dcc* parameter to a value of 0.5 s		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Wait until Source is sending some CAM messages
	2	verify	Elapsed time between consecutively received CAM messages is 0.5 s (*T_GenCam_Dcc* value), even though the vehicle dynamics related trigger is more frequent
Note: this test requires 10 Hz position update from the position server			

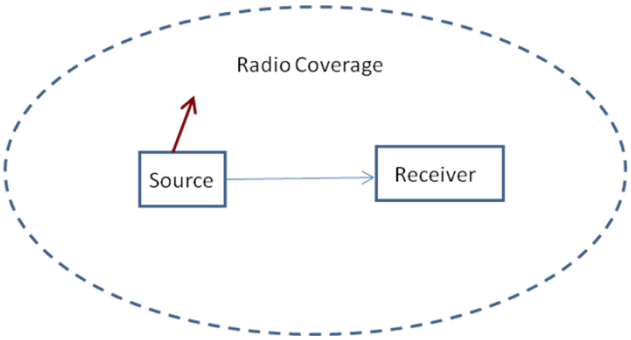

Figure 22: GEO_CFG_17

Interoperability Test Description			
Identifier:	TD_CAM_10		
Objective:	CAM generation frequency corresponds to the position difference based dynamic trigger		
Configuration:	GEO_CFG_17		
References:	[1] 9.8.5 and 9.4 [3] 6.1.3		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure *T_GenCam_Dcc* parameter to a value of 0.1 s		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Wait until Source is sending some CAM messages

Interoperability Test Description			
	2	verify	Elapsed time between consecutively received CAM messages is 0.2 s, corresponding to the vehicle dynamics related trigger frequency
Note: this test requires 10 Hz position update from the position server. The displacement trigger set in the standard is 4 m. The defined speed corresponds to 2.5 m / 0.1 sec; i.e. the 4 m threshold is exceeded every 0.2 sec from the previous CAM			

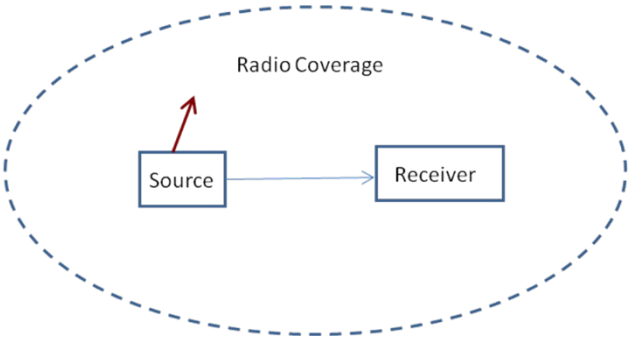

Figure 23: GEO_CFG_18

Interoperability Test Description			
Identifier:	TD_CAM_11		
Objective:	CAM generation interval equals T_GenCam_Dcc while speed difference with respect to previous CAM exceeds 0.5 m/s (acceleration is constant)		
Configuration:	GEO_CFG_18		
References:	[1] 9.8.5 and 9.4 [3] 6.1.3		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure *T_GenCam_Dcc* parameter to a value of 0.5 s		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Wait till Source is sending some CAM messages
	2	verify	Elapsed time between consecutively received CAM messages is 0.5 s (*T_GenCam_Dcc* value), even though the vehicle dynamics related trigger is more frequent
Note: this test requires 10 Hz position update from the position server.			

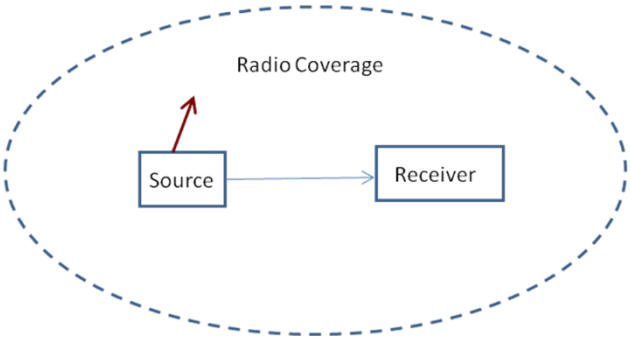

Figure 24: GEO_CFG_18

Interoperability Test Description			
Identifier:	TD_CAM_12		
Objective:	CAM generation frequency corresponds to the speed difference based dynamic trigger		
Configuration:	GEO_CFG_18		
References:	[1] 9.8.5 and 9.4 [3] 6.1.3		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure *T_GenCam_Dcc* parameter to a value of 0.1 s		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Wait till Source is sending some CAM messages
	2	verify	Elapsed time between consecutively received CAM messages is 0.2 s, corresponding to the vehicle dynamics related trigger frequency
Note: this test requires 10 Hz position update from the position server. The speed change trigger set in the standard is 0.5 m/s. The defined speed corresponds to 2.5 m / 0.1 sec; i.e. the 4 m threshold is exceeded every 0.2 sec from the previous CAM. The intention is for the GPS data to correspond to a constant acceleration of 3 m/s2, so that the speed change is 0.3 m/s within 0.1 sec. Again, the CAM is triggered every 0.2 sec from the previous CAM.			

8.2 DENM message transmission

8.2.1 EUT driving into DENM Relevance area within the DENM lifetime

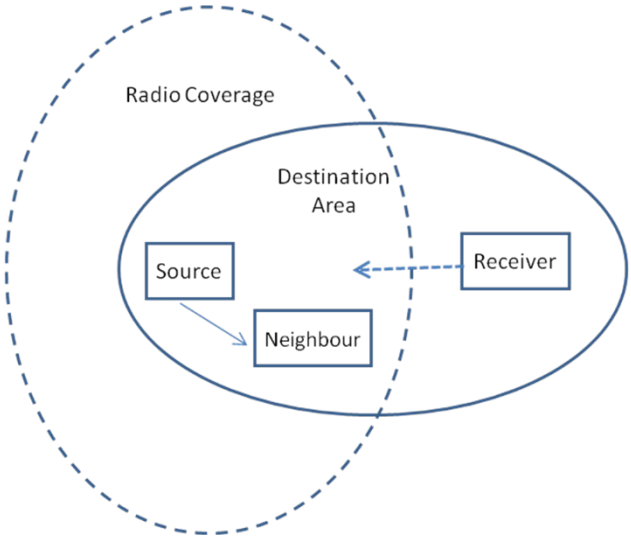

Figure 25: GEO_CFG_06

Note: Neighbor is necessary in this configuration in order to avoid that DENM messages get cached.

Interoperability Test Description			
Identifier:	TD_DENM_01		
Objective:	DENM re-transmissions are correctly received within the DENM lifetime		
Configuration:	GEO_CFG_06		
References:	[1] 9.8.5 and 9.4 [4] 6.1.3.2, 7.1.2		
Pre-test conditions:	3 ITS-S devices (Source, Receiver, Neighbor devices) installed with controllable link attenuator Prepare the DEN message so that the destination area is as defined in the geo configuration DENM repetitionInterval is set to 1000ms (1 Hz), and validityDuration set to some minutes in the future Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration Source and Receiver are off-link Source and Neighbor are on-link Neighbour and Receiver are off-link Each ITS-S device has sent at least 1 beacon or 1 CAM		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	stimulus	Lower the Source-Receiver attenuation before DENM lifetime expires, so that the two devices are on-link.
	3	verify	Receiver devices receive a GeoBroadcast packet containing DENM message.
	4	verify	Receiver passes the DENM message to its Facility layer, where it is processed as a valid message
	5	verify	Steps 3 and 4 are repeated at the frequency defined by the 'repetitionInterval' parameter of the DEN trigger

8.2.2 EUT driving into DENM Relevance area after the DENM lifetime

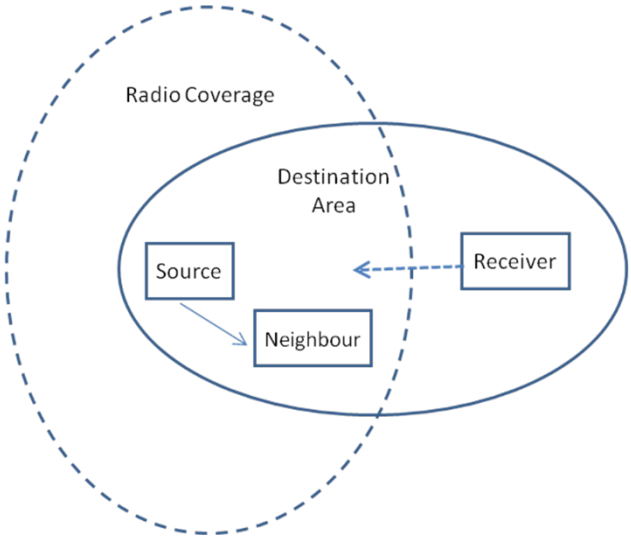

Figure 26: GEO_CFG_06

Note: Neighbor is necessary in this configuration in order to avoid that DENM messages get cached.

Interoperability Test Description			
Identifier:	TD_DENM_02		
Objective:	DENM re-transmissions are not received after the DENM lifetime		
Configuration:	GEO_CFG_06		
References:	[1] 9.8.5 and 9.4 [4] 6.1.3.2, 7.1.2		
Pre-test conditions:	3 ITS-S devices (Source, Receiver, Neighbor devices) installed with controllable link attenuator Prepare the DEN message so that the destination area is as defined in the geo configuration DENM repetitionInterval is set to 1000ms (1 Hz), and validityDuration set to some seconds in the future Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration Source and Receiver are off-link Source and Neighbor are on-link Neighbour and Receiver are off-link Each ITS-S device has sent at least 1 beacon or 1 CAM		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	stimulus	Lower the Source-Receiver attenuation after the DENM lifetime expires, so that the two devices are on the same link
	3	verify	Receiver devices does not receive any GeoBroadcast packet containing DENM message

8.2.3 Keeping DENM information alive after removal of the source (optional feature)

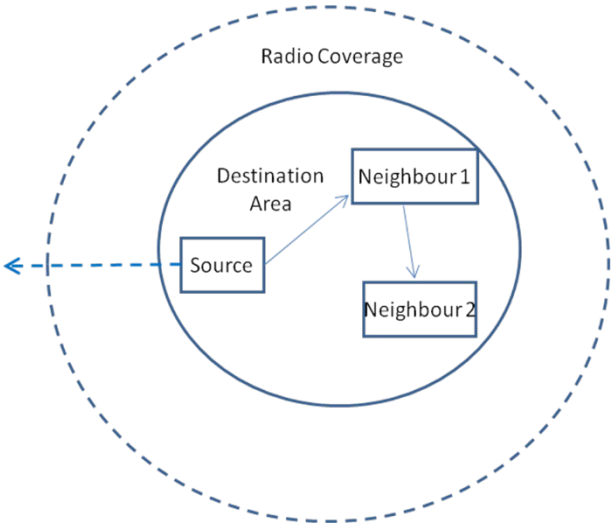

Figure 11: GEO_CFG_03

Interoperability Test Description			
Identifier:	TD_DENM_03		
Objective:	DENM information is kept alive as expected during its lifetime		
Configuration:	GEO_CFG_03		
References:	[1] 9.3.11 [4] 6.1.3.2, 7.1.2, 6.1.4		
Pre-test conditions:	3 ITS-S devices (Source, Neighbor 1 and 2 devices) installed in RF testbench with controllable link attenuator Prepare the DEN message so that the destination area is as defined in the geo configuration DENM repetitionInterval and transmissionInterval set to 1000ms (1 Hz), and validityDuration set to some minutes in the future Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration All ITS-S devices are on-link Each ITS-S device has sent at least 1 beacon or 1 CAM		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	stimulus	Raise the Source-Neighbor attenuation before DENM expiry time, so that the Source device becomes off-link from the two Neighbor devices, while the two Neighbor devices remain on-link
	3	verify	One of the Neighbor devices receives from the other Neighbor device a GeoBroadcast packet containing DENM message
	4	verify	Receiving Neighbor passes the received DENM message to its Facility layer, where it is processed as a valid message
	5	verify	Steps 3 and 4 are repeated at the frequency defined by the transmissionInterval parameter of the DEN message, until the DENM lifetime expiration

8.3 SPAT/MAP message transmission

The following configuration applies to all tests in this chapter.

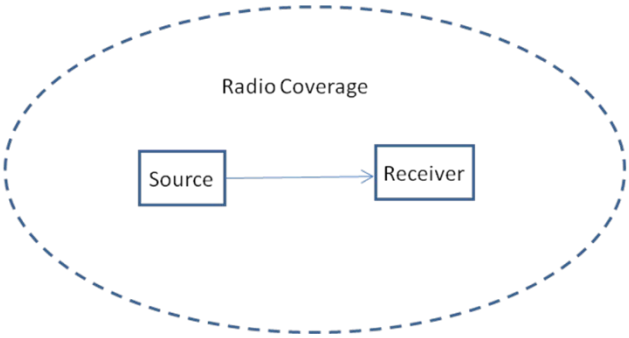

Figure 12: GEO_CFG_01

8.3.1 Exchange of MAP messages

Interoperability Test Description			
Identifier:	TD_SPAT_MAP_01		
Objective:	MAP messages and their mandatory intersection data elements are interoperable This includes the description of the topology as defined in the ETSI TS 103 301 [9] and ISO19091 [10] (e.g. vehicle lanes, signalGroups, connectsTo, etc.)		
Configuration:	GEO_CFG_01		
References:	[9], [10]		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure a basic MAP message as defined in [9] using the ASN elements defined in [10].		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a MAP message
	2	verify	Receiver devices process the MAP as a valid message
	3	verify	Steps 2 to 3 are repeated at the MAP frequency of 2 Hz

NOTE: Due to the complexity of the MAP message intersection topology samples provided by different manufacturer will be helpful forinteroperability.

8.3.2 Exchange of SPAT messages

Interoperability Test Description			
Identifier:	TD_SPAT_MAP_02		
Objective:	SPAT messages and their mandatory intersection data elements are interoperable This includes the description of the traffic light signalitation as defined in ETSI TS 103 301 [9] and ISO19091 annex-D [10] (e.g. Signal Groups cycle staus and timing) NOTE: As the information is transmitted in UTC time format a detailed view to correct timing is essential.		
Configuration:	GEO_CFG_01		
References:	[9], [10]		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure a basic SPAT message as defined in [9] using ASN elements defined in [10].		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a SPAT message
	2	verify	Receiver devices process the SPAT as a valid message
	3	verify	Steps 2 to 3 are repeated at the SPAT frequency of 1 Hz

8.3.2 Exchange of SPAT and MAP messages related each other.

Interoperability Test Description			
Identifier:	TD_SPAT_MAP_03		
Objective:	A SPAT messages, containing signal groups with signalization cyclus (e.g. go=green, stop=red, etc) is almost related to a lane of a map (topology). The scope that the receiver interprets correcltly the signal, timing related to a specific lane number.		
Configuration:	GEO_CFG_01		
References:	[9], [10]		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration; these locations are in close proximity so that all devices are within single-hop transmission range Configure a basic SPAT message as defined in [9] using ASN elements defined in [10].		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a MAT message Source is requested to send a SPAT message
	2	verify	Receiver devices process the MAP as a valid message Receiver devices process the SPAT as a valid message Receiver compares the signalization related the lanes of the MAP.

Interoperability Test Description			
	3	verify	Steps 2 to 3 are repeated at the SPAT frequency of 1 Hz and the MAP frequency of 2 Hz.

Change History

Document history		
0.0.1	10.09.2019	Draft test scenarios for CV2X Plugtest
0.1.1	31.01.2022	Draft test scenarios for 3rd CV2X Plugtest
0.1.4	21.03.2022	Add SPAT/MAP scenarios