ETSI CTI Plugtests Guide V0.0.11 (2015-03)

4th Cooperative Mobility Services Plugtest;
TASS, Netherlands;
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ETSI

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Contents

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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 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 necessary 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 4th Cooperative Mobility Services Plugtests event, in Helmond, Germany, from 17 to 27 March 2015. 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 (PHY, MAC, NWT, …)
- 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] 802.11-2007 and IEEE802.11p-2010 IEEE Standard for Information technology— Telecommunications and information exchange between systems— Local and metropolitan area networks— Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications and Amendment 6: Wireless Access in Vehicular Environments.

[2] ETSI EN 302 636-4-1 (V1.2.1): "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".

[3] ETSI EN 302 636-5-1 (V1.2.1): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol".

[4] ETSI EN 302 637-2 (V1.3.2): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".

[5] ETSI EN 302 637-3 (V1.2.2): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

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

[7] ETSI EN 302 636-6-1 (V1.2.1): "Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 6: Internet Integration; Sub-part 1: Transmission of IPv6 Packets over GeoNetworking Protocols".

[8] ISO TS 19091 Annex-D (Version 12) "Intelligent transport systems — Co-operative ITS - Using V2I and I2V Communications for Applications Related to Signalized Intersections

[9] SAEJ2735 "BallotDraft_J2735_Amend_1_Oct20.doc" (SPAT / MAP)

[10] DSRC_R37_Source_REG-D.asn (ASN.1 Specification)

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

GN6 IPv6 over 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.

MAC Media Access Control layer of the access layers

PHY The Physical layer of the access layers

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 meesage 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 2 devices from different vendors. For some test purposes, it may be necessary to have more than 2 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 [6]. 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	CAM
	DENM	DENM
	UC	Use Case specific
	GN6	IPv6 over GeoNetworking
<gr> = group	BEA	Beaconing
	PING	IP connectivity
	GBC	Geo Broadcast
	GUC	Geo Unicast
	DAD	Duplicate Address Detection
	SHB	Single Hop Broadcast
	LSA	Asymmetric Links
	SCF	SCF disabled scenarios
<gr> = subgroup	GRD	Greedy Forwarding Algorithm
	CBF	CBF Forwarding Algorithm
	FW	Forwarding
<nn> = sequential number		01 to 99

4.4 Test Summary –Mandatory Tests

Table 2: GN Tests

1	TD_GN_BEA_01	Detection of neighbour
2	TD_GN_SHB_01	Broadcasting of CAM messages is correctly handeled
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
7	TD_GN_DAD_01	Resolution of duplicate Gn address scenario
8	TD_GN_GBC_FW_01	DEN message is correctly forwarded to its Destination
9	TD_GN_GBC_FW_02	DEN message is correctly geo-routed towards its Destination Area
10	TD_GN_GBC_FW_03	DEN message geo-routing is correctly handled when no suitable forwarder exists
11	TD_GN_GBC_FW_04	Verify that the best positioned EUT is forwarding a message

Table 3: CAM and DENM Tests

12	TD_CAM_05	CAM messages and their mandatory data elements are interoperable
13	TD_CAM_08	CAM generation frequency of stationary vehicle is T_GenCamMax
14	TD_CAM_09	CAM generation interval equals T_GenCam_Dcc while position difference with respect to previous CAM exceeds 4 m (speed is constant)
15	TD_CAM_10	CAM generation frequency corresponds to the position difference based dynamic trigger
16	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)
17	TD_CAM_12	CAM generation frequency corresponds to the speed difference based dynamic trigger
18	TD_DENM_01	DENM re-transmissions are correctly received within the DENM lifetime
19	TD_DENM_02	DENM re-transmissions are not received after the DENM lifetime
~~20~~	~~TD_DENM_04~~	~~DENM expiry handling is correctly implemented~~

4.5 Test Summary –Optional Tests

Table 4: GeoNetworking Tests

20	TD_GN_GBC_05	DENM message is processed inside a rectangular Destination Area
21	TD_GN_GBC_06	DENM message is not processed outside its rectangular Destination Area
22	TD_GN_GBC_07	Verify that the best positioned EUT is retransmitting a broadcast under CBF algorithm
23	TD_GN_GUC_01	Verification of geo-unicast messages being interoperable
24	TD_GN_GUC_02	Multi-hop geo-unicast forwarding is interoperable (Greedy Forwarding Algorithm)
25	TD_GN_GUC_GRD_01	Geo-unicast message is correctly forwarded to its Destination over an intermediate node, including location service
26	TD_GN_GUC_GRD_02	Geo-routing is correctly handled when no suitable forwarder exists
27	TD_GN_GUC_CBF_01	Verify that the best positioned EUT is forwarding a unicast message under CBF algorithm
28	TD_GN_GUC_CBF_03	Verify that the EUT is not forwarding a unicast message under CBF algorithm when it is in the wrong direction from the destination
29	TD_GN_GBC_SCF_01	Geo-broadcast message caching is correctly implemented
30	TD_GN_GBC_SCF_02	DENM message geo-routing is correctly handled when no suitable forwarder exists
31	TD_GN_GBC_SCF_03	DENM message is correctly geo-routed towards its Destination Area
32	TD_GN_GBC_SCF_04	DENM message is correctly geo-routed towards its Destination Area

Table 5: IPv6 over GeoNetworking Tests

33	TD_GN6_01	Neighbour ITS nodes can ping each other using their link-local IPv6 address (FE80::)
34	TD_GN6_02	Neighbour ITS nodes can ping each other using their link-local IPv6 address (FE80::) in presence of configured GVLs
35	TD_GN6_03	ITS nodes can ping each other IPv6 Global address
36	TD_GN6_04	ITS nodes can ping other GVL nodes using IPv6 all-nodes multicast address
37	TD_GN6_05	ITS nodes can perform IPv6 Neighbour Discovery
38	TD_GN6_06	ITS nodes can configure a GVL by receiving Router Advertisement
39	TD_GN6_07	ITS nodes can configure several GVL by receiving Router Advertisements
40	TD_GN6_08	ITS nodes can deconfigure GVL after prefix expiration
41	TD_GN6_09	ITS nodes can communicate with legacy IPv6 node
42	TD_GN6_10	ITS nodes can communicate via legacy IPv6 network
43	TD_GN6_11	In-vehicle IPv6 host can communicate with the other in-vehicle IPv6 host
44	TD_GN6_12	In-vehicle IPv6 host can communicate with the a legacy IPv6 host

Table 6: CAM and DENM Tests

45	TD_CAM_06	CAM messages and their optional data elements are interoperable
46	TD_CAM_07	CAM message decoding properly handles extended data elements
47	TD_DENM_03	DENM information is kept alive during its lifetime
48	TD_DENM_05	DENM message decoding properly handles extended data elements

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

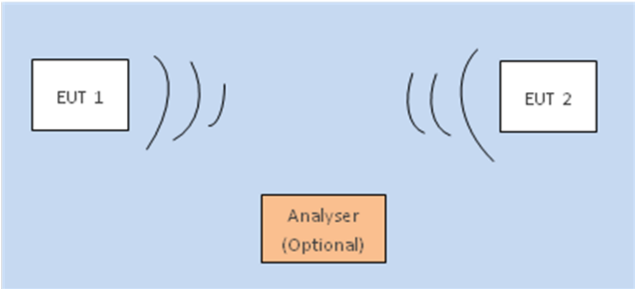

Figure 1: Basic Face 2 Face Configuration

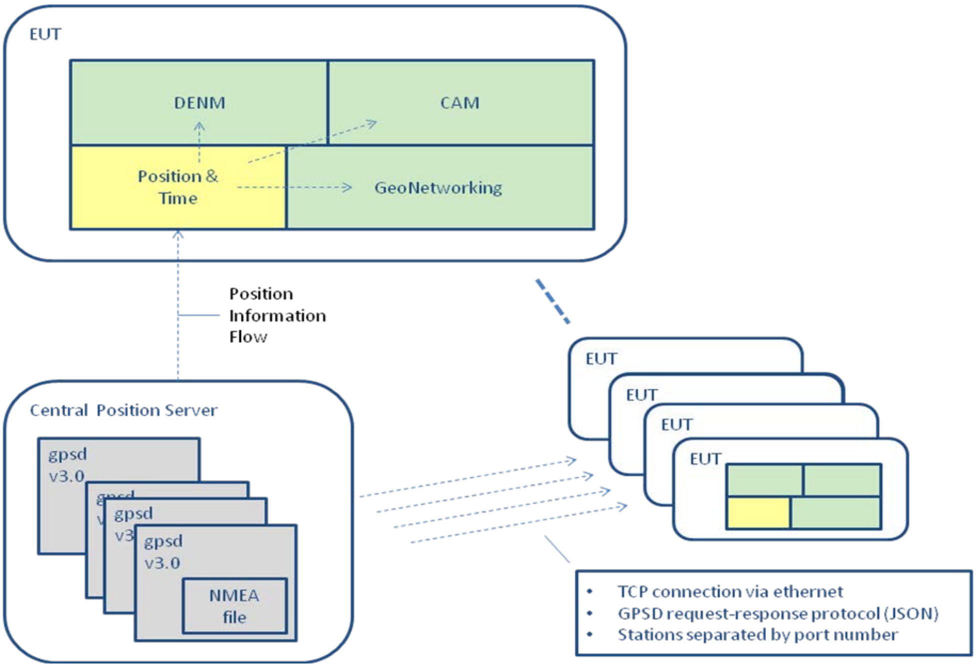

Figure 2: Central Position Server

6 Basic Configuration

6.1 PHY

The PHY layer of the communication system is based on IEEE802.11p-2010. This section only fixes the parameters to be used and, optionally, values that differ from this standard, when necessary for interoperability.

Table 7: PHY Parameters

Parameter	Value	Remarks
Center Frequency	5.900 GHz (CH 180) CCH	Optional 5.9 GHz. The choice of the channel depends on the results of interoperability and propagation tests.
Channel Bandwidth	10 MHz	
Max Transmit Power	20 dBm	Recommended value.
Default Rate	6 Mb/s	
Antenna type	omni directional	

6.2 MAC

6.2.1 Frame Format

Only data frames of subtype 0000 and 1000 (Data and QoS Data) are used. STAs must be able to process both subtypes.

6.2.2 Source MAC Addresses

Each supplier shall use a fixed MAC address.

6.3 LLC

6.3.1 Ether type

The ether type 0x8947 shall be used to indicate a GeoNetworking packet.

6.4 GN

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

The tests shall cover itsGnSecurity parameter set to both DISABLED state (unsecured Gn packet, used in most test cases) and to ENABLED state (secured Gn packet, used in some test cases).

6.5 BTP Port Mapping

BTP - A shall not be used.

BTP - B shall be used with the following mapping:

Table 8: BTP Port Mapping

	Dst port
CAM	2001
DENM	2002
MAP	2003
SPAT	2004

6.7 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.

6.7.1 Single hop messaging (GEO_CFG_01)

Table 9: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Receiver	1942	51.4714725806061 N	5.60842987805713 E

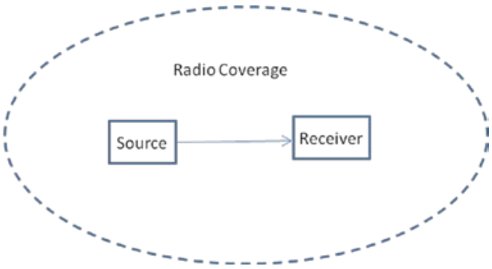

Figure 3: GEO_CFG_01

6.7.2 Distribution within Destination Area (GEO_CFG_02)

Table 10: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Receiver	1942	51.4714725806061 N	5.60842987805713 E

Table 11: 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

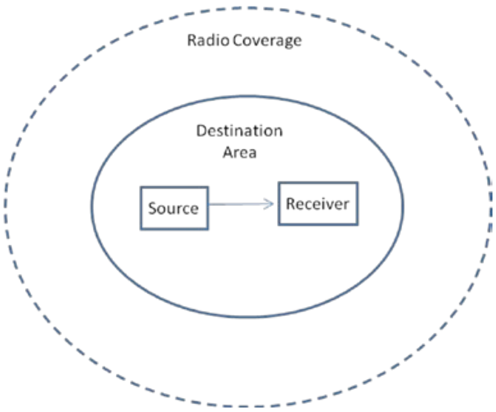

Figure 4: GEO_CFG_02

6.7.3 Distribution within Destination Area (GEO_CFG_02_B)

Table 12: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Receiver 1	1942	51.4714725806061 N	5.60842987805713 E
Receiver 2	1943	51.471427196132 N	5.60819751814514 E

Table 13: 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

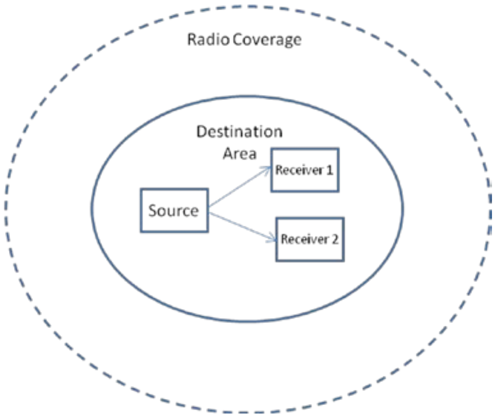

Figure 5: GEO_CFG_02_B

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

Table 14: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Neighbour 1	1942	51.4714725806061 N	5.60842987805713 E
Neighbour 2	1943	51.471427196132 N	5.60819751814514 E

Table 15: 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

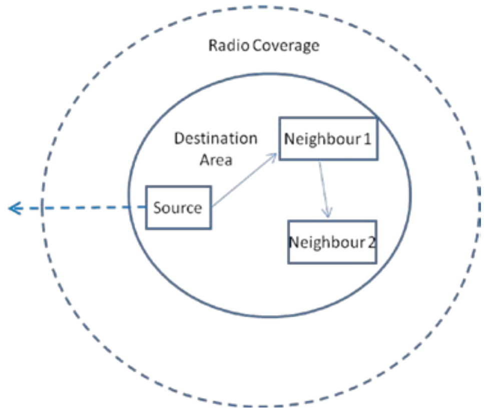

Figure 6: GEO_CFG_03

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

6.7.5 Receivers being outside of Destination Area (GEO_CFG_04)

Table 16: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Receiver	1942	51.4714725806061 N	5.60842987805713 E

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	0	Ellipse	100 m	20 m	0 degrees

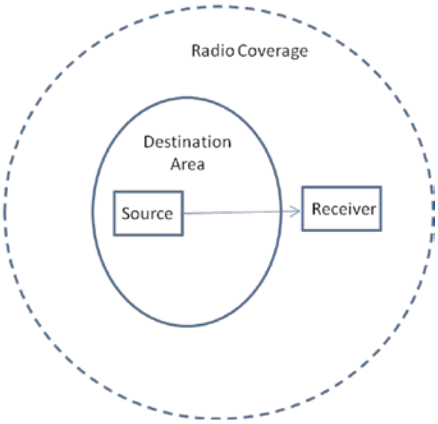

Figure 7: GEO_CFG_04

6.7.6 First receiver appears in Destination Area (GEO_CFG_05)

Table 18: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Receiver	1942	51.4714725806061 N	5.60842987805713 E

Table 19: 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

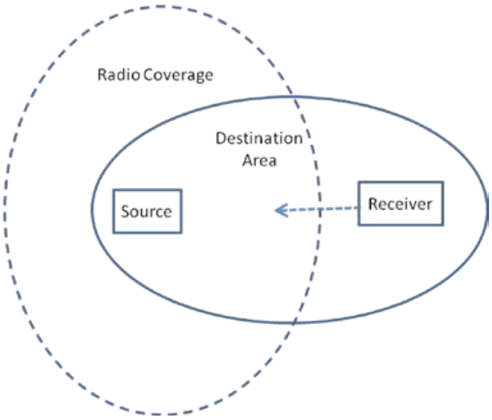

Figure 8: GEO_CFG_05

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

6.7.7 New receivers appears in Destination Area (GEO_CFG_06)

Table 20: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Neighbour	1942	51.4714725806061 N	5.60842987805713 E
Receiver	1943	51.471427196132 N	5.60819751814514 E

Table 21: 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

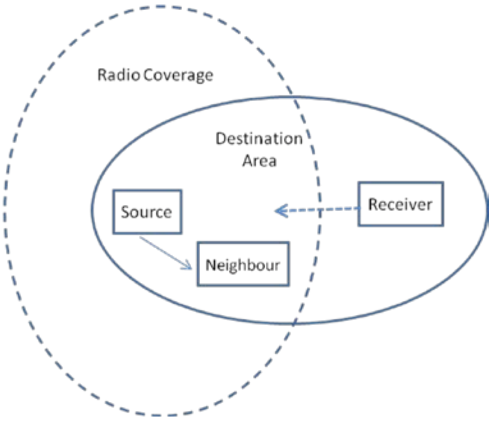

Figure 9: GEO_CFG_06

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

6.7.8 Line forwarding towards Destination Area (GEO_CFG_07)

Table 22: Geo Positions

Role	GPSD port	Lat	Lon
Source	1944	51.4713380467220 N	5.60773205529688 E
Forwarder	1942	51.4714725806061 N	5.60842987805713 E
Next Hop	1941	51.4716071144902 N	5.60912770081777 E

Table 23: 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
0.0002690677	0.0013956455	Ellipse	100 m	20 m	10 degrees

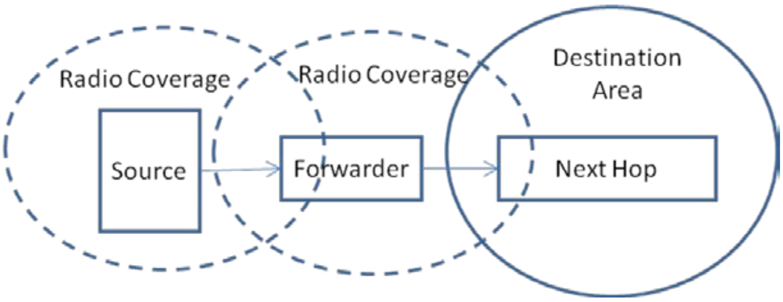

Figure 10: GEO_CFG_07

6.7.9 Geo Unicast Forwarding (GEO_CFG_07_B)

Table 24: Geo Positions

Role	GPSD port	Lat	Lon
Source	1944	51.4713380467220 N	5.60773205529688 E
Forwarder	1942	51.4714725806061 N	5.60842987805713 E
Destination	1941	51.4716071144902 N	5.60912770081777 E

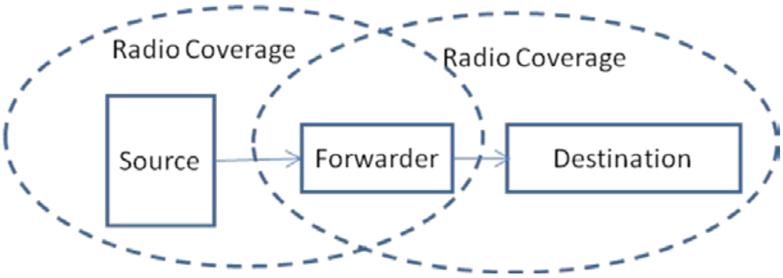

Figure 11: GEO_CFG_07_B

6.7.10 Forwarder moves towards Destination Area (GEO_CFG_08)

Table 25: Geo Positions

Role		GPSD port	Lat	Lon
Source		1944	51.4713380467220 N	5.60773205529688 E
Forwarder ~~Start position~~	Start position ~~10~~ ~~seconds later~~	1945	51.4710689789671 N ~~51.4713380467220 N~~	5.60703423251263 E ~~5.60842987805713 E~~
	~~10~~15 seconds later		51.4713380467220 N	5.60842987805713 E

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Table 26: 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
0.0002690677	0.0013956455	Ellipse	100 m	20 m	10 degrees

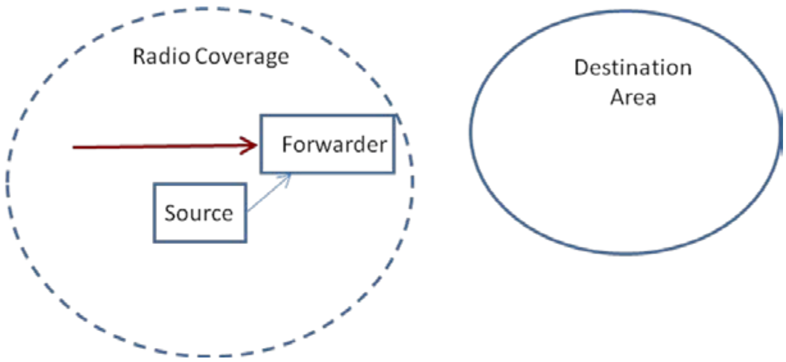

Figure 12: GEO_CFG_08

6.7.11 Source getting into the direction of Destination Area (GEO_CFG_08_B)

Table 27: Geo Positions

Role		GPSD port	Lat	Lon
Source	Start position	1945	51.4710689789671 N	5.60703423251263 E
	~~10~~ 15 seconds later		51.4713380467220 N	5.60842987805713 E
Forwarder		1944	51.4713380467220 N	5.60773205529688 E

Table 28: 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
0.0002690677	0.0013956455	Ellipse	100 m	20 m	10 degrees

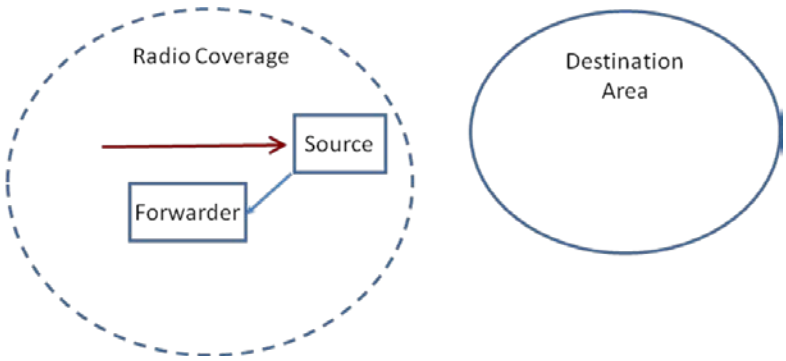

Figure 13: GEO_CFG_08_B

6.7.12 Forwarder not in direction of Destination Area (GEO_CFG_08_C)

Table 29: Geo Positions

Role	GPSD port	Lat	Lon
Source	1944	51.4713380467220 N	5.60773205529688 E
Forwarder ~~Start position~~	1955	51.4710689789671 N	5.60703423251263 E

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Table 30: 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
0.0002690677	0.0013956455	Ellipse	100 m	20 m	10 degrees

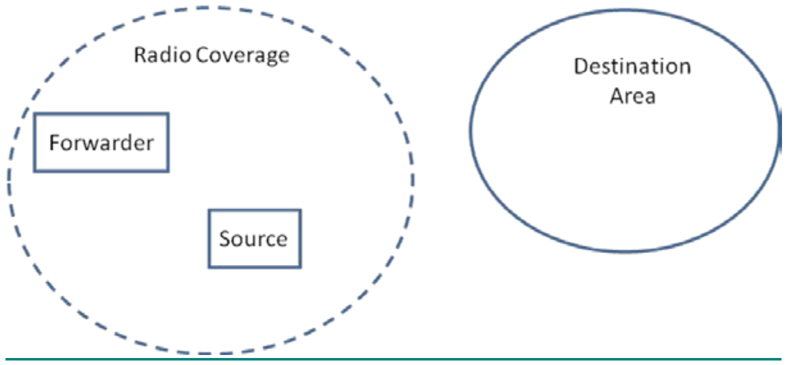

Figure 14: GEO_CFG_08_C

6.7.~~12~~13 Forwarder remains away from the Destination Area (GEO_CFG_09)

Table 31: Geo Positions

Role		GPSD port	Lat	Lon
Source		1944	51.4713380467220 N	5.60773205529688 E
Forwarder	Start position	1946	51.4710689789671 N	5.60703423251263 E
	~~10~~ 15 seconds later		51.4716071144902 N	5.60703423251263 E

Table 32: 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
0.0002690677	0.0013956455	Ellipse	100 m	20 m	10 degrees

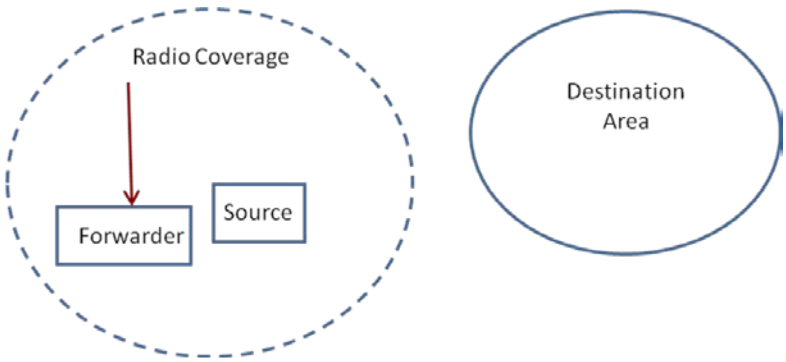

Figure 15: GEO_CFG_09

6.7.~~13~~14 Forwarded has no neighbour to the direction of Destination Area (GEO_CFG_09_B)

Table 33B: Geo Positions

Role	GPSD port	Lat	Lon
Source	1943	51.471427196132 N	5.60819751814514 E
Forwarder	1941	51.4716071144902 N	5.60912770081777 E

Table 34: 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
0.0002690677	0.0013956455	Ellipse	100 m	20 m	10 degrees

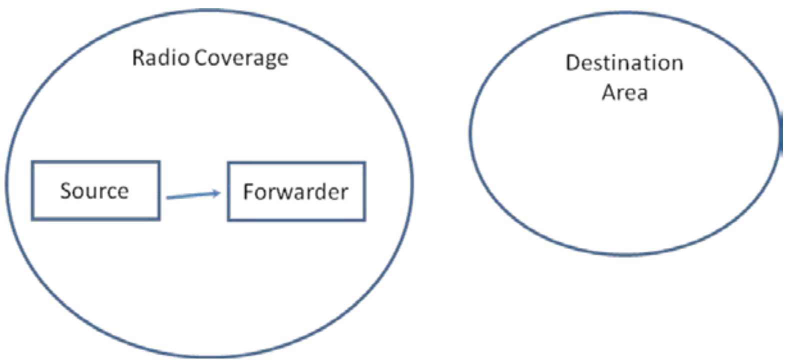

Figure 16: GEO_CFG_09_B

6.7.~~14~~15 Distribution within rectangular Destination Area (GEO_CFG_10)

Table 35: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Receiver	1942	51.4714725806061 N	5.60842987805713 E

Table 36: Destination Area

Destination area midpoint Lat – relative to originator	Destination area midpoint Lon – relative to originator	Destination area shape	Half-length of the long side	Half-length of the short side	Azimuth angle of the short side of the rectangle
-0.0001	-0.0001	Rectangle	200 m	100 m	90 degrees

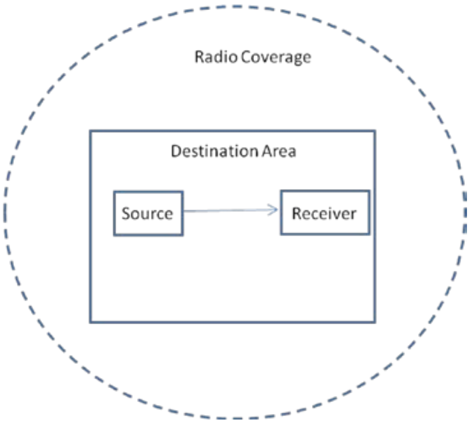

Figure 17: GEO_CFG_10

6.7.~~15~~16 Receivers being outside of rectangular Destination Area (GEO_CFG_11)

Table 37: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Receiver	1942	51.4714725806061 N	5.60842987805713 E

Table 38: Destination Area

Destination area midpoint Lat – relative to originator	Destination area midpoint Lon – relative to originator	Destination area shape	Half-length of the long side	Half-length of the short side	Azimuth angle of the short side of the rectangle
0	0	~~Ellipse~~Rectangle	100 m	20 m	0 degrees

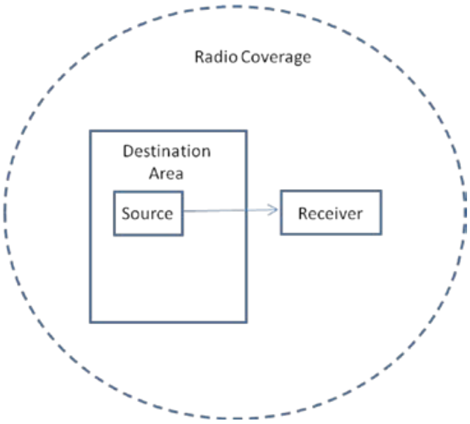

Figure 18: GEO_CFG_11

6.7.~~16~~17 Neighbors at varying distance from nearby destination area (GEO_CFG_12)

Table 39: Geo Positions

Role	GPSD port	Lat	Lon
Source	1944	51.4713380467220 N	5.60773205529688 E
Forwarder	1942	51.4714725806061 N	5.60842987805713 E
Neighbour	1947	51.4713071144902 N	5.60802770081777 E

Table 40: 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
0.0002690677	0.0013956455	Ellipse	100 m	20 m	10 degrees

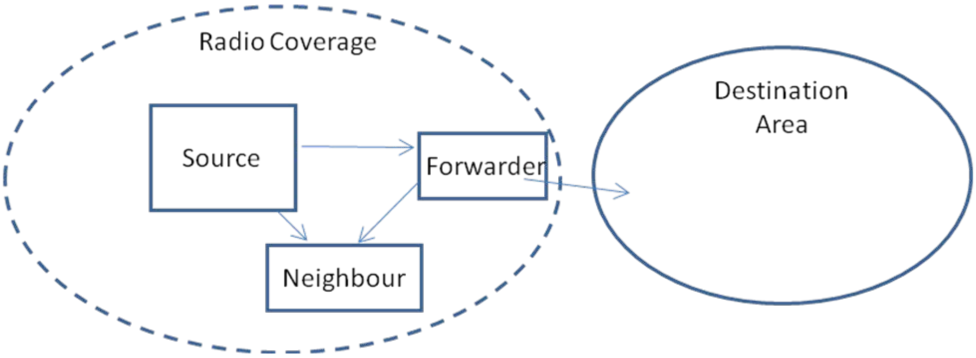

Figure 19: GEO_CFG_12

6.7.~~17~~18 Forwarder getting into the direction of Destination node (GEO_CFG_13)

Table 41: Geo Positions

Role		GPSD port	Lat	Lon
Source		1944	51.4713380467220 N	5.60773205529688 E
Forwarder	Start position	1945	51.4710689789671 N	5.60703423251263 E
	~~10~~ 15 seconds later		51.4713380467220 N	5.60842987805713 E
Destination		1948	51.4716071144 N	5.6091277008 E

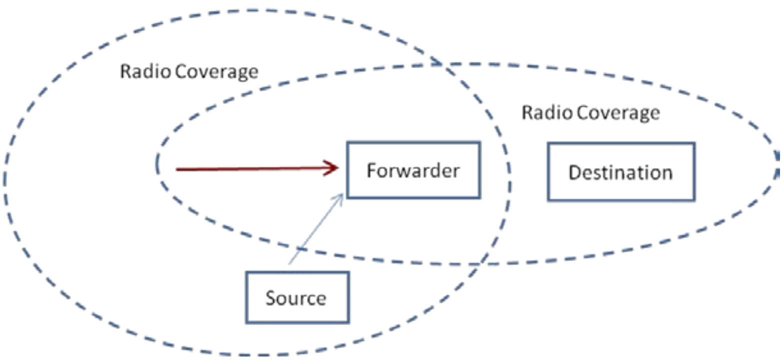

Figure 20: GEO_CFG_13

6.7.~~18~~19 Forwarder remains away from Destination node (GEO_CFG_14)

Table 42: Geo Positions

Role		GPSD port	Lat	Lon
Source		1944	51.4713380467220 N	5.60773205529688 E
Forwarder	Start position	1946	51.4710689789671 N	5.60703423251263 E
	~~10~~ 15 seconds later		51.4716071144902 N	5.60703423251263 E
Destination		1948	51.4716071144 N	5.6091277008 E

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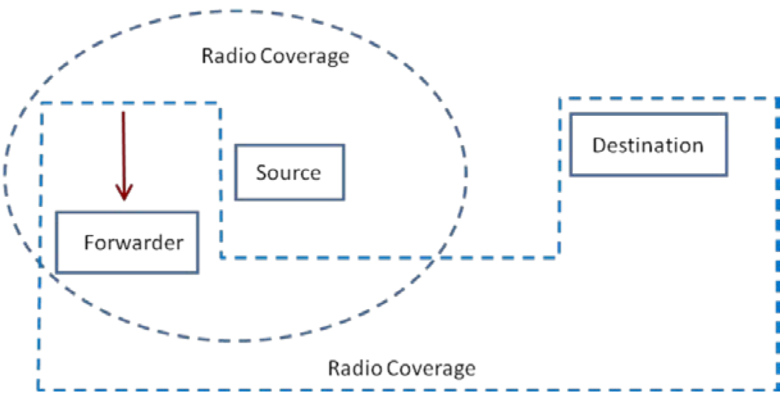

Figure 21: GEO_CFG_14

6.7.~~19~~20 Neighbors at varying distance from nearby destination device (GEO_CFG_15)

Table 43: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Forwarder	1950	51.4705710000000 N	5.60443100000000 E
Neighbour	1943	51.471427196132 N	5.60719751814514 E
Destination	1949	51.4696080000000 N	5.60132900000000 E

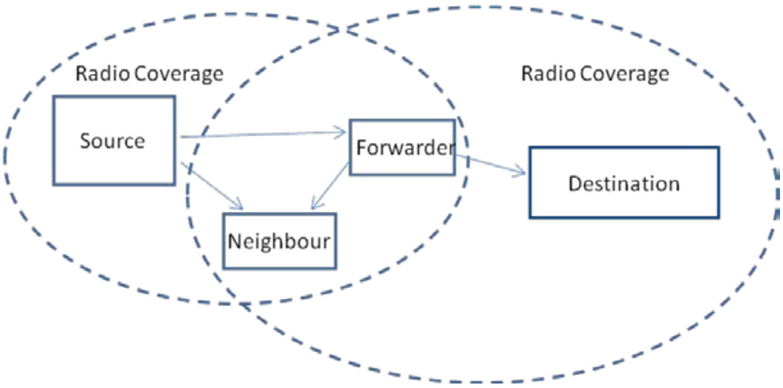

Figure 22: GEO_CFG_15

6.7.~~20~~21 Distribution within Destination Area – forwarders aligned in the same direction (GEO_CFG_16)

Table 44: Geo Positions

Role	GPSD port	Lat	Lon
Source	1941	51.4716071144902 N	5.60912770081777 E
Neighbour	1951	51.47151715530 N	5.608662609482 E
Forwarder	1943	51.471427196132 N	5.60719751814514 E

Table 45: 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

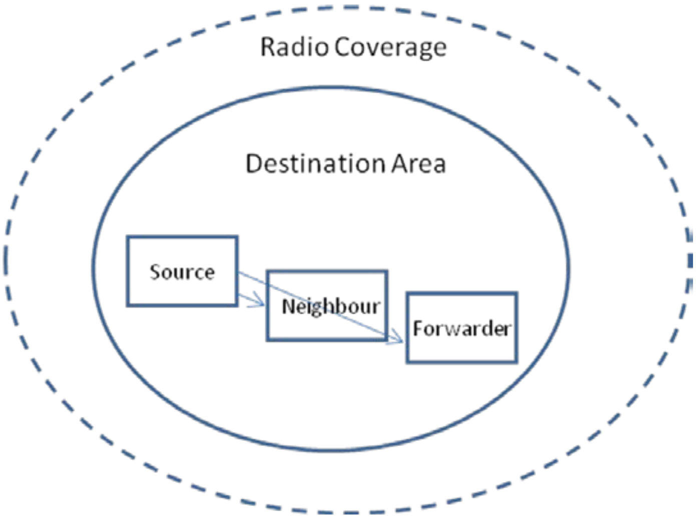

Figure 23: GEO_CFG_16

6.7.~~21~~22 Source moving at constant 90 km/h speed (GEO_CFG_17). Note: requires 10 Hz position server rate

Table 40: Geo Positions

Role		GPSD port	Lat	Lon
Source	Start position (0m)	1953	51.4716071144902 N	5.60912770081777 E
	0.1 seconds later (2.5m)		51.4716295723725 N	5.60912770081777 E
	0.2 seconds later (5m)		51.4716520302549 N	5.60912770081777 E
	10 seconds later (250m)		51.4738529027202 N	5.60912770081777 E
Receiver		1942	51.4714725806061 N	5.60842987805713 E

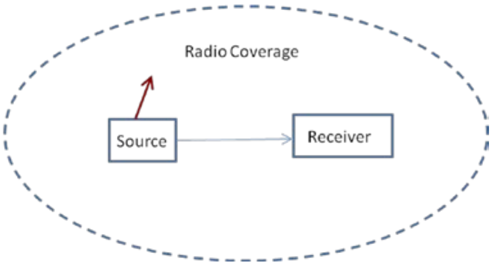

Figure 24: GEO_CFG_17

6.7.~~22~~23 Source moving at constant 3 m/s² acceleration (GEO_CFG_18). Note: requires 10 Hz position server rate)

Table 40B: Geo Positions

Role		GPSD port	Lat	Lon
Source	Start position (0m)	1954	51.4716071144902 N	5.60912770081777 E
	0.1 seconds later (0.015 m)		51.4716072492373 N	5.60912770081777 E
	0.2 seconds later (0.06 m)		51.4716076534785 N	5.60912770081777 E
	10 seconds later (150m)		51.472952 N	5.60912770081777 E
Receiver		1942	51.4714725806061 N	5.60842987805713 E

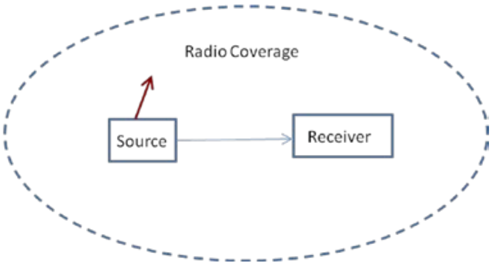

Figure 25: GEO_CFG_18

6.7.~~23~~24 All ITS nodes in the same GVL (GN6_CFG_01)

Table 46: Geo Positions

Role	GPSD port	Lat	Lon
EUT 1	1944	51.4713380467220 N	5.60773205529688 E
EUT 2	1942	51.4714725806061 N	5.60842987805713 E
EUT 3	1947	51.4713071144902 N	5.60802770081777 E

Table 47: GVL1

GeoArea midpoint Latitude	GeoArea midpoint Longitude	GeoArea shape	Dist. A	Dist. B	Angle	Prefix
51.4713380467220 N	5.60773205529688 E	Rectangle	100 m	100 m	0 degrees	3ffe:1::/64

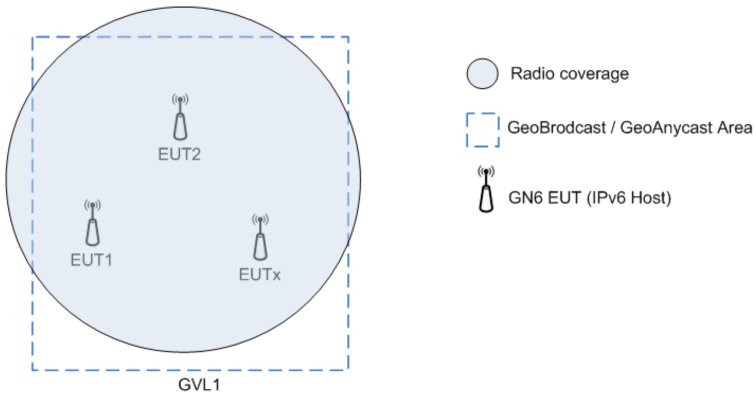

Figure 26: GN6_CFG_01

6.7.~~24~~25 ITS nodes in nearby GVLs (GN6_CFG_02)

Table 48: Geo Positions

Role	GPSD port	Lat	Lon
EUT 1	1944	51.4713380467220 N	5.60773205529688 E
EUT 2	1949	51.4696080000000 N	5.60132900000000 E

Table 49: GVL1

GeoArea midpoint Latitude	GeoArea midpoint Longitude	GeoArea shape	Dist. A	Dist. B	Angle	Prefix
51.4713380467220 N	5.60773205529688 E	Rectangle	100 m	100 m	0 degrees	3ffe:1::/64

Table 50: GVL2

GeoArea midpoint Latitude	GeoArea midpoint Longitude	GeoArea shape	Dist. A	Dist. B	Angle	Prefix
51.4696080000000 N	5.60132900000000 E	Rectangle	100 m	100 m	0 degrees	3ffe:2::/64

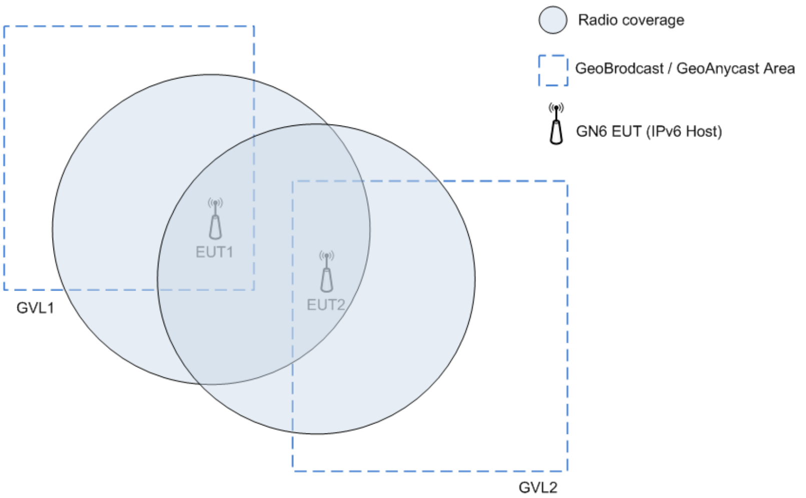

Figure 27: GN6_CFG_02

6.7.~~25~~26 Distant GVLs and legacy IPv6 backbone (GN6_CFG_03)

Table 51: Geo Positions

Role	GPSD port	Lat	Lon
EUT 1	1944	51.4713380467220 N	5.60773205529688 E
EUT 2	1942	51.4714725806061 N	5.60842987805713 E
EUT 3	1949	51.4696080000000 N	5.60132900000000 E
EUT 4	1952	51.4693000000000 N	5.60132900000000 E

Table 52: GVL1

GeoArea midpoint Latitude	GeoArea midpoint Longitude	GeoArea shape	Dist. A	Dist. B	Angle	Prefix
51.4713380467220 N	5.60773205529688 E	Rectangle	100 m	100 m	0 degrees	3ffe:1::/64

Table 53: GVL2

GeoArea midpoint Latitude	GeoArea midpoint Longitude	GeoArea shape	Dist. A	Dist. B	Angle	Prefix
51.4696080000000 N	5.60132900000000 E	Rectangle	100 m	100 m	0 degrees	3ffe:2::/64

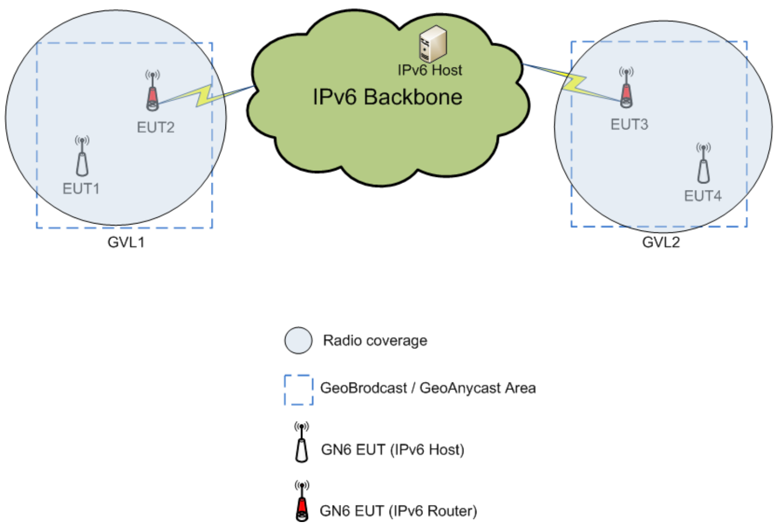

Figure 28: GN6_CFG_03

6.7.~~26~~27 Overlapping GVLs (GN6_CFG_04)

Table 54: Geo Positions

Role	GPSD port	Lat	Lon
EUT 1	1944	51.4713380467220 N	5.60773205529688 E
EUT 2	1949	51.4696080000000 N	5.60132900000000 E
EUT 3	1950	51.4705710000000 N	5.60443100000000 E

Table 55: GVL1

GeoArea midpoint Latitude	GeoArea midpoint Longitude	GeoArea shape	Dist. A	Dist. B	Angle	Prefix
51.4713380467220 N	5.60773205529688 E	Rectangle	700 m	700 m	0 degrees	3ffe:1::/64

Table 56: GVL2

GeoArea midpoint Latitude	GeoArea midpoint Longitude	GeoArea shape	Dist. A	Dist. B	Angle	Prefix
51.4696080000000 N	5.60132900000000 E	Rectangle	700 m	700 m	0 degrees	3ffe:2::/64

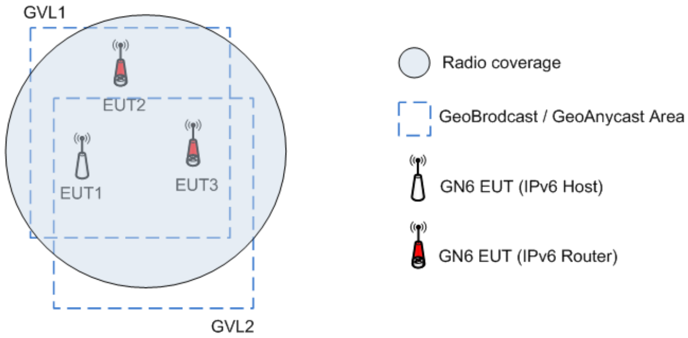

Figure 29: GN6_CFG_04

6.7.~~27~~28 Distant GVLs and in-vehicle IPv6 hosts (GN6_CFG_05)

Table 57: Geo Positions

Role	GPSD port	Lat	Lon
EUT 1	1944	51.4713380467220 N	5.60773205529688 E
EUT 2	1949	51.4696080000000 N	5.60132900000000 E
EUT 3	1950	51.4705710000000 N	5.60443100000000 E

Table 58: GVL1

GeoArea midpoint Latitude	GeoArea midpoint Longitude	GeoArea shape	Dist. A	Dist. B	Angle	Prefix
51.4713380467220 N	5.60773205529688 E	Rectangle	100 m	100 m	0 degrees	3ffe:1::/64

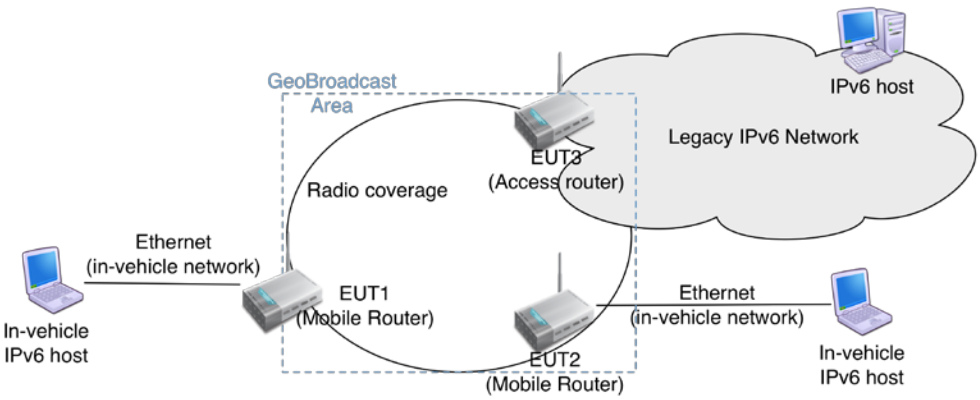

Figure 30: GN6_CFG_05

6.8 CPS parameters

Table 59: CPS Parameters

CFG	TD ID	Role	Test Session 1 CPS IP@:port	Motion Path	Usage of RF Test Bench
GEO_CFG_01	TD_GN_BEA_01 TD_GN_SHB_01 TD_GN_SHB_02 TD_GN_DAD_01 TD_GN_GUC_01 TD_CAM_05 TD_CAM_06 TD_CAM_07 TD_CAM_08	Source	1941		
		Receiver	1942		
GEO_CFG_02	TD_GN_GBC_01 TD_DENM_05	Source	1941		
		Receiver	1942		
GEO_CFG_02_B	TD_GN_GBC_02	Source	1941		YES
		Receiver 1	1942		
		Receiver 2	1943		
GEO_CFG_03	TD_DENM_03	Source	1941		YES (attenuation)
		Neighbor 1	1942		
		Neighbor 2	1943		
GEO_CFG_04	TD_GN_GBC_03	Source	1941		
		Receiver	1942		
GEO_CFG_05	TD_GN_GBC_04 TD_DENM_04 TD_GN_GBC_SCF_01	Source	1941		YES (attenuation)
		Receiver	1942		
GEO_CFG_06	TD_DENM_01 TD_DENM_02	Source	1941		YES (attenuation)
		Neighbor	1942		
		Receiver	1943		
GEO_CFG_07	TD_GN_GBC_FW_01	Source	1944		YES (attenuation)
		Forwarder	1942		
		Next Hop	1941		
GEO_CFG_07_B	TD_GN_GUC_02	Source	1944		YES (attenuation)
		Forwarder	1942		
		Next Hop	1941		
GEO_CFG_08	TD_GN_GBC_FW_02 ~~TD_GN_GBC_SCF_03~~	Source	1944	YES	
		Forwarder	1945*		
GEO_CFG_08_B	TD_GN_GBC_SCF_04	Source	1945*	YES	
		Forwarder	1944		
GEO_CFG_08_BC	TD_GN_GBC_SCF_03	Source	1945*	YES	
		Forwarder	1955		
GEO_CFG_09	TD_GN_GBC_FW_03	Source	1944	YES	
		Forwarder	1946*		
GEO_CFG_09_B	TD_GN_GBC_SCF_02	Source	1943		
		Forwarder	1941		
GEO_CFG_10	TD_GN_GBC_05	Source	1941		
		Receiver 1	1942		
GEO_CFG_11	TD_GN_GBC_06	Source	1941		
		Receiver 1	1942		

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CFG	TD ID	Role	Test Session 1 CPS IP@:port	Motion Path	Usage of RF Test Bench
GEO_CFG_12	TD_GN_GBC_FW_04	Source	1944		YES
		Forwarder	1942		
		Neighbour	1947		
GEO_CFG_13	TD_GN_GUC_GRD_01	Source	1944	YES	YES (attenuation)
		Forwarder	1945*		
		Destination	1948		
GEO_CFG_14	TD_GN_GUC_GRD_02 TD_GN_GUC_CBF_03	Source	1944	YES	YES (attenuation)
		Forwarder	1946*		
		Destination	1948		
GEO_CFG_15	TD_GN_GUC_CBF_01	Source	1944		YES (attenuation)
		Forwarder	1942		
		Neighbour	1947		
		Destination	1948		
GEO_CFG_16	TD_GN_GBC_07	Source	1941		YES
		Neighbor	1951		
		Forwarder	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		
GN6_CFG_01	TD_GN6_01 TD_GN6_03 TD_GN6_04 TD_GN6_05	EUT 1	1944		YES
		EUT 2	1942		
		EUT 3	1947		
GN6_CFG_02	TD_GN6_02	EUT 1	1944		YES
		EUT 2	1949		
GN6_CFG_03	TD_GN6_09 TD_GN6_10	EUT 1	1944		YES (attenuation)
		EUT 2	1942		
		EUT 3	1949		
		EUT 4	1952		
GN6_CFG_04	TD_GN6_06 TD_GN6_07 TD_GN6_08	EUT 1	1944		YES
		EUT 2	1949		
		EUT 3	1950		
GN6_CFG_05	TD_GN6_11 TD_GN6_12	EUT1	1944		YES
		EUT2	1949		
		EUT3	1950		

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

6.9 CAM frequency

CAM generation frequency shall be controlled according to clause 6.1.3 of [4].

6.10 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.

6.11 Security Settings

There are dedicated Security Tests defined. However, unless security settings are explicitly defined, it is assumed that the IOP testing is done without security, i.e. in the case of GN that is NH field always 0 or 1, never 2.

6.12 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 '6.11 Security Settings' and '6.12 SCF Bit Settings'.

7.1 GN Beaconing

7.1.1 Detection of neighbour

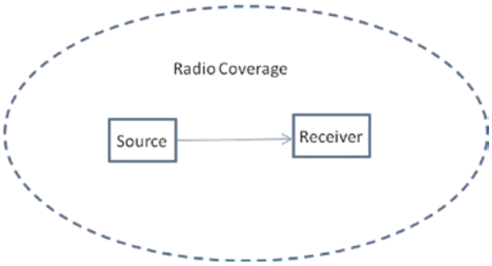

Figure 31: GEO_CFG_01

Interoperability Test Description			
Identifier:	TD_GN_BEA_01		
Objective:	Detection of neighbour		
Configuration:	GEO_CFG_01		
References:	[2] 9.2.3~~.1~~, 9.3.6.3		
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		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source ITS-S sends beacons
	2	verify	Receiver ITS-S detects its neighbour
	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

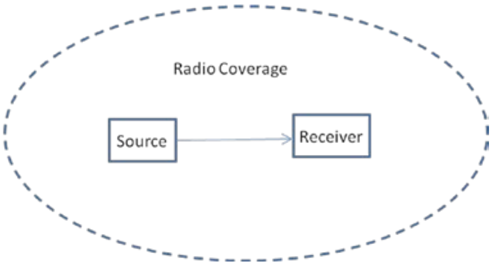

Figure 32: GEO_CFG_01

Interoperability Test Description			
Identifier:	TD_GN_SHB_01		
Objective:	Broadcasting of CAM messages is correctly handled		
Configuration:	GEO_CFG_01		
References:	[2] 9.3.10~~1~~ [4] 7~~.2~~		
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)

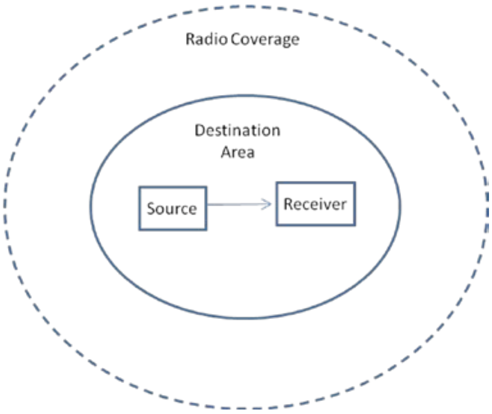

Figure 33: GEO_CFG_02

Interoperability Test Description			
Identifier:	TD_GN_GBC_01		
Objective:	DENM message is processed inside its Destination Area		
Configuration:	GEO_CFG_02		
References:	[2] 9.3.11 [5] 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)

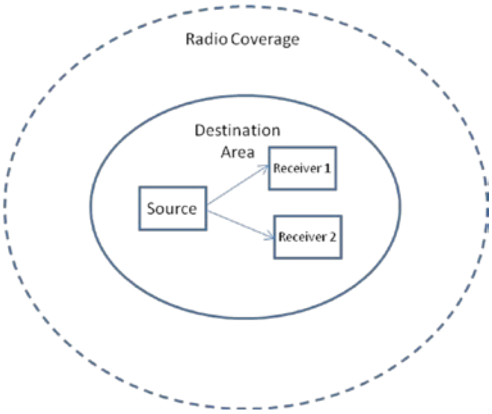

Figure 34: GEO_CFG_02_B

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:	[2] 9.3.11 [5] 6.1.3.2~~, B.7~~		
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 ~~expiryTime~~ 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 ~~Configure the CBF(2) algorithm value for the *itsGnGeoBroadcastForwardingAlgorithm* protocol parameter (or set otherwise CBF broadcast algorithm to be used)~~ · 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

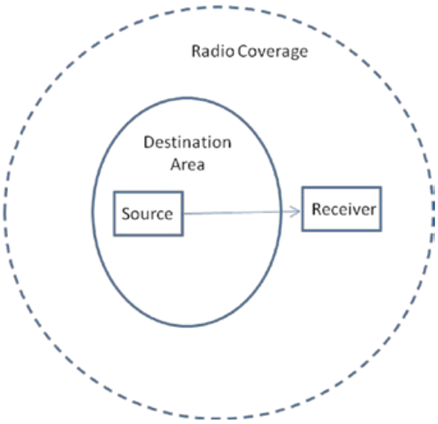

Figure 35: GEO_CFG_04

Interoperability Test Description			
Identifier:	TD_GN_GBC_03		
Objective:	DENM message is not processed outside its Destination Area		
Configuration:	GEO_CFG_04		
References:	[2] 9.3.11 [5] 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

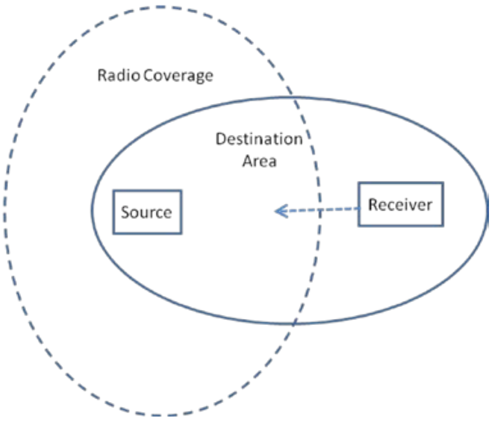

Figure 36: GEO_CFG_05

Interoperability Test Description			
Identifier:	TD_GN_GBC_04		
Objective:	Geo-broadcast message caching is correctly implemented		
Configuration:	GEO_CFG_05		
References:	[2] 9.3.11 [5] 6.1.3.2, 7.1.2~~B.6~~		
Pre-test conditions:	• ITS-S devices (Source and Receiver) installed in RF testbench, connected through antenna cable with controllable link attenuator on it • ~~Set itsGnMaxPacketLifetime parameter to 600 s (default value) in the MIB if the 'Maximum packet lifetime' parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set 'Maximum packet lifetime' parameter of GN-DATA.request primitive to 600 s~~ • 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 o and ~~expiryTime~~ validityDuration set to 6 seconds ~~o DENM transmission frequency set to 1.1 Hz Hz (i.e. transmissionInterval repetitionInterval is 900 ms), and DENM repetitionDuration is set to 5 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	~~After the DENM lifetime expires, but before the expiry of itsGnMaxPacketLifetime timer; l~~Lower the attenuation on the connection, so that the two devices are on-link
	3	verify	Receiver devices receives ~~all the 6 cached~~ buffered GeoBroadcasts containing the DENM message
	~~4~~	~~verify~~	~~Receiver passes all received DENM messages to its Facility layer~~

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

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7.3.5 Forwarding outside GeoArea

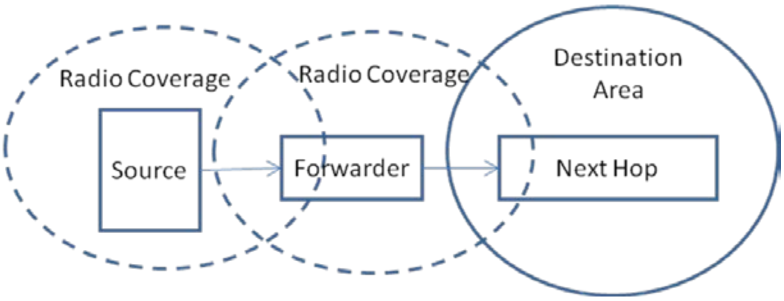

Figure 37: GEO_CFG_07

Note: This test can be run with itsGnGeoBroadcastForwardingAlgorithm set to SIMPLE/CBF/ADVANCED

Interoperability Test Description			
Identifier:	TD_GN_GBC_FW_01		
Objective:	DEN message is correctly forwarded to its Destination Area		
Configuration:	GEO_CFG_07		
References:	[2] 9.3.11 [45] 5.1		
Pre-test conditions:	• 3 ITS-S devices (Source, Forwarder and Next Hop) installed in RF testbench with controllable link attenuator • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • 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 • Source and Next Hop are off-link • Source and Forwarder are on-link • Forwarder and Next Hop 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	verify	Forwarder receives GeoBroadcast packet containing DENM message
	3	check	Received GeoBroadcast packet is carried by a link layer packet containing the link layer destination address indicating the Forwarder MAC address
	4	verify	Forwarder does not pass DENM message to its Facility layer
	5	verify	Next Hop receives GeoBroadcast packet containing DENM message
	6	check	Received GeoBroadcast packet is carried by a link layer packet containing the link layer destination address indicating the Next Hop MAC address
	7	verify	Next Hop passes DENM message to its Facility layer
	8	check	Next Hop sends a GeoBroadcast packet carried by a link layer packet containing the link layer destination address indicating broadcast MAC address

7.3.6 GeoRouting towards Destination Area

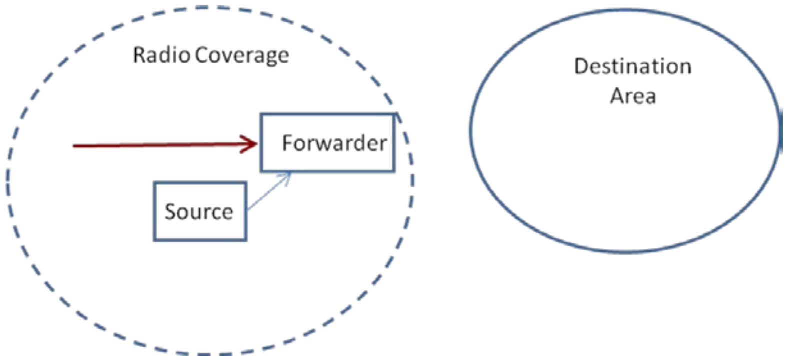

Figure 38: GEO_CFG_08

Note: This test can be run with itsGnGeoBroadcastForwardingAlgorithm set to SIMPLE/CBF/ADVANCED

Interoperability Test Description			
Identifier:	TD_GN_GBC_FW_02		
Objective:	DEN message is correctly geo-routed towards its Destination Area		
Configuration:	GEO_CFG_08		
References:	[2] 9.3.11 [5] 6.1.3.2		
Pre-test conditions:	• 2 ITS-S devices (Source, Forwarder) • Set itsGnMaxPacketLifetime parameter to 600 s (default value) in the MIB if the ‘Maximum packet lifetime’ parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set ‘Maximum packet lifetime’ parameter of GN-DATA.request primitive to 600 s • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • 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 • 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	Forwarder does not receive a GeoBroadcast packet while it’s position is opposite the Destination area
	3	stimulus	At some point along the pre-programmed path, the Forwarder’s position becomes less distant from the Destination area than the position of the Source
	4	Verify	Forwarder receives GeoBroadcast packet containing DENM message
	5	Check	Received GeoBroadcast packet is carried by a link layer packet containing the link layer destination address indicating the Forwarder MAC address
	6	Verify	Forwarder does not pass DENM message to its Facility layer

7.3.7 No suitable Forwarder towards Destination Area

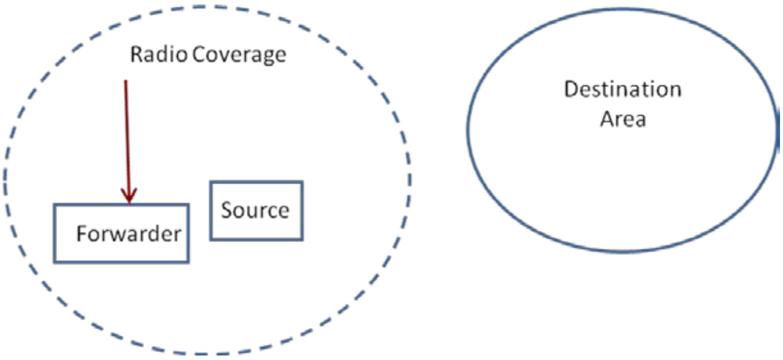

Figure 39: GEO_CFG_09

Note: This test can be run with itsGnGeoBroadcastForwardingAlgorithm set to SIMPLE/CBF/ADVANCED

Interoperability Test Description			
Identifier:	TD_GN_GBC_FW_03		
Objective:	DEN message geo-routing is correctly handled when no suitable forwarder exists		
Configuration:	GEO_CFG_09		
References:	[2] 9.3.11 [5] 6.1.3.2		
Pre-test conditions:	• 2 ITS-S devices (Source, Forwarder) • Set itsGnMaxPacketLifetime parameter to 600 s (default value) in the MIB if the 'Maximum packet lifetime' parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set 'Maximum packet lifetime' parameter of GN-DATA.request primitive to 600 s • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • 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 • 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	Forwarder does not receive a GeoBroadcast packet at all, as its path stays always more distant from the Destination area than the position of the Source

7.3.~~8~~6 EUT line-forwards the DENM message when it is the best forwarder

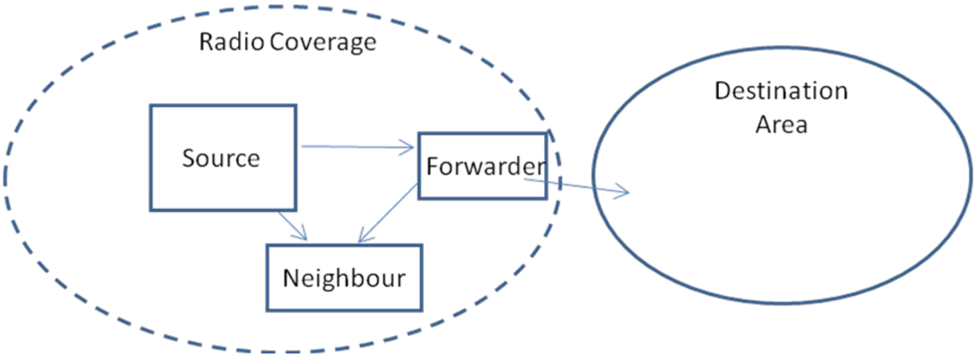

Figure 40: GEO_CFG_12

Note: This test can be run with itsGnGeoBroadcastForwardingAlgorithm set to SIMPLE/CBF/ADVANCED

Interoperability Test Description			
Identifier:	TD_GN_GBC_FW_04		
Objective:	Verify that the best positioned EUT is forwarding a message		
Configuration:	GEO_CFG_12		
References:	[2] 9.3.11, Annex D.~~3~~2 [5] 6.1.3.2		
Pre-test conditions:	3 ITS-S devices (1 Source, 1 Forwarder, 1 Neighbour) 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 All ITS-S devices are on-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	verify	Forwarder receives a GeoBroadcast packet containing DENM message. Neighbour does not ~~receive~~ process a GN packet, since it is addressed to Forwarder MAC address.

7.4 Duplicate Address Detection

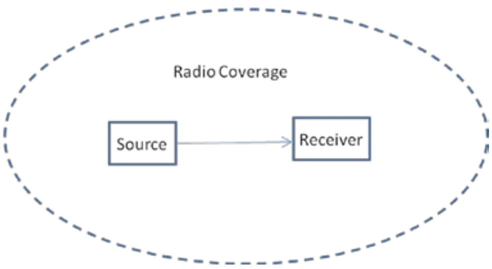

Figure 41: GEO_CFG_01

Interoperability Test Description			
Identifier:	TD_GN_DAD_01		
Objective:	Resolution of duplicate Gn address scenario		
Configuration:	GEO_CFG_01		
References:	[2] 9.2.3.1, 9.2.1.4		
Pre-test conditions:	2 ITS-S devices (Source, Forwarder) Set Gn address configuration method of ITS-S devices to use managed configuration (MIB attribute itsGnLocalAddrConfMethod is set to ~~MANAGED~~ AUTO (~~1~~0)) Configure the Gn addresses of each ITS-S device to be the same one (10000001) 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	Each ITS-S sends beacons or CAM
	2	verify	Starting from the second beacon or CAM, each ITS-S detects its neighbour(s) having a different Gn address from its own one

7.5 Rectangular Destination Area

7.5.1 EUT inside rectangular DENM Destination area (no duplicate checking)

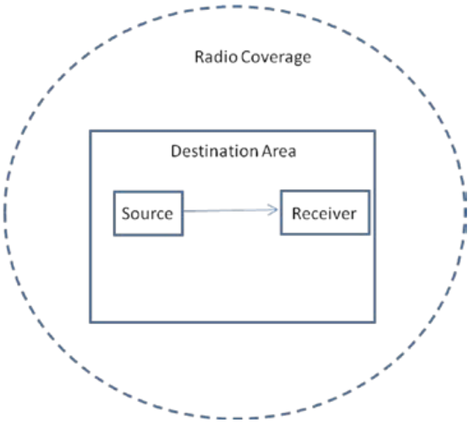

Figure 42: GEO_CFG_10

Interoperability Test Description			
Identifier:	TD_GN_GBC_05		
Objective:	DENM message is processed inside a rectangular Destination Area		
Configuration:	GEO_CFG_10		
References:	[2] 9.3.11 [5] 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

7.5.2 EUT outside rectangular DENM Destination area

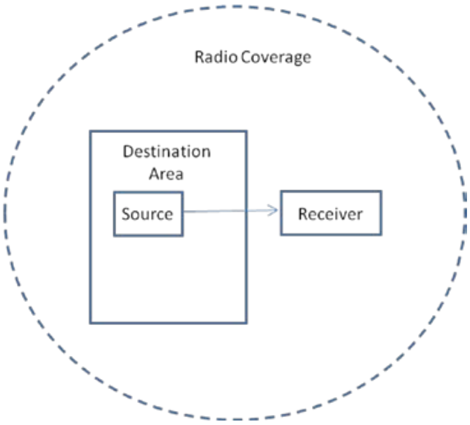

Figure 43: GEO_CFG_11

Interoperability Test Description			
Identifier:	TD_GN_GBC_06		
Objective:	DENM message is not processed outside its rectangular Destination Area		
Configuration:	GEO_CFG_11		
References:	[2] 9.3.11 [5] 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

7.6 CBF algorithm based dissemination of Geo-broadcast information

7.6.1 DENM message is re-broadcasted by furthest neighbour (CBF algorithm) inside Destination Area

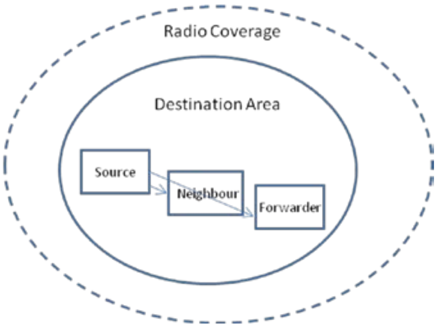

Figure 44: GEO_CFG_16

Interoperability Test Description				
Identifier:	TD_GN_GBC_07			
Objective:	Verify that the best positioned EUT is retransmitting a broadcast under CBF algorithm			
Configuration:	GEO_CFG_16			
References:	[2] Annex E.3			
Pre-test conditions:	3 ITS-S devices (Source, Neighbour, Forwarder) 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 the CBF(2) algorithm value for the *itsGnGeoBroadcastForwardingAlgorithm* protocol parameter (or set otherwise CBF broadcast algorithm to be used) 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	verify	Both Neighbour and Forwarder receive a GeoBroadcast packet containing DENM message	
	3	verify	Forwarder retransmits a GeoBroadcast packet containing DENM message	
	4	verify	Neighbour does not retransmit a GeoBroadcast packet after receiving Forwarder's retransmission	

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7.7 Geo-Unicast scenarios

7.7.1 Geo-unicast messages are interoperable

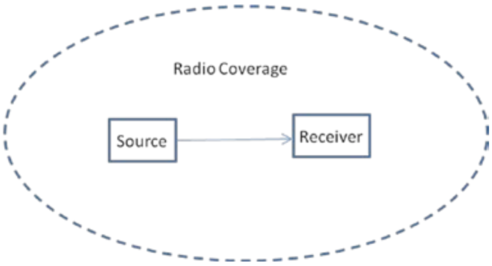

Figure 45: GEO_CFG_01

Interoperability Test Description			
Identifier:	TD_GN_GUC_01		
Objective:	Verification of Geo-unicast messages being interoperable		
Configuration:	GEO_CFG_01		
References:	[2] 9.3.8		
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 Preconfigure the a geo-unicast message in one ITS-S device, which is addressed to the Gn address and geographic position of the other ITS-S device. This requires direct access to the Gn protocol SAP.		
Test Sequence:	**Step**	**Type**	**Description**
	1	verify	Each ITS-S devices has received beacon or CAM message from the other one
	2	stimulus	Trigger the transmission of the preconfigured geo-unicast message in the source ITS-S device by passing it to the Gn upper SAP
	3	check	The destination ITS-S device receives the geo-unicast message and correctly recognizes it being a geo-unicast message type
	4	check	The destination ITS-S device recognizes being the destination of the received geo-unicast message, and passes it to the Gn upper SAP

7.7.2 Multi-hop geo-unicast forwarding is interoperable (Greedy Forwarding Algorithm)

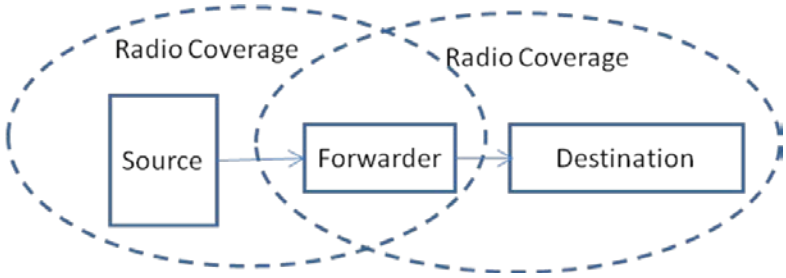

Figure 46: GEO_CFG_07_B

Interoperability Test Description				
Identifier:	TD_GN_GUC_02			
Objective:	Geo-unicast message is correctly forwarded to its Destination over an intermediate node, including location service			
Configuration:	GEO_CFG_07_B			
References:	[2] 9.3.8			
Pre-test conditions:	• 3 ITS-S devices (Source, Forwarder and Next Hop) installed in RF testbench with controllable link attenuator • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • Preconfigure a geo-unicast message in the source ITS-S device, which is addressed to the Gn address of the Next Hop ITS-S device. This requires direct access to the Gn protocol SAP • Configure the GREEDY(1) algorithm value for the *itsGnGeoUnicastForwardingAlgorithm* protocol parameter (or set otherwise GREEDY broadcast algorithm to be used) • Each ITS-S device has sent at least 1 beacon or 1 CAM • Source and Destination are off-link • Source and Forwarder are on-link • Forwarder and Destination are on-link • TSB from Destination via Forwarder to Source (so that Source can get the position of Destination)			
Test Sequence:	**Step**	**Type**	**Description**	
	1	stimulus	Source is requested to send a preconfigured GeoUnicast message	
	2	verify~~verify~~	Forwarder receives a GeoUnicast packet~~Forwarder receives Location Service Request packet~~	
	3	check~~check~~	Received GeoUnicast packet is carried by a link layer packet containing the link layer destination address indicating the Forwarder MAC address~~Received Location Service Request packet contains the Gn address of the Next Hop device and is carried by a link layer packet containing the link layer destination address indicating the broadcast MAC address~~	
	4	verify~~verify~~	Forwarder does not pass GeoUnicast packet to its upper Gn SAP~~Forwarder retransmits the Location Service Request packet~~	
	5	verify~~verify~~	Next Hop device receives GeoUnicast packet from the Forwarder device~~Forwarder receives Location Service Response packet~~	
	6	check~~check~~	Received GeoUnicast packet is carried by a link layer packet containing the link layer destination address indicating the Next Hop MAC address~~Received Location Service Response packet contains in the DEPV field the Gn address of the Source device and is carried by a link layer packet containing the link layer destination address indicating the Forwarder's MAC address~~	
	7	verify~~verify~~	Next Hop passes GeoUnicast message content to its upper Gn SAP~~Forwarder retransmits the Location Service Response packet~~	
	~~8~~	~~verify~~	~~Forwarder receives a GeoUnicast packet~~	
	~~9~~	~~check~~	~~Received GeoUnicast packet is carried by a link layer packet containing the link layer destination address indicating the Forwarder MAC address~~	
	~~10~~	~~verify~~	~~Forwarder does not pass GeoUnicast packet to its upper Gn SAP~~	
	~~11~~	~~verify~~	~~Next Hop device receives GeoUnicast packet from the Forwarder device~~	
	~~12~~	~~check~~	~~Received GeoUnicast packet is carried by a link layer packet containing the link layer destination address indicating the Next Hop MAC address~~	
	~~13~~	~~verify~~	~~Next Hop passes GeoUnicast message content to its upper Gn SAP~~	

7.7.3 A message is correctly geo-routed towards its Destination (Greedy Forwarding algorithm)

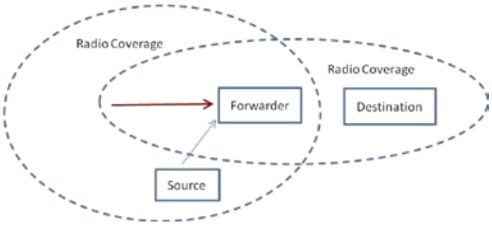

Figure 47: GEO_CFG_13

Interoperability Test Description			
Identifier:	TD_GN_GUC_GRD_01		
Objective:	DENM message is correctly geo-routed towards its Destination Area		
Configuration:	GEO_CFG_13		
References:	[2] 9.3.8		
Pre-test conditions:	• 3 ITS-S devices (Source, Forwarder, Destination) installed in RF testbench with controllable link attenuator • Set *itsGnMaxPacketLifetime* parameter to 600 s (default value) in the MIB if the 'Maximum packet lifetime' parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set 'Maximum packet lifetime' parameter of GN-DATA.request primitive to 600 s • Configure the GREEDY(1) algorithm value for the *itsGnGeoUnicastForwardingAlgorithm* protocol parameter (or set otherwise GREEDY forwarding to be used) • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • Preconfigure the a geo-unicast message in the source ITS-S device, which is addressed to the Gn address of the destination ITS-S device. This requires direct access to the Gn protocol SAP. • Source and Destination are off-link • Source and Forwarder are on-link • Neighbour and Destination are on-link • Each ITS-S device has sent at least 1 beacon or 1 CAM • TSB from Destination via Forwarder to Source (so that Source can get the position of Destination)		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a preconfigured GeoUnicast message
	2	verify	Forwarder does not receive a GeoUnicast packet while it is in the opposite direction from the Destination device
	3	stimulus	At some point along the pre-programmed path, the Forwarder's position becomes less distant from the Destination device than the position of the Source
	4	verify	Forwarder receives GeoUnicast packet
	5	check	Received GeoUnicast packet is carried by a link layer packet containing the link layer destination address indicating the Forwarder MAC address
	6	verify	Forwarder does not pass the GeoUnicast message to its upper Gn SAP

7.7.4 Geo-routing is correctly handled when no suitable forwarder exists (Greedy Forwarding algorithm)

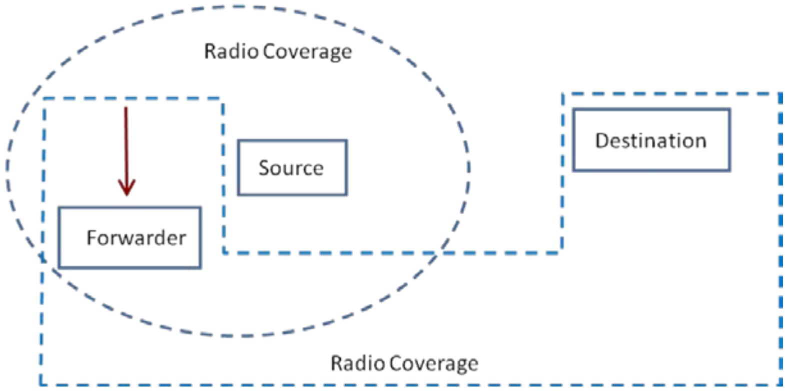

Figure 48: GEO_CFG_14

Interoperability Test Description			
Identifier:	TD_GN_GUC_GRD_02		
Objective:	DENM message geo-routing is correctly handled when no suitable forwarder exists		
Configuration:	GEO_CFG_14		
References:	[2] 9.3.8		
Pre-test conditions:	• 3 ITS-S devices (Source, Forwarder, Destination) installed in RF testbench with controllable link attenuator • Set *itsGnMaxPacketLifetime* parameter to 600 s (default value) in the MIB if the 'Maximum packet lifetime' parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set 'Maximum packet lifetime' parameter of GN-DATA.request primitive to 600 s • Configure the GREEDY(1) algorithm value for the *itsGnGeoUnicastForwardingAlgorithm* protocol parameter (or set otherwise GREEDY forwarding to be used) • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • Preconfigure the a geo-unicast message in the source ITS-S device, which is addressed to the Gn address of the destination ITS-S device. This requires direct access to the Gn protocol SAP. • Source and Destination are off-link • Source and Forwarder are on-link • Forwarder and Destination are on-link • Each ITS-S device has sent at least 1 beacon or 1 CAM • TSB from Destination via Forwarder to Source (so that Source can get the position of Destination)		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a preconfigured GeoUnicast packet
	2	verify	Forwarder does not receive a GeoUnicast packet at all, as its path stays always more distant from the Destination device than the position of the Source

7.7.~~5~~3 EUT forwards the geo-unicast message when it is the best forwarder (CBF algorithm)

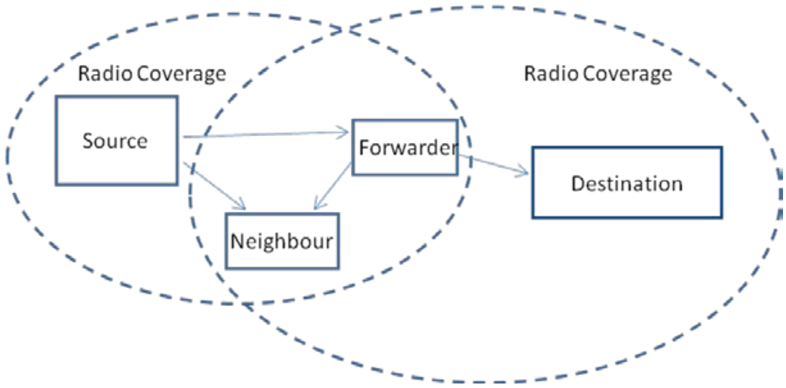

Figure 49: GEO_CFG_15

Interoperability Test Description				
Identifier:	TD_GN_GUC_CBF_01			
Objective:	Verify that the best positioned EUT is forwarding a unicast message under CBF algorithm			
Configuration:	GEO_CFG_15			
References:	[2] 9.3.8			
Pre-test conditions:	4 ITS-S devices (Source, Neighbour, Forwarder and Destination devices) installed in RF testbench with controllable link attenuator 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 the CBF(2) algorithm value for the *itsGnGeoUnicastForwardingAlgorithm* protocol parameter (or set otherwise CBF forwarding to be used) Preconfigure the a GeoUnicast message in the source ITS-S device (EUT 1), which is addressed to the Gn address of the destination ITS-S device. This requires direct access to the Gn protocol SAP • Source, Forwarder and Neighbour are on-link • Destination is off-link with all, except with Forwarder • Each ITS-S device has sent at least 1 beacon or 1 CAM • TSB from Destination via Forwarder to Source (so that Source can get the position of Destination			
Test Sequence:	**Step**	**Type**	**Description**	
	1	stimulus	Source is requested to send a preconfigured GeoUnicast message	
	2	verify	Both Neighbour and Forwarder devices receive a GeoUnicast packet	
	3	check	Received GeoUnicast packet is carried by a link layer packet containing the broadcast MAC address	
	4	verify	Forwarder retransmits ~~a~~ the GeoUnicast packet ~~containing DENM message~~	
	5	verify	Neighbour does not retransmit ~~a~~ the GeoUnicast packet	

7.7.~~6~~4 The EUT does not forward the geo-unicast message when it is in the wrong direction from the destination (CBF algorithm)

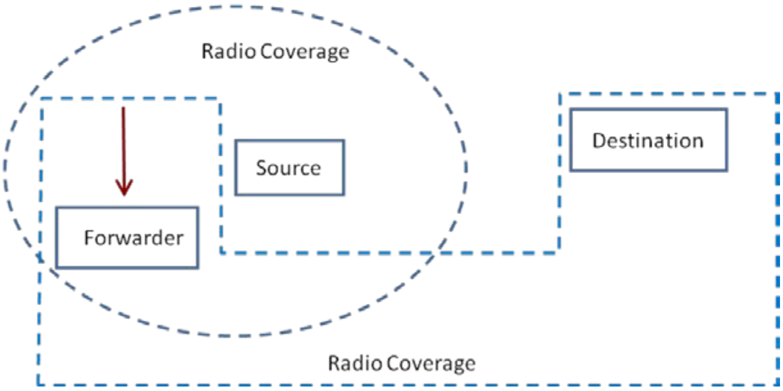

Figure 50: GEO_CFG_14

Interoperability Test Description			
Identifier:	TD_GN_GUC_CBF_03		
Objective:	Verify that the EUT is not forwarding a unicast message under CBF algorithm when it is in the wrong direction from the destination		
Configuration:	GEO_CFG_14		
References:	[2] 9.3.8		
Pre-test conditions:	3 ITS-S devices (Source, Forwarder, Destination) installed in RF testbench with controllable link attenuator 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 the CBF(2) algorithm value for the *itsGnGeoUnicastForwardingAlgorithm* protocol parameter (or set otherwise CBF forwarding to be used) Preconfigure the a GeoUnicast message in the source ITS-S device (EUT 1), which is addressed to the Gn address of the destination ITS-S device. This requires direct access to the Gn protocol SAP. • Source and Destination are off-link • Source and Forwarder are on-link • Forwarder and Destination are on-link • Each ITS-S device has sent at least 1 beacon or 1 CAM • TSB from Destination via Forwarder to Source (so that Source can get the position of Destination)		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send a preconfigured GeoUnicast message
	2	verify	~~EUT2~~ Forwarder receives a GeoUnicast packet ~~containing DENM message~~
	3	verify	~~EUT2~~ Forwarder does not retransmit ~~a~~ the GeoUnicast packet

7.8 SCF disabled scenarios

7.8.1 No DENM message caching in absence of neighbours when SCF is disabled

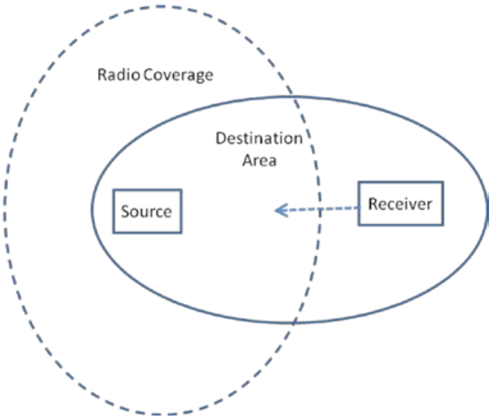

Figure 51: GEO_CFG_05

<table>
<tr><th colspan="4">Interoperability Test Description</th></tr>
<tr><td>Identifier:</td><td colspan="3">TD_GN_GBC_SCF_01</td></tr>
<tr><td>Objective:</td><td colspan="3">Geo-broadcast message caching is correctly implemented</td></tr>
<tr><td>Configuration:</td><td colspan="3">GEO_CFG_05</td></tr>
<tr><td>References:</td><td colspan="3">[2] 9.3.11
[5] 6.1.3.2, ~~B.6~~7.1.2</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Pre-test conditions:</td><td colspan="3">• ITS-S devices (Source and Receiver) installed in RF testbench with controllable link attenuator
• Set itsGnMaxPacketLifetime parameter to 600 s (default value) in the MIB if the ‘Maximum packet lifetime’ parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set ‘Maximum packet lifetime’ parameter of GN-DATA.request primitive to 600 s
• Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent
• Prepare the DEN message so that the destination area is as defined in the geo configuration
o and ~~expiryTime~~ validityDuration set to 6 seconds
o DENM transmission frequency set to 1.1 Hz (i.e. ~~transmissionInterval~~ repetitionInterval is 900 ms), and DENM repetitionDuration is set to 5 seconds
• Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration
• The two devices are off-link</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="4">Test Sequence:</td><td>Step</td><td>Type</td><td>Description</td></tr>
<tr><td>1</td><td>stimulus</td><td>Source is requested to send a DEN message with settings as defined in pre-test conditions</td></tr>
<tr><td>2</td><td>stimulus</td><td>After the DENM lifetime expires, but before the expiry of itsGnMaxPacketLifetime timer; lower the attenuation on the connection, so that the two devices are on-link</td></tr>
<tr><td>3</td><td>verify</td><td>Receiver device does not receive any the 6 transmitted GeoBroadcasts containing the DENM message</td></tr>
</table>

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

7.8.2 Forwarder has no suitable nextHop towards Destination Area with SCF disabled~~Forwarder GeoRouting when there is no suitable next forwarder towards Destination Area with SCF disabled~~

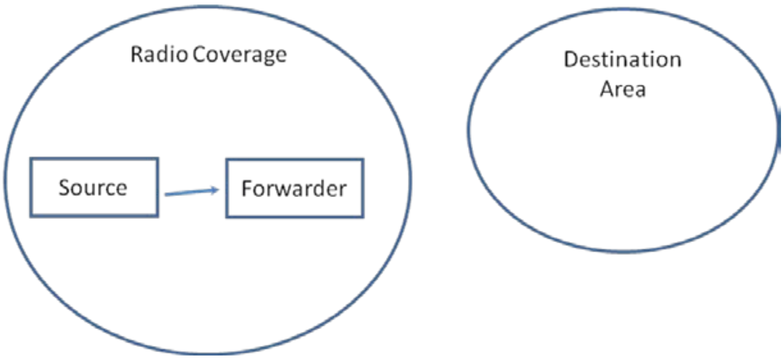

Figure 52: GEO_CFG_09_B

Note: This test can be run with itsGnGeoBroadcastForwardingAlgorithm set to SIMPLE/CBF/ADVANCED

Interoperability Test Description			
Identifier:	TD_GN_GBC_SCF_02		
Objective:	DENM message geo-routing is correctly handled when no suitable forwarder exists		
Configuration:	GEO_CFG_09_B		
References:	[2] 9.3.11 [5] 6.1.3.2		
Pre-test conditions:	• 2 ITS-S devices (Source, Forwarder) • Set itsGnMaxPacketLifetime parameter to 600 s (default value) in the MIB if the 'Maximum packet lifetime' parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set 'Maximum packet lifetime' parameter of GN-DATA.request primitive to 600 s • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • Prepare the DEN message so that the destination area is as defined in the geo configuration • Ensure that the SCF flag in the Traffic Class field of generated packet is disabled • Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration • 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	Forwarder receives a GeoBroadcast packet which is carried by a link layer packet containing the link layer destination address indicating the Forwarder MAC address
	3	verify	Forwarder broadcasts without a delay the GeoBroadcast packet containing DENM message, which is received again by the Source device~~Forwarder does not retransmit the GeoBroadcast packet containing DENM message~~

7.8.3 Source GeoRouting towards Destination Area with SCF disabled

This is an experimental test, as SCF source operation works only without neighbour, but in this configuration there is a neighbour. This test is rather an illustration on how SCF could work in a future release of the GN base spec.

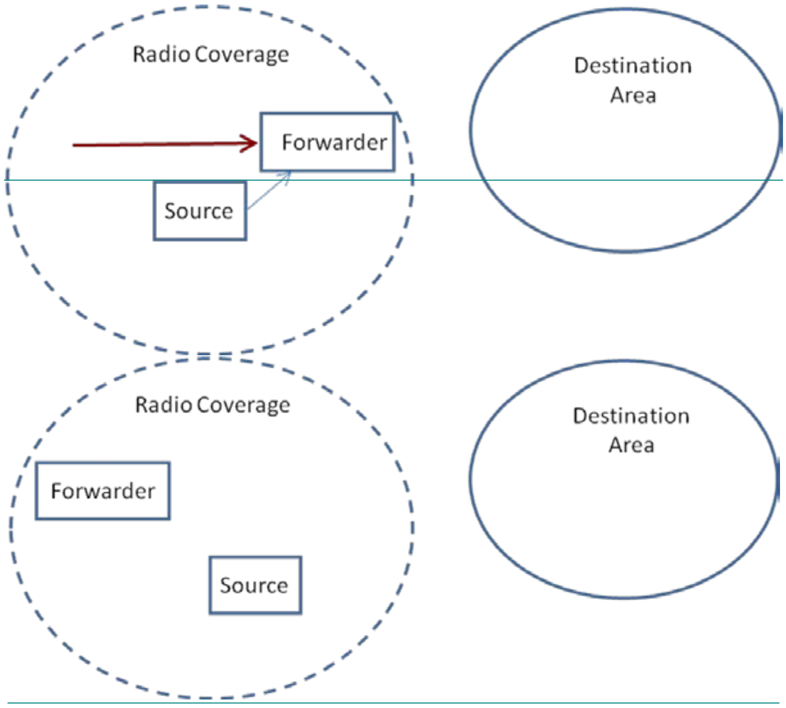

Figure 53: GEO_CFG_08

Note: This test can be run with itsGnGeoBroadcastForwardingAlgorithm set to SIMPLE/CBF/ADVANCED

Interoperability Test Description			
Identifier:	TD_GN_GBC_SCF_03		
Objective:	DENM message is correctly geo-routed towards its Destination Area		
Configuration:	GEO_CFG_08_C		
References:	[2] 9.3.11 [5] 6.1.3.2		
Pre-test conditions:	• 2 ITS-S devices (Source, Forwarder) • Set itsGnMaxPacketLifetime parameter to 600 s (default value) in the MIB if the 'Maximum packet lifetime' parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set 'Maximum packet lifetime' parameter of GN-DATA.request primitive to 600 s • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • Prepare the DEN message so that the destination area is as defined in the geo configuration • Ensure that the SCF flag in the Traffic Class field of generated packet is disabled • Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration • Each ITS-S device has sent at least 1 beacon or 1 CAM		
Test Sequence:	**Step**	**Type**	**Description**

Interoperability Test Description			
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	verify	Forwarder receives a GeoBroadcast packet without any delay, even though it is in the opposite direction from the Destination area. This is the expected SCF disabled operation in the source device.
	3	check	Received GeoBroadcast packet is carried by a link layer packet containing the link layer destination address indicating the broadcast MAC address
	4	verify	Forwarder does not pass DENM message to its Facility layer
	5	verify	Forwarder transmits to the Source device without a delay the GeoBroadcast packet containing DENM message, which is received again by the Source device

7.8.4 Forwarder GeoRouting GeoRouting towards Destination Area with SCF disabled

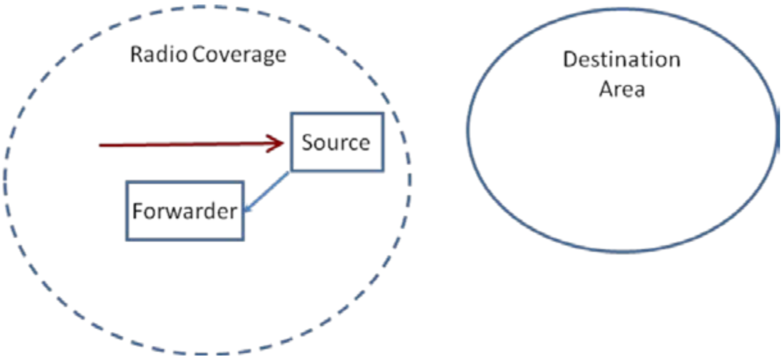

Figure 54: GEO_CFG_08_B

Note: This test can be run with itsGnGeoBroadcastForwardingAlgorithm set to SIMPLE/CBF/ADVANCED

Interoperability Test Description			
Identifier:	TD_GN_GBC_SCF_04		
Objective:	DENM message is correctly geo-routed towards its Destination Area		
Configuration:	GEO_CFG_08_B		
References:	[2] 9.3.11 [5] 6.1.3.2		
Pre-test conditions:	• 2 ITS-S devices (Source, Forwarder) • Set itsGnMaxPacketLifetime parameter to 600 s (default value) in the MIB if the 'Maximum packet lifetime' parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set 'Maximum packet lifetime' parameter of GN-DATA.request primitive to 600 s • Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent • Prepare the DEN message so that the destination area is as defined in the geo configuration • Ensure that the SCF flag in the Traffic Class field of generated packet is disabled. • Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration • Each ITS-S device has sent at least 1 beacon or 1 CAM		
Test Sequence:	**Step**	**Type**	**Description**

Interoperability Test Description			
	1	stimulus	Source is requested to send a DEN message with settings as defined in pre-test conditions
	2	verify	Forwarder receives a GeoBroadcast packet which is carried by a link layer packet containing the link layer destination address indicating the Forwarder MAC address
	3	stimulus	At some point along the pre-programmed path, the Source device's position becomes less distant from the Destination Area than the position of the Forwarder
	4	verify	Forwarder retransmits the GeoBroadcast packet containing DENM message, which is received again by the Source device
	5	check	Received GeoBroadcast packet in the source is carried by a link layer packet containing the link layer destination address indicating the Source MAC address
	6	verify	Source device detects that this packet is a duplicate of the one it has already sent

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.

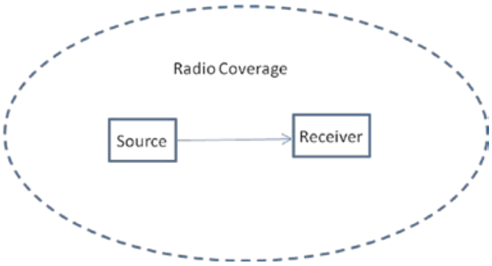

Figure 55: GEO_CFG_01

8.1.1 Exchange of CAM messages

<table>
<tr><th colspan="4">Interoperability Test Description</th></tr>
<tr><td>Identifier:</td><td colspan="3">TD_CAM_05</td></tr>
<tr><td>Objective:</td><td colspan="3">CAM messages and their mandatory data elements are interoperable</td></tr>
<tr><td>Configuration:</td><td colspan="3">GEO_CFG_01</td></tr>
<tr><td>References:</td><td colspan="3">[2] 9.3.11
[4] 7~~.2~~</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Pre-test conditions:</td><td colspan="3">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</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="4">Test Sequence:</td><td>Step</td><td>Type</td><td>Description</td></tr>
<tr><td>1</td><td>stimulus</td><td>Source is requested to send a CAM message</td></tr>
<tr><td>2</td><td>verify</td><td>Receiver devices process the CAM as a valid message</td></tr>
<tr><td>3</td><td>verify</td><td>Steps 2 to 3 are repeated at the CAM frequency of 1 Hz</td></tr>
</table>

<table>
<tr><th colspan="4">Interoperability Test Description</th></tr>
<tr><td>Identifier:</td><td colspan="3">TD_CAM_06</td></tr>
<tr><td>Objective:</td><td colspan="3">CAM messages and their optional data elements are interoperable</td></tr>
<tr><td>Configuration:</td><td colspan="3">GEO_CFG_01</td></tr>
<tr><td>References:</td><td colspan="3">[2] 9.3.10
[4] 7~~.2~~</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Pre-test conditions:</td><td colspan="3">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 with all optional data elements enabled</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="4">Test Sequence:</td><td>Step</td><td>Type</td><td>Description</td></tr>
<tr><td>1</td><td>stimulus</td><td>Source is requested to send a CAM message</td></tr>
<tr><td>2</td><td>verify</td><td>Receiver devices process the CAM as a valid message</td></tr>
<tr><td>3</td><td>verify</td><td>Steps 2 to 3 are repeated at the CAM frequency of 1 Hz</td></tr>
</table>

Interoperability Test Description			
Identifier:	TD_CAM_07		
Objective:	CAM message decoding properly handles extended data elements		
Configuration:	GEO_CFG_01		
References:	[2] 9.3.10 [4] Annex B~~A~~		
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) 1 CAM Source device, which uses some private extension fields in the CAM message data elements. 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 injector is triggered to send the pre-configured CAM message
	2	verify	Receiver devices process the CAM as a valid message
	3	verify	All data elements of the received CAM message are properly decoded, with the exception of the unknown extensions
Note: if there is no implementation having private extensions, the testing of extensions handling may be done as part of the Conformance Test			

8.1.2 Testing of CAM generation frequency management

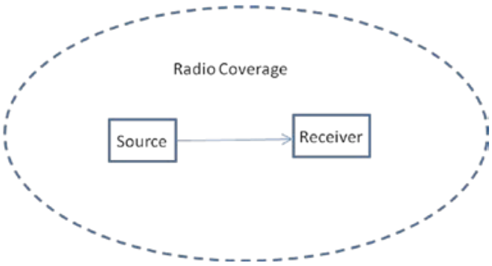

Figure 56: GEO_CFG_01

Interoperability Test Description			
Identifier:	TD_CAM_08		
Objective:	CAM generation frequency of stationary vehicle is T_GenCamMax		
Configuration:	GEO_CFG_01		
References:	[2] 9.3.11 [4] 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~~ until Source is sending some CAM messages

Interoperability Test Description			
	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.

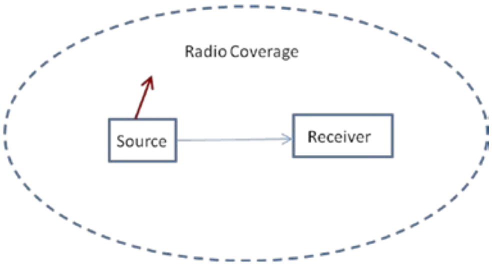

Figure 57: GEO_CFG_17

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:	[2] 9.3.11 [4] 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~~ 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			

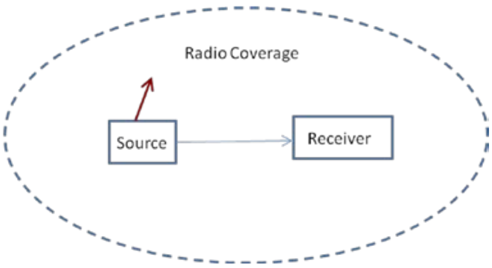

Figure 58: GEO_CFG_17

Interoperability Test Description			
Identifier:	TD_CAM_10		
Objective:	CAM generation frequency corresponds to the position difference based dynamic trigger		
Configuration:	GEO_CFG_17		
References:	[2] 9.3.11 [4] 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~~ until 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 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			

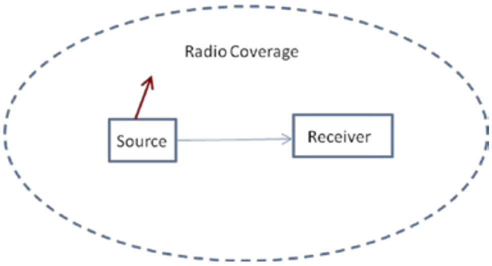

Figure 59: GEO_CFG_18

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:	[2] 9.3.11 [4] 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**

Interoperability Test 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.			

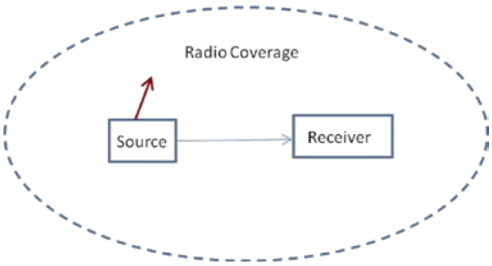

Figure 60: GEO_CFG_18

Interoperability Test Description			
Identifier:	TD_CAM_12		
Objective:	CAM generation frequency corresponds to the speed difference based dynamic trigger		
Configuration:	GEO_CFG_18		
References:	[2] 9.3.11 [4] 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

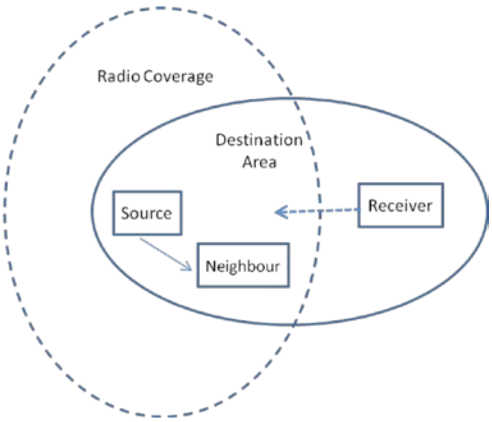

Figure 61: GEO_CFG_06

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

<table>
<tr><th colspan="4">Interoperability Test Description</th></tr>
<tr><td>Identifier:</td><td colspan="3">TD_DENM_01</td></tr>
<tr><td>Objective:</td><td colspan="3">DENM re-transmissions are correctly received within the DENM lifetime</td></tr>
<tr><td>Configuration:</td><td colspan="3">GEO_CFG_06</td></tr>
<tr><td>References:</td><td colspan="3">[2] 9.3.11
[5] 6.1.3.2, ~~B.6, B.7~~7.1.2</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Pre-test conditions:</td><td colspan="3">3 ITS-S devices (Source, Receiver, Neighbor 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 repetition ~~frequency~~ Interval is set to 1000ms (1 Hz), and ~~expiryTime~~ 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</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="6">Test Sequence:</td><th>Step</th><th>Type</th><th>Description</th></tr>
<tr><td>1</td><td>stimulus</td><td>Source is requested to send a DEN message with settings as defined in pre-test conditions</td></tr>
<tr><td>2</td><td>stimulus</td><td>Lower the Source-Receiver attenuation before DENM lifetime expires, so that the two devices are on-link.</td></tr>
<tr><td>3</td><td>verify</td><td>Receiver devices receive a GeoBroadcast packet containing DENM message.</td></tr>
<tr><td>4</td><td>verify</td><td>Receiver passes the DENM message to its Facility layer, where it is processed as a valid message</td></tr>
<tr><td>5</td><td>verify</td><td>Steps 3 and 4 are repeated at the frequency defined by the '~~frequency'~~ repetitionInterval' parameter of the DEN~~M message~~trigger</td></tr>
</table>

8.2.2 EUT driving into DENM Relevance area after the DENM lifetime

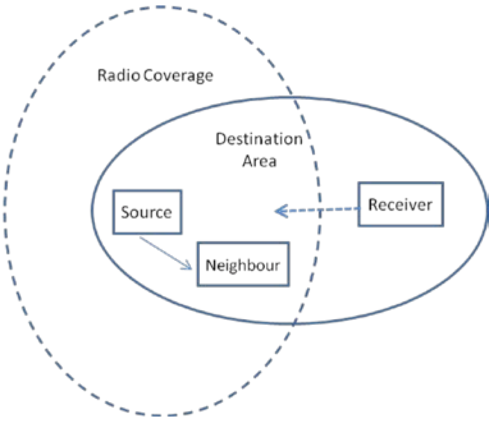

Figure 62: GEO_CFG_06

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:	[2] 9.3.11 [5] 6.1.3.2, ~~B.6, B.7~~7.1.2		
Pre-test conditions:	3 ITS-S devices (Source, Receiver, Neighbor 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 ~~frequency~~ is set to 1000ms (1 Hz), and ~~expiryTime~~ 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)

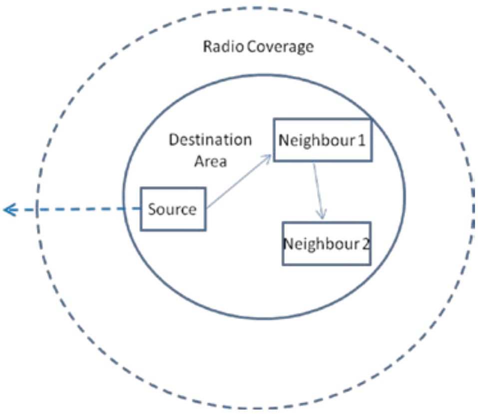

Figure 63: GEO_CFG_03

Interoperability Test Description			
Identifier:	TD_DENM_03		
Objective:	DENM information is kept alive as expected during its lifetime		
Configuration:	GEO_CFG_03		
References:	[2] 9.3.11 [5] 6.1.3.2, ~~B.6, B.7~~7.1.2, ~~C.5 (informative)~~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 ~~frequency~~ set to 1000ms (1 Hz), and ~~expiryTime~~ 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 ~~'frequency'~~ transmissionInterval parameter of the DEN~~M~~ message, until the DENM lifetime expiration

8.2.4 EUT receiving an expired DENM message

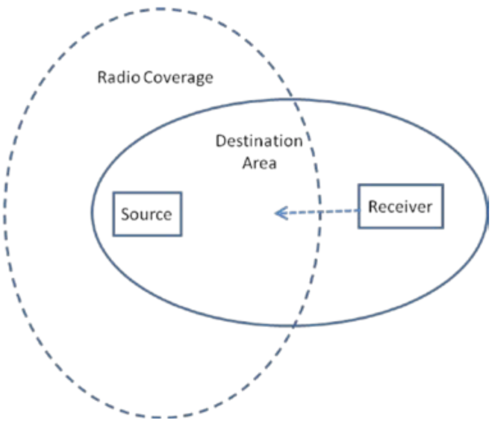

Figure 64: GEO_CFG_05

~~**Interoperability Test Description**~~				
~~**Identifier:**~~	~~TD_DENM_04~~			
~~**Objective:**~~	~~DENM expiry handling is correctly implemented~~			
~~**Configuration:**~~	~~GEO_CFG_05~~			
~~**References:**~~	~~[2] 9.3.11~~ ~~[5] 6.1.3.2, B.67.1.2~~			
~~**Pre-test conditions:**~~	• ~~2 ITS-S devices (Source and Receiver) installed in RF testbench with controllable link attenuator~~ • ~~Set itsGnMaxPacketLifetime parameter to 600 s (default value) in the MIB if the 'Maximum packet lifetime' parameter of GN-DATA.request primitive is not used by the upper layer. Otherwise configure the upper layer to set 'Maximum packet lifetime' parameter of GN-DATA.request primitive to 600 s~~ • ~~Wait until itsGnLifetimeLocTE to ensure that LocationEntry table is consistent~~ • ~~Prepare the DEN message so that the destination area is as defined in the geo configuration~~ o ~~and expiryTime validityDuration set to 6 seconds~~ o ~~DENM transmission frequency set to 1,1 Hz (i.e. transmissionInterval repetitionInterval is 900 ms), and DENM repetitionDuration is set to 5 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~~	~~After the DENM lifetime expires, but before the expiry of itsGnMaxPacketLifetime timer; lower the attenuation on the connection, so that the two devices are on-link~~	
	~~3~~	~~verify~~	~~Receiver devices receive all the 6 cached GeoBroadcasts containing the DENM message~~	
	~~4~~	~~verify~~	~~The Facility layer of the receiver device detects that DENM messages are expired (because of their expired lifetime)~~	

Note 1: TD_GN_GBC_04 shall be run successfully before the execution of this tests.

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Note 2: Formula to calculate the total number of packets: f = 1.1 Hz equals T = 900 ms; min(~~expiryTime~~validityDuration, repetitionDuration) / 900 ms ~ 5 ; total number of packets = 5 + initial packet sent at t_0 = 6 packets

8.2.5 Decoding of DENM messages containing extended data elements

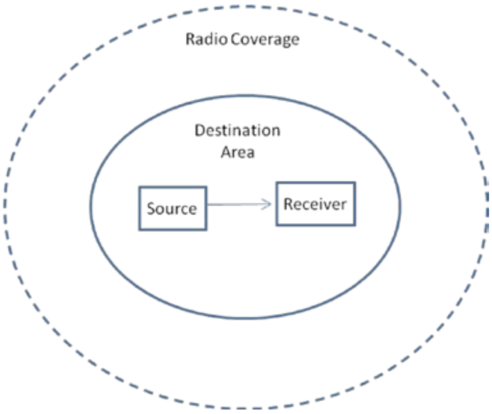


Figure 65: GEO_CFG_02

Interoperability Test Description				
Identifier:	TD_DENM_05			
Objective:	DENM message decoding properly handles extended data elements			
Configuration:	GEO_CFG_02			
References:	[2] 9.3.11 [5] ~~Annex A~~7.2.2			
Pre-test conditions:	2 ITS-S devices (1 Source, 1 Receiver) 1 DENM Source device, which uses some private extension fields in the DENM message data elements. Configure the positions of the ITS-S devices according to the above geo-configuration.			
Test Sequence:	**Step**	**Type**	**Description**	
	1	stimulus	Source injector is triggered to send the pre-configured DENM message	
	2	verify	Receiver devices process the DENM as a valid message	
	3	verify	All data elements of the received DENM message are properly decoded, with the exception of the unknown extensions	
Note: if there is no implementation having private extensions, the testing of extensions handling may be done as part of the Conformance Test				

8.3 SPAT/MAP message transmission

The following configuration applies to all tests in this chapter.

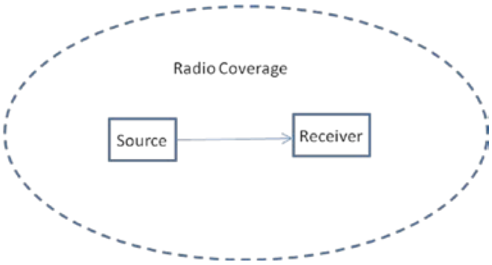


Figure 66: GEO_CFG_01

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 ISO19091 annex-D [8] document (e.g. vehicle lanes, signalGroups, connectsTo, etc.) Due to the complexity of the MAP message intersection topology samples provided by different manufacturer will be helpful forinteroperability. 1 Siemens: deliver the topology of an intersection in Vienna. 2 3		
Configuration:	GEO_CFG_01		
References:	[8], [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 [8] and [9] usingthe 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

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 the ISO19091 annex-D [8] document (e.g. Signal Groups cycle staus and timing) As the information is transmitted in UTC time format a detailed view to correct timing is essential!. AS defined in clause 8.3.1 intersection samples are provided by different manufacturer for assuring interoperability: 1 Siemens: delivery the SPAT message related to a specific MAP topology from clause 3.8.1. 2 3		
Configuration:	GEO_CFG_01		
References:	[8], [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 [8] and [9] usingthe 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. AS defined in clause 8.3.1 and 8.3.2 intersection map and signalization samples are provided by different manufacturer for assuring interoperability: 1 Siemens: delivery the MAP and the corresponding SPAT message related to a specific MAP topology. 2 3		
Configuration:	GEO_CFG_01		
References:	[8], [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 [8] and [9] usingthe 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.
	3	verify	Steps 2 to 3 are repeated at the SPAT frequency of 1 Hz and the MAP frequency of 2 Hz.

9 GN6 Scenarios

9.1 TVL

9.1.1 Exchange of IPv6 packets using link-local addresses

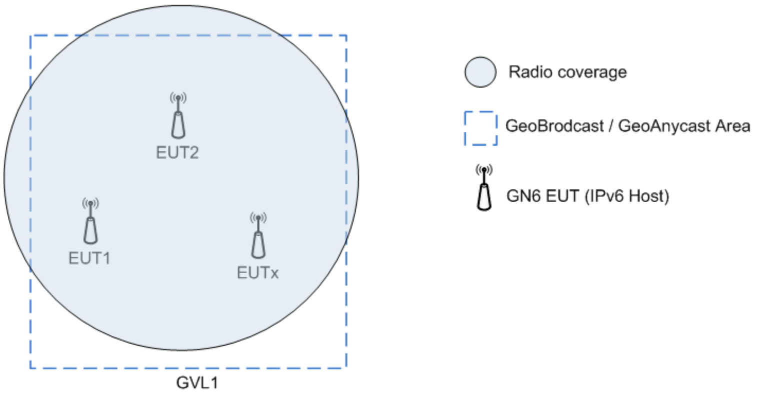


Figure 67: GN6_CFG_01

Interoperability Test Description			
Identifier:	TD_GN6_01		
Objective:	Neighbour ITS nodes can ping each other using their link-local IPv6 address (FE80::)		
Configuration:	GN6_CFG_01		
References:	[7]		
Pre-test conditions:	3 ITS-S devices (1 Source, 2 Receiver devices) 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 No GVL is configured All ITS-S devices are on-link Each ITS-S device has sent at least 1 beacon		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send an IPv6 ping to link-local address of each receiver
	2	check	Receiver devices receive a GeoUnicast packet containing IPv6 Echo Request message.
	3	check	Received IPv6 packet indicates link-local IPv6 address of the node
	4	verify	Source receives IPv6 pong from each receiver

9.1.2 Interaction between TVL and SGVLs

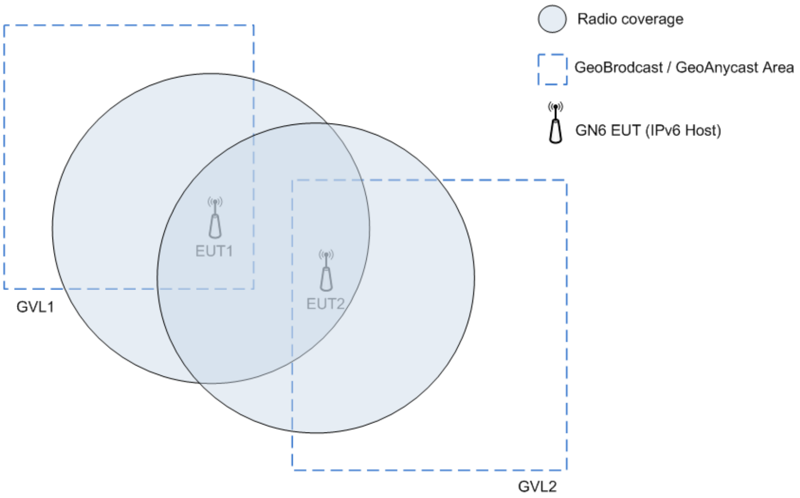


Figure 68: GN6_CFG_02

Interoperability Test Description			
Identifier:	TD_GN6_02		
Objective:	Neighbour ITS nodes can ping each other using their link-local IPv6 address (FE80::) in presence of configured GVLs		
Configuration:	GN6_CFG_02		
References:	[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 device has been configured with a different SGVL All ITS-S devices are on-link Each ITS-S device has sent at least 1 beacon		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send an IPv6 ping to link-local address of each receiver
	2	check	Receiver devices receive a GeoUnicast packet containing IPv6 Echo Request message.
	3	check	Received IPv6 packet indicates link-local IPv6 address of the node
	4	verify	Source receives IPv6 pong from each receiver

9.2 SGVL

The following configuration applies to all tests in this chapter.

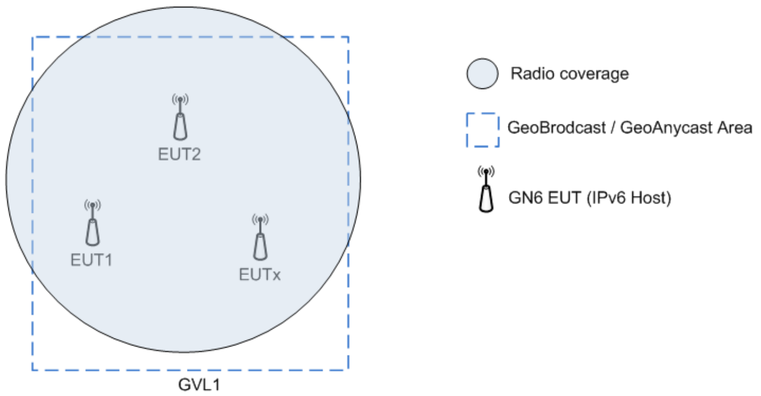


Figure 69: GN6_CFG_01

9.2.1 Exchange of IPv6 packets using global addresses

Interoperability Test Description			
Identifier:	TD_GN6_03		
Objective:	ITS nodes can ping each other IPv6 Global address		
Configuration:	GN6_CFG_01		
References:	[7]		
Pre-test conditions:	3 ITS-S devices (1 Source, 2 Receiver devices) 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 device has been configured with the same SGVL All ITS-S devices are on-link Each ITS-S device has sent at least 1 beacon		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send an IPv6 ping to global address of each receiver
	2	check	Receiver devices receive a GeoUnicast packet containing IPv6 Echo Request message.
	3	check	Received IPv6 packet indicates global IPv6 address of the node
	4	verify	Source receives IPv6 pong from each receiver

9.2.2 Exchange of IPv6 packets using multicast address

Interoperability Test Description			
Identifier:	TD_GN6_04		
Objective:	ITS nodes can ping other SGVL nodes using unicast prefix-based IPv6 multicast address		
Configuration:	GN6_CFG_01		
References:	[7]		
Pre-test conditions:	3 ITS-S devices (1 Source, 2 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 device has been configured with the same SGVL All ITS-S devices are on-link Each device has joined the multicast group FF3E::40:PREFIX::1 Each ITS-S device has sent at least 1 beacon		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send an IPv6 ping to unicast prefix-based IPv6 multicast address corresponding to configured SGVL (FF3E::40:PREFIX::1)
	2	check	Receiver devices receive a GeoBroadcast packet indicating GVL's GeoArea and containing IPv6 Echo Request message.
	3	check	Received IPv6 packet indicates unicast prefix-based IPv6 multicast address as destination
	4	verify	Source receives IPv6 pong from each receiver
Note: PREFIX is the IPv6 prefix associated with SGVL			

9.2.3 Usage of Neighbour Discovery messages

Interoperability Test Description			
Identifier:	TD_GN6_05		
Objective:	ITS nodes can perform IPv6 Neighbour Discovery (itsGn6aslVIResolAddr=false)		
Configuration:	GN6_CFG_01		
References:	[7]		
Pre-test conditions:	3 ITS-S devices (1 Source, 2 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 device has been configured with the same SGVL All ITS-S devices are on-link All devices are configured with itsGn6aslVIResolAddr=false IPv6 neighbour cache of the source is empty Each ITS-S device has sent at least 1 beacon		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source is requested to send an IPv6 ping to global address of each receiver

Interoperability Test Description			
	2	check	Source sends GeoBroadcast packets containing IPv6 neighbour solicitation message indicating solicited-node multicast address as destination to each receiver
	3	check	Each receiver answers with : GeoBroadcast packet containing IPv6 neighbour advertisement message indicating all-nodes multicast address as destination or GeoUnicast packet containing IPv6 neighbour advertisement message indicating Source's address as destination
	4	check	Receiver devices receive a GeoUnicast packet containing IPv6 Echo Request message.
	5	check	Received IPv6 packet indicates global IPv6 address of the node
	6	verify	Source receives IPv6 pong from each receiver

9.3 Automatic SGVLs

The following configuration applies to all tests in this chapter.

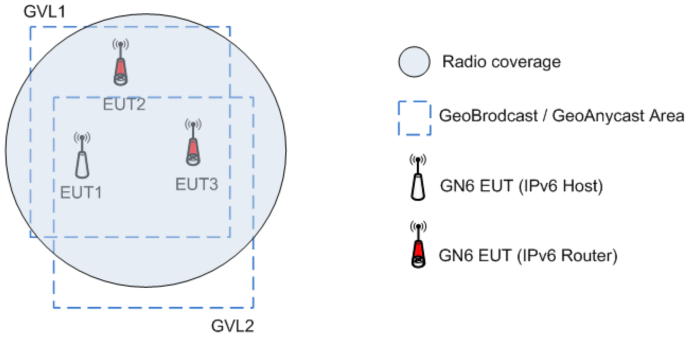


Figure 70: GN6_CFG_06

9.3.1 Automatic SGVL configuration

Interoperability Test Description			
Identifier:	TD_GN6_06		
Objective:	ITS node can configure a SGVL by receiving Router Advertisement		
Configuration:	GN6_CFG_04		
References:	[7]		
Pre-test conditions:	1 ITS-S devices acting as IPv6 router 1 ITS-S device acting as IPv6 host (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 All ITS-S devices are on-link Each ITS-S device has sent at least 1 beacon		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	ITS-S IPv6 router sends periodical Router Advertisement
	2	verify	ITS-S IPv6 hosts process the Router Advertisement and configure a SGVL
	3	stimulus	ITS-S IPv6 router is requested to send an IPv6 ping to global address of receiver
	4	check	Receiver device receives a GeoUnicast packet containing IPv6 Echo Request message.
	5	check	Received IPv6 packet indicates global IPv6 address of the node
	6	verify	ITS-S IPv6 router receives IPv6 pong from each receiver

9.3.2 Multiple automatic SGVL configurations

Interoperability Test Description			
Identifier:	TD_GN6_07		
Objective:	ITS node can configure several GVL by receiving Router Advertisements		
Configuration:	GN6_CFG_04		
References:	[7]		
Pre-test conditions:	2 ITS-S devices acting as IPv6 router 1 ITS-S devices acting as IPv6 host (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 All ITS-S devices are on-link Each router is configured with a different SGVL Each ITS-S device has sent at least 1 beacon		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	ITS-S IPv6 routers send periodical Router Advertisement
	2	verify	ITS-S IPv6 host processes the Router Advertisements and configure several SGVLs
	3	stimulus	ITS-S IPv6 routers are requested to send an IPv6 ping to global address of receiver

Interoperability Test Description			
	4	check	Receiver device receives a GeoUnicast packet containing IPv6 Echo Request message from each ITS-S IPv6 router
	5	check	Received IPv6 packets indicate global IPv6 address of the node
	6	verify	ITS-S IPv6 routers receive IPv6 pong from receiver

9.3.3 Automatic SGVL deconfiguration

Interoperability Test Description			
Identifier:	TD_GN6_08		
Objective:	ITS nodes can deconfigure GVL after prefix expiration		
Configuration:	GN6_CFG_04		
References:	[7]		
Pre-test conditions:	1 ITS-S devices acting as IPv6 router 1 ITS-S devices acting as IPv6 host (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 All ITS-S devices are on-link Each ITS-S device has sent at least 1 beacon ITS-S IPv6 router has sent a Router Advertisement ITS-S IPv6 hosts have processes the Router Advertisement and configured a SGVL		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	ITS-S IPv6 router stops sending Router Advertisement
	2	verify	After prefix expiration ITS-S IPv6 host deconfigure the SGVL
	3	stimulus	ITS-S IPv6 router is requested to send an IPv6 ping to global address of each receiver
	4	check	No message is sent
	5	verify	ITS-S IPv6 router indicates failure of operation (no route to host)

9.4 Interaction with legacy IPv6 network

The following configuration applies to all tests in this chapter.

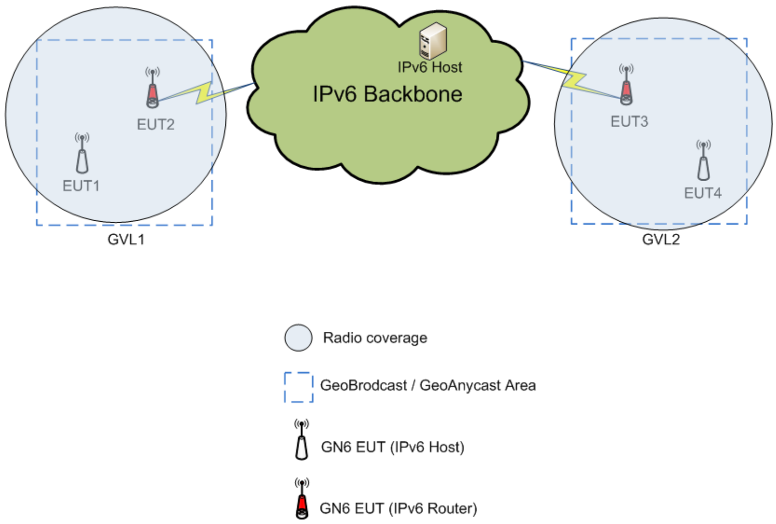


Figure 71: GN6_CFG_03

9.4.1 Communication with legacy IPv6 nodes

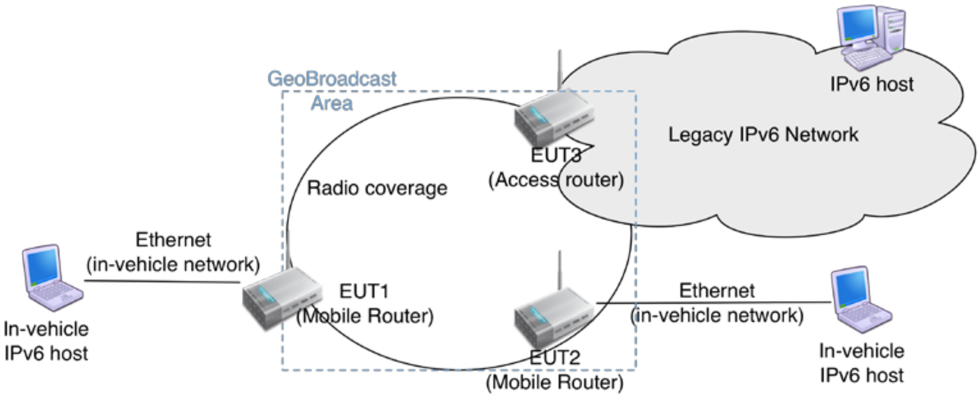
Interoperability Test Description			
Identifier:	TD_GN6_09		
Objective:	ITS nodes can communicate with legacy IPv6 node		
Configuration:	GN6_CFG_03		
References:	[7]		
Pre-test conditions:	2 ITS-S devices acting as IPv6 router installed in RF testbench with controllable link attenuator 2 ITS-S devices acting as IPv6 host installed in RF testbench with controllable link attenuator 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 EUT 1 and EUT2 are on-link, and off-link with EUT3 and EUT4 EUT 3 and EUT4 are on-link, and off-link with EUT1 and EUT2 Each ITS-S device has sent at least 1 beacon ITS-S IPv6 router has sent at least 1 router advertisement		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source ITS-S IPv6 host is requested to send an IPv6 ping to global address of legacy IPv6 node
	2	check	ITS-S IPv6 router devices receive a GeoUnicast packet containing IPv6 Echo Request message.
	3	check	Received IPv6 packet indicates global IPv6 address of the legacy IPv6 node
	4	check	ITS-S IPv6 router forwards IPv6 packet to legacy IPv6 node
	5	check	ITS-S IPv6 router receives IPv6 packet from legacy IPv6 node

Interoperability Test Description			
	6	check	Received IPv6 packet indicates global IPv6 address of the Source
	7	check	ITS-S IPv6 router forwards IPv6 packet to Source into a GeoUnicast message indicating Source GnAddress
	8	verify	Source receives IPv6 pong from legacy IPv6 node

9.4.2 Communication via legacy IPv6 network

Interoperability Test Description			
Identifier:	TD_GN6_10		
Objective:	ITS nodes can communicate via legacy IPv6 network		
Configuration:	GN6_CFG_03		
References:	[7]		
Pre-test conditions:	2 ITS-S devices acting as IPv6 router installed in RF testbench with controllable link attenuator 2 ITS-S devices acting as IPv6 host installed in RF testbench with controllable link attenuator 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 router is configured with a different SGVL EUT 1 and EUT2 are on-link, and off-link with EUT3 and EUT4 EUT 3 and EUT4 are on-link, and off-link with EUT1 and EUT2 Each ITS-S device has sent at least 1 beacon ITS-S IPv6 routers have sent at leat 1 router advertisement Node within SGVL1 have no mean to directly communicate with node from SGVL2		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source ITS-S IPv6 host is requested to send an IPv6 ping to remote Receiver ITS-S IPv6 host
	2	check	ITS-S IPv6 router devices receive a GeoUnicast packet containing IPv6 Echo Request message.
	3	check	Received IPv6 packet indicates global IPv6 address of the Receiver ITS-S IPv6 host
	4	check	ITS-S IPv6 router forwards IPv6 packet to remote ITS-S IPv6 router via legacy IPv6 network
	5	check	ITS-S IPv6 remote router receives IPv6 packet
	6	check	Received IPv6 packet indicates global IPv6 address of the destination ITS-S IPv6 host
	7	check	ITS-S IPv6 router forwards IPv6 packet to remote ITS-S IPv6 host into a GeoUnicast message indicating Receiver GnAddress
	8	check	Receiver ITS-S IPv6 host answers to ping
	9	check	Remote ITS-S IPv6 router devices receive a GeoUnicast packet containing IPv6 Echo Reply message.
	10	check	Remote ITS-S IPv6 router forwards IPv6 packet to ITS-S IPv6 router via legacy IPv6 network
	11	check	ITS-S IPv6 router forwards IPv6 packet to Source into a GeoUnicast message indicating Source GnAddress
	12	verify	Source receives IPv6 pong from legacy IPv6 node

9.5 Interaction with in-vehicle IPv6 host



9.5.1 Communication between in-vehicle IPv6 hosts

Interoperability Test Description			
Identifier:	TD_GN6_11		
Objective:	In-vehicle IPv6 host can communicate with the other in-vehicle IPv6 host		
Configuration:	GN6_CFG_05		
References:	[7], [ISO-21210]		
Pre-test conditions:	2 ITS-S devices acting as IPv6 mobile router (EUT1, EUT2) 1 ITS-S devices acting as IPv6 access router (EUT3) 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 All ITS-S devices are on-link Each ITS-S device has sent at least 1 beacon EUT1 and EUT2 send Router Advertisement to in-vehicle network EUT1 and EUT2 have the route to the in-vehile network of each other		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source in-vehicle IPv6 host (behind EUT1) is requested to send an IPv6 ping to global address of the other in-vehicle IPv6 host (behind EUT2)
	2	check	Mobile Router (EUT1) sends a GeoUnicast packet containing IPv6 Echo Request message.
	3	check	Mobile Router (EUT2) receives a GeoUnicast packet containing IPv6 Echo Request message.
	4	check	Mobile Router (EUT2) forwards an IPv6 Echo Request message to in-vehicle IPv6 host.
	5	check	Mobile Router (EUT2) sends a GeoUnicast packet containing IPv6 Echo Reply message.
	6	check	Mobile Router (EUT1) receives a GeoUnicast packet containing IPv6 Echo Reply message.
	7	check	Mobile Router (EUT1) forwards an IPv6 Echo Reply message to in-vehicle IPv6 host.
	8	verify	Source in-vehicle IPv6 host (behind EUT1) receives IPv6 pong from the other in-vehicle IPv6 host (behind EUT2)

9.5.2 Communication between in-vehicle IPv6 host and legacy IPv6 host

Interoperability Test Description			
Identifier:	TD_GN6_12		
Objective:	In-vehicle IPv6 host can communicate with the a legacy IPv6 host		
Configuration:	GN6_CFG_05		
References:	[7], [ISO-21210]		
Pre-test conditions:	An ITS-S devices acting as IPv6 mobile router (EUT1) An ITS-S devices acting as IPv6 access router (EUT3) 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 All ITS-S devices are on-link Each ITS-S device has sent at least 1 beacon EUT1 sends Router Advertisement to in-vehicle network EUT3 sends Router Advertisement to the access network EUT1 has the default route to the legacy IPv6 network EUT3 has the route to the in-vehicle network behind EUT1		
Test Sequence:	**Step**	**Type**	**Description**
	1	stimulus	Source in-vehicle IPv6 host (behind EUT1) is requested to send an IPv6 ping to global address of the legacy IPv6 host
	2	check	Mobile Router (EUT1) sends a GeoUnicast packet containing IPv6 Echo Request message.
	3	check	Access Router (EUT3) receives a GeoUnicast packet containing IPv6 Echo Request message.
	4	check	Access Router (EUT3) forwards an IPv6 Echo Request message to the legacy IPv6 host.
	5	check	Access Router (EUT3) sends a GeoUnicast packet containing IPv6 Echo Reply message.
	6	check	Mobile Router (EUT1) receives a GeoUnicast packet containing IPv6 Echo Reply message.
	7	check	Mobile Router (EUT1) forwards an IPv6 Echo Reply message to in-vehicle IPv6 host.
	8	verify	Source in-vehicle IPv6 host (behind EUT1) receives IPv6 pong from the legacy IPv6 host

Change History

Document history		
0.0.1	01.06.2013	GN6 scenarios updated
0.0.2	26.07.2013	GN and CAM&DEN scenarios updated
0.0.3	20.10.2013	GN Forwarding scenarios corrected
0.0.4	09.11.2013	SCF scenarios added
0.0.5	20.11.2013	Chapter 6.3.1 Ethertype changed from 0x0707 to 0x8947
		Chapter 6.11 added on 'Security Settings'
		Chapter 6.12 added on 'SCF flag Settings' and mentioned in clause 6.12 and clause 9
		Deleted deprecated chapter 8.3 Applications
		Deleted Annex C: C2C CC and TT Vienna Demo 2012
		Added note to TD_CAM_08 re lowest T_GenCamMax sending frequency
		Major GEO_CFG clean up: Radio Coverage marked in blue dotted line Attenuation marked with blue dotted arrow Port numbers added to each GEO_CFG CFG descriptionin tests more concise, eg 2 ITS-S devices (1 Source, 1 Receiver) Clarified GN6 GEO_CFGs so that drawing and text match
		TD_GN_BEA_01: Deleted check on Altitude in Long Position Vector
		Moved TD_GN_GBC_CBF_01 into clause 'DENM message transmission'
		Deleted TD_GN_GBC_CBF_02 because both EUTs receive a broadcast packet outside destination area (and this is NOT how line forwarding is supposed to work).
		Deleted TD_GN_GBC_CBF_03 because check that Source only line forwards to best position is handeled already in TD_GN_GBC_CBF_01
		Deleted TD_GN_GUC_CBF_02 (merged with TD_GN_GUC_CBF_01). In fact as a result of Forwarder retransmitting, Neighbour will not send anything.
		All nodes MAC address change to broadcast MAC address
		Note added to indicate forwarding algo to be used
		Replaced 'Relevance Area' by 'Destination Area' everywhere
		Test Objective made clearer for TD_CAM_09, TD_CAM_11
		SCF bit disabled tests Deleted all tests with Greedy algo SCF bit disabled Deleted SCF test "Source GeoRouting when there is no suitable Forwarder towards Destination Area with SCF disabled" because this test is covered already in TD_GN_SCF_03
		Renamed "Configure the positions of the ITS-S devices according to the table above to "Configure the positions of the ITS-S devices according to their roles in the appropriate geo configuration
		Added instruction on TSB usage
		Renamed "Configure in Source device DENM message ..."to "Prepare the DEN message so that the destination area is as defined in the geo configuration
		"Renamed "Source is requested to send a preconfigured DENM message" to "Source is requested to send a DEN message with settings as defined in pre-test conditions"
		GEO_CFGs hyperlinked for easy navigation
		TD_GN_GBC_GRD_01,2,3 renamed to TD_GN_GBC_FW_01,2,3
		TD_GN_GBC_CBF_01 renamed to TD_GN_GBC_FW_04
0.0.6	21.11.2013	GEO_CFG_18: port number 1953 changed to 1954
		GEO_CFG_02: shall not be run in radiobench, and table in clause 6.8 updated
		TD_GN_CAM_09,10,11,12 renamed to TD_CAM_09,10,11,12 in chapter 6.8
		Added Destination device to Pre-test condition of TD_GN_GUC_GRD_01,02 and TD_GN_GUC_CBF_03
		TD_GN_GBC_SCF_01,02,03,04 added to chapter 4.5 TD_GN_GBC_07
		Deleted TD_GN_GBC_08 (merged with TD_GN_GBC_07). In fact as a result of Forwarder retransmitting, Neighbour will not send anything.
		GEO_CFG_15 update with new ports to allow for clearer timeout behaviour
		Made CAM/DENM tests mandatory execpt those with optional features
0.0.10	13.02.2015	Added MAP/SPAT scenarios
0.0.11	11.03.2015	MotionPath duration modified in CFG_08, CFG_08B, CFG_09, CFG_13 to values used at 2013 Plugtest
		CFG_11 corrected to rectangular area