2nd ITS Cooperative Mobility Plugtest; Versailles, France; 11 - 15 June 2012

World Class Standards

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Contents

1 Executive Summary 4
2 Introduction 5
3 Abbreviations 5
4 Participants 6
5 Technical and Project Management 8
5.1 Test Plan 8
5.1.1 Mandatory Tests 9
5.1.2 Optional Tests 9
5.2 Test Scheduling 10
5.3 Test Infrastructure 12
5.3.1 Central Position Server 12
5.3.2 Vehicle Position Monitoring Tool 12
5.3.3 Face 2 Face Configuration 13
5.3.4 Radio Bench 13
5.4 Interoperability Test Procedure 14
5.5 Conformance Validation Framework 15
6 Achieved Results 16
6.1 Overview of mandatory GN tests 16
6.2 Listing of mandatory GN tests 17
6.3 Overview of other tests 17
7 Summary of Wrap Up Sessions 20
7.1 Review of IOP Issues from plugtest#1 20
7.2 IOP Issues from plugtest#2 20
7.3 GN Base Spec Issues 21
7.4 GN6 Base Spec Issues 21
Annex A Interoperability Test specification 23
Annex B Workshop on Cooperative Mobility services - Benefits and deployment challenges 23
B.1 Programme 23
B.2 Agenda 23
B.3 Some photos 24
History 25

1 Executive Summary

Following the success of the first event hosted by TNO in Helmond (NL) in November 2011, ETSI and ERTICO decided to hold a second CMS Plugtest. From the 11th to 15th June, more than 15 companies with over 45 participants met at IFSTTAR's Versailles-SATORY test site.

Similar like the first plugtest, this event aimed to test the interoperability of ITS equipment from all key vendors implementations of ITS protocols CAM, DENM, BTP, GeoNetworking and ITS-G5. This event focused on GeoNetworking and included new tests such as Contention-based fowarding, GeoUnicast and IPv6 over geo-networking. Furthermore intelligent intersection information exchange (TOPO/SPAT) were tested in order to prepare for the DRIVE C2X / Testfeld Telematik Demo taking place at the ITS World Congress in Vienna (22 - 26 October).

14 companies participated in this event executing more than 250 interoperability tests.

90% of the executed tests indicated interoperability which shows the high level of interoperability and maturity of the ITS technology.

The highlights are that

- 3 new companies joined the plugtest
- 5 companies tested IPv6 over GeoNetwoking for the first time
- All newcomer implementations have been compatible on a basic level
- New features such as GeoUnicast, CBF algorithm and processing of rectangular areas were tested

The presence of experts at the Plugtests event enabled holding a public workshop at the same place on Thursday 14th June 2012, during the interoperability testing week. More than 70 persons, mainly from local organizations, attended this workshop, where the first results of the Plugtests event were presented. This public workshop aimed at presenting Cooperative Mobility principles and highlighting the importance of testing and certification to ensure successful deployment of cooperative systems (see the workshop agenda in Annex B).

2 Introduction

This plugtest aimed to assess the level of interoperability and to validate the base specifications. A very detailed preparation was required in order to allow for a smooth and efficient test week.

The implementations were connected via a test network to the Central Position Server (CPS) which provide for each test scenario the appropriate GPS feed. The GPS server was provided by IFFSTAR.

TNO provided for the tests of the multi hop scenarios a radio bench setup.

ETSI produced a plugtest guide containing 53 interoperability tests. Also, the ETSI interoperability tool suite of wiki, scheduling and test reporting tool was deployed.

During the event conformance test sessions were conducted with the support from Testing Technologies and Cohda Wireless.

Fraunhofer FOKUS provided a geo position visualization tool.

Each day test sessions for IOP assessment were conducted. At the end of each day a wrap-up meeting was held to discuss main interoperability points of the day.

3 Abbreviations

CAM	Cooperative Awareness Message
CBF	Contention Based Forwarding
CPS	Central Position Server
DENM	Decentralized Environmental Notification Message
DAD	Duplicate Address Detection
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
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
VIS	ITS Vehicle Station
NO	Test is recorded as NOT successfully passed.
NA	Test is not applicable.
OK	Test is recorded as successfully passed.
OT	Test is recorded as not being executed due to lack of time.
Test Session	A paring of vendors that test together during a given time slot.
TSR	Test Session Report. Report created during a test session.

4 Participants

The companies which attended the plugtest are listed in the table below.

Table 1: List of teams

#	Teams
1	Cohda /NXP
2	DENSO
3	Hitachi/Renesas
4	INRIA
5	ITRI
6	Kapsch
7	Marben
8	NEC/Swarco
9	QUWIC
10	Siemens
11	TNO

The test tool vendors which attended the plugtest are listed in the table below.

Table 2: List of test tool vendors

#	Test Tool Vendor	Role
1	**Fraunhofer FOKUS**	Visualization of geo positions
2	**TNO**	Radio bench set-up, Spectrum Analyzer and Monitoring
3	**Testing Technologies**	Conformance Validation Framework
4	**Vector Informatik**	Monitoring and Demo Tests
5	**IFFSTAR**	Central Position Server

The following FOTs were represented by the companies.

Table 3: List of FOTs

#	FOT
1	**DRIVE C2X**
2	**eCoMove**
3	**SCORE@F**

5 Technical and Project Management

5.1 Test Plan

The test plan containing 33 interoperability tests was developed by ETSI CTI together with a team of 2 experts. During the regular conference calls which were held as part of the event preparation, companies could propose additional tests. The tests were grouped in mandatory and optional tests. The features covered by all tests are listed below:

- DENM
  - Expiry Handling
  - Re-transmission
  - Message encoding/decoding
  - Message interpretation
- CAM
  - Message encoding/decoding
  - Message interpretation
- GN
  - DAD
  - Caching
  - Greedy forwarding
  - SHB
  - GeoBroadcast
  - Rectangular Area
  - CBF
  - Unicast
  - Link Asymmetry Tests
- GN6
  - TVL (Link local addresses)
  - GVL (global addresses)
  - Interaction with legacy networks

5.1.1 Mandatory Tests

Table 4: GeoNetworking 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_GRD_01	DENM message is correctly forwarded to its Destination Area (Greedy Forwarding algorithm)
9	TD_GN_GBC_GRD_02	DENM message is correctly geo-routed towards its Destination Area (Greedy Forwarding algorithm)
10	TD_GN_GBC_GRD_03	DENM message geo-routing is correctly handled when no suitable forwarder exists (Greedy Forwarding algorithm)

5.1.2 Optional Tests

Table 5: GeoNetworking Tests

11	TD_GN_GBC_05	DENM message is processed inside a rectangular Destination Area
12	TD_GN_GBC_06	DENM message is not processed outside its rectangular Destination Area
13	TD_GN_GBC_07	DENM message is re-broadcasted by furthest neighbour (CBF algorithm)
14	TD_GN_GBC_CBF_01	EUT line-forwards the DENM message when it is the best forwarder (CBF algorithm)
15	TD_GN_GBC_CBF_02	The EUT does not line-forward the DENM message when some other neighbor has already forwarded it (CBF algorithm)
16	TD_GN_GBC_CBF_03	The EUT does not line-forward the DENM message when it is in the wrong direction from the destination (CBF algorithm)
17	TD_GN_GUC_01	GeoUnicast messages are interoperable
18	TD_GN_GUC_02	Multi-hop geo-unicast forwarding is interoperable
19	TD_GN_GUC_GRD_01	A message is correctly geo-routed towards its Destination (Greedy Forwarding algorithm)
20	TD_GN_GUC_GRD_02	Geo-routing is correctly handled when no suitable forwarder exists (Greedy Forwarding algorithm)
21	TD_GN_GUC_CBF_01	EUT forwards the geo-unicast message when it is the best forwarder (CBF algorithm)
22	TD_GN_GUC_CBF_02	The EUT does not forward the geo-unicast message when some other neighbor has already forwarded it (CBF algorithm)
23	TD_GN_GUC_CBF_03	The EUT does not forward the geo-unicast message when it is in the wrong direction from the destination (CBF algorithm)

Table 6: IPv6 over GeoNetworking Tests

24	TD_GN6_01	Neighbour ITS nodes can ping each other using their link-local IPv6 address (FE80::)
25	TD_GN6_02	Neighbour ITS nodes can ping each other using their link-local IPv6 address (FE80::) in presence of configured GVLs
26	TD_GN6_03	ITS nodes can ping each other IPv6 Global address
27	TD_GN6_04	ITS nodes can ping other GVL nodes using IPv6 all-nodes multicast address
28	TD_GN6_05	ITS nodes can perform IPv6 Neighbour Discovery
29	TD_GN6_06	ITS nodes can configure a GVL by receiving Router Advertisement
30	TD_GN6_07	ITS nodes can configure several GVL by receiving Router Advertisements
31	TD_GN6_08	ITS nodes can deconfigure GVL after prefix expiration
32	TD_GN6_09	ITS nodes can communicate with legacy IPv6 node
33	TD_GN6_10	ITS nodes can communicate via legacy IPv6 network
34	TD_GN6_11	In-vehicle IPv6 host can communicate with the other in-vehicle IPv6 host
35	TD_GN6_12	In-vehicle IPv6 host can communicate with the a legacy IPv6 host

Table 7: Basic SPAT Tests

36	TD_SPAT_01	SPAT messages are interoperable
37	TD_SPAT_02	The lane reference contained in a TOPO/SPAT message is correctly interpreted
38	TD_SPAT_03	The current signal state contained in a SPAT message is correctly interpreted based on the “movement” for the driving approach towards intersection (ingress)
39	TD_SPAT_04	The current signal state contained in a SPAT message is correctly interpreted based on the “movement” and the corresponding lane reference
40	TD_SPAT_05	The colour of the next signal change contained in a SPAT message is correctly interpreted in relation to the movement and the corresponding “”movement and corresponding lanes for the relevant approach
41	TD_SPAT_06	The traffic light state contained in a SPAT message is correctly interpreted in relation to the ingress lanes for the relevant approach

Table 8: Basic TOPO Tests

42	TD_TOPO_01	TOPO messages are interoperable
43	TD_TOPO_02	The approach(ingress) reference of an intersection contained in a TOPO message is correctly interpreted
44	TD_TOPO_03	The approach(egress) reference of an intersection contained in a TOPO message is correctly interpreted
45	TD_TOPO_04	The continuation from an ingress approach to an egress of an intersection contained in a TOPO message is correctly interpreted

Table 9: Link Asymmetry Assessment Tests

46	TD_GN_LSA_01	Measurement of Rx sensitivity difference
47	TD_GN_LSA_02	Measurement of Tx power setting accuracy

Table 10: Generic CAM and DENM Tests

48	TD_CAM_05	CAM messages and their mandatory data elements are interoperable
49	TD_CAM_06	CAM messages and their optional data elements are interoperable
50	TD_DENM_01	DENM re-transmissions are correctly received within the DENM lifetime
51	TD_DENM_02	DENM re-transmissions are not received after the DENM lifetime
52	TD_DENM_03	DENM information is kept alive as expected during its lifetime
53	TD_DENM_04	DENM expiry handling is correctly implemented

5.2 Test Scheduling

The preliminary test schedule was developed before the plugtest and was circulated to all the participants in advance for comments. The initial test schedule allowed for each company to test against a fair number of other companies.. The radio bench test slots and conformance test slots had a duration of 4 hours. The face-to-face test slots had a duration of 2 hours. The day was organized in a morning test session from 9.00 to 13.00 and in an afternoon test sessions from 14.00 to 18.00.

During the test event the test schedule was constantly updated according to the progress of the test sessions. This was done during the daily wrap-up meetings at the end of each day and during face-to-face meetings with the participants.

The figure below shows the preliminary version of the test schedule.

		RadioBench1	RadioBench2	Vienna Demo	ConFormance1	ConFormance2	Face-to-Face1	Face-to-Face2
Mon 11	14:00-16:00	DENSO De1 QUWIC Qu1 TNO Tn1	Hit_Ren Hi1 Kapsch Ka1 Siemens Si1	Nec_Swa Ne1 Vector Ve1	Marben Ma1		Cohda_NXP Co1 ITRI It1	
	16:00-18:00	DENSO De1 QUWIC Qu1 TNO Tn1	Hit_Ren Hi1 Kapsch Ka1 Siemens Si1		Marben Ma1		Nec_Swa Ne1 Inria In1	
Tue 12	9:00-11:00	Cohda_NXP Co1 QUWIC Qu1 Siemens Si1	ITRI It1 Nec_Swa Ne1 TNO Tn1	DENSO De1 Vector Ve1		Inria In1	Hit_Ren Hi1 Marben Ma1	
	11:00-13:00	Cohda_NXP Co1 QUWIC Qu1 Siemens Si1	ITRI It1 Nec_Swa Ne1 TNO Tn1	Kapsch Ka1 Vector Ve1			DENSO De1 Marben Ma1	Hit_Ren Hi1 Inria In1
	14:00-16:00	Hit_Ren Hi1 Nec_Swa Ne1 Inria In1	Cohda_NXP Co1 DENSO De1 Kapsch Ka1	Vector Ve1 Siemens Si1		TNO Tn1	ITRI It1 Marben Ma1	
	16:00-18:00	Hit_Ren Hi1 Nec_Swa Ne1 Inria In1	Cohda_NXP Co1 DENSO De1 Kapsch Ka1			TNO Tn1	ITRI It1 QUWIC Qu1	
Wed 13	9:00-11:00	Cohda_NXP Co1 ITRI It1 Inria In1	Hit_Ren Hi1 Siemens Si1 TNO Tn1			QUWIC Qu1	DENSO De1 Kapsch Ka1	Marben Ma1 Nec_Swa Ne1
	11:00-13:00	Cohda_NXP Co1 ITRI It1 Inria In1	Hit_Ren Hi1 Siemens Si1 TNO Tn1			QUWIC Qu1	Kapsch Ka1 Marben Ma1	DENSO De1 Nec_Swa Ne1
	14:00-16:00	Kapsch Ka1 QUWIC Qu1 Inria In1	DENSO De1 ITRI It1 Siemens Si1		Nec_Swa Ne1	Cohda_NXP Co1	Marben Ma1 TNO Tn1	
	16:00-18:00	Kapsch Ka1 QUWIC Qu1 Inria In1	DENSO De1 ITRI It1 Siemens Si1		Nec_Swa Ne1	Cohda_NXP Co1	Hit_Ren Hi1 TNO Tn1	
Thu 14	9:00-11:00	Hit_Ren Hi1 ITRI It1 QUWIC Qu1	Cohda_NXP Co1 Nec_Swa Ne1 Inria In1		DENSO De1	Siemens Si1	Kapsch Ka1 TNO Tn1	
	11:00-13:00	Hit_Ren Hi1 ITRI It1 QUWIC Qu1	Cohda_NXP Co1 Nec_Swa Ne1 Inria In1		DENSO De1	Siemens Si1		
	14:00-16:00	DENSO De1 Kapsch Ka1 TNO Tn1	ITRI It1 QUWIC Qu1 Siemens Si1			Inria In1	Cohda_NXP Co1 Marben Ma1	Hit_Ren Hi1 Nec_Swa Ne1
	16:00-18:00	DENSO De1 Kapsch Ka1 TNO Tn1	ITRI It1 QUWIC Qu1 Siemens Si1				Marben Ma1 Inria In1	Cohda_NXP Co1 Nec_Swa Ne1
Fri 15	9:00-11:00	DENSO De1 Siemens Si1 Inria In1	Cohda_NXP Co1 Hit_Ren Hi1 TNO Tn1		ITRI It1	Kapsch Ka1	Marben Ma1 QUWIC Qu1	
	11:00-13:00	DENSO De1 Siemens Si1 Inria In1	Cohda_NXP Co1 Hit_Ren Hi1 TNO Tn1		ITRI It1	Kapsch Ka1		

Figure 1: Preliminary Test Schedule

5.3 Test Infrastructure

5.3.1 Central Position Server

The CPS provided the GPS feed to each implementation which used dynamically this data in their Facility and GN layer implementations.

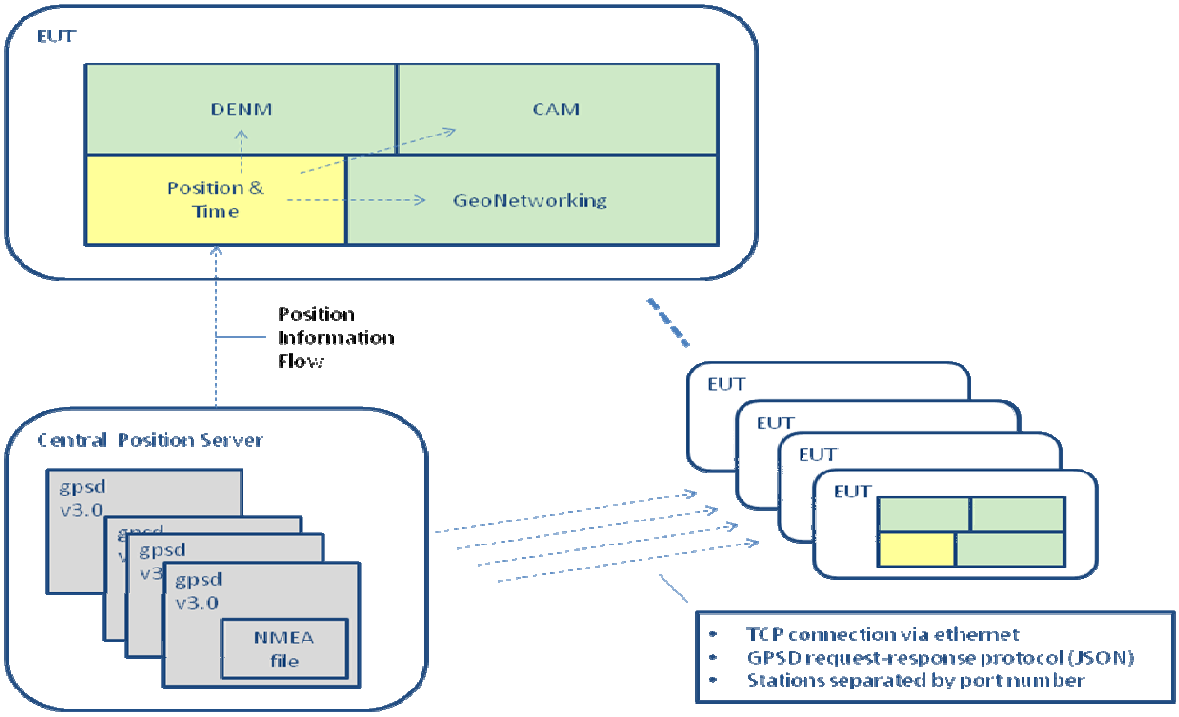

Figure 2: Central Position Server

5.3.2 Vehicle Position Monitoring Tool

The FOKUS Vehicle Position Monitoring tool is part of a web-based tool-chain for scenario-based testing. In the context of the plugtest the tool-chain has been used to visualize the vehicle positions for tests with dynamic position updates (see tests TD_GN_GBC_GRD_02, TD_GN_GBC_GRD_03, TD_GN_GUC_GRD_01, TD_GN_GUC_03, TD_GN_GUC_CBF_03). During the whole event the tool-chain was connected to the CPS so that position updates provided by the CPS were displayed directly as vehicle positions on a map. To support different test configurations separate configuration related visualizations have been prepared and provided by separate URLs so that the test operators were able to log in to a specific configuration of the web-based tool. The visualization of the vehicle positions has been mainly used to manually synchronize the test execution with the cyclic updates of the position data from the CPS. The figure below shows a screenshot of the monitoring tool as used during the plugtest.

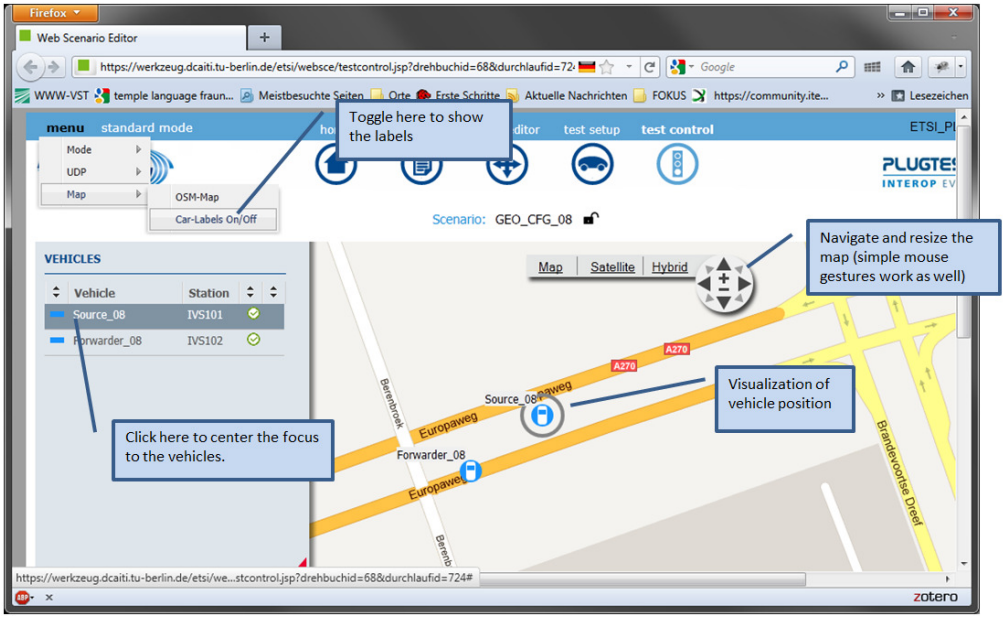

Figure 3: Vehicle Position Monitoring Tool

5.3.3 Face 2 Face Configuration

The face 2 face configuration was the basic configuration used for the majority of the test. It was important to use radio cables and not to do OTA tests as there were up to 6 test sessions running in parallel.

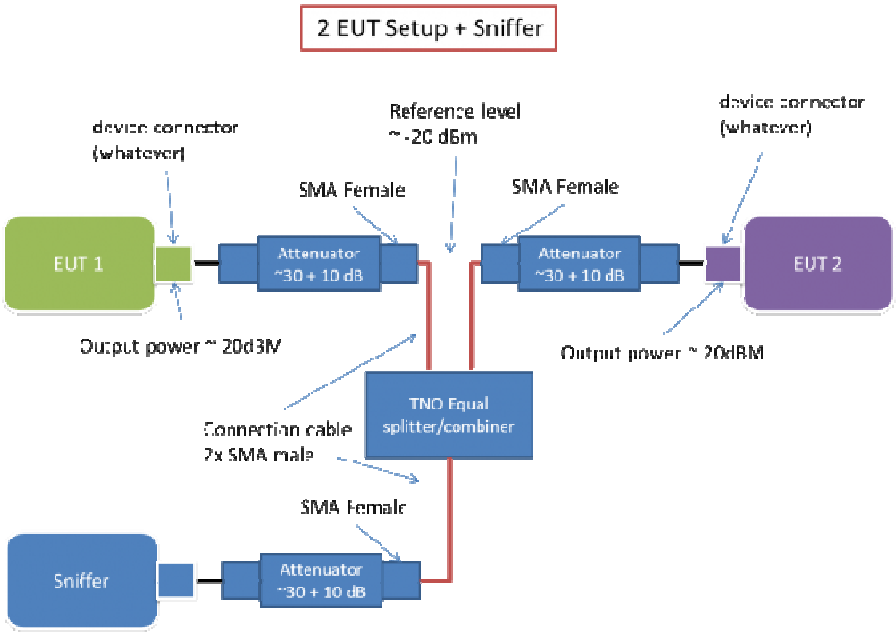

Figure 4: Face 2 Face Configuration

5.3.4 Radio Bench

The radio bench was used to test the multi hop scenarios such as 'GN Greedy forwarding' and 'GN Re-broadcast'. It was also used to test scenarios that needed specific radio attenuation such as 'GN Caching'. The Faraday cages prevented unintended RF signal leakage as data and mains were filtered and the radio devices (EUTs) were not able to radiate through the air. This forced a communication path depending on the settings of the attenuators. This enabled the

participants to exercise their tests in a controlled manner. Moreover, the relay function would otherwise have been difficult to examine in a proper way. In addition a spectrum/network analyser was used for checking the setup and to solve issues regarding RF power settings. Each setup contained a 802.11 p sniffer device with all related wireshark ITS dissectors.

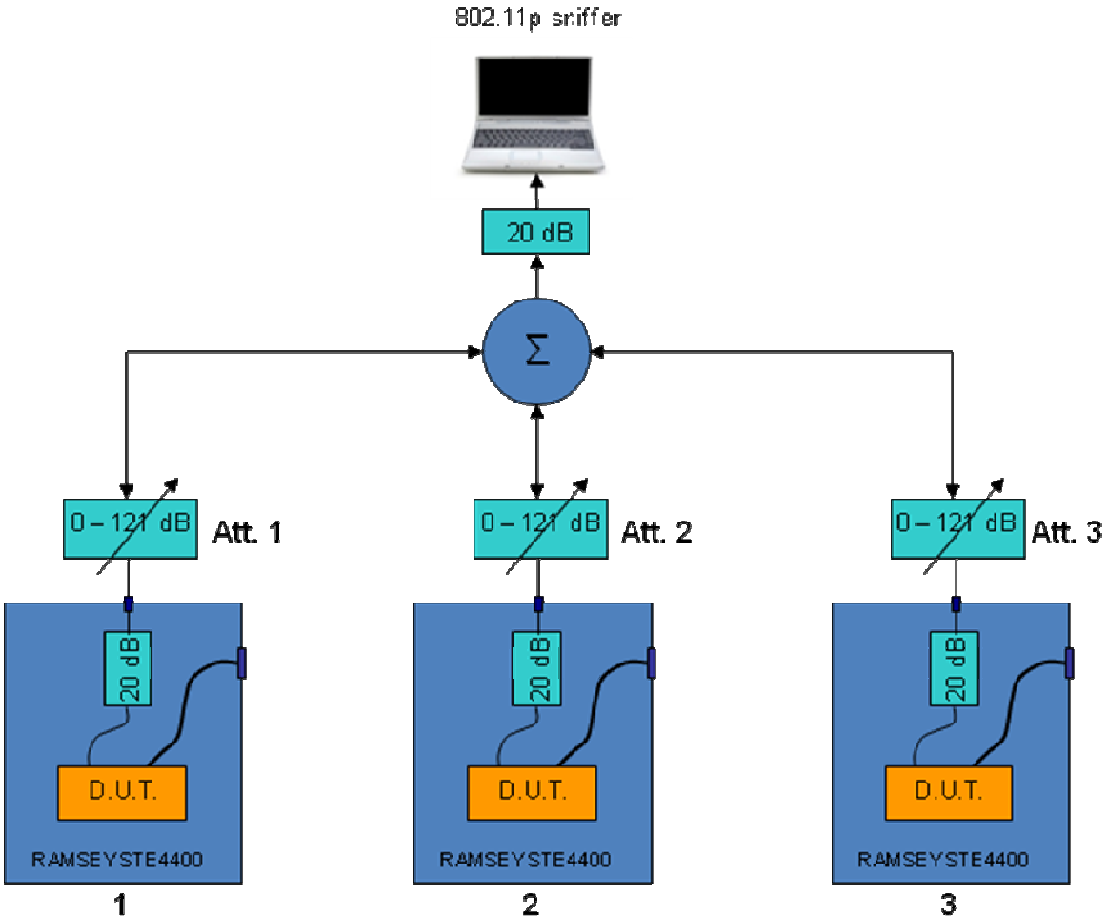

Figure 5: Radio Bench

5.4 Interoperability Test Procedure

Each test was executed in the same manner as listed below:

1) Connect two or three devices from different vendors

2) Check connectivity between devices

3) Perform tests according to Test Descriptions

4) Check if devices can send/receive frames from each other

5) Check if data is handled correctly in the network and facility layers

6) Check if implemented algorithms work correctly

7) Result determination and reporting

8) Result OK: run next test

9) Result NOK: check monitor tools to identify source of error

10) Report results in ETSI Test Reporting Tool

11) Once all tests executed swap receiver / sender roles and run all tests again

5.5 Conformance Validation Framework

Due to the success of the conformance testing sessions carried out at the first CMS Interoperability event with the ETSI ITS Conformance Validation Framework, vendors requested more conformance testing slots. Therefore, 2 conformance testing slots have been set up and used during this week.

The ETSI ITS Conformance Validation Framework is an open test system (available for free for the ITS community) and can be used to assess the compliance of implementations with the ETSI standards. The development of test suites and test systems are part of the ETSI Test Methodology. Test suites and systems are also used for certification purposes. With its high degree of flexibility, it can be also used for company internal testing.

At the plugtest, the conformance tests have been executed based on the TTCN-3 environment, provided by Testing Technologies, and the radio hardware provided by Cohda Wireless.

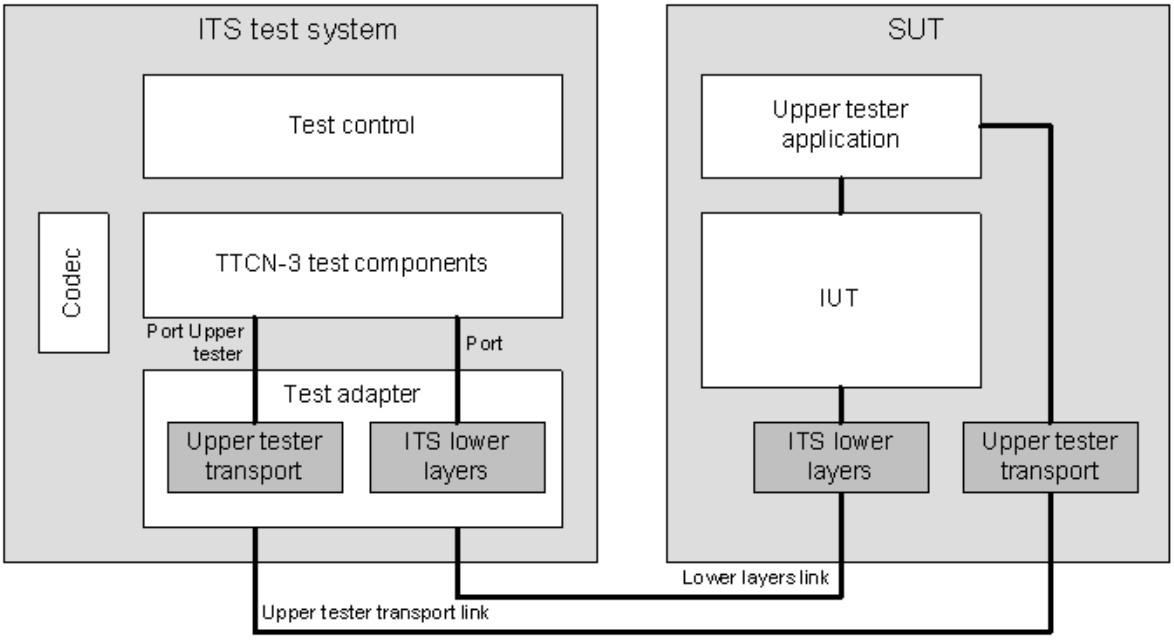

Figure 6: Conformance Validation Framework

6 Achieved Results

The achieved results show that all implementations have been compatible on a basic level, i.e. sent data could be decoded and interpreted properly by receivers. Furthermore the vast majority of equipment performed well on the physical layer.

However, mature and prototype implementations exist, and the difference between mature and prototype implementations is in the level of coverage of implemented features. It needs to be stated that when features were implemented, then high interoperability was observed.

Almost all mandatory tests were executed for the face-to-face tests and Radio Bench Tests.

Conformance test sessions were held for every vendor. This provided valuable feedback for vendors on the compliance of their implementation. Also bugs were found in the test suite which lead to an enhancement of the quality of the test suite.

First interoperability tests have been performed during the week in view of the C2C CC / Testfeld Telematik demonstration organised at the ITS World Congress in Vienna (22 - 26 October 2012). The aim was to check whether the implementations of the devices from the demo participants are based on the same specifications, for GeoNetworking and also for the application messages (CAM, DENM, SPAT, TOPO), and to make sure that they are interoperable. The tests were performed with CANoe.Car2x, a test tool from Vector.

Radio Bench – RF aspects

- No cross talk observed between DUTs situated in the Faraday cages
- Transmissions by other participants while performing face-to-face or other tests, caused minor pollution of the observed data at the externally situated 802.11p sniffer. This was caused by insufficient shielding of the WiFi cards inside the sniffer laptops and (too) high emissions of external devices performing tests in the premises
- RF getting in- or out of the Faraday cages was not observed
- A sixth variable attenuator would have somewhat simplified the measurements
- A few participants asked for additional feed through options in the Faraday cages, in order to accommodate USB or extra ethernet. This could not be provided, but did not pose any real issue
- Contrary to plugtest#1, virtually all participants used common SMA connectors

6.1 Overview of mandatory GN tests

There were 10 mandatory tests of which 7 tests where to be executed in the face 2 face configuration (2 vendors), and the remaining 3 in the radio bench (3 vendors). The tests in the face 2 face configuration were to be executed bidirectional. The tests in the radio bench were to be executed in such a way that each vendor played at least for once all important roles, i.e. source and forwarder. In a total more than 170 tests were executed and the figure below shows the results of all tests.

The execution rate of 77% is a satisfying result, given the fact that newcomers attended the event. Actually, when excluding the newcomers' test session reports from the overall result, it can be observed that the execution rate goes up to 85%.

13 % of the tests were not executed due to non implemented features. The non implemented features were mainly GeoBroadcast, Caching or DAD. DAD is not being implemented yet by all companies as there are ongoing security discussions on pseudonym change which will also impact the DAD mechanism.

10% of the tests were not executed due to time limitation. It seems that only longer test session slots could solve this problem. However, given the restricted time of 4 days and the wish to have face-to-face, radio bench and conformance tests excludes the possibility to prolong the test session slots.

92% of the test verdicts were PASS which shows the high level of maturity of the implementations.

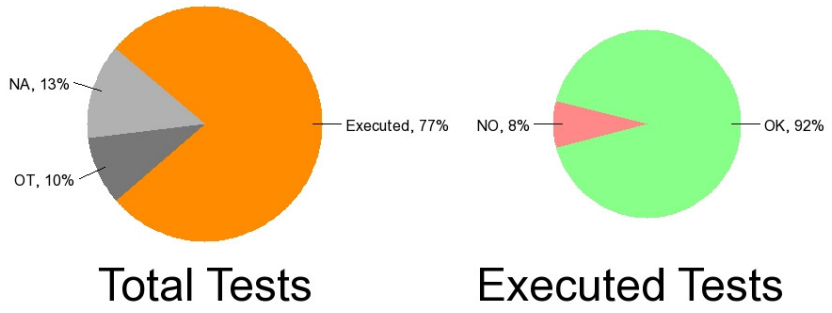

Figure 7: Results of mandatory tests

6.2 Listing of mandatory GN tests

The figure below provides the results per test. It can be observed that the DAD feature is not always implemented. The features Caching (TD_GN_GBC_04) and Forwarding (TD_GN_GBC_GRD_01,02) have encountered the most issues.

Results per Test

		Interoperability		Not Executed		Totals	
Group	Test Id	OK	NO	NA	OT	Run	Results
	TD_GN_GBC_02	11 (84.6%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	13 (100.0%)	13
	TD_GN_GBC_04	8 (80.0%)	2 (20.0%)	2 (15.4%)	1 (7.7%)	10 (76.9%)	13
	TD_GN_GBC_GRD_01	9 (75.0%)	3 (25.0%)	0 (0.0%)	1 (7.7%)	12 (92.3%)	13
	TD_GN_BEA_01	24 (100.0%)	0 (0.0%)	1 (3.8%)	1 (3.8%)	24 (92.3%)	26
	TD_GN_SHB_01	24 (100.0%)	0 (0.0%)	1 (3.8%)	1 (3.8%)	24 (92.3%)	26
	TD_GN_GBC_01	24 (100.0%)	0 (0.0%)	1 (3.8%)	1 (3.8%)	24 (92.3%)	26
	TD_GN_GBC_03	22 (91.7%)	2 (8.3%)	1 (3.8%)	1 (3.8%)	24 (92.3%)	26
	TD_GN_DAD_01	15 (100.0%)	0 (0.0%)	8 (30.8%)	3 (11.5%)	15 (57.7%)	26
	TD_GN_GBC_GRD_02	12 (75.0%)	4 (25.0%)	4 (15.4%)	6 (23.1%)	16 (61.5%)	26
	TD_GN_GBC_GRD_03	14 (93.3%)	1 (6.7%)	4 (15.4%)	7 (26.9%)	15 (57.7%)	26

Figure 8: Results per mandatory tests

6.3 Overview of other tests

No statistics were created for Conformance test sessions and the tests for C2C CC / Testfeld Telematik demonstration as conformance test results are strictly confidential.

The GN6 tests are considered as experimental, but already 5 companies participated in these tests. The tests TD_GN609 – 10 deal with connectivity checks from in-vehicle stations to IPv6 legacy networks. During the event it was discovered that different algorithms were implemented, and in the wrap up session it was concluded that the GN6 base specification still contains some major design flaws. IPv6 Neighbour Discovery (TD_GN6_05) was not always supported, but this test could be strictly spoken considered to be a native IPv6 test, and hence the support of this feature does not necessarily need to be tested in the scope of a GN plugtest.

Results per Test

		Interoperability			Not Executed		Totals	
Group	Test Id	OK	NO		NA	OT	Run	Results
	TD_GN6_01	6 (100.0%)	0 (0.0%)		0 (0.0%)	0 (0.0%)	6 (100.0%)	6
	TD_GN6_02	5 (100.0%)	0 (0.0%)		0 (0.0%)	1 (16.7%)	5 (83.3%)	6
	TD_GN6_03	5 (100.0%)	0 (0.0%)		0 (0.0%)	1 (16.7%)	5 (83.3%)	6
	TD_GN6_04	4 (100.0%)	0 (0.0%)		1 (16.7%)	1 (16.7%)	4 (66.7%)	6
	TD_GN6_05	2 (100.0%)	0 (0.0%)		1 (16.7%)	3 (50.0%)	2 (33.3%)	6
	TD_GN6_06	5 (100.0%)	0 (0.0%)		0 (0.0%)	1 (16.7%)	5 (83.3%)	6
	TD_GN6_07	2 (100.0%)	0 (0.0%)		3 (50.0%)	1 (16.7%)	2 (33.3%)	6
	TD_GN6_08	0 (0.0%)	0 (0.0%)		3 (50.0%)	3 (50.0%)	0 (0.0%)	6
	TD_GN6_09	0 (0.0%)	0 (0.0%)		0 (0.0%)	6 (100.0%)	0 (0.0%)	6
	TD_GN6_10	0 (0.0%)	0 (0.0%)		0 (0.0%)	6 (100.0%)	0 (0.0%)	6
	TD_GN6_11	0 (0.0%)	0 (0.0%)		0 (0.0%)	6 (100.0%)	0 (0.0%)	6
	TD_GN6_12	0 (0.0%)	0 (0.0%)		0 (0.0%)	6 (100.0%)	0 (0.0%)	6

Figure 9: Results per GN6 tests

The optional GN tests focused on rectangular destination area, geounicast operations and CBF algorithms for both unicast and broadcast.

Processing of rectangular areas (TD_GN_GBC_05-06) showed a high level of interoperability.

The simple geounicast test (TD_GN_GUC_01) showed a high level of interoperability. All other geounicast tests such as geounicast greedy forwarding (TD_GN_GUC_02, TD_GN_GUC_GRD_01-02) were only reported in small numbers, as these tests implied to have Location Service implemented; which was not supported by many companies.

None of the proposed tests for geounicast CBF (TD_GN_GUC_CBF_01-03) and only one test for geobroadcast CBF (TD_GN_GBC_CBF_01-03, TD_GN_GBC_07) was reported. The reason for the small number of reports is that the corrected 'CBF for GeoUnicast' and simplified 'CBF for GeoBroadcast' algorithm specifications were agreed upon by WG3 delegates and made available only shortly before the event. However, these corrections can be taken into account for a next revision of the geonetworking base specification.

Results per Test

		Interoperability			Not Executed		Totals	
Group	Test Id	OK	NO		NA	OT	Run	Results
	TD_GN_GBC_07	1 (50.0%)	1 (50.0%)		5 (38.5%)	6 (46.2%)	2 (15.4%)	13
	TD_GN_GBC_08	0 (0.0%)	0 (0.0%)		5 (38.5%)	8 (61.5%)	0 (0.0%)	13
	TD_GN_GBC_09	0 (0.0%)	0 (0.0%)		2 (15.4%)	11 (84.6%)	0 (0.0%)	13
	TD_GN_GBC_CBF_01	0 (0.0%)	0 (0.0%)		5 (38.5%)	8 (61.5%)	0 (0.0%)	13
	TD_GN_GBC_CBF_02	0 (0.0%)	0 (0.0%)		5 (38.5%)	8 (61.5%)	0 (0.0%)	13
	TD_GN_GBC_05	11 (91.7%)	1 (8.3%)		5 (19.2%)	9 (34.6%)	12 (46.2%)	26
	TD_GN_GUC_02	2 (66.7%)	1 (33.3%)		3 (23.1%)	7 (53.8%)	3 (23.1%)	13
	TD_GN_GBC_06	11 (91.7%)	1 (8.3%)		5 (19.2%)	9 (34.6%)	12 (46.2%)	26
	TD_GN_GUC_GRD_01	1 (100.0%)	0 (0.0%)		3 (23.1%)	9 (69.2%)	1 (7.7%)	13
	TD_GN_GUC_GRD_02	1 (100.0%)	0 (0.0%)		3 (23.1%)	9 (69.2%)	1 (7.7%)	13
	TD_GN_GUC_CBF_01	0 (0.0%)	0 (0.0%)		6 (46.2%)	7 (53.8%)	0 (0.0%)	13
	TD_GN_GBC_CBF_03	1 (100.0%)	0 (0.0%)		18 (69.2%)	7 (26.9%)	1 (3.8%)	26
	TD_GN_GUC_CBF_02	0 (0.0%)	0 (0.0%)		6 (46.2%)	7 (53.8%)	0 (0.0%)	13
	TD_GN_GUC_CBF_03	0 (0.0%)	0 (0.0%)		6 (46.2%)	7 (53.8%)	0 (0.0%)	13
	TD_GN_GUC_01	12 (92.3%)	1 (7.7%)		5 (19.2%)	8 (30.8%)	13 (50.0%)	26

Figure 10: Results per optional GN tests

7 Summary of Wrap Up Sessions

7.1 Review of IOP Issues from plugtest#1

- There was an important ramp up time of 2 days. For a next event the ramp up time should be reduced.
  - For a next event it is recommended to propose to newcomers and prototype implementations to pre test 2 – 3 days before the start of the plugtest, in order to bring them to the same stage of interoperability level. **Pre testing was not done in plugtest#2 as only a small number of newcomers had registered and these newcomers were quite well advanced.**
  - The prototype implementations from this event should run in a next event all mandatory tests in the face 2 face as well as in the radio bench configurations. **This was almost achieved in plugtest#2.**
- The test infrastructure worked well. However optimizations can be done, especially in the following fields:
  - For a next event it is recommended to provide a wireshark monitoring support for the radio bench setup. **This was done in plugtest#2.**
  - For a next event it is recommended to provide more wireshark monitoring support for the face 2 face configurations. **This was not realized in plugtest#2. However, participants could monitor themselves using the wireshark ITS dissectors.**
- The conformance monitoring of select trace probes showed that conformance testing is required
  - For a next event it is recommended to provide more conformance tests slots. **This was done in plugtest#2.**
- Issues were discovered with non quality ASN.1 compilers
  - For a next event it is recommended to provide reference packets so that each vendor can ensure that their implementations can correctly encode/decode the packets. **This was done in plugtest#2.**
- The IOP issues discovered with implementations were mainly
  - Bugs with timestamps lead to not processing received packets, i.e Time Module stuck, Bug in the software. **Solved in plugtest#2.**
  - Bugs with destination area computation **Solved in plugtest#2.**
  - Output power too low, i.e. some hardware had broken power amplifiers, Malfunctioning Tx behaviour **Solved in plugtest#2.**
  - Choice of quality ASN.1 compiler is essential, i.e. Support for extensions (e.g. …), Support for extended integer range. **Still ongoing in plugtest#2.**

7.2 IOP Issues from plugtest#2

- The CPS was configured to provide for each Test Session (there were multiple Test Sessions in parallel) different geo positions in order to minimize potential interference between Test Sessions. This concept was dropped for plugtest#2 as all participants reported that they had used the same geo positions in parallel without having an impact on their test scenarios.
- Issues were discovered with non quality ASN.1 compilers
- Location service not implemented by all vendors
  - This is an issue for GeoUnicast Testing

7.3 GN Base Spec Issues

- 2 modifications to forwarding algorithms were proposed as a result of the plugtest preparation
    - Corrected CBF for GeoUnicast
    - Simplified CBF for GeoBroadcast
- CBF timer values
    - TO_CBF_MIN/MAX need to take into account the expected processing time variation
- Asymmetric link tests show that
    - A can see B, does not imply that B can see A
    - the transmission power has been close to nominal values on most equipment (at 20 dBm)
    - This can be taken into account for CBF versus Greedy usage
- Wrong order of execution steps in chapter 9.3.4.3
    - Step 7 should come before step 5
- Add to D.2 and all advanced fwd algorithms: GBC received outside destination area: If the previous hop is inside the destination area then drop packet
- Should MAC ACKs be used to update Neighbour Tables? Discussion whether MAC ACKs should be sent or not (this applies to GeoUnicast)
- A(1)-B-A(2) radio scenario where A(1) and A(2) do have same GN@, but cannot see each other: how to handle this?
    - to add duplicate address notification service (via exposed node B as SHB)
    - to elaborate the logic of SN checking for Duplicate Packet Detection/Delayed Packets/Packet Ordering
    - Do nothing as this is a very rare case (location could be used to distinguish)
- Shall it be mentioned that you should drop a packet if the GN@ is not built according to MAC@? Wait for a decision from WG5 on pseudonym handling, and decide then
- To add a new MIB parameter to handle the itsGnLineForwardingAlgorithm (to make distinction from itsGnGeoUnicastForwardingAlgorithm during line forwarding)
- To add an optional parameter to existing GN-SAP to pass Destination coordinates from BTP to GN layer
- Handling packet repetition procedure is not a task for the network
    - rather the application should handle this itself

7.4 GN6 Base Spec Issues

- Clause 8.2.2 on Inbound Traffic defines that IPv6 Router shall discard packets which are addressed to destinations not corresponding to GVL prefix
    - It is proposed to remove this restriction to allow end-2-end communication between IPv6 hosts that are behind the IPv6 routers
- Clause 8.2.2 on Inbound Traffic defines that IPv6 Router shall discard IPv6 packets of type geoBroadcast which do not contain a RouterAdvertisement
    - It is proposed to remove this restriction to allow other types of multicast packets to be handled

- Clause 8.2.2 deals with geobroadcast and geoanycast in the same manner
    - It is proposed to define separate behaviour for the 2 cases

Annex A Interoperability Test specification

The ETSI CTI Plugtest Guide, which forms parts of the present technical report, is contained in the file ITS_TestDescriptions_2ndPlugtest.pdf which accompanies the present document.

Annex B Workshop on Cooperative Mobility services - Benefits and deployment challenges

The workshop took place Thursday 14 June 2012 - 09:30 to 17:00 at the test site of IFSTTAR.

B.1 Programme

The availability of appropriate vehicle to vehicle and vehicle to infrastructure communication systems will allow proposing a wide range of application to the drivers:

- Safety application to warn drivers about potential dangers
- Application to broadcast information like parking availability
- Business applications like fleet management

From 11 to 15 June 2012, cooperative mobility solution vendors will meet at IFSTTAR to test the interoperability of their communication components. The experts involved in the standardization, the development and the deployment of cooperative systems will present their views during this one day workshop. This will be an opportunity to understand the principles, the benefits and the challenges of the Cooperative Mobility Services.

Organizer: François Fischer, Project Manager, ERTICO – ITS Europe

Moderator: Jacques Ehrlich, IFSSTAR

B.2 Agenda

Time	Programme
09:00	Registration
09:20	**Welcome Session**
1	Jacques Ehrlich, Research director, IFSTTAR
09:30	**Introduction to the cooperative systems** **Presentation of the cooperative system technologies & standards**
2	Bernadette Villeforceix, Orange - Access Technologies
3	Andras Kovacs, Broadbit - The ITS protocols
4	Oyunchimed Shagdar, INRIA - IPv6 for cooperative systems
5	Nicolas Hautière, IFSTTAR - The “Automated Road” research roadmap
10:30	**Coffee Break**

10:45	**Cooperative mobility benefits and challenge** **Presentation of the applications provided by cooperative systems & the expected benefits**
6	Stefan Herrig, Swarco - Traffic light optimization
7	Amira Horozovic, Honda R&D - Motorcycle Approaching Indication use case
8	Gerard Segarra, Renault - Safety applications - standardization
9	Paul Barnard, Ygomi - Fleet management applications
11:45	**Test and Certification** **Presentation of the test methodologies & intitiatives towards certification. How to ensure interoperabioity, funtionalies & required performanace of the cooperative systems.**
10	Dirk Tepelmann, Testing Technologies - Conformance testing for ITS protocols
11	Francois Fischer, ERTICO - Benefits of the certification
12	Jean-Marc Blosseville, IFSTTAR - the point of view of the test laboratories
12:30	**Summary of the first interoperability test results**
13	Sebastian Müller, ETSI - Presentation of the event programme. Summary of the first results
13:00	**Lunch Break**
14:00	**Round Table** **How to ensure the successful deployment of Cooperative ITS systems**
Moderator	Maxime Flament - Head of Sector - SafeMobility ERTICO ITS Europe
RT1	Bernadette Villeforceix, Orange
RT2	Stefan Herrig, SWARCO
RT3	Gérard Ségarra, RENAULT
RT4	Jean-Marc Blosseville, IFSTTAR
RT5	Amira Horozovic, Honda R&D
15:00	**Wrap-up & Conclusions**
15:30	**Demo and visit of IFSTTAR & networking cocktail**
D1	SCORE@F demonstrations will be achieved involving Renault, PSA, IFSTTAR and NEAVIA (Roadside equipment supplier)

B.3 Some photos

The pictures below have been taken during the workshop. For more pictures and live information please refer to the event blog:
http://www.ertico.com/2nd-cms-interoperability-event-follow-it-live/

History

Document history		
V1.1.1	July 2012	First version