TECHNICAL REPORT

3rd ITS Cooperative Mobility Services Plugtest; Essen, Germany; 25 - 29 November 2013 RF Measurements and DENM, GN Interoperability in Radio Bench

Keywords
Testing, Interoperability, ITS

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1 Executive Summary

ETSI‘s ITS technical committee develops standards for communications between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure). ITS is scheduled to be deployed in Europe in 2015. In order to meet this goal, the European Commission has financially supported the development of ETSI’s release 1 package of ITS standards. The existence of common European standards is paramount to ensure the interoperability of ITS services and applications as well as to accelerate their introduction for the car industry and road users.

Standard development should ideally undergo a cycle of specification development, followed by validation of the specification, followed by development of standardized test specifications. ETSI implements these best practices through organizing Plugtests™ interoperability events and creating standardized test specifications.

ETSI, in collaboration with ERTICO, has organized the latest in a series of Plugtests™ interoperability events for Intelligent Transport Systems (ITS) Cooperative Systems. This event was held in parallel with the ITS CMS event and was hosted by CETECOM, from 25 to 29 November in Essen, Germany.

Participating companies from the automotive sector tested the interoperability of their solutions. In addition they ran tests to assess their compliance with the latest standards developed by the ETSI ITS technical committee. The event also included a workshop on Future Perspectives of Car-to-X Communication, gathering experts from both public and private organizations specializing in ITS technologies and implementations.

2 Introduction

This PHY event aimed to test the interoperability of ITS equipment from all key vendor implementations and to validate the base specifications of ITS protocols DENM and GeoNetworking. A radio bench was provided to connect three devices and to test multi hop scenarios.

Other interoperability tests during this event covered RF regulatory and performance measurements to evaluate the radio capabilities of prototype ITS devices, and these confirmed the feasibility of ITS in the 5 GHz frequency band. Valuabel feedback for the revision of the harmonized standard HEN 302 571 was collected.

At the end of each day a wrap-up meeting was held to discuss main interoperability points of the day.

A very detailed preparation was required in order to allow for a smooth and efficient test week. The following test tool and equipment providers supported the event:

- CETECOM – RF Lab and Equipment
- Qosmotec - Automated Attenuation Platform
- Rohde&Schwarz – RF Measurement Setup
- VECTOR – Monitoring Tool

A blog and a press release were produced. They are accessible at http://www.etsi.org/news-events/events/665-plugtests-2013-itscms3?tab=4 and http://www.etsi.org/news-events/news/728-2013-12-press-release-its-interop-event

2 References

The following base specifications were validated in the Plugtest.

[i.1] ETSI EN 302 637-2 v1.3.0: CAM base specification

[i.2] ETSI EN 302 637-3 v1.2.0: DENM base specification

[i.3] ETSI EN 302 636-5-1 v1.1.1: BTP base specification

[i.4] ETSI EN 302 636-4-1 v1.2.0: GN base specification

[i.6] ETSI TS 102 894-2 V1.1.1: Common Data Dictionary

[i.6] ETSI EN 302 571 V1.2.1: Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive

[i.7] IEEE 802.11-2012: 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

3 Abbreviations

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
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
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 Plugtests are listed in the table below.

Table 1: List of teams

#	Teams
1	AUTOTALKS

2	**COMMSIGNIA**
3	**Cohda /NXP**
4	**DENSO**
5	**FRAUNHOFER ESK**
6	**HITACHI/RENESAS**
7	**IMTECH**
8	**ITRI**
9	**KAPSCH**
10	**MARBEN**
11	**NEC**
12	**QMIC**
13	**TRIALOG**
14	**SIEMENS**
15	**UNEX**

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

Table 2: List of test tool vendors

#	Test Tool Vendor	Role
1	**CETECOM**	RF Lab and Equipment
2	**Qosmotec**	Automated Attenuation Platform
3	**Rohde&Schwarz**	RF Measurement Setup
4	**Vector Informatik**	Monitoring and Demo Tests

The following FOTs were represented by the companies.

Table 3: List of FOTs

#	Test Tool Vendor
1	PRESERVE
2	DRIVE C2X
3	SCORE@F

5 RF Regulatory and Performance Measurements

5.1 Introduction

As part of the 3rd ITS Plugtest event in Essen an RF measurement session has been defined in order to evaluate the initial RF performance parameter of the available ITS G5-A and B devices and chipsets. As the basic reference for these measurements the minimum performance requirements defined in the IEEE 802.11-2012 [i.7] standard and the regulatory requirements covered in the harmonized ETSI standard HEN 302 571 1.2.1[i.6] have been considered.

ITS-G5 RF specifications allow single and multi-channel devices within the ITS-G5A, ITS-G5B and ITS-G5C band, with possible extension towards the ITS-G5D band in the future. However, for the first generation of ITS-G5 devices (day 1 implementations), it is expected that there are single channel devices only, supporting the 10 MHz bandwidth Control Channel G5CC at 5900 MHz in the ITS-G5A band. Thus, the design of the 3rd ETSI plugtest RF minimum performance measurement setup assumes ITS-G5A single channel devices only.

The overall RF measurement session during the 3rd ITS plugtest has been split into two main parts:

- RF performance measurements for TX and RX and
- Evaluation measurements of the Channel Busy Ratio (CBR) evaluation required for the mechanism.

The detailed test setup will be presented in the next section, see Figure 1.

5.2 Test setup

5.2.1 Overview

In Figure 1 the setup for the all RF measurements including TX, RX and CBR performance is depicted. The device under test (DUT) is connected to a RF signal generator (here: R&S SMW200A) and a signal analyser (here: R&S FSV). A PC controls the complete system. The overall setup has been designed to support up to two antennas at the DUT. During the test session only single antenna devices have be evaluated.

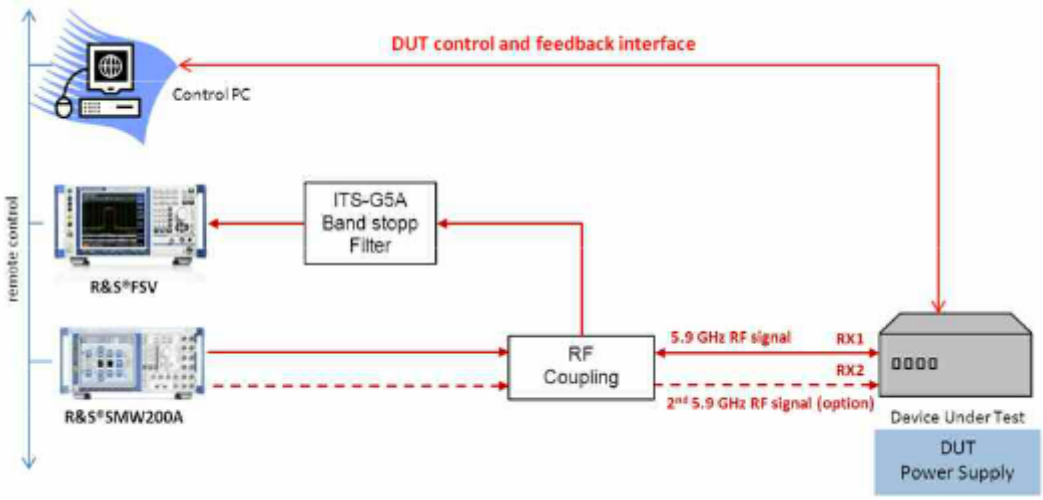

Figure 1: ITS-G5 Measurement Setup Hardware

The presented setup has been used to perform a sample of regulatory RF measurements according to EN 302 571 and additional minimum performance measurements. The regulatory measurements include:

- Unwanted emissions within the ITS-G5 band according to EN 302 571 subclause 6.4.2.
- Unwanted emissions outside the ITS-G5 band according to EN 302 571 subclause 6.4.1.

The out of band unwanted emission measurements will be restricted to the range 30 MHz – 6 GHz. However, this includes the critical ranges next to the ITS-G5A/B/D bands.

The additional minimum performance measurements include:

- Modulation quality, incl. constellation error, spectral flatness, carrier frequency and clock error
- Minimum receiver sensitivity measurements under static conditions
- Receiver performance measurements under AWGN (static channels) and fading conditions

For the modulation quality and minimum receiver sensitivity measurements the requirements provided by IEEE Std. 802.11-2012 apply. For the receiver performance measurements under non-static conditions are no standardized performance requirements available, yet. Thus, those measurements will be conducted without final measurement verdicts, unless there will be a common agreement on dedicated performance limits for the plugtest.

5.2.2 Transmitter spectrum mask measurements within the ITS G5 spectrum

In this test the DUT output spectrum emission mask is being verified according to EN392 571, subclause 6.4.2. The measurement parameters have been set in accordance with the EN with the exception of the resolution bandwidth for the emission measurements in the ITS-G5 band. This resolution bandwidth was set to 100KHz as defined in IEEE 802.11-2012 and the results have bee recalculated taking into account the limits defined in dBm/MHz.

These measurements have been performed using the ITS channel center frequency of 5.9GHz with the TX power of the DUT set to the highest output power.

DUT meets requirements according to modified EN 302 571 table 7:

Table 4: ITS-Band spectrum emission measurement result

Data rate	Modulation and Coding rate	verdict
6 Mbit/s	QPSK½	PASS / FAIL

5.2.3 Transmitter spectrum mask measurements outside the ITS G5 spectrum

In this test the DUT output spectrum emission mask is being verified according to EN392 571, subclause 6.4.1. The measurement parameters have been set in accordance with the EN:

- Spectral measurement range limited to 30 MHz – 6 GHz
- Positive peak detector measurements for the entire spectral range
- Reference bandwidth 100 kHz below 1GHz
- Reference bandwidth 1 MHz above 1 GHz
- Maximum hold trace
- Optional RMS detector measurements on request

These measurements have been performed using the ITS channel center frequency of 5.9GHz with the TX power of the DUT set to the highest output power.

The results have been recorded in a format given in Table 5

Table 5: ITS-out-of-Band spectrum emission measurement result

Freq start / MHz	Freq stop / MHz	Maximum power results	limits
30	1000	[dBm / 100kHz]	<-36dBm/100kHz
1000	5795	[dBm / MHz]	<-30dBm/MHz
5795	5815	[dBm / MHz]	<-65dBm/MHz
5815	5850	[dBm / MHz]	<-55dBm/MHz
5850	5855	[dBm / MHz]	<-30dBm/MHz
5925	5965	[dBm / MHz]	<-65dBm/MHz
5965	6000	[dBm / MHz]	<-30dBm/MHz

5.2.3 Transmitter modulation quality measurements

The DUT modulation quality is a set of parameters defined in IEEE802.11-2012.

- Transmit center frequency tolerance according to IEEE Std. 802.11-2012 subclause 18.3.9.5.
- Symbol clock frequency tolerance according to IEEE Std. 802.11-2012 subclause 18.3.9.6.
- Transmitter relative constellation error according to IEEE Std. 802.11-2012 subclause 18.3.9.7.4.
- Transmitter spectral flatness according to IEEE Std. 802.11-2012 subclause 18.3.9.7.3.

The measurement setup given in Figure 1 has been deployed with the DUT set to a center frequency of 5.9GHz with the maximum TX power.

The results have been recorder in accordance with the following tables:

1. Frequency error:

Table 6: Frequency error results and limits

Data rate	Modulation and Coding rate	Center frequency error	limits
3 Mbit/s	BPSK½	[Hz]	< ±118kHz
6 Mbit/s	QPSK½	[Hz]	< ±118kHz
12 Mbit/s	16-QAM½	[Hz]	< ±118kHz

2. Symbol clock error:

Table 7: Symbol error results and limits

Data rate	Modulation and Coding rate	Symbol clock error	limits
3 Mbit/s	BPSK½	[ppm]	< ±20ppm
6 Mbit/s	QPSK½	[ppm]	< ±20ppm
12 Mbit/s	16-QAM½	[ppm]	< ±20ppm

3. The relative constellation error (corresponds to EVM, Error Vector Magnitude), averaged over subcarriers, OFDM frames and packets:

Table 8: Constellation error results and limits

Data rate	Modulation and Coding rate	EVM	limits
3 Mbit/s	BPSK½	[dB]	< -10dB
6 Mbit/s	QPSK½	[dB]	< -10dB
12 Mbit/s	16-QAM½	[dB]	< -10dB

4. The average energy of the constellations in each of the spectral lines -16 ... -1 and +1 ... +16 shall deviate no more than +/- 4dB from their average energy. The average energy of the constellations in each of the spectral lines -26 … -17 and +17 … +26 shall deviate no more than +4/-6 dB from the average energy of spectral lines -16 ... -1 and +1 ... +16.: yes/no?

Table 9: Spectrum flatness results and limits

Data rate	Modulation and Coding rate	verdict	limits
3 Mbit/s	BPSK½	PASS / FAIL	See text above
6 Mbit/s	QPSK½	PASS / FAIL	See text above
12 Mbit/s	16-QAM½	PASS / FAIL	See text above

5.2.4 Receiver sensitivity measurements

In a cooperative communication system the receiver performance is of significant importance for the overall system performance and fairness. The sensitivity of traditional radio LAN systems based on IEEE 802.11-2012 have only be defined and evaluated using static AWGN channels. This is sufficient for indoor quasi static operating wireless systems. For the mobile systems dynamic channels have to be added to the sensitivity performance evaluation of the DUT. During the measurements performed in the 3rd ITS plugtest both setup have been evaluated.

According to Figure 1, the RF test setup supports both, single and dual receiver DUT implementations. Nevertheless, during the RF measurement session only single antenna devices have been tested.

During the receiver sensitivity testing the packet error ration (PER) at different received power levels is being evaluated as specified in IEEE Std. 802.11-2012 subclause 18.3.10.2. The packet length (PSDU length) is set to 1000 Octets. The receiver sensitivity is defined as the required received power level to reach a PER of ≤ 10%. In the measurements only Gaussian noise is being considered as interference.

The results of the sensitivity evaluation for the static case are recorded in a table:

Table 10: RX sensitivity results and limits for 10% PER in a 10MHz channel, static case

Data rate	Modulation and Coding rate	sensitivity level	Number of RX antennas	Limit in static case see 802.11-2012
3 Mbit/s	BPSK½	[dBm]	1	< -85dBm
6 Mbit/s	QPSK½	[dBm]	1	< -82dBm
12 Mbit/s	16-QAM½	[dBm]	1	< -77dBm

For the sensitivity evaluation in a dynamic channel case a set of channel models have been defined. Theses models are depicted in Annex ??. The evaluation was only done using a 6Mbit/s mode (QPSK modulation with a ½ Rate Channel coding) for the 5 different fading channel models. The results have been recovered in a table:

Table 11: RX sensitivity results and limits for 10% PER in a 10MHz channel, dynamic case

Fading Profile	Modulation and Coding rate	sensitivity level	Number of rx antennas	Limits
1	QPSK½ (6 Mbit/s)	[dBm]	1	No limits defined yet
2	QPSK½ (6 Mbit/s)	[dBm]	1	No limits defined yet
3	QPSK½ (6 Mbit/s)	[dBm]	1	No limits defined yet
4	QPSK½ (6 Mbit/s)	[dBm]	1	No limits defined yet
5	QPSK½ (6 Mbit/s)	[dBm]	1	No limits defined yet

5.2.2 Channel busy ration evaluation test

In addition to these measurements an initial evaluation of the available Channel Busy Ration measurements has been performed using two separate devices deploying different evaluation methods.

The basic test setup has been similar to the one presented in Figure 1. In this case the signal generator has been used t generate a given channel load to be evaluated by the DUT.

The DUT then reported the measured channel load to the control PC. Due to the lack of available devices and the lack of a detailed definition for the CBR measurement no quantitative measurements have been performed during the session.

5.3 Test result summary

5.3.1 General

Overall 10 different devices have been evaluated during the test session in Essen. In this report an overview over the obtained results will be given without a reference to the specific DUT. All measurements have been performed using the 5.9GHz channel (IEEE Channel #180) with a bandwidth of 10MHz. Only single antenna devices have been presented. Most of the devices supported a automated receiver testing which reduces the measurement time significantly.

5.3.2 Modulation quality results

All devices under test passed the modulation quality measurement as defined IEEE802.11-2012. Some example measurement results are given in Figure 2 and Figure 3 for the costallation error measurement and the spectrum flatness measurement, respectively.

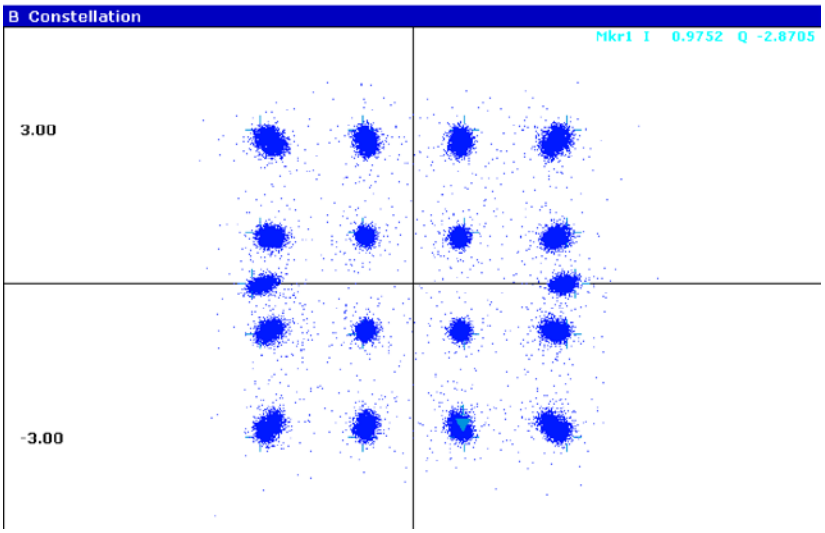

Figure 2: Modulation constellation diagram for a 12Mbit/s mode

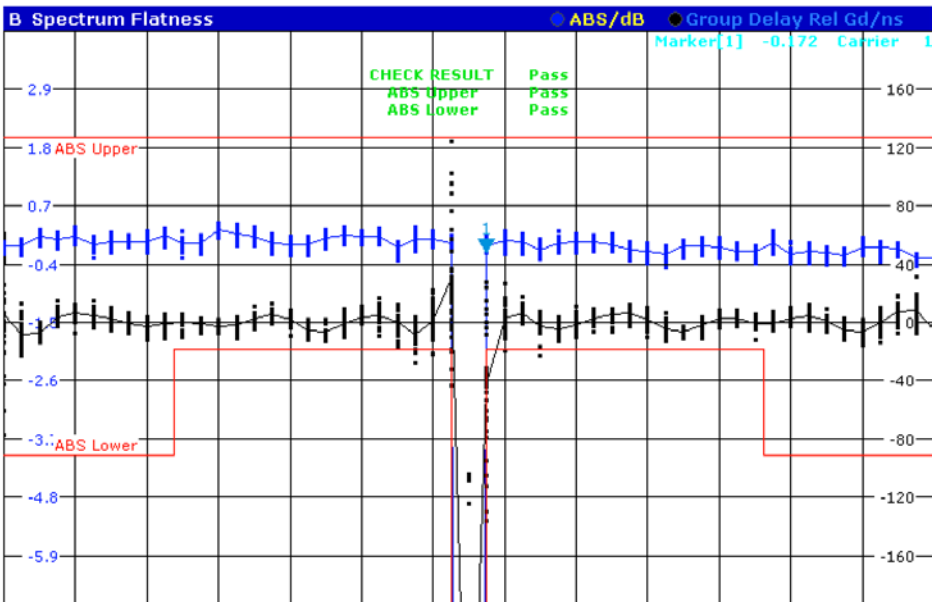

Figure 3: Spectrum flatness result

5.3.3 ITS G5 Inband emission spectral emission mask

The inband spectrum emission mask has to be measured at the maximum available TX output power. The maximum output power of the 10 DUTs ranged from 7dBm to 24dBm. 40% of the DUT failed to reach the limits defined in EN302 571, 60% reached this limits. An example measured spectrum mask is given in Figure 4.

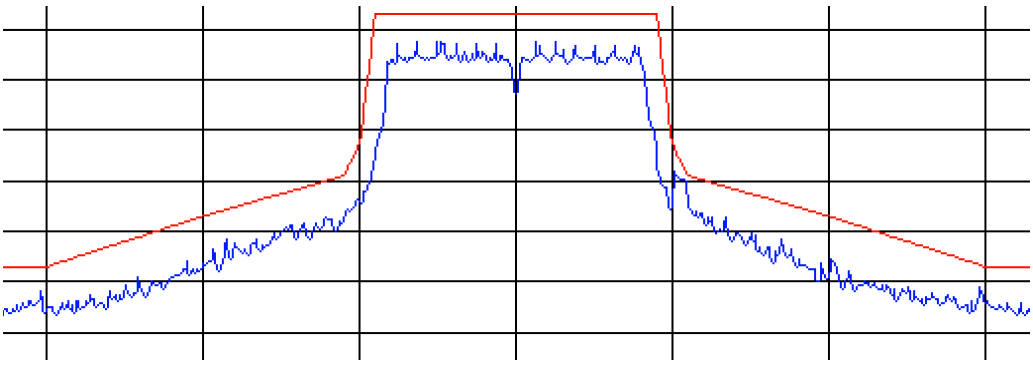

Figure 4: Example inband spectrum emission mask

5.3.4 Out-of-band spectral emission mask

The most critical spectrum measurement was the out-of-band emission mask measurement. In this measurement non of he devices could comply with the limits defined in EN302571 and the corresponding regulation. The most critical limits are the limit above 5.925GHz and between 5.795GHz and 5.815GHz with TX limits below -65dBm/MHz. This is illustrated in Figure 5.

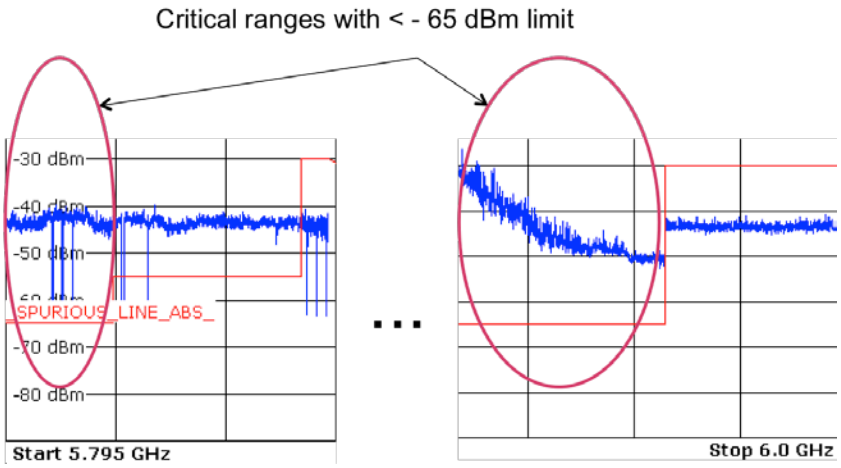

Figure 5: Critical areas in the out-of-band spectrum emission mask

5.3.5 RX sensitivity performance results

This measurements have been split into a the static measurements using an AWGN channel and the limits given in IEEE 802.11.2012 and dynamic measurements using a set of multipath fading channel defined in Annex ???. For the dynamic channel measurements no limits have been defined yet.

All 10 DUTs could reach the static sensitivity limits defined by IEEE with a range of -89.5dBm to -96.5dBm (green curve in Figure 6). In the dynamic case the Profile 1 results in sensitivity level between -88dBm and -96.5dBm and all devices could reach the limit of PER < 10% (red curve in Figure 6). For the other profiles (2 to 5) only 30% of the devices have been capable of reaching the required PER of 10%. All other devices ended up in an irreducible error floor due to multipath interference effects (blue curve in Figure 6). These effects are depicted in Figure 6

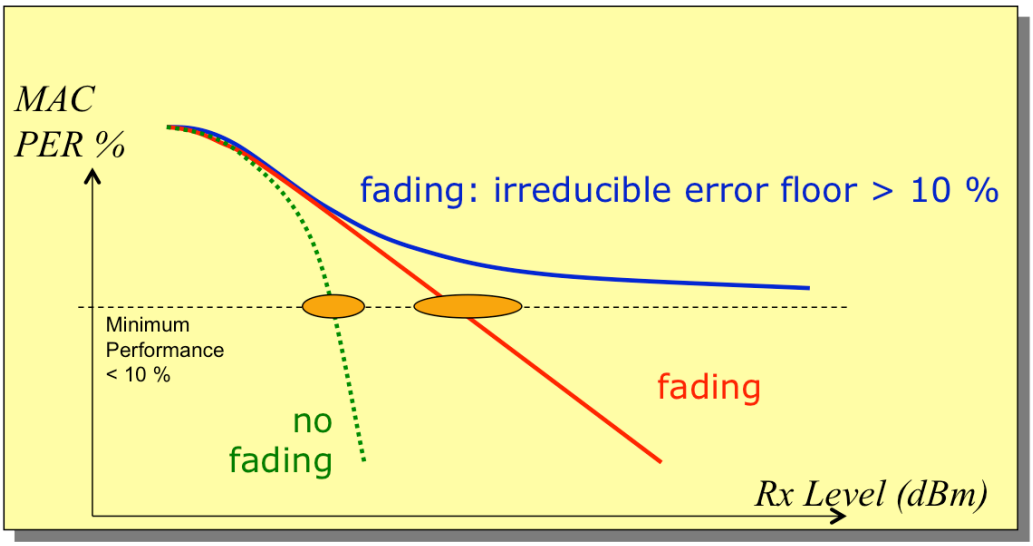

Figure 6: Sensitivity results for static and dynamic channels

5.4 Conclusion

The RF measurements during the 3rd ITS Plugtest in Essen in November 2013 have been the first time where a broad range of ITS devices have been neutrally evaluated against the limits contained in the harmonized standard EN 302 571 1.2.1 and the performance parameters included in the IEEE 802.11-2012 standard. Several of these devices have been close to the market introduction.

The IEEE performance figures like modulation quality, spectrum flatness and receiver static sensitivity have been reached by all devices under test. The sensitivity test performed using the newly introduced dynamic fading channel model (see Annex A) could only be passed by the devices deploying specific mobile capable modem designs, which was the case for 30% of the DUTs.

Thus mobile usage of ITS-G5 technology based on IEEE 802.11-2012 is possible with limited losses when this deployment is taken into account in the design of the receivers. In addition, the results show the urgent requirement for the definition of a set of mandatory dynamic fading reference channel models for receiver performance evaluation tasks and certification processes. The static tests defined in IEEE are not sufficient for the mobile environment where ITS systems will be deployed.

The Channel Busy Ration evaluation measurement has only been performed using two devices. The measurements have to be included in future Plugtest in order to get a more detailed overview over the available performance and reachable precision of the measurement. These evaluations are important for the development of conformance test for the mandatory DCC functionality of the ITS-G5 systems.

The most critical results have been the spectrum measurements defined in the harmonized standard EN302 571 1.2.1 based on the ITS spectrum regulation in Europe. None of the available 10 devices passed these tests and thus non of the available devices would be allowed for market entry in the EU. Here regulatory and technology action have to be taken in order to guarantee a timely market introduction of cooperative ITS devices based on ITS-G5 standards in Europe.

In upcoming Plugtests the RF measurement should be repeated with a stronger focus on the CBR measurements and potentially the DCC functionality of the ITS-G5 devices. The results of these measurements can then support the development of appropriate DCC mechanisms and the related validation tests.

6 DENM, GN Interoperability in Radio Bench

6.1 Introduction

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.

6.2 Test setup

In the figure below the test setup is depicted with the sniffer device from Vector and the automated attenuation device from Qosmotec.

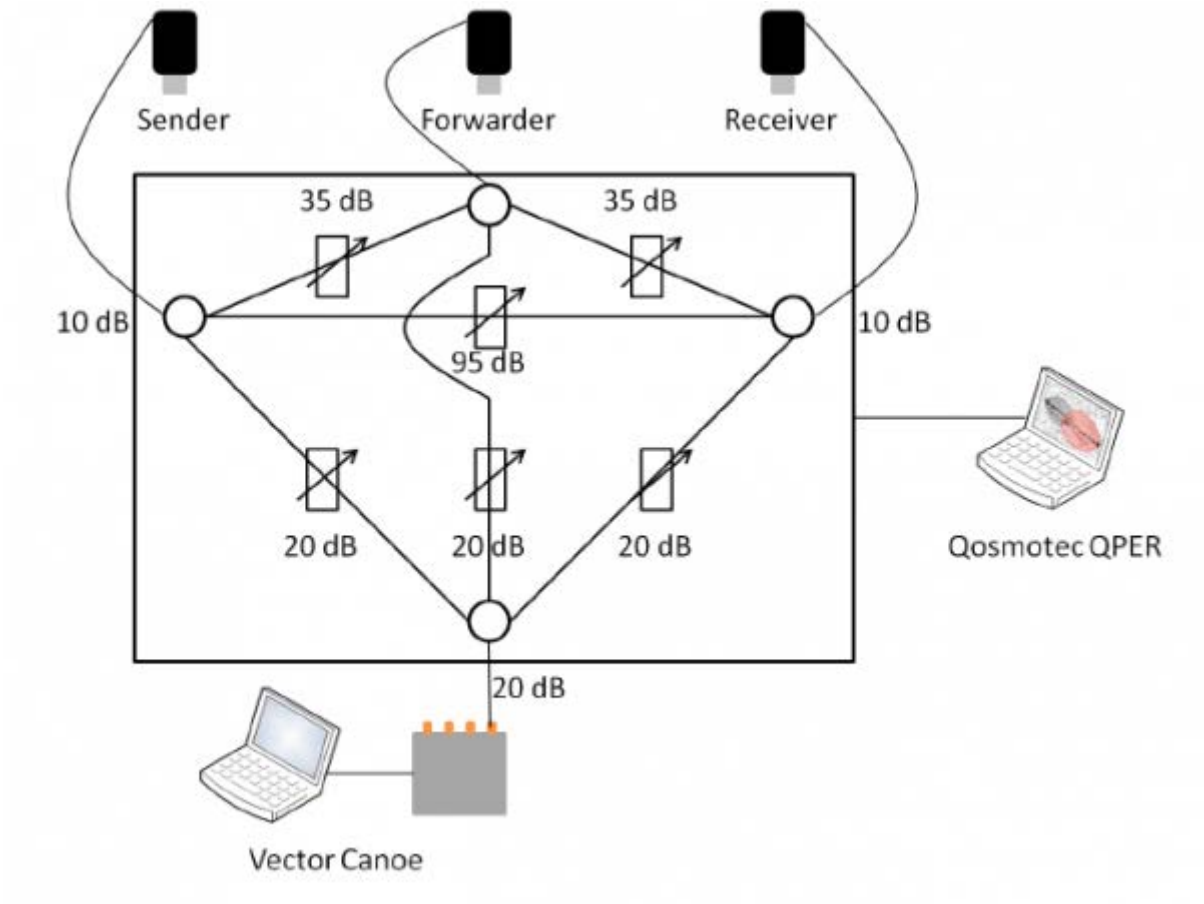

Figure 7: Radio Bench

6.3 Test Result Summary

6.3.1 Overall Results

This clause presents the achieved interoperability results of the tests executed in the radio bench configuration. 14 different devices (DUT) attended the tests. The following base specifications were validated:

- DENM base specification (EN 302637-3 v1.2.0)
- Common Data Dictionary (TS 102 894-2 V1.1.1)
- GN base specification (EN 302636-4-1 v1.2.0)

Test activities contributed to the base spec validation. For identified issues please refer to 'chapter 7 Base Specification Validation' of 'Plugtest Report Part 1 : CAM, DENM, GN Interoperability in F2F configuration'.

The table below provides the overall result. The PASS rate (Executed - OK) of ~85 % provides a fair result, given the technical complexity of the radio bench configuration. The execution rate of ~22% is too low. Out of Time (OT) is the main reason for not executed tests. This is an indicator that the 2 hr time slots were probably too short.

Table 12: Results Overview

Executed		Not Executed		Totals
OK	NO	NA	OT	Run
140 (84.8%)	25 (15.2%)	34 (4.5%)	551 (73.5%)	165 (22.0%)

6.3.2 Results per GN Tests

The table below provides the GN test results. An explanation is given why some tests underperformed.

- TD_GN_GBC_02 Number of re-broadcasts not handled correctly during DENM flooding
    - Too many rebroadcasts
    - Rebroadcasts were not sent due to timestamp reference problems
- TD_GN_GBC_04 Flushing of buffer very fast (few hundred microsec)
    - Not all packets are received
- TD_GN_GBC_FW_01, TD_GN_GBC_FW_04 Issues with Line forwarding
    - MAC-broadcast by sender
    - MAC-broadcast by forwarder due to PAI=0 of source
    - Position Accuracy indicator. Vendors use different settings (nextHop selection difficult)
- TD_GN_GUC_XX Not enough GUC tests executed

Table 13: Results per GN test

	Executed		Not Executed		Total
Test ID	OK	NO	NA	OT	Run
TD_GN_GBC_02	29 (80.6%)	7 (19.4%)	1 (2.0%)	13 (26.0%)	36 (72.0%)
TD_GN_GBC_04	16 (94.1%)	1 (5.9%)	1 (2.0%)	32 (64.0%)	17 (34.0%)
TD_GN_GBC_SCF_01	11 (100.0%)	0 (0.0%)	0 (0.0%)	39 (78.0%)	11 (22.0%)
TD_GN_GBC_FW_01	20 (71.4%)	8 (28.6%)	0 (0.0%)	22 (44.0%)	28 (56.0%)
TD_GN_GUC_02	1 (33.3%)	2 (66.7%)	4 (8.0%)	43 (86.0%)	3 (6.0%)
TD_GN_GBC_FW_04	17 (89.5%)	2 (10.5%)	0 (0.0%)	31 (62.0%)	19 (38.0%)
TD_GN_GUC_GRD_01	2 (100.0%)	0 (0.0%)	3 (6.0%)	45 (90.0%)	2 (4.0%)
TD_GN_GUC_GRD_02	1 (100.0%)	0 (0.0%)	3 (6.0%)	46 (92.0%)	1 (2.0%)
TD_GN_GUC_CBF_03	3 (75.0%)	1 (25.0%)	4 (8.0%)	42 (84.0%)	4 (8.0%)
TD_GN_GUC_CBF_01	2 (100.0%)	0 (0.0%)	3 (6.0%)	45 (90.0%)	2 (4.0%)
TD_GN_GBC_07	1 (100.0%)	0 (0.0%)	3 (6.0%)	46 (92.0%)	1 (2.0%)

6.3.3 Results per DENM Tests

The tables below show the results of the DENM tests. An explanation is given why some tests underperformed.

- TD_DENM_01 Number of re-transmissions not handled correctly
- TD_DENM_04 Issue with radio connection

Table 14: Results per DENM test

	Executed		Not Executed		Total
Test ID	OK	NO	NA	OT	Run
TD_DENM_04	17 (94.4%)	1 (5.6%)	1 (2.0%)	31 (62.0%)	18 (36.0%)
TD_DENM_01	8 (80.0%)	2 (20.0%)	0 (0.0%)	40 (80.0%)	10 (20.0%)
TD_DENM_02	10 (100.0%)	0 (0.0%)	0 (0.0%)	40 (80.0%)	10 (20.0%)

6.4 Conclusion

The achieved results show that the majority of equipment performed well on the multi hop scenarios and fair PASS rates where achieved. The radio bench setup is a good playground to evaluate GN forwarding scenarios. As it is a complex setup, it is recommended for a next event that all vendors should run a conformance session prior to attend test sessions in the radio bench. Also, longer time slots should be considered. With these measures a higher execution rate of the tests could be achieved.

Annex A Channel Models

5 typical C2C multipath scenarios exist:

1. Rural LOS

2. Highway LOS
3. Urban Approaching LOS
4. Crossing NLOS
5. Highway NLOS

The corresponding channel model parameters are given in the following tables.

	Tap1	Tap2	Tap3		Units
Power	0	-14	-17		dB
Delay	0	83	183		ns
Doppler	0	492	295		Hz
Profile	STATIC	Rayleigh	Rayleigh		
K					dB

Profile 1: Rural LOS Parameters

	Tap1	Tap2	Tap3	Tap4	Units
Power	0	-10	-15	-20	dB
Delay	0	100	167	500	ns
Doppler	0	689	492	886	Hz
Profile	STATIC	Rayleigh	Rayleigh	Rayleigh	
K					dB

Profile 2: Highway LOS Parameters

	Tap1	Tap2	Tap3	Tap4	Units
Power	0	-8	-10	-15	dB
Delay	0	117	183	333	ns
Doppler	0	236	157	492	Hz
Profile	STATIC	Rayleigh	Rayleigh	Rayleigh	
K					dB

Profile 3: Urban Approaching LOS Parameters

	Tap1	Tap2	Tap3	Tap4	Units
Power	0	-2	-5	-7	dB
Delay	0	200	433	700	ns
Doppler	0	689	492	886	Hz
Profile	STATIC	Rayleigh	Rayleigh	Rayleigh	
K					dB

Profile 4: Highway NLOS Parameters

	Tap1	Tap2	Tap3	Tap4	Units
Power	0	-3	-5	-10	dB
Delay	0	267	400	533	ns
Doppler	0	295	98	591	Hz
Profile	STATIC	Rayleigh	Rayleigh	Rayleigh	
K					dB

Profile 5: Crossing NLOS Parameters

Annex B Feedback to ETSI EN 302 571 V1.2.1

Subclause 4.6.

Subclause 4.6. introduces “three receiver categories” and refers to table 1b. However, table 1b lists two receiver categories only.

Subclause 6.3.2.1. Table 3 and 6.4.2.2. Table 7

Content of table 3 and table 7 not consistent with table 2b and EN 302 663 table 2: Relaxations for SCH5 and SCH6 missing.

Subclause 6.4.1.2.

Referencing of tables 5, 6a and 7 in the introductory text of subclause 6.4.1.2. inconsistent.

Subclause 6.4.1.2. Table 5

Maximum power defined in (e.r.p.)? Assuming this should be (e.i.r.p.).

Subclause 6.4.1.2. Table 6a

The out of band limit of maximum power e.i.r.p. in the range 5,795 – 5,850 GHz and 5,925 – 5,965 GHz have not been met by any implementation during the ETSI ITS 2013 plugtest. This issue is currently under discussion at ETSI and CEPT. Immediate action required to meet 2015 C-ITS deployment target.

Subclause 6.4.2.2. Table 7

Table 7 specifies the transmitter unwanted emission limits inside the 5 GHZ bands @ 10 MHz bandwidth. However, it is not clear how the mask should look like. The shape of the mask could be stairs or shaped like in IEEE 802.11-2012. The latter one is assumed.

The proposed RBW of 1MHz exceeds the 0.5 MHz portions (e.g. 5 MHz – 5.5 MHz). This does not make sense. Thus, the RBW should be changed to a suitable value, e.g. 100 kHz as in IEEE 802.11-2012, and the emission limits in table 7 should be adapted accordingly. The IEEE 802.11-2012 method has been used during the ETSI ITS 2013 plugtest.

Subclause 6.5.2. Table 7

Maximum power defined in (e.r.p.)? Assuming this should be (e.i.r.p.).

Subclause 6.6.1.

Why is this test restricted to ITS-G5B band only?

Rationale of LBT definition in table 9, note 2 is unclear.

Subclause 6.9.

Subclause does not make any sense. Referencing to a void subclause 7.3.10.

Subclause 6.10.2

This chapter refers to EN 302 663, which in turn refers back to EN 302 571? Thus, this reference is obsolete.

Sublause 7.2. Table 11

Table 11 specifies the maximum measurement uncertainty. However, the given value of uncertainty for “RF frequency” is without unit. It is assumed that it is “ppm” (parts per million).

Subclause 7.3.3.2.1.1. and 7.3.3.2.1.2.

What is the definition of “wideband”? Is a “wideband” RF power meter really necessary here? It is assumed that wideband means 10 times the channel bandwidth, i.e. 100 MHz.

Subclause 7.3.3.2.1.3.

What is exactly meant by the “above procedure” that shall be repeated for each frequency declared by the provider.

What is exactly meant by a “non-Gaussian” bandwidth. It is never mentioned that a Gaussian-shaped analyser filter shall be used by default in EN 302 571.

Subclause 7.3.4.1.

Is peak detector the right detector to be used here, or should it be rms detector? The limits specified should match for the used detector.

Subclause 7.3.4.2.1.

It is specified to use video averaging OR “peak hold”. If “peak hold” is used a measurement offset of 10 dB is observed. Thus, there should be only one measurement option, i.e. peak hold or “gated”.

Subclause 7.3.4.2.1.

It is specified to start gate 4 us before burst, which is not possible in frequency scan mode. Isn’t measurement of burst power sufficient, i.e. remove “gated” requirement. Furthermore it is not specified how many symbols have to be measured per measuring point.

Subclause 7.3.4.2.11. d) and e)

Step size for zero span measurement is missing.

Subclause 7.3.5.2.1.

No detector type specified. If rms detector is required, the sweep time is not specified, too. Measurement time per point should be specified to be < 8 us (symbol duration)

Subclause 7.3.5.2.1.

RBW of 1 MHz exceeds 0.5 MHz portions. See subclause 6.4.2.2. issue.

Subclause 7.3.8.2.

How many messages/samples have to be measured until 90% message acceptance (packet success rate) are reliably reached?

What does “approximately +/- 10 MHz” relative to the carrier frequency mean?

Subclause 7.3.9.

It is required to adjust the adjacent channel signal level until a certain bit error rate is reached. However, this is the only reference to a bit error rate, and there is also no reference in section 3.3. to BER abbreviation.

It is assumed that instead of bit error rate it should be packet error rate PER, to which other tests refer too, and for which the limit of 10 % makes sense only.

See also document ERMTG37(14) 000003.

General issue

The calibration procedure is explained in some test case sections in detail (e.g. 7.3.11). Can this be removed? The RF system is calibrated once before the first test run. After that, many test cases can run in a row without running a calibration before each test case.

History

Document history		
V001	9.01.2014	First draft