TECHNICAL REPORT TR11.2

NGH-PH.1 LAB TEST VALIDATION PLAN

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EXECUTIVE SUMMARY

This document describes the measurement guidelines for the laboratory measurements to be carried out in TF11, to test the prototypes developed in TF10 that implement “NGH-Phase1” features, as described in ENGINES deliverable D10.2: “Identification and Specification of "NGH-Ph.1" Prototypes to be Built”, V0.1 - August 25, 2011. [1]. It also describes the logistical details for the laboratory measurements.

The main goals of the laboratory tests are focused on testing the “NGH-Phase 1” (T2-Lite & SC-OFDM) new features implemented by the prototypes developed in TF10. These features should be validated in a full simulated chain, in order to check the HW interoperability of the equipment from different providers and to check that the prototypes fulfil the specifications defined in the standard. Moreover, in these laboratory tests some channel propagation models will be emulated to validate the performance of the prototypes in different reception scenarios.

The results from these laboratory tests will also be used as an input for planning and carrying out the field trials in TF12.

The first sections of the document are focused on the overall description of the tests and the logistical details. Section 1 defines the TF10 prototypes and the “NGH-Ph1” features to validate. Sections 2 and 3 provide logistic information related to the place of tests, infrastructure required and contact details. Sections 4 to 6 define the schedule for the tests, the participant list and the main working specifications of the equipment to be tested in the laboratory measurements.

In section 7 the document describes the measurement guidelines related to the validation of the T2-Lite features. Four subsections are presented for each of the different tests, where the cases for T2-lite and mixed T2-Base/T2-Lite, both in MFN and SFN, are considered. Each test starts with the definition of the specific goals, following with the description of the T2 configuration modes to be used and the propagation channel models under test. For each test, the equipment required and the reference set-up is described. Finally, the test procedure and the expected results are presented.

Section 8, describes the measurement guidelines related to the validation of the SC-OFDM modulation for satellite broadcasting towards handheld terminals. The description of this test includes the definition of the specific goals, the configuration and channel models to be used, the equipment required, the test procedure and the results expected.

LIST OF CONTRIBUTORS

- **University of the Basque Country UPV/EHU**
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- **TDF**
  Jean-Roger Roy

- **Mitsubishi Electric R&D**
  Arnaud Bouttier

1 INTRODUCTION

The main objective of these laboratory measurements is to check the correct operation of available DVB-T2 equipment in the transmission and reception sides when using "NGH-Ph.1" new features. These features should be validated in a full simulated chain, in order to check the HW interoperability of the equipment from different providers and to check that the prototypes fulfill the specifications defined in the standard.

The prototypes described in D10.2 [1], that should be evaluated in the laboratory measurements are presented in *Table 1*:

Table 1. TF10 prototypes to be tested.

Id.	***Prototype***	***Provider***
P.1	T2 Modulator	TeamCast
P.2	T2 Modulator	Thomson Broadcast
P.4	T2 Transmitter	Mier
P.5	T2 Gap-Filler	Mier
P.7	SC-OFDM Evaluation Platform	MERCE
P.8	T2 Gateway	Enensys
P.11	T2 Demodulator	UPV/EHU

Particularly, the T2-Lite standard will be checked. Its inclusion in the DVB-T2 standard has supposed a new profile with new features, including new code rates, *post-scrambling* for L1 and additional signaling.

This Plug Fest will concentrate on these items by testing parameter sets that use the T2-Lite as well as the T2-Base profiles. Besides, the correct compatibility between the prototypes in *Table 1* will be tested in a SFN network so as to ensure a correct operation in the posterior TF12 field trials.

On the other hand, the suitability of the SC-OFDM modulation for satellite broadcasting towards handheld terminals will be also tested.

The new features to test that should be considered for validation are presented in *Table 2*:

Table 2. "NGH Phase 1" features to test.

Id.	***NGH Phase 1 FEATURE***
F.1	T2-Lite FEF, with support of T2-MI rel 1.3.1
F.2	Mixed T2 and T2-Lite
F.3	T2-Lite in SFN networks
F.4	Mixed T2 and T2-Lite in SFN networks
F.5	SC-OFDM for satellite segment

2 PLACE OF TESTS AND CONTACT DETAILS

The plug-fest will take place at the ABERTIS facilities in Barcelona, Spain. ***For more information, see Apendix I: Location Information.***

ABERTIS PARC LOGISTIC **Av. Parc Logistic, 12-20** **Building C** **08040, Barcelona (SPAIN)**
GPS coordinates : N 41º 20' 28.8" , E 2º 7' 40.1"

NOTE: Although tests 1, 2, 3 and 4 will be carried out in the Abertis facilities in Barcelona (Spain), the test 5: "SC-OFDM for satellite segment" will be carried out in parallel in Mitsubishi Electric R&D facilities in Rennes (France). From this point, all the logistical information in the present document is focused on the Abertis facilities.

The contact details are as follows:

First Contact Person	Luis Moreno
Email	luis.moreno@abertistelecom.com
Telephone	+34 912 026 139
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3 INFRASTRUCTURE

Two rooms have been reserved in the second floor of the building C in the ABERTIS facilities. The fisrt one, the "*Excellence room*", has been booked to hold the meetings. It will be also possible to configure and control all the equipments through the "*Management Network*" in that room. Apart from that, a part of the "*Exploitation Laboratory*" will be used as the laboratory where laboratory measurements will be carried out.

For more information, see Apendix II: Detailed Layout and floor plan.

Figure 1 shows the suggested location of the equipment needed for the laboratory tests in the laboratory available for the plug-fest.

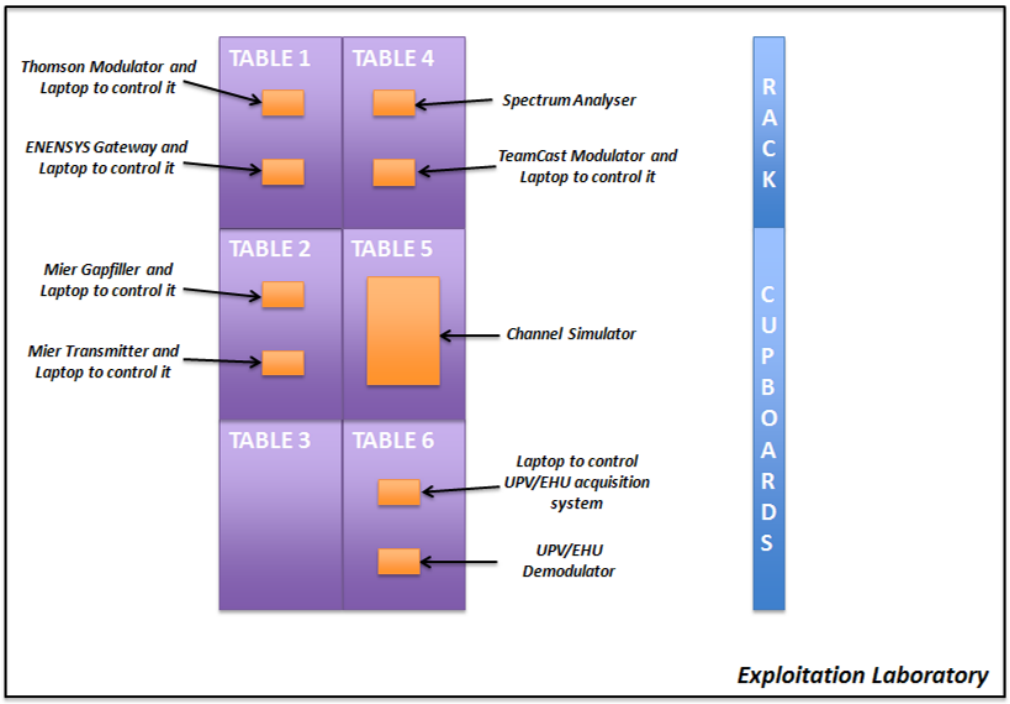


Figure 1. Equipment location for T2-Lite laboratory tests in the room available

For more information on the additional equipments needed, see sections 7.1.3.3, 7.2.3.3, 7.3.3.3 and 7.4.3.3 for each test.

Table 3 resumes additional supplies for all the plug-fest participants.

Table 3. Additional supplies

Power Supply	Standard Spanish plugs (230V, 50Hz)
Internet Connection	Wired or wireless Internet Connection
Tables/Trolleys/Racks	Suitable desks, trolleys or racks to place equipments upon
Other laboratory equipments	Connection cables, attenuators, splitters, combiners, Ethernet cables....

4 DATES AND SCHEDULE

The plug-fest will be held from ***17th September* until *18th September 2012***. Each day, testing will start at *09:00 am* and finish at *18:00 pm*. Lunch will be from *13:00 pm* to *14:30 pm* in *La Coma* restaurant, which is near the ABERTIS facilities.

***La Coma* Restaurant** Carrer 27 de Parc. Logistic, 4 08040 Barcelona *Telephone*
GPS coordinates : N 41° 20' 24.8", E 2° 7' 35.5"

The plan is to carry out sessions in the morning (from *09:00 am* to *13:00 pm*) and in the afternoon (from *14:30 pm* to *18:00 pm)* with the following schedule planned.

Day 1 (*17th September 2012*):

***09:00 – 13:00: Set-up* of equipment (4 hours)**
***13:00 – 14:30*: Lunch**
14:30 – 16:30: Test 1: Session 1 (2 hours)
16:30 – 18:00: Test 1: Session 2 (1 hour and 30 minutes)

Day 2 (*18th September 2012*):

09:00 – 10:00: Test 1: Session 3 (1 hour)
*10:*00 – *11:30:* Test 2: Session 4 (1 hour and 30 minutes)
11:30 – 13:00: Test 3: Session 5 (1 hour and 30 minutes)
***13:00 – 14:30*: Lunch**
14:30 – 16:30: Test 4: Session 6 (2 hour)
***16:30 – 18:00*: *Packing-up* of equipment (1 hour and 30 minutes)**

The description of the activities to be carried out in each session is detailed in sections 7.1.4, 7.2.4, 7.3.4 and 7.4.4. ***For more information, consult those sections.***

There will be a chairman in every test. The chairman is responsible for the test coordination and the collection of results in each test for the final report. The chairmen are shown on *Table 4*:

Table 4. Different tests chairmen

	Chairman
Test 1: T2-Lite FEF, with support of T2-MI rel 1.3.1	UPV/EHU
Test 2: Mixed T2 and T2-Lite	UPV/EHU
Test 3: T2-Lite in SFN Networks	Thomson
Test 4: Mixed T2 and T2-Lite in SFN Networks	TeamCast
Test 5: SC-OFDM for satellite segment	MERCE

5 PARTICIPANT LIST

Table 5 resumes the partners that have participated in the laboratory tests. Some of them providing equipment for testing and others elaborating measurements guidelines and reporting.

Table 5. Participant list

Company	*Name and contact email*	*Contribution*	*Equipment provided*
AbertisTelecom	Luis Moreno *(luis.moreno@abertistelecom.com)*	Infrastructure provider	Infrastructure
UPV/EHU	Manuel Velez *(manuel.velez@ehu.es)*	TF11 Task Coordination. Measurement guidelines Equipment provider	Demodulator
Teamcast	Laurent Boher *(laurent.boher@teamcast.com)* Alain Untersee *(alain.untersee@teamcast.com)*	Equipment provider	Modulator
Thomson-Broadcast	Bruno Le Breton *(bruno.lebreton@thomsonbroadcast.com)*	Equipment provider	Modulator
MIER Comunicaciones	Joan Casas *(jcasas@mier.es)* Montserrat Puertolas *(mpuertolas@mier.es)*	Equipment provider	Transmitter. Gap filler
ENENSYS	Laurent Roul *(laurent.roul@enensys.com)*	Equipment provider	Gateway
TUAS University	Vainisto Atte *(atte.vainisto@turkuamk.fi)* Aurala Niko *(niko.aurala@turkuamk.fi)* Ekman Reijo *(Reijo.Ekman@turkuamk.fi)*	Equipment provider	Channel Simulator
TDF	Roy Jean-roger (*Jean-Roger.Roy@Tdf.Fr*)	Measurement guidelines.	---
Mitsubishi Electric R&D	Arnaud Bouttier (*A.Bouttier@fr.merce.mee.com*)	Measurement guidelines. Equipment provider	SC-OFDM Evaluation Platform

6 EQUIPMENT MAIN WORKING SPECIFICATIONS

Table 6 resumes the main characteristic about the input and output connectors of all the equipments to be tested in this plug-fest.

Table 6. Input and output connectors of the prototypes

PROTOTYPE	*INPUT CONNECTOR*	*OUTPUT CONNECTOR*
P.1 TeamCast Modulator	Female SMA 50Ω	Female SMA 50Ω
P.2 Thomson Broadcast Modulator	Female BNC 50Ω	Female SMA 50Ω
P.4 Mier Comunicaciones Transmitter	Female BNC 75Ω	Female N 50Ω
P.5 Mier Comunicaciones Gapfiller	Female N 50Ω	Male SMB 50Ω
P.8 Enensys Gateway	Female BNC 75Ω	Female BNC 75Ω
P.11 UPV/EHU Demodulator	Female SMA 50Ω	--

Taking this into consideration, some laboratory accessories will be necessary in the different tests. These will be transitions and cables that make the interconnection between the different equipments possible. ***For more information, see sections 7.1.3.3, 7.2.3.3, 7.3.3.3 and 7.4.3.3.***

7 TESTS 1, 2, 3 AND 4: T2-LITE NEW FEATURES LABORATORY TESTS

Four different tests related to the T2-Lite standard will be carried out during this plug fest. The main goal of these laboratory measurements is to test some of the new features of T2-Lite both in MFN (*Multiple Frequency Networks*) and in SFN (*Single Frequency Networks*). Besides, a mixed T2-Base and T2-Lite mode will be tested in both MFN and SFN as well.

The main objective of the four tests is to check the HW interoperability of all the prototypes from TF10 by testing them with an emulated Gaussian channel profile. Moreover, it is necessary to guarantee their correct operation for the posterior TF12 field trials by testing some of the equipments with portable and/or mobile channels.

Considering the prototypes in *Table 1*, there is only one demodulator. Regarding the transmission side, there are 3 different modulator/transmitters but only one gateway, so the gateway will be always tested while all the modulator/transmitters will be only tested with the Gaussian channel, choosing one of them for the other channel profiles.

Figure 2 resumes the main characteristics of the four tests about T2-Lite new features in MFN and SFN, including general information about the configuration modes for each test. Besides, the number of equipments that will be tested for each channel model to be tested and each main goal are also included. In SFN tests, two different measurements will be carried out: one with a transmitter/modulator for the secondary transmission and another one with a gapfiller as for the secondary transmission.

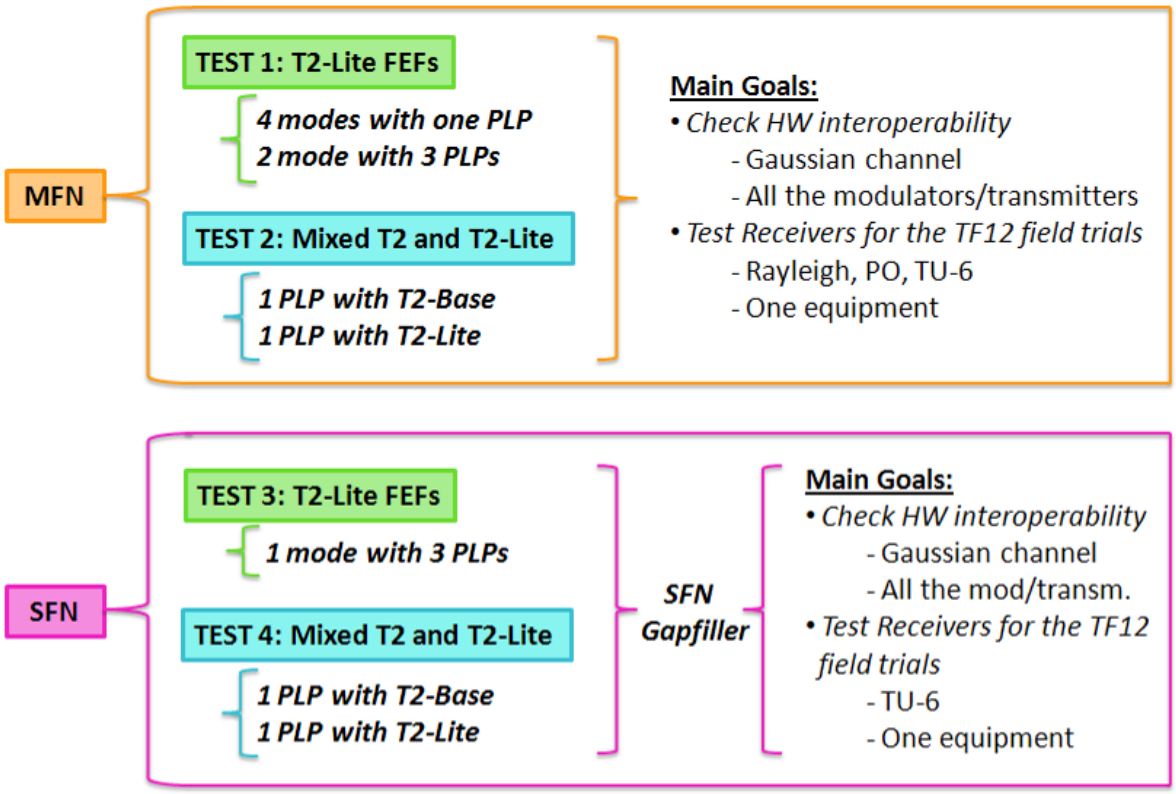


Figure 2. Main characteristics of the T2-Lite new features laboratory tests

7.1 TEST 1 T2-Lite FEF, with support of T2-MI, Evaluation

7.1.1 Tests Goals

The main objectives of this test will be:

- Test that both transmitters and receivers can implement T2-Lite in Single PLP mode.
- Test that both transmitters and receivers can implement T2-Lite in Multiple PLP mode.
- Test the effect of the *post-scrambling* feature on the signalling.
- Test the effect of using the *sub-slicing* feature.
- Test the effect of the new code-rates introduced in T2-Lite on the robustness of the signal.
- Test how robust the system is by carrying out laboratory tests with different attenuation-delay profiles and measuring the minimum C/N ratio in order to guarantee a correct reception.
- Test TF10 prototypes in full chain to guarantee a correct performance in TF12 field trials
- Obtain reference performance values for comparison with TF12-field trials results.

7.1.2 Configuration and Channel Models

The UHF channel C22 (482 MHz) will be used in this laboratory test, as it is the same channel that will be used on the field trials in TF12. *Table 7* is a restricted table of the different sets of T2-Lite configuration parameters that will be used to validate this feature.

- M1 and M2 allow the testing of the influence of the *post-scrambling* feature on the C/N thresholds.
- M3 and M4 allow the testing of the new code-rates included in T2-Lite (1/3 and 2/5).
- M5 allows the testing of the multiple PLP feature in the T2-Lite. This mode includes three PLPs with three different interleaving lengths, so as to test the influence of this parameter on the C/N thresholds. This mode will be the same as one of the field trials in TF12.
- M6 allows the testing of the multiple PLP feature in the T2-Lite. This mode includes three PLPs with very long interleaving lengths by using *sub-slicing*, so as to test the influence of this parameter on the C/N thresholds. This mode will be the same as one of the field trials in TF12.

Table 7. T2-Lite Profiles for T2-Lite FEF evaluation.

Scenario	T2-Lite FEF	T2-Lite FEF	T2-Lite FEF	T2-Lite FEF	T2-Lite FEF			T2-Lite FEF		
Goals	*Post-scrambling* ON	*Post-scrambling* OFF	New code-rate	New code-rate	Multiple PLP			*Sub-slicing* ON		
Reference	**M1**	**M2**	**M3**	**M4**	**M5**			**M6**		
Single or Multiple PLP	Single	Single	Single	Single	Multiple			Multiple		
Frames per Superframe	2	2	2	2	2			2		
Number of data symbols	109	109	83	98	91			125		
Subslices	1	1	1	1	1			1620		
Channel BW (MHz)	7.61	7.61	7.61	7.61	7.61			7.61		
FFT	8k	8k	8k	8k	8k			8k		
Guard Interval	1/8	1/8	1/8	1/8	1/8			1/8		
Guard Interval Duration (µs)	112	112	112	112	112			112		
Resulting Cell Size (km)	33.5	33.5	33.5	33.5	33.5			33.5		
L1 Constellation	BPSK	BPSK	BPSK	BPSK	BPSK			BPSK		
Post-scrambling	Yes	No	Yes	Yes	Yes			Yes		
Pilot Pattern	PP2	PP2	PP2	PP2	PP2			PP2		
TR-PAPR	L1 & P2	L1 & P2	L1 & P2	L1 & P2	L1 & P2			L1 & P2		
SISO/MISO	SISO_LITE	SISO_LITE	SISO_LITE	SISO_LITE	SISO_LITE			SISO_LITE		
FEF	No	No	No	No	No			No		
	PLP0	**PLP0**	**PLP0**	**PLP0**	**PLP0**	**PLP1**	**PLP2**	**PLP0**	**PLP1**	**PLP2**
PLP Type	Type 2	Type 2	Type 2	Type 2	Type 2	Type 2	Type 2	Type 2	Type 2	Type 2
Constellation	QPSK-R	QPSK-R	QPSK-R	QPSK-R	QPSK-R	QPSK-R	QPSK-R	QPSK-R	QPSK-R	QPSK-R
Code Rate	½	1/2	1/3	2/5	1/2	1/2	1/2	1/3	2/5	1/2
LDPC Frame Length (bits)	16200	16200	16200	16200	16200	16200	16200	16200	16200	16200
Number of FEC blocks	64	64	64	64	32	26	13	32	32	32
HEM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ISSY	None	None	None	None	Yes	Yes	Yes	Yes	Yes	Yes
NPD	No	No	No	No	No	No	No	No	No	No
IL Type	0	0	0	0	0	0	0	0	0	0
IL Length	2	2	2	2	1	1	1	1	1	1
Frame Interval	1	1	1	1	1	1	1	1	1	1
Interleaving time (ms)	41.92	41.92	42.33	42.04	43.74	33.33	16.67	126.22	126.22	126.22
In band Signalling	Type B	Type B	Type B	Type B	Type B	Type B	Type B	Type B	Type B	Type B
Network Topology	SFN	SFN	SFN	SFN	SFN	SFN	SFN	SFN	SFN	SFN
Bit-Rate (Mbps)	**3.99**	**3.99**	**3.90**	**3.97**	**2.38**	**1.93**	**0.97**	**1.31**	**1.58**	**1.77**
Channels to be tested	AWGN / Rayleigh / PO / TU-6									

The measurements will be for the set of channel profiles given in *Table 8*. For each propagation channel model, the related profile column reports on the T2-Lite profiles that should be tested in each case.

Table 8. Channel models for T2-Lite FEF evaluation.

Configuration	***Propagation Channel Model***	***Related Profiles***
Reference	Gaussian - AWGN	M1, M2, M3, M4, M5 and M6
Portable	Rayleigh Pedestrian Outdoor - PO	
Mobile	TU6 – Doppler = 20 Hz (44Km/h @ 482 MHz)	

The reference mode (Gaussian - AWGN) will be tested with all the possible modulator/transmitter and for all the configuration modes defined in *Table 7* in order to validate all the TF10 prototypes in a full chain as well as determining the modulator/transmitter which operates better for further measurements. This will also guarantee a correct performance of all the prototypes that will be used in the TF12 field trials.

However, other channel models (Rayleigh, PO and TU-6) will be tested only with one modulator/transmitter. This one will be the "*most suitable*" modulator/transmitter based on the results obtained with the Gaussian-AWGN channel; in other words, the modulator/transmitter that works better with this new feature to be tested in each configuration mode. This means, that the election could be different for each configuration mode to be tested with Portable and Mobile channels depending on the previous results of each configuration mode with the Gaussian channel.

7.1.3 Equipment

7.1.3.1 Prototypes to be used

The prototypes that will be tested in the T2-Lite FEFs laboratory test are those on *Table 9*. These are shown in *Figure 3* in *green*.

Table 9. Prototypes to test in the T2-Lite FEFs laboratory test

EQUIPMENT	***COMPANY***
P.1 T2 Modulator A	TeamCast
P.2 T2 Modulator B	Thomson Broadcast
P.4 T2 Transmitter	Mier
P.8 T2 Gateway	Enensys
P.11 T2 Demodulator	UPV/EHU

7.1.3.2 Set-up

The reference measurement *set-up* is summarized in *Figure 3*.

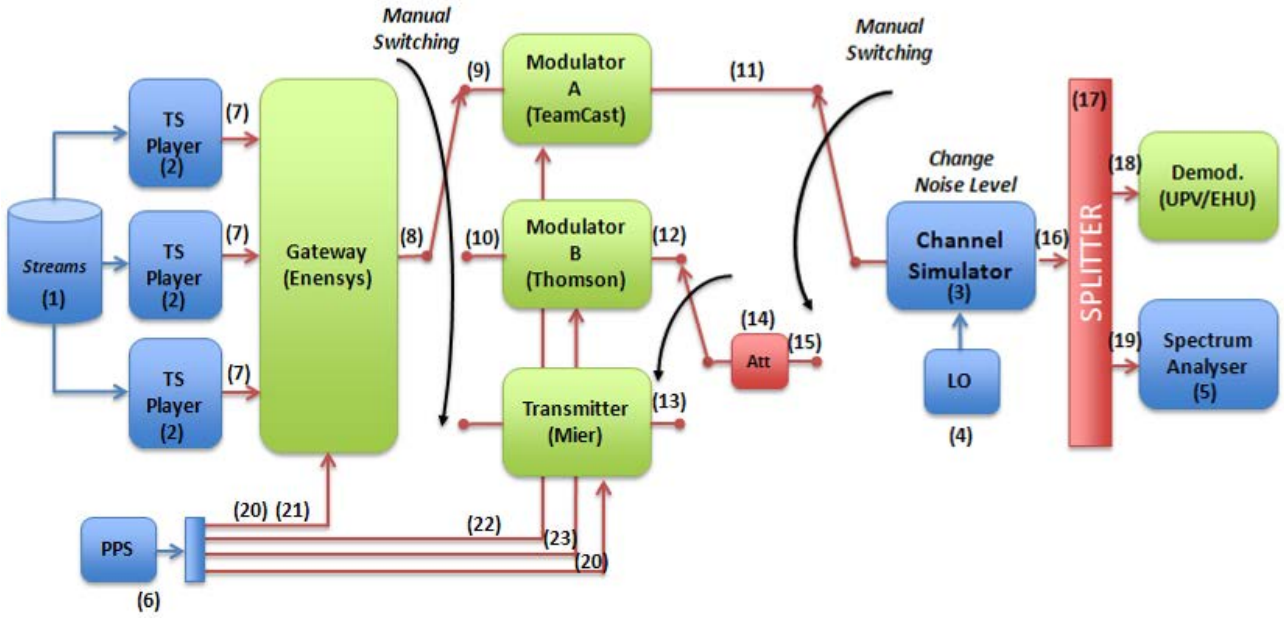


Figure 3. Reference test set-up for T2-Lite FEFs laboratory test

The prototypes in *green* in *Figure 3* must be controlled by an *Ethernet* link. Five long Ethernet cables are necessary in order to establish 5 direct links between the used equipment and its control laptop.

7.1.3.3 Other equipment necessary to simulate de full chain Tx-Rx

Apart from the prototypes indicated on *Table 9*, the laboratory equipments shown on *Table 10* are necessary. These are shown in *blue* in *Figure 3*. Three TS players are necessary in order to play the TS that will be later modulated (three in case of multiple PLP mode).
It is also necessary a channel simulator in order to simulate the different channel profiles described on *Table 8* to increase the noise level to measure the C/N ratio at the QEF point. A Local Oscillator is needed in order to make the channel simulator work properly. Besides, a spectrum analyser is also recommended for debugging.

Table 10 resumes the other necessary equipments for carrying out this test and who is going to contribute with them.

Table 10. Other necessary laboratory equipments for T2-Lite FEFs laboratory test

N.	*EQUIPMENT*	*USE*	*QUANT.*	*PARTNER*
1	TS files	--	3	UPV/EHU
2	TS player with female BNC 75Ω connector	--	3	TBC
3	Channel Simulator with female N 50Ω connectors	--	1	TUAS
4	Local Oscillator	Needed by 4	1	Mier
5	Spectrum Analyser with female N 50Ω connector	--	1	TBC
6	External PPS with female BNC 50Ω connector	To synchronize all equipments	1	TBC

Besides, it is also necessary some laboratory accessories to connect all the prototypes, as it can be shown in *Figure 3* in *red*. These are cables, transitions attenuators, splitters and impedance adapters. Besides, 5 Ethernet cables are also necessary so as to configure the different prototypes.

Table 11 resumes the other necessary accessories for carrying out this test and who is going to contribute with them.

Table 11. Other necessary accessories for T2-Lite FEFs laboratory test

N.	*EQUIPMENT*	*USE*	*QUANT.*	*PARTNER*
7	Cable male BNC-male BNC 75Ω	Connect n.2 with the gateway	3	TBC
8	Cable male BNC-male BNC 75Ω	Connect the gateway with the modulators	1	TBC
9	Impedance adapter from 75Ω to 50Ω with female BNC input and male SMA output	Adapt from 75Ω (gateway) to 50Ω (modulator A)	1	TeamCast
10	Impedance adapter from 75Ω to 50Ω with female BNC input and male BNC output	Adapt from 75Ω (gateway) to 50Ω (modulator B)	1	TBC
11	Cable male SMA- female N 50Ω	Connect modulator A with n. 3	1	TUAS
12	Cable male SMA – female N 50Ω	Connect modulator B with n.13	1	TUAS
13	Cable male N-male N 50Ω	Connect the transmitter with n.13	1	TUAS
14	Variable attenuator with female N 50Ω connectors	Attenuate the high power level from the transmitter/modulator	1	Mier
15	Cable male N-male N 50Ω	Connect n.13 with n.3	1	TUAS
16	Cable male N-male N 50Ω	Connect n.3 with n.15	1	TUAS
17	Splitter with 2 outputs with female N 50Ω connectors	Divide the signal from n.3 to the demodulator and n.5	1	TBC
18	Cable male N-male SMA 50Ω	Connect n.15 with demodulator	1	TBC
19	Cable male N-male N 50Ω	Connect n.15 with n.5	1	TUAS
20	Cable male BNC – male BNC 50 Ω	Connect n.6 with the gateway and the transmitter	2	TBC
21	Impedance adapter from 50Ω to 75Ω with male BNC input and female BNC output	Adapt from 50Ω (n.6) to 75Ω (gateway)	1	TBC
22	Cable male BNC – male SMA 50 Ω	Connect n.6 with modulator A	1	TBC
23	Cable male BNC – male SMA 50 Ω	Connect n.6 with modulator B	1	TBC
24	Ethernet cables	Control prototypes	5	TBC

7.1.4 Test Procedure

The threshold criterion for the DVB-T2 performance measurements is typically defined as Quasi Error Free (QEF) reception. That corresponds to a BER = 10^{-11} at the TS data level at the input of the MPEG-2 demultiplexer. For a practical reason, the threshold criteria of the T2-Lite new features laboratory tests is set here as BER = 10^{-7} after LDPC decoder, or alternatively, as an accepted subjective test result of 30 seconds error free decoded video [2].

In this test, the C/N ratio at the QEF point should be measured. The following C/N measurements have to be conducted for a RF level + 5dB to +10dB beyond the threshold sensitivity.

The test procedure to follow in the T2-Lite FEFs laboratory test, which is shown on *Figure 4* is:

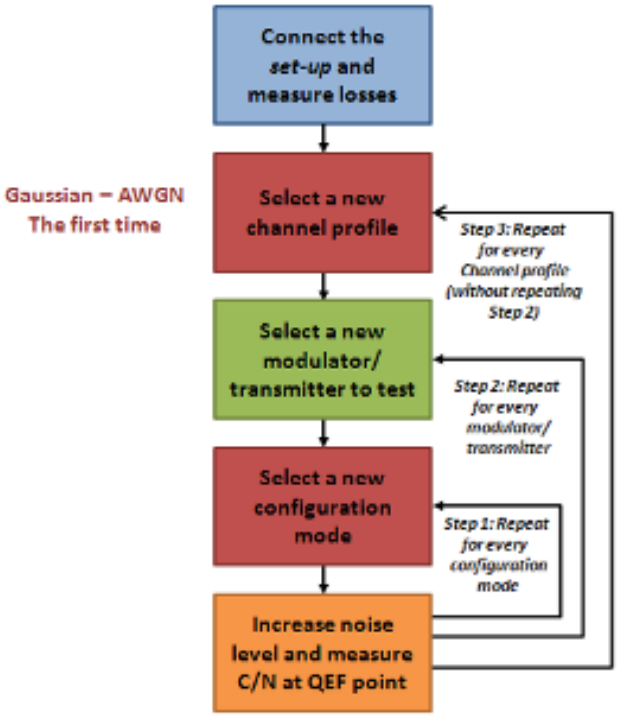


Figure 4. Test procedure for T2-Lite FEFs laboratory test

1.- Measure the cable losses and connectors that will be used in the test *set-up*.
2.- Connect the test *set-up* as it is explained in the 7.1.3.2 point.
3.- Set one channel profile from *Table 8*. The first one should be Gaussian-AWGN.
4.- Choose one modulator or transmitter to be tested.
5.- Set one T2-Lite configuration mode from *Table 7*.
6.- Validate that both the transmitters and the receivers work properly, by observing that the signalling detected in the receiver is correct.
7.- Increase the noise level until QEF point is reached (video is degraded).
8.- Measure the required C/N value at the QEF point.
9.- Fill in the measured C/N value in dB in measurements record (excel sheet).
10.- Repeat the process from step 5 to 9 with all the configuration modes in *Table 7*.
11.- Repeat the process from step 4 to 10 with all the modulators/transmitters.
12.- Repeat the process from step 3 to 10 with all the channel profiles in *Table 8* with only one modulator/transmitter (the selection will be based on the previous results with the Gaussian-AWGN channel).

Considering that this procedure takes no more than 5 minutes for each measure, the test has been divided into 4 sessions. Each session corresponds to different combinations of modulator/transmitter, configuration mode and channel profile until all the possibilities are tested.

Table 12 resumes the different sessions of test 1 showing the gateway and modulator/transmitter tested in each case. The configuration modes and channel profiles measured are shown as well.

Table 12. Session characteristics for the T2-Lite FEFs laboratory test

Session	Day	Timetable	Gateway	Modulator/transmitter	Demodulators	Configuration modes	Channel profiles
1	Day 1	14:30-16:30	Enensys	TeamCast mod. Thomson mod.	UPV/EHU	M1, M2, M3, M4, M5 and M6	Gaussian
2	Day 1	16:30-18:00	Enensys	Mier trans.	UPV/EHU	M1, M2, M3, M4, M5 and M6	Gaussian
				To Be Selected	UPV/EHU	M1, M2, M3, M4, M5 and M6	Rayleigh
3	Day 2	09:00-10:00	Enensys	To Be Selected.	UPV/EHU	M1, M2, M3, M4, M5 and M6	PO TU-6

7.1.5 Results

The results expected to obtain in this tests are a *measurements record* with a list of the ***C/N ratios at the QEF point*** for each T2-Lite profile and for each channel model and for each combination of gateway and modulator/transmitter tested. *Figure 5* shows the measurement record for a particular channel profile and modulator.

Channel: Gaussian - AWGN

Modulator: TeamCast		Results: C/N (dB) at QEF point									
		M1	M2	M3	M4	M5			M6		
		PLP0	PLP0	PLP0	PLP0	PLP0	PLP1	PLP2	PLP0	PLP1	PLP2
Demodulator	UPV/EHU										

Figure 5. Measurement record sample for T2-Lite FEFs laboratory test

This measurement record is also valid for other modulator/transmitter in *Table 9* (Thomson modulator and Mier transmitter). It is also valid for other channel profiles in *Table 8* (Rayleigh, PO, TU-6) but only with one modulator/transmitter that must be selected between all the possibilities in this case. In total, 6 measurement records like the one in *Figure 5* should be filled.

NOTE: For more information see the excel sheets attached (ENGINES TR11.2 V.06 (2012.09.10) - Results Test 1_ T2 Lite FEF with support of T2 MI.xlsx).

7.2 TEST2: Mixed T2 and T2-Lite Evaluation

7.2.1 Tests Goals

The main objectives of this test will be:

- Test that both transmitters and receivers can implement this feature transmitting and receiving properly mixed T2 and T2-Lite signals.
- Test that the receivers can decode correctly the T2-Base and the T2-Lite when mixed T2 and T2-Lite signals are transmitted.
- Test how robust the system is by carrying out laboratory tests with different attenuation-delay profiles and measuring the minimum C/N ratio in order to guarantee a correct reception.
- Test TF10 prototypes in full chain to guarantee a correct performance in TF12 field trials
- Obtain reference performance values for comparison with TF12-field trials results.

7.2.2 Configuration and Channel Models

The UHF channel C22 (482 MHz) will be used in this laboratory test, as it is the same channel that will be used on the field trials in TF12. *Table 13* is a table of the T2-Lite configuration parameters and the DVB-T2 fixed mode (in the yellow column) that will be used in order to evaluate the correct mixed DVB-T2 and T2-Lite reception.

- M7 and T2 combination mode is the same as one of the field trials modes in TF12. The T2-Base mode has been selected in order to have high *bit-rate* although its robustness is not very high (256QAM). This is because it is thought for high definition fixed reception. The T2-Lite mode has been selected to be quite robust (QPSK 1/2) but with low bit-rate (near 1MBps). By this way, a realistic balance between the T2 and T2-Lite parts is achieved.

Table 13. T2-Lite Profiles for Mixed T2 and T2-Lite evaluation

Scenario	Mixed T2 and T2-Lite	
Goals	Multiple components	
	T2-Lite	**T2-Base**
Reference	**M7**	**T2**
Single or Multiple PLP	Single	Single
Frames per Superframe	2	2
Number of data symbols	39	31
Subslices	1	1
Channel BW (MHz)	7.61	7.77
FFT	8k	32k ext.
Guard Interval	1/8	1/16
Guard Interval Duration (µs)	112	224
Resulting Cell Size (km)	33.5	67
L1 Constellation	BPSK	BPSK
Post-scrambling	Yes	Yes
Pilot Pattern	PP2	PP4
TR-PAPR	L1 & P2	L1 & P2
SISO/MISO	SISO_LITE	SISO
FEF	Yes	Yes
FEF Length	1.116.160	379.904
FEF Interval	1	1
	PLP0	**PLP0**
PLP Type	Type 2	Type 2
Constellation	QPSK-R	256QAM-R
Code Rate	1/2	2/3
LDPC Frame Length (bits)	16200	64800
Number of FEC blocks	30	103
HEM	Yes	Yes

ISSY	Long	Long
NPD	No	No
IL Type	0	0
IL Length	1	2
Frame Interval	1	1
Interleaving time (ms)	41.32	60.92
In band Signalling	Type B	Type A
Network Topology	SFN	SFN
Bit-Rate (Mbps)	**1.28**	**27.18**
Channels to be tested	AWGN / Rayleigh / PO / TU-6	

The number of profiles to measure is greater than in the previous test, due to the hybrid broadcast mode, as it is shown on *Table 14*.

Table 14. Channel models for Mixed T2 and T2-Lite evaluation.

Configuration	***Propagation Channel Model***	***Related Profiles***
Reference	Gaussian - AWGN	M7/T2
Portable	Rayleigh Pedestrian Outdoor - PO	
Mobile	TU6 – Doppler = 20 Hz (44Km/h @ 482 MHz)	

The reference mode (Gaussian - AWGN) will be tested with all the possible modulator/transmitters and for all the configuration modes defined in *Table 13* in order to validate all the TF10 prototypes in a full chain as well as determining the modulator/transmitter which operates better for further measurements. This will also guarantee a correct performance of all the prototypes that will be used in the TF12 field trials. However, other channel models (Rayleigh, PO and TU-6) will be tested only with one modulator/transmitter. This one will be the "*most suitable*" modulator/transmitter based on the results obtained with the Gaussian-AWGN channel; in other words, the modulator/transmitter that works better with the multiple components feature.

7.2.3 Equipment

7.2.3.1 Prototypes to be used

The prototypes that will be tested in the laboratory Mixed T2 and T2-Lite laboratory test are those on *Table 15*. These are shown in *Figure 6* in *green*.

Table 15. Prototypes to test in the Mixed T2 and T2-Lite laboratory test

EQUIPMENT	***COMPANY***
P.1 T2 Modulator A	TeamCast
P.4 T2 Transmitter	Mier
P.8 T2 Gateway (x2)	Enensys
P.11 T2 Demodulator	UPV/EHU

7.2.3.2 Set-up

The reference measurement *set-up* is summarized in *Figure 6*.

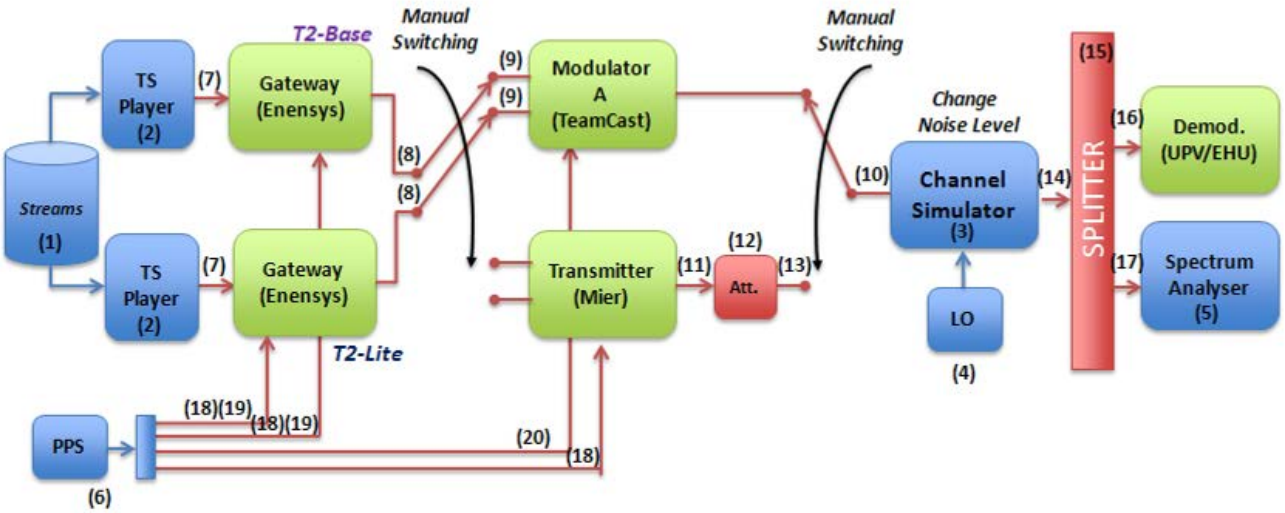


Figure 6. Reference test set-up for Mixed T2 and T2-Lite laboratory test

The prototypes in *green* in *Figure 6* must be controlled by an *Ethernet* link. Five long Ethernet cables are necessary in order to establish 5 direct links between the used equipment and its control laptop.

7.2.3.3 Other equipment necessary to simulate de full chain Tx-Rx

Apart from the prototypes indicated on *Table 15*, the laboratory equipments shown on *Table 16* are also necessary. These are shown in *blue* in *Figure 6*. Two TS players are necessary in order to play the TS that will be later modulated using T2-Base and T2-Lite.
It is also necessary a channel simulator in order to simulate the different channel profiles described on *Table 14* to increase the noise level to measure the C/N ratio at the QEF point. A Local Oscillator is needed in order to make the channel simulator work properly. A spectrum analyser is also recommended for debugging.

Table 16 resumes the other necessary equipments for carrying out this test and who is going to contribute with them.

Table 16. Other necessary laboratory equipments for Mixed T2 and T2-Lite laboratory test

N.	*EQUIPMENT*	*USE*	*QUANT.*	*PARTNER*
1	TS files	--	2	UPV/EHU
2	TS player with female BNC 75Ω connector	--	2	TBC
3	Channel Simulator with female N 50Ω connectors	--	1	TUAS
4	Local Oscillator	Needed by 4	1	Mier
5	Spectrum Analyser with female N 50Ω connector	--	1	TBC
6	External PPS with female BNC 50Ω connector	To synchronize all equipments	1	TBC

Besides, it is also necessary some laboratory accessories to connect all the prototypes, as it can be shown in *Figure 6* in *red*. These are cables, transitions attenuators, splitters and impedance adapters. Besides, 5 Ethernet cables are also necessary so as to configure the different prototypes. *Table 17* resumes the other necessary accessories for carrying out this test and who is going to contribute with them.

Table 17. Other necessary accessories for Mixed T2 and T2-Lite laboratory test

N.	*EQUIPMENT*	*USE*	*QUANT.*	*PARTNER*
7	Cable male BNC-male BNC 75Ω	Connect n.2 with the gateway	2	TBC
8	Cable male BNC-male BNC 75Ω	Connect the gateway with the modulators	2	TBC
9	Impedance adapter from 75Ω to 50Ω with female BNC input and male SMA output	Adapt from 75Ω (gateway) to 50Ω (modulator A)	2	TeamCast
10	Cable male SMA- female N 50Ω	Connect modulator A, B with n. 3	1	TUAS
11	Cable male N-male N 50Ω	Connect the transmitter with n.11	1	TUAS
12	Variable attenuator with female N 50Ω connectors	Attenuate the high power level from the transmitter	1	Mier
13	Cable male N-male N 50Ω	Connect n.11 with n.3	1	TUAS
14	Cable male N-male N 50Ω	Connect n.3 with n.14	1	TUAS
15	Splitter with 2 outputs with female N 50Ω connectors	Divide the signal from n.3 to the demodulator and n.5	1	TBC
16	Cable male N-male SMA 50Ω	Connect n.14 with demodulator	1	TBC
17	Cable male N-male N 50Ω	Connect n.14 with n.5	1	TUAS
18	Cable male BNC – male BNC 50 Ω	Connect n.6 with the gateways and the transmitter	3	TBC
19	Impedance adapter from 50Ω to 75Ω with male BNC input and female BNC output	Adapt from 50Ω (n.6) to 75Ω (gateway)	2	TBC
20	Cable male BNC – male SMA 50 Ω	Connect n.23 with modulator A	1	TBC
21	Ethernet cables	Control prototypes	5	TBC

7.2.4 Test Procedure

The threshold criterion for the DVB-T2 performance measurements is typically defined as Quasi Error Free (QEF) reception. That corresponds to a BER = 10^{-11} at the TS data level at the input of the MPEG-2 demultiplexer. For a practical reason, the threshold criteria of the T2-Lite new features laboratory tests is set here as BER = 10^{-7} after LDPC decoder, or alternatively, as an accepted subjective test result of 30 seconds error free decoded video [2].

In this test, the C/N ratio at the QEF point should be measured. The following C/N measurements have to be conducted for a RF level + 5dB to +10dB beyond the threshold sensitivity.

The test procedure to follow in the T2-Lite new features laboratory tests, which is shown on *Figure 7* is:

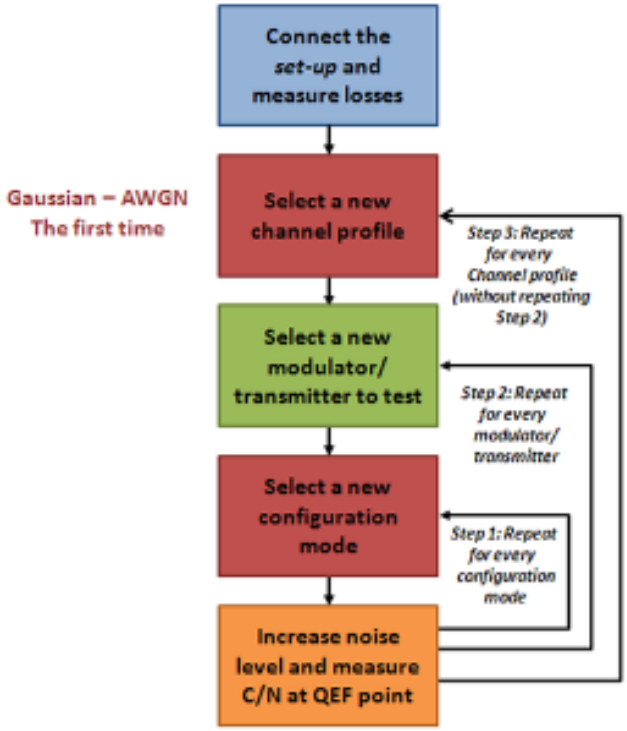


Figure 7. Test procedure for Mixed T2 and T2-Lite laboratory test

1.- Measure the cable losses and connectors that will be used in the test *set-up*.
2.- Connect the test *set-up* as it is explained in the 7.2.3.2 point.
3.- Set one channel profile from *Table 14.* The first one should be Gaussian-AWGN.
4.- Choose one modulator or transmitter to be tested.
5.- Set one T2-Lite configuration mode from *Table 13.*
6.- Validate that both the transmitters and the receivers work properly, by observing that the signalling detected in the receiver is correct.
7.- Increase the noise level until QEF point is reached (video is degraded).
8.- Measure the required C/N value at the QEF point.
9.- Fill in the measured C/N value in dB in measurements record (excel sheet).
10.- Repeat the process from step 5 to 9 with all the configuration modes in *Table 13*.
11.- Repeat the process from step 4 to 10 with all the modulators/transmitters.
12.- Repeat the process from step 3 to 10 with all the channel profiles in *Table 14* with only one modulator/transmitter (the selection will be based on the previous results with the Gaussian-AWGN channel).

Considering that this procedure takes no more than 5 minutes for each measure, the test has been divided into 1 session. This session corresponds to different combinations of modulator/transmitter, configuration mode and channel profile until all the possibilities are tested.

Table 18 resumes the different sessions of test 2 showing the gateway and modulator/transmitter tested in each case. The configuration modes and channel profiles measured are shown as well.

Table 18. Session characteristics for the Mixed T2 and T2-Lite laboratory test

Session	Day	Timetable	Gateway	Modulator/transmitter	Demodulators	Configuration modes	Channel profiles
4	Day 2	10:00-11:30	Enensys	TeamCast mod. Mier trans.	UPV/EHU	M7/T2	Gaussian
				To Be Selected	UPV/EHU	M7/T2	Rayleigh PO TU-6

7.2.5 Results

The results expected to obtain in this tests are a *measurements record* with a list of the ***C/N ratios at the QEF point*** for each T2-Lite profile and for each channel model and for each combination of gateway and modulator/transmitter tested. *Figure 8* shows the measurement record for a particular channel profile and modulator.

Channel:	**Gaussian - AWGN**		
Modulator: TeamCast		**Results: C/N (dB) at QEF point**	
		M7/T2	
		M7	**T2**
Demodulator	**UPV/EHU**		

Figure 8. Measurement record sample for Mixed T2 and T2-Lite laboratory test

This measurement record is also valid for other modulator/transmitter in *Table 15* (Mier transmitter). It is also valid for other channel profiles in *Table 14* (Rayleigh, PO, TU-6) but only with one modulator/transmitter that must be selected between all the possibilities in this case. In total, 6 measurement records like the one in *Figure 8* should be filled.

NOTE: For more information see the excel sheets attached (ENGINES TR11.2 V.06 (2012.09.10) - Results Test 2_ Mixed T2 and T2 Lite.xlsx).

7.3 TEST 3: T2-Lite in SFN Networks Evaluation

7.3.1 Tests Goals

The main objectives of this test will be:

- Test TF10 prototypes in full chain to guarantee a correct HW interoperability in TF12 field trials using a SFN network with T2-Lite modes
- Test how robust the system is by carrying out laboratory tests with different attenuation-delay profiles and measuring the minimum C/N ratio in order to guarantee a correct reception.
- Obtain reference performance values for comparison with TF12-field trials results.

7.3.2 Configuration and Channel Models

The UHF channel C22 (482 MHz) will be used in this laboratory test, as it is the same channel that will be used on the field trials in TF12. *Table 19* shows the sets of T2-Lite configuration parameters that will be used to validate this feature. The selected mode is one of the modes that will be also used in the field trials so as to guarantee its correct performance.

- M5 allows the testing of the multiple PLP feature in the T2-Lite. This mode includes three PLPs with three different interleaving lengths, so as to test the influence of this parameter on the C/N thresholds. This mode will be the same as one of the field trials in TF12.

Table 19. T2-Lite Profiles for T2-Lite in SFN networks evaluation.

Scenario	T2-Lite in SFN Networks		
	T2-Lite		
Reference	**M5**		
Single or Multiple PLP	Multiple		
Frames per Superframe	2		
Number of data symbols	91		
Subslices	1		
Channel BW (MHz)	7.61		
FFT	8k		
Guard Interval	1/8		
Guard Interval Duration (µs)	112		
Resulting Cell Size (km)	33.5		
L1 Constellation	BPSK		
Post-scrambling	Yes		
Pilot Pattern	PP2		
TR-PAPR	L1 & P2		
SISO/MISO	SISO_LITE		
FEF	No		
	PLP0	**PLP1**	**PLP2**
PLP Type	Type 2	Type 2	Type 2
Constellation	QPSK-R	QPSK-R	QPSK-R
Code Rate	1/2	1/2	1/2
LDPC Frame Length (bits)	16200	16200	16200
Number of FEC blocks	32	26	13
HEM	Yes	Yes	Yes
ISSY	Long	Long	Long
NPD	No	No	No
IL Type	0	0	0
IL Length	1	1	1
Frame Interval	1	1	1
Interleaving time (ms)	43.74	33.33	16.67
In band Signalling	Type B	Type B	Type B
Network Topology	SFN	SFN	SFN
Bit-Rate (Mbps)	**2.38**	**1.93**	**0.97**
Channels to be tested	Gaussian/TU-6		

The measurements will be for the set of channel profiles given in *Table 20*. For each propagation channel model, the related profile column reports on the T2-Lite profiles that should be tested in each case.

Table 20. Channel models for T2-Lite in SFN networks evaluation.

Configuration	***Propagation Channel Model***	***Related Profiles***
Reference	Gaussian - AWGN	M5
Mobile	TU6 – Doppler = 20 Hz (44Km/h @ 482 MHz)	

The reference mode (Gaussian - AWGN) will be tested as a reference. The TU-6 propagation channel model will be tested in order to guarantee the correct performance in the SFN network used in the posterior TF12 field trials. It allows the obtaining of reference values to compare with the results obtained in the field trials as well. For both propagation channel models, only the modulator/transmitter/gapfillers that will be used on the field trials will be tested.

7.3.3 Equipment

7.3.3.1 Prototypes to be used

The prototypes that will be tested in the T2-Lite in SFN Networks laboratory test are those on *Table 21*. These are shown in *Figure 11, 12, 13* and *14* in *green*.

Table 21. Prototypes to test in the T2-Lite in SFN Networks laboratory test

EQUIPMENT	***COMPANY***
P.1 T2 Modulator A	TeamCast
P.2 T2 Modulator B	Thomson Broadcast
P.4 T2 Transmitter	Mier
P.5 T2 Gapfiller	Mier
P.8 T2 Gateway	Enensys
P.11 T2 Demodulator	UPV/EHU

7.3.3.2 Set-up

Figure 9 and *Figure 10* show the possible network schemes for the posterior TF12 T2-Lite field trials. The possibly used modulator/transmitters/gapfillers are also shown. As this test focuses on a check of the correct HW interoperability in SFN networks in order to guarantee a correct working on the posterior field trials, only the equipment that will be possibly used in the field trials will be tested in the laboratory. *Figure 9* shows a SFN network using a secondary transmitter while *Figure 10* shows an SFN network but with a secondary gapfiller.

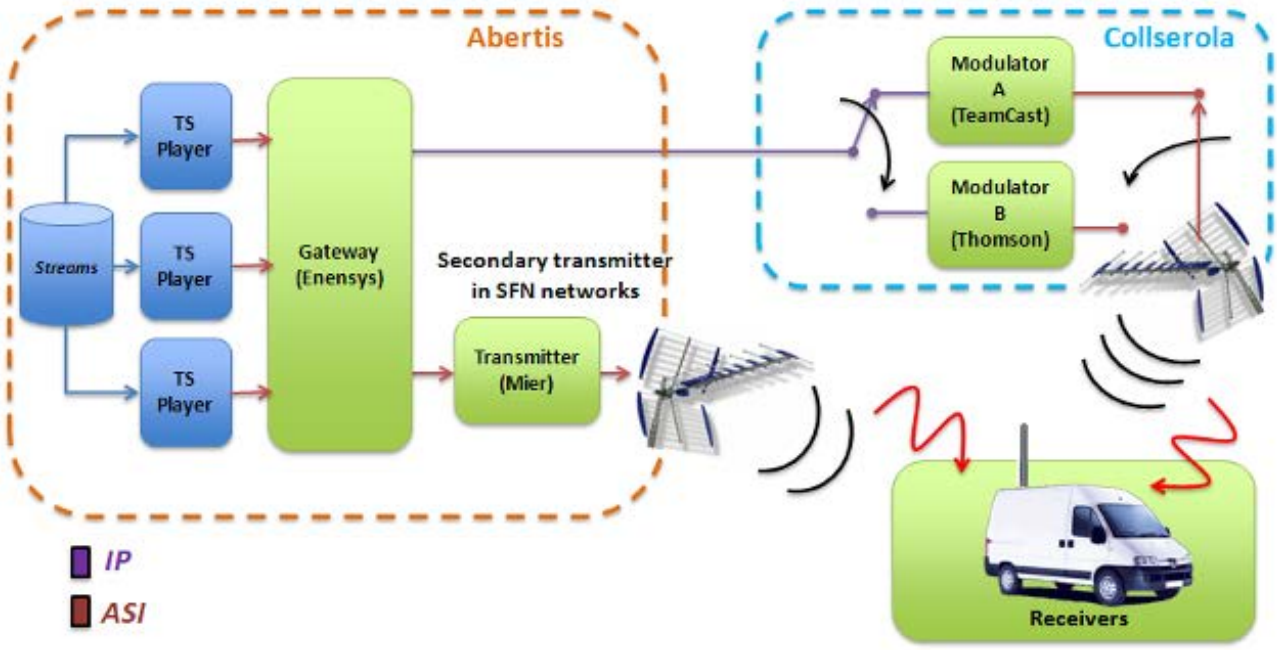


Figure 9. Reference set-up for T2-Lite in SFN Networks field trials using a secondary transmitter

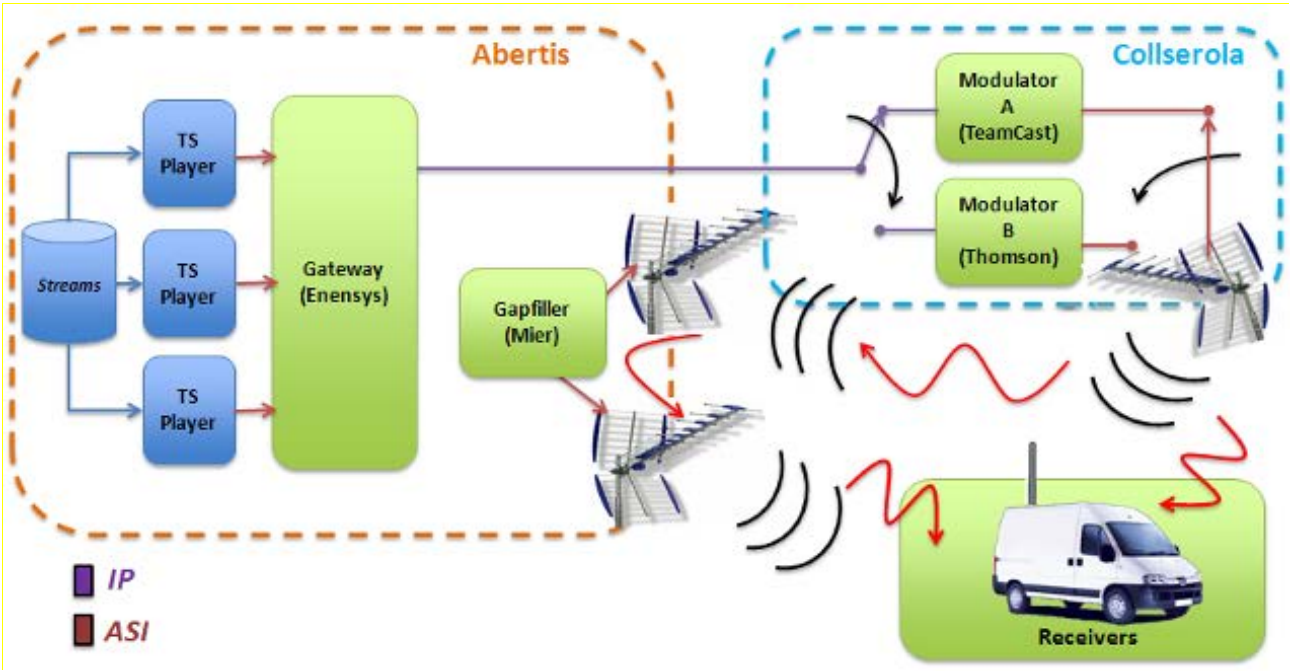


Figure 10. Reference set-up for T2-Lite in SFN Networks field trials using a gapfiller

Figure 11 and *Figure 12* show the reference *set-up* for this laboratory test. The modulator/transmitter/gapfillers selected are those from *Figure 9* and *Figure 10*, showing the two possibilities for the SFN networks in the field trials: using a secondary modulator/transmitter (*Figure 11*) or using a gapfiller (*Figure 12*), so that both cases will be tested.

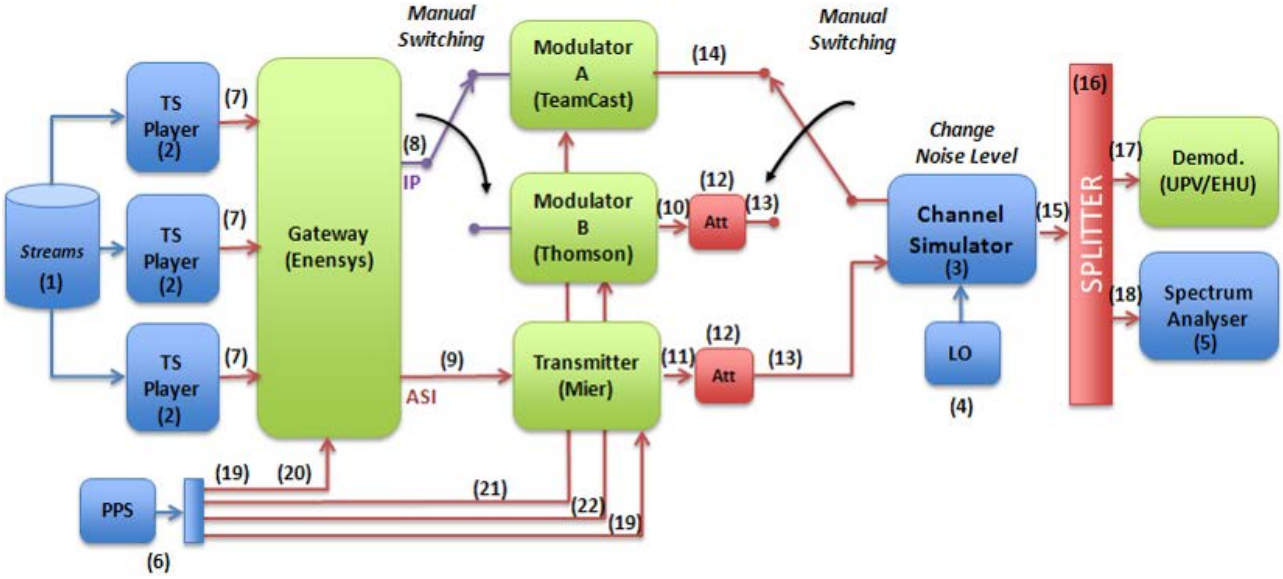


Figure 11. Reference test set-up for T2-Lite in SFN Networks evaluation using a secondary transmitter

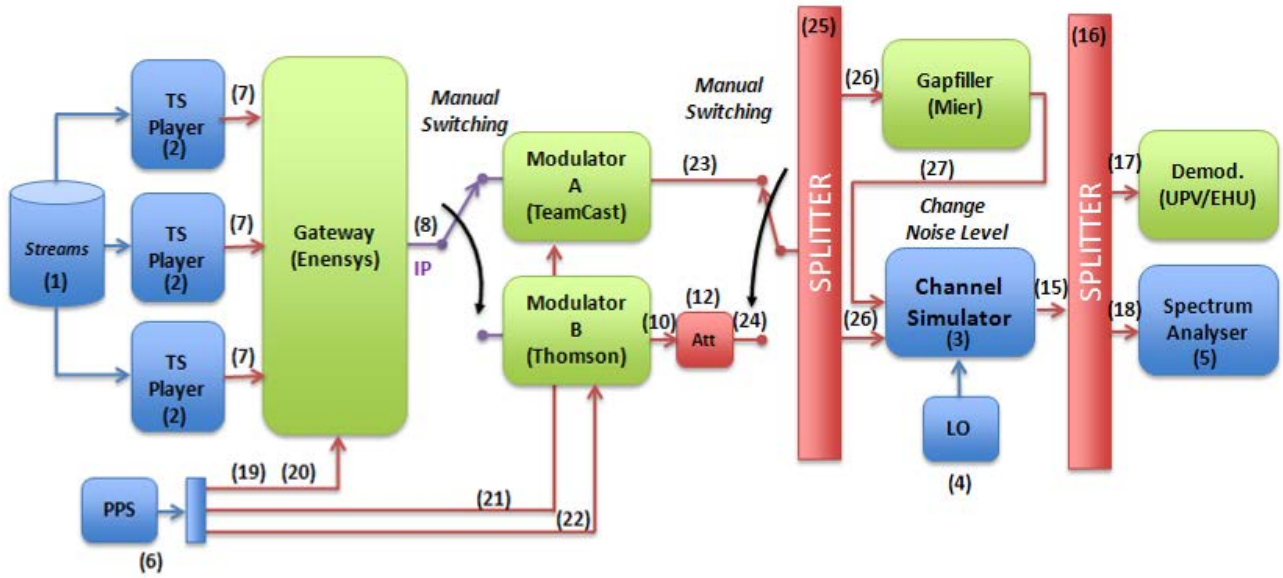


Figure 12. Reference test set-up for T2-Lite in SFN Networks evaluation using a gapfiller

NOTE: These figures show that the primary transmitter (the one that will be used in Collserola in the TF12 field trials) will use a Thomson or TeamCast modulator as these modulators are already in the Collserola facilities. However, the secondary transmitter, located on the Abertis building C dependencies, could be a Mier transmitter or a gapfiller, depending on the equipment that will be use in the field trials. For this reason, both possibilities will be measured in the laboratory sessions.

The prototypes in *green* in *Figure 11* and *12* must be controlled by an *Ethernet* link. Four long Ethernet cables are necessary at once in order to establish 4 direct links between the equipment and its control laptop used for each test (the one with the secondary transmitter and the one with the gapfiller).

7.3.3.3 Other equipment necessary to simulate de full chain Tx-Rx

Apart from the prototypes indicated on *Table 21*, the laboratory equipments shown on *Table 22* are necessary. These are shown in *blue* in *Figure 11 and 12*. Three TS players are necessary in order to play the TS that will be later modulated.
It is also necessary a channel simulator in order to simulate the different channel profiles described on *Table 20* to increase the noise level to measure the C/N ratio at the QEF point. A Local Oscillator is needed in order to make the channel simulator work properly. A spectrum analyser is also recommended for debugging.

Table 22 resumes the other necessary equipments for carrying out this test and who is going to contribute with them.

Table 22. Other necessary laboratory equipments for T2-Lite in SFN Networks laboratory test

N.	*EQUIPMENT*	*USE*	*QUANT.*	*PARTNER*
1	TS files	--	3	UPV/EHU
2	TS player with female BNC 75Ω connector	--	3	TBC
3	Channel Simulator with female N 50Ω connectors	--	1	TUAS
4	Local Oscillator	Needed by 4	1	Mier
5	Spectrum Analyser with female N 50Ω connector	--	1	TBC
6	External PPS with female BNC 50Ω connector	To synchronize all equipments	1	TBC

Besides, it is also necessary some laboratory accessories to connect all the prototypes, as it can be shown in *Figure 11 and 12* in *red* and *purple*. These are cables, transitions attenuators, splitters and impedance adapters. Besides, 4 Ethernet cables are also necessary so as to configure the different prototypes.

Table 23 resumes the other necessary accessories for carrying out this test and who is going to contribute with them.

Table 23. Other necessary accessories for T2-Lite in SFN Networks laboratory test

N.	*EQUIPMENT*	*USE*	*QUANT.*	*PARTNER*
7	Cable male BNC-male BNC 75Ω	Connect n.2 with the gateway	3	TBC
8	Ethernet cable	Connect the gateway with the modulators using IP connection	1	TBC
9	Cable male BNC-male BNC 75Ω	Connect the gateway with the transmitter	1	TBC
10	Cable male SMA-male N 50Ω	Connect modulator B with n.12	1	TBC
11	Cable male N-male N 50Ω	Connect the transmitter with n.12	1	TUAS
12	Variable attenuator with female N 50Ω connectors	Attenuate the high power level from the transmitter/modulator	2	Mier
13	Cable male N-male N 50Ω	Connect n.12 with n.3	1	TUAS
14	Cable male SMA – male N 50Ω	Connect modulator A with n.3	1	TBC
15	Cable male N-male N 50Ω	Connect n.3 with n.16	1	TUAS
16	Splitter with 2 outputs with female N 50Ω connectors	Divide the signal from n.3 to the demodulator and n.5	1	TBC
17	Cable male N-male SMA 50Ω	Connect n.16 with demodulator	1	TBC
18	Cable male N-male N 50Ω	Connect n.16 with n.5	1	TUAS

19	Cable male BNC – male BNC 50 Ω	Connect n.23 with the gateway and the transmitter	2	TBC
20	Cable male BNC – male BNC 50 Ω	Connect n.6 with the gateway and the transmitter	2	TBC
20	Impedance adapter from 50Ω to 75Ω with male BNC input and female BNC output	Adapt from 50Ω (n.6) to 75Ω (gateway)	1	TBC
21	Cable male BNC – male SMA 50 Ω	Connect n.6 with modulator A	1	TBC
22	Cable male BNC – male BNC 50 Ω	Connect n.6 with modulator B	1	TBC
23	Cable male BNC – male N 50 Ω	Connect modulator A with n.27	1	TBC
24	Cable male N – male N 50 Ω	Connect modulator B with n.27	1	TUAS
25	Splitter with 2 outputs with female N 50Ω connectors	Divide the signal from the modulators to the gapfiller and n.3	1	TBC
26	Cable male N-male N 50Ω	Connect n.27 with the gapfiller and n.3	2	TUAS
27	Cable male SMB-male N 50Ω	Connect the gapfiller with n.3	1	TBC
28	Ethernet cables	Control prototypes	4	TBC

7.3.4 Test Procedure

The threshold criterion for the DVB-T2 performance measurements is typically defined as Quasi Error Free (QEF) reception. That corresponds to a BER = 10^{-11} at the TS data level at the input of the MPEG-2 demultiplexer. For a practical reason, the threshold criteria of the T2-Lite new features laboratory tests is set here as BER = 10^{-7} after LDPC decoder, or alternatively, as an accepted subjective test result of 30 seconds error free decoded video [2].

In this test, the C/N ratio at the QEF point should be measured. The following C/N measurements have to be conducted for a RF level + 5dB to +10dB beyond the threshold sensitivity.

The test procedure to follow in the T2-Lite SFN performance laboratory test, which is shown on *Figure 13* is:

1.- Measure the cable losses and connectors that will be used in the test *set-up*.
2.- Set the Multiple PLP T2-Lite configuration mode from *Table 19.*
3.- Connect the test *set-up* as it is explained in *Figure 11* (secondary transmitter)
4.- Set one channel profile from *Table 20*. The first one should be Gaussian-AWGN.
5.- Choose one modulator or transmitter to be tested.
6.- Validate that both the transmitters and the receivers work properly, by observing that the signalling detected in the receiver is correct.
7.- Increase the noise level until QEF point is reached (video is degraded).
8.- Measure the required C/N value at the QEF point.
9.- Fill in the measured C/N value in dB in measurements record (excel sheet).
10.- Repeat the process from step 5 to 9 with all the modulators/transmitters/gapfillers shown in *Figure 11 or 12.*
11.- Repeat the process from step 4 to 10 with all the channel profiles in *Table 20* with only one modulator/transmitter combination (the selection will be based on the previous results with the Gaussian-AWGN channel).
12.- Repeat the process from step 3 to 11 with the *set-up* explained in *Figure 12* (gapfiller).

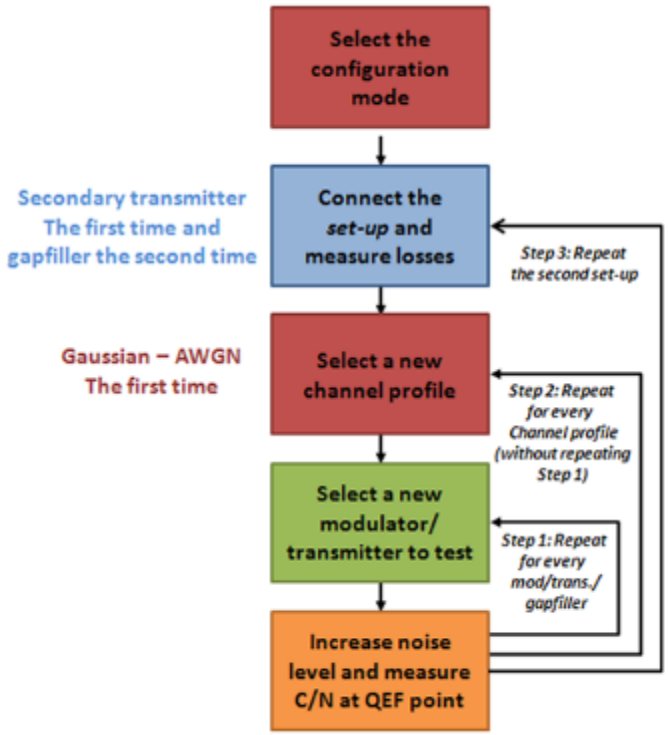


Figure 13. Test procedure for T2-Lite in SFN Networks laboratory test

Considering that this procedure takes no more than 5 minutes for each measure, the test has been divided into 1 session. This session corresponds to different combinations of modulator/transmitter, *set-ups* (secondary transmitter or gapfiller) and channel profile until all the possibilities are tested.

Table 24 resumes the different sessions of test 3 showing the gateway and modulator/transmitter tested in each case. The configuration modes and channel profiles measured are shown as well.

Table 24. Session characteristics for T2-Lite in SFN Networks laboratory test

Session	Day	Timetable	Gateway	Modulator/transmitter	Demodulators	Configuration modes	Channel profiles
5	Day 2	11:30-13:00	Enensys	TeamCast mod./Mier trans. Thomson mod./Mier trans.	UPV/EHU	M5	Gaussian
				To Be Selected/Mier trans.			TU-6
				TeamCast mod./Mier gapfiller. Thomson mod./Mier gapfiller			Gaussian
				To Be Selected/Mier gapfiller			TU-6

7.3.5 Results

The results expected to obtain in this tests are a *measurements record* with a list of the ***C/N ratios at the QEF point*** for each T2-Lite profile and for each channel model and for each combination of gateway and modulator/transmitter tested. *Figure 14* shows the measurement record for a particular channel profile and modulator.

Channel:	Gaussian - AWGN			
Modulator: TeamCast Transmitter: Mier		Results: C/N (dB) at QEF point		
		M5		
		PLP0	PLP1	PLP2
Demodulator	UPV/EHU			
Modulator: TeamCast Gapfiller: Mier		Results: C/N (dB) at QEF point		
		M5		
		PLP0	PLP1	PLP2
Demodulator	UPV/EHU			

Figure 14. Measurement record sample for T2-Lite in SFN Networks laboratory test

This measurement record is also valid for other modulator/transmitters in *Table 21* and *Figure 11* and *12* (Thomson modulator for primary transmitter). It is also valid for other channel profiles in *Table 20* (TU-6) but only with one modulator/transmitter for the primary transmitter that must be selected between all the possibilities. In total, 3 measurement records like the one in *Figure 14* should be filled.

NOTE: For more information see the excel sheets attached (ENGINES TR11.2 V.06 (2012.09.10) - Results Test 3_ T2 Lite in SFN Networks.xlsx).

7.4 TEST 4: Mixed T2 and T2-Lite in SFN Networks Evaluation

7.4.1 Tests Goals

The main objectives of this test will be:

- Test TF10 prototypes in full chain to guarantee a correct HW interoperability in TF12 field trials using a SFN network with Mixed T2 and T2-Lite modes
- Test how robust the system is by carrying out laboratory tests with different attenuation-delay profiles and measuring the minimum C/N ratio in order to guarantee a correct reception.
- Obtain reference performance values for comparison with TF12-field trials results.

7.4.2 Configuration and Channel Models

The UHF channel C22 (482 MHz) will be used in this laboratory test, as it is the same channel that will be used on the field trials in TF12. *Table 25* shows the sets of Mixed T2 and T2-Lite configuration parameters that will be used to validate this feature. The selected mode is one that will be also used in the field trials so as to guarantee its correct performance.

- M7 and T2 combination mode is the same as one of the field trials modes in TF12. The T2-Base mode has been selected in order to have high *bit-rate* although its robustness is not very high (256QAM). This is because it is thought for high definition fixed reception. The T2-Lite mode has been selected to be quite robust (QPSK 1/2) but with low bit-rate (near 1MBps). By this way, a realistic balance between the T2 and T2-Lite parts is achieved.

Table 25. Mixed T2 and T2-Lite Profiles for Mixed T2 and T2-Lite in SFN networks evaluation.

Scenario	Mixed T2 and T2-Lite in SFN Networks	
	T2-Lite	**T2-Base**
Reference	**M7**	**T2**
Single or Multiple PLP	Single	Single
Frames per Superframe	2	2
Number of data symbols	39	31
Subslices	1	1
Channel BW (MHz)	7.61	7.77
FFT	8k	32k ext.
Guard Interval	1/8	1/16
Guard Interval Duration (µs)	112	224
Resulting Cell Size (km)	33.5	67
L1 Constellation	BPSK	BPSK
Post-scrambling	Yes	Yes
Pilot Pattern	PP2	PP4
TR-PAPR	L1 & P2	L1 & P2
SISO/MISO	SISO_LITE	SISO
FEF	Yes	Yes
FEF Length	1.116.160	379.904
FEF Interval	1	1
	PLP0	**PLP0**
PLP Type	Type 2	Type 2
Constellation	QPSK-R	256QAM-R
Code Rate	1/2	2/3
LDPC Frame Length (bits)	16200	64800
Number of FEC blocks	30	103
HEM	Yes	Yes
ISSY	Long	Long
NPD	No	No
IL Type	0	0
IL Length	1	2
Frame Interval	1	1
Interleaving time (ms)	41.32	60.92

In band Signalling	Type B	Type A
Network Topology	SFN	SFN
Bit-Rate (Mbps)	**1.28**	**27.18**
Channels to be tested	Gaussian/TU-6	

The measurements will be for the set of channel profiles given in *Table 26*. For each propagation channel model, the related profile column reports on the Mixed T2 and T2-Lite profiles that should be tested in each case.

Table 26. Channel models for Mixed T2 and T2-Lite in SFN networks evaluation.

Configuration	***Propagation Channel Model***	***Related Profiles***
Reference	Gaussian - AWGN	M7/T2
Mobile	TU6 – Doppler = 20 Hz (44Km/h @ 482 MHz)	

The reference mode (Gaussian - AWGN) will be tested as a reference. The TU-6 propagation channel model will be tested in order to guarantee the correct performance in the SFN network used in the posterior TF12 field trials. It allows the obtaining of reference values to compare with the results obtained in the field trials as well. For both propagation channel models, only the modulator/transmitter/gapfillers that will be used on the field trials will be tested.

7.4.3 Equipment

7.4.3.1 Prototypes to be used

The prototypes that will be tested in the Mixed T2 and T2-Lite in SFN Networks laboratory test are those on *Table 27*. These are shown in *Figure 18, 19, 20 and 21* in *green*.

Table 27. Prototypes to test in the Mixed T2 and T2-Lite in SFN Networks laboratory test

EQUIPMENT	***COMPANY***
P.1 T2 Modulator	TeamCast
P.4 T2 Transmitter	Mier
P.5 T2 Gapfiller	Mier
P.8 T2 Gateway(x2)	Enensys
P.11 T2 Demodulator	UPV/EHU

7.4.3.2 Set-up

Figure 15 and *Figure 16* show the possible network schemes for the posterior TF12 T2-Lite field trials. The possibly used modulator/transmitters/gapfillers are also shown. As this test focuses on a check of the correct HW interoperability in SFN networks in order to guarantee a correct working on the posterior field trials, only the equipment that will be possibly used in the field trials will be tested in the laboratory. *Figure 15* shows a SFN network using a secondary transmitter while *Figure 16* shows an SFN network but with a secondary gapfiller.

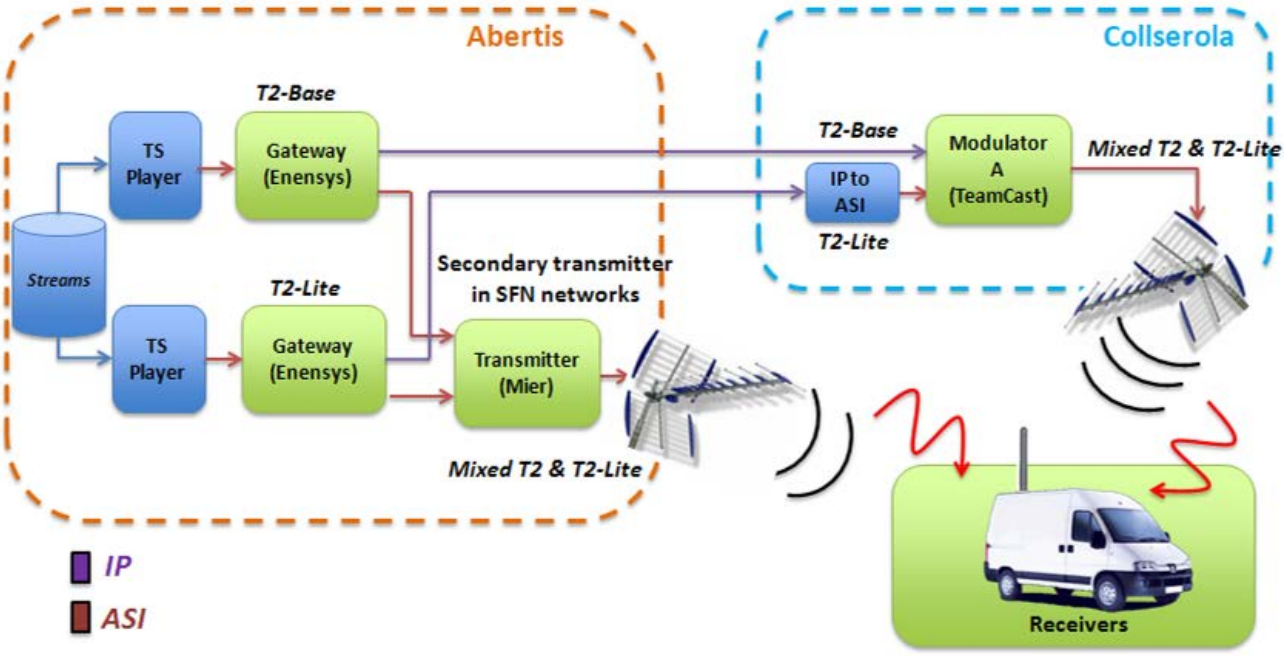


Figure 15. Reference set-up for Mixed T2 and T2-Lite in SFN Networks field trials using a secondary transmitter

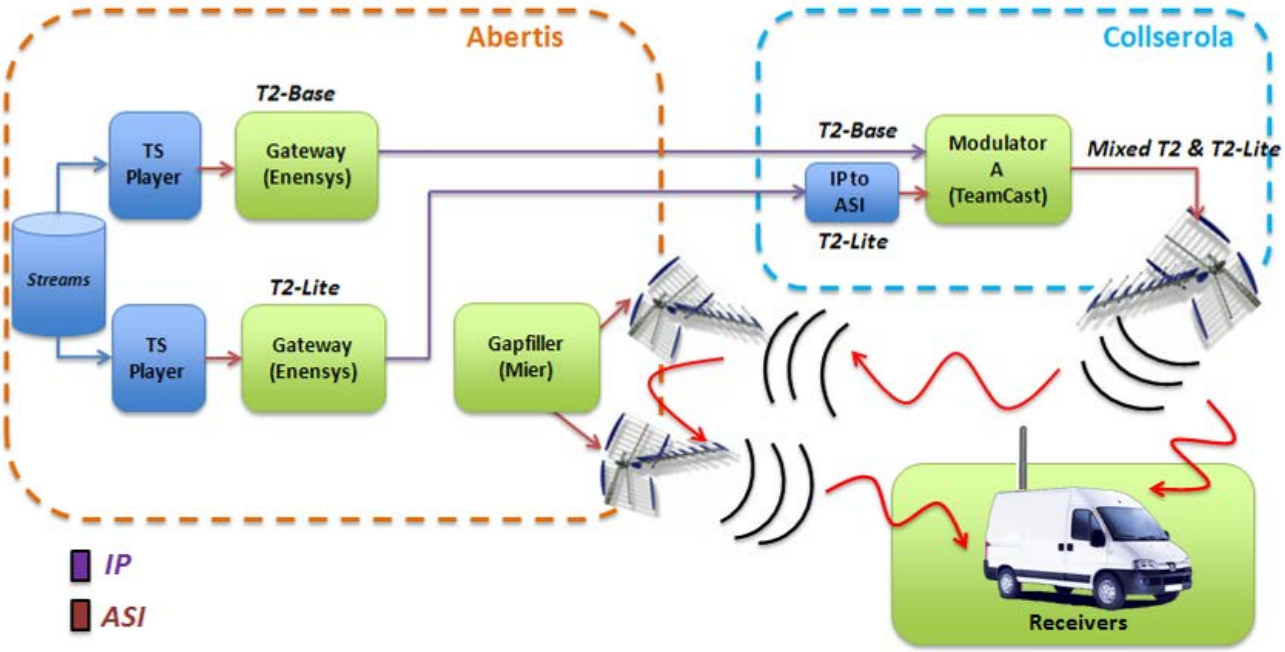


Figure 16. Reference set-up for Mixed T2 and T2-Lite in SFN Networks field trials using a gapfiller

Figure 17 and *Figure 18* show the reference *set-up* for this laboratory test. The modulator/transmitter/gapfillers selected are those from *Figure 15* and *Figure 16*, showing the two possibilities for the SFN networks in the field trials: using a secondary modulator/transmitter (*Figure 17*) or using a gapfiller (*Figure 18*), so that both cases will be tested.

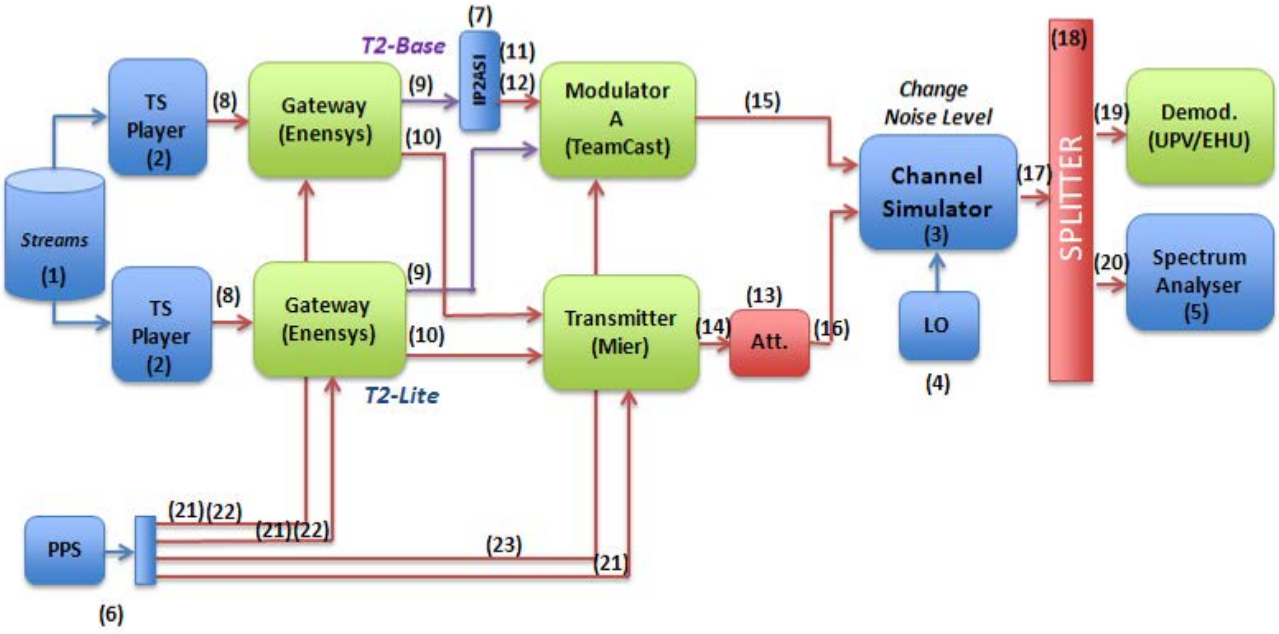


Figure 17. Reference test set-up for Mixed T2 and T2-Lite in SFN Networks evaluation using a secondary transmitter

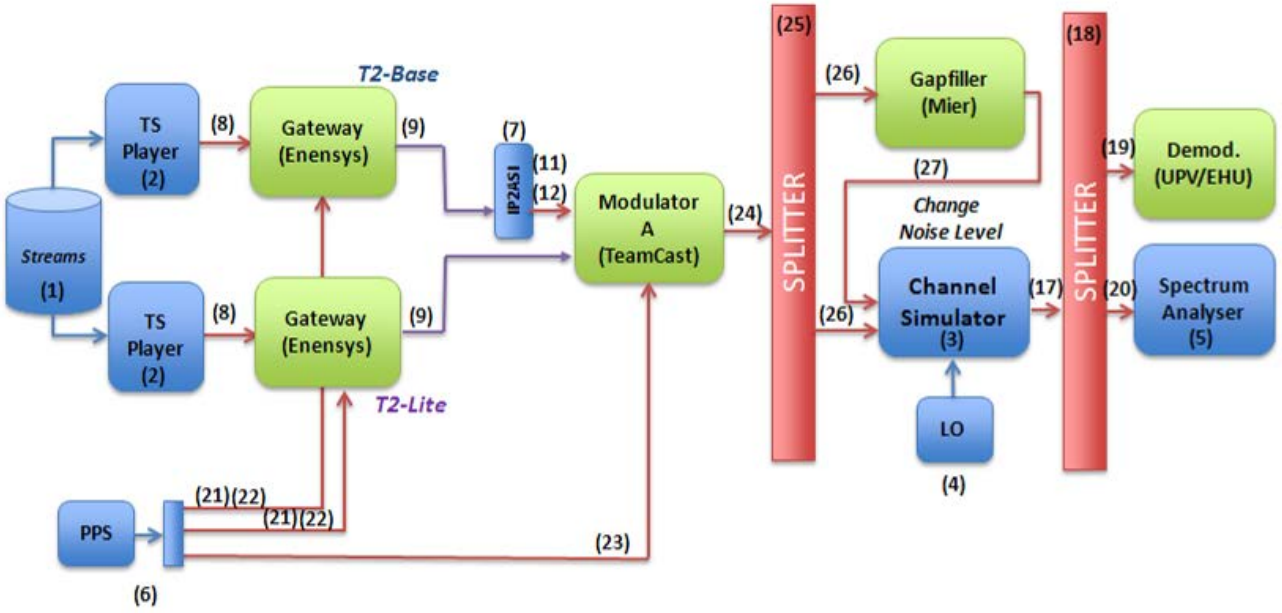


Figure 18. Reference test set-up for Mixed T2 and T2-Lite in SFN Networks evaluation using a gapfiller

NOTE: These figures show that the primary transmitter (the one that will be used in Collserola in the TF12 field trials) will use TeamCast modulator as this modulator is already in the Collserola facilities. Thomson modulator, which is also in Collserola does not support mixed modes.
The secondary transmitter, located on the Abertis building C dependencies, could be a Mier transmitter or a gapfiller, depending on the equipment that will be use in the field trials. For this reason, both possibilities will be measured in the laboratory sessions.

The prototypes in *green* in *Figure 17* and *18* must be controlled by an *Ethernet* link. Four long Ethernet cables are necessary at once in order to establish 4 direct links between the equipment and its control laptop used for each test (the one with the secondary transmitter and the one with the gapfiller).

7.4.3.3 Other equipment necessary to simulate de full chain Tx-Rx

Apart from the prototypes indicated on *Table 27*, the laboratory equipments shown on *Table 28* are necessary. These are shown in *blue* in *Figure 17 and 18*. Two TS players are necessary in order to play the TS that will be later modulated.
It is also necessary a channel simulator in order to simulate the different channel profiles described on *Table 26* to increase the noise level to measure the C/N ratio at the QEF point. A Local Oscillator is needed in order to make the channel simulator work properly.
A spectrum analyser is also recommended for debugging. Two patch panels have been suggested in order to make the connections between the equipments easier.

Table 27 resumes the other necessary equipments for carrying out this test and who is going to contribute with them.

Table 27. Other necessary laboratory equipments for Mixed T2 and T2-Lite in SFN Networks laboratory test

N.	*EQUIPMENT*	*USE*	*QUANT.*	*PARTNER*
1	TS files	--	2	UPV/EHU
2	TS player with female BNC 75Ω connector	--	2	TBC
3	Channel Simulator with female N 50Ω connectors	--	1	TUAS
4	Local Oscillator	Needed by 4	1	Mier
5	Spectrum Analyser with female N 50Ω connector	--	1	TBC
6	External PPS with female BNC 50Ω connector	To synchronize all equipments	1	TBC
7	IP to ASI converter	Needed by TeamCast modulator	1	Enensys

Besides, it is also necessary some laboratory accessories to connect all the prototypes, as it can be shown in *Figure 17 and 18* in *red* and *purple*. These are cables, transitions attenuators, splitters and impedance adapters. Besides, 4 Ethernet cables are also necessary so as to configure the different prototypes..
Table 28 resumes the other necessary accessories for carrying out this test and who is going to contribute with them.

Table 28. Other necessary accessories for Mixed T2 and T2-Lite in SFN Networks laboratory test

N.	*EQUIPMENT*	*USE*	*QUANT.*	*PARTNER*
8	Cable male BNC-male BNC 75Ω	Connect n.2 with the gateway	2	TBC
9	Ethernet cables	Connect the gateways with the modulator by IP connectivity	2	TBC
10	Cable male BNC-male BNC 75Ω	Connect n.8 with the transmitter	2	TBC
11	Impedance adapter from 75Ω to 50Ω with male BNC input and male SMA output	Adapt from 75Ω (n.7) to 50Ω (modulator)	2	TeamCast
12	Cable female BNC – female BNC 50Ω	Connect n.11 with the modulator	1	TBC
13	Variable attenuator with female N 50Ω	Attenuate the high power level	1	TBC

	connectors	from the transmitter		
14	Cable male N-male N 50Ω	Connect the transmitter with n.13	1	TUAS
15	Cable male SMA- male N 50Ω	Connect modulator with n.3	1	TBC
16	Cable male N-male N 50Ω	Connect n.13 with n.3	1	TUAS
17	Cable male N-male N 50Ω	Connect n.3 with n.18	1	TUAS
18	Splitter with 2 outputs with female N 50Ω connectors	Divide the signal from n.3 to the demodulator and n.5	1	TBC
19	Cable male N-male SMA 50Ω	Connect n.18 with demodulator	1	TBC
20	Cable male N-male N 50Ω	Connect n.18 with n.5	1	TUAS
21	Cable male BNC – male BNC 50 Ω	Connect n.6 with the gateway and the transmitter	3	TBC
22	Impedance adapter from 50Ω to 75Ω with male BNC input and female BNC output	Adapt from 50Ω (n.6) to 75Ω (gateway)	2	TBC
23	Cable male BNC – male SMA 50 Ω	Connect n.22 with modulator A	1	TBC
24	Cable male SMA-male N 50Ω	Connect the modulator with n.27	1	TBC
25	Splitter with 2 outputs with female N 50Ω connectors	Divide the signal from the modulator to the gapfiller and n.3	1	TBC
26	Cable male N-male N 50Ω	Connect n.27 with the gapfiller and n.3	2	TUAS
27	Cable male SMB-male N 50Ω	Connect the gapfiller with n.3	1	TBC
28	Ethernet Cable	Control prototypes	4	TBC

7.4.4 Test Procedure

The threshold criterion for the DVB-T2 performance measurements is typically defined as Quasi Error Free (QEF) reception. That corresponds to a BER = 10^{-11} at the TS data level at the input of the MPEG-2 demultiplexer. For a practical reason, the threshold criteria of the T2-Lite new features laboratory tests is set here as BER = 10^{-7} after LDPC decoder, or alternatively, as an accepted subjective test result of 30 seconds error free decoded video [2].

In this test, the C/N ratio at the QEF point should be measured. The following C/N measurements have to be conducted for a RF level + 5dB to +10dB beyond the threshold sensitivity.The test procedure to follow in the T2-Lite SFN performance laboratory test, which is shown on *Figure 19* is:

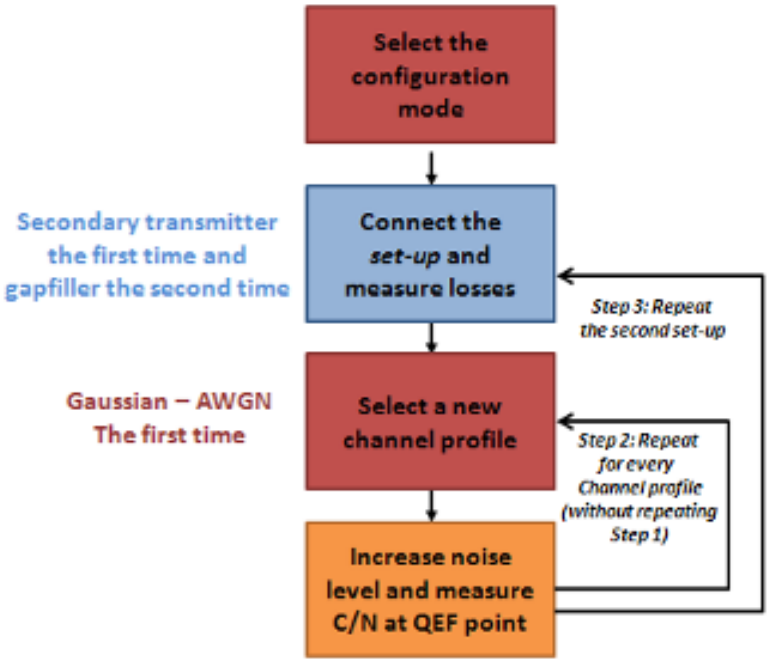


Figure 19. Test procedure for Mixed T2 and T2-Lite in SFN Networks laboratory test

1.- Measure the cable losses and connectors that will be used in the test *set-up*.
2.- Set the Mixed T2 and T2-Lite configuration mode from *Table 25*.
3.- Connect the test *set-up* as it is explained in *Figure 17* (secondary transmitter).
4.- Set one channel profile from *Table 26*. The first one should be Gaussian-AWGN.
5.- Choose the only one modulator or transmitter to be tested.
6.- Validate that both the transmitters and the receivers work properly, by observing that the signalling detected in the receiver is correct.
7.- Increase the noise level until QEF point is reached (video is degraded).
8.- Measure the required C/N value at the QEF point.
9.- Fill in the measured C/N value in dB in measurements record (excel sheet).
10.- Repeat the process from step 4 to 9 with all the channel profiles in *Table 26*.
11.- Repeat the process from step 3 to 10 with the *set-up* explained in *Figure 18* (gapfiller).

Considering that this procedure takes no more than 5 minutes for each measure, the test has been divided into 1 session. This session corresponds to different *set-ups* (secondary transmitter or gapfiller) and channel profiles until all the possibilities are tested.

Table 29 resumes the different sessions of test 4 showing the gateway and modulator/transmitter tested in each case. The configuration modes and channel profiles measured are shown as well.

Table 29. Session characteristics for Mixed T2 and T2-Lite in SFN Networks laboratory test

Session	Day	Timetable	Gateway	Modulator/transmitter	Demodulators	Configuration modes	Channel profiles
6	Day 2	14:30-16:30	Enensys	TeamCast mod./Mier trans.	UPV/EHU	M7/T2	Gaussian
							TU-6
				TeamCast mod./Mier gapfiller.	UPV/EHU	M7/T2	Gaussian
							TU-6

7.4.5 Results

The results expected to obtain in this tests are a *measurements record* with a list of the ***C/N ratios at the QEF point*** for each T2-Lite profile and for each channel model and for each combination of gateway and modulator/transmitter tested. *Figure 20* shows the measurement record for a particular channel profile and secondary transmitter.

Channel:	Gaussian - AWGN		
Modulator: TeamCast Transmitter: Mier		Results: C/N (dB) at QEF point	
		M7/T2	
		M7	T2
Demodulator	UPV/EHU		

Figure 20. Measurement record sample for Mixed T2 and T2-Lite in SFN Networks laboratory test

This measurement record is also valid for other channel profiles in *Table 26* (TU-6) and for the *set-up* with a gapfiller instead a secondary transmitter. In total, 4 measurement records like the one in *Figure 20* should be filled.

NOTE: For more information see the excel sheets attached (ENGINES TR11.2 V.06 (2012.09.10) - Results Test 4_ Mixed T2 and T2 Lite in SFN Networks.xlsx).

8 TEST 5: SC-OFDM FOR SATELLITE SEGMENT EVALUATION

8.1 Tests Goals

The primary goal of the tests is to assess the suitability of the SC-OFDM modulation for satellite broadcasting towards handheld terminals. With that respect, the following tests should be carried out:

- Test of the SC-OFDM robustness against power amplifier non-linearity (MER, PAPR CCDF, OoB, shoulders with respect to IBO).
- Test of the SC-OFDM performance with respect to terminal velocity (BER, FER, and MER for reference channels through hardware emulation).
- Test of the SC-OFDM performance with respect of the interleaving depth (BER and FER).

For all these different tests, the SC-OFDM shall be compared to pure OFDM through the bypass of the DFT spreading stage.

8.2 Configuration and Channel Models

The exact test configurations will be defined later based on the ones defined for the DVB-NGH Plug-Fest to be held in March 2012. The SC-OFDM performance will be measured for the set of channel profiles given in *Table 30.*

Table 30. Channel models for SC-OFDM evaluation.

SCENARIO	*CHANNEL MODELS*	*OPTIONS*
Fixed	Gaussian - AWGN	
Portable	Pedestrian Indoor - PI Pedestrian Outdoor - PO	
Mobile	Typical Urban	6 paths

8.3 Equipment

8.3.1 Prototypes to be used

The tests will be carried out using the MERCE hardware evaluation platform (HEP) that realizes a partial implementation of the DVB-NGH standard for satellite transmission. The main specifications of the HEP platform are described in *Deliverable TF10-D10.2 0*. *Table 31*shows the prototypes that should be tested in this laboratory test.

Table 31. Prototypes to test in the SC-OFDM for Satellite Segment test

EQUIPMENT	*COMPANY*
P.7 SC-OFDM Evaluation Platform	MERCE

8.3.2 Set-up

Figure 21 depicts the test *set-up* for the evaluation of the SC-OFDM modulation.

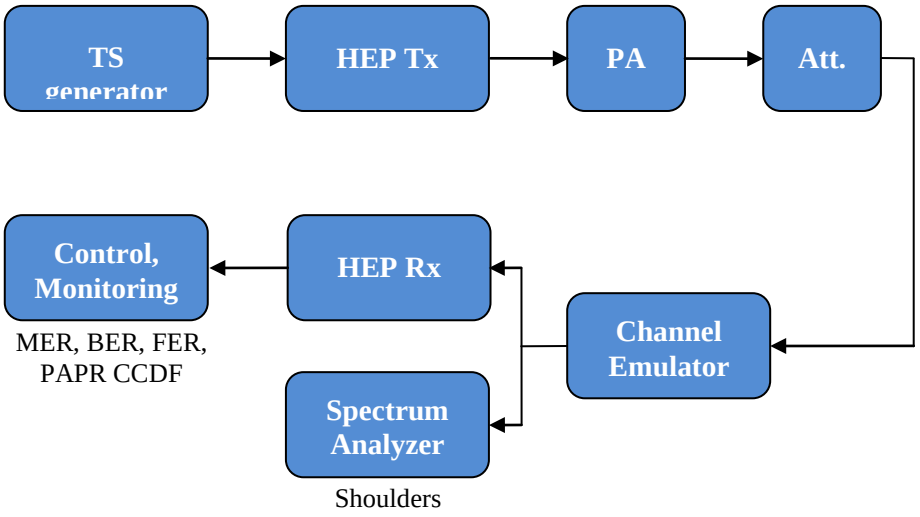


Figure 21. Reference test set-up for SC-OFDM evaluation

8.3.3 Other equipment necessary to simulate de full chain Tx-Rx

As not fully compliant with the standard, the MERCE prototype cannot be easily interconnected to other DVB-NGH equipment. The HEP platform will thus embed all the means required to carry on the tests and measurements. The impact of the PA and channel will be evaluated using external equipment interconnected in analogue at low-IF.

8.4 Test Procedure

Two kinds of performance evaluation shall be conducted: first, the measurement of the maximum C/N required to achieve the QEF point for a representative range of parameter sets to be defined and BER versus C/N measurements for a selected set of parameters also to be defined. The test procedures are derived from those specified in the NorDig Unified Test Specifications [3].

The measurement methodology for C/N performance is as follows:

1. Set up the instruments.
2. Set test parameters.
3. Set the fading simulator.
4. Set the RF input level to –50dBm.
5. Increase the C/N from low value to higher value until the quality measurement procedure 2 is fulfilled (See [3]).
6. Fill in the measured C/N value in dB in the measurement record.

The quality limit is defined as Quasi Error Free (QEF) reception, where QEF means less than one uncorrected error event per hour [3]. The definition of QEF corresponds to BER of 10^{-11} in the TS data at input of the MPEG-2 de-multiplexer. Direct measurements on the TS data packets are the preferred measurement method, but it takes long time to measure such a low BER at TS data level. We rely here on the

indirect objective measurement method that consists in measuring a BER of 10^{-7} after LDPC decoder for Gaussian type of channels.

The measurement methodology for BER vs. C/N performance is as follows:

1. Set up the instruments.
2. Set test parameters.
3. Set the fading simulator.
4. Set the RF input level to –50dBm.
5. Starting from high C/N, decrease the C/N and fill in the corresponding BER after LDPC value measured by the receiver in measurement record.

The test procedure related to the evaluation of the SC-OFDM robustness against PA non-linearity shall be defined later according to the available equipments. The HEP platform will embed means for measuring the CCDF of the PAPR.

The tests for the evaluation of the SC-OFDM modulation for satellite segment can be carried out at the same time as the tests described in section 7. Therefore, no specific planning in sessions is required.

8.5 Results

The results expected to obtain in this tests are a *measurements record* with a list of the ***C/N ratios***.

9 REFERENCES

[1] ENGINES; “Identification and Specification of "NGH-Ph.1" Prototypes to be Built”; Deliverable D10.2 - V0.1 - August 25, 2011.
[2] International Telecommunicarion Union, Recommendation ITU-R BT.1368-8 – ”Planning criteria for digital terrestrial television services in the VHF/UHF bands”, April 2011.
[3] NorDig; “NorDig Unified Test specification for DVB-T2 addendum ver. 2.2”; December 14, 2010.

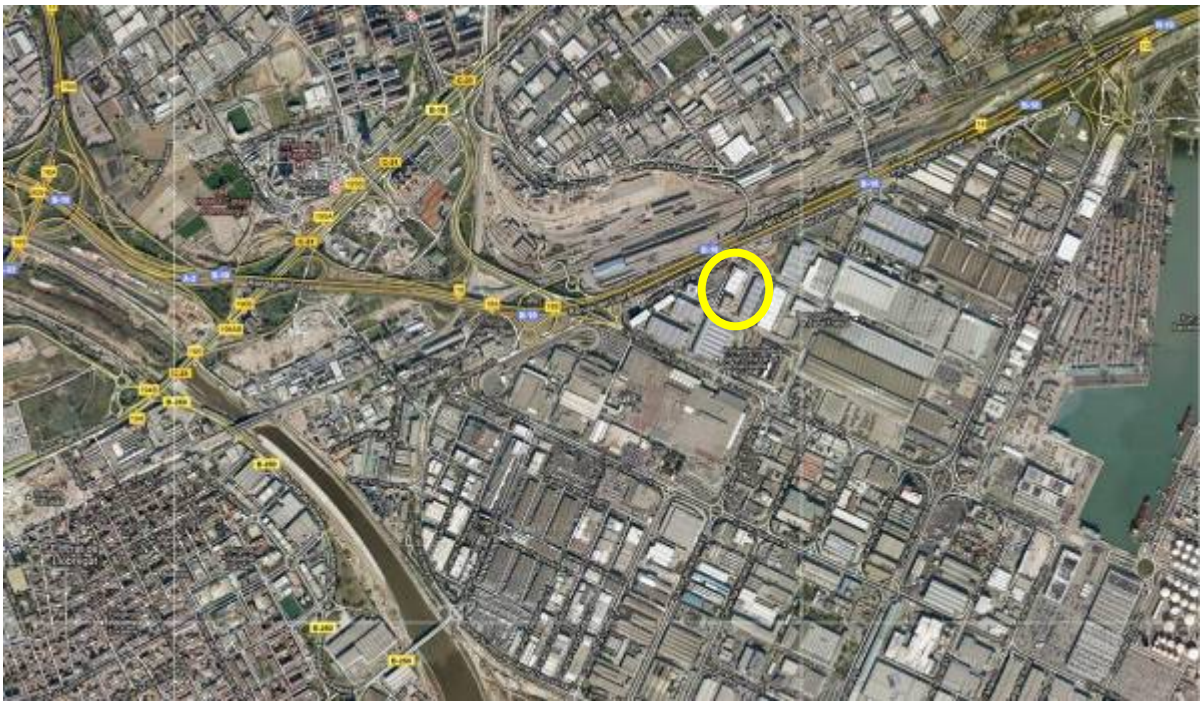
APPENDIX I: LOCATION INFORMATION

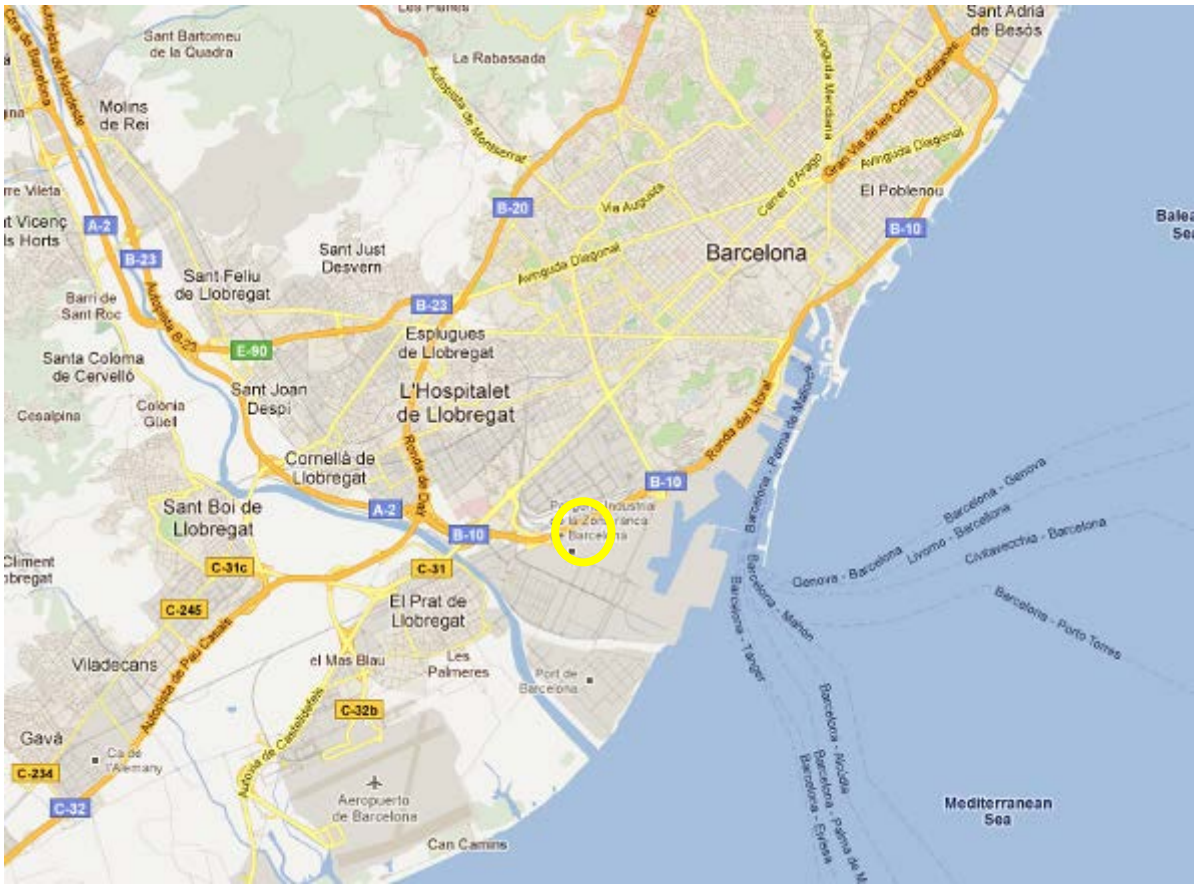
The plug-fest will take place at the ABERTIS facilities in Barcelona, Spain.

ABERTIS PARC LOGISTIC
Av. Parc Logistic, 12-20
Building C
08040, Barcelona
(SPAIN)

GPS Coordinates : N 41º 20' 28.8" , E 2º 7' 40.1" (http://g.co/maps/rh9rr) (http://binged.it/K6WMm4)

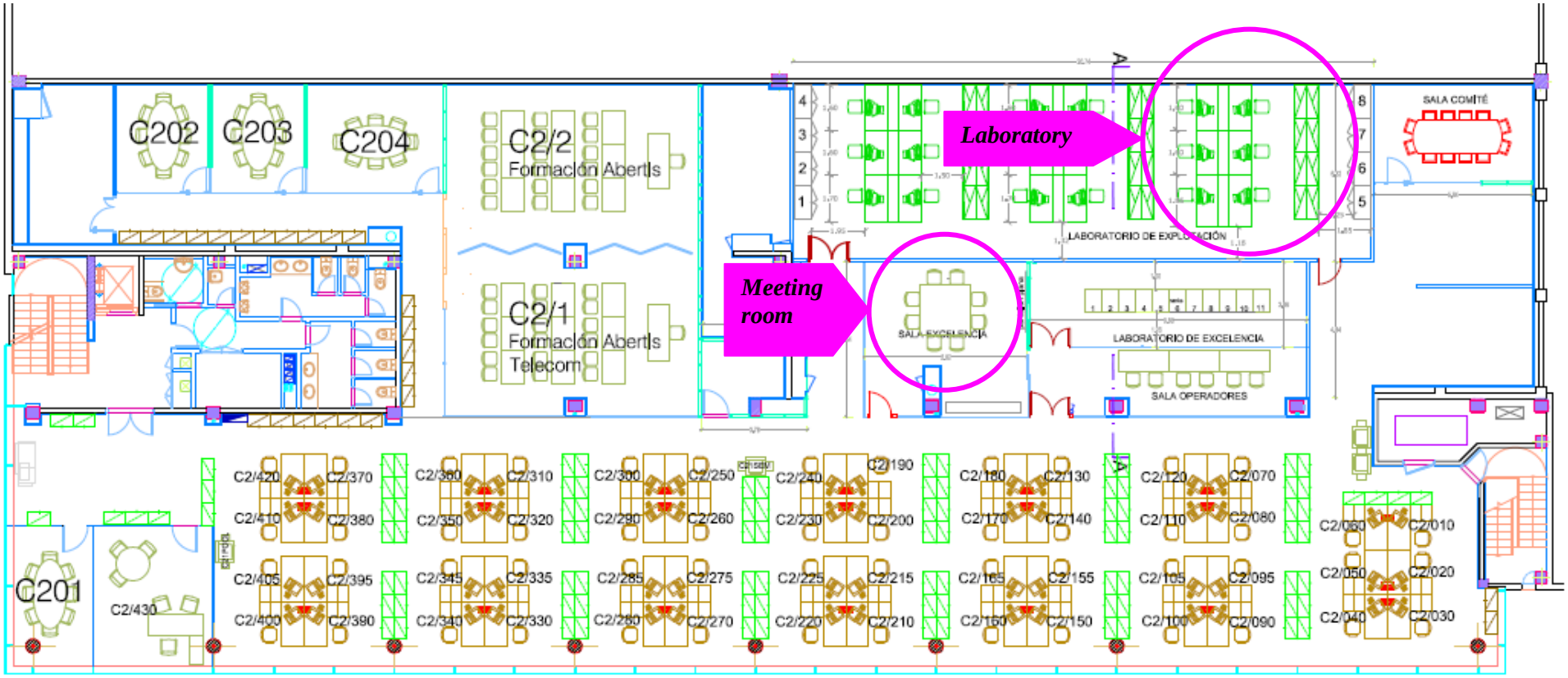
The following maps show where the ABERTIS building is.





For more information about how to get, see the following link: http://www.abertis.com/contactar

APPENDIX II: DETAILED LAYOUT AND FLOOR PLAN



APPENDIX III: RECOMMENDED ACOMMODATION

A list of hotels is provided as reference. The address and telephone number are presented. For more information, click on the hotel's name.

1

Hotel AC Som (3*)
Arquitectura 1 – 3
L´Hospitalet De Llobregat, Barcelona

Tel: +34 93 445 82 00
Fax: +34 93 445 82 01

2

Hotel NH Calderon (4*)
Rambla de Cataluña, 26
Barcelona

Tel: +34 93 301 00 00
Fax: +34 93 412 41 93

3

Hotel Catalonia Barcelona Plaza (4*)
Plaza de España,6-8,
Barcelona

Tel: +34 93 426 26 00
Fax: +34 93 426 04 00

4

Hotel Prestige Congress (4*)
C/ de José Agustín Goytisolo, 9-11
08908 Hospitalet de Llobregat,
Barcelona

Tel: +34 93 267 18 00

5

Aparthotel Hesperia Fira Suites (5*)
Avda Mare de Deu de Bellvitge,3
Hospitalet de Llobregat, Barcelona

Tel: +34 93.503.59.70
Fax: +34 93 503 59 71

6

Hotel AC Vilamarí (4*)
C/Vilamarí 34-36
Barcelona

Tel: +34 93.289.09.09
Fax: +34 93 289 05 01

7

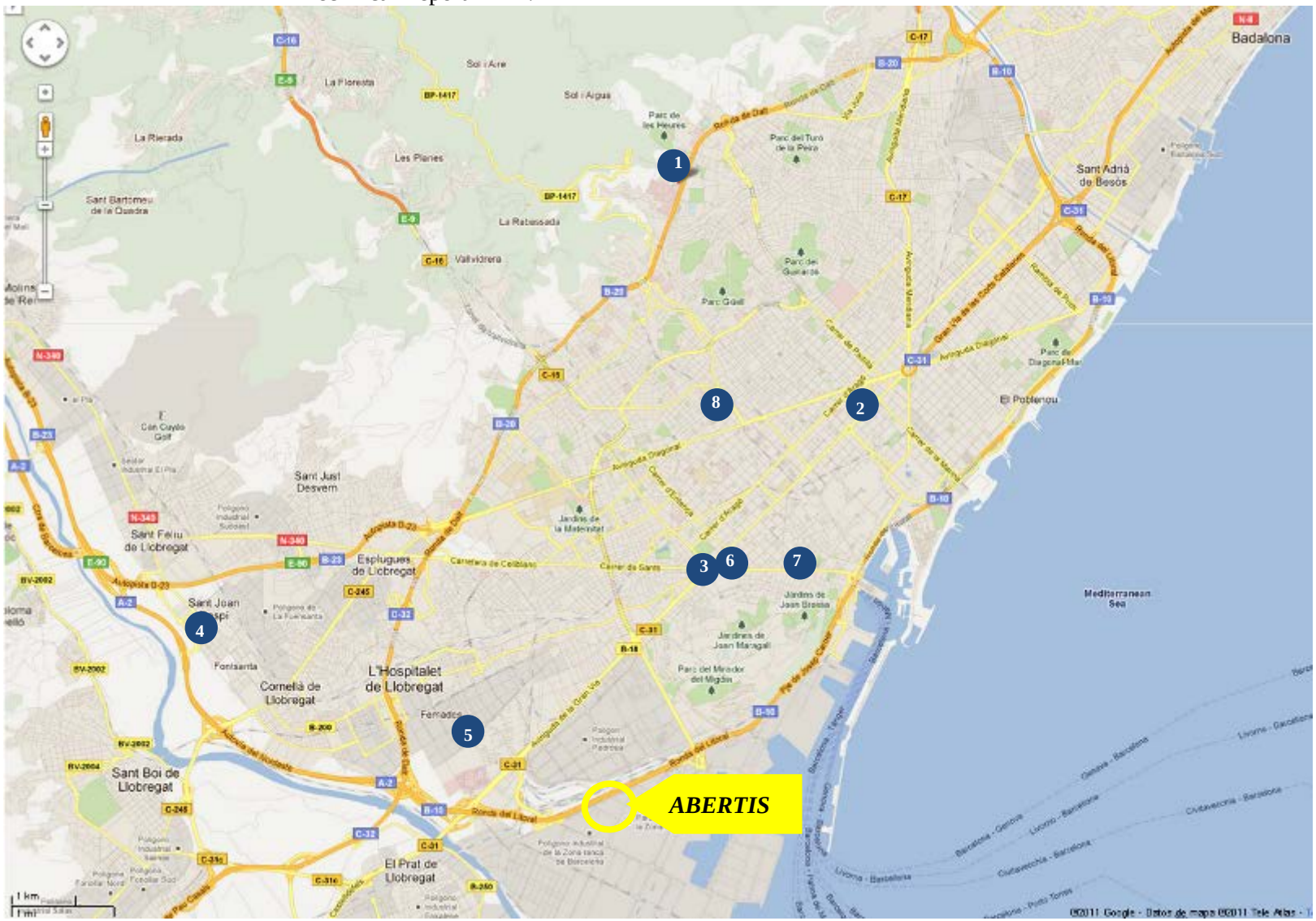
Hotel Silken Concordia (3*)
Avda Paralelo,115
Barcelona

Tel: +34 93.324.91.80
Fax: +34 93 324 91 85

8

Hotel Barcelona Center (4*)
C/Balmes 103-105
Barcelona

Tel: +34 93.273 00.00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ABERTIS
Badalona
Sant Adrià de Besòs
El Poblenou
Mediterranean Sea
Sant Just Desvern
Sant Feliu de Llobregat
Esplugues de Llobregat
Sant Joan Despí
Cornellà de Llobregat
L'Hospitalet de Llobregat
Fondarta
Sant Boi de Llobregat
El Prat de Llobregat
Les Planes
Sant Bartomeu de la Quadra
Vallvidrera
Parc Güell
Jardins de Joan Brossa
Jardins de Joan Maragall
Parc del Mirador del Migdia
Parc de Diagonal Mar
Parc del Turó de la Peira
Parc de les Heures
Jardins de la Maternitat
Fernadas
1 km
1 mi