Project acronym:	**SACRA**
Project title:	Spectrum and Energy Efficiency through multi-band Cognitive Radio
Project number:	European Commission – 249060
Call identifier:	FP7-ICT-2007-1.1
Start date of project:	01/01/2010 **Duration:** 36 months

Document reference number:	**D6.2**
Document title:	**Integration specification**
Version:	1.0
Due date of document:	Month M24 (December 2011)
Actual submission date:	12/01/2012
Lead beneficiary:	IIS
Participants:	Alexander JASCHKE (IIS), Robért GLEIN (IIS), Dominique NUSSBAUM (EURE), Dorin PANAITOPOL (NTUK), Wael GUIBENE (EURE), Bassem ZAYEN (EURE), Van Tam NGUYEN (IT), Hussein FAHKOURY (IT), Anne Claire LEPAGE(IT), Philippe DELAHAYE (NTUK), Sylvain TRAVERSO (TCF)

Project co-funded by the European Commission within the 7th Framework Programme		
DISSEMINATION LEVEL		
PU	Public	
PCA	Public with confidential annex	
CO	Confidential, only for members of the consortium (including Commission Services)	**X**

EXECUTIVE SUMMARY

This deliverable D6.2 of the FP7 ICT SACRA project provides the specifications for the system integration.

- Connection to WP4/5

One, system integration consists of the hardware (HW) integration, which is closely linked to WP4.4. In this document we describe the technical and electrical specifications needed for the HW integration. In order to verify the demonstrator, terminals (eNodeBs) have been built. The integration specification for this radio system is also described in this document.

- Connection to WP2/3

System integration also consists of the SW integration, which is closely linked to WP2 and WP3. Integration specification for the detection algorithms and classification is given in chapter 5.1.

- Description of contents of D6.2

In order to realize the scenarios described in D6.1, general specifications for the user equipment are given. In chapter 2, we summarize the equipment specification like the SACRA terminal, user equipment, and base station. Chapter 3 consists of the system overview and general specifications for the test scenario, also described in D6.1. To ensure a good HW and SW integration, chapter 4 and 5 specifies the HW and SW parts.

- Conclusion to D6.2

In this document, we have refined the specifications of the building block that will be conducted to the WP6. An equipment specification shows the components used for the selected scenarios described in D6.1 and D1.1. The system overview and general specifications describes the specification needed for the selected scenario which is chosen. Closely linked to WP5 the chapter 4 (Integration of HW parts) and chapter 5 (Integration of SW parts) consists of integration specifications to combine all parts developed in WPs 2, 3, and 4.

Furthermore, the present document can be seen as a schedule for the activities in WP6, especially illustrated in chapter 6 (Step by step integration).

CONTENTS

1 INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

This document is the deliverable D6.2 of the project and defines the specifications for the system integration including software and hardware integration. Moreover it describes the step-by-step integration procedure to enable the validation of efficient cognitive radio communications.

Indeed D4.2 (performed in WP4) has defined the specifications for each RF modem component but for WP4.4 integration specifications are needed. The digital interfaces defined in WP5 are also taken into account in this deliverable.

In order to integrate WP2 and/with WP3, SW integration specifications are needed. For SW system integration we take the input of D2.2 into account.

WP3 plans an additional verification and validation for their developed radio resource management and networking for cognitive radio systems, which needs a higher amount of user equipment (UE). This additional verification and validation is going to be described in D6.3.

It is planned to validate the use cases described in D6.1, therefore the D6.2 only includes integration specifications for WP2, WP4, WP5, and partially WP3.

D6.2 proposes a timetable for step-by-step integration in chapter 6. With that schedule, a good integration at the end of the project is ensured.

1.2 DOCUMENT VERSIONS SHEET

Version	Date	Description, modifications, authors
0.1	24.11.2011	Initial document, Alexander Jaschke (IIS), Robért Glein (IIS)
0.2	02.12.2011	Addition of chapters, Alexander Jaschke (IIS), Robért Glein (IIS)
0.3	08.12.2011	Addition of chapters, Dominique Nussbaum (Eure), Dorin Panaitopol (NTUK)
0.4	13.12.2011	Addition to chapter 5.3.1, Tapio Rautio (VTT)
0.5	23.12.2011	Edited chapter 2 and 5, Alexander Jaschke (IIS), Robért Glein (IIS),
0.6	23.12.2011	Chapter 5.1.1 update by Bassem Zayen (Eure)
0.7	23.12.2011	Addition to chapter 6 and update of the document, Alexander Jaschke (IIS), Robért Glein (IIS)
0.8	28.12.2011	Contributions by IT
0.9	03.01.2012	Review by Philippe (NTUK) and Sylvain (Thales)
0.95	05.01.2012	Chapter 5 – updated, Dorin (NTUK)
0.96	09.01.2012	Addition of executive summary and chapter 7, Alexander Jaschke (IIS)
1.0	11.01.2012	Final updates of the D6.2 by Alexander Jaschke (IIS), Robért Glein (IIS)

2 EQUIPMENT SPECIFICATION

This section summarizes the requirements needed for the SW and HW system integration. The implementation is already described in the specific deliverables of WP4 and WP5.

2.1 USER EQUIPMENT

Table 2-1 shows the necessary user equipment for the test scenarios described in D6.1.

Parameter	Description	Relevant scenarios	Described in deliverable
UE1	SACRA terminal	Intra-cell scenario	D4.2
UE2	Primary user (microphone)	Intra- and inter-cell scenario	D6.2
UE3	Unused mobile terminal		
UE4	Unused mobile terminal		
UE5	SACRA terminal	Inter-cell scenario	D4.2

Table 2-1: Specification user equipment

The unused mobile terminals UE3 and UE4 are not used in the chosen SACRA test scenario. These UEs are other mobile terminals out of the test cells, shown in D6.1 chapter 2.2.2.2.

2.1.1 SACRA terminal

The SACRA terminal integration specification is already described in D4.2.

2.1.2 Primary user

As primary user a microphone is planned to be used. The primary user should have the following parameters:

- FM modulation (because of the widely used wireless programme making and special events (PMSE) devices) or DVB-T signal
- Adjustable channels for channel selection
- UHF TVWS frequency range

The primary user should be utilized during the test scenario. In case of a microphone, an audio signal should be transmitted.

2.2 BASE STATION

Table 2-2 shows the necessary base station (eNodeB) for the test scenarios described in D6.1.

Parameter	Description	Relevant for system integration	Described in deliverable
eNB1	Operation in UHF TVWS and 2.6GHz LTE bands	Intra- and inter-cell scenario	D6.1
eNB2 – eNB7	Unused		D6.1

Table 2-2: Specification user equipment

The unused base stations eNB2 – eNB7 are not used in the chosen SACRA test scenario. These eNBs are base stations out of the inter-cells, shown in D6.1 chapter 2.2.2.2.

2.3 FREQUENCY RESOURCE

Corresponding to the eNodeB's the frequency resources for the test scenarios are described in D6.1 chapter 5.2.4.

3 SYSTEM OVERVIEW AND GENERAL SPECIFICATION

As described in D6.1, the overall SACRA system will aim at demonstrating a Spectrum Aggregation (SA) Use case, with a cognitive access to the TVWS band. The overall system will comprise:

- The SACRA terminal (dual band, developed in the WP4 for RF modem, and WP5 for the baseband)
- A TVWS (470-790 MHz) and 2.6 GHz LTE NodeB: those logical entities can be co-localized, or even can be the same equipment, depending on the scenario.
- A Joint Radio Resource Management (JRRM) entity, which attributes the radio resources in both bands, UHF and 2.6 GHz. In spectrum aggregation (use case 1), it allows the combination of the 2 bands resources to increase the throughput. In a Femto Cell usage (use case 3), it allows the handover (soft or hard) between the 2 bands.
- A Mobility Management entity: as in classical cellular network, there is a need to manage the mobility of the terminal to allow the routing of the data from/to the terminal to/from the rest of the world (outside the Domain).

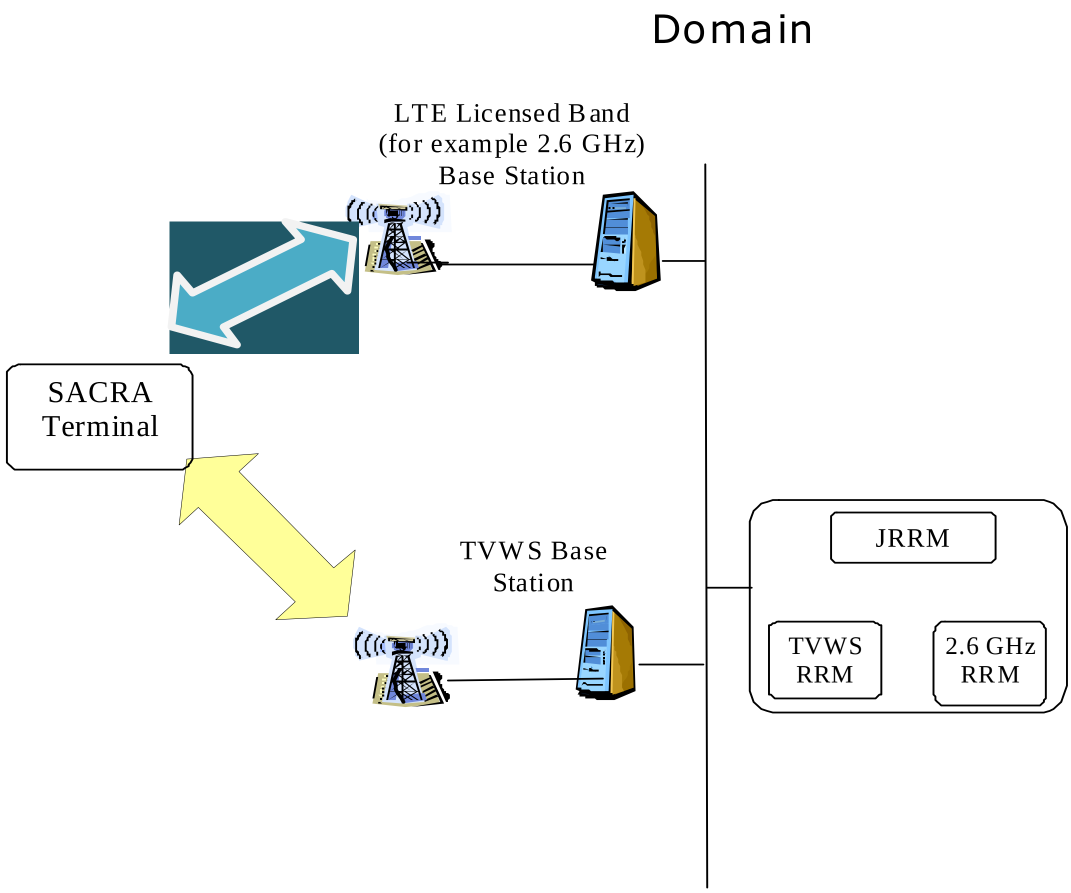

Figure 3-1: SACRA system overview

As stated in D6.1, the SA scenario that will be implemented can be divided into 5 steps:

- Step 1: the SACRA terminal is connected to LTE base station through the 2.6 GHz band. The SACRA system monitors the available/free TVWS band in the area (continuous sensing). Here we can simulate interference on some part of TVWS if necessary and hence sensing is able to detect which band is free and which is in use. Indeed, there is no guaranty that a primary user can enter in our coverage at a given time; we will therefore emulate a primary user thanks to a microphone. We will transmit in a specific channel, in order to validate the sensing algorithms.
- Step 2: Better QoS is required and the system sends a request to the TVWS base station asking for allocation of resources in TVWS.
- Step 3: the SACRA terminal gets a TVWS resource (the same it asked) from the TVWS base station. From now it is receiving one 2.6GHz carrier (from LTE base station) and one TVWS carrier (from TVWS base station). During this period, the sensing system monitors the band in order to ensure an efficient evacuation of the used band. The list of the available/free TVWS channels is also maintained.
- Step 4: A primary user (a microphone) appears on the TVWS carrier used by the SACRA terminal. The system detects the primary user (detection distributed between the TVWS base station and the UE). The information is sent to the JRRM.
- Step 5: The TVWS carrier of our SACRA terminal is changed from the initial carrier and from now it is receiving the same 2.6GHz carrier but a new TVWS carrier.

The specifications of the SACRA system are derived from this scenario, and are mainly described in D6.1.

The following figure visualises the test scenario activities in the described five steps with the mobile phone as SACRA terminal and a microphone as PU.

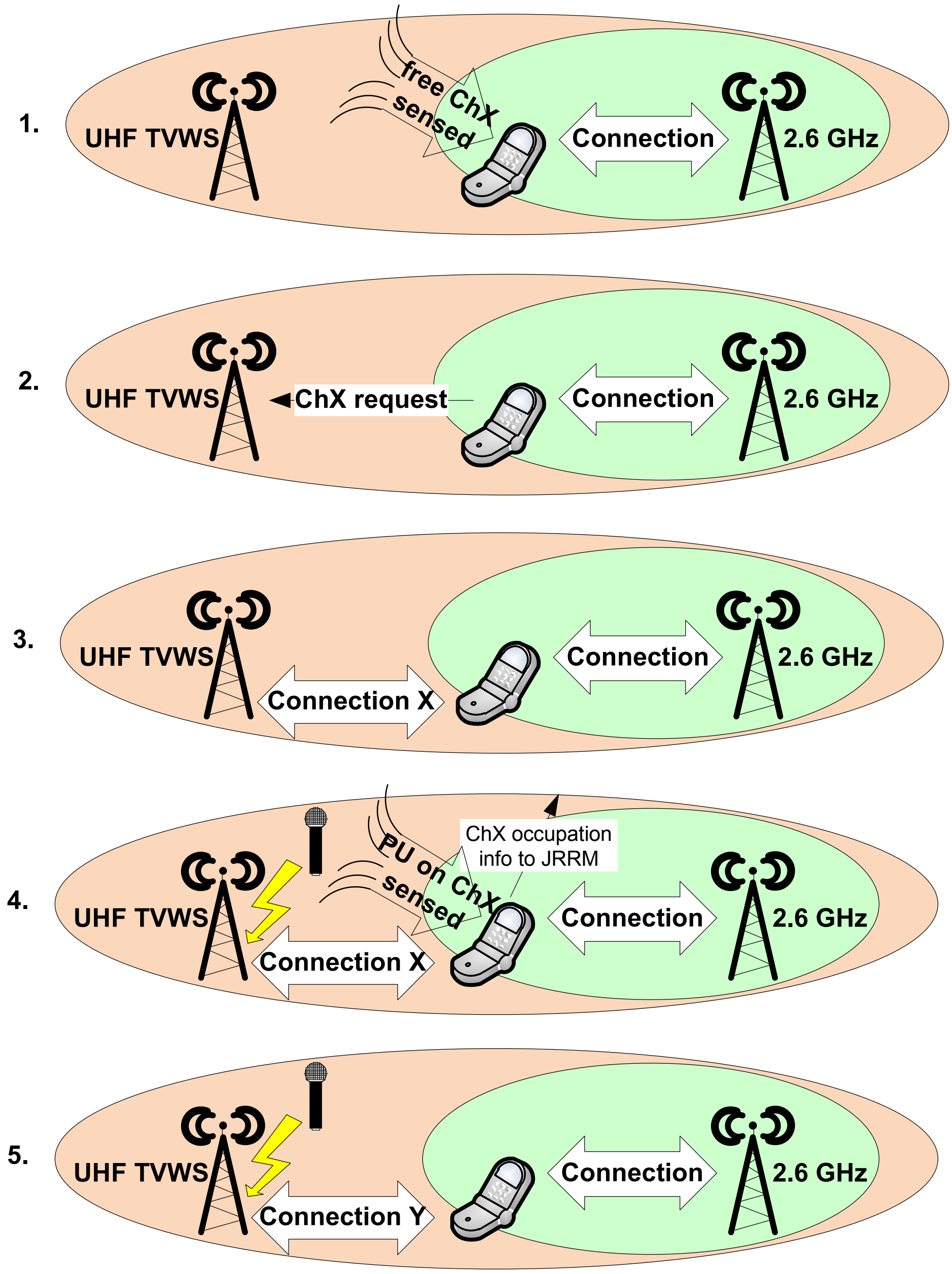

Figure 3-2: Test scenario activities

4 INTEGRATION OF THE HW PARTS

In this section, the integration of WP4 and WP5 parts are described in a coherent way in the SACRA terminal. The integrated terminal will allow us to implement the spectrum aggregation use case.

4.1 INTEGRATION OF THE SACRA TERMINAL

In this section, we assume that the WP4.4 task has been performed. The WP4.4 task consists of the RF modem integration. The overall RF modem developed in the WP4 is illustrated in the figure below:

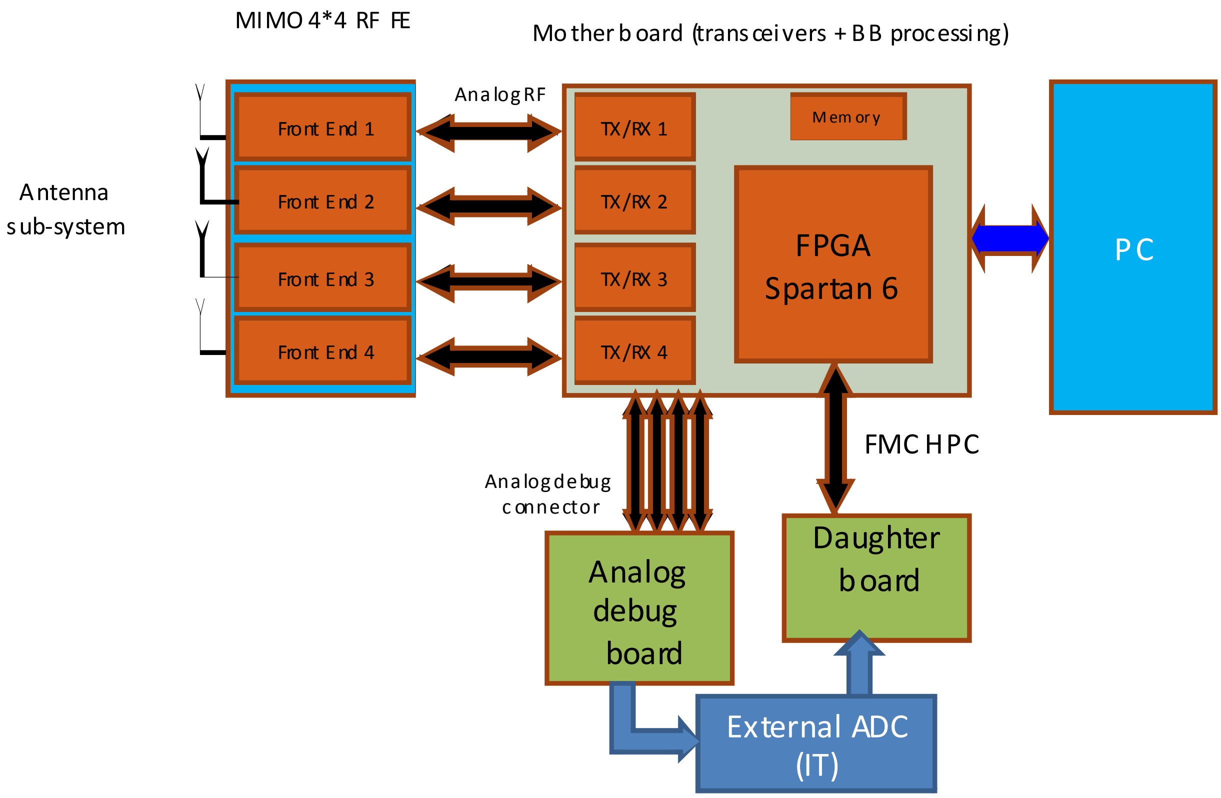

Figure 4-1: WP4 modem

The components, as well as the interfaces, are extensively described in D4.1 and D4.2. We assume that the RF modem including antennas, RF FE, the motherboard and the PC, has been tested and is functional. In particular, the RF modem shall be capable to receive and transmit a LTE signal according to the specifications (see D4.1 and D4.2).

In WP5, it has been decided to connect Express MIMO to the WP4 modem through the FMC HPC connector (see D5.2). The resulted integration is given in the figure below:

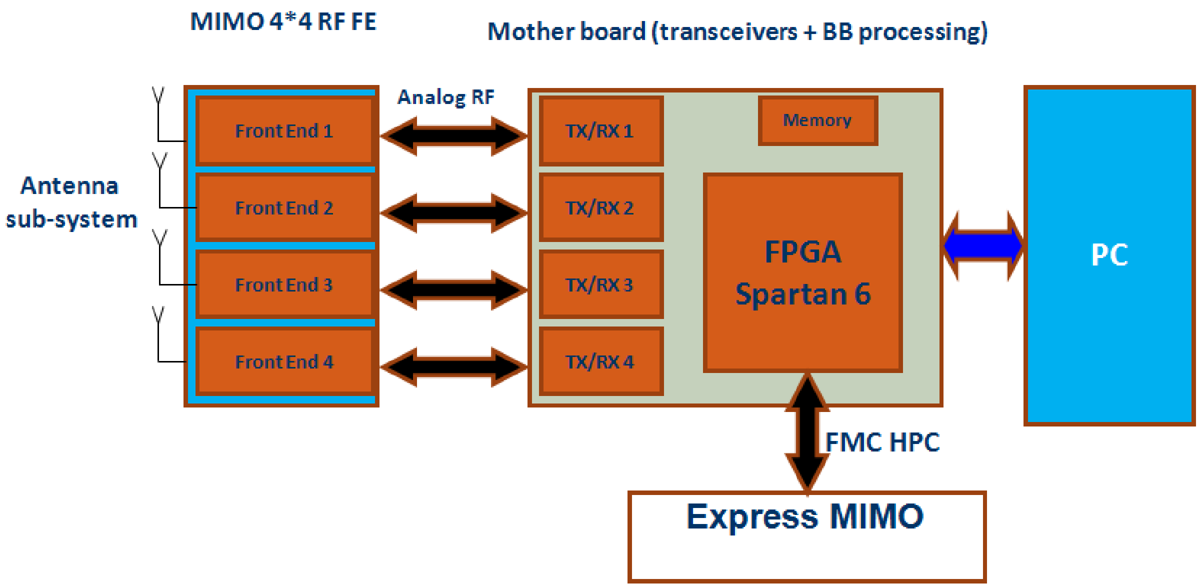

Figure 4-2: integration of ExpressMIMO in the WP4 modem

Hence, the target for WP5 remains unchanged, on Virtex 5 (Express MIMO board), and the integration in WP6 will consist to connect motherboard to Express MIMO board. Therefore, we will have 2 settings for WP6:

A setting with external ADC (Figure 4-1)

- Figure 4-2)

The first setting, with external ADC, is used specifically to validate the ADC and the compare its performance to the state-of-the-art. The second setting, with Express MIMO, is used to validate the motherboard with the internal ADC of the Lime transceiver and the dedicated algorithms from WP2.

In WP6, WP2 algorithms will be implemented in Express MIMO thanks the library, and WP3 algorithms will be implemented on the PC, since they are a part of higher layers (L3 and above). This integration is described in the SW related sections (chapter 5.1) of the present document.

4.2 OVERVIEW OF THE BASE STATION PARTS

The base station comprises:

- An express MIMO board (host PC) and a distribution card
- An equipment to be installed in the control room beneath the mast, namely the **RF Conversion** TX/RX. This part is based on 4 LIME LMS6002D evaluation boards [4]. LMS6002D is a fully integrated multi-band, multi-standard single-chip RF transceiver for 3GPP (WCDMA/HSPA and LTE), 3GPP2 (CDMA2000) and WiMAX applications.
- An RF equipment to be co-located with the antennas, namely the **PA-LNA Subsystem (PA in the** Figure 4-7**).**

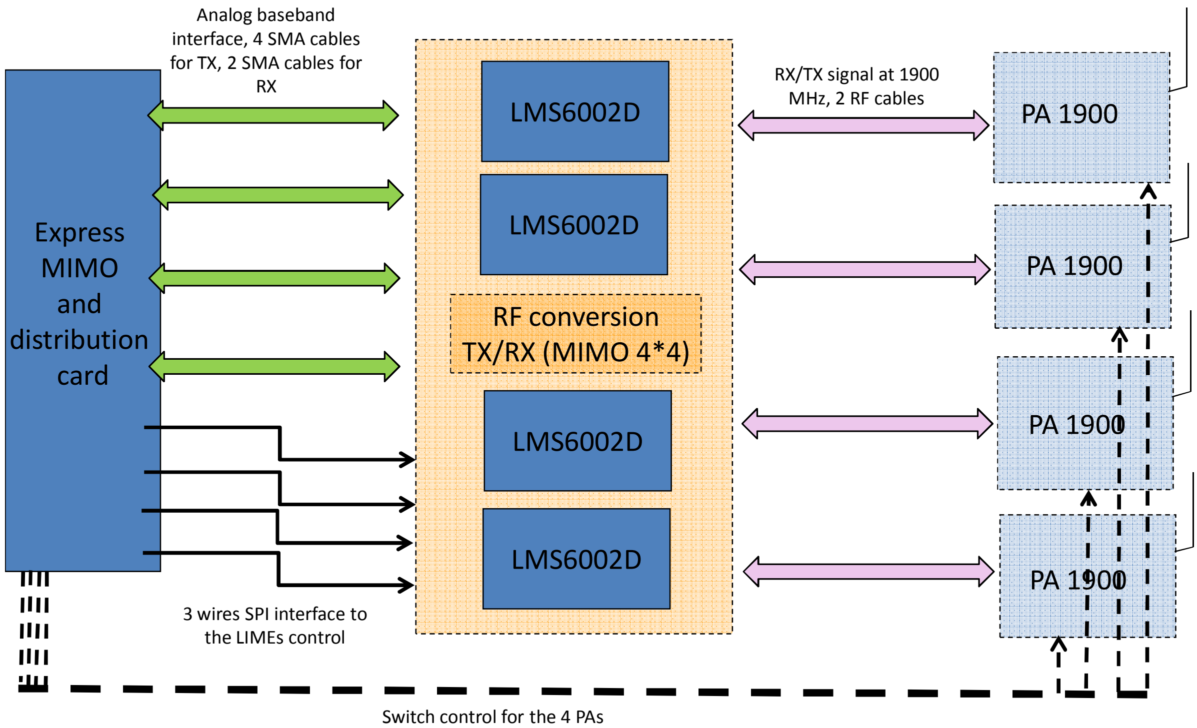

Figure 4-3: base station overview

The aim of the Express MIMO is to handle 4 data flows (MIMO 4*4), both for TX and RX. Express MIMO includes AD and DA conversion, as well as the base band processing. The interface of EXPRESS to the rest of the system in the following:

- Data interface: Express MIMO has 4 RX and 4 TX. The signals are analog (EXPRESS MIMO includes ADDAC) in base band (IF=0) and complex. The signals can be single ended (16 SMA cables, 8 for TX and 8 for RX)
- Control of the 4 LIME LMS6002D transceivers

The host PC and the RF conversion subsystem (MIMO 4 by 4, 4 TX and 4 RX) are located in the control room beneath the mast. The RF conversion subsystem is connected to the PA-LNA subsystem trough coaxial N-type cables on the order of 30m. The signals (8 signals, 4 RX and 4TX) are analog, at the RF frequency (800, 1900 MHz or 2600 MHz).The PA-LNA subsystem is co-located with the antennas and is contained in hermetically sealed enclosures. The eNB antennas (as an example) are from Kathrein. These are typical antennas with dual (cross) polarized ports per sector, and are furnished by EURECOM.

4.3 RF CONVERSION SUBSYSTEM

The figure below gives an overview of one RX/TX path in the RF conversion subsystem. This module is based on the LIME LMS6002D evaluation board.

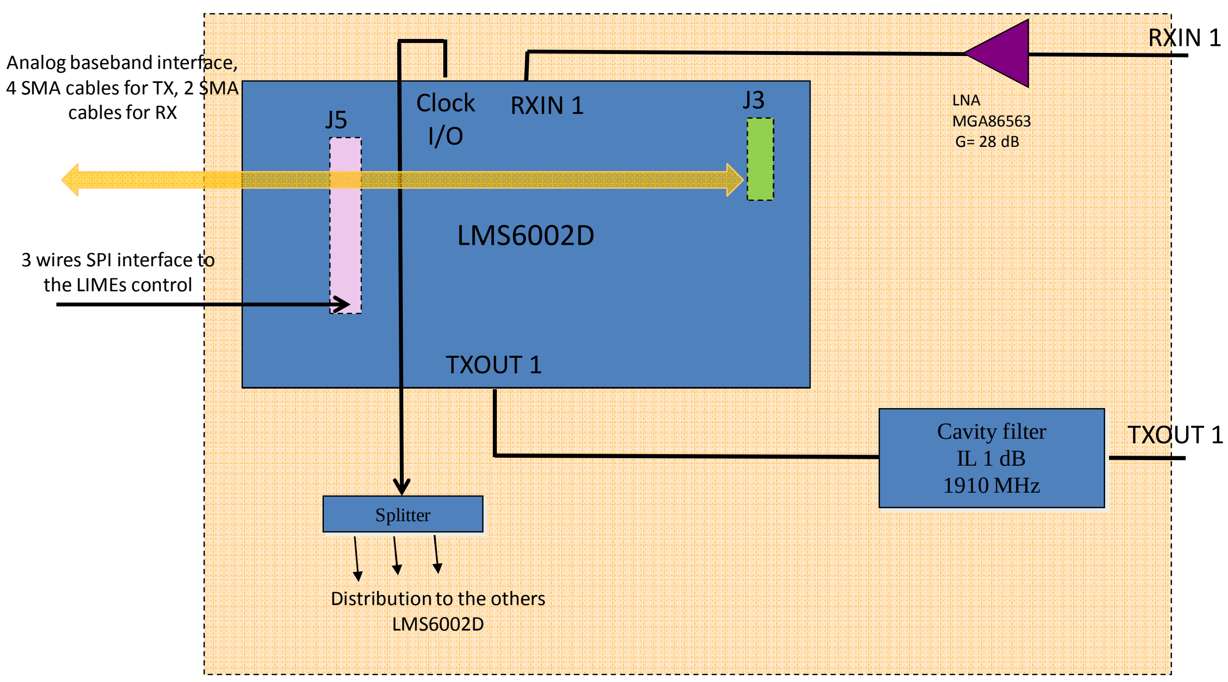

Figure 4-4: RF conversion TX/RX

The RF conversion box (that includes the 4 TX/RX paths) is depicted in the following figures.

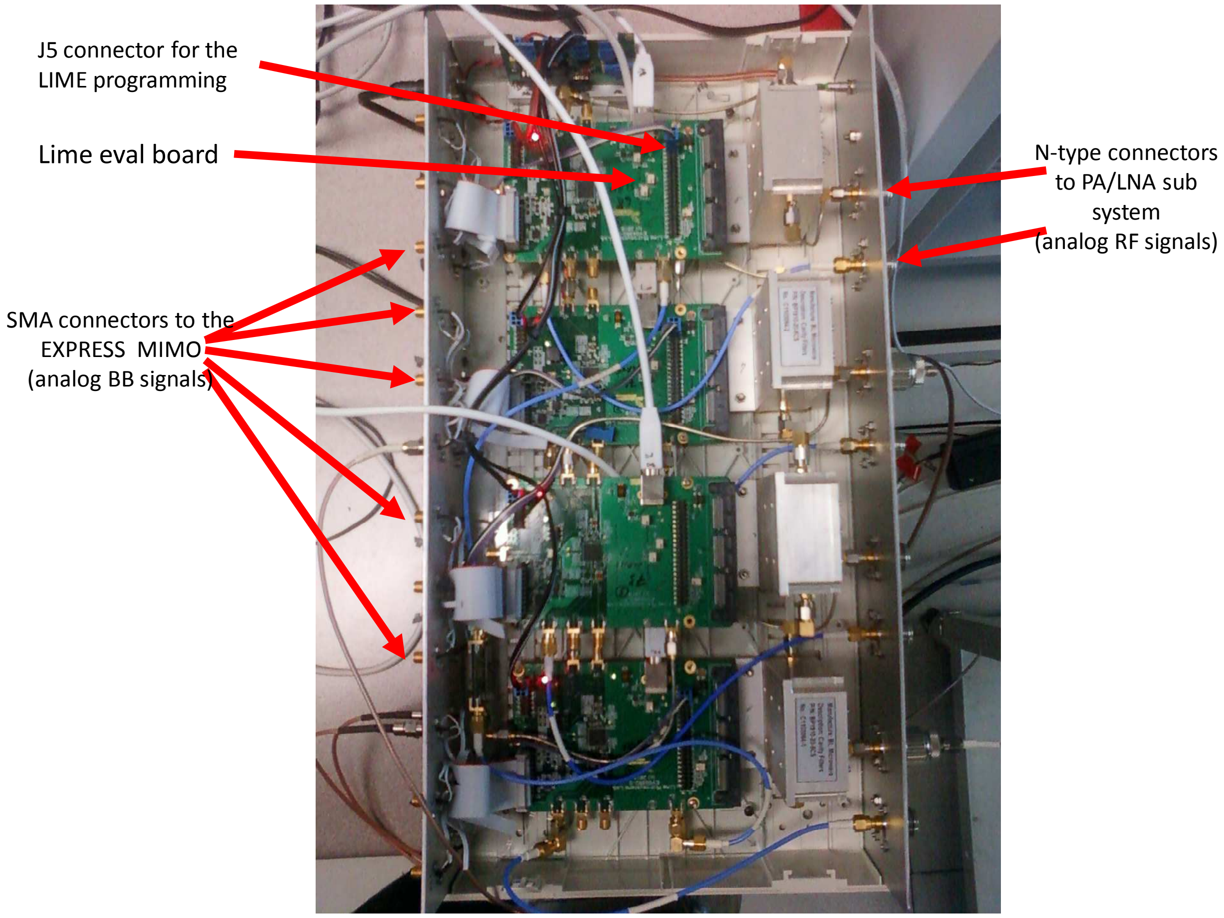

Figure 4-5: RF conversion sub system

4.4 PA/LNA SUBSYSTEM DESCRIPTION

The PA/LNA subsystem is collocated with the antennas on the pylon. As described in the below figure, the Tx signal is received from the RF conversion at a relatively low level (- 15 dBm). The signal is amplified by a 2-stage PA sub-system and feeds the switching system. On the RX side, the signal is received on the antenna, is separated from the Tx signal thanks to the switching, and filtered and then amplified by an LNA.

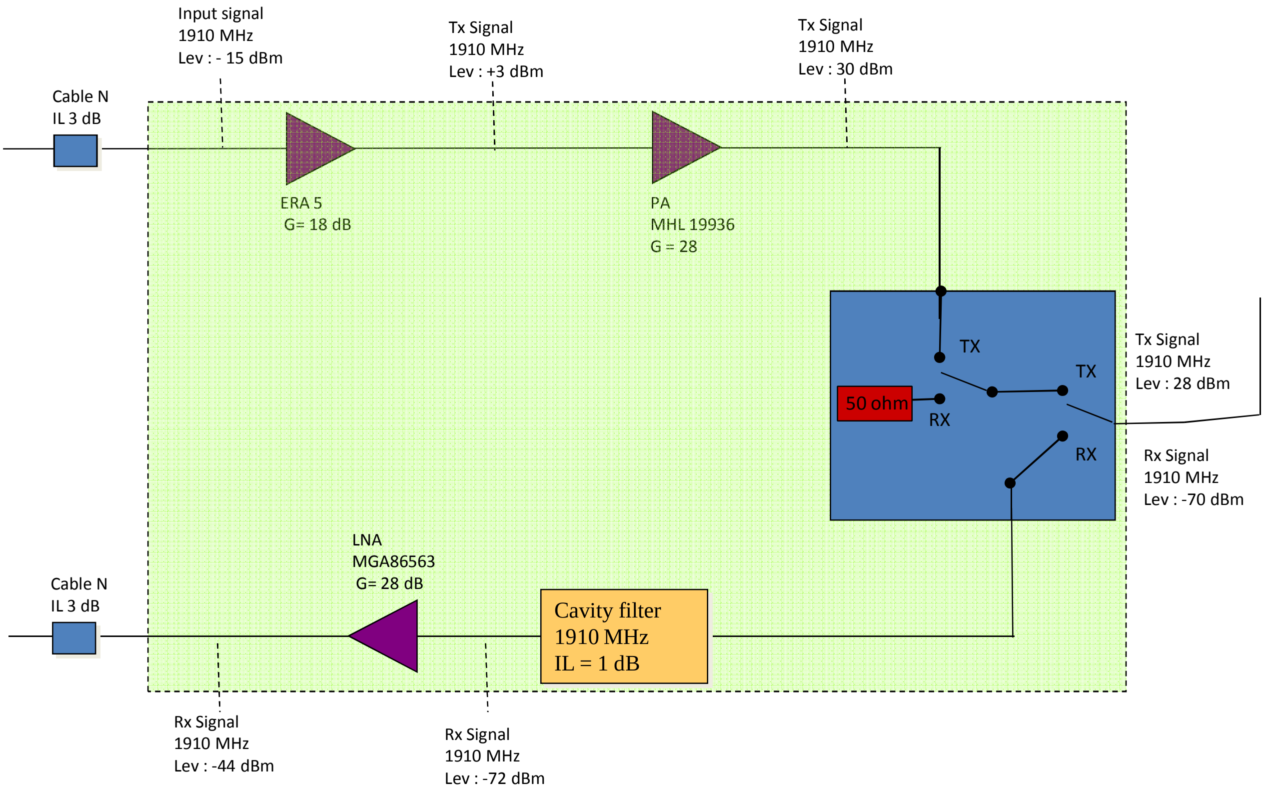

Figure 4-6 : functional view of the PA/LNA sub-system

The PA/LNA subsystem is depicted in the following picture

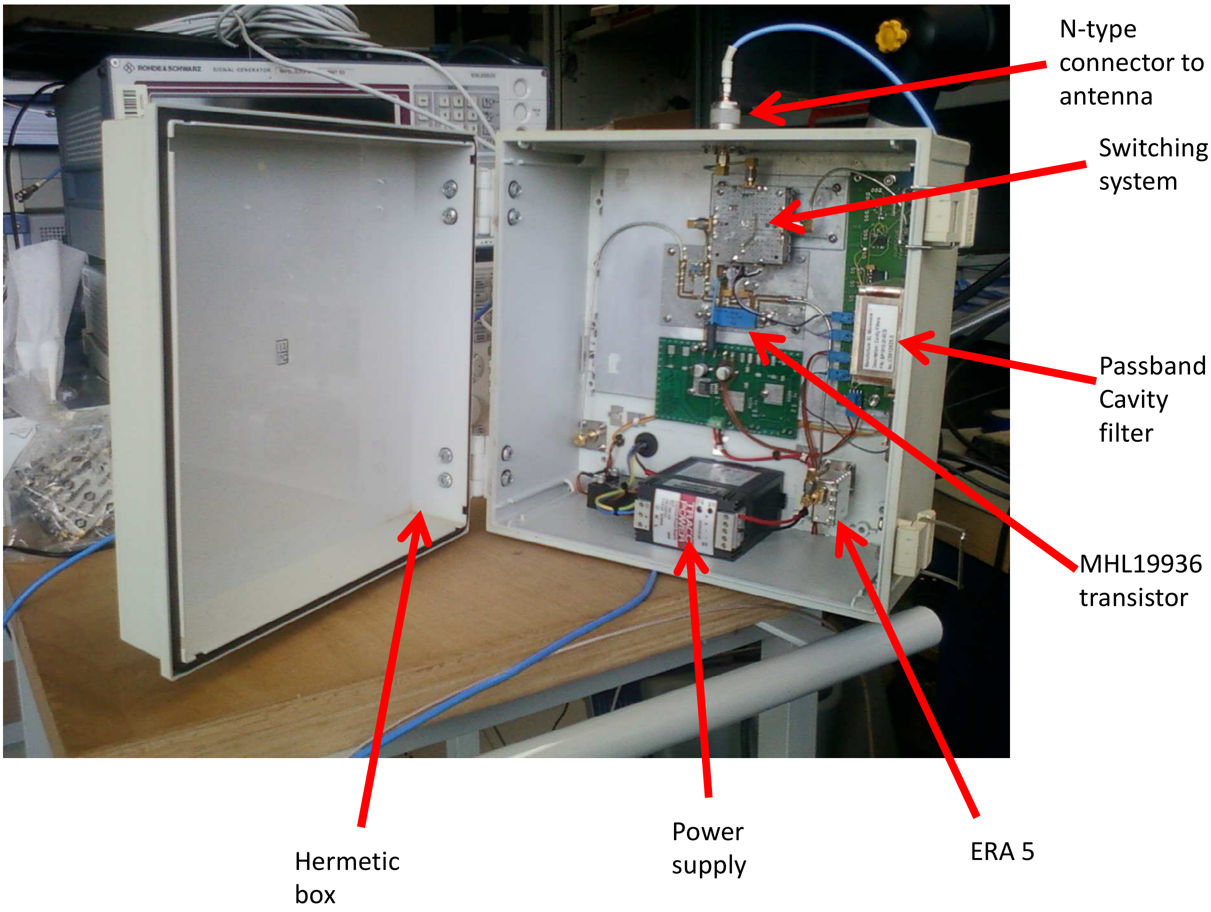

Figure 4-7 : PA/LNA picture

5 INTEGRATION OF THE SW PARTS

In this chapter, the integration of the WP2 and WP3 algorithms is addressed. The requirements for those algorithms were given in D6.1, and the scope of this chapter is to describe how the algorithms will be integrated in the overall demonstration activities. The software development environment that will be used to develop the applications running on the baseband processor is detailed in WP5 deliverable D5.2 Report on SACRA embedded software library, RF/BB co-design, RF/BB interface, functional and performances validations. It is not described again in the following.

5.1 INTEGRATION OF THE WP2 ALGORITHMS

The WP2 algorithms, described in the WP2 deliverables (from D2.1 to D2.5), will be implemented in the WP5 library. In summary, we have identified the following Phases/Tasks:

- Fixed point C implementation of the selected algorithms (sensing, classification and access techniques)
- Non real-time simulation of the algorithms in software
- Embedded software implementation of selected sensing algorithms using the software development kit from WP5.

As mentioned before in the introductory chapter, different algorithms provided by WP2 are serving as inputs for WP6, for implementation purposes on SACRA platform. As mentioned in Section 5.1.1, WP2 is providing a detection algorithm used to check the availability of a certain TVWS frequency band. If this band is not used by a primary (licensed) user, the platform will start using the opportunistic band as a non-licensed (secondary) user. However, during this opportunistic transmission process, there are cases when, at a given unknown time, a primary user starts reusing, or it starts using for the first time the same frequency band currently used by the SACRA platform. If this happens, classification algorithms implemented on the SACRA platform are necessary to discriminate between the primary user transmissions and secondary user transmissions received by the SACRA platform. This concept is further described in Section 5.1.2.

5.1.1 Detection - Proof of Concept

The goal of this chapter is to describe integration settings of the detection algorithms used to check the availability of certain TVWS band. Three algorithms will be integrated to the demonstrator: energy detection, Welch periodogram based detection and pilot based detection.

<u>Welch periodogram based detection</u>

Welch periodogram based detector can be used in sensing both PMSE and DVB-T primary systems. Integration requires a SACRA platform, embedded software implementation of the detector and a signal generator for generating PMSE and DVB-T signals. The purpose of integration is to find proper settings for the algorithm parameters to be able to perform the demonstrations. Welch periodogram based detection algorithm is configured with the following parameters:

- FFT size
- Number of frequency domain samples in the band of interest
- Frequency bin number of lower edge of the band of interest
- Number of segments

- Target false alarm probability

The following data are to be monitored by user:

- Sensing status (signal found / not found)
- Detected energy value

The most important thing in the integration is to find out required sensing time of the algorithm for both the possible primary systems according to the requirements specified in D6.1. Sensing time is controlled with two parameters: FFT size and Number of segments. All the other parameters are needed in the search as well. Performance of the sensing is critical to detection threshold setting. For a proper setting, the target false alarm probability should be user defined and noise variance should be estimated precisely. This can be done best by receiving noise only signal until the estimate is precise enough. Welch periodogram based sensing algorithm demonstrations will be started in noise only situation and after certain time the primary user(s) are turned on.

Welch periodogram based detector demonstrations will produce data for performance comparison of different detection algorithms in real situation.

<u>Energy detection</u>

Energy detector will be used to detect PMSE primary signal. This detector can be simply implemented like spectrum analyser. It measures the received energy during a finite time interval and compares it to a predetermined threshold. The main advantage of this detector is its non-coherency and low complexity. To implement this detector, we need to estimate the noise variance and to define false alarm probability.

<u>Pilot based detection</u>

Pilot based detector is described in D2.2. This detector will be implemented for DVB-T primary signal detection. We will exploit pilot sequences which are integrated in the transmitted signal. These predefined pseudo-noise sequences are used generally in order to estimate the channel conditions. Alternatively, in multicarrier transmissions such as DVB-T some subcarriers may be dedicated for transmitting pilot signals. Pilot signals may be scattered over the subcarriers and over the time depending on the coherence time and coherence bandwidth of typical channel. The primary user standards are usually known and these sequences are defined correspondingly. Based on the knowledge of these sequences, we will implement this detector with a simple correlation between the received primary user signal and the pilot sequence. As in the case of energy detector and Welch detector, we need to estimate for this detector false alarm probability value.

5.1.2 Classification - Proof of Concept

The goal of this section is to describe the integration settings to be used by a demonstration platform which performs signal classification in order to discriminate between the primary user (PMSE or DVBT) transmissions and own secondary system transmissions (LTE).

It is important to mention that an alternative for the proposed method is to use a technique employing Quiet Periods (QPs), and the advantage of this method would be that it requires a detection algorithm similar to the one used in Section 5.1.1, which is less complex. However, such a technique using QP is very disadvantageous:

- Firstly, if the secondary system uses QPs, this will directly impact different Quality of Service (QoS) parameters of the secondary system such as the transmission delay. For example, it will be impossible to use such a system for voice calls or other services which demand very low transmission delays. If the system stops transmitting more often (for sensing purposes in our case), the expected communication quality of the user will be very low.
- Secondly, the entire secondary system has to synchronize its users to stop transmitting at a given time, otherwise own secondary transmissions would be interpreted as primary transmissions. In this case, false alarm probabilities will be imminent even if very low target false alarm probabilities are imposed by the system itself, and this will affect again the secondary system Quality of Service (QoS), as the secondary system will stop transmitting even if primary users are not present. As previously mentioned, QP is a possible option used to overcome this problem, but this option is very expensive from the secondary system point of view, as it demands huge amount of signalling between the secondary users for synchronization.

For all these reasons, SACRA opted for classification instead of using Quiet Period techniques, and as explained in the next sections.

5.1.2.1 LTE incumbent classification without Quiet Period

As shown in the figure below, the proposed solution for the demonstration platform consists of the following materials:

- 1 LTE transmitter operating in TVWS (eNodeB from EURECOM), which will transmit the signal (2)
- 1 LTE transmitter operating in 2.4GHz (optional for this demo), which will transmit the signal (1)
- 1 PU generator (PMSE or DVB-T – provided by EURECOM) with manual/automatic ON/OFF switch, which will transmit the signal (3)
- 1 Classification device (e.g., SACRA Platform) capable of detecting PU while LTE is transmitting

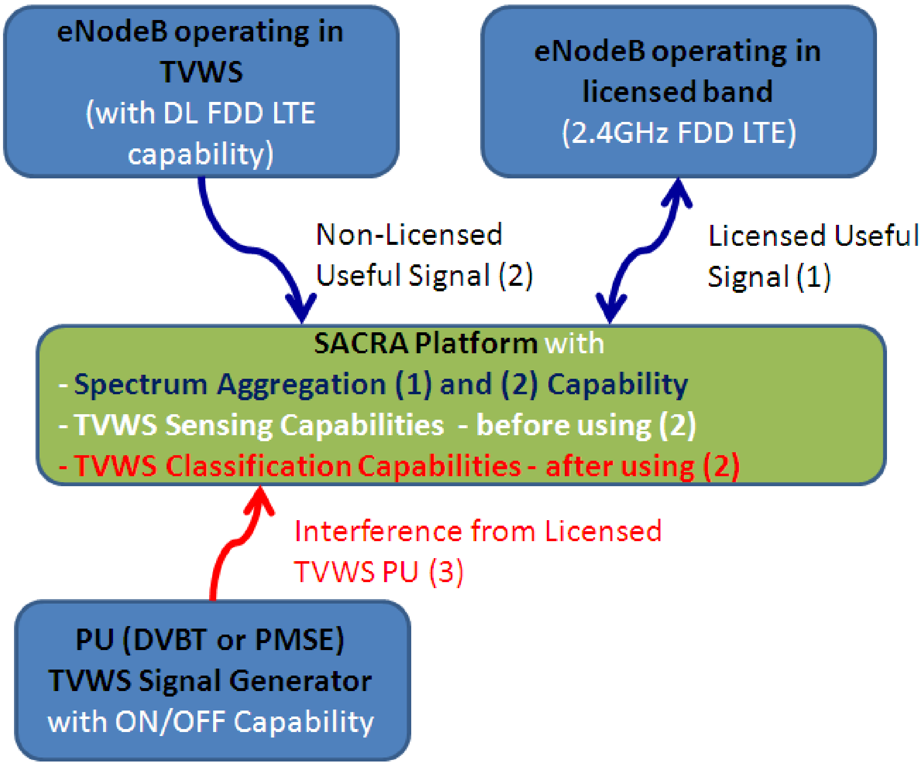

Figure 5-1: Demonstration Platform

This demonstration scenario considers a DL FDD LTE transmission coming from an eNodeB using the non-opportunistic frequency band (see signal (2) on the figure). The SACRA platform aggregates spectrum from two different frequency bands: (1) the licensed LTE band (2.4GHz) and (2) the non-licensed (TVWS) band. The signal classification will be performed only on the non-licensed TVWS band, as shown in the figure. Finally, the demonstration platform informs only if PU (3) is transmitting or not.

The MATLAB analysis from WP2 shows that the cyclostationary property, and more precisely the cyclic autocorrelation function (CAF) of the PU (PMSE or DVBT), can be used to discriminate PU from SU (LTE in our case) – as shown in the Figures below and in D2.2.

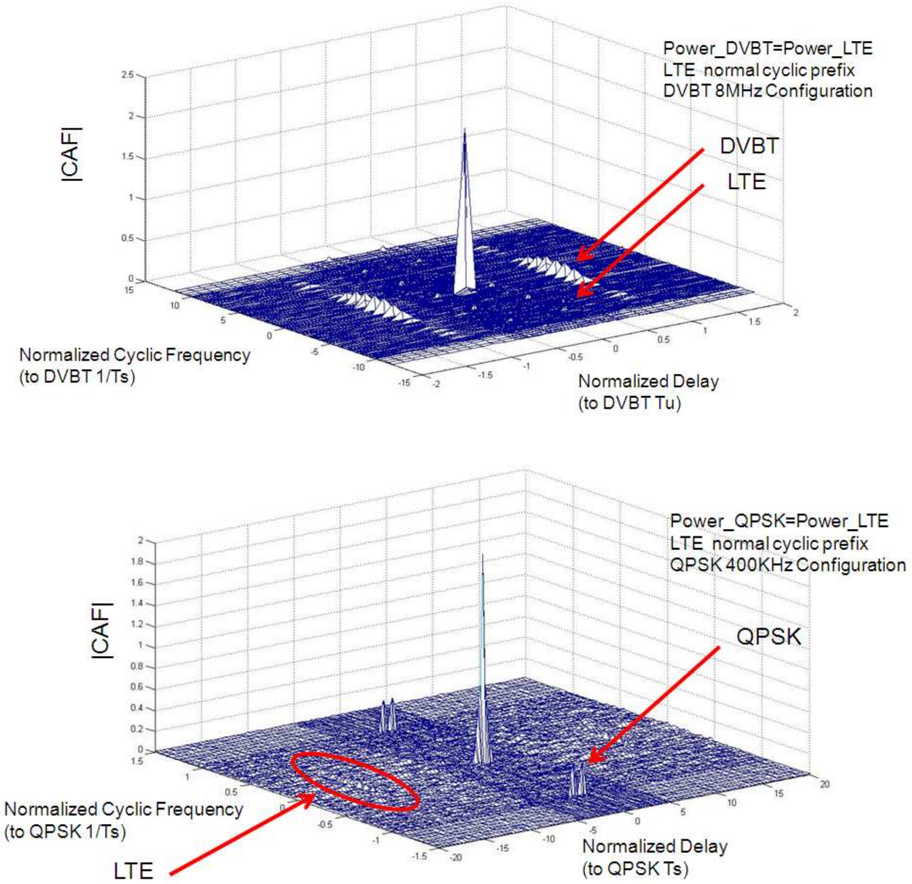

Figure 5-2: LTE / DVBT discrimination (a) and LTE / QPSK PMSE discrimination (b)

Simulations performed in MATLAB (see D2.2) have considered a 8 MHz DVB-T signal with 224 µs useful symbol and a cyclic prefix equal to ¼ of the useful symbol period, while the LTE configuration was of 10 MHz bandwidth, with normal cyclic prefix. However, as described in D2.2, other configurations are also possible.

The platform will use parameters obtained from D2.2, such as necessary classification time or the classification period (see Figure below).

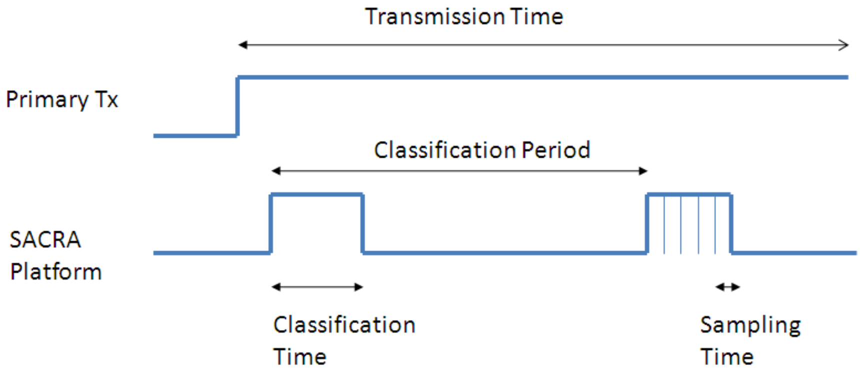

Figure 5-3: Classification Time and Classification Period

Simulation results from D2.2 show that there are several design parameters that have to be taken into account, with respect to the FCC sensing requirements. Some of these parameters are the classification time, the SNR received in DL from the non-licensed LTE system, the LTE bandwidth configuration (which will impact both the noise power and the sampling frequency being used), and the noise figure of the amplification chain.

The main goal of the contribution is of course to demonstrate the classification capabilities. However, the purpose is also to deal with the possible implementation issues on the platform such as:

- System-related implementation issues, e.g., processing time, quantization problems, differences between floating point (MATLAB representation) and fixed point (Hardware Platform).
- Memory-related implementation issues, e.g., the memory necessary to save all samples useful for signal classification, from the measured signal.
- Hardware-related implementation issues, e.g., extra noise generated by the RF amplifiers, the noise figure, the variation of the noise temperature, or other interfering sources which would be interpreted as noise.

5.1.2.2 Signal Classification combined with Signal Separation

In a wideband cognitive network cognitive terminals continuously sense the entire wideband spectrum to locate spectrum holes. Once a spectrum hole has been identified, cognitive terminals can access the frequency band under certain utilization or allocation strategies. While one spectrum hole is in use, other cognitive terminals keep on sensing, so that once the spectrum hole is available again, it can be detected immediately.

The proposed solution to classify the multiple signals occupying the same spectrum bands, can be summarized in three steps:

1) Separate mixed signals occupying wideband frequency.

2) Analyze separated signals.

3) Classify the separated signals.

We propose a two-step algorithm to separate signals over the wideband spectrum in a cognitive network. As a result, the separated signals can be references for cognitive networks to develop new communication strategies against hostile terminals. The steps are listed as follows:

1) Frequency Edge Location: Frequency edge is a frequency point where spectrum changes intensely. Detecting frequency edges would provide brief information about the occupancy of the wideband frequency.

2) Signal Separation: Separating signals occupying the wideband frequency will provide detailed information about the usage of wideband spectrum.

5.2 INTEGRATION OF THE WP3

As described in chapter 1.1, WP3 will be verified in a separate demonstration. These integration settings are described in a further deliverable.

6 STEP BY STEP INTEGRATION PROCEDURE

This chapter gives a schedule for the step by step integration procedure. With this timetable a good integration is ensured at the end of the project.

WP/Task	Planned deliverable time	Action item until deliverable time	Responsibility
WP4/Task 2/ ADC	February 2012	Design of the test card and evaluation of the stand-alone ADC	Hussein Fahkoury (IT)
WP4/Task 2/tBPF	February 2012	1st prototype of the tBPF-600	Alexander Jaschke (IIS)
WP4/Task 1/Antenna	February 2012	Antenna Design for diversity including UHF TVWS lower freq.band	Alexander Popugaev (IIS)
WP4/Task 1/Antenna	February 2012	Manufacturing and measurement of several prototypes of antennas	Anne Claire Lepage (IT)
WP4/Task 2/AFE Extension	February 2012	AFE extension PCB for versatile MIMO investigations	Andreas Mayer (DMCE)
WP6/Task 3	September 2012	Eurecom platform available for integration	Dominique (Eurecom)
WP6/Task 3	September 2012	Dual TX demonstration setup	Andreas Mayer (DMCE)
WP6/Task 2	September 2012	WP2 algorithms ready to use in the SACRA platform in real-time	IT
WP6/Task 4	October 2012	Integration of the SACRA modem Control	Dominique (Eurecom)
WP6/Task 4	November 2012	Trials in real time with the overall SACRA platform	Dominique (Eurecom)

7 CONCLUSION

In this document, we have refined the specifications of the building block that will be conducted to the WP6. An equipment specification shows the components used for the selected scenarios described in D6.1 and D1.1. The system overview and general specifications describes the specification needed for the selected scenario which is chosen. Closely linked to WP5 the chapter 4 (Integration of HW parts) and chapter 5 (Integration of SW parts) consists of integration specifications to combine all parts developed in WPs 2, 3, and 4.

Furthermore, the present document can be seen as a schedule for the activities in WP6, especially illustrated in chapter 6 (Step by step integration).

Summarized this document consists of:

- Refine the specifications of the building blocks
- Ensure good integration at the end of the project

The next steps will be:

- To integrate HW components to experimental sites
- To integrate SW components to experimental sites

8 REFERENCES

[1] http://www.openairinterface.org/components/page1016/page1041.en.htm

[2] http://www.openairinterface.org/components/page1016/page1040.en.htm

[3] LMS6002D specification, v1.1.0, 23/10/2010, LIME Microsystems

[4] LMS6002D evaluation board documentation, LIME Microsystems

[5] http://www.limemicro.com/products.php

9 ACRONYMS

ADC	Analog Digital Converter
BB	Baseband
CAF	Cyclic Autocorrelation Function
ChX	Channel X
DAC	Digital Analog Converter
DL	Downlink
DVB-T	Digital Video Broadband Television
eNodeB /eNB	Enhanced Node B
FCC	Federal Communications Commission
FDD	Frequency Division Duplex
FFT	Fast Fourier Transformation
FPGA	Field Programmable Gate Array
HW	Hardware
JRRM	Joint Radio Resource Management
LNA	Low Noise Amplifier
LTE	Long Term Evolution
MIMO	Multiple Input Multiple Output
PA	Power Amplifier
PMSE	Programme Making and Special Events
PU	Primary User
QoS	Quality of Service
QP	Quiet Period
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RRM	Radio Resource Management
Rx	Reception
SA	Spectrum Aggregation
SNR	Signal to Noise Ratio
SU	Second User
SW	Software
tBPF	tunable Band Pass Filter
TVWS	TV White Spaces
Tx	Transmission
UE	User Equipment
UHF	Ultra High Frequency