

## COGEU

### FP7 ICT-2009.1.1

#### COgnitive radio systems for efficient sharing of TV white spaces in EUropean context

### D8.1

## Dissemination and use plan report

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**Abstract:**

This deliverable summarizes the first year of COGEU dissemination activities and provides a description of dissemination and exploitation plan for the near future.

**Keyword list:** Dissemination, Exploitation, Project impact, Use plan

## Executive Summary

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This deliverable reports on the dissemination activities in the first year of COGEU project (January 2010-December 2010) and provides plans for the exploitation of the project's results.

In the first year project, COGEU was presented in 38 events: 5 CEPT SE43 meetings, 2 ECO SEAMCAT meetings, 4 IEEE P1900.6 standardization meetings, 1 ETSI meeting, 7 meetings with other international research activities, 6 international conferences, 9 invited presentations and 4 tutorials.

### Main achievements and plans:

#### On regulatory level

- On an European level, CEPT (European Conference of Postal and Telecommunications Administrations) is the relevant organization for regulatory issues on spectrum coordination. In 2009 CEPT WG SE (Spectrum Engineering) established project team SE43 dealing with "*Technical and operational requirements for the possible operation of cognitive radio systems in the "White Space" of the frequency band 470-790 MHz*". COGEU is represented in SE 43 by IRT. COGEU contributed to SE 43 by inputting a document on Protection Ratio measurements for DVB-T interfered with by LTE. A report on the results was generated and forwarded to SE43 as an input document (SE43(10)32) [1] to serve as a technical basis for their subsequent decisions. The IRT part of the work leading to these results was supported by COGEU project.
- For interference simulation a software tool –SEAMCAT- was developed by ECO under the supervision of WG SE STG (SEAMCAT Technical Group). The software is continuously improved and extended. IT represents COGEU in STG and contributed to the work by presentations and applying SEAMCAT software.
- COGEU aspires to a more liberal and efficient spectrum management and therefore supports contacts to national regulators to inform on COGEU aims and results. In the reporting period especially PUT was in close contact with the Polish regulator UKE; but also CTVR, Trinity College was in contact with the Irish regulator ComReg and the UK regulator OFCOM; IT presented COGEU at ANACOM, Portugal and, in Germany, IRT fostered its informal contacts to German BNetzA.

#### On standardization level

- The IEEE 1900.6 working group was launched in 2008 to address the development of spectrum sensing interfaces and data structures for the exchange of sensing related information to increase interoperability between sensors and their clients provided by different manufacturers. Paulo Marques from IT is a member with voting rights in IEEE P1900.6 Working Group. In the reporting period, Paulo Marques participated in four IEEE P1900.6 meetings contributing to the standard development and presenting COGEU model.
- Contact was established to ETSI (European Telecommunication Standardization Institute) group RRS (Reconfigurable Radio Systems). At the 12th meeting of ETSI RRS, IRT could present COGEU and it was agreed that a close cooperation could be beneficial for both and should be intensified. COGEU, will contribute to ETSI RRS work during the second year of the project through PTIN (ETSI member) and IT (invited member). The main target identified is WG1: System aspects.

#### On cooperation with other international research projects

- The COST ICT Action IC0902 proposes coordinated research in the field of cognitive radio and networks. The cognitive concept applies to coexistence between heterogeneous wireless networks that share the electromagnetic spectrum for maximum efficiency in resource management. CTVR, Trinity College acts as liaison officer between COST IC0902 and Wireless Innovation Forum. Luiz DaSilva (member of COGEU project) is on the management committee for the COST Action IC0902 and the interface with COGEU.

- COST-TERRA is a COST action to bring together technical and economic experts for spearheading a regulatory break-through for European development of Cognitive Radio and Software Defined Radio (CR/SDR) technologies. COGEU use this action through CTVR, Trinity College to disseminate achievements on the economic models for secondary spectrum market of TVWS.
- The EC FP7 concertation cluster "Radio Access & Spectrum" (RAS) aims to provide a platform for exchanges and concertation between FP7 projects. COGEU was represented at two meetings in January and October by Paulo Marques. An exchange of ideas with FP7 project SACRA (Spectrum and energy efficiency through multi-band cognitive radio) was initiated and common research topics identified.
- NEWCOM++ (Network of Excellence in Wireless COMMunications) promotes solutions to problems and challenges of future wireless networks by creating a trans-European virtual research center. NEWCOM++ and COGEU belong to the "Radio Access & Spectrum" EC concertation cluster, where the coordinators and delegated responsible from these projects have the opportunity to interact and exchange ideas in the area of future wireless networks, which are of common interest. Hanna Bogucka from PUT, active in COGEU and a member of the COGEU Project Coordinating Committee (PCC) has become also member of the Executive Board of NEWCOM++.
- IT presented COGEU project in the Wireless Innovation Forum (WIF) conference and in the CR WG – Radio Environment Map Project. CTVR, Trinity College currently has a leadership position within WIF through representation on the board of directors. This position allows CTVR, Trinity College to influence key decisions taken within the Forum and to help set the Forum's agenda.
- COGEU project was presented by IT during the second session of WG8 of WWRF (World Wireless Research Forum). COGEU was invited to participate in the editing of the ongoing white paper "Spectrum Issues in the post WRC07 era" and also in a new white paper which is expected to include issues like secondary spectrum trading and the stability of spectrum holes.

#### **On other means to disseminate COGEU plans and results**

- In the reporting period, COGEU project has published 6 scientific papers and contributed with one book. Key conferences and target journals were identified for the near future.
- COGEU also aims to train researchers, engineers and students in topics dealt with in COGEU. In the reporting period, 4 tutorials were given.
- COGEU established an External Advisory Board (EAB) with two global industry advisors (RIM and Huawei) to help its dissemination towards wider audience. In the reporting period two face-to-face meetings with the EAB took place.
- COGEU website has attracted a significant audience from academia and industry with 1,671 visits from March to December 2010.
- At the end of 2011 a COGEU workshop is planned, at which time the European digital switchover will be completed and COGEU will have intermediated results to present.
- COGEU will submit an application for the Exhibition at the Future Network and Mobile Summit, 2011 to be held in Warsaw Poland. The Exhibition presents COGEU with an opportunity to showcase our cognitive radio-enabled TVWS transceiver prototypes.

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## List of Abbreviations

3GPP	3rd Generation Partnership Project
APWPT	Association of Professional Wireless Production Technologies e.V.
ARNS	Aeronautical RadioNavigation Service
BEM	Block Edge Mask
BS	Base Station
CEPT	Conference of European Postal & Telecommunications
COST	European Corporation is Science and Technology
COST-TERRA	COST Techno Economic Regulatory Framework for Radio Spectrum Access for Cognitive Radio/Software Defined Radio
CR	Cognitive Radio
CRD	Cognitive Radio Devices
DVB-H	Digital Video Broadcasting – Handheld
DVB-T	Digital Video Broadcasting - Terrestrial
EBU	European Broadcast Union
ECC	CEPT Electronic Communications Committee
ETSI	European Telecommunication Standards Institute
EU	European Union
FCC	Federal Communications Commission
FM	Frequency Modulation
ICT	Information and Communications Technologies
IEEE	The Institute of Electrical and Electronics Engineers
IPR	Intellectual Property Rights
ITU	International Telecommunication Union
LTE	Long Term Evolution
LOS	Line of Sight
OFCOM	Office of Communications
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
PMSE	Programme Making and Special Events
PWMS	Professional Wireless Microphone Systems
QoS	Quality of Service
RAS	Radio Astronomy Service
RSPG	Radio Spectrum Policy Group
SDR	Software Defined Radio
SEAMCAT	Spectrum Engineering Advanced Monte Carlo Analysis Tool
TVWS	TV White Spaces
US	Unites States of America
WGSE	CEPT Working Group Spectrum Engineering
WIF	Wireless Innovation Forum
WinCOMM	Wireless Innovation Forum Conference on Communications Technologies and Software Defined Radio
WWRF	World Wireless Research Forum

# 1 Introduction

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The main objective of the COGEU project is to design, implement and demonstrate enabling technologies to allow an efficient use of TV White Spaces (TVWS) for radio communications based on two spectrum sharing business models: spectrum commons and real-time secondary spectrum markets. COGEU will also define new methodologies for TVWS equipment certification while addressing coexistence with the DVB-T European standard. As a consequence the project should aid the European decision makers to move the TV spectrum management paradigm towards a more liberal and efficient method, by providing sufficient evidence on the technology and economic viability and its deployment.

The eventual move from the classical “command and control” to a more liberal approach of spectrum sharing (secondary spectrum trading) in the context of the digital switchover represents an immense paradigm shift. Hence the proof of evidence for the technological feasibility and socio-economic benefits are crucial to encourage decision makers to take such a step. COGEU has the potential to make a large impact in encouraging this decision to take place and showing the way not just in terms of implementation but also in terms of economic gains.

The main objective of WP8 is to promote the widespread utilisation and exploitation of the project results. To achieve the above impact the project will follow a dissemination plan subdivided into:

- Contributions to regulatory groups;
- Contributions to standardisation;
- Cooperation with international research projects;
- Other means to disseminate COGEU plans and results;

This deliverable reports the dissemination activities in the first year of COGEU project and plans for the exploitation of the results. The following chapters describe the means planned and used to disseminate and promote COGEU solutions like contributing to regulatory and standardisation groups, cooperating with other international research projects or presenting COGEU results at scientific events or at courses.

## 2 Regulatory Groups

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COGEU aims to inform EU policy in relation to the enabling of efficient spectrum sharing and usage over TVWS at European level. During the first year of the project COGEU consortium has disseminated preliminary results in national and European regulatory bodies:

### 2.1 CEPT SE43

At its 53<sup>rd</sup> meeting and following a request from the ECC, CEPT Working Group Spectrum Engineering (WGSE) decided to set up a new project team - SE43 - dealing with white spaces and cognitive radio systems. SE43 met for the first time in June 2009; the second meeting was in October 2009.

After the start of COGEU project 5 meetings were held:

January 2010	3 <sup>rd</sup> meeting at ANFR, Paris
March 2010	4 <sup>th</sup> meeting at ECC, Copenhagen
April 2010	5 <sup>th</sup> meeting at ECC, Copenhagen
June 2010	6 <sup>th</sup> meeting at BNetzA, Mainz
September 2010	7 <sup>th</sup> meeting at OFCOM CH, Biel

#### Terms of Reference

Under the direction of WG SE SE43 was mandated to:

- define technical and operational requirements for the operation of cognitive radio systems in the white spaces of the UHF broadcasting band (470-790 MHz) to ensure the protection of incumbent radio services/systems and investigate the consequential amount of spectrum potentially available as “white space”;
- provide, if required, technical assistance on further issues related to white spaces and cognitive radio systems that ECC may identify in the future;
- liaise directly with relevant groups within ECC and ETSI as necessary

Under this mandate SE43 treated different topics:

#### - **Sensing**

A drafting group was established which held some telephone conferences to speed up progress. It was found that due to the hidden node problem, which causes extremely low detection thresholds for the WSD, sensing only would not be feasible at least in the near future.

#### - **Geo-location**

Here also a drafting group was initiated. It was found that geo-location together with a database seems to be a possible way to enable white space use while appropriately protecting incumbent services. The national regulators favoured nationwide databases so a European database was not further considered. Only general specification for the database was given as SE43 believes that the detailed database specification is a matter of industrial standardization bodies.

#### - **Beacon**

The beacon concept where WSD were informed on a separate channel on free or occupied TV channels requires a database and a separate beacon transmitter network. As this is exhaustive and also requires a separate communication channel, only weak interest was shown for this cognitive concept.

#### - **Amount of White Space**

First investigations were made for three locations in France, for Piemonte area in Italy and in UK. The exact amount of available spectrum at any location depends upon national situation (DTT planning configuration, PMSE use, Radio Astronomy use...). SE43 draft recommendation provides methodology, general trends and example figures based on specific scenarios.

#### - **PMSE**

Guaranteeing protection of PMSE is a difficult task as these devices in some CEPT countries are so far not registered in a database. Spectrum sensing with a low sensing threshold is currently considered as a problematic approach for the protection of PMSE systems from WSD interference due to the wide range of potential application scenarios. Some proposals for alternative cognitive techniques were made. The Geo-location database appears to be the most satisfactory approach considered so far for the protection of PMSE. Although not considered in all details, the disable beacon concept, where the detection by the WSD of the beacon implies that the considered

channel is occupied therefore not available for WSD may be an approach. A save-harbour-concept for not registered PMSE equipment could be a reasonable way.

Further considerations are required for the protection of PMSE.

- **RAS**

The studies conducted for both the co-channel (WSD in channel 38) and adjacent channels (ch. 37 and 39) have revealed very large separation distances. Therefore, it is recommended that the TV channels 37 to 39 should be avoided for autonomous WSD based on sensing only mechanism. For WSD which have access to a geo-location database, exclusion zones around RAS sites should be defined in the database.

- **ARNS**

Preliminary considerations have been provided on the relevance of the sensing and geo-location techniques for the protection of ARNS (645-790 MHz). Further considerations are still required.

- **Protection of fixed/mobile services in bands adjacent to the band 470-790 MHz**

Initial studies in the band 790-862 MHz were performed showing that in order to maximize permitted in-block power for WSDs operating close to the band edge at 790 MHz, very high adjacent channel leakage ratios (ACLR) over frequencies in the band 790-862 MHz are required. So either the in block power in the upper channels has to be reduced or more stringent block edge masks (ACLR) are required. No study has been performed for the protection of mobile service below 470 MHz.

- **Power limits**

The acceptable transmit power depends, among other aspects like minimum distance to the nearest receiver or the available TV signal strength, mainly on the protection ratios (PR) for co channel and adjacent channel operation.

So far, no WSD are available on the market; in order to determine the PR some assumptions of the possible WSD technology had to be made. SE43 believes, as OFDM is the leading technology, LTE technology can be used as a proxy for a future WSD system. To determine PR the interference of LTE signals to DVB-T reception within the COGEU project was investigated.

Whereas in older TV receivers still can-tuners (built with discrete components) are used, an increasing number on receivers use silicon tuners.

Three silicon type devices and one can type device were investigated with one downlink signal and seven different uplink signals which followed principal properties of LTE uplink signals. Investigations were made in cooperation with Media Broadcast, a German network operator and with BNetzA, the German regulator. **A report on the results was generated and forwarded to SE43 as an input document (SE43(10)32) [1] to serve as a technical basis for their subsequent decisions. The IRT part of the work leading to these results was supported by COGEU project.**

In the September meeting SE43 finalized the draft report and forwarded it to WGSE. Under the title ECC draft report 159 [2] the document was submitted for public consultation. Consultation period ended on 30<sup>th</sup> November 2010.

There are however some relevant aspects that could not be treated due to missing material or due to a lack in time. Some of the open issues are:

- What are the benefits if geo-location is combined with sensing?
- Is sensing only possible ?
- Amount of white space
- PMSE protection issues

A further (8<sup>th</sup>) meeting was fixed for mid of December to consider the comments received on the report during the public consultation and to update the report accordingly. Also the open issues shall be treated in the next meetings.

Plan until the end of the project

If SE43 will continue its work, COGEU partner IRT will attend meetings both to get latest information from the cutting edge of regulation on European level as well as to bring COGEU results to the awareness of SE43.

## 2.2 ECO SEAMCAT group

SEAMCAT (Spectrum Engineering Advanced Monte Carlo Analysis Tool ) is a simulation tool that permits statistical modeling of different radio interference scenarios for performing sharing and compatibility studies between radio communications systems in the same or adjacent frequency bands.

STG is one of the WG SE - Working Groups Spectrum Engineering within the CEPT/ECC, as depicted in the structure diagram of Figure 1, responsible for the development and maintenance of SEAMCAT.

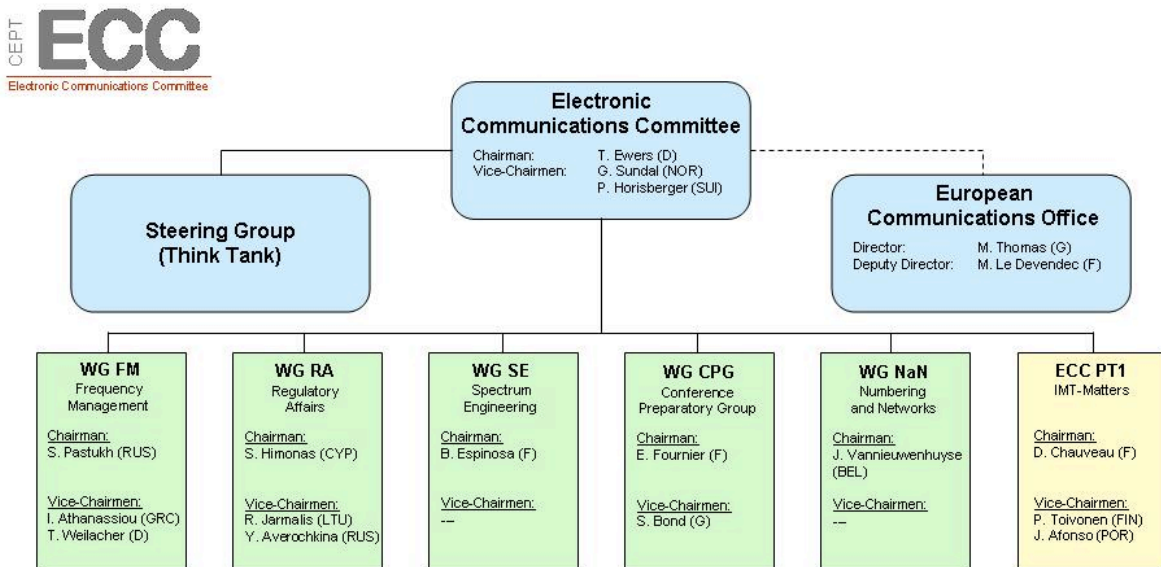


Figure 1 Structure of the CEPT/ECC.

### 2.2.1 STG, 23<sup>rd</sup> plenary meeting

COGEU was represented at the 23<sup>rd</sup> STG plenary meeting, on October 4<sup>th</sup>, 2010. The meeting was hosted by ECO - European Communications Office, Copenhagen, Denmark.

COGEU contributed with improvements and bug fixes for the next official release of SEAMCAT (version 3.2.2). Table 1 summarizes the inputs from COGEU submitted as Tickets, using a web-based bug-tracking tool [3].

Table 1 – Summary of COGEU contributions to SEAMCAT development.

Ticket	Title	Description	Feedback from STG
#458	Multiple interfering system generation	When the distance between the Victim Receiver and the Wanted Transmitter exceeds a certain value, and multiple interfering generation tool is opened, SEAMCAT stops responding.	Status changed from new to closed. Resolution set to Fixed Milestone changed from 3.2.0 to 3.2.2 - Beta 3
#475	Saving translation results as a text file	When right clicking and choose "Save as..." from the resulting probability function graphic in translation mode, an extra option could be added to save the results in text (ASCII or binary) format for further use and analysis.	Enhancement approved and available in the next official release (3.2.3 - Beta x- WiMAX).
#517	User-defined dRSS with CR features	When CR features are used, User-defined dRSS should be deactivated, in order to maintain coherence between dRSS and sRSS values. See Figure <b>Error! Reference source not found.</b> and associated text for a detailed description.	STG decided to keep flexibility in SEAMCAT simulations, to leave the "user-defined dRSS" as it is, when the CR is activated. The option "Use CR features will be moved" to the general dialog box.

Improvement from Ticket #475 will be implemented as a new "Save" button, as depicted in Figure 2, so that x and y are saved (Power in X and probability in Y).

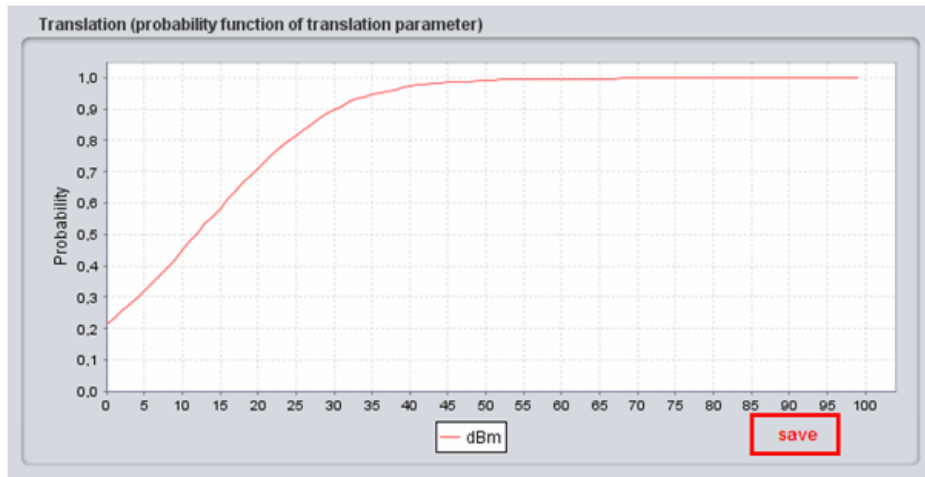


Figure 2 New "Save" button in the results window to save data as a text file.

Detailed description of Ticket #517: In Figure 3, sRSS (sensed signal) depends on the characteristics of the Wanted Transmitter, as for dRSS (primary signal). However, in the general definitions of the victim link, we can define a User-defined dRSS in dBm. With this feature active, the user could change the Wanted transmitter characteristics, such as power, emissions mask, antenna height or pattern, all of them affecting sRSS values, but no changes would occur in the dRSS vector. Moreover, the user may check "Use CR features" on the Wanted transmitter Emission characteristics, even if the power distribution is not relevant for the dRSS when "User-defined dRSS" is checked.

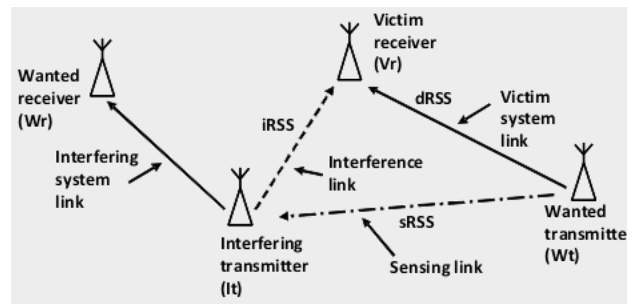


Figure 3 Scenario geometry and signals for autonomous sensing (from [4])

When CR features are used, “User-defined dRSS” option should be deactivated, in order to maintain coherence between dRSS and sRSS values.

## 2.2.2 SEAMCAT workshop

COGEU was also represented in SEAMCAT Workshop organized by STC in ECO premises, on October 5<sup>th</sup>, 2010. The program focused the following topics:

- General presentation of SEAMCAT
- Modeling of unwanted, blocking, overloading and interference
- Basic example of setting simulations
- OFDMA LTE tutorial
- Implementation of Cognitive Radio in SEAMCAT
- Exercise TETRA versus FM

As part of the Workshop program, Rogério Dionisio (COGEU Research Engineer) presented COGEU's results on “TVWS characterization using SEAMCAT”, before an audience with mobile network operators (Omnitele, TeliaSonera AB), research centers (JRC), spectrum regulators (ECO, BNetzA), academics (University of Kaiserslautern) and others (Bolt Consulting).

The summary of his presentation was:

- COGEU project overview
- Simulations
  - Case study 1: Interference from LTE BS / UE to DVB-T
  - Case study 2: Interference from Cognitive LTE BS / UE to DVB-T
  - Case study 3: Interference from LTE BS / UE to PMSE
- Conclusions
- Future work
  - Autonomous sensing for wireless microphones (using the Cognitive module in SEAMCAT)
    - Indoor, outdoor, with or without LOS
    - Block Edge Mask (BEM) approach
  - Post-processing plug-in to improve simulation times
    - Avoid batch processing
    - Propagation model plug-in for wireless microphones

COGEU presentation received a good feedback from the audience, including suggestions to improve the accuracy of the simulation results.

STG chairman was questioned about the possibility to include more than one victim link in the same simulation scenarios, as an improvement to create TVWS maps. This option will not be available in the forthcoming versions. However, SEAMCAT source code and build are available on request. Documentation explaining how to do it will also be made available by STG.

COGEU plans to contribute actively to the development of new cognitive features of SEAMCAT, participating in the SEAMCAT expert meetings with proposals and bugs reporting until the end of the project.

## 2.3 Contacts with national regulatory bodies

### **ComReg, Ireland**

CTVR, Trinity College engages in an ongoing basis with the ComReg in an informal capacity, meeting with personnel from time to time to share ideas and to solicit the informal advice and experience of the regulator's staff.

In July, 2010 CTVR, Trinity College hosted a ComReg-organised workshop on cognitive radio which was attended by industry, academia and other regulators.

### **OfCOM, UK**

CTVR, Trinity College has a formal link with Ofcom, UK, through Linda Doyle's membership of Ofcom's Strategic Advisory Board (OSAB). OSAB provides independent advice to Ofcom on strategic spectrum management issues and meets on a quarterly basis.

### **BNetzA, Germany**

BNetzA and IRT are both represented at CEPT SE43. Due to the regular meetings, informal communication was established. BNetzA supplied IRT with information on German regulation and IRTs Frequency Planning Software FRANSY, used for TVWS estimation, accesses data provided by BNetzA.

### **UKE, Poland**

Contacts with Polish national regulatory body (*UKE – Urząd Komunikacji Elektronicznej* - the Office of Electronic Communications) in the context of COGEU project have been established by PUT at the beginning of 2010. People contacted in this matter by phone and e-mail were:

- President of UKE – Mrs. Anna Strezynska,
- Director of the Department of Frequency Resources Management – Mr. Wiktor Segal.

The contact person from PUT is Jerzy Kubasik.

In February 2010, during the phone call with Mr. Segal, a general description and work plan of COGEU project was presented. Jerzy Kubasik has received up-to-date information on the process of introduction of the digital television in Poland (delayed according to EU schedule) and on the actions of the Polish communications administration bodies (the minister competent for communications, currently the Minister of Infrastructure, and the President of UKE) in the field of cognitive TVWS. It has been noted that, so far, these bodies have not undertaken any initiatives concerning TVWS, in particular the use of cognitive radio technology. They avidly observe works, which analyze the possibilities of using UHF band also in other systems on the basis of interleaved spectrum or white spaces that are underway in Europe and the USA.

In April 2010 the COGEU Deliverable 2.1 has been sent to Mr. Segal asking him for feedback (not received yet, but still expected). He was also informed, later, on further deliverables accessible at the COGEU web page ([www.ict-coge.eu](http://www.ict-coge.eu)).

A face-to-face meeting with Mr. Segal (and possibly Mrs. Strezynska) in Warsaw is planned for December 2010 (exact date to be determined shortly) to present project's achievements so far and receiving opinions from regulatory point of views.

### **ANACOM Portugal**

IT's team was invited to present COGEU's vision and initial results in a face to face meeting with the Spectrum Management Group of the Portuguese regulator (ANACOM). The meeting took place on November 8 in ANACOM head quarter in Lisbon. The main objective was to provide guidance for the preparation of the Portuguese position in the WRC12 conference regarding the agenda item 1.19 on the introduction of cognitive radio systems.

## 2.4 Plan for contribution to RSPG

The Radio Spectrum Policy Group (RSPG) is a high-level advisory group that assists the European Commission in the development of radio spectrum policy. The RSPG currently holds a consultation on a draft opinion on cognitive radio. The consultation ends on 15 January 2011. [[http://rspg.groups.eu.int/consultations/index\\_en.htm](http://rspg.groups.eu.int/consultations/index_en.htm)]

This consultation is strongly related to COGEU T2.2 "*Policies to enable efficient spectrum sharing over TVWS at European level*". Based on COGEU results, the consortium will submit a response to RSPG supporting the key regulatory requirements of COGEU model, highlighting the following aspects:

- 1-The importance of TVWS trading model and fast reassignment of spectrum rights, temporally exclusive rights of TVWS (not just unlicensed use of TVWS in Europe);
- 2-The combination of Secondary trading with Commons model to potentiate an efficient use of TVWS in Europe;
- 3-The need of databases for PMSE (wireless microphones) registration and "Safe harbors" channels in EU countries to protect PMSE devices enabling a secondary spectrum market of stable and valuable TVWS;
- 4-The need of European concertation and common approach to protect incumbent systems in cross border areas;
- 5- The need of suitable policies to improve interference rejection of incumbent receivers (DVB-T);
- 6- The need of more EU research and real testing on secondary spectrum trading.

### 3 Standardization

One of the major objectives of COGEU project is to providing standardization contributions. In first approach the following target standards bodies were addressed: ETSI RRS, ETSI STF386, IEEE P1900 (SCC41) and all standardization efforts targeting DVB project

#### 3.1 ETSI RRS

Mid of the year a contact between COGEU and ETSI RRS (Reconfigurable Radio Systems) was established. Following an invitation from ETSI RRS for the 12<sup>th</sup> meeting at Infineon in Munich, IRT (Georg Schuberth) presented COGEU project to the attendees. In a bilateral discussion, Markus Mueck, head of ETSI RRS, expressed his interest to install a permanent cooperation. It was decided that a COGEU partner will be nominated for participation at ETSI RRS.

The work of ETSI RRS TC is organized within four working groups:

- WG1: System aspects
- WG2: Radio equipment architecture
- WG3: Functional architecture and cognitive pilot channel
- WG4: Public Safety

WG1 is actually working on draft ETSI TR 102 907 which describes use cases for the operation of Reconfigurable Radio Systems within White Spaces in the UHF 470-790 MHz frequency band and gives an overview on methods for protecting the incumbent users like TV broadcast and wireless microphones. ETSI RRS WG1 (COGEU target) is in the feasibility study process as shown in Figure 4.

Similar topics are treated in COGEU, see e.g. discussion of COGEU use cases in deliverables D2.1 and D3.1, so cooperation between COGEU and ETSI RRS (WG1) can be expected to be fruitful for both sides. Therefore, COGEU, will contribute to ETSI RRS work during the second year of the project trough PTIN (ETSI member) and IT (with invited member status).

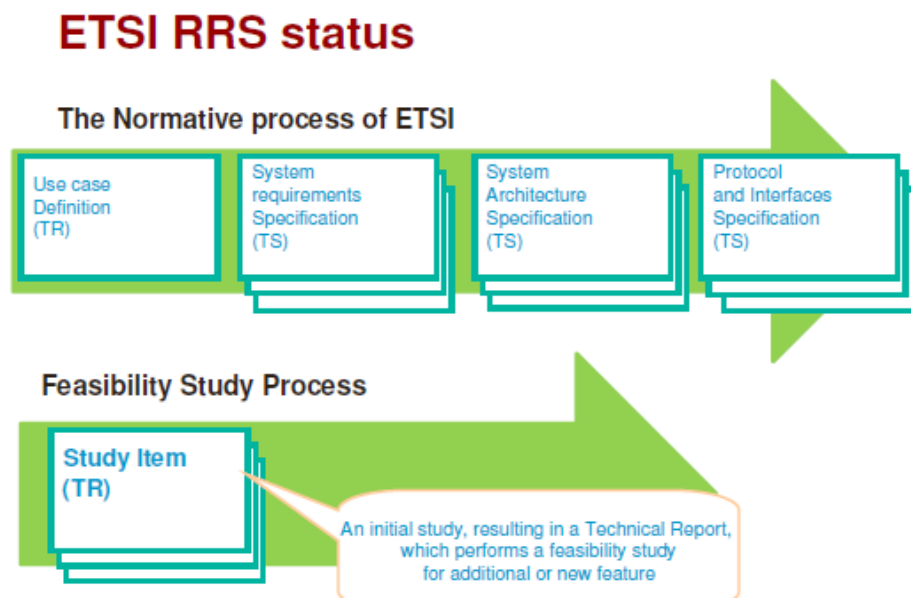


Figure 4 The normative process of ETSI. The ETSI RRS WG1 (COGEU target) is in the feasibility study process.

#### 3.2 ETSI STF386

In many European countries, after digitization of broadcast transmission, parts of the spectrum, so far exclusively used by TV broadcast and PMSE application, were released for auction to mobile communication use in the future (the Digital Dividend). Although the transition is not completed yet,

there are voices coming up demanding a second reduction of broadcast bands. The PMSE community has objection towards this:

- Production companies fear that there is not enough spectrum to support a full featured production
- A constant growth in spectrum need for production is seen
- Production companies and equipment manufacturers (e.g. AKG, Audio-Technica, Beyer dynamic, Bosch, Sennheiser, Shure) cannot agree that their spectrum grant is reduced

Utilization of locally unused spectrum (TVWS) by cognitive applications offers an alternative way to increase spectrum efficiency without reducing the spectrum for TV broadcast and PMSE. In 2009 APWPT (Association of Professional Wireless Production Technology) initiated within ETSI a Specialist Task Force (STF 386) working for a limited period of time on “Methods, parameters and test procedures for cognitive interference mitigation techniques for use by PMSE devices (Program Making and Special Events)”. The purpose of the work is to “achieve co-existence of high audio quality PMSE devices using often a 100% transmitter duty cycle emission profile with victim radio services such as Services in L-Band or Broadcast Services and future Land Mobile Services and applications in the UHF frequency range that is currently under investigation under the “Digital Dividend” discussions in EC, ECC and ETSI fora”.

Institutions contributing to STF386 are: APWPT, Bosch conference systems, Sennheiser, Shure, University Erlangen, University Hannover and IRT (COGEU partner).

Among others, one of the scientific questions of STF386 is on technical methods to be implemented to boost PMSE spectral efficiency to ensure PMSE QoS. The project is subdivided into three phases:

- Phase 1: ETSI Technical Report on “Operation methods and principles for spectrum access systems and quality control of used spectrum for PMSE technologies utilizing cognitive interference mitigation techniques”: This phase ended with Technical Report 102 799, accepted in June 2010.
- Phase 2: ETSI Technical Specification on the recommended spectrum access technique. The issued technical specification TS 102 800 describes the protocols of the control systems.
- Phase 3: ETSI Technical Report on the different RF compliance tests for the selected spectrum access mechanism. At the end of this phase the developed concepts shall be compared to practical experience. The planned duration of STF386 is until mid of 2011, but an extension of one year is likely.

To gain the practical experience, STF applied for a German national research project “C-PMSE” which is actually under negotiation.

### **Relation to COGEU project**

STF386 also uses the notation C-PMSE, but, compared to COGEU's C-PMSE, the target is different, as for PMSE the 100% QoS is the predominant aim. E.g. cooperative spectrum sensing is considered, however not to find TVWS but instead to identify possible interferer that might lower QoS and to proactively change to free, non-interfered channels. Also improved spectrum management is a target, dealing with the problem of blocking free channels due to intermodulation. Finally the results shall be disseminated in national and international regulation and standardization bodies. The work of STF386 and its project “C-PMSE” comprises interesting aspects and shall be looked at by COGEU. IRT as a COGEU's partner contributes and follows this standardization activity.

### **3.3 IEEE P1900.6**

The IEEE 1900 Standards Committee was established in the first quarter 2005 jointly by the IEEE Communications Society and the IEEE Electromagnetic Compatibility Society. The objective of this effort is to develop supporting standards dealing with new technologies and techniques being developed for next generation radio and advanced spectrum management. On March 22, 2007, the IEEE Standards Board approved the reorganization of the IEEE 1900 effort as Standards Coordinating Committee 41 (SCC41) on Dynamic Spectrum Access Networks (DySPAN). The IEEE Communications Society and Electromagnetic Compatibility Society are sponsoring societies for this effort, as they were for the IEEE 1900 effort.

In particular, the 1900.6 working group was launched in September 26, 2008 to address the development of spectrum sensing interfaces and data structures for the exchange of sensing related information to increase interoperability between sensors and their clients provided by different manufacturers. Such capabilities will assist devices and associated radio equipment in identifying locally/temporally available spectrum that can be accessed without affecting the incumbent users of that spectrum.

The standard under development provides a formal definition of data structures and interfaces for exchange of spectrum sensing related information, IEEE P1900.6 scope is illustrated in Figure 5. Paulo Marques from IT is a member with voting rights in IEEE P1900.6 Working Group (WG) and IEEE SCC41 and contributes to IEEE P1900.6 development with COGEU results.

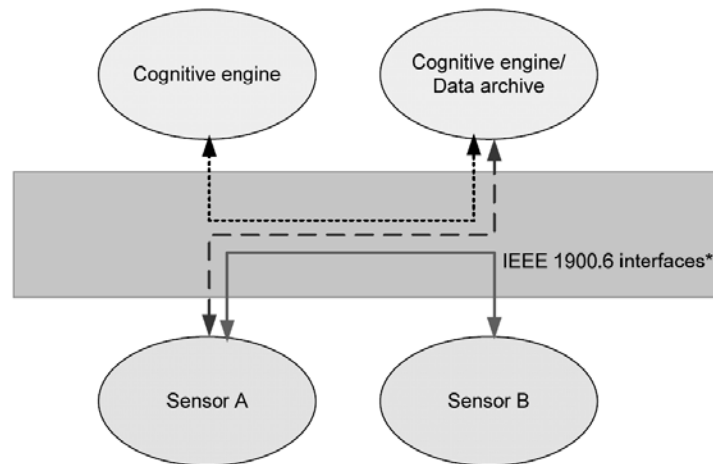


Figure 5 Scope of IEEE P1900.6 standard.

#### **Meeting IEEE P1900.6 WG, San Diego, U.S. March 08th — 11th, 2010**

During the review phase of IEEE P1900.6 first draft, the WG received 131 comments from the IEEE Standards Coordinating Committee 41 (SCC41). The main objective of this meeting was the resolution of technical, general and some selected editorial comments. Paulo Marques contributed to the resolution of comments related with the description of sensing parameters and metrics for the quality of detection included in the standard draft. Paulo Marques gave a COGEU's project presentation and pointed out potential links between IEEE P1900.6 and the COGEU framework and interfaces; and presented the document DCN 6-10-0009-00-0000: Cognitive radio systems for efficient sharing of TV white spaces in European context.

#### **Meeting IEEE P1900.6 WG Delft, NL, July 6th — 9th, 2010**

The main objective of this meeting was to discuss the comments resolution of IEEE P1900.6 draft and prepare the necessary documents for the recirculation of IEEE P1900.6 standard. The discussion results of comments have been included in document DCN 10-0019-04-0000. Paulo Marques contributed to the resolution of some technical comments considering the COGEU vision on the combination of sensing with geo-location database access.

#### **Meeting IEEE SCC41 ad hoc group on White Space Radio, Delft, NL, July 8th, 2010**

In this meeting, Paulo Marques, on behalf of COGEU project, contributed to the discussion on the usage models for white spaces with the document scc41-ws-radio-10-0023-01. In this document COGEU proposes the inclusion of a new use case scenario "Cellular extension over TV white spaces" in the Project Authorization Request (PAR) prepared by the White Space ad hoc group. A detailed list of system requirements for this scenario was also presented. The contribution was welcome and the proposed scenario was partially included as a usage model in the new PAR (IEEE P1900.7).

**Meeting IEEE P1900.6 WG Cagliari, IT, September 20th — 21st, 2010**

This meeting completed the comments resolution and it was decided to initiate the recirculation for IEEE-SA sponsor ballot with the new draft. It was discussed the future directions of the IEEE P1900.6 WG. Currently the formulation of two new PARs (amendments of IEEE P1900.6) has been considered:

- Development of protocols for interfaces defined in IEEE P1900.6;
- Based on P1900.6 define the interfaces and potentially the means to populate and exploit the data set in the data archive;

Based on COGEU T4.2 outputs on the anti-interference spectrum database specification, Paulo Marques contributed to the discussion with the document DCN 6-10-0033-01-0000.

COGEU intends to follow and contribute to the amendment of IEEE P1900.6, in particular concerning the interfaces with the spectrum database (data archive in IEEE P1900.6 terminology).

**3.4 DVB standardization project**

Partner R&S follows the work in the DVB Project closely and attended the meetings of the DVB Technical Module during the 2nd half of 2010. Depending on the priority that the topic 'TVWS' is given in DVB, R&S is prepared to offer an overview presentation on the COGEU approach and its intermediate results during 2011. In 2012, the up-date of the DVB Measurement Guidelines document is planned to be completed for the DVB Baseline Systems of the second generation. If sufficient interest inside DVB can be generated, the addressing of measurement recommendations for TVWS is a potential new work item for the Measurement Group.

## 4 Cooperation with other international research activities

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The COGEU consortium interacts with international research projects and activities in the specific area to closely follow the coming evolutions and technological achievements as well as to communicate COGEU ideas and results to a broad audience of experts.

### 4.1 COST ICT Action IC0902

This Action proposes coordinated research in the field of cognitive radio and networks. The cognitive concept applies to coexistence between heterogeneous wireless networks, that share the electromagnetic spectrum for maximum efficiency in resource management. Several efforts are currently in place in European research centers and consortia to introduce cognitive mechanisms at different layers of the communications protocol stack. This Action goes beyond the above trend by integrating the cognitive concept across all layers of system architecture, in view of joint optimization of link adaptation based on spectrum sensing, resource allocation, and selection between multiple networks, including underlay technologies. The cross-layer approach will provide a new perspective in the design of cognitive systems, based on a global optimization process that integrates existing cognitive radio projects, thanks to the merge of a wide-range of expertise, from hardware to applications, provided by over 30 academic and industrial partners. The final result will be the definition of a European platform for cognitive radio and networks. To reach this goal, algorithms and protocols for all layers of the communications stack will be designed, and a set of standard interfaces as well as a common reference language for interaction between cognitive network nodes will be defined.

CTVR, Trinity College act as liaison officer between COST IC0902 and Wireless Innovation Forum. Luiz DaSilva is on the management committee for the COST Action IC0902. He participated in their meeting in Bologna in June, 2010 and presented some research conducted at CTVR, Trinity College under COGEU framework.

CTVR, Trinity College have just submitted a proposal for a short term scientific mission (STSM) to COST IC0902. If funded, this will allow a student from Hanover to visit CTVR, Trinity College and continue his research on single and multi-stage sensing and collaborative sensing, contributing to COGEU developments.

### 4.2 COST TERRA-ICT Action IC0905

COST-TERRA is a forum to bring together technical and economic experts for spearheading a regulatory break-through for European development of Cognitive Radio and Software Defined Radio (CR/SDR) technologies. The project was launched in May 2010 and will run until May 2014, with the main focus on the coordination of technical and economic studies towards the development of a harmonised European regulatory framework for CR and SDR. It is hoped that this framework will propel forward the realisation and deployment of CR and SDR systems, while maximising their potential in Europe and elsewhere.

CTVR, TRINITY COLLEGE (COGEU partner) attended IC0905 meeting in June 2010 in Cannes, France which was the kick-off meeting for Harmonising Regulatory Environment for CR/SDR Working group. A second meeting held on September was attended.

At the August 2010 meeting of COST-TERRA MC WG3 "Economic aspects of CR/SDR regulation" has been activated, chaired by CTVR, TRINITY COLLEGE. The first meeting is scheduled along with the COST-TERRA block of meetings on 19-21 January 2011.

COGEU was invited by the COST-TERRA chair, Arturas Medeisis, to participate in the January 2011 meeting with two opportunities to showcase the COGEU project:

- during the regular technical session;
- during the round-table on lessons from ongoing attempts at regulating TV white-spaces (FCC in US and Ofcom in UK).

COGEU presentation will be split in two parts:

1. COGEU objectives and main technical challenges & COGEU business model and regulatory requirements & COGEU reference architecture – to be presented as technical contribution within WG1;
2. Measurements of TV white spaces & COGEU's specific views on FCC/Ofcom rule-making - to be presented during the round-table dedicated to TV white spaces regulation.

### 4.3 NewCOM ++

NEWCOM++ is the acronym of the Network of Excellence in Wireless COMMunications, funded by the 7<sup>th</sup> Framework Program under the Objective ICT-2007.1.1: "The Network of the Future", mainly in its target direction "Ubiquitous network infrastructure and architectures". NEWCOM++ promotes solutions to problems and challenges of future wireless networks by creating a trans-European virtual research centre linking a proper number of leading European research groups in a highly integrated, carefully harmonized, cooperative fashion.

The overall NEWCOM++ organization comprises 11 core research work packages spanning physical layer communications (PHY), networking (NET) and cross-layer interactions (X-LAYER). From a purely academic perspective this number and types of work packages will lead to cross-fertilization and exchange of ideas, mathematical tools and design methodologies stemming from the different scientific communities comprising the consortium.

Hanna Bogucka from PUT, active in COGEU and the member of the COGEU Project Coordinating Committee (PCC) has become also the member of the Executive Board of NEWCOM++, providing a link between these two EU FP7 projects. Moreover, both NEWCOM++ and COGEU belong to the "Radio Access & Spectrum" EC concentration cluster, where the coordinators and delegated responsible persons from these projects have the opportunity to interact and exchange ideas in the area of future wireless networks, which are in common interest.

### 4.4 FP7 Radio Access and Spectrum - RAS Cluster

The EC concertation cluster "Radio Access & Spectrum" (RAS) aims to provide a platform for exchanges and concertation between FP7 projects. The main objectives are:

- To create a technical platform where all projects can harmoniously exchange/disseminate information;
- To identify synergies and future technical challenges/requirements in the field of radio networks;
- To Assist European Commission (EC) on future research directions;
- To develop a recommendation to standardization and regulation bodies.

The RAS cluster allow the consortium to share the results of the project with the European Community. IT, as COGEU project coordinator, participated in the RAS cluster meeting on 26 January 2010 in Brussels, where Paulo Marques introduced the COGEU project and contributed with suggestions to extend current cluster issues, including TV white spaces as new potential frequency bands.

At a second meeting held on 20<sup>th</sup> October 2010 in Brussels, Paulo Marques presented initial COGEU project results and joined the Technical Program Committee of the Future Networks and Mobile Summit 2011. Initial contacts with FP7 SACRA (Spectrum and Energy Efficiency through multi band cognitive radio) project were established and the following common research issues were identified:

- 1- Common scenario: LTE over fragmented spectrum (such as TVWS)
- 2- Spectrum aggregation techniques (spectrum shaping algorithms)
- 3- Sensing of incumbent systems

In order to exchange ideas and technical approaches in these common issues, COGEU will invite SACRA project to present results in COGEU workshop and vice-versa.

Moreover, the consortium conducted a survey of ongoing EU funded research projects with common areas of interest with COGEU (see table below). IT as a project coordinator is the contact point between COGEU and these EU projects.

Table 2 – Ongoing EU research projects related with COGEU.

Project	Title	
<b>SACRA</b>	Spectrum and energy efficiency through multi-band cognitive radio	STREP
<b>QoS MOS</b>	Quality of service and Mobility driven cognitive radio systems	IP
<b>QUASAR</b>	Quantitative Assessment of Secondary Spectrum Access	STREP
<b>SAMURAI</b>	Spectrum Aggregation and Multi-User MIMO: Real-World Impact	STREP
<b>oneFIT</b>	Opportunistic networks and Cognitive Management Systems for Efficient Application Provision in the Future Internet	STREP
<b>FARAMIR</b>	Enabling Spectrum-Aware Radio Access for Cognitive Radios	STREP
<b>CREW</b>	Cognitive Radio Experimentation World	IP
<b>CROWN</b>	Cognitive Radio Oriented Wireless Networks	FET
<b>SAPHYRE</b>	Sharing Physical Resources - Mechanisms and Implementations for Wireless Networks	STREP
<b>ACROPOLIS</b>	Advanced coexistence technologies for radio optimisation in licensed and unlicensed spectrum	NoE
<b>COST IC0902</b>	Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks	COST ACTION
<b>COST IC0905</b>	TERRA-Techno economic regulatory framework for radio spectrum access for CR/SDR	COST ACTION

COGEU will participate in the forthcoming EC concertation meeting which is to be held in Brussels, from 9 Feb-11 Feb 2011.

#### 4.5 Wireless Innovation Forum

At a Wireless Innovation Forum meeting held in San Diego, U.S in March 2010, Paulo Marques presented the COGEU reference model to the Cognitive Radio Work Group - Radio Environment Map Project (Geo-Location Database).

CTVR, Trinity College currently has a leadership position within WIF through representation on the board of directors. This position allows CTVR, Trinity College to influence key decisions taken within the Forum and to help set the Forum's agenda. CTVR, Trinity College members also regularly both plan and attend conferences and workshops organised by the Forum, presenting research papers and demonstration systems. Regular teleconference meetings of the board, conference planning committees and working groups are also attended by CTVR, Trinity College members.

COGEU plans are to continue the current interaction through conferences, workshops and teleconferences, e.g., Linda Doyle (COGEU PCC member) will give a keynote speech at the Wireless Innovation Forum European Conference on Communications Technologies and Software Defined Radio to be held in Brussels in June, 2011.

COGEU was invited and will be presented in the "programs track" of the Wireless Innovation Forum Conference on Communications Technologies and Software Defined Radio (SDR'11 – WInnCOMM – Europe) held in Brussels from 22nd to 24th of June, 2011. The "programs track" goal is to present and discuss national and European projects related to Software Defined Radio, Cognitive Radio and Dynamic Spectrum Access technologies.

#### 4.6 World Wireless Research Forum (WWRF)

COGEU project was presented during the second session of WG8 of WWRF in April 13<sup>th</sup>, 2010 Penang, Malaysia. WG8 is responsible for Spectrum issues within WWRF. The COGEU project was well received during the presentation. After the presentation, there was a discussion about WG8 progress. Based on the good quality expected from COGEU, the project was invited to participate in the editing of the white paper "Spectrum Issues in the post WRC07 era".

In addition, the WG8 chair suggested starting a new white paper for the new challenges in the spectrum allocation and utilization. The white paper is expected to include issues like secondary spectrum trading and the stability of spectrum holes. COGEU was invited to participate in this new white paper.

## 5 Scientific Papers

### 5.1 Conference papers

In the following table all contributions published by COGEU partners in the first year of COGEU are listed:

Date	Title	Event	Lead Partner
March 10	The COGEU FP7 project: Cognitive Radio Systems for Efficient Sharing of TV White Spaces in European Context	Future Network & Mobile Summit 2010, 16 - 18 June 2010, Florence, Italy	IT
Apr. 10	Contribution to the WWRF white paper: "Spectrum Issues in the post WRC07 era" edited by Christos Politis	WWRF, 24th meeting (special session of WG8) in Penang, Malaysia	IT
Jun 10	QoS Support in Radio Resource Sharing with Cournot Competition	The 2nd International Workshop on Cognitive Information Processing (CIP-2010), 14-15-16 June, 2010 Elba Island (Tuscany) Italy	PUT
Jul. 10	Efficient sharing of TV White Spaces utilizing mobile TV networks with a cognitive radio approach	Temu 2010, International conference on telecommunications and Multimedia, 14-16 July 2010, Chania, Crete, Greece	AEGEAN
Aug. 10	Distributed Spectrum Allocation with the Cournot Competition	2010 European Signal Processing Conference (EUSIPCO-2010), August 23-27 2010, Aalborg, Denmark	PUT
Oct. 10	Cognitive Mobility Management in Heterogeneous Networks	8th ACM International Symposium on Mobility Management and Wireless Access, October 17-18, Bodrum, Turkey, 2010	IT

### 5.2 Journal papers

In 2010 no Journal papers were submitted by COGEU partners.

### 5.3 Book Chapters

In 2010, IT contributed with a chapter on Elements of Efficient TVWS allocation to a book:

Joseph W. Mwangoka, Paulo Marques and Jonathan Rodriguez, "*Elements of Efficient TV White Space Allocation*", part of the book "*TV White Space for Wireless Broadband: Concepts, Techniques and Applications*" to be published by CRC in 2011.

## 5.4 Plans for publications

Apart from the already accepted papers, the following conferences and journals will be targeted by the project partners for the near future,

Table 3 – COGEU target conferences and journals for the near future.

<b>Conferences</b>	
Dynamic Spectrum Access Network (DySPAN'11)	3-6 May 2011 Aachen, Germany
6th International ICST Conference on Cognitive Radio Oriented Wireless Networks (CrownCom 2011)	31 May - 3 June 2011 Yokohama, Japan Submission Deadline: January 15, 2011
1st International Workshop on QoS & Mobility in Cognitive Communications (QMCC'11)	31st May 2011, Yokohama, Japan, in conjunction with CrownCom 2011, Submission Deadline: Feb. 28, 2011
Future Network & Mobile Summit 2011 (FuNEMS'11)	15-17 June 2011 Warsaw, Poland
IEEE 74th Vehicular Technology Conference (VTC 2011 Fall)	5-8 September 2011 - San Francisco, United States Submission Deadline: June 13, 2011
IEEE Personal, Indoor and Mobile Personal Communications (PIMRC 2011)	11-14 September 2011 - Toronto, Canada Submission Deadline: March 04, 2011
<b>Journals</b>	
Special issue on Game Theory in Wireless Communications in IEEE Journal on Selected Areas in Communications	Submission deadline: 1 <sup>st</sup> of January 2011;
Journal call for papers: EURASIP Journal on Wireless Communications and Networking - Special issue "Ten Years of Cognitive Radio: State of the Art and Perspectives"	Submission deadline: 1 <sup>st</sup> of May 2011

## 6 Invited presentations

Besides the scientific papers there were further COGEU dissemination activities listed in the subsequent table.

Date	Event	Audience	Partners involved	Nature
Jan. 10	FP7 Concertation Plenary Meeting	EC officers and project managers of ICT call 4 projects	IT	Presentation
Jan. 10	" <i>Dois dedos de ciência</i> " at the Municipal Theatre in Guarda (Portugal). Paulo Marques was invited to give a talk on the present and future of mobile communications and Cognitive Radio, January 29.	Broad audience including students from secondary schools	IT	Invited talk
Jan. 10	Face-to-face meeting	Xilinx team	CTVR, TRINITY COLLEGE	Presentation
Feb. 10	<i>Publics workshop</i> , Dublin	public	CTVR, TRINITY COLLEGE	Workshop and demonstration
Feb. 10	Face-to-face meeting	Comreg, Irish regulator	CTVR, TRINITY COLLEGE	Presentation
Mars 10	Workshop <i>Comunicações Wireless na PTIn</i> , Aveiro Portugal	PTIN internal	PTIN	Presentation
Apr. 10	WWRF, 24th meeting (special session of WG8) in Penang, Malaysia	World Wireless Reserach Forum Presentation of COGEU project	IT	Presentation
May 10	LTE Advanced Workshop	One-day LTE Advanced workshop attended by a range of industries, SMEs and large companies, and academic researchers and regulators.	CTVR, TRINITY COLLEGE	Workshop
Sep. 10	ICT 2010 "Regulatory and Technological Requirements for Cognitive Radio"	COST-TERRA event, COGEU presentation on regulatory requirements	CTVR, TRINITY COLLEGE	Networking Session
Oct. 10	RAS Cluster Meeting	EC officers and project managers of ICT call 4 and 5 projects	IT	Presentation
Nov. 10	Third IBBT-MIT Joint Workshop on Cognitive Radio Standardization & Markets, Brussels	One-day workshop attended by a range of large companies, academic researchers and regulators.	IT	Invited speaker

## 7 Training, education and tutorials

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The project consortium consists of a well-balanced number of manufacturers, research institutes and universities. These partners have the potential to reach a broad range of researchers, engineers and students through training activities. The results will also be used for company internal courses, lectures given by university partners in their courses and for consulting activities to the outside world in workshops and tutorials.

- **6<sup>th</sup> International Mobile Multimedia Communications Conference**  
Tutorial title: *Cognitive radios in TV white spaces: a great opportunity for mobile multimedia communications.*  
<http://www.mobimedia.org/index.html>  
Presenter: Paulo Marques (IT)
- **Advance Satellite Multimedia Systems Conference**  
Tutorial title: *Cognitive radios for efficient sharing of DVB bands in European context*  
<http://www.asms2010.org/>  
Presenter: Paulo Marques (IT)
- **Summer academy at Ilmenau University of Technology**  
Tutorial title: *Cognitive Radio Prototyping and Testbeds, July 2010*  
Presenter: Linda Doyle (CTVR, TRINITY COLLEGE)
- **DySpan 2010**  
Tutorial title: Game Theory for Cognitive Radio Networks  
<http://www.ieee-dyspan.org/2010/>  
Presenter: Luiz da Silva (CTVR, TRINITY COLLEGE) and Allen B. MacKenzie (Virginia Tech)

## 8 Plans for exhibition

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COGEU intends to submit an application for the Exhibition at the Future Network and Mobile Summit, 2011 to be held in Warsaw Poland. The Exhibition presents COGEU with an opportunity to showcase our cognitive radio-enabled TVWS transceiver prototypes.

COGEU will submit an application to demonstrate key features of the TVWS transceiver platform being developed by COGEU. Specifically, with regard to the transceiver prototype, we intend to demonstrate;

- Spectrum shaping algorithms developed for the TVWS application.
- Initial TVWS sensing algorithms.
- Physical-layer rendezvous techniques for TVWS applications.

Furthermore, the consortium will demonstrate the COGEU TVWS opportunity maps which have been developed using information gathered in the Munich, Germany region.

This exhibition is of importance to COGEU as it will give the project higher visibility among both industry and academia. Unlike dissemination through a conference paper, an exhibition which uses working prototype radios will attract wider interest from non-academic audiences such as SMEs, larger industry and regulators as it enables the audience to actually see concepts operating on real radio systems.

## 9 COGEU web site

The official website for the COGEU project was set up at the IT web servers with the address: [www.ict-cogeu.eu](http://www.ict-cogeu.eu). The web site is regularly updated and acts as the first dissemination tool of the project. IT also set up a collaborative tool used as a means to share and manage project files from the Consortium members. COGEU website is the first results when searching “COGEU” in Google web site engine.

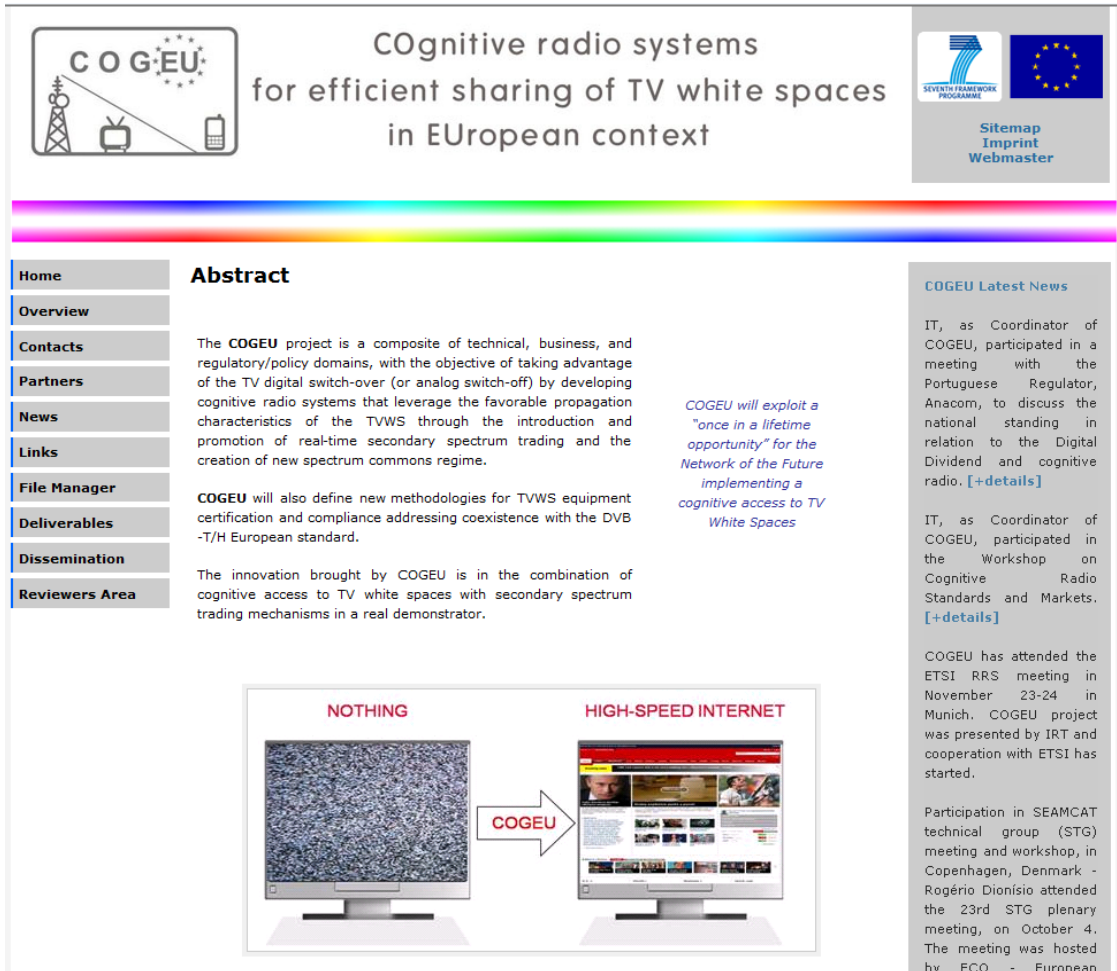


Figure 6. Main page of COGEU web site ([www.ict-cogeu.eu](http://www.ict-cogeu.eu)).

The website has a tracker tool installed that monitors COGEU website visits, geo-location of the visitors, among other important statistics. Examples of usage statistics for the period from March to December 2010 are given below.

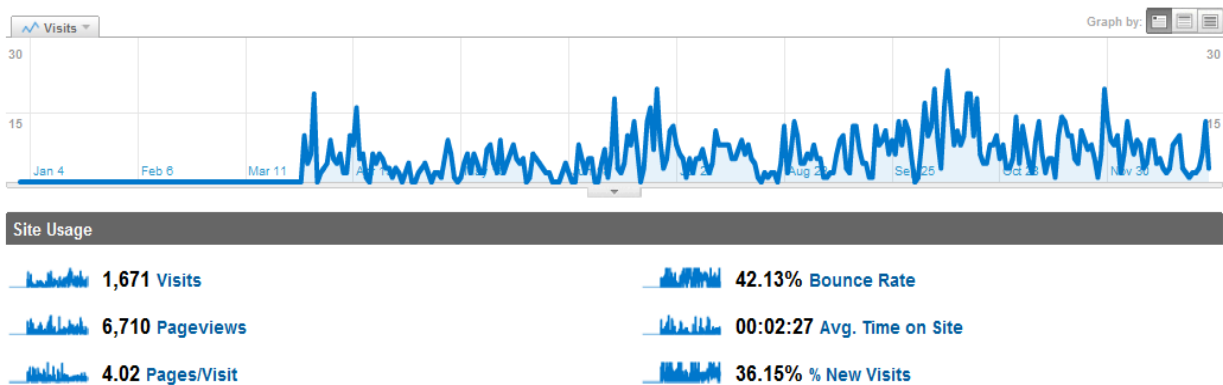


Figure 7 Summary Period: March 2010 – December 2010 – Total Visits (1,671 visits come from 50 countries)

Table 4 – Selection of visitors outside COGEU consortium: March 2010 – December 2010.

Visitors from Universities and research centres	Visitors from Telecom industry, regulators and standardization bodies
universidad de vigo rechen- und kommunikationszentrum der rwth aachen eircom gottfried wilhelm leibniz universitaet hannover budapest university of technology and economics universidad de zaragoza centre tecnologic de telecomunicacions de catalunya king s college london national technical university of athens technische universitaet dresden technische universitaet dortmund technische universitaet ilmenau; rechenzentrum universita degli studi di bologna universita degli studi di pisa academic & research network in the region of patras de montfort university democritus university of thrace ecole nationale superieure des telecommunications edinburgh university local area network federal university of rio de janeiro jacobs university bremen ggmbh katholieke universiteit leuven kingston university rijks universiteit groningen swedish institute of computer science technical research centre of finland technical university of cluj - romania technical university of crete tu berlin campus network technische universitaet berlin informatik technische universiteit eindhoven universita degli studi dell aquila universita degli studi di cagliari universitaet duisburg-essen universitaet kiel universitaet osnabrueck; rechenzentrum universite libre de bruxelles university of athens university of california los angeles university of kansas university of southampton university of thessaly waterford institute of technology	deutsche telekom ag shenzhen branch china netcom corp shenzhen huawei technology co. japan network information center toshiba trl etsi france telecom r&d huawei technologies co ltd kddi r&d laboratories inc. philips campus-ict alcatel-lucent deutschland ag british broadcasting corporation (BBC) microsoft corp motorola inc. nokia group networks qinetiq t-systems international telecom italia s.p.a. telefonica de espana sau upc broadband operations b.v. european broadcasting union federal unitary state enterprise general radio frequency google inc. ntt communications corporation philips laboratories telefonica investigacion y desarrollo the state enterprise the Ukrainian state centre of radio frequency egyptian ministry of communication and it projects european patent office european radio communications office intracom sa defense electronics iran telecommunication research center. itr kddi corporation marconi mobile (uk) group media broadcast / line bussinesarchitetur (lba) national institute of standards and technology research in motion corporation samsung networks inc. sc lithuanian radio and tv center towercom a.s. unitel samsungeurope verizon australia pty limited

## 10 Plans for the COGEU workshop

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The COGEU consortium will host a COGEU Workshop by the end of the project's second year, at which time the European digital switchover will be completed and COGEU will have intermediated results to present.

The workshop is planned as follows:

**Date:** End of 2011

**Location:** Most probably Brussels

**Duration:** 1 day, covering technical, business and regulatory perspectives

**Participants:** Spectrum management specialists;  
European regulatory officials;  
Spectrum users;  
Researchers from other FP7 projects on cognitive radio technologies  
EU officers / funding authority;

**Envisaged number of participants:** >30

**Objectives:** To stimulate discussions and exchange of ideas between the COGEU team, invited speakers and the audience;  
To validate COGEU's views and approaches about an efficient use of TV white spaces in European context;

**Content:** Present COGEU's intermediate results: scenarios, business models, technology options and preliminary trial results of COGEU demonstrator;  
Report on other ongoing activities in the field;  
Regulator's view, broadcaster's view and PMSE industry.  
Discussion topic : Digital dividend II or TVWS usage?

**Schedule:** Jan./Feb. first draft of agenda, fix date, location, ...  
Jan./Feb. cost estimation  
Jan./Feb. announce event via CEPT WG SE and WG FM reflector  
Inform at COGEU web site  
Feb./Mar. contact possible speakers  
May contact possible participants by email  
Aug./Sept. reminder to target group

## 11 COGEU External Advisory Board

After contacts from external entities seeking to join COGEU project, the COGEU PCC (Project Coordinator Committee) decided to establish an External Advisory Board. The EAB will include representatives from industry or academia who can advise on the research topics. These experts can be suggested by any partner and will be agreed by the PCC (Project Coordinator Committee).

The current COGEU EAB members are:

- Dr David Steer (PhD)  
Principal Member of Technical Staff  
**Research In Motion (RIM)**
- Dr Egon Schulz (PhD)  
Director of Wireless Innovation Centre  
**Huawei Technologies Duesseldorf GmbH**

The COGEU consortium consider cooperation with global industrial players such as RIM and HUAWEI beneficial for COGEU impact and visibility, contributing to the success of the project. The EAB members have a strong involvement on standardization activities, RIM is chairing the IEEE 802.11af standard on WiFi over TVWS and Huawei participates in ETSI RRS working groups with special interest on the LTE over TVWS scenario. COGEU benefits with the up-to-date vision of the standardization effort brought by the EAB.

During the EAB meetings the COGEU consortium, mainly WP leaders, provide research results and technical approaches that are commented on by the EAB. Feedback from the EAB may influence COGEU technical options. RIM and HUAWEI representatives are interested to follow the project with a special interest in the final demonstrator.

It was decided that meetings with the EAB take place twice a year. The process of the flow of information between COGEU partners and the EAB follows a NDA (Non Disclosure Agreement).

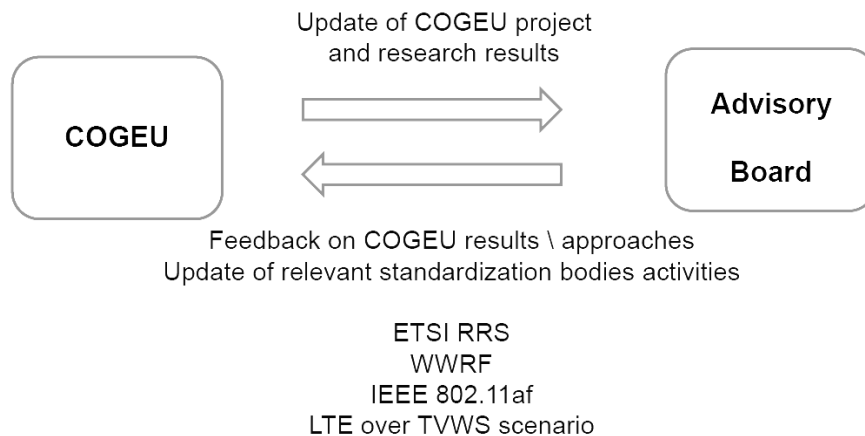


Figure 8. Information flow between COGEU and the EAB

During the first year of the project life two EAB meetings took place with the following agendas.

- **1<sup>st</sup> EAB meeting**

23<sup>rd</sup> June, Limassol, Cyprus, hosted by SIGINT

Meeting agenda:

1. COGEU project presentation: COGEU vision, work package structure and ongoing work;
2. Introduction of individual COGEU partners;
3. Introduction of RIM and main research interests and activities in TVWS;
4. Introduction of Huawei Technologies and main research interests and activities in TVWS;
5. Discussion on common interests and how cooperation can be effective;

- **2nd EAB meeting**

13th October 2010, Poznan, Poland, hosted by PUT

Meeting agenda:

1. Overview of COGEU system requirements based on D3.1 by IT;
2. Feedback on COGEU system requirements by the EAB;
3. Update vision on ETSI RRS activities by Huawei;
4. Update vision on IEEE 802.11af by RIM;
5. Discussion on opportunities for COGEU dissemination in ETSI RRS and IEEE 802.11af
6. COGEU initial system architecture by THALES;
7. Feedback on COGEU initial system architecture by the EAB;
8. Discussion on the FCC approval of unlicensed use of TVWS and impact on COGEU;
9. LTE over TVWS, scenario and dynamic RRM considering QoS aspects by PTIN;
10. Feedback on LTE over TVWS scenario by the EAB;

The next EAB meeting will take place in Warsaw, Poland, collocated with the FuNEMS'11 conference where an exhibition of COGEU initial demonstrator is planned.

## 12 Coordination of Intellectual Property Rights

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For the second project year and based on first results, a survey will be started among the project partners (Plan: 2nd quarter 2011) to identify the areas where a patent application or other means of protection of intellectual property rights may be advisable. This initial plan is then to be reviewed and up-dated regularly at the quarterly consortium meetings.

## 13 COGEU exploitation plan

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### 13.1 IT

As an interface (University – Industry / Operators) non-profit organisation, the plans of IT in relation to the exploitation of the results of COGEU project are linked to its mission of improving the competitiveness of Portuguese industry and telecommunications operators, and can be synthesized as the formation of a group of skilled people with deep knowledge in design, analysis and implementation techniques envisioned for future cognitive wireless communication systems that may transfer this knowledge to the industry or operators (through consultancy actions, amongst other methods). Furthermore depending on the final achievements of the project, a spin-off company may be envisaged. IT will contribute to the overall dissemination of the project results through presentations in conferences, journals and participation in IEEE P1900 standardization groups. IT has been in contact with the Portuguese regulator ANACOM and will provide assistance in the preparation of the Portuguese position in the WRC12 regarding the agenda item 1.19 on cognitive radio.

### 13.2 CTVR, Trinity College

CTVR, Trinity College will publish papers in leading conferences and journals over the course of the COGEU project.

As spectrum regulation forms a key enabling component for the development and deployment of new technologies which embrace dynamic spectrum access and cognitive radio technologies, interaction with key decision-makers is necessary. CTVR, Trinity College engages in an ongoing basis with the Irish regulator; we have already hosted joint workshops with ComReg, the Irish telecommunications regulator.

Linda Doyle is also a member of the U.K's Ofcom Strategic Advisory Board (OSAB). OSAB provides independent advice to Ofcom on strategic spectrum management issues. Provision of independent strategic advice helps Ofcom to carry out its remit in securing optimal use of the radio spectrum, taking account of the different needs and interests of all users. Involvement in this organisation provides CTVR, Trinity College with a broader, deeper and more long-term understanding of telecommunications developments and trends. It also allows CTVR, Trinity College to feed out experience, of which COGEU is part, into this group.

A key component of the CTVR, Trinity College's remit is to engage in outreach programmes. Outreach involves engaging the interest of students (at all stages of their education) in engineering and computer science and providing them with educational-level-appropriate information, i.e. workshops, tutorials, seminars. CTVR Trinity College have, and will continue, to promote outreach through these channels.

Commercialization of an IRIS-based platform seems unlikely at this time. IRIS serves a key purpose as a prototyping platform; it is more likely that ideas which may be developed, evaluated and proven as concepts on the IRIS platform are brought to commercial development and exploitation on bespoke, dedicated platforms.

### 13.3 Thales Communication

THALES Communications will exploit the results of the COGEU project in the Private Mobile Radio (PMR) application domain. Cognitive features have been identified as key enablers for future PMR systems, in order to support increased interoperability and efficient use of the scarce radio resources.

The project will help design much more dynamic frequency selective radios in order to respond dynamically to the radio's surrounding environment. The expected results of the COGEU project are thus of strategic values for THALES. In the Professional Mobile Radios(PMR) market THALES will exploit the project's results to feed its PMR-related activities with support of preliminary advanced studies in the TV White spaces environment. The objectives are to develop new cost effective and spectrum efficient PMR/TETRA products line increasing public safety units interoperability during multi-organizational critical operations (such as cognitive radio PMR gateways).

### **13.4 R&S**

R&S is planning to exploit software tools that it is currently developing in COGEU as part of an upgrade of the software platform of the DVB-T test receiver, and possibly as a stand-alone product (at a later stage). These include the sensing algorithms for DVB-T and a tool that controls the DVB-T test receiver during measurements in a mobile environment and allows the visualisation of the results as well as extended post-processing of a multitude of measurement parameters including the geo-location information.

### **13.5 PTIN**

Portugal Telecom Inovação (PTIN) acts inside the PT Group as an instrumental company that supports all the companies of the group in terms of new technologies and applications development and therefore be at the leading edge in the telecommunications area. PTIN joined this project with high expectations in making sure that the experimental results are of high value for real implementation, to provide consulting and training services to the PT companies or to motivate the suppliers of telecommunication systems to adopt the COGEU solutions. Of particularly importance to PTIN is the LTE extension over TVWS scenario and the gains in terms of system capacity, radio coverage and QoS that the mobile network operator can achieve. In this sense PTIN intends to motivate the mobile operators inside the PT Group and the mobile equipment suppliers to adopt this new approach in order to improve the company competitiveness.

### **13.6 SIGINT**

SIGINT Solutions plans to exploit the potential outcomes of the COGEU project for the purpose of creating innovative products and services. SIGINT Solutions is heavily involved with the definition and development of the geo-location database, the interference emulator, the broker and the development of simulation driving models for its own radio planning tool, 3DTruEM.

SIGINT's contributions to the project are expected to assist in the development of the following products and services:

1. A White Spaces Interference Emulator
2. Simulator add-on modules to drive the White Spaces Interference Emulator
3. A Broker system, consisting of a geo-location database that can be used to manage spectrum and more specifically white spaces frequency spectrum
4. A research platform that can be utilized to extend the work carried in COGEU
5. An online Service that will provide the functionality defined in products 1-3.

Possible recipients of the above products and services include telecommunication companies, operators, regulators, universities and research centers etc.

### **13.7 PUT**

As an academic partner, Poznan University of Technology will publish papers in leading conferences and journals as well as disseminate the project by (co)organizing the special COGEU sessions and plenary talks. The results obtained within COGEU project will be exploited to advance two PhD theses which refer to the main research areas investigated within WP5 and WP6 of the COGEU project. Two PhD students working specifically for COGEU are Mr. Marcin Parzy, and Mr. Pawel Kryszkiewicz. Moreover, PUT intends to exploit some of the work produced during the project, in particular work related with WP2, WP5 and WP6, by exploring the possibility to develop new algorithms and platforms for further research dealing with spectrum sharing and designing waveforms for cognitive radio

systems. The research results will help to implement application-targeted projects with the industry. This will allow PUT to extend its current expertise portfolio.

Since PUT is also involved in other European projects (7<sup>th</sup> FP European Network of Excellence ACROPOLIS and COST0902) special effort will be put on information and experience exchange between the projects as well as on making the collaboration more official due to the formal agreements.

### **13.8 AEGEAN**

AEGEAN intends to exploit its participation in the COGEU project by exposing its graduate engineers and researchers to high-level technical work, mainly in the area of different networking topologies concerning integration of new cognitive radio mechanisms in real DVB-H networks, in the development of RRM algorithms and in the exploitation of TVWS under spectrum sharing business models. Pertinent knowledge will be widely disseminated through publications in journals and conferences proceedings and the participation in trials, conferences and demonstrations. As experienced in the past, AEGEAN put extreme value in its participation in high level research with manufacturers, operators and other industrial/research partners, since this is the only way to be promptly acquainted with upcoming standards and major imminent technical and implementation decisions. The AEGEAN will develop software appropriate for the optimum allocation of TVWS, utilized by a dynamic mechanism which will be incorporated in the spectrum broker entity of COGEU overall system. In this context, AEGEAN will empower its own research position and reputation among the European universities and academia giving the chance to other researchers/students to make use of its own software tools and experimental facilities.

### **13.9 IRT**

On the one hand the broadcasters as the primarily licensed user of the considered spectrum and the PMSE production industry as a secondarily licensed user do have a vital interest in maintaining an interference free service usage even in the case where numerous new wireless systems are coming up to operate in these bands. On the other hand, due to this additional pressure on using the scarce broadcast spectrum, it is important to increase the efficient use of spectrum for PMSE applications. IRT as a research and development institute of public broadcasters in Germany, Austria and Switzerland has to ensure that the incumbent systems are not interfered (...in excess to an acceptable level...) by cognitive systems and nevertheless enables the exploitation of the cognitive technology.

Thanks to COGEU, IRT can extend its expertise and experience on interaction of different radio transmission systems theoretically (simulation) as well as practically (measurements). Hence IRT can provide advanced approaches to both the broadcasters and the PMSE operators to cope with future spectrum demands and to assure, for the broadcasters, sufficient spectrum access for broadcasting services still on a primary basis.

IRT will communicate the results of COGEU work to its associates as well as to EBU and so mediate between the incumbent users and the needs of the upcoming new industry of TVWS users.

IRT plans to use the knowledge as a consultant for its associates as well as for third party companies requesting IRT experience on spectrum usage and radio transmission.

## 14 Conclusions

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The activities foreseen for WP8 have been advanced substantially in the reporting period. In the first year project COGEU was presented in 38 events: 5 CEPT SE43 meetings, 2 ECO SEAMCAT meetings, 4 IEEE P1900.6 standardization meetings, 1 ETSI meeting, 7 meetings with other international research activities, 6 international conferences, 9 invited presentations and 4 tutorials.

Given the number of already published and accepted papers, contributions to various standardization meetings and the fact that regulatory bodies in partners' countries have been contacted, it can be stated that the COGEU dissemination goes in the right track.

Also the interested showed by global industrial players such as RIM and HUAWEI in join COGEU trough the EAB (External Advisory Board), attending regular meetings at their own expense, means they see value in the project.

One of the main and important activities of the dissemination work package is the organization of COGEU demonstrations and workshops at international conferences. They are already planned for the next year of COGEU life.

In particular, TVWS availability measurements and initial demonstration results, envisage for the second year of the project, will feed into the WP8 as it offers plenty of opportunity to interface with the stakeholders and the wider public.

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