

**COGEU response to the call for public input
on the draft RSPG Opinion on Cognitive Technologies
(RSPG10-348)**

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Disclaimer: The views and opinions expressed in this response are those of the authors as researchers only and do not necessarily reflect the position of specific COGEU consortium partners concerning the implementation of cognitive technologies in the European context.

The **COGEU** is an ICT collaborative project supported by the European Commission, 7th Framework Programme, under the project 248560, ICT-COGEU (www.ict-cogeu.eu), in the years 2010-2012. Nine partners from 7 EU countries representing academia, research institutes and industry (Instituto de Telecomunicações (PT), Trinity College Dublin (IE), Thales Communications (FR), Rohde & Schwarz (DE), Portugal Telecom Inovação (PT), Sigint Solutions (CY), Poznan University of Technology (PO), University of Aegean (GR), Institut für Rundfunktechnik (DE)) are involved in the project. The COGEU project is a composite of technical, business, and regulatory/policy domains, with the objective of taking advantage of the TV digital switch-over by developing cognitive radio systems that leverage the favorable propagation characteristics of the TV white spaces (TVWS) through the introduction and promotion of real-time secondary spectrum trading and the creation of new spectrum commons regime. COGEU will also define new methodologies for TVWS equipment certification and compliance addressing coexistence with the DVB-T European standard. The innovation brought by COGEU is in the combination of cognitive access to TV white spaces with secondary spectrum trading mechanisms in a real demonstrator.

The COGEU team is pleased to provide the comments to the RSPG Opinion on Cognitive Technologies (RSPG10-348) based on main technical and regulatory assumptions agreed so far within the project.

COGEU identifies one of the causes for the lack of confidence in current spectrum users and industry players to invest in CR technologies are immature regulatory policies concerning the technology. Hence, COGEU wishes to share its insights with the hope that informed regulators will quickly adopt policies that are supportive to technological innovation as well as boost investors' confidence. The key is in creating predictability on the availability of spectrum resources (TV white spaces). This can only be achieved through the collaboration of all stakeholders in the TV white space ecosystem.

From other hand, secondary markets initiatives in Europe generally lag the rest of the developed world. There has been very little progress in the development of comprehensive frameworks for secondary trading at European level. The subject needs further massive research, concertation and harmonized regulation within EU.

COGEU team is convinced that unlicensed use of TVWS bands is not fully adequate solution for all possible applications which may apply in Europe. Therefore we strongly promote the combination of spectrum commons regimes and temporally exclusive rights for use within Europe.

Spectrum commons regimes promote sharing, but do not provide adequate quality of service (QoS) for some applications. For specific applications that require sporadic access to spectrum and for which QoS guarantees are important, licensed spectrum within the

framework of real-time secondary spectrum markets may be the best solution. Unlike today's unlicensed bands, COGEU proposes that primary and secondary users would coordinate through a centralized broker, making it possible to protect QoS for both primary and secondary users. In this explicit coordination, the broker runs an admission control algorithm, which only allows secondary users access to spectrum when QoS of both primary and secondary are adequate. The broker also uses an intelligent frequency assignment algorithm for determining the frequency at which a secondary user should be allowed to operate and the economics of such transactions which provides incentives to maximize spectrum utilization. Secondary users dynamically request access to spectrum when and only when spectrum is needed.

We are strongly convinced that the allowing coordinated commons and secondary spectrum trading through geo-location database will potentiate TVWS usage in Europe.

Therefore, **COGEU supports the creation of a geo-location database to enable guaranteed access to the spectrum resources.** Unlike the current approach of unlicensed use of TVWS, currently addressed by regulators such as FCC, OFCOM and CEPT, COGEU project goes beyond the spectrum commons model and creates a secondary spectrum trading of TVWS. In COGEU model, the regulatory bodies assign TVWS for spectrum commons (free access) in given areas. The remaining TVWS can be traded in a secondary spectrum market using a centralized broker. Figure 1 shows a (COGEU) broker model where the spectrum of commons model will operate in the bands marked for unlicensed use TVWS, and the broker(s) will trade the spectrum that is marked for secondary trading. An entity called spectrum commons manager will make sure that the enquiries of white space devices (WSD) are served from the already divided spectrum for the specific use, and an entity called Broker manager will deal with enquiries coming from the Brokers. The difference is that the Broker will request and receive batch data concerning the availability for the spectrum that is available for trading, and then the broker will use the available spectrum information efficiently through trading.

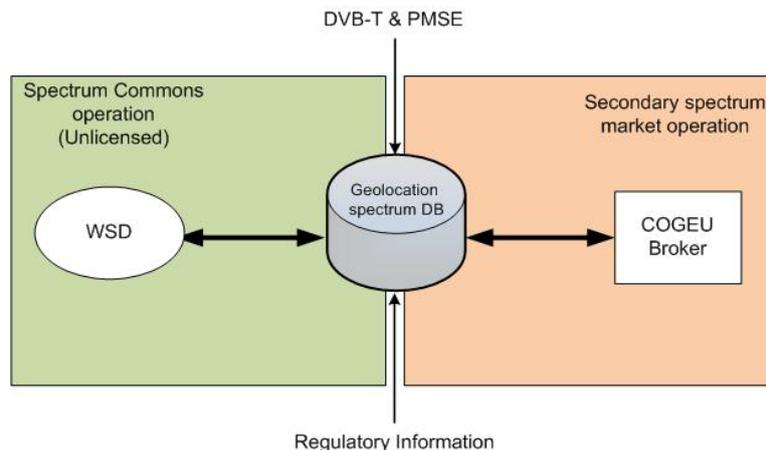


Figure 1: Geo-location spectrum database proposed by COGEU. The database supports two spectrum sharing regimes: spectrum commons and secondary spectrum market.

Information on DVB-T incumbents is stable and hence suitable for the spectrum database approach. The same is the case with registered PMSEs, usually for professional applications. COGEU assumes that a database for professional PMSE is either available or will be built up in advance of introduction of white space using equipment. However, the unpredictability of unregistered PMSE applications and Electronic News Gathering (ENG), which requires protection, is the main challenge in the design of the geo-location database. To curb the

unpredictability of unregistered PMSE, COGEU supports the creation of “safe harbor” concept as will be discussed below.

For the white space devices (WSDs) (operating within spectrum commons regime) a master-slave configuration is envisaged, where the master connects to the database and the slaves are managed by the master, without access to the database. This configuration could reduce signaling overhead in database access.

COGEU recommends secondary spectrum trading. Secondary users in unlicensed bands hold a risky position in their service operations since they may not have direct control over the availability of radio spectrum, quality of service, and coverage expectation. This may make it difficult for the secondary users to control the quality of service they provide to their clients, so it is important to guarantee by the regulatory and technical restrictions. Trading allows players to directly trade spectrum usage rights, thereby establishing a secondary market for spectrum leasing and spectrum auction. This model has the potential to enable small companies to enter the spectrum market, have access to TVWS and be charged based on spectrum utilization, thus boosting competition and innovation in the telecommunications sector. Summarizing, the introduction of secondary spectrum market allows a portion of players who cannot afford an exclusive license or find it impractical to use to become secondary users. Just freed TVWS bands may serve as a test-bed for such market solutions. If TVWS can be exploited as tradable and flexible spectrum, then it further expands the range of spectrum available over which key services can be provided. In turn, this increases the difficulty of big players to dominate a market or develop market-abusive strategies.

In the event of an emergency, COGEU recommends that a higher priority policy be propagated into the spectrum broker temporarily rescinding non-emergency utilization of the TVWS in the specific areas of need. Moreover, service prioritization can be incorporated into the database. Public Safety systems would have the highest priority.

It should be noted, that there is no clear regulatory framework regarding sensing requirements in Europe. Therefore, on the protection of incumbent systems namely DVB and PMSE systems, COGEU envisions two regulatory scenarios.

- **Regulatory Scenario 1:** Because the process of switch PMSE to “safe harbor” will take years to be concluded in Europe, therefore we can assume a scenario where TVWS commons has to coexist with unpredictable PMSE through combination of cooperative sensing and geo-location database access (master-slave topology) should be assumed for unlicensed use of TVWS.
- **Regulatory Scenario 2:** COGEU envisions a scenario where geo-location database access and “safe harbor” channels for non-registered PMSE will be required. Within this scenario we assume that sensing is not necessary. The proposed solution is to consider that Europe has implemented “safe harbor” for the exclusive PMSE usage, i.e., number of TVWS channels for reserved PMSE usage only in which no TVWS devices would be permitted. The “safe harbor” bands are flexible and it may change from country to country. These channels are excluded by the geo-location database and therefore out of the market. In this case the broker doesn’t need to consider sensing (only database access) and system doesn’t need backup channels to guarantee QoS and increasing spectrum efficiency.

From the COGEU perspective, the implications of the **1st Regulatory Scenario** are as follows:

- In order to provide means to protect incumbent systems, combining the use of geo-location database together with autonomous sensing seems plausible. The database protects DVB-T and professional PMSE systems that can be planned in advance. The maximum allowed transmit power in a specific vacant DVB channel is computed based on co-channel and adjacent channel protection ratios. Other PMSE users (not planned, not registered) such as ENG shall be protected through autonomous sensing.
- In this scenario, autonomous sensing should be mandatory for PMSE and optional for DVB-T signals (mainly protected by the geo-location database). Detection thresholds are adopted from current regulatory framework. The system should provide a signaling channel for reporting of local sensing data and supports centralized cooperative sensing.
- Combining the two approaches can relax the sensitivity required for sensing devices which is a major limitation of TVWS developments. Also, since local sensing is only performed in a limited number of TV channels indicated by the database, the hybrid approach will speed up the sensing process. Cooperative sensing exploits spatial diversity of sensors located in different positions (preferentially with low correlated shadowing). COGEU will investigate cooperative sensing able to relax the sensitivity requirements of single nodes through the reduction of the hidden terminal margin. Cooperative sensing requires protocols for sharing sensing information among TVWS devices which add extra complexity and sensing overhead to the TVWS system.
- The system should provide a means to support applications with different QoS parameters, such as transmission rate, delay and delay jitter. Thus, COGEU system should be flexible enough to satisfy different QoS requirements. Because TVWS devices have to do database access (and spectrum sensing, if necessary) and reconfiguration before transmitting, some delay sensitive services, such as voice service, should be considered when designing the RRM strategies.

Similarly, the implications of the 2nd **Regulatory Scenario** are as follows:

- The system shall be able to facilitate coexistence with other secondary systems operating in TVWS. This is done through dynamic TVWS allocation mechanisms based on protection rules specified for each combination.
- **The need of concertation and common approach to protect incumbents in cross border areas should be matter of special interest.** Cross-border issues have to be considered in the specification of the database. In COGEU context, assisted-GPS technology will be adopted in order to overcome problems with low signal levels, enabling also the usage of secondary systems devices in indoor environments.
- Players (spectrum holders and spectrum seekers) are subject to regulation. Regulators must determine exactly what rights can be granted to secondary users. A centralized spectrum broker manages TVWS on real-time regime subject to non interference rules. Moreover, specification of spectrum usage rights and obligations, the minimum set of information that parties to a spectrum trade must disclose, and approaches to the protection of competition needs to be investigated. It is important to note that this model has the potential not just to open the market to new players but that it also has the potential to create new business opportunities for the spectrum broker entity be that in new public sector roles or in the commercial sector.

COGEU asserts that the following core elements for an efficient secondary spectrum market should be taken into account:

- *a large number of buyers and sellers to create competition necessary for an efficient market,*
- *clearly defined rights to the spectrum for both buyers and sellers,*
- *free entry and exit to the secondary markets,*
- *availability of relevant information to all buyers and sellers,*
- *a mechanism to bring buyers and seller together and facilitate the transaction with reasonable administrative costs and time delay,*
- *reliable procedures for payment between players, etc.*

In line with the trading mechanism, price discovery is an important requirement to enable the broker to allocate the spectrum to the most valuable players. Efficient spectrum policies to enable fairness in the spectrum sharing models need to be implemented. COGEU considers that under the **2nd Regulatory Scenario**, a fast re-assignment of spectrum ownership is allowed.

COGEU recommends that more EU research/testing on secondary trading of spectrum is needed. Regulatory and policy issues to be investigated covers:

- Policies for free and efficient spectrum market including definition of the rights to the spectrum for buyers and sellers, buyers validation, legal protection for users means of determining prices dispute resolution mechanisms between market players, policies against market abuse (anti-monopoly issues, competition law, ...), role of public agencies (participation, benefits, flexibility, market effectiveness).
- Regulatory policies to incentivize business models in the TVWS including policies to control the geo-location database (policies in populating the database, policies to ensure the integrity of the database, access policies, including authorization, authentication, accreditation, etc., security policies, database accessibility policies, which include backup policies, privacy policies), policies for automation of spectrum acquisition (policies for market intermediaries such as the COGEU broker, ontology-based policy description, e.g., use of machine readable, formally provable XML policies, policies to provide validation of the buyer being restricted to their TVWS in time, space and frequency), emergency situation policies (policies to provide control of the TVWS spectrum by the regulator or trusted agency in case of emergency, give priority to the public safety systems, provide incentives for devices to have emergency functions for lifesaving purposes), and finally, impact on TVWS uses on the SLA.
- Policies in the technical domain, including policies to improve interference rejection of incumbent receivers, promoting the single market for equipment and services in the TVWS, policies for joint standardization and certification activities in Europe, policies for peaceful coexistence with wireless microphones.
- Policies to promote harmonization of TVWS usage among member states including policies to leverage the TVWS to achieve the i2010 goals, policies to promote innovation and strengthening the internal market, and sector-specific policies such as universal broadband interconnectivity initiatives, policies to promote access and inclusion for citizens to ICT based services through WiFi-like wireless technology through the TVWS.

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