CRS-i

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Coordination Action

Cognitive Radio Standardization-initiative: from FP7 research to global standards

D2.2

White paper on "How to Use the CRS-i consultancy services"

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Author(s): Klaus Moessner (UNIS), Dionysia Triantafyllopoulou (UNIS), Dominique Noguet (CEA), Michael Gundlach (NSN), Paulo Marques (IT), José Cardoso (IT), Philippe Delahaye (NTUK), Simon Delaere (iMINDS)

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Abstract:
This document contains the non-formatted white paper on "How to Use the CRS-i consultancy services", it is intended as one communication tool for CRS-i and summarizes the project objectives. It discusses the complexity of bridging the gap between research and standardization and describes the process how FP7 projects can be more engaged in standardisation, via the CRS-i consultancy service.

Keyword list: Project cluster, FP7, Standardization, Consultancy Service, Cognitive Radio

Executive Summary

This Deliverable contains the non-formatted white paper on "How to Use the CRS-i consultancy services", it is intended as one communication tool for CRS-i and summarizes the project objectives. It discusses the complexity of bridging the gap between research and standardization and describes the process how FP7 projects can be more engaged in standardisation, via the CRS-i consultancy service.

More specifically, this deliverable presents:

- A brief introduction of the main objectives of the CRS-i Coordination Action;
- The European regulatory framework for spectrum sharing;
- An overview of the standards creation process in the two main targeted organizations, i.e., ETSI and IEEE;
- An overview of the CR standardisation ecosystem and roadmap, describing briefly the activities of the main CR-related standardization bodies;
- An overview of the challenges to the effective participation of FP7 projects in CR global standardization;
- A description of the CRS-i consultancy service structure and information flow, emphasizing on the potential benefits offered to the involved projects.
- A case study demonstrating the process starting from the identification of an interesting research idea with standardization potential, followed by the assistance of the CRS-i consultancy service in bringing a technical contribution to IEEE.

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List of Abbreviations

3GPP	3rd Generation Partnership Project
BRAN	Broadband Radio Access Networks
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CEPT	Conférence Européenne des Administrations des Postes et des Télécommunications
COGEU	FP7 Call 4 STREP "COGnitive radio systems for efficient sharing of TV white spaces in EUropean context"
CR	Cognitive Radio
DVB-T	Digital Video Broadcast – Terrestrial
DSA	Dynamic Spectrum Access
DySPAN-SC	Dynamic Spectrum Access Networks Standards Committee
ECC	European Communication Council
ETSI	European Telecommunications Standards Institute
EU	European Union
FP7	The Seventh Framework Programme
GSM	Global System for Mobile Communications
ICT	Information and Communications Technology
IEEE	Institute of Electrical and Electronics Engineers
IEEE-SA	IEEE Standards Association
IETF	Internet Engineering Task Force
ITU	International Telecommunication Union
LTE	Long Term Evolution
MAC	Medium Access Control
NSO	National Standardization Organization
OneFit	FP7 STREP "Opportunistic networks and cognitive management Systems for Efficient Application Provision in the Future Internet"
PAR	Project Approval Request
PAWS	Protocol to Access White Space database
ProSe	Proximity Services
QoSMOS	FP7 Call 4 IP "Quality of Service and Mobility driven cognitive radio systems"
R&D	Research and Development
RFC	Request for Comments
RRM	Radio Resource Management
RRS	Reconfigurable Radio Systems
SACRA	FP7 Call 4 STREP "Spectrum and Energy efficiency through multi-band cognitive radio"
SDO	Standards Development Organization
TVBD	TV Band Device
TVWS	TV White Spaces
UHF	Ultra-High Frequency
US	United States
Wi-Fi	Wireless Fidelity
WI	Work Item

1 Introduction and main objectives of CRS-i

Research into cognitive radio (CR) systems and CR networks has matured for more than ten years now. Many research and industry projects and initiatives have provided proof of concept implementations, demonstrators and showcases. But to date, there are only few standards that may be used as benchmark for the certification and interoperability tests of CR equipment. The standards under study are rather incomplete and fragmented. There is a range of standards in the IEEE 802 family (e.g. 802.22, 802.11af), in the IEEE DySPAN P1900.x family and efforts by the ETSI Reconfigurable Radio Systems (RRS) technical committee and related working groups.

Considering this status, and looking at the amount of project outcomes and the individual rather small scale standardisation efforts, there is a clear need to support research efforts through a coordinated standardisation approach. To achieve the biggest impact, either de-facto leadership of standards needs to be established, e.g., as happened with the Global System for Mobile Communications (GSM), or IEEE 802.11,, or concerted efforts, e.g. Long Term Evolution (LTE), need to be undertaken. In the Digital Agenda for Europe, the European Commission rises the growing importance of Information and Communications Technology (ICT) standards developed by global fora and highlights the need of coordination: "Enhancing interoperability through coordination: Europe's standard-setting framework must catch up with fast-moving technology markets because standards are vital for interoperability" [1].

The aim of CRS-i is to coordinate and support existing and future projects and to facilitate the exploitation of their results by strengthening their momentum and impact on CR standardisation. In CRS-i, this is achieved by stimulating, facilitating and easing cooperation and exchange between current as well as future Seventh Framework Programme (FP7) research projects on CR systems and ICT standardization organizations.

More specifically, CRS-i has the following specific three objectives:

- Offer a consultancy service on standardization to FP7 projects addressing CR, Dynamic Spectrum Access (DSA) and Coexistence issues. Through its Consultancy Service, CRS-i will identify and concentrate on the most promising standard developments and standardization groups, will review their work-plans and will make the research projects aware about forthcoming opportunities and topics that would be positively received in the different groups. Research projects will then be able to concentrate on the technical contributions and immediate follow up rather than spend time and effort on monitoring several standards groups.
- Extend standardization activities of the ongoing FP7 projects beyond the projects' lifetime, namely QoSMOS (www.ict-qosmos.eu), COGEU (www.ict-cogeu.eu), SACRA (www.ict-sacra.eu) and OneFIT (www.ict-onefit.eu). These projects have relevant and successful track record, but their impact stopped before the standardisation projects were finalized. CRS-i, helps promote and continue their impact on standard, thereby strengthening European research outcome into standardization development.
- Reinforce the collaboration of FP7 projects with United States (US) and Japan "CR stakeholders" and ensure that Europe are be able to turn the research outcomes into standard compliant products. US and Japan have been very active in the promotion of CR oriented standards, notably in IEEE standardization committees (802 and DySPAN). It is important that strong links are established between these groups and European research in order to reach worldwide CR adoption.

In CRS-i, coordination towards standardization will be achieved through task forces with partners from CRS-i liaison projects (also called CRS cluster), in order to target specific CR standardization groups. These task forces exploit results from FP7 projects on CR, avoiding fragmentation of the standardization effort and unnecessary competition between European Union (EU) projects and between standards. Through these clusters, the extension of ongoing standardization activities, CRS-i aims at global harmonization and standardization, which is the key to achieve mass market and economy of scale of CR systems and networks.

This white paper, provides a comprehensive overview of the current state of work in standardization organizations in all fields related to cognitive radio and dynamic spectrum access. It discusses the complexity of bridging the gap between research and standardization and describes the process how FP7 projects can be more engaged in standardisation, via the CRS-i consultancy service.

2 European regulatory framework for spectrum sharing

This section addresses recent advances on the European regulatory landscape for the adoption of spectrum sharing technologies.

At European level, the European Commission (EC), the European Telecommunications Standards Institute (ETSI) and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT) cooperate on aspects related to the regulatory environment for radio equipment and spectrum both at the EU level and at the wider intergovernmental level across Europe. As indicated in Figure 1, the CEPT can request feasibility studies from the ECC, which is composed of working groups (WGs), task groups, and project teams. Representatives of national spectrum regulators participate to the activity of CEPT WGs. WGs and the ETSI Technical Committees (TC) collaborate through Liaisons Statements (LS). The requirements specified in CEPT WGs are the input for the definition of the standards created in ETSI TCs. The EC can request specific standardization mandates from CEPT and/or ETSI on specific technologies. A good introduction to the European regulatory environment for radio equipment and spectrum is given in [21].

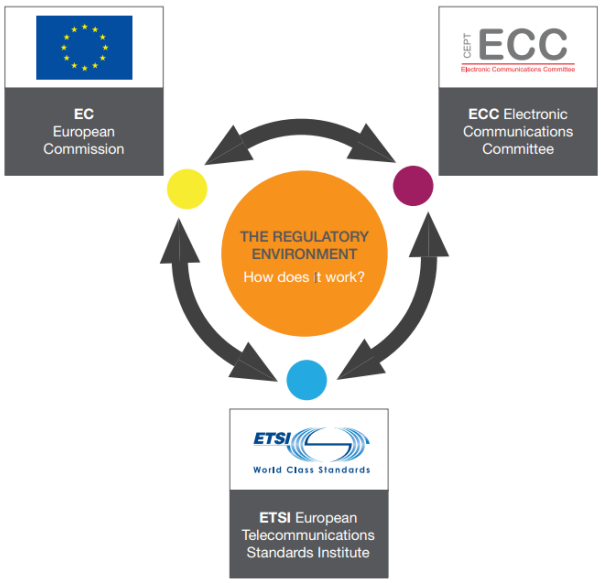

Figure 1: Relationship among entities involved in European spectrum regulation [21].

As a first step in the process of translating political priorities into strategic policy objectives for radio spectrum use, the European Parliament and Council approved the first Radio Spectrum Policy Programme (RSPP) in March 2012 [2]. While moving towards the freeing up of significant new pieces of radio spectrum and promoting the trading of usage rights, the Program also sets out a number of actions with regard to spectrum sharing including CR solutions. Specifically with regard to spectrum sharing, a study was commissioned by the EC and published in March 2012 [3]. Based on its RSPP principles and the outcomes of this study, the Commission released a Communication on "Promoting the shared use of radio spectrum resources in the internal market" in September of that year [4]. In this Communication, the Commission sets forth two actions:

- The development of an EU approach to identify so-called beneficial sharing opportunities (BSOs), defined as situations in which "the combined net socio-economic benefit of multiple applications sharing a band is greater than the net socio-economic benefit of a single application, taking into account additional costs resulting from shared use". After defining sharing conditions and rules, a harmonized, transparent and incentivizing procedure for gaining access to BSO frequencies should be set out.
- The authorization of Licensed Shared spectrum Access (LSA) via so-called spectrum sharing contracts, with regulators handing out "shared spectrum access rights" (SSAR) and acting as impartial technical advisers and registrars of the contract terms.

Mentioned as a specific, high-potential BSO in this Communication, and also referred to in the RSPP, is the shared use of so-called TV White Spaces in the 470-790 MHz band. Several European regulatory actions have already been taken into account in this dossier. In a first report, ECC Report 24 ("Technical considerations regarding harmonization options for the Digital Dividend") [5] the

European white spaces were defined, while in ECC Report 159: "Technical and Operational requirements for the possible operation of cognitive radio systems in the "White Spaces" of the frequency band 470-790 MHz" [6], CEPT thoroughly addresses the way forward in European TV White Spaces, assessing both geolocation database and spectrum sensing as enabling technologies and setting out technical requirements for the use of TVWS. With regard to LSA as a second BSO, CEPT approved a report in April 2012 [7].

Subsequently, in September 2012 CEPT created a new project team (called PT FM53) on Reconfigurable Radio Systems (RRS) and Licensed Shared Access (LSA). The objectives of this Project Team are to continue to monitor and investigate CR systems, in order to develop a relevant regulatory framework and to work on technical and business requirements, regulatory and harmonization framework and general and band/specific technical and operational conditions for the implementation of LSA.

Almost simultaneously with the establishment of FM53, in November 2012 the European Commission issued a mandate to European standardization organizations CEN, CENELEC and ETSI in the domain of Reconfigurable Radio Systems [7], asking these organizations to develop harmonized standards with three objectives:

a. to deploy and operate cognitive radio systems (CRSs) including white space devices and devices under Licensed Shared Access regime, dependent for their use of radio spectrum on information obtained from geo-location databases;
b. to ensure standardization of suitable, SCA-based SDR architecture(s) for the military domain;
c. to explore potential areas of synergy among commercial, civil security and military applications

Final results of this mandate are expected by the Commission to come within 42 months after its acceptance.

Another impact field of regulatory activity relevant to the enabling of spectrum sharing is the revision of the EU Radio & Telecommunications Terminal Equipment (RTT&T) Directive. In October 2012, after extensive consultation [8], the Commission put forward its proposals aiming at "ensuring that software can only be used with radio equipment after the compliance of that particular combination of software and radio equipment has been demonstrated". Concretely, manufacturers and software providers would need to provide the Member States and the Commission with information on the compliance of intended combinations of wireless equipment and software with the essential requirements put forward by the Directive [9].

More recently the ECC approved in January 2013 the Report 185 [10] "Further definition of technical and operational requirements for the operation of white space devices in the band 470-790 MHz" and the Report 186 [11] "Technical and operational requirements for the operation of white space devices under geo-location approach".

3 The standards making process

Different standardization organizations have different procedures, and it would lead us too far to describe all of them in detail here. As the CRS-i consultancy service starts to offer assistance to specific projects for their standardization activities, detailed roadmaps and procedures will be discussed depending on the SDO (Standardization Organization) concerned. Rather, the objective in this section is to provide an overview of the overall process for two of the main targeted organisations, i.e. ETSI and IEEE. We have chosen these two since:

- They are large SDOs with a wide range of standardisation activities, so they are not concerned with one particular technology, as *de facto* industry consortia often are, and may cater to the needs of a diverse set of research projects;
- They are internationally oriented. A number of important SDOs such as CEN, CENELEC and ISO work in a tiered system, where the members are national standards bodies which appoint delegates to the SDO's committees. Both ETSI and IEEE have a direct membership of individuals, enterprises and/or public administrations[1].

[1] For the sake of completeness, it needs to be added that, for ETSI European Standards, a public enquiry and a vote by the National Standardization Organisations resorting under ETSI, is also required. See [17] for more information.

- They have important completed as well as ongoing standardisation activities in the field of heterogeneous networks, efficient spectrum management, cognitive and reconfigurable radio, with Committees, Working Groups and Working Items already in place.

Therefore, the processes outlined below are primarily based on those used within these bodies. However, they are also largely applicable to the procedures of other organisations such as CEN, CENELEC, ISO, IETF etc.

Most SDOs are comprised of one or more Boards, a (significant) number of Committees (*Areas* in IETF) in which the standardization activities are carried out, and a central staff to set up and maintain rules and procedures, facilitate the standardization activities and publicize and market the eventual standards. The number of Committees is relatively stable as they already comprise a diverse set of topics and are relatively flexible in the topics on which standardization activities can be initiated. Therefore, such activities are usually oriented at and started in a specific, existing Committee. However, sometimes the need is felt to create a new Committee in order to deal with the standardization of a new set of technologies, requiring specific expertise. For example, the ETSI Technical Committee on Reconfigurable Radio Systems (ETSI RRS) first started as an ad-hoc group, established by the ETSI Board in February 2007 in order to evaluate the potential for standardisation on these topics and propose orientation to the Board. On year later, after a number of meetings and the publishing of a report, the Technical Committee was established. Similarly, the IEEE Dynamic Spectrum Access Networks Standards Committee (DySPAN-SC) was established in 2005 (then as the P1900 Committee).

Typically, a formal request is made within a Committee to start work on a new Standard, which is sponsored by one or more members. For example, in ETSI, four members are required to start a new Work Item, which usually resorts under one of the Working Groups of a Technical Committee. Similarly, in IEEE a Project Approval Request (PAR) needs to be filed and approved. When a proposal for a new standard is approved, a team of contributors starts to work on the standard within the Working Group. In ETSI, WI activities take place under the direction of a rapporteur. This active process, in which Members continuously file contributions to a reference document and in which contributions are assessed, discussed and approved at face-to-face meetings and using electronic means, can take from months to a year or more, before a standard draft is finalised and can go through an approval process.

Participation rules vary widely per SDO: within some organisations, membership and meeting attendance is free of charge and attendance and regular contribution are not required, while in others, a minimum attendance to meetings and a minimum contribution is obliged in order to obtain and/or maintain voting rights, and members need to pay for membership and/or to attend individual meetings. With not all meetings offering the possibility to be conducted on-line as yet, and with Committees of internationally oriented SDOs (such as IEEE DYSPAN-SC) rotating meetings between North-America, Europe and Asia while also requiring presence (and the payment of a meeting fee) to obtain voting rights, the barriers of entry to actual participation is highly diverging. Another potential complexity is the specific jargon and structure in which standards are created, the correct use of which might require some assistance to newcomers. In ETSI, for example, a number of these conventions are captured by the Drafting Rules, which complement the SDO's Technical Working Procedures.

Once a draft standard is ready, the approval process can start. In ETSI, this process is dependent on the deliverable type of the document up for approve –note that this type is pre-established at the point of approval of a Work Item: types are European Standards, ETSI Standards, ETSI Guides, Special Reports, ETSI Technical Specifications, ETSI Technical Report and ETSI Group Specification.[2] Depending on the deliverable type, approval within the Committee might be sufficient, or ETSI-wide and/or national standardizations bodies' approval might be required. In IETF, an approved draft becomes an RFC (Request for Comments) Document. In IEEE, after approval of a draft within the Working Group, a balloting process is opened in which all the members of the Sponsor (IEEE-SA or one of its associated bodies), as well as entities which have paid a balloting fee, may vote on the proposal. Here again, voting procedures (voting rights, timing, quora, majority rules, balloting fees etc.) diverge from one SDO to the other. In most cases, however, the approval of a standard does not mean that the document will no longer change.

[2] Of these types, the Technical Specifications, ETSI Standards and ETSI European Standards contain normative elements and therefore have the most impact.

The IEEE, for example, attributed different kinds of status to its standards documents [18]:

- Approved Project - An initial project request is approved, in stages of group formation.
- Active Project - An active standards development project.
- Withdrawn Project - A cancelled standards development project.
- Approved Standard - The standard is approved and published for public use.
- Withdrawn Standard - The standard is no longer market relevant or active.
- Superseded Standard - The standard has been replaced by a new standard.

In keeping with the standards development lifecycle, Working Groups may also go through periodic stages of activity or dormancy. Depending on where a standard is in its lifecycle a standard may be accompanied by supplemental documents that are produced by its respective Working Group. These may include errata (which address errors in the standard), amendments (which modify sections of the standard), corrigenda (which only correct errors or ambiguities in a standard), handbooks, tutorials and other related materials. Supplemental documents help interested parties better understand and apply the standard. An overview of the standards development process in IEEE is given in Figure 2.

Finally, in some cases, the standardization ecosystem related to a research project is not ready/in place to progress its standardization objectives. In this case, a research focused standardization phase needs to complement the classical standardization process to feed it with a stream of de-risked ideas that will, if successful, lead to a full standardized solution. For this reason, this phase is generally referred to as the pre-standardization phase. Specific instruments have been created by different bodies (such as ETSI's Industry Specification Groups or IRTF- Internet Research Task Force Research Groups) to offer an lightweight, open environment for pre-standardization, in addition to existing opportunities such as "Informative RFCs", "Technical Reports", "Feasibility Studies" etc...

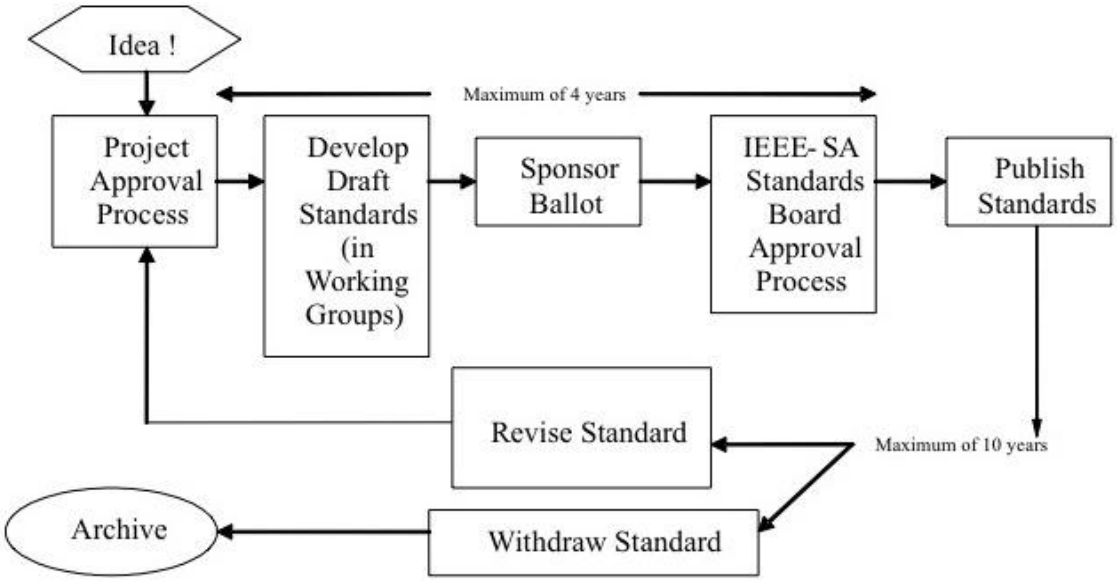

Figure 2:The standards development process in IEEE [18].

For additional information on the standardization making process the reader is referred to:

- CENELEC - Bridging the Gap between Research and Standardization [16] ;
- ETSI standards creation process [17];
- IEEE Standards Association - How are standards made? [18]
- IETF standards process [22]

4 CR standardization framework and roadmap

Standardization of cognitive radio and dynamic spectrum technologies is spread to several organizations around the world . CRS-i deliverable D3.1 [19] gives a comprehensive state of the art on CR standardization in ETSI, IEEE, 3GPP and IETF. Figure 3 and Figure 4 highlight the complexity of the current international standardization activities dealing with CR, DSA and Coexistence issues.

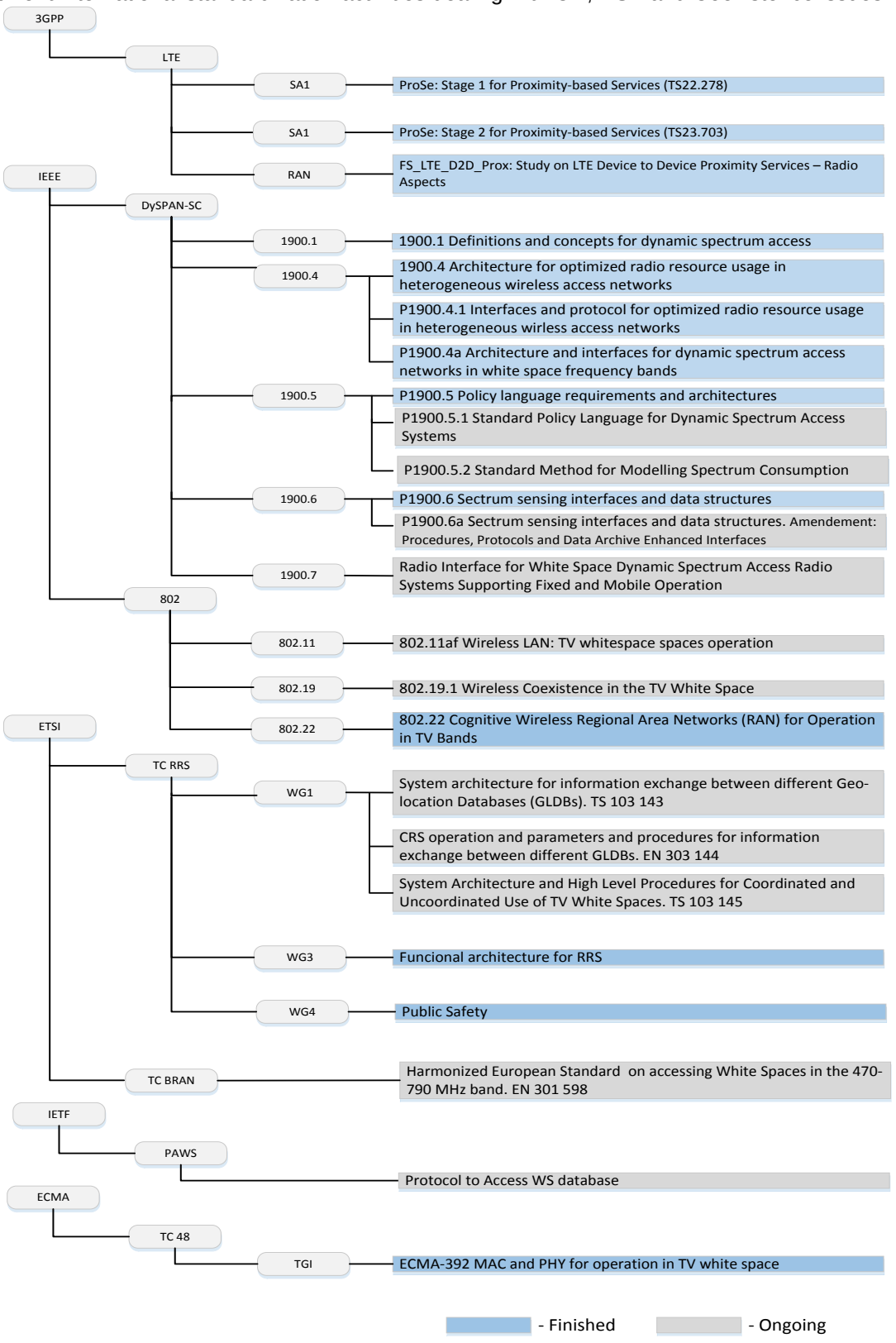

Figure 3 Summary of international standardization on Cognitive Radio, Dynamic Spectrum Access and Coexistence issues.

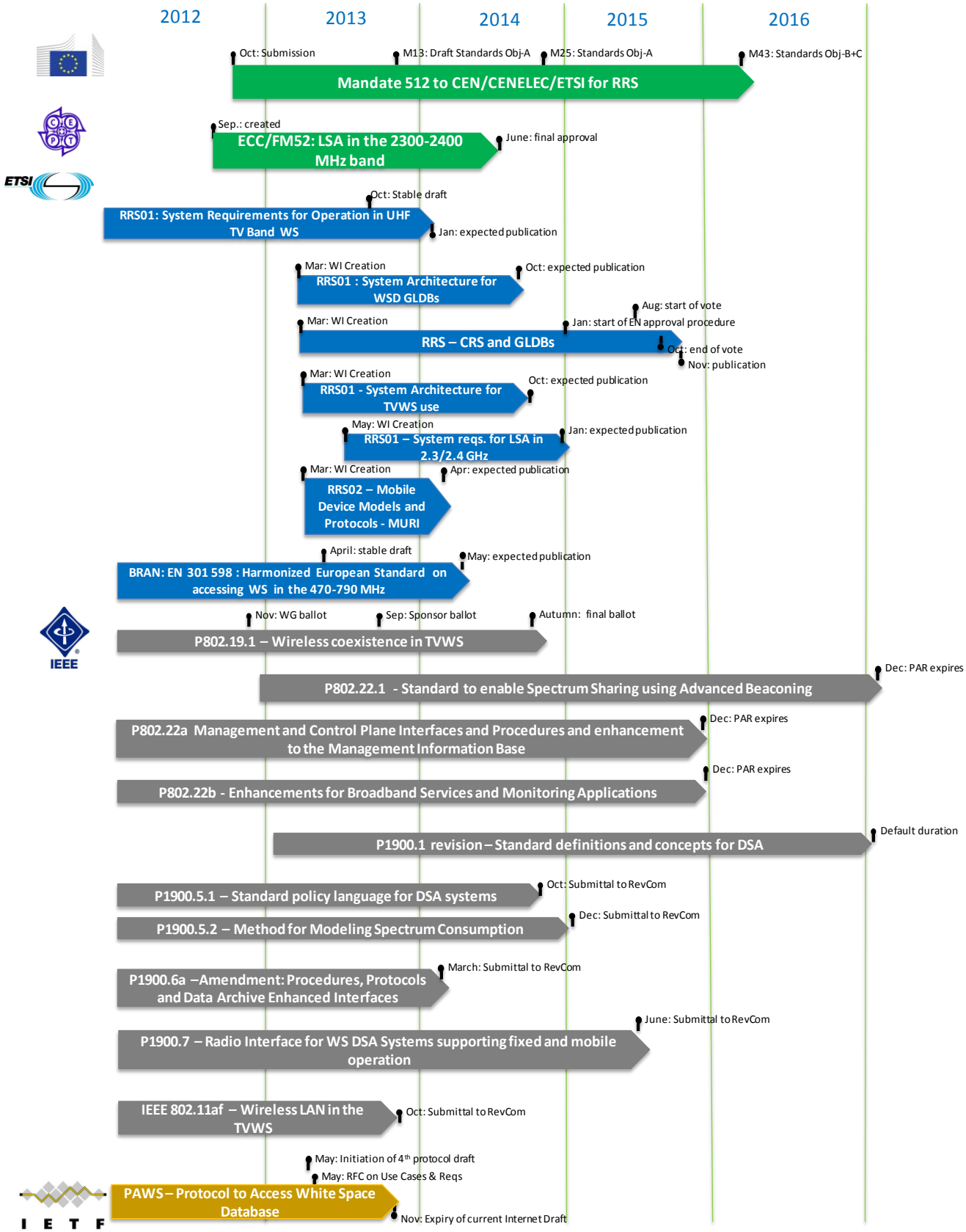

Figure 4: The overall CR roadmap (only shows active WI in June 2013).

5 Challenges to the effective participation of FP7 projects in CR global standardization

The generic challenges to the participation of FP7 projects in ICT standardization were identified by the IST Support Action COPRAS (COoperation Platform for Research And Standards) [13]. Many different issues creating barriers were pointed out by COPRAS, such as confidentiality, IPR or membership of a standards organization, mapping research activities with standards work, or finding the standards and standards organizations most relevant to a project, and contacting them. The conclusions of the COPRAS action final report state [13]:

> *"Despite the good overall qualitative and quantitative results, analysis of projects' and standards organizations' experience also shows that projects are many times too optimistic with respect to the standards work they will be able to complete, and frequently have to adjust their plans due to lack of resources."*

This means that the common approach of many projects to tackle as many standardization groups as available, often with very limited effort and with the common resource allocations, is counterproductive. This means that the necessary know-how and customised roadmaps for individual projects are needed to be able to overcome these barriers. CRS-i will address the main challenges, which are summarized in the following.

5.1 Challenge: Many standards – identification of the right standard family and best time window

Innovation through standardization requires identification of a target standard ecosystem and alignment of research and standard life-cycles. In particular, the CR standardization environment is a dynamic environment with several standards bodies and many working groups, making it relatively hard for research projects finding the organization(s) and particular working group that best fit their needs and objectives (this can be realised by the complexity of the CR roadmap described in Figure 4).

In the CR area there are many standards families with various degrees of maturity and intensity of activities as illustrated by Figure 5. As a consequence, windows for standardization often appear too short or are even missed out on, causing resources being wasted (both on the side of research projects and standards bodies), and projects' output not becoming available to industry and society.
What further complicates and slows down the process of CR Standardisation is the fact that this technology envisages a new use of radio spectrum which has to convince not only standards committees (e.g. ETSI) but also regulators (e.g. CEPT).

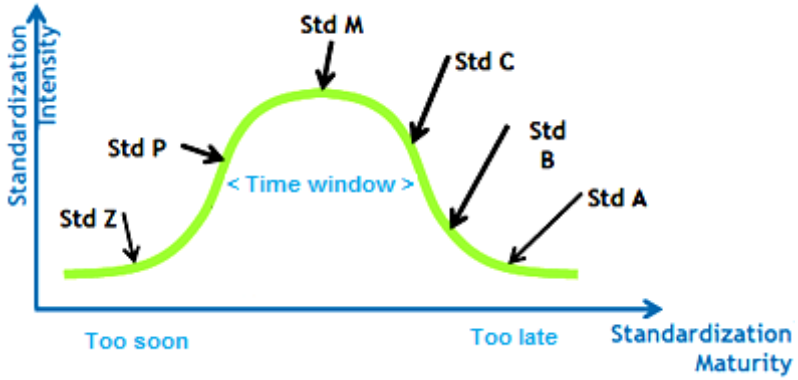

Figure 5: Understand the complex standard ecosystem is important to identify the best time window for project contributions, adapted from [14].

CRS-i approach
As in most research projects the actual standardization effort is rather low (in terms of allocated person months), projects often spread themselves too thinly to be able to make a meaningful contribution. Input to standardization groups is not only the provision of technical content, but it needs to be at the right time and needs to be followed up to be meaningful and impacting.
CRS-i, through its Consultancy Service, will identify and concentrate on the most promising standard developments and standardization groups, it will review their work plans and will make the research

projects aware about forthcoming opportunities and topics that would be positively received in the different groups. Research projects will then be able to concentrate on the technical contributions and immediate follow up rather than spending time and effort monitoring several standards groups.

5.2 Challenge: Lack of time, resources and effective industrial involvement to influence standards

Given the tasks and the resources required to interface with standards bodies, it can be a major challenge for the project partners to accommodate standardisation activities within an existing project programme or budget. In particular, partners in project consortia comprised of smaller or regional organisations may not have resources to regularly participate in standards activities including travel costs and fees for membership, but also effort required for the active monitoring and evaluation of contributions.

Another issue is that academic and SMEs contributions from FP7 projects are extremely valuable when contributing to the development of standards. However they need to advise or work alongside large industrial partners which have a much larger impact. Even in cases when project partners are global players and they do have standards delegates in other parts of their company, it does happen that the researchers are not able to get sufficient internal support from their companies.
Only certain participating members of the FP7 project may have access through membership (for example ETSI). Membership is important to get and keep voting rights and influence the standard. For instance, in ETSI a minimum of 4 ETSI members are required to propose a Work Item for a new standard.

CRS-i approach
To facilitate the access to standards, especially by SMEs participating in FP7 projects CRS-i will coordinate and support the submission of technical findings. In cases where project outcomes would be suitable but no project partner is able to submit the work themselves, CRS-i will identify potential caretakers that can help presenting and support submissions. Two key players in CR global standardization arena, NSN and NEC are CRS-i partners and they are committed to advise standardization initiatives from CRS-cluster projects.
Impact and exploitation activities in most research projects are kept to a rather small part of the overall budget, this means there is usually very little effort and time allocated for actual standardization activities. To be able to concentrate the available standardization effort in these research projects CRS-i will pinpoint the most suitable standards group, depending on the type of technical output from the research projects and will recommend the most efficient course of action that should be taken to achieve the best possible standardization impact during the life time of the research project.
CRS-i will create tasks forces with partners from CRS cluster projects to target specific CR standardization groups. These task forces will exploit results from FP7 projects on cognitive radio, avoiding fragmentation of standardization effort and unnecessary competition between EU projects and between standards.

5.3 Challenge: Legalities issues

Some standards bodies require that membership agreements between the standards body and a legal entity. This may be because there are provisions related to copyrights, confidentiality, etc. that can be sometimes difficult to interpret when dealing with an individual or project. Some project partners may have internal procedures that make it difficult for them to become a member of a standards body.

CRS-i approach
CRS-i will support projects that produce technical output that should feed into standards by either identifying suitable caretakers or proxies that can put research findings forward, e.g. in standard working groups with individual voting rights attendees can act as agent for the project. In such cases the project can use external individuals to pursue submissions that individual project members could not do.

6 The CRS-i consultancy service

The objective of the CRS-i consultancy service is to strengthen the position of the research projects that comprise the CRS cluster in standardization bodies related to cognitive radio at a global level, and to facilitate the exploitation of the European project outcomes.

The overall idea and information flow of the standardization consultancy service proposed by CRS-i is shown in Figure 6.

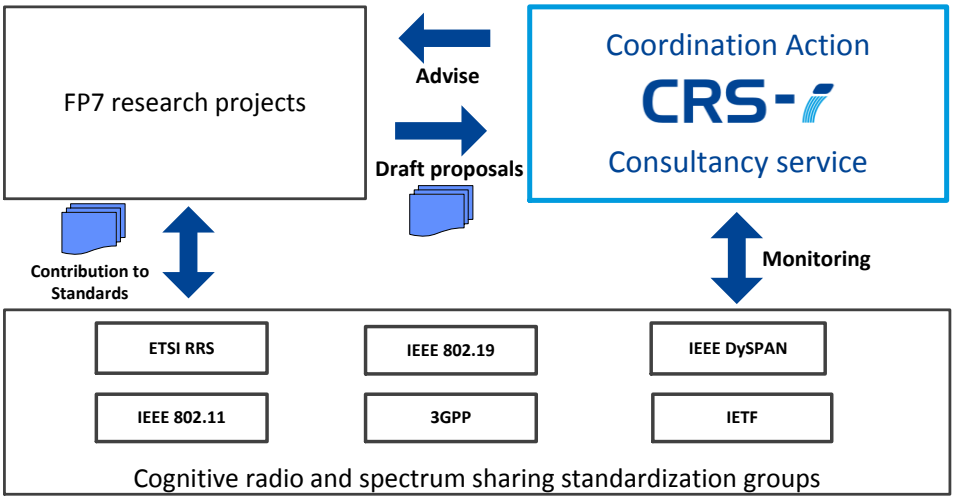

Figure 6: The CRS-i consultancy service

The standardization consultancy process is structured into the following phases:

1. The first step towards the initiation of the information sharing process between the CRS-cluster projects and the CRS-i Coordination Action is the establishment of the necessary legal framework to address confidentiality between them. To this end, as a framework to handle and govern the interactions and information exchanges with the various cluster projects, CRS-i provides a liaison agreement that outlines the nature of the interactions and the rules under which information shall be shared. The details of this liaison agreement can be found in [15].

2. CRS-i will determine and familiarize with the standardization target and potential of the CRS-cluster member projects and will derive a coherent standardization plan for each of them. Meanwhile, CRS-i will pro-actively investigate and seek opportunities for contributions to standards that potentially match the objectives of the different research projects.

   In this phase, the issues that need to be addressed by the CRS-cluster research projects are the following:

   - Determination of the project results to be standardized.
   - Selection of the most appropriate standardization body.
   - Selection of the proper time window for standardization.
   - Allocation of the funding required for membership, and participation to the different standardization activities.
   - Selection of the partners that will participate to the standardization process.
   - IPR ownership issues.

   In case that no suitable Working item is opened in any SDO another option is to trigger a pre-standardization activity (e.g. a TR (Technical Report) in ETSI)[3].

3. The FP7 projects (or, more specifically, the project partners responsible for the project standardization activities), based on their own standardization plans and research results, will

[3] ETSI also develops Technical Reports (named System Reference Documents (SRDoc)) providing technical, legal and economic background on new radio systems under standardisation and informs the ECC accordingly.

submit draft proposals to be analyzed by the CRS-i consultancy service. This will be done in a voluntary basis.

4. The CRS-i consultancy service will consider these draft proposals and will provide the respective recommendations with the aim to increase the likelihood of their acceptance by the target standardization bodies. Such recommendations include the appropriate time window and best location to standardize a specific Research and Development (R&D) result, editorial revision, etc. CRS-i will also pro-actively suggest potential convergence points between the different FP7 projects with potential for standardization, thus avoiding effort fragmentation and unnecessary competition between research projects and between standardization groups. Moreover, task forces can be built up in order to create sufficient momentum for successfully introducing new technical ideas into standardization or to initiate the foundation of a new Work Item or Working Group in standardization, if needed;

5. The FP7 project will then revise the draft proposal taking into consideration the CRS-i recommendations or will ask for further advice. Finally, the project (or the project partner responsible for the standardization activities) will submit the contribution to the target standardization Working Group;

6. The CRS-i partners, taking advantage of their deep involvement in the global CR standardization activities, will follow and support the contribution through the standardization process providing continuous feedback to the FP7 R&D projects. A mix of support from different types of organizations can be seen as a stronger endorsement of the EU project proposals.

To summarize, the benefits of the CRS-i consultancy service to the CRS-cluster research projects are the following:

- Derivation of a plan for interfacing with the various standardization bodies at the beginning of a new project's activities. This plan will allow the project to synchronize with relevant on-going standardization processes, and start the process of building the consensus required in order to achieve the project's goals;
- Selection of the most suitable standardization Working Groups for each research project;
- Provision of advice on the most appropriate time-window in order to achieve an effective standardization impact and the requested standardization procedure;
- Dissemination of calls for contributions among the different CRS-i cluster projects;
- Setting up a communication flow within the CRS-i cluster, concerning potential synergies and common interests across projects in standardization bodies;
- Following-up of the standardization contributions resulting from the interaction between the member projects and the CRS-i consultancy service.
- Provision of up-to-date information with respect to the discussions and progress in the CR standardization Working Groups.
- Circulation of information from standardization bodies that is directly relevant to the research community/projects.
- Creation of a platform for joint contributions and submissions to relevant standardization bodies.

7 A success story of CRS-i consultancy service

One of the main goals of CRS-i is to promote and assist in transferring relevant results of research projects into the best fitting standardization fora. This is an essential step in order to deploy new technologies into products and systems. This section introduces a case study of the CRS-i consultancy service throughout the process of submitting a research idea to a standardization body.

As an example for first achievements of the CRS-i standardization consultancy service, we refer to COST Action IC0902 (Cognitive Radio and Networking for Cooperative Coexistence of Heterogeneous Wireless Networks) [20]. After some interactions CRS-i has identified a potential contribution to IEEE 802.11 on self-coordination of channel assignment in adjacent Wi-Fi Access Points.

Working Group 3 of COST Action IC0902 is responsible for the definition of network-wide mechanisms for enabling the cognitive approach. This group has provided a Temporary Working Document on "Radio Resource Management Protocol for Control Plane Signaling of Co-operative Dynamic Spectrum Access Algorithms". Scope of this working document is the following:

- In Wireless Local Area Network (WLAN) deployment scenarios there is a very high probability that the access points (APs) of different manufacturers apply different algorithms to select the radio channel potentially leading to exaggerate interference.
- In order to properly cooperate, exchange of the needed information has to take place requiring beforehand the establishment of cooperation agreements among adjacent APs.
- A unified control plane signaling framework is required to allow multiple cooperative DSA techniques to operate on a general interface.

The protocol defines a common set of packet formats and procedures that allow the handling and exchange of basic agreement formation/negotiation messages. A simple negotiation procedure involves an agreement request including the proposed deal, a corresponding reply, and an ACK/NACK potentially leading to multiple message exchanges. The agreement can be renegotiated or terminated by using the same set of messages.

The proposed Radio Resource Management (RRM) protocol can be used for both inter-operator and intra-operator purposes allowing multiple vendor-specific/firmware specific algorithms embedded in the deployed Cognitive APs to interact. Renegotiations may happen when particular conditions arise.

On the other hand, the need for standardized methods for Automatic Channel Selection has been repeatedly raised in Wi-Fi standardization. Specifically, IEEE 802.11 is in early discussions on potential standard enhancements for "Carrier Wi-Fi". The "Radio Resource Management Protocol for Control Plane Signaling of Cooperative Dynamic Spectrum Access Algorithms" as been specified by the above mentioned Working Group 3 would be a potential candidate for solving the Automatic Channel Selection problem in Wi-Fi. That means: A potential standardization opportunity exists in IEEE802.11.

CRS-i, represented by NSN, discussed with COST Action IC0902 on the standardization potential of this contribution and has also assisted in drafting the standardization contribution. The contribution will be presented at the IEEE 802.11 plenary in Geneva in July 2013 as official activity of the COST Action IC0902. NSN will also assist in giving the presentations and in the relevant discussions.

8 Conclusions

Standardization is a global process by nature. Significant developments in CR and SDR have in recent years been achieved by a wide array of academia, research institutions and industry spread all over the world, and have been inputs to equally distributed standardization organizations –the vast majority of which have a global reach. Within Europe, some of the most prominent advances have been made by EU funded collaborative projects such as E2R, E3, SACRA, COGEU, OneFIT and QoSMOS, and many of these projects have actively pushed standardization, with the E3 project for example being at the basis of activities within both IEEE and ETSI. Therefore, most of the research foundations for CR advance are already laid in international collaborative programmes, and the standardization of these technologies also by definition needs to take place across boundaries, in order to create the necessary economies of scale for manufacturers and operators.

Despite recent advances, we concluded that barriers still remain to the efficient participation of FP7 projects in the CR standardization process and we have identified the main challenges to be addressed. In that regard, CRS-i aims to facilitate a more systematic policy driven approach, coupling R&D with standards.

Although many EU projects on CR are present in the standardization domain, and most industrial partners are aware of its importance for the commercial viability of CR solutions, standardization is but one of the objectives of these projects, and is usually –and logically- subordinate to the realization of technical objectives. As a consequence, the European CR standardization is fragmented, both within projects, between projects and between standardization organizations. Such fragmentation is firstly significantly slowing down the commercial introduction of CR solutions which, due to their high complexity, the degree of coordination required and the operational risks associated with any malfunctions, are treated with caution and restraint by vendors and operators as long as no regionally and globally standardized and certified systems are available. Secondly, it is also holding back reforms in the regulatory frameworks required to allow their introduction, since regulators equally demand industry-wide consensus on trusted systems for CR before committing to such reform. Thirdly, fragmentation between projects' standardization activities is undermining the position of European industry compared to its global counterparts and decreasing the overall impact of the EU FP7 research efforts into CR and SDR.

For these reasons, the coordination action CRS-i is implementing a European approach to coordinating research efforts towards the complex CR standardization ecosystem. The goal is to have a concerted, reinforced European input to the standardization of CR as a foundation for regulation and commercial deployment, while also promoting European IPR in the global domain.

To this end, this deliverable introduced the CRS-i consultancy service and described its structure and information flow, emphasizing on the benefits offered to the FP7 projects that participate in the CRS-cluster. These are summarised as follows:

- Derivation of an efficient plan to provide an interface to the various standardization bodies at the beginning of a new project's activities;
- Selection of the most suitable standardization Working Groups for each research project;
- Achievement of an effective standardization impact through advice on the most appropriate time-window and the requested standardization procedure;
- Dissemination of calls for contributions among the different CRS-i cluster projects;
- Setting up a communication flow within the CRS-i cluster, concerning potential synergies and common interests across projects in standardization bodies;
- Following-up of the standardization contributions resulting from the interaction between the member projects and the CRS-i consultancy service;
- Provision of up-to-date information with respect to the discussions and progress in the CR standardization Working Groups;
- Circulation of information from standardization bodies that is directly relevant to the research community/projects;
- Creation of a platform for joint contributions and submissions to relevant standardization bodies;

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