



Adaptive Reconfigurable Access and Generic interfaces for Optimisation in Radio Networks – ARAGORN

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Abstract:

ARAGORN is mainly a scientific project, so its major dissemination focus is towards scientific and industrial research community, enhanced with a strong dissemination towards a chosen standardization forum (SCC41).

Keywords: Cognitive radio, cross layer-optimization, resource management, generic API, cooperative communication, project presentation, dissemination strategy.

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Glossary and Definitions

Term	Description
ARAGORN	Adaptive Reconfigurable Access and Generic interfaces for Optimisation in Radio Networks
CAPRI	Common Applications Requirements Interface
CFR	Consorzio Ferrara Ricerche
CRM	Cognitive Resource Management/Manager
EC	European Commission
EMIC	European Microsoft Innovation Center
FEEIT	University Ss. Cyril and Methodius, Skopje, Faculty of Electrical Engineering and Information Technologies
FP	EU Framework Programme
GENI	Generic Network Interface
ICT	Information and Communications Technology
IEEE	Institute of Electrical and Electronics Engineers
IET	Institute of Engineering & Technology
IPR	Intellectual Property Rights
ISM	Industrial, Scientific and Medical (Frequency Band)
NSF	National Science Foundation, USA
RAS	Radio Access and Spectrum
REU	Research Experiences for Undergraduates
RWTH	Rheinisch-Westfälische Technische Hochschule (RWTH-Aachen University)
SCC41	Standards Coordinating Committee 41
STM	ST Microelectronics
TPC	Techical Program Committee
TREL	Toshiba Research Europe Limited
TRL	Telecommunication Research Laboratory , Toshiba Research Europe Limited
UCL	University College, London
ULLA	Unified Link Layer API

1 Introduction

The technical objective of ARAGORN is to research and develop technologies and cross-layer techniques for efficient utilization of the radio resources in a cognitive fashion. In addition to fulfilling the technical objectives, the ARAGORN consortium members are motivated and committed to disseminate the research results and exchange ideas with the community to raise awareness about the capabilities and potential of cognitive radios among different groups of target audiences. This document describes how the project presents itself to different audiences and the strategies chosen for communicating with the target audience groups.

A general dissemination outlet is created by exposing the relevant ARAGORN project outcomes through a web-site. This serves as a public front-end of ARAGORN to the community at-large. In addition to the website, the consortium intends to exploit their excellent links into other European research activities in order to maximise collaboration at the European Projects level. Suitable results will be published in academic forums (like journals and conferences), tradeshows, company organized events and trade magazines.

As the communication modalities for different audiences need to be addressed this document is made to keep the track and plan different project presentation needs.

2 General Dissimination strategy

ARAGORN is mainly a focused scientific and technical project with an objective to perform quality research in the domain of cognitive radio networks. Hence a major dissimination focus is towards scientific and industrial *research* community. The consortium plans to have a dissimination strategy targeted mainly towards this community. However, we are also proactively directing part of our dissemination and exploitation opportunities towards in the IEEE Standards Coordinating Committee 41 (SCC41) that is involved in standardizing Dynamic Spectrum Access Networks. This is our project presentations we have to take care also about standardization type of dissemination

As a targeted research project with a clear vision, consortium will streamline its efforts towards dissemination by laying following ground rules. In order to achieve maximum impact while efficiently using of project resources, consortium will liaise with other projects in dissemination activities. As the major goal of the project presentations is towards technical and research community, this is also where we are using most of our limited resources. The following general dissemination strategy issues are thus followed:

1. ARAGORN prides itself being a professional project with serious organizations participating into it. We avoid unnecessary waste of resources for work that will not produce results. As such we have decided not to make "empty press-releases" or instead when necessary project results will be communicated through best channels to achieve maximum impact.
2. The major goal is to provide technical presentations, as papers and talks, which will clearly tell technical experts to value of ARAGORN project and innovations done within it.
3. The goal is to make the work visible not only for outside technical community through scientific articles and other dissemination, but also to evangelise within our own organizations early on to prepare for later exploitation.
4. Although our primary audience is scientific community, consortium expects to put some efforts to disseminate project results to a wider audience including industry and standardization bodies.

The different audiences require different project presentations, but the constant theme will be to present the ARAGORN consortium, the unified vision and scenarios. However, the technical content and especially exploitation trajectories will vary, including also the format of the presentations. As the main focus of the project is to show our technical relevance and scientific quality to majority of the presentations are not "administrative", this meaning that we avoid marketing ARAGORN as "person months" and "WPs" projects, instead our message is focused to technological challenges, solutions and European partnership solving them.

3 Project presentation modalities and target groups

3.1 *The project portal for all different audiences*

The ARAGORN project has created a new website (<http://www.ict-aragorn.eu/objectives.html>) that serves as a portlet to the external world. The webpage is available since M1. RWTH is now working with the new Typo3 based version which will be released soon. In addition to enhancing the visual image of the web-page, this upgrade will provide better editing capabilities for the partners to disseminate the information regarding ARAGORN. The webpage also hosts all the major deliverables and general information for the project. Within limitations of copyrights, we will also try to put pdf-files of our articles available from the web-page. A new professional logo has been also designed by RWTH for ARAGORN to deliver a corporate image to the project.

The project forms the corner stone of our outside project presentation. Due to that it will be kept up to date and design as clean as possible in order to enhance the visibility of the project. The web-page is maintained by the coordinator, but all the partners, esp. commercial partners, are participating into content production and reviewing of the web-presence.

3.2 *Scientific and Industrial research community*

The scientific and Industrial research community is one of the primary target audiences to dissipate the research ideas and results that are carried out as a part of ARAGORN. The consortium plans to achieve this through presentations, scientific papers, and well targeted tutorials.

Discussing the research projects and results through tutorial sessions are seen as an important “new” method to increase the visibility and credibility of ARAGORN. The consortium members also plan to publish the project results in competitive international conferences and journals. The paper presentations at the conferences attract the scientific community who are present to have a closer look on ARAGORN. Publications also create awareness about the project ideas and aid in disseminating the technical findings of the project to an international group of academic and industrial researchers.

The consortium also plans to arrange for external talks about the project at various applicable research venues. While this is one of the main approaches of disseminating ARAGORN projects, the members will also organize internal talks within our own organizations to spread the information among the the faculty members, colleagues and the graduate and undergraduate students.

The presentations towards scientific and industrial research communities are done by all the partners, so this activity is not limited to academic partners. Although the general project description is agreed with partners, the partners can do individual visual image for any of their scientific presentations. The only constant part is the use of ARAGORN logo, and acknowledgements to ARAGORN.

The consortium has also internally agreed on the process, how to handle review and acceptance for various submissions towards conferences and journals. This process is streamlined efficiently to support strong scientific and industrial dissemination, but still ensures that the legitimate concerns on the protection of IPR is ensured. For the rapid decisions also coordinator is empowered to give some limited unilateral authorizations. The process itself is also enhancing the image of ARAGORN as a major targeted research project, which has high ambitions in the domain of publications and presenting itself for technical community. The openness of the communication is one of the hallmarks we have selected for the ARAGORN.

ARAGORN aims to obtain high visibility to its research results in the wider scientific and industrial community. We will also expect to meet this target. To realistically achieve this ambitious objective, consortium will exploit collaboration opportunities including other EC projects whenever applicable. As a focused collaborative research project, our man-power and dissemination budget will not allow large dissemination campaigns. But we expect to also benefit from the collaborative projects and efforts. For example, consortium has already in discussion with the FP7 E3 project to understand common objectives and possible areas for collaboration. Initial discussions disclosed common interests in topics related to radio resource management and in particular common dissemination targets (including SCC41). In future discussions, consortium will focus on identifying joint workshop and/or demonstration opportunities. In addition, ARAGORN will participate in the EC concertation cluster "Radio Access & Spectrum" (RAS) [2] aims to provide a platform for exchanges and concertation between FP6 and FP7 projects. The project coordinator and another academic partner are also a member of several TPCs in the field, and also participate actively to newly formalized IEEE Technical Committee on Cognitive Networks. These involvements also increase our dissemination capabilities and visibility inside the community.

3.3 *Standardization committee and Industrial relevance*

Despite significant efforts in research and standardization of cognitive radio systems over the years, wireless world is yet to see a full cognitive radio system in deployment. Industry has shown some reluctance to adopt CR techniques especially related to dynamic spectrum management partly due to lack of experimentation results and incomplete understanding of implications of using them. One of the main objectives of ARAGORN is to demonstrate advanced cognitive techniques in a realistic and near time wireless deployment environments, using existing frequency band allocations. Project will not only develop enabling technologies to provide an evolutionary path to realize advanced radio resource management technique but also will make ARAGORN technology specifications and reference implementations publically available. To achieve this, consortium recognises the importance of raising awareness of ARAGORN project within the industry possibly through participation in standardization and industrial forums/exhibitions etc.

Involvement in standardization committees is an effective form for proactively participating in leading future research direction in a technical area. With the vast technical expertise, the ARAGORN consortium will use this targeted approach for not only disseminating the research results, but also exploiting the long-term impact the standardization group provides for leading the way for research in cognitive radio networks. However, as the overhead for standardization is high, and the processes are slow one has to carefully select where to participate in.

The consortium plans to have a participation in the IEEE Standards Coordinating Committee 41 (SCC41) that is involved in standardizing Dynamic Spectrum Access Networks. This standardization group focuses in the "areas of dynamic spectrum access, cognitive radio, interference management, coordination of wireless systems, advanced spectrum management, and policy languages for next generation radio systems" [1]. After careful consideration, the "IEEE P1900 Standard" (by SCC41 group) was chosen as main exploitation and dissemination forum. IEEE P1900 deals with standardization efforts towards new technologies and techniques for next generation radio and advanced spectrum management. The consortium actively involves in participating in the SCC41 through submitting technical proposals and participating in face-to-face meetings and teleconferences. The experiences and the trends observed in the SCC41 is disseminated to the internal members through discussions and presentations.

In the participation towards SCC41, we have chosen an approach where in the beginning one partner (TRL) is providing a single "corporate face" towards IEEE P1900. TRL is also formally member of the

standardization committee; however, they are empowered to give ARAGORN presentations in IEEE P1900. This approach is chosen to ensure efficient communication, and to ensure cohesive message towards standardization. We will later consider also ARAGORN consortium membership towards SCC41, but even in this case it is planned that ARAGORN will clearly distinguish itself through “spokesman” and that all the partners will provide consistent and technically coherent message towards SCC41.

3.4 *Graduate/Undergraduate students*

ARAGORN takes positive steps towards educating the next-generation researchers and engineers by spreading and sharing the research ideas with graduate and under-graduate students. Academic partners plan to advertise several thesis topics for Master students in order enable them to learn about the technical advances in the cognitive radio domain and will also enable the flow of fresh ideas into this research area. The communication policy in this domain is that when advertising thesis topics for students is that we expose the name of ARAGORN project to them. Also the plan is that their work is integrated to ARAGORN so that their thesis works can acknowledge ARAGORN, and when applicable and possible such students can also participate to some meetings. This way we will integrate some of the students more into European research area and educate them on the workings of framework programmes.

Educating the undergraduate students about the up-to-date research activities has been used in many developed communities (like REU program by NSF, USA). The academic members of the consortium plans to integrate the research experiences and results of ARAGORN to some of the university courses to make students aware of this research. When applicable such teaching material might also mention ARAGORN-project as a source of the material.

3.5 *Public outreach*

As highly targeted high-tech research project the main goal is not to make public outreach. This would be complex due to lack of dissemination resources, and also the nature of the work is such that it is not easy to popularize. However, we will be actively looking opportunities and if such will come up we will grasp those.

Because of the cross disciplinary nature of cognitive radio/networking concepts, it is important to disseminate results to a broader audience in particular to industrial and academic communities working in other engineering and technology discipline or in other words outside networking and communications area. Consortium expects to reach such technical conversant audience in other fields by publishing project results in general engineering and technical magazines (e.g. IEEE Spectrum, IEEE Computer, and IET Engineering & Technology).

The consortium is carefully analyzing the possibility to include “public outreach” components to our web-page. The university partners are reviewing the possibility to make general public talks and articles, if the impact is deemed relevant. Probably the issues such as spectral efficiency, “smart radios” and how to use “spectrum opportunities” could be also popularized.

The web-portal is effectively used to reach the general public. If there is opportunity within our organizations to get some more general (“popular”) articles done from the topic area, or for example there is spontaneous interest from mass-media (or e.g. EU public relations), we will be very open to use some resources to make such public outreach. If such opportunities will be coming up, those will be coordinated through the coordinator and UCL, who is another partner who have taken

responsibility to help dissemination WP-leader (TRL) on coordinating public outreach opportunities., It is to be expected that most of the public outreach were mostly done by academic partners.

3.6 *General Material*

The consortium will create a set of slides that are made available through the web portal. This will help all the partners to make quick demonstrations and talks on the ARAGORN project. It will also reach out to the university students and the public by summarizing the project reports in a few easy-to-read slides.

For more scientific and corporate purposes we use customized presentations. A 5-slides short general summary of the ARAGORN project is produced for short presentations that can be used by partners. This has been used also in concertation meetings.

A one page general flyer was produced for different meeting and EU concentration purposes. This flyer will be updated by M7 (RWTH) to make it more general purpose and to enhance visual appearance, e.g. with the new logo that was designed.

RWTH has also designed a general poster describing ARAGORN-project which can be used in different venues. The template will be available also for all the partners for customization purposes.

4 Conclusion

ARAGORN project aims to develop enabling technologies to realise cognitive wireless networks. The original philosophy is to fill the current gap in the knowledge and experience in practical cognitive radio systems, by demonstrating advance cognitive radio techniques in real and near-term deployment environments. To achieve this, firstly ARAGORN expects to use off-the-shelf equipments and already allocated frequency bands. Secondly, instead of focusing only on radio resource management, ARAGORN will consider the whole protocol stack empowering the various modules within a terminal and hence associated stakeholders including users, application developers, network operators etc.

Consortium believes that ARAGORN will make a significant contribution to research knowledge. Partners have identified numerous dissemination and exploitation avenues to realize this vision. Primary audience for ARAGORN project will be the research and scientific community in academia and industry. They will be reached through publication and presentation in research results in relevant conferences, workshops and journals.

ARAGORN project intends to make the technical specifications and reference implementations of the developed technologies publically available for use by anyone. The motivation for this will be to promote wider adoption of open and standardized cognitive network frameworks as an evolutionary path to realise fully cognitive communication systems in the future. Consortium would raise awareness mainly through participation in industrial forums and collaboration with other research projects. Participation in relevant standardization such as P1900 projects of IEEE SCC41 is another suitable strategy which has already been identified.

Industrial members of ARAGORN project are planning ways to exploit project results in their own products and services. With better visibility, and first hand know-how and knowledge, they are in a better position to use the ARAGORN technology in innovative ways. Further, they have identified importance of raising the profile of ARAGORN project within the wider industry since multi-vendor and/or multi-operator deployment scenarios are expected to be a common feature of many of future wireless systems.

Overall, consortium is fully committed to exploit the opportunities that will be created by the ARAGORN project. They have already identified the potential stakeholders and suitable strategies to maximize impact of ARAGORN in cognitive wireless networking research.

References

- [1] "IEEE Standards Coordinating Committee 41 (Dynamic Spectrum Access Networks)"
<http://www.scc41.org/>
- [2] EC Radio Access and Spectrum (RAS) Cluster <http://www.newcom-project.eu:8080/Plone/ras>
- [3] "Project factsheet", Factsheet for ARAGORN project, http://www.ict-aragorn.eu/docs/Project_factsheet_ARAGORN_D1.pdf.

Appendix A ARAGORN Project Summary

Introduction

The ARAGORN project is aiming at designing and applying machine intelligence and adaptive communications technologies to optimize wireless networks and provide several necessary key enabling technologies. The goal especially is to apply methods originating from the artificial intelligence community in order to increase the efficiency and system performance of the present day and future systems following the cognitive radios and networks paradigm. The developed technology is addressing the issue of increased system complexity of reconfigurable and software radio based devices and enables co-operation between smart objects. In the context of cognitive radio, the ARAGORN project is not focusing on the Dynamic Spectrum Management but on the whole protocol stack. Hence, we concentrate on the initial Cognitive Radio vision bringing cognition and machine learning to the wireless devices enabling them to optimize their settings and lower the need for pre- or re-configuration by human beings.

Work Plan

The proposed research will be organised as six work packages. WP1 is MGT workpackage for administrative and technical project management:

WP1 – Management

In addition, the project will have five RTD-workpackages:

WP2 – Generic Interfaces and Multilink-Multiradio Support

WP3 – Cognitive Resource Management and System Architecture

WP4 – Cooperative Spectrum Resource Management in ISM-bands

WP5 – Prototyping and Scenarios

WP6 – Dissemination & Exploitation

WP2 will work on the new interfaces GENI and CAPRI and provide the enhanced version of the ULLA. The main outcome of WP3 will be a system level architecture with the CRM as the main component. WP4 will work on the scenario of enhanced inter-working between different systems based on the use case of systems working in ISM-bands. Finally, WP5 will concentrate on scenarios and prototyping. It will also perform the overall system integration. WP6 will handle all project-wide dissemination activities and prepare successful exploitation of the project innovations.

The management workpackage WP1 will naturally run throughout the whole project lifetime

System Architecture Proposal

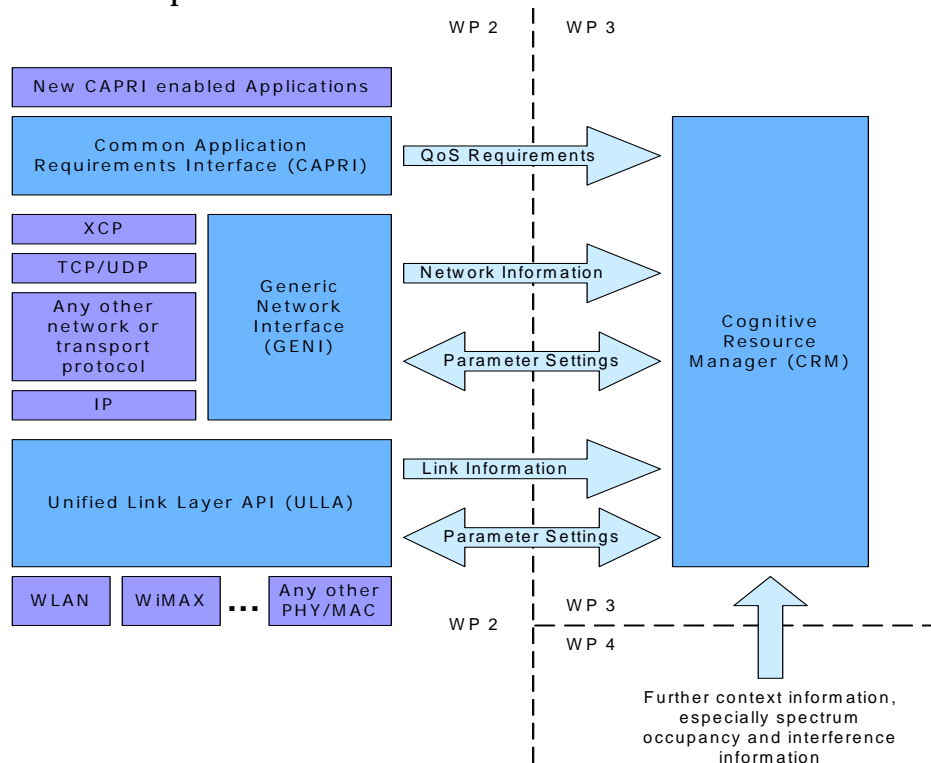


Figure 1: Proposed System architecture of an ARAGORN-enabled node

The figure above shows the abstract system architecture as it could be used in ARAGORN-enabled communication systems. The central entity is the Cognitive Resource Manager (CRM) that combines reasoning and resulting actions and optimizes the whole system. It gets information from lower layers through an enhanced version of the Unified Link-Layer API (ULLA), from network and transport layer through the Generic Network Interface (GENI) and from applications through the Common Applications Requirements Interface (CAPRI). This information is used in the CRM through machine learning algorithms to make systems situation aware and to build a world model.

The CRM can gather information through all three generic interfaces but it can also update the settings of the four major protocol layers. The QoS requirements of running applications are provided to the CRM through CAPRI. Due to this fact, the cross-layer optimization in ARAGORN can be seen as targeted optimization, where optimization targets are informed through CAPRI, optimization space possibilities are gathered through GENI and ULLA, and the optimization itself is finally done by the CRM. The ARAGORN-project chose the inter-working of multiple different systems in the ISM-bands as one use case. The required information about the spectrum occupancy and interference situation is provided to the CRM as one example of further context information.

Objectives:

The main expected outcomes of the project are a solid basis of theoretical and architectural work for next generation cognitive radios and networks and a working prototype implementation. The prototype will apply the developed techniques and prove their practical feasibility working in one of the ISM frequency-bands.

The following list summarises the technical goals set by the Aragorn project:

- The project will study, propose, and implement appropriate methods to provide cross-layer optimization for wireless communications, and will provide useful abstraction of underlying communications facilities.

- The project will develop and implement a Cognitive Resource Manager (CRM), which optimally manages spectrum resources, networking and link parameters, using information from applications, network and transport layers, and lower OSI-layers and will enable the use of historical and collaborative information sharing. This will all be done to gain better overall system performance and more efficient resource usage.
- CRM will use machine learning and artificial intelligence algorithms that are tied with the low-complexity optimization and pattern recognition methods.
- The interfaces that CRM will require to access all required state information and update the parameter configuration in a cross-layer fashion will also be designed and their technology- and platform-independent specification will be made publicly available.
- The system will be experimentally tested and validated with reconfigurable devices and implementation work will be conducted. This work will focus on the ISM-band because of regulatory restrictions but also because such state-of-the-art testing and validation work will have also inherent exploitation value of its own through the generation of novel new diagnostic measurement and evaluation systems.

Consortium:

Project team possesses a unique combination of expertise and forms a well chosen team of academic (e.g. UCL, RWTH) and industrial partners (e.g. STM, Microsoft, Toshiba Europe) which already participate in related standardisation work.

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Appendix B ARAGORN Project factsheet

The two-page project factsheet summarizes the ARAGORN project and is publicly available on the ARAGORN website [3] and has been disseminated in different EU and national meetings. Figure 2 and Figure 3 depicts the pages of the factsheet.

Adaptive reconfigurable access and generic interfaces in radio networks

The primary aim of the ARAGORN project is to research and to develop a Cognitive Resource Manager for collaborative wireless networks. The cognitive radio approach aims to ensure that efficient use is made of both node-local and shared resources. The project consists of seven partners from four European countries.

At A Glance: ARAGORN
Adaptive reconfigurable access and generic interfaces for optimization in radio networks

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Duration: January 2008 – June 2010
Total Cost: € 4,194,637,00
EC Contribution: € 2,636,773,00
Contract Number: INFSo-ICT-216856

Figure 2: Page 1 of the factsheet

Technical Approach

The project aims to generate not only new knowledge and methods, but also provide practical impact for the future wireless devices. The application of machine-learning methods to wireless systems has a high potential to lead a paradigm shift on the efficient use of wireless networks.

Technical and strategic goals of the project will be implemented by five workpackages.

Workpackage 1 will be responsible for the overall management and coordination of the ARAGORN project. The project will design generic interface for CRM to be able to access all required state information and update the parameter configuration in a cross-layer fashion. Final interfaces will be reported and validated by Workpackage 2.

ARAGORN will develop and implement a Cognitive Resource Manager (CRM), which optimally manages the spectrum resources, networking and link parameters, using information from applications, network and transport layers, and lower OSI-layers.

ARAGORN will also enable the use of historical and collaborative information sharing to achieve better overall system performance and more efficient resource usage.

Workpackage 3 is responsible for these scientific and technical tools.

Workpackage 4 will develop or enhance existing solutions for representation of spectrum occupancy and interference information. WP4 will address the tangible problem of interworking of non-cooperative systems working in the same frequency band.

ARAGORN will prototype, test and validate the system on a reconfigurable hardware with advanced software control. All verifications and specifications will be released through Workpackage 5. The project will yield a hardware prototype and a software reference implementation that are validated in WP5.

About the Consortium

The consortium consists of seven partners from four different European countries. The participants have a proven track record on research and many of its partners have been the first movers in the domain of cognitive radios. The consortium is also striking a strong balance between academic and industry excellence in the field.

The partners are well connected not only in the research community but also have relevant contacts to standardization groups such as SCC41.

Expected Impact

Apart of building core-scientific competence for European academic and industrial partners we actively seek to apply methods to consumer-oriented products. One of the key impact expectations is to apply Cognitive Resource Manager to ISM-band devices.

The overall system and cognitive resource manager will be prototyped on reconfigurable hardware with advanced software control. The experiments will be performed mostly in the 2.4 GHz ISM-band. The planned impacts of these experiments are to show feasibility of the chosen approaches, but also prototype the first exploitation steps towards incorporating technology into commercial ISM-band devices.

Developed tools and methodologies will be published and tools will be distributed through suitably chosen licensing rules. We expect to leverage tools and methodology development in the dissemination and exploitation of the project. Especially open dissemination of the results and tools is expected to influence cognitive radio networks community and other project.

The ARAGORN partners will actively contribute to the appropriate standardization entities.

Figure 3: Page 2 of the factsheet