FARAMIR: Enabling Spectrum-Aware Radio Access for Cognitive Radios

The main goal of FARAMIR is to research and develop techniques for increasing the radio environmental and spectral awareness of future wireless systems. Holistic approach is taken in order to coverer technology development from spectrum sensing to spectrum use models and their application in network optimization.

At A Glance: FARAMIR

Flexible and spectrum-Aware Radio Access through Measurements and modelling In cognitive Radio systems

FARAMIR

A Cognitive Radio Project
Making Cognitive Radios Reality

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Duration: *January 2010 – June 2012*

Funding scheme: *STREP*

Total Cost: €**5.37***m*

EC Contribution: €**3.46***m*

Main Objectives

The next generation mobile radio technologies must be optimised better to exhibit cost, spectrum and energy efficiency. The previous decades long approach has been based on "generations game" (1G, 2G, 3G), where increasingly more complex standards with massive efforts have been developed.

FARAMIR moves the state of the art in cognitive radios from concepts to factual engineering science and business

Although this mainly air interface and standardization driven work has been successful so far it is starting to have problems due to diminishing return of investment. Recent measurements have also indicated that although spectral efficiency of many technologies is remarkably good, the spectrum itself is mostly under utilized. Moreover the reallocation of spectrum to different services or providers is a slow and cumbersome process because the interests of numerous stakeholders have to be considered and international coordination is required.

Recently cognitive radio (CR) and cognitive wireless network technologies have been proposed as a new paradigm to reduce management complexity, enabling heterogeneous networking, and as a technique to exploit spectrum more efficiently. This is achieved either through Dynamic Spectrum Access (DSA) or by employing other flexible and more optimal spectrum and resource allocation techniques.

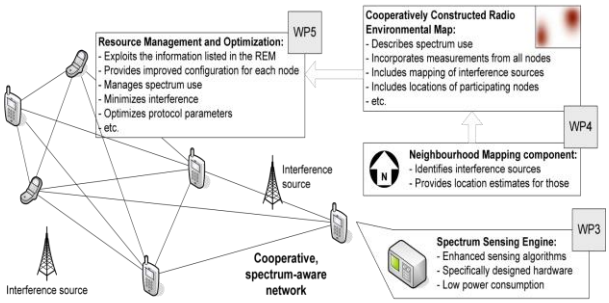
FARAMIR-project is specifically designed to change this by moving the state of the art in CR and DSA **from "concepts and order of magnitude estimates" to the "factual engineering science and business by providing facts, field trials and *focused technology development".*** As a focused project FARAMIR has measurable and targeted technology goals, which have been chosen to provide a good science and exploitation basis both in the short- and long term. The overall goal of FARAMIR is to develop advanced and pragmatic sensing mechanisms, and enable their exploitation to increase the spectral efficiency of wireless systems.

Technical Approach

The work in FARAMIR is organized into following technical work packages.

WP2 develops the system architecture and reference, and studies in depth the possible use cases and scenarios for applications and prototyping. The main components include distributed spectrum sensing and spectrum management. The developed architecture will be extended to include hybrid networks that are able to support both cellular type of operations and ad-hoc type of operations. The system architecture will consider coordination between the different networks and elements that share the spectrum as well as the enabling elements and procedures. Moreover, it will take into account the required capabilities of the different types of radios and functional components such as sensing, databases, reconfigurability, decision-making, etc.

WP3 has two major thrust areas. One is the development of new spectrum sensing concepts and empirical models of spectrum use. The work package also coordinates and conducts several long-term measurement campaigns in different European countries. The work on spectrum sensing will consider algorithmic and implementation aspects. This integrated approach will guarantee practical relevance of the project. This work package will also develop new low-cost CMOS based spectrum sensing technologies that will be prototyped.



WP4 develops algorithms and protocols for cooperative spectrum sensing. In addition to coherent and energy detection approaches, feature detection techniques will be investigated. Moreover novel interference localization algorithms will be studied. We will also develop the required information models for the radio environment maps. We also make trade-off analysis, which takes in the account accuracy, costs of information exchange, data fusion algorithms and architectures complexity of cooperative sensing systems.

WP5 applies the project results to radio resource management (RRM) problems. Parameters necessary for the terminal to enable cognition and context-awareness for achieving near-optimal capacity and spectral efficiency will be analyzed and novel optimization techniques will be developed.

Finally, **WP6** integrates the outcomes of the technical work of other work packages, and will develop prototype implementations that will be extensively tested and verified in field trials.

Key Issues

The core task of the project is the development of functional and realistic reference architecture for cognitive radio networks that utilize radio environment maps (REM). We apply the developed architecture and REMs to develop novel optimization technologies for future radio systems. FARAMIR will develop a comprehensive technology chain for this and will show how radio environmental information can be measured, collected, and represented efficiently.

Consortium

The consortium consists of ten partners from nine different 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 academia, industry and regulators. The partners are well connected not only in the research community but also have strong contacts to standardization groups.

Expected Impact

Apart of building core-scientific competence for European academic and industrial partners we actively seek to apply methods and developed techniques to products and standardisation process. The project aims to enhancing the competitiveness of European industry in the area of *wireless devices, networks and new applications,* specifically by innovating better radio and spectrum optimisation methods, adding intelligence and machine-learning capabilities to RRM and REM modules. FARAMIR is also strengthening of the Information Society by providing technologies that *ensure affordable, robust and resource-friendly wireless access methods* towards information sources.

Developed tools and methodologies will be published. The project will also distribute most of the data that is generated by spectrum measurement campaigns. This open dissemination of the results and tools is expected to influence cognitive radio networks community and other project. The FARAMIR partners will also actively contribute to the appropriate standardisation.