

# Enhanced Wireless Communication Systems Employing Cooperative Diversity

The project aimed at researching, developing and validating radio technologies exploiting channels diversity and cooperation between users, targeting three major goals: enabling high bit rates in the broadband component of future wireless system; improving the power and spectrum efficiencies of existing wireless systems; improving and extending coverage and fairness. The project targeted the evolution of cellular networks and WMAN's.

### Main Project Team

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### Funding Agencies

	700K€
Start Date	01-01-2008
Ending Date	01-12-2010

### Indicators

Journal Papers	6
Conference Papers	12
Patents	1
Concluded PhD Theses	2
Concluded MSc Theses	4

### Two Main Publications

V. Gil, A. Gameiro and A. Armada, "Space-Time Code Diversity by Phase Rotation in Multi-carrier Multi-user Systems" EURASIP Journal on Wireless Communications and Networking 2013

V. Gil, C. Ribeiro, A. Gameiro, A. Garcia Armada: "Virtual Maximum Ratio Transmission for Downlink OFDMA Relay-based Networks", Wiley Journal on Personal Communications 2010

### PROJECT WEBPAGE URL

[http://www.it.pt/project\\_detail\\_p.asp?ID=1055](http://www.it.pt/project_detail_p.asp?ID=1055)  
[www.ict-codiv.eu](http://www.ict-codiv.eu)

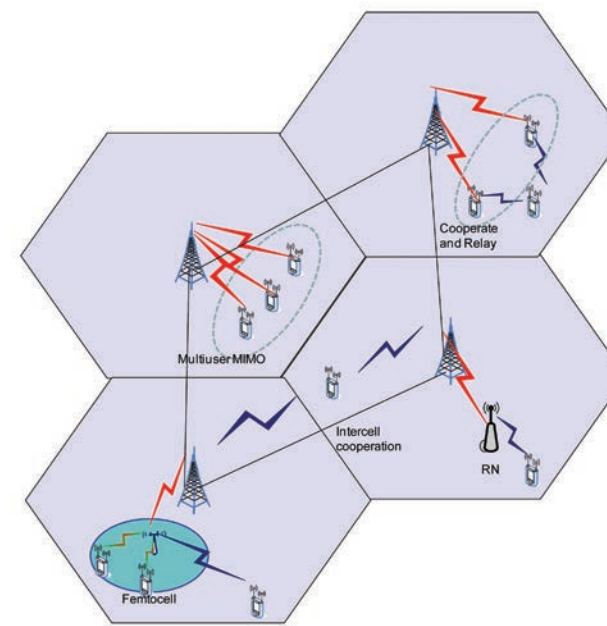


Fig. 1 Reference Model for the project.

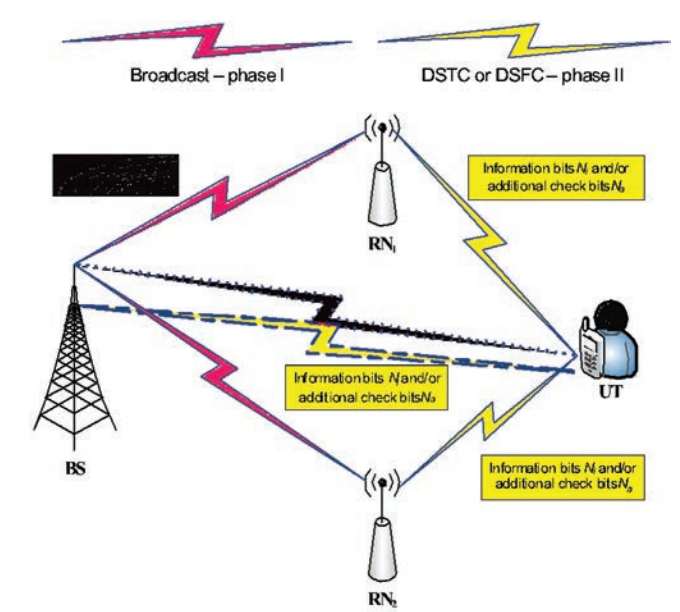


Fig. 2 Concept for Enhanced Communication Using Relays.

### MOTIVATION

Wireless systems are one of the key components for enabling the information society. Wireless networks and related services will become as pervasive as microprocessors are today. Therefore it is expected that the demand for wireless services will continue to increase in the near and medium term, calling for more capacity and putting more and more pressure on the usage of radio resources. From a high level perspective the shape of the future wireless and mobile area will be dictated by the interaction of four different types of forces and constraints. The market demand sets the general goals and requirements which are constrained by the OPEX/CAPEX issues, regulations and also the public concerns about some aspects of the technology. The innovation and research activities have to provide solutions that efficiently combine the conflicting trade-offs between goals and constraints. The main motivation of the work was to provide an efficient answer to these requirements, which may be conflicting. The objectives were therefore: to develop and optimize combinations of physical and network techniques based on intercell and wireless intracell cooperation in a cellular enhanced architecture to increase network capacity and coverage, improve flexibility, robustness and fairness, and demonstrate their feasibility.

### ACHIEVEMENTS

Achievements are classified in several categories and summarized as follows:

System Concept: a clear definition of scenarios and system model to augment a cellular system through cooperative relaying.

Algorithmic development: several competitive algorithms were developed and evaluated.

In the physical layer, after completion of the studies on algorithms to be integrated in the demonstrator, advanced studies addressing: cooperative communications with distributed coding, LDPC, MU-MIMO, channel estimation, synchronization and precoding, proposed, and evaluated. These algorithms led to three patents.

The work on the MAC / RRM followed the same methodology, with algorithms to be integrated in the system level simulator. The studied algorithms included relay assignment, scheduling and signaling, to ensure cooperation with reduced overhead

Proof of concept: the proof of concept encompassed system level evaluation and laboratory prototyping. The system level evaluation included the development of a system level simulator for cellular systems augmented with relays and the integration of the selected algorithms. This allowed to evaluate at a global level the different options and to quantify the benefits of using relays.

The test-bed prototypes, including the cooperative algorithms used a WiMax platform for which a relay unit was developed and enhanced with the defined algorithms.

A second part of the laboratory demonstrator was the multiuser-MIMO which was based in an LTE platform enhanced with the CODIV algorithms.

Final analysis of the impact of CODIV techniques on deployment and business models of cellular networks in particular from an operator perspective and the analysis of the economic impact of CODIV technology in wireless communication systems, estimating according to models developed by the techno-economic group of the consortium operator.