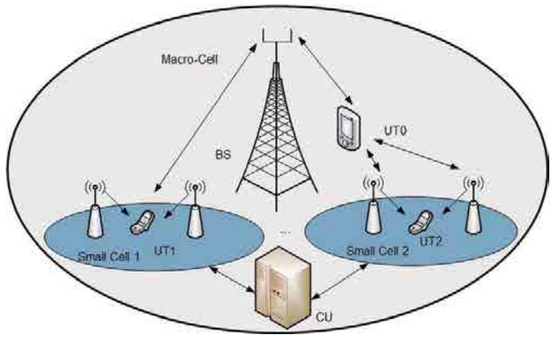
HETCOP

# Joint Cooperative and Cognitive Strategies for Heterogeneous Wireless Systems...

The collaborative HETCOP project addressed the problem of efficient coexistence of macro cell and small cells systems under the same spectrum. This requires the development of efficient and low complexity interference management techniques since, if not carefully designed, the small cells signals may generate unsustainable levels of interference on the macro-cell.




| Main Project Team | |
|---|---|
| **Adão Silva** | **MN-Av** |
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| Manuel Violas | OCP-Av |

| Indicators | |
|---|---|
| Funding | 40k € |
| Journal papers | 12 |
| Conference papers | 14 |
| Book Chapters | 2 |
| Concluded PhD | 1 |
| Concluded MSc | 4 |

## Two Main Publications


D. Castanheira, A. Silva, R. Dinis, A. Gameiro, Efficient Transmitter and Receiver Designs for SC-FDMA Based Heterogeneous Networks, "IEEE Trans. on Communications", Vol. 63, No. 7, pp. 2500 - 2510, July, 2015.

D. Castanheira, A. Silva, A. Gameiro, Set Optimization for Efficient Interference Alignment in Heterogeneous Networks, "IEEE Trans. on Wireless Communications", Vol. 13, No. 10, pp. 5648 - 5660, October, 2014.


PROJECT WEBPAGE URL

https://www.it.pt/Projects/Index/1973

**Fig. 1** HETCOP Prototype..

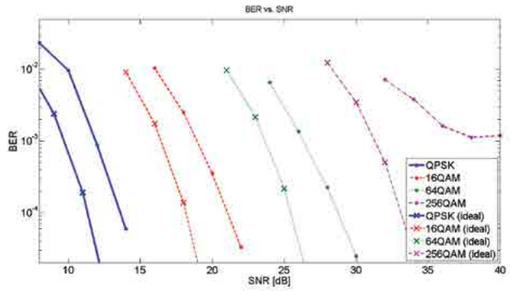


**Fig. 2** Experimental BER performance.

## GENERAL MOTIVATION AND OBJECTIVES

The rapid growth of wireless traffic and the number of devices have as a result the interference level to continuously increase. An attractive option to improve the capacity is the cell reduction concept, (e.g. small cells, femtocells, M2M clusters, relaying, etc). However, the deployment of a large number of small cells is not without new technical challenges. Most of the interference mitigation challenges originate from the "edge users/devices" that are increasing as the number of partitions/clusters/cells increase. The collaborative HETCOP project aimed at the definition, design, implementation and validation of techniques that enables efficient coexistence of different systems sharing the same spectrum. Specifically, develop novel joint cooperative and cognitive techniques, namely based on the principle of interference alignment in to order to mitigate the intra/inter-tier interferences and increases the capacity of the entire heterogeneous network. Moreover, develop a FPGA based testing infrastructure allowing to experimentally show the feasibility of some proposed algorithms.

## CHALLENGE

Small cells are being considered by the operators as a solution to overcome the capacity limitations of the current macro cell cellular system. Beyond the capacity improvements, small cells offer other advantages: they are easier to deploy, less expensive and more energy efficient, etc. Nevertheless, due to the expected extensive deployment of small cells and costs involved in the acquisition of new spectrum licenses the two systems, small and macro cells should coexist under the same spectrum resulting in unsustainable levels of interference. Therefore the main challenge of the project was to design low complexity interference mitigation approaches to efficiently deal with inter-tier/inter-system interference. Namely, design and implement practical cooperative joint precoding and equalization schemes under limited inter-system information exchange.

## WORK DESCRIPTION AND ACHIEVEMENTS

The project activities encompassed three main phases: a preparatory phase where the scenarios, main requirements and overall architecture were defined. This was articulated with other projects and worldwide activities to ensure alignment with the trends towards 5G.The second phase consisted in designing and validation of interference mitigation algorithms to efficiently deal with inter-tier/inter-system interference. The emphasis was put on the design low complexity algorithms under minor intersystem information exchange to allow practical implementation. Firstly it was designed efficient channel and feedback signaling techniques and then some robust algorithms were specifically designed under this quantized information. The last phase was devoted to implement a FPGA based testing infrastructure to evaluate a selected algorithm developed in the second phase. This infrastructure consists in a primary connection with a single antenna board emulating the macro user terminal and a dual antenna board emulating the BS and two secondary connections with a dual antenna board emulating the macro cell user equipment's. an interference alignment algorithm to align all the two small cells interference in a given sub-space of the macro cell was implemented..

The main tangible achievements can be synthesized as follows:

• Proposal of Novel precoding, equalization and low feedback algorithms for heterogeneous systems.

• One FPGA based demonstrator was developed to demonstrate selected algorithms

• Formation of a group of skilled people (MSc and PhD) with deep knowledge in design, analysis and implementation techniques envisioned for future wireless communication systems.

• Publication of scientific papers in reputable technical journals and technical presentations at major international conferences.

• Consolidate the research collaboration of different research groups within the Instituto de Telecomunicações. Specifically between the research teams in Aveiro, Leiria and Lisbon.