



UNIVERSITAT POLITÈCNICA  
DE CATALUNYA

## **FOUNDED RESEARCH PROJECTS AT UPC**

**November 2008**



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- Architecture design and programming for multicore-based Petaflop supercomputers
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## **PROJECT DESCRIPTION**

Architecture design and programming for multicore-based Petaflop supercomputers

The Architecture design and programming for multicore-based Petaflop supercomputers project encompasses the efforts done at the Computer Architecture Department of the UPC (Technical University of Catalunya) and the Computer Sciences Department of the BSC-CNS (Barcelona Supercomputing Center) towards designing future petaflop supercomputing systems. The emerging era of multicore architectures, that will include hundreds of processors in a single chip, has pushed the research community to seek for new techniques to make it easier for application and library programmers to develop scalable and efficient multi-threaded applications. Heterogeneity in these multicores is also becoming a trend (for instance, the IBM Cell BE processor that mixes a traditional superscalar core and eight more specialized cores). GPGPU- and FPGA-based architectures will also play an important contribution to this heterogenous world, leading to systems with millions of threads that cooperate in the efficient exploitation of parallelism for challenging scientific applications. The approximation taken by the UPC and BSC researchers considers the design of future petaflop systems in an interdisciplinary way, including applications, numerical methods, programming models, tools for performance analysis and prediction, node and interconnect design as well as processor/accelerator design.

## **RESPONSIBLE UPC RESEARCHER**

Prof. Mateo Valero and Prof. Eduard Ayguade

## **UPC RESEARCHER CONTACT**

Prof. Mateo Valero  
Department of Computer Architecture  
mateo@ac.upc.edu

Prof. Eduard Ayguade  
Department of Computer Architecture  
eduard@ac.upc.edu

[www.bsc.es](http://www.bsc.es)

## **TYPE OF RESEARCH COOPERATION ENVISIONED**

We primarily envision PhD students, although Post-Doc and sabbatical could also be interesting for the project.

## **FUNDING AND FACILITIES OFFERED**

The Computer Architecture Department at UPC and the Computer Sciences Department at BSC offer grants for PhD students (equivalent to grants offered by national research programs) and the necessary equipment and access to supercomputing facilities to develop the research project.



## **PROJECT DESCRIPTION**

Design of refrigeration systems

Project description: Engineering of refrigeration systems. Design, numerical simulation and optimization of domestic, commercial and industrial refrigerating systems. Development of devices using non-contaminant refrigerants such as hydrocarbons and carbon dioxide. Design of absorption cooling systems, trans-critical cycles. Development of simulation software: two-phase flow, frosting effects, absorption phenomena.

## **RESPONSIBLE UPC RESEARCHER**

Prof. Asensi Oliva

## **UPC RESEARCHER CONTACT**

Prof. Asensi Oliva  
Department of Heat Engines

oliva@cttc.upc.edu  
<http://www.cttc.upc.edu>

## **TYPE OF RESEARCH COOPERATION ENVISIONED**

Students who just finished or are in the last year of their degree in physics, engineering, mathematics or computer science. Post-Doc students may also be considered.

## **FUNDING AND FACILITIES OFFERES**

Grants of 1000 euro / month plus medical insurance and traveling expenses.



## **PROJECT DESCRIPTION**

Development of advanced parallel cfd codes

Project description: Development of advanced parallel CFD codes for the numerical simulation of turbulent flows of technical interest. Use of large scale parallel computers for direct numerical simulation (DNS) of turbulent flows and large eddy simulation (LES). Applications to different fields of thermal engineering.

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## **TYPE OF RESEARCH COOPERATION ENVISIONED**

Students who just finished or are in the last year of their degree in physics, engineering, mathematics or computer science. Post-Doc students may also be considered.

## **FUNDING AND FACILITIES OFFERES**

Grants of 1000 euro / month plus medical insurance and traveling expenses.



### **PROJECT DESCRIPTION**

Development of MIMO techniques for transmission and reception in satellite communications.

### **RESPONSIBLE UPC RESEARCHER**

Prof. Ana I. Perez-Neira

### **UPC RESEARCHER CONTACT**

Prof. Ana I. Perez-Neira  
Department of Signal Theory and Communications

anuska@gps.tsc.upc.edu  
<https://gps-tsc.upc.es/array>

### **TYPE OF RESEARCH COOPERATION ENVISIONED**

Either Post-Doc or PhD Student

### **FUNDING AND FACILITIES OFFERED**

Equivalent to a Spanish PhD grant



## **PROJECT DESCRIPTION**

European Master in Advanced Materials Science and Engineering (AMASE)

## **RESPONSIBLE UPC RESEARCHER**

Prof. Marc J. Anglada

## **UPC RESEARCHER CONTACT**

Prof. Marc J. Anglada,  
Department of Materials Science and Metallurgy

marc.j.anglada@upc.edu  
www.amase-master.net

## **TYPE OF RESEARCH COOPERATION ENVISIONED**

Master program in Advanced Materials Science and Engineering (AMASE) in cooperation with universities of France (EEIGMM from INPL of Nancy), Germany (University of Saarlandes) and Sweden (Lulea Technical University).

## **FUNDING AND FACILITIES OFFERED**

A two years grant of the European Union for the AMASE Master degree (in two different European Universities).

A three years grant for PhD at UPC (only for students which have achieved an AMASE Master degree) in cooperation with the European Universities of the AMASE program.



## **PROJECT DESCRIPTION**

Microarchitectures and compilers

The ARCO (Architecture and Compilers) research group of the Universitat Politècnica de Catalunya at Barcelona (Spain) is seeking candidates to pursue a Phd (or Master+PhD) in the area of computer architecture. The research group ARCO consists of members of the Department of Computer Architecture at UPC, members of the Intel-UPC Barcelona Research Center and members of the Computer Science Department at the Universitat Rovira Virgili (URV). The group is formed by professors, PhD students, and post-doc researchers. The research of the group focuses on microarchitectures and compilers techniques to increase performance, enhance reliability and reduce power dissipation of future processors. The group is working on several projects encompassing the areas of multicore architectures, new threading schemes, hardware/software codesign, power-aware computing, programmable accelerators and resilient microarchitectures among others.

Duration: 4 years

Number of scholarships: 2

## **RESPONSIBLE UPC RESEARCHER**

Prof. Antonio González

## **UPC RESEARCHER CONTACT**

Prof. Antonio González  
Department of Computer Architecture

antonio@ac.upc.edu

## **FUNDING AND FACILITIES OFFERES**

Each scholarship will cover an air ticket to Barcelona, tuition and a stipend of Euro 1150 per month.





## PROJECT DESCRIPTION

### Reconfigurable Cooperative Communication Networks Enabled by Agile Spectrum Use

The project ROCKET ([www.ict-rocket.eu](http://www.ict-rocket.eu)) is financed by the European Commission in its 7th Framework Program, and seeks to define wireless solutions capable of delivering bit rates higher than 100 Mbps with peak throughputs higher than 1 Gbps, based on reconfigurable OFDMA cooperative networks enabled by agile spectrum usage. While increasing peak rates is a natural must-do for new standards, providing homogeneous high rate coverage is equally important as it guarantees a constant user experience over the whole served area and is the key enabler to a higher average spectral efficiency of the system. Those goals are inline with the IMT-Advanced requirements and match the requirements of the IEEE 802.16 Task Group m for Advanced Air Interface. In order to guarantee a strong focus and efficiency ROCKET spans the scope research to two questions which will be at the centre of future IMT-advanced system design:

- How can the bandwidth be enlarged and make the whole system benefit of it?
- How can the system spectral efficiency be increased and provide ubiquitous high bitrate coverage?

Those questions are addressed by devising methods for improved spectrum management, advanced multi-user cooperative transmission, collaborative inter-cell operation and ultra-efficient MAC design. Moving from theory to implementation, a highly efficient prototyping platform (empowered by state-of-the-art multi-core processors) accommodating PHY, MAC and Networking functionality, will be used to prove the computational feasibility of key MAC and cooperation concepts.

The activities of the project will be timely scheduled according to the activities of the working groups in the standards, namely in 802.16m and 3G-LTE. Results are to be spread into a wider audience for maximum impact, but also the protection of knowledge is considered as a crucial aspect.

The ROCKET consortium (formed by 9 European companies, universities and research centers) expects to generate techniques and results well beyond the state-of-the art in cutting edge technologies and aims at producing valuable intellectual property rights to boost world wide competitiveness of the partners.

## RESPONSIBLE UPC RESEARCHER

Prof. Josep Vidal

## UPC RESEARCHER CONTACT

Prof. Josep Vidal  
Department of Signal Theory and Communications

[josep.vidal@upc.edu](mailto:josep.vidal@upc.edu)

## TYPE OF RESEARCH COOPERATION ENVISIONED

We offer doctoral and post-doctoral openings for good candidates.

## FUNDING AND FACILITIES OFFERES

Salaries are competitive and commensurate with the value of the candidate. The position allows working in an international atmosphere with possibilities of travelling to meetings and conferences, and being in contact with world-classe companies and research groups.



## PROJECT DESCRIPTION

### Remote sensing

The Active Remote Sensing Group belongs to the Remote Sensing Laboratory (RSLab), which is a part of the Signal Theory and Communications Department (TSC). The activities of this group are related with the observation of the Earth surface by means of active remote sensing systems, especially with Synthetic Aperture Radar (SAR) systems, comprising from the conception and construction of real systems up to the final applications, passing through the theoretical analysis and characterization of the data. These research activities are carried out in a context of international collaboration with well reputed institutions and private companies. The Active Remote Sensing group has several research lines where collaboration is offered:

- GBSAR system: The GBSAR developed by the RSLab is a ground-based SAR zero base-line interferometer with polarimetric capabilities designed for field use. Current research is focused on boarding the system on a UAV platform. The interferometric capabilities of the developed systems allow retrieving information related to the ground displacement along the sight-line of the radar system with a very high precision. Data gathered in this imaging mode allows to the GBSAR to be used as a real time Early Warning System for hazards monitoring (landslides, subsidences, etc...).
- Bistatic systems: There is an increasing scientific interest in bistatic SAR (BiSAR) systems, which allow measurements in a wide range of geometries, that allow to investigate new scattering mechanisms. The RSLab is developing a family of fixed-receiver BiSAR systems that use existing orbital SAR systems as transmitters of opportunity. These systems are primarily intended for differential interferometry applications. Possible research activities related to our BiSAR activities range from technological development to the development of advances BiSAR processing algorithms.
- mmW and THz Imaging systems. Active (Radar) and Passive (Radiometer) System architectures and front-end technologies for real-time passenger and luggage scanning for security applications.
- SAR Interferometry (InSAR) and SAR Differential Interferometry (DInSAR): InSAR makes possible to study the terrain topography and remotely generate Digital Elevation Models for large areas. The terrain deformation caused by subsidence phenomena can also be monitored from satellites or airborne platforms with DInSAR techniques, with milimetric precision.
- SAR Polarimetry (PolSAR): PolSAR allows an accurate extraction of bio- and geophysical parameters of the Earth Surface, which can be employed to improve, for instance, terrain classification. The research activities cover from the statistical modelling, filtering, simulation and estimation of data to the definition and assessment of electromagnetic models for the extraction of bio- and geophysical parameters.
- Polarimetric SAR Interferometry (PolInSAR): aims to mix the capabilities of both interferometry and polarimetry. It has opened the door to quantitatively analyze forested areas to extract biophysical parameters and to develop new classification methods for vessel monitoring and improve the performance of DInSAR techniques.
- Time-frequency analysis: Time-frequency analysis tools, as the Wavelet transform, have shown a very good performance in solving different problems present on SAR data understanding and exploitation. These tools have been employed in the group to propose new filtering techniques, to detect vessels in the sea, to perform a fine detection of the coast line and to detect and characterize oil spills.

## RESPONSIBLE UPC RESEARCHER

Prof. Jordi J. Mallorquí

## UPC RESEARCHER CONTACT

Prof. Jordi J. Mallorquí  
Department of Signal Theory and Communications

malloqui@tsc.upc.edu  
www.tsc.upc.edu/sar

## TYPE OF RESEARCH COOPERATION ENVISIONED

Primarily PhD Students, but also open for Post-Doc and Sabbatical stages.

## FUNDING AND FACILITIES OFFERES

The group can cover all expenses for doing the PhD thesis in our group. The expenses include registration fees, grant and medical insurance. The group, in the scope of different projects, has access to a large dataset of SAR images from orbital (ERS, ENVISAT, RADARSAT1/2, TerraSAR-X and bistatic SABRINA), airborne sensors (DLR's E-SAR) and ground-based (UPC's GB-SAR).



## **PROJECT DESCRIPTION**

Renewable energy

Project description: Renewable energy. Design, numerical simulation and optimization of low temperature solar energy collectors for heating and high temperature (concentrated) solar energy for electric power generation (central tower receivers and parabolic trough collectors). Large scale heat storage using different technologies.

## **RESPONSIBLE UPC RESEARCHER**

Prof. Asensi Oliva

## **UPC RESEARCHER CONTACT**

Prof. Asensi Oliva  
Department of Heat Engines

oliva@cttc.upc.edu  
<http://www.cttc.upc.edu>

## **TYPE OF RESEARCH COOPERATION ENVISIONED**

Students who just finished or are in the last year of their degree in physics, engineering, mathematics or computer science. Post-Doc students may also be considered.

## **FUNDING AND FACILITIES OFFERES**

Grants of 1000 euro / month plus medical insurance and traveling expenses.



## **PROJECT DESCRIPTION**

Sensor networks

COMONSENS is a five-year project, starting in 2009, that integrates 67 researchers from 10 different research institutions in Spain and is coordinated by Universitat Politècnica de Catalunya (UPC).

The objectives of the project include development of theoretical tools, algorithmic design, and testbed evaluation, combining disciplines such as Information Theory, Signal Processing and Network Theory with the aim of advancing the state of the art in communication and sensor networks.

Further info: [www.comonsens.org](http://www.comonsens.org)

## **RESPONSIBLE UPC RESEARCHER**

Prof. Javier R. Fonollosa

## **UPC RESEARCHER CONTACT**

Prof. Javier R. Fonollosa  
Department of Signal Theory and Communications

[javier.fonollosa@upc.edu](mailto:javier.fonollosa@upc.edu)  
<http://gps-tsc.upc.es/comm2>

## **TYPE OF RESEARCH COOPERATION ENVISIONED**

Post-Doc and Sabatical stages

## **FUNDING AND FACILITIES OFFERES**

Two year Post-Doc contract at UPC, office and lab facilities.



## **PROJECT DESCRIPTION**

Signal Processing Advanced Techniques for Cognitive Radio Systems

The project is devoted to the design of highly efficient wireless communication systems using dynamic spectrum access. This paradigm results in better usage of the radio resource but requires transceivers with cognitive capabilities ("Cognitive Radio") in order to ensure coexistence with other services in the same frequency band. This requirement poses a series of design challenges for the physical and medium access control layers of such Cognitive Radio networks.

## **RESPONSIBLE UPC RESEARCHER**

Prof. Javier Villares

## **UPC RESEARCHER CONTACT**

Prof. Javier Villares  
Department of Signal Theory and Communications

javi@gps.tsc.upc.edu  
gps-tsc.upc.es/comm2

## **TYPE OF RESEARCH COOPERATION ENVISIONED**

PhD estudent

## **FUNDING AND FACILITIES OFFERES**

- Integration into the group of Signal Processing and Communications as a PhD student.
- Possibility of receiving a four-years PhD grant from the Spanish Ministry of Science and Innovation. Approximated salary: 13700 euros (1st & 2nd years), 16400 euros (3rd & 4 thyears).