

PEst-C/EEI/LA0014/2013  
**ACTIVITY REPORT 2013-2014**  
Research groups and research lines



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## 2 OBJECTIVES AND ACHIEVEMENTS

*This part of the report will allow you to describe the way in which the Unit or the LA is organized and managed, to give the general objectives of the research within the Unit or the LA and finally to give a brief description of the main achievements of the research carried out as a whole during the 2013-14 period. A maximum number of characters (without spaces) are allowed in each field. If the number of characters exceeds the maximum you will not be able to complete the form and an error message will appear when you try to save your work*

### 2.1 Unit Description (3000 ca.)

*Here indicate form of organization and management*

#### IMPORTANT FOREWORD

INESC TEC (managed by INESC Porto) is reporting its activity in the period 2013-2014 following the general same template, with adaptations, used for the activities in 2011-2012, allowing a fair comparison. However, such format is not adequate to describe an organization as complex as INESC TEC. Therefore, this report must be understood as depicting only partially the description of the whole set activities developed.

The site <http://profile.inescporto.pt/> includes historical charts, comparisons 2002-2007 and data from 2008 to 2014, some presentations in power point form and other material relevant to the understanding of all the dimensions of activity of the Unit.

This FCT report format was based on the assumption that the generic organization of an Associate Lab was based on "research groups" per scientific area, with multi-disciplinarity at the "research line" level. This was never the typical case with INESC TEC, which is organized in multi-disciplinary internal units, assimilated to Research Groups. In a Unit, one may find a blend of several skills or scientific knowledge in distinct areas, as required for technology transfer.

When examining this report, please note that:

- a) The Section Research Groups is used to refer to our internal Research Units with a scientific multidisciplinary profile
- b) The Section Research Lines is used just to refer to a second tier of interdisciplinary activities.

A descriptive site for INESC Porto: <http://www.inesctec.pt>.

A monthly news bulletin is <http://bip.inesctec.pt>.

Some Units/RG that were defined as Associate Units to INESC Porto had their own sites:

LIAAD: <http://www.liaad.up.pt/>

CRACS: <http://cracs.fc.up.pt/>

CISTER: <http://www.cister.isep.ipp.pt/>

HASLab: <http://haslab.di.uminho.pt/>

#### MANAGEMENT

In 2013-2014 INESC TEC, while recognized as an Associate Laboratory, was composed of 8 Units hosted by INESC Porto, one of which actually is in the University of Minho, plus 4 autonomous Associate Units. In 2014 a new group denoted BRAIN – Biomedical Research and Innovation was launched, as a seed for a new RG to appear in 2015.

INESC Porto is a private non-profit institution with the following associates: UP - University of Porto, INESC and IPP – Polytechnic Institute of Porto.

INESC Porto acted as the coordinating entity for INESC TEC. The General Council of INESC Porto appoints the BD - Board of Directors for a 2-year mandate. It is organized in a Dpt. of Information and Logistics (DIL) and 5 Support Services (Communications and Informatics, Media, Informatics for Management, Building Manag., Lab and Workshop Service). Under DIL other services exist (juridical, human resources, accounting and treasury, project manag.). The BD meets every other week in the Units Council (UC) with Unit Coordinators (including Associates), DIL and support services. Decisions are collectively discussed and policies deployed through the UC mechanism. Processes of delegation of responsibility are also in place. The INESC Porto Units have independent executive management and complete scientific autonomy. The pool of resources is under common management and the solidarity among groups is a rule. The BD of INESC Porto has put in place the necessary set of regulations applying to the different statutes of researchers, working conditions, careers and rewards, and performance evaluation.

The Associate Units (LIAAD, CRACS, UGEI, CISTER and HASLab) had independence of governance and autonomy of decision but they must however coordinate their scientific policy with one another and INESC Porto under the INESC TEC framework. As some of them were hosted in other institutions, they sometimes depended on local administrative staff while others are already integrated in administrative terms within INESC Porto.

The Scientific Council (SC) has representatives of the Units plus 3 members appointed by the BD.

The Scientific Advisory Board (SAB) is composed of invited high-profile international scientists and is now common to the entire INESC TEC.

## **2.2 General Objectives (3000 ca.)**

*This refers to the current aims of the Unit or LA as a whole*

### **2.2.1 MISSION**

INESC TEC extends the original mission of INESC Porto, which was created with the complementary objectives of developing high level scientific research and acting as an effective interface between university and economic agents and/or public administration. So, INESC TEC has activity both in Science and in Technology Transfer. In this respect, INESC TEC champions and has nurtured and evolved a technology transfer model different from other research institutions in Portugal, and which is also uncommon worldwide.

### **2.2.2 DOUBLE ROLE**

INESC TEC, with INESC Porto as the coordinating entity, is recognized by the Ministry of Science as an Associate Laboratory within the Science and Technology System of Portugal.

At the same time, INESC Porto is also a Technological Infra-structure recognized by the Ministry of Economy and Innovation.

This double character means that its mission is not limited to scientific research but extends to the assistance of economic agents and public administration and institutions in general, through technology transfer and innovation as well as highly specialized consultancy.

INESC TEC also promotes spin-off and spin-out companies, hosting them during an early-stage pre-incubation phase and often participates in their capital. The profile of its researchers, therefore, reflects the large spectrum of responsibilities incurred in by the Associate Laboratory.

This means that the evaluation of the output and productivity must comply with all items identified in the Decree-Law 125/99, Art. 29 and cannot be condensed on an isolated "paper counting". For this exercise, one must take in account that a fraction of the research body is devoted to technology transfer. In this respect, the role and model of INESC TEC displays high similarities with the Fraunhofer Institutes in Germany.

### **2.2.3 STRATEGIC CONCEPT**

INESC TEC embodies the concept of knowledge-to-value production chain: FROM KNOWLEDGE PRODUCTION TO SCIENCE-BASED INNOVATION. The working organization obeys to the concept of smooth integration of

knowledge producers (creating science) with developers (producing applications) and of these with appliers (transferring to industry, generating spin-off companies, etc.). Therefore, the profile of a typical Unit in INESC TEC includes all these components and is a more effective integration than the one achieved with the research lines.

Research projects generate new knowledge and excellence at the international level: post graduate theses and papers are published. Projects in tandem move knowledge along the chain: prototypes are developed and relationship with industry is strengthened. New projects are designed, materializing the value of innovation at the end of the chain: technology transfer, licensing. Eventually, new spin-off companies are incubated and launched.

This is done with a careful blending of scientists from the University with full time contracted researchers and full time contracted professionals – engineers, mathematicians, economists, physicists. And this is supported by a highly qualified staff in project management, juridical, public relations, human resources.

## **2.3 Main Achievements during the years of 2013-14**

*Highlights from past research over the reported period.*

The elements reported below relate to the criteria defined in Art. 29 of the Decree-Law 125/99 from April 20, under which an Associate Lab activity should be evaluated.

### **2.3.1 SCIENCE AND TECHNOLOGY RESULTS AND EFFICIENCY**

New **record** number of 316 papers published in international journals in 2014 (306 in 2013) and **record** total number of additional 745 publications in other journals, book chapters and international conferences in 2014 (711 in 2013).

New **record** number of 58 PhD theses completed by INESC TEC researchers in 2013 (52 in 2014).

**Record** turnover from projects, in 2014, of over 9 million Euro with an added yearly financing from FCT of 1 million Euro only (multiplying factor of 10). This result was achieved after two years of contraction – in 2011 the value was at 8 million with added 2 million from FCT, but in 2013 the value was of only 6.8 million with added 1 million from FCT.

Specific scientific results are reported by each RG in the corresponding sections.

### **2.3.2 DIRECT R&D CONTRACTS AND CONSULTING**

R&D advanced projects and consulting, in direct contracts with national and international industry, represented about 33% of the income in project activity in 2014, with a **record** value of 3 million Euros (after a severe contraction on 2013 with a value of 1.8 million Euros).

Spin-off companies (with INESC Porto as shareholder) successfully sold to international companies.

### **2.3.3 CONTRIBUTION TO NATIONAL SCIENCE AND TECHNOLOGY POLICIES**

Research results finding application in tech transfer in industry

E-Government projects contribution to management of municipalities and regions

Exporting technology (e.g., robotics)

### **2.3.4 INTERNATIONALIZATION/WORLD RECOGNITION**

Large no. of papers co-authored with researchers from foreign institutions

Exporting technology and consultancy: contracts with ESA (EU), ONS (BR), and other prestigious organizations in Europe and Brazil

32 European projects simultaneously run in 2014 (**record** of 34 in 2013).

34% of project activity income derives from international activity in 2014.

**Record** of 92 grantees from foreign countries, most of them PhD students, in 2014 (79 in 2013)

Projects with top USA Universities: CMU, MIT and UT Austin

INESC TEC in Brazil consolidated via INESC P&D Brasil, with increasing project activity.

1 IEEE Fellow with permanent link, other IEEE Fellows with regular collaboration. International prizes gained by INESC TEC Researchers.

### **2.3.5 QUALITY OF MANAGEMENT AND ORGANIZATION**

The quality of the management and support services has been externally considered exceptional. A process of reorganization of its management and services was launched and the new scheme will enter in operation in 2015.

The economic crises of the country was dealt with adequate responses, in policy but also in prudent management, resulting in the continuous growth of the organization in spite of the external difficulties.

INESC TEC managed, in the period 2013-14, a high number of collaborators, which may be estimated at the end of 2014 as circa 900 people, among which 270 integrated members holding a Doctoral degree.

### **2.3.6 COOPERATION WITH OTHER INSTITUTIONS**

A large body of evidence shows that the cooperation with other institutions is very strong.

In 2013-14, INESC TEC conducted a consolidation policy instead of expansion. However, it is worth noting the agreement signed with the Polytechnic Institute of Bragança (IPB) to create there a nucleus of the Unit.

It started operating the Centre of Knowledge for Sustainable Energy (including investment of about €3.5 M in 2010-2012). This includes the Laboratory for Smart Grids and Electric Vehicles, recognized by FCT as a Technologic Infrastructure in 2014.

The cooperation with CMU, MIT and UTexas Austin was promoted to a stronger level with joint projects and activities.

INESC TEC reinforced its cooperation with Brazilian Universities by an action of consolidation of INESC P&D Brazil (the IB), a non-profit association with headquarters in São Paulo where INESC TEC is the major owner. The IB is now recognized as a Brazilian Institute of Science and Technology.

### **2.3.7 DISSEMINATION OF RESULTS**

External impact (national and international) of INESC Porto Bulletin BIP (read in 143 countries in 2014, with 340 visits on average per day in 2011).

**Record** number of 554 papers in international conferences in 2014.

## 2.4 Activities

*This part of the report will allow you to describe general activities of the Unit or the LA that are aimed at integrating the research of various groups of which multidisciplinary and/or trans-disciplinary activities are of particular relevance. The second part is aimed to describe work that the Unit or the LA does to extend beyond the scientific environment and to reach the general public, schools or other forms of engaging the public in the work of the Unit or the LA.*

### 2.4.1 Integrative/multidisciplinary activities during the year of 2011 (3000 ca.)

*Special activities that aim to carry out research across disciplines.*

According to the reports of our Scientific Advisory Board, the successes of INESC Porto are centred at its ability to bring "on-demand" to the technology transfer activities an effective blend of engineering disciplines. This is achieved because its Research Groups are formed and run under the concept of being multi-disciplinary. Therefore, for INESC TEC the need for a special reporting section to declare activities aiming to stimulate and carry out research across disciplines is somewhat redundant.

Furthermore, an important number of projects gather together resources from different groups, as it may be observed in the activity reports of each group.

To enhance cross-communication, several Groups organize a regular (weekly or bi-weekly) series of scientific discussion meetings, which receive the name of "Lab Meetings". The most active are on Telecommunications, Power Systems, Optoelectronics and Technology Transfer.

The Board of Directors (BD) also promotes, with the supervision of the Scientific Council and under the recommendation of the Scientific Advisory Board, a strain of activities denoted LAI (Inter-unit Action Lines).

A LAI is a coherent scientific or technological domain that cuts across INESC Porto organization and promotes scientific discussion, workshops, exchange of experience and ideas in an organized fashion. To support this activity, the BD defined a set of supporting measures including guaranteeing a base budget to each self-organized LAI. The Scientific Council manages the recognition of each LAI proposal and monitors its activity. There are scientific and activity targets that must be met in order to maintain the recognition of a LAI. LAIs in Optimization or in Machine Learning and Signal Processing are examples of this.

This structuring of scientific coordination cross-groups is built over an increasing number of projects being tackled by 2 or more Groups in consortium. A growing number of examples can be found in 2011, either in European projects or in direct research contracts with industry, e.g., joining power systems and telecommunications, manufacturing engineering systems with information systems, telecommunications with optoelectronics, power systems with artificial intelligence, manufacturing engineering systems with management and industrial engineering, telecommunications with robotics, etc.

This multidisciplinary integration encompasses all Units (INESC Porto and Associate).

The constitution of a new Centre of Knowledge for Sustainable Energy is a new organized effort to support research across disciplines. In 2010 the approval of funding was obtained, and in 2011 the works began for the erection of a new building next to INESC Porto headquarters. Also, INESC TEC is providing support for the Associate Unit CISTER to move into a new building, improving considerably the working conditions including cross-cooperation.

### 2.4.2 Outreach activities during the year of 2011

*Science and Society/general public/schools, etc.*

INESC TEC gives great importance to communication with citizens. In 2013-14 this activity followed the general trend of recent years:

The Communication Service (SCom) includes three specialists with post-graduation in Media and Communication and in Translation. Monitoring for 2013 and 2014 identified a total of 648 news items regarding INESC Porto/INESC TEC in the main Portuguese media.

The SCom, among other duties, runs a digital monthly Bulletin (BIP, <http://bip.inesctec.pt/>) in Portuguese, with news on science and projects developed, that reaches a vast community of readers in Portugal and Brazil. A version of BIP in English (<http://bip.inesctec.pt/en>) is also published every 3 months and is sent to 25 countries.

AWStats provided a counting of accesses to BIP. In 2013, people from 86 countries accessed BIP, with Portugal, USA, Brazil, Canada, and the United Kingdom being the most frequent, in a total of 603,616 hits and 157,365 visitors. In 2014, people from 143 countries accessed BIP, with Portugal, USA, Germany, Brazil and France being the most frequent, in a total of 521,763 hits, and 123,991 visitors.

INESC TEC developed a consistent action of presence in the civil society with participation in a diversity of events and initiatives. As a consequence, experts from INESC Porto are regularly interviewed by TV and radio stations (beside the press) on the hot topics that the society is debating.

INESC Porto, the coordinator of INESC TEC, is one of the partners of the Ciência Viva (CV) association whose aim is to promote science among youth. It has regularly cooperated with the CV initiatives, namely in the annual programs to receive students from secondary schools for short periods of time in its laboratories. Also, a member of the Board of Directors is a member of the Scientific Advisory Board of the Ciência Viva Center of Bragança.

INESC TEC also participated in several national Exhibitions (e.g. Forum do Mar), and supported to the University of Porto annual event as well as the Engineering and Sciences Faculties Open Days.

The SCom also organised diverse external and internal initiatives.

Public talks and lectures were given by the senior members of INESC TEC in various locations, in secondary schools and in Civic Associations, beside scientific and technical meetings.

## 2.5 Funding

*In this section include funding details during the reporting period. In the item LA FCT include the total sum of the Base+Programmatic funding of the Associate Laboratory.*

	2013	2014		Total
LA FCT	1.993.314	1.006.697		3.000.011
Projects FCT	995.585	866.679		1.862.264
Other National	2.045.369	2.392.645		4.438.014
Other International	1.987.021	2.868.924		4.855.945
National Industry	1.410.086	2.741.841		4.151.927
International Industry	410.369	258.562		668.931
<b>Total</b>	<b>8.841.743</b>	<b>10.135.349</b>		<b>18.977.092</b>

## 2.6 Other General Indicators

*This section is designed to provide information regarding the researchers and the technical personnel hired, and the total number of completed PhDs thesis during the reported period.*

### 2.6.1 Composition and Training

	2013	2014	
Nº Researchers Hired (LA)	3	2	
No. of Researchers Hired (Ciencia Programme)	5	4	
No. of Researchers integrated with PhD (*)	254	269	
Training PhDs (PhD thesis completed)	34	44	

(\*) Number of eligible integrated researchers holding a doctoral degree.

### 3 RESEARCH GROUPS

*In this section of the report you have the names of each Research Group and their Principal Investigators that were indicated in the last report. By following the link in the groups name you will be able to access the individual form of the group.*

*This list includes the currently active Research Groups as well as the Research Groups reported to be active in the previous year.*

Reference	Group Title
RG-Norte-50014-3346	Manufacturing Systems Engineering
RG-Norte-50014-3347	Telecommunications and Multimedia
RG-Norte-50014-3348	Optoelectronics and Electronic Systems
RG-Norte-50014-3349	Power Systems
RG-Norte-50014-3351	Innovation and Technology Transfer
RG-Norte-50014-3406	LIAAD Laboratory of Artificial Intelligence and Decision Support
RG-Norte-50014-3435	Information Systems and Computer Graphics
RG-Norte-50014-3507	CRACS Center for Research in Advanced Computing Systems
RG-Norte-50014-3946	Robotics and Intelligent Systems
RG-Norte-50014-3947	High Assurance Software Laboratory
RG-Norte-50014-3948	UGEI Unidade de Gestão e Engenharia Industrial
RG-Norte-50014-3949	CISTER Centro de Investigação em Sistemas Confiáveis e de Tempo Real

### 3.1 Group Description - UESP

Research Group Title	Manufacturing Systems Engineering
Principal Investigator	Jorge Manuel Pinho de Sousa
Research Area	Electrical and Computer Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements

#### 3.2.1 Objectives (4000 ca.)

##### FOREWORD

The Coordinators of this Centre during 2013 and 2014 were Prof. Jorge Pinho de Sousa (PhD) and Luís Carneiro (MSc).

##### OBJECTIVES

The mission of the Centre for Enterprise Systems Engineering (CESE) can be summarized by the following general goals:

- i) to contribute for the performance improvement of industrial and service companies, through R&D projects, consultancy, technology transfer and advanced training;
- ii) to foster high quality research initiatives in a set of specific areas where the elements of the group have international recognition, and to start innovative research programs in new emergent topics;
- iii) to transfer the resulting knowledge and technologies to software houses, equipment producers and industrial companies, through applied research, technology transfer and consultancy projects.

Along with a strong application focus, the group is committed to conduct high quality research projects. The main activity areas of the group are: Enterprise Collaborative Networks, Operations Management, Decision Support Systems including Production Planning and Cutting and Packing Problems, Transportation Systems and Logistics, Systems Integration, and Consultancy services.

The Centre for Enterprise Systems Engineering (CESE) undertakes research and development activities of a multidisciplinary nature, in broad domains such as decision support systems and operations management. The research activities are structured in four main research vectors:

- 1 – Operations Management and Logistics
- 2 – Collaborative Networks
- 3 – Decision Support and Business Analytics
- 4 – Enterprise Information Systems

The OPERATIONS MANAGEMENT AND LOGISTICS research vector covers a broad set of topics such as operations strategy, operations management, performance management, layouts design, supply chain management, logistics, and transportation systems.

Research is focused on the design and development of models and innovative techniques for operations management and logistics, including the definition of strategies for the manufacturing of complex and customized products. Advanced multi-objective optimization and simulation models are used to support decision-making for these problems. More recently, a strong effort has been put in logistics problems and on the design and management of multi-modal transportation systems.

COLLABORATIVE BUSINESS NETWORKS form a strong interdisciplinary research area that covers topics such as networked business models, supply-chain management, virtual organizations or organizational networks, collaboration and network governance, or collaborative performance management. Special focus is given to information and knowledge management in collaborative networks, including topics such as knowledge and collaboration organization systems, information organization and retrieval, as well as IT platforms for collaborative networks management.

The DECISION SUPPORT AND BUSINESS ANALYTICS research vector deals with methods and techniques such as structuring of decision-making problems, mathematical programming, multi-criteria decision analysis, combinatorial optimization and meta-heuristics, simulation, decision support systems, business intelligence, and data mining.

Applications cover a broad range of problems, including planning and scheduling problems, layout design, vehicle routing and distribution, predictive maintenance, and recommender systems. For the centre, operations scheduling and planning problems are one key research area and an important field for the development of software solutions. More recently research has been directed to the development and assessment of innovative hybrid approaches particularly on what concerns the integration of optimization and simulation.

ENTERPRISE INFORMATION SYSTEMS play an important role on the research activities of the centre, particularly in what concerns the design of advanced information systems, the design of information systems supporting new organisational paradigms, systems integration and inter-operability. The main applications of these competencies are on industrial companies and on supply-chain design and management.

It should also be emphasized that the centre has a very strong link with industry. It develops regular collaboration with technology suppliers, software houses or equipment manufacturers, on the design and development of new products. For industrial companies the centre supplies consultancy services on manufacturing systems design and industrial management, and support to the selection and implementation of advanced information systems and equipment. It also provides RTD services to meet specific requirements that are not answered by available commercial solutions and that require innovative solutions and a clear research component.

### **3.2.2 Main Achievements (4000 ca)**

During the period under analysis (2013/2014) the centre has reinforced its strong links with industry while increasing its scientific output. In terms of publication in peer-reviewed journals, the group has published 14 papers in 2013, and 12 in 2014.

13 PhD theses were concluded during the period, strongly contributing to the positive scientific performance of the group.

The centre has a strong tradition of participation in large European research projects. These projects have highly contributed to achieving critical mass in the fields of Enterprise Collaborative Networks and Operations Management and to strengthening partnerships with leader research organisations in Europe. During this period the group has participated in 11 projects, representing a total funding of about 900 K Euro.

The very active participation in the MANUFUTURE and Footwear European Technology Platforms led to the establishment of important partnerships at a European level. These partnerships have played an important role in the preparation and set-up of several European projects that strongly contributed to the results of the group.

A large number of projects has also been pursued at a national level, including research projects funded by FCT, RTD projects in partnership with technology based companies and consultancy firms funded by the QREN programme. A total of 15 projects were executed, representing a total funding of 959 K Euros.

During the period under analysis a total of 18 research and technology transfer projects directly contracted by companies were active, representing a total income of 815 k Euros.

A number of relevant outcomes can be highlighted:

- A new framework was designed and developed, to support the definition and implementation of hierarchic and compound performance measurement systems (VFF - Virtual Factory Framework, European project). The framework was implemented at VW Autoeuropa plant with quite good results.
- Within several consulting projects with IKEA, a new simulation framework has been developed to represent production lines and evaluate different scenarios according to multiple perspectives. This framework was used to support decisions concerning layouts, lot sizes, sequencing, etc. The methodology was applied first in the IKEA plant in Portugal and later in a factory in Lithuania. The good results achieved so far are motivating the design of new projects.
- A very large national RTD project on Production Technologies, within the scope of the PRODUTECH competitiveness pole, was concluded with excellent results. Some of the main results include: an innovative logistic system for machine tools assembly lines including AGVs; an integration platform, data model and definition of standards for the interoperability of manufacturing companies; a framework for the quick development of simulation models of manufacturing systems and a methodology and support ICT tool for the design of innovative business models for production technologies suppliers. These results were implemented and demonstrated in companies such as Adira, Tegopi, Silampos and CEI. Several publications were submitted and presented in international conferences.
- Within the HighSpeedShoeFactory project a new production and logistic system for shoe manufacturing, with 24 to 48 hours lead time, was designed and implemented at Kyaia. This new system has enabled a fast response time and reduced costs for the production of small series.
- Within the PT21 project (the shop of the future), systems and technologies were developed in order to generate new experiences of interaction between customer and point of sale. Moreover, a demonstrator was designed and implemented at CITEVE, to provide an integrated approach to collection, processing and provision of varied information, relevant to the point of sale management
- Innovative business analytics, recommender systems and software to manage market trends, using information from social networks, were designed in projects such as Creative Retail, Corenet and PT21.
- The centre played a key role in the design and implementation of interoperability architectures and platforms, to enable the integration of SMEs for the European electronic market, in several industrial sectors (Automotive, Textile and Garments, Footwear, and Food). During this period the Unit participated in the eFood-Chain EU project.
- Research and developments on the multi-objective optimisation “scheduler” have been pursued, leading to an innovative up-graded software tool that has been integrated with several ERP systems, with a considerable commercial success. More than 30 licences have already been sold internationally, in countries such as Portugal, Spain, Germany, Austria, Poland, Peru and Brazil.
- In the European projects FOCUS (Advances in Forestry Control and Automation Systems in Europe) and MOFSS (Make to Order Fast and Smart Scheduler), both having started in January 2014, new innovative approaches are being developed, to exploit the integrated use of simulation and optimization techniques in advanced production and logistic systems.

- In the BEST CASE project (research line “Smart Manufacturing and Logistics”) coordinated by CESE, but integrating multiple research teams at INESC TEC, significant developments in terms of mathematical programming models and heuristics were achieved, and interesting results and innovative approaches in hybrid implementations were obtained. Some successful applications of these techniques took place in planning problems in production and operations scheduling (“scheduling”), or problems of cutting and packing. The integration of simulation to optimization in their multiple variations was also deeply explored.

In summary, during the period 2013/2014, 13 PhD theses were successfully finished, 26 papers were published in peer review journals, and 56 in international conference proceedings subject to a refereeing process. Moreover several papers have been accepted for publication in peer review journals, and some out of these were published or are expected to be published during 2015. Due to a significant increase of PhD students in recent years, there are currently 26 on-going doctoral projects, with 13 concluded or expected to be concluded during 2015.

During these 2 years, several initiatives have been launched to strengthen the interaction with other research groups within the INESC TEC universe, as reported in other points of this document.

In total, 11 European projects were active during 2013/2014. An important critical mass has been achieved in the fields of Enterprise Collaboration Networks and Operations Management.

### **3.3 Productivity**

#### **3.3.1 Publications in peer review Journals (6000 ca.)**

2013

[14]

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2014

[12]

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### 3.3.2 Other international publications (6000 ca.)

Total number of publications: 56

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Gil Gonçalves, Catarina Azevedo, César Toscano, outros et al., "Assisting SMEs to integrate digital Food Supply Chains", EFITA2013 - EFITA 2013 Conference, June, 2013.

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António Henrique Almeida, Filipe David Ferreira, Américo Azevedo, Álvaro Gabriel Caldas, "Process Performance Assessment in Collaborative Manufacturing Environments: A Role Oriented Approach", FAIM 2013 - 23rd International Conference Flexible Automation and Intelligent Manufacturing, June, 2013.

Ana Cristina Barros, Rui Diogo Rebelo, outros et al., "RFID Implementation in the Footwear Supply Chain: From Production Line to Retail Store and Back", FAIM 2013 - 23rd International Conference Flexible Automation and Intelligent Manufacturing, June, 2013.

Alexandra Sofia Marques, António Correia Alves, Jorge Pinho de Sousa, "An approach for integrated design of flexible production systems", CIRP2013 - 46th CIRP Conference on Manufacturing Systems, May, 2013.

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Pedro Fernandes, Carla Pereira, and Armando Barbosa. 2013. “BTTE - An Automated Timetabling Software for Higher Education.” In Atas Da 8a Conferência Ibérica de Sistemas e Tecnologias de Informação, edited by Álvaro Rocha, Luís Paulo Reis, Manuel Pérez Cota, Marco Painho, and Miguel Castro Neto, II:90–93. Lisboa, Portugal. <http://www.aisti.eu/cisti2013/>.

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Patrícia Ramos, José Manuel Oliveira and Paula Silva (2014), "Predictive maintenance of production equipment based on neural network autoregression and ARIMA", 21st EurOMA Conference – Operations Management in an Innovation Economy, 20-25 June, Palermo, Italy.

Patrícia Ramos and José Manuel Oliveira (2014), "Supply chain management of consumer goods based on linear forecasting models", 21st EurOMA Conference – Operations Management in an Innovation Economy, 20-25 June, Palermo, Italy.

Ahm Shamsuzzoha, Filipe Ferreira, Sven Abels, Americo Azevedo and Petri Helo5 , "Visualization functionality of virtual factories: an enhancement to collaborative business process management", 16th International Conference on Enterprise Information Systems (ICEIS 2014), At Lisbon, Portugal

Filipe Ferreira, Ahm Shamsuzzoha and Americo Azevedo, "Predictive industrial maintenance: a collaborative approach", 7th International Conference on Interoperability for Enterprise Systems and Applications, At Albi, France

Filipe Ferreira, Américo Azevedo, José Faria, Evelyn Rojas, "Virtual Enterprise Process Management: An Application to Industrial Maintenance", 15th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2014 in Collaborative Systems for Smart Networked Environments - IFIP Advances in Information and Communication Technology Volume 434, 2014, pp 71-79

Evelyn Paola Soto Rojas and Américo Azevedo, "Pillars and Elements to Develop an Open Business Model for Innovation Networks", 15th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2014 in Collaborative Systems for Smart Networked Environments - IFIP Advances in Information and Communication Technology Volume 434, 2014, pp 71-7

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Catarina Félix, Carlos Soares, Alípio Jorge, João Vinagre: Monitoring Recommender Systems: A Business Intelligence Approach. ICCSA (6) 2014: 277-288

Pedro Abreu, Carlos Soares, Rui Carlos Camacho: Distributed Environment Framework for Optimization Experiments. ICCSA (Workshops/Short Papers/Posters) 2014: 256-259

Fábio Pinto, Carlos Soares, João Mendes-Moreira: An Empirical Methodology to Analyze the Behavior of Bagging. ADMA 2014: 199-212

Tiago Cunha, Carlos Soares, Eduarda Mendes Rodrigues: TweepProfiles: Detection of Spatio-temporal Patterns on Twitter. ADMA 2014: 123-136

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José Soeiro Ferreira (Editor), Rui Carvalho Oliveira (Editor). *Investigação Operacional em Ação - Casos de Aplicação*. Imprensa da Universidade de Coimbra, 2014

### **3.3.3 Ph.D. thesis completed (3000 ca.)**

Marisa Oliveira, Modelos matemáticos e heurísticas para problemas de posicionamento de polígonos ortogonais, PhD thesis, Programa Doutoral em Engenharia Industrial e Gestão, February 2013 (supervisor: António Miguel Gomes)

Reza Fazeli, A combined multi-criteria and system dynamics methodology for mid-term planning of light duty vehicle fleets, PhD thesis, Programa Doutoral em Sistemas Sustentáveis de Energia, March 2013 (supervisors: Jorge Pinho de Sousa, Vítor Leal)

Rui Gomes, Dynamic Vehicle Routing for Demand Responsive Transportation Systems, PhD thesis, Programa Doutoral em Sistemas de Transportes, March 2013 (supervisors: Jorge Pinho de Sousa, Teresa Galvão Dias)

Vitor Santos, Human and Technological Dynamics in Complex Research and Development Projects, PhD thesis, Programa Doutoral em Sistemas e Tecnologias de Informação (U Minho), April 2013 (supervisors: João Álvaro Carvalho, António Lucas Soares)

Manuel Silva, Localização de ontologies de domínio no contexto de redes colaborativas, PhD thesis, Programa Doutoral em Linguística, Lexicologia, Lexicografia e Terminologia (U Nova de Lisboa) May 2013 (supervisors: Rute Costa, António Lucas Soares)

Lia Oliveira, Dealing with uncertainty in supply chains design in automotive industry, PhD thesis, Programa Doutoral em Líderes para Indústrias Tecnológicas, November 2013 (supervisors: Jorge Pinho de Sousa, João Claro)

André Rossi, Meta-aprendizado aplicado a fluxos contínuos de dados PhD thesis, Programa Doutoral em Ciências de Computação e Matemática Computacional (U São Paulo), December 2013 (supervisors: André Carvalho, Carlos Soares)

Roberto da Piedade Francisco, Performance Management and Alignment on Collaborative Networks of SMEs, PhD thesis, Programa Doutoral em Engenharia Industrial e Gestão, February 2014 (supervisor: Américo Azevedo)

Samuel Moniz, Scheduling of Multipurpose Batch Plants - Towards the Development of a Decision-Making Tool for the Chemical-Pharmaceutical Industry, PhD thesis, Programa Doutoral em Líderes para Indústrias Tecnológicas, March 2014 (supervisors: Jorge Pinho de Sousa, Ana Barbosa Póvoa)

Ana Maria Rodrigues, Sectores e rotas na recolha de resíduos sólidos urbanos, Programa Doutoral em Engenharia Industrial e Gestão, PhD thesis, March 2014 (supervisor: José Soeiro Ferreira)

António Almeida, Performance Estimation for Complex Manufacturing Environments, PhD thesis, Programa Doutoral em Engenharia Industrial e Gestão, April 2014 (supervisor: Américo Azevedo)

Pedro Rocha, Geometrical models and algorithms for irregular shapes placement problems, PhD thesis, Programa Doutoral em Engenharia Informática, July 2014 (supervisor: António Miguel Gomes)

Michael Donauer, Identification of cost effective inspection strategies by means of tailored quality tools, cost modeling and simulation, PhD thesis, Programa Doutoral em Líderes para Indústrias Tecnológicas, July 2014 (supervisor: Américo Azevedo)

On-going PhD projects (and expected conclusion date): 26

Edgar Jimenez Perez, Airport strategic planning in the context of low-cost carriers ascendancy: insights from the European experience (concluded February 2015)

Cristóvão Sousa, Collaborative knowledge representation processes and techniques to support domain experts in conceptual modelling (2015)

José Pedro Rodrigues, Implementation of technological innovations in networks of preventive healthcare organizations (2015)

Ricardo Greenfield, On the development of internal legitimacy in intentional innovation networks (2015)

João Bastos, Dynamic supply networks: Models, Organizational Issues and Supporting Technologies (2015)

Senay Sadic, Managing Dynamic Supply Networks through SME Collaboration (2015)

Mohammad Nozari, Architectural and Networking Aspects of Sensing Applications for Vehicular Networks (2015)

Ana Simões, Assessment of the value creation in management models of hospitals – a conceptual framework for a multiobjective and multi-perspective alignment (2015)

Manuela Azevedo, Reconfiguration of facilities and supply networks for higher levels of flexibility (2015)

Nazaré Rego, Supporting the definition of strategies in the configuration of health care supply chains (2015)

André Alho, Improved mobility and more sustainable urban logistics through the configuration and enforcement of (un)loading bays (2015)

Artur Aiguzhinov, Predicting rankings of financial analysts (2015)

Cláudio Sá, Association Rules for Label Ranking (2015)

Pedro Abreu, Machine Learning to Improve Heuristic Search Methods for the Job-Shop Scheduling Problem (2016)

Pedro Saleiro, Mining of News and Twitter (2016)

Fábio Pinto, Model Management using Metalearning (2016)

Ricardo Almeida, Flexible information technologies for complex and non-hierarchical supply chain networks (2016)

Pedro Strecht, Educational Data Mining (2016)

Tiago Cunha, Metalearning for Recommender Systems (2016)

Luís Cruz, Living Analytics for Educational Data Mining (2016)

Parisa Sadeghi, Assembly Line Balancing and Scheduling – Applications in the Footwear Industry (2016)

Solange Mazarotto, Creative and adaptive information models and architectures to support knowledge management in collaborative networks (2017)

Eric Costa, Information, knowledge and collaborative networks in internationalisation processes of SMEs (2017)

Catarina Oliveira, Metalearning and Transfer Learning (2017)

Dario Messina, Information management in supply chain networks: development of an information model for supply chain network monitoring (2018)

Ana Rita Tedim, Supply Chain Strategy of Start-ups Commercializing Emergent Technologies (2018)

### **3.3.4 Patents/prototypes (2000 ca.)**

Prototypes:

Name: New framework to define and implement complex (hierarchic and compound) performance measurement systems (New version with improvements after the end of the EU project)

Developed under the project: VFF – Virtual Factory Framework

Demo Place: VW - AutoEuropa

Development Period: 2014

Name: Multi-criterion scheduling and optimisation for projects in a production environment

Developed under the project: Proj-plan

Demo Place: INESC Porto, Softi9

Development Period: 2014

Name: Market trends using social networks and analysis

Developed under the project: Corenet

Demo Place: INESC Porto, Bivolino (B)

Development Period: 2012-2014

Name: Process modelling and monitoring for plug and play virtual factories

Developed under the project: Adventure

Demo Place: INESC Porto, Azevedos Industria

Development Period: 2012-2014

Name: New production and Logistic System for shoe manufacturing with 24 to 48 hours lead time

Developed under the project: High Speed Shoe Factory

Demo Place: Kyaia

Development Period: 2013-2014

Name: A system for reliable exchange of business documents in the Agrifood industry

Developed under the project: eFoodChain

Demo Place: INESC Porto, Associação dos Produtores Agrícolas da Sobrena

Development Period: 2013-2014

Name: Performance measurement system supporting data collection, fusion and KPI calculation

Developed under the project: Bidirco

Demo Place: Sonafi and Creative Systems

Development Period: 2008-2011

Name: Data analysis and recommender system for fashion products

Developed under the project: Creative Retail

Demo Place: INESC Porto, Creative Systems

Development Period: 2013-2014

Name: Innovative Logistic System for machine tools assembly lines including AGVs

Developed under the project: Produtech-PSI

Demo Place: Adira

Development Period: 2013-2014

Name: Integration platform, data model and definition of standards for the interoperability of manufacturing companies

Developed under the project: Produtech-PSI

Demo Place: Silamos

Development Period: 2013-2014

Name: Framework for the quick development of simulation models of manufacturing systems

Developed under the project: Produtech-PTI

Demo Place: INESC Porto, Adira

Development Period: 2013-2014

Name: Methodology and support ICT tool for the design of innovative business models for production technologies suppliers

Developed under the project: Produtech-PTI

Demo Place: INESC Porto, Azevedos

Development Period: 2013-2014

Name: Shop of the future, enabling new experiences of interaction between customer and point of sale, analysis and new services

Developed under the project: PT21

Demo Place: CITEVE

Development Period: 2013-2014

### **3.3.5 Organization of Conferences (2000 ca.)**

#### 2013

- XV Latin-Iberoamerican Congress of Management of Technology (ALTEC), October 2013, Porto, Portugal [Scientific Committee – Ana Barros]

- 23rd International Conference on Flexible Automation and Intelligent Manufacturing (FAIM), June 2013, Porto, Portugal [Conference Chair - Américo Azevedo; Scientific Committee – Ana Barros]
- 2nd International Conference on Creative Learning for Innovation (CAL4INO), May 2013, Porto, Portugal [Scientific Committee – Ana Barros]
- 2nd International Conference on Creative Learning for Innovation (CAL4INO), May 2013, Porto, Portugal [Organizing Committee – Ana Barros]
- Pro-VE 2013 – 14th IFIP Working Conference on Virtual Enterprises. Dresden, October 2013 [Program Committee – António Lucas Soares]
- 7th Terminology & Ontology: Theories and applications TOTh International Conference. Chambéry, France. June 2013 [Program Committee – António Lucas Soares; Américo Azevedo; Jorge Pinho de Sousa]
- 46th CIRP Conference on Manufacturing Systems. Setúbal, Portugal. May 2013 [Program Committee – Américo Azevedo]
- 10th ESICUP Meeting. Lille, France. April, 2013 [Program Committee – António Miguel Gomes (chairman)]
- EWGT2013 Euro Working Group on Transportation. Porto. September 2013 [Organizing Committee - Jorge Pinho de Sousa; Program Committee – Carlos Soares]
- European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases. Prague. September 2013 [Program Committee – Carlos Soares]

#### 2014

- 10th Workshop on Ontology Content OntoContent 2014. Part of the “On the move Conferences”. Amantea, Calabria, Italy. October, 2014 [Organizing Committee – António Lucas Soares; Carla Pereira]
- Pro-VE 2014 – 15th IFIP Working Conference on Virtual Enterprises. Amsterdam, October 2014 [Program Committee – António Lucas Soares; Américo Azevedo; Jorge Pinho de Sousa]
- 8th Terminology & Ontology: Theories and applications TOTh International Conference. Chambéry, France. June 2014 [Program Committee – António Lucas Soares]
- CAPSI 14ª Conferência da Associação Portuguesa de Sistemas de Informação. Santarém, Portugal. October 2014 [Program Committee – Américo Azevedo]
- DET 2014 8th International Conference on Digital Enterprise Technology. Stuttgart, Germany. March 2013 [Program Committee – Américo Azevedo]
- 11th ESICUP Meeting. Beijing, China. March, 2014 [Program Committee – António Miguel Gomes]
- Brazilian Conference on Intelligent Systems (BRACIS), São Carlos, SP, Brazil. October 2014 [Program Committee – Carlos Soares]
- Encontro Nacional de Inteligência Artificial e Computacional (ENIAC), São Carlos, SP, Brazil October 2014 [Program Committee – Carlos Soares]
- European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases, Nancy. September 2014 [Program Committee – Carlos Soares]
- International Conference on Information Systems (ICIS 2014), Auckland, New Zealand. December 2014 [Program Committee – Carlos Soares]
- 14th edition of the Ibero-American Conference on Artificial Intelligence (IBERAMIA'2014), Santiago de Chile. November 2014 [Program Committee – Carlos Soares]

- 9th International Conference on the Quality of Information and Communications Technology (QUATIC 2014), Guimarães. September 2014 [Program Committee – Carlos Soares]

### **3.3.6 Industry contract research (2000 ca.)**

National direct RTD contracts: 18

CESE has a very strong link with industry and regular collaboration with technology suppliers. The centre provides consultancy services on industrial management, on requirements analysis, and on the selection of technical solutions. For suppliers of technologies in industry, the group offers RTD services on the design and development of new products they commercialize, in fields such as production planning and scheduling, optimization of cutting and packing, automation and logistics, enterprise collaboration and interoperability.

Some of the main industry contracted research, consultancy and technology transfer projects during the period 2013/2014 were:

- PMD - Performance measurement and management;
- ESPP - Extended Shoe Production Planning;
- Proj-Plan - Multi-criterion scheduling and optimisation for projects in a production environment;
- CRITICAL – Production scheduling optimisation for the semiconductor and high-tech industries;
- HFAPS - Specialised consulting to improve a manufacturing system in the electronics sector;
- SPS - Specialised consulting to improve a manufacturing system;
- ESI - Business Process Engineering and Information System;
- BI4UP - Business Intelligence (BI) tool;
- BSHM - Automatic identification of pathologies in steel-concrete connectors in composite bridges;
- LOG-Config - Internal logistics configuration system;
- FLUPLAN – Design of operations planning processes and IT requirements;
- COOL - Paper cutting optimisation module;
- RCE - Platform to manage information and knowledge for the European collaboration network of players in the textile and clothing sector;
- ParqueEscolar – Construction works standardisation and support system.

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the international level*

International projects (2013/2014): 11

International consultancy: 01

- VFF (Holistic, extensible, scalable and standard Virtual Factory Framework) – developing a simulation framework to support the design and reconfiguration of factories;
- CORENET (Customer-ORiented and Eco-friendly NETworks for healthy fashionable goods);
- ADVENTURE (ADaptive Virtual ENTerprise ManufacTURING Environment);

- PROsumer.NET (European Consumer Goods Research Initiative - Networking European Technology Platforms addressing Design-based Consumer Goods Industries and Related RTD Fields);
- FoodManufuture (Conceptual Design of a Food Manufacturing Research Infrastructure to boost up innovation in Food Industry);
- APPS4aME (Engineering Apps for advanced Manufacturing Engineering);
- EXPLORE (Extended exploitation of European Research Project's Knowledge and Results);
- STAMINA (Sustainable and reliable robotics for part handling in manufacturing automation);
- FOCUS (Advances in FOrestry Control and aUtomation Systems in Europe);
- MOFFS (Make to Order Fast and Smart Scheduler);
- FoodSupplyChain (Stimulating innovation in the food supply-chain through smart use of ICT: assisting SME's participate in digital supply chains in the single market);
- IزارoGrey (Maintenance and licensing of the new versions of the "IZARO GREY" software module).

#### International educational programs

Active participation in the MIT Portugal Program (MPP), namely in the doctoral programs in Engineering Design and Advanced Manufacturing (EDAM) and Transportation Systems. These participations are an important opportunity for the exchange of information and experiences.

#### International Associations

- EFFRA - European Factories of the Future Research Association (J C Caldeira, Board Member);
- Manufuture European Technology Platform (J M Mendonça, J C Caldeira, Members of management bodies);
- Footwear European Technology Platform (L Carneiro, J M Mendonça, Members of management bodies);
- EURO Special Interest Group on Cutting and Packing of EURO, the Association of European Operational Research Societies (A M Gomes).

Number of papers in journals in cooperation with authors from foreign institutions: 13

### **3.3.8 Other national publications (6000 ca.)**

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

National programs – FCT: 06; QREN: 09

The Centre participated in a total of 14 projects with support or collaboration with national agencies. Some of the main national projects during the period 2013/2014 were:

- SysMAP- Modular and intelligent production equipment;
- HighSpeedShoefactory - Model to manufacture customised footwear;
- Produtech-PSI - New products and services for the manufacturing industry;

- PRODUTECH\_PTI - Innovative processes and technologies for the manufacturing industry;
- PowerTextilesXXI - Collective R&D initiatives with the participation of companies within the textile and clothing industries;
- NEWALK - Materials, components and technology for the footwear of the future;
- GNOSIS - Knowledge management for the improvement of manufacturing equipment and tools in the stone industry;
- PLM4all - Low-cost toolbox to help manage the lifecycle of manufacturing equipment;
- Micro-Fab – Methodology and support systems for the design and operation of micro-factories (one container factory).

Participation in sectorial initiatives:

The following are some key sectorial initiatives in which members of the Centre participate actively:

- MANUFUTURE European Technology Platform and EFFRA (European Factories of the Future Research Association);
- Footwear European Technology Platform;
- PRODUTECH – Competitiveness Pole for Production Technologies;
- NEWALK – Mobilization R&D project for the footwear sector (promoted by the associated Competitiveness Pole);
- PowerTextilesXXI – Mobilization R&D project for the textile sector (promoted by the associated Competitiveness Pole).

### 3.1 Group Description - UTM

Research Group Title	Telecommunications and Multimedia
Principal Investigator	José António Ruela Simões Fernandes
<b>Research Area</b>	Electrical and Computer Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements - UTM

#### 3.2.1 Objectives (4000 ca.)

##### OBJECTIVES

The Telecommunications and Multimedia Unit (UTM) is a main contributor of a RL that envisions a lively and sustainable world where networked intelligence enables ubiquitous interaction with sensory-rich content. The RG defined as its mission the development of advanced systems and technologies enabling high capacity, efficient, and secure communications, media knowledge extraction, and immersive ubiquitous multimedia applications. This mission is being accomplished by directing the activities towards four main research areas.

##### INFORMATION PROCESSING AND PATTERN RECOGNITION

The main goal of this area is to develop intelligent automatic or semi-automatic audiovisual applications that enhance people's life across different dimensions. This requires investigating techniques for efficient automatic extraction of high-level features of video, audio and image signals and the generation of additional knowledge and rich models from the extracted data.

These aspects are addressed by combining fundamental and applied research in machine learning, signal processing and human-computer interaction, with applications in computer vision, image and video processing (medical images, manuscript documents and video object tracking), sound and music computing (music information retrieval, interactive music systems and musical robotics) and network information processing.

##### MULTIMEDIA COMMUNICATIONS TECHNOLOGIES

The main goal of this area is to devise solutions to ease the access to distributed multimedia resources in heterogeneous environments to any user in a seamless and adaptable way. This includes metadata and multimedia content management, context-aware multimedia services, adaptable mobile and immersive multimedia applications.

The main research topics focus on personalised access and consumption of multimedia content through context awareness; content recommendation using hybrid approaches; immersive multi-view experiences; metadata in collaborative annotation systems employing concepts of crowdsourcing and Games With a Purpose to motivate users. The goal is also to: investigate efficient search and content analysis methods; accurate algorithms to validate annotations; to devise metadata model and tools for sensing, representing and reproducing multi-sensorial real-life experiences.

##### COMMUNICATIONS NETWORKS

The main goal of this area is designing and evaluating new architectural solutions suitable for next generation networks. The focus is on wireless networks and mobile communications, extending infrastructure networks and enabling the emergence of the Internet of Everything in terrestrial and maritime environments. This requires theoretical and simulation modelling, implementation, and experimental evaluation of communications networks and their elements.

The main research topics include the development of solutions for medium access control in and self-configuration of static and mobile multi-hop wireless networks, large scale networks, network congestion control, optimisation using cross-layer techniques and machine to machine communications.

#### OPTICAL TECHNOLOGIES AND ELECTRONICS

The main goal of this area is to integrate advanced skills in optical communications and microwaves, and microelectronics and programmable logic.

Research activities in optical communications and microwaves addresses the development of optical and wireless communication systems, including the convergence between both wireless and optical systems, and passive optical access networks, supported in advanced modulation formats and signal processing techniques as well as the R&D of novel microwave/radio devices and antennas.

Research in microelectronics and programmable logic addresses design and testability of circuits, characterisation and adaptive correction of performance, RF design and transparent electronics, A/D and D/A conversion, dedicated computing applications in reconfigurable logic, and hardware/software co-design and VLSI design.

### **3.2.2 Main Achievements (4000 ca)**

#### INFORMATION PROCESSING AND PATTERN RECOGNITION

A 3D Low-cost Solution for the Aesthetic Evaluation of Breast Cancer Treatment

The Data Replication Method for the Classification with Reject Option

Algorithms for people detection and localization in retail environments

Language for expression of Computer Vision Metadata

Algorithms for physical activity classification using video

A real-time beat tracking method designed for drums

A real-time music mashup system

A new evaluation methodology for beat tracking systems

A method for real-time automatic piano accompaniment

A system for manipulation of syncopation in MIDI data

Paper wins the SoundSoftware.ac.uk Prizes for Reproducibility in Audio and Music Research 2013

A robot audition system for real-time music genre recognition

First Place in the IEEE BTAS 2013: LivDet – Iris 2013: Iris Liveness Detection Competition,

First Place in the ICDAR 2013 Music Scores Competition: Staff Removal, August 2013

#### MULTIMEDIA COMMUNICATIONS TECHNOLOGIES

Performance evaluation of content recommendation algorithms

Contextualized user profiling techniques

Context sensing middleware platform for Android OS

Human activity recognition in Android devices

Content recommendation in mobile environments

Personalized multiview system

Adaptable video streaming

Collaborative multimedia annotation application based on concepts of Games with a Purpose

## COMMUNICATIONS NETWORKS

Simulation framework for 802.11-based WMN using directional antennas

Power interference model for CSMA/CA based networks using directional antennas

Energy-efficient scheduling mechanism for 802.11-based WMN using FM as a control channel

Accurate positioning technique in underground tunnels using Software Defined Radio

Energy-Aware routing for biomedical wireless sensor networks

Simple and backwards compatible routing for Multi-technology Personal Area Networks

Cooja simulation framework for 802.15.4 wireless sensor networks in Smart Grids

Energy-efficient packet relaying mechanism in Wireless Visual Sensor Networks

ns-3 based simulation framework for TCP/IP Wireless Underground Networks

Simple multi-hop scheduling mechanism for single-radio 802.11-based WMN

QoS-based management mechanism for biomedical wireless sensor networks

RSSI prediction algorithm for 802.11-based communications

Dynamic MTU Algorithm for 802.11-based maritime communications

## OPTICAL TECHNOLOGIES AND ELECTRONICS

Assessment of Digitised radio techniques for fibre-wireless applications

Evaluation of modulation for pico-cellular access networks based on resonant tunneling diodes

Evaluation of a digitized fiber-wireless system employing sigma delta modulation

Performance assessment pre-distortion techniques in multicarrier digitised RoF system

Performance comparison of OFDM and SC-OFDM in Radio-over-fiber systems

Propagation model accounting for the attenuation of radio electromagnetic waves in underwater

Novel layer-peeling algorithm for the synthesis of nonuniform transmission lines

Design and synthesis of band-stop filters with arbitrary group delay lines and wide-band couplers

Novel analog-to-digital transformation for minimum length synthesis of transmission lines

Evaluation of a differential GPS-over-fiber system for aircraft attitude determination

Inverted-L antenna design using fractal geometry for dual band WLAN

Design and test of omnidirectional antennas using LTCC substrates for UWB.

IC design and test, in 130nm, of an UWB LNA.

Design of DC/DC converters for MPPT in PV panels of 140W  
Integration of multipanel power-adaptation and testing  
Circuit design and testing using a-GIZO devices  
Hybrid packet/circuit switching protocol for sensor networks  
Compact open-loop clock and data recovery method for use in wearable system  
Data over power supply communication chip for wearable wired network  
Sensor network for capturing and transmission of biomedical signals  
Processing of biomedical signals for dependability analysis  
Study of supercontinuum generation in the normal dispersion regime

### **3.3 Productivity - UTM**

#### **3.3.1 Publications in peer review Journals (6000 ca.)**

2013

Sordo, M., Gouyon, F., Sarmiento, L., Celma, O., Serra, X., "Inferring Semantic Facets of a Music Folksonomy with Wikipedia", *Journal of New Music Research*, December 2013, vol.42, no.4, p.346-363.

Azad, A., Morla, R., "Caller-REP: Detecting unwanted calls with caller social strength", *Computers & Security*, November 2013, vol.39, no.8, p.219-236.

Sturm, B., Gouyon, F., "Revisiting Inter-Genre Similarity", *IEEE Signal Processing Letters*, November 2013, DOI:10.1109/LSP.2013.2280031, vol.20, no.11.

Machado da Silva, J., Renaud, S., Canas Ferreira, J., "Special issue of *Microelectronics Journal* on the Conference on Design of Circuits and Integrated Systems 2011 (DCIS 2011)", *Microelectronics Journal*, October 2013, vol.44, no.10, p.869.

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Mohamed Massa, D., Morla, R., "Modeling 802.11 AP Usage through Daily Keep-alive Event Counts", *Wireless Networks*, July 2013, vol.19, no.5, p.1005-1022.

Romeira, B., Pessoa, L.M., Salgado, H., Ironside, C., Figueiredo, J., "Photo-Detectors integrated with Resonant Tunneling Diodes", *Sensors Journal*, July 2013, vol.13, no.7, p.9464-9482.

Sousa, R., Cardoso, J., "The Data Replication Method for the Classification with Reject Option", *AI Communications*, July 2013, vol.26, no.3, p.281-302.

Facção, M., Carvalho, M.I., Almeida, P., "Accelerating solitons in gas-filled hollow-core photonic crystal fibers", *Physical Review A*, June 2013, DOI:10.1103/PhysRevLett.107.203902, vol.87, no.6.

Ciobanu, L., Corte Real, L., "Multi-view codec with low-complexity encoding for Distributed Video Coding", *Multimedia Tools and Applications*, June 2013, vol.64, no.3, p.731-755.

Pessoa, L.M., Salgado, H., Darwazeh, I., "Simplified back-propagation for fibre nonlinearity compensation employing multi-band OFDM signals", *OPTICAL AND QUANTUM ELECTRONICS*, June 2013, vol.45, no.6, p.491-502.

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Aurélío Domingues, M., Gouyon, F., Jorge, A., Leal, J.P., Vinagre, J., Lemos, L.F., Sordo, M., "Combining usage and content in an online recommendation system for music in the Long Tail", *International Journal of Multimedia Information Retrieval*, March 2013, vol.2, no.1, p.3-13.

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Silva, P., Andrade, M.T., Carvalho, P.M., Mota, J., "A Structured and Flexible Language for Physical Activity Assessment and Characterization", *Journal of Sports Medicine* 2013, DOI:10.1155/2013/420916, vol.2013.

Paulino, N., Canas Ferreira, J., Cardoso, J., "Architecture for Transparent Binary Acceleration of Loops with Memory Accesses", *Reconfigurable Computing: Architectures, Tools and Applications 2013*, P. Brisk, J. G. Figueiredo Coutinho, and P. C. Diniz, Eds. Berlin, Heidelberg: Springer Berlin Heid, vol.7806, p.122-133.

Calçada, T., Ricardo, M., "Characterization of the impact of network topology on the performance of single-radio wireless mesh networks", *Telecommunication Systems Journal* 2013, DOI:10.1007/s11235-013-9812-0.

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Costa, L.M., Pereira, J.E., Filipe, V.M., et al. , "Rolipram promotes functional recovery after contusive thoracic spinal cord injury in rats", *Behavioural Brain Research* 2013, vol.243, no.15, p.66-73.

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Viegas, C., Vasques, F., Portugal, P., "Real-time communication in IEEE 802.11s mesh networks: simulation assessment considering the interference of non-real-time traffic sources", *EURASIP Journal on Wireless Communications and Networking*, December 2014, Doi:10.1186/1687-1499-2014-219.

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F. Pinto da Costa, J., Alonso, H., Cardoso, J., "Corrigendum to 'The unimodal model for the classification of ordinal data' [*Neural Netw.* 21 (2008) 78-79]", *Neural Networks*, November 2014, vol.59, p.73-75.

Grade Tavares, V., Santos, M.C., Guedes de Oliveira, P., Príncipe, J.C., "Filter & hold: a mixed continuous-/discrete-time technique for time-constant scaling", *International Journal of Circuit Theory and Applications*, November 2014, DOI: 10.1002/cta.2046.

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Abreu, C.J., Ricardo, M., Mendes, P., "Energy-aware routing for biomedical wireless sensor networks", *Journal of Network and Computer Applications*, April 2014, vol.40, p.270-278.

Zapata, J.R., Davies, M., Gómez, E., "Multi-feature beat tracking", *IEEE Transactions on Audio, Speech and Language Processing*, April 2014, vol.22, no.4, p.816-825.

- Soares, M.M., Viana, P., "Tuning metadata for better movie content-based recommendation systems", *Multimedia Tools and Applications*, April 2014, DOI:10.1007/s11042-014-1950-1.
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- Domingues, I.C., Cardoso, J., "Max-ordinal learning", *IEEE Transactions on Neural Networks and Learning Systems* 2014, *IEEE Transactions on Neural Networks and Learning Systems*, vol.25, no.7, p.1384-1389.
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### **3.3.2 Other international publications (6000 ca.)**

Books and book chapters

2013

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2014

Bernardes Almeida, G., Davies, M., "Beyond Music Information Retrieval: A Proposed Model for Automatic Generation of Dialogic Music ", December 2014, p.123-134.

Ferreira, S.A., Pimenta Alves, A., Quico, C., "TravelPlot Porto - exploring transmedia storytelling's potential to promote Porto as a tourism destination", October 2014, *Porto as a Tourism Destination*, p.153-162.

Luo, Q., Rocha Pereira, J., Salgado, H., "Low Cost Compact Multiband Printed Monopole Antennas and Arrays for Wireless Communications", September 2014, *Progress in Compact Antennas*, Doi: 10.5772/56980.

Otebolaku, A., Andrade, M.T., "Context-Aware Multimedia Content Recommendations for Smartphone Users", July 2014, *Encyclopedia of Information Science and Technology*, Third Edition, p.5658-5666.

Monteiro, J.C., Sequeira, A.F., Oliveira, H.P., Cardoso, J.S., "Robust Iris Localisation in Challenging Scenarios" 2014, *Computer Vision, Imaging and Computer Graphics: Theory and Applications*, DOI: 10.1007/978-3-662-4491.

### **3.3.3 PhD thesis completed (3000 ca.)**

PHD THESES AUTHORED BY MEMBERS OF THE UNIT

2013

Oliveira, Hélder P., "An Affordable and Practical 3D Solution for the Aesthetic Evaluation of Breast Cancer Conservative Treatment", June 2013, PhD thesis.

Lobato Oliveira, J., "Live Beat-Synchronous Robot Dancing", May 2013, PhD thesis.

Fernandes Castro, H., "P2P Strategies for the Safe Distribution of Rich Media Content", April 2013, PhD thesis.

Caçada, T., "Topology Aware Channel Assignment in Single-radio Stub Wireless Mesh Networks", January 2013, PhD thesis.

2014

Bahubalindrani, Pydi., "Analog/Mixed Signal Circuit Design with Transparent Oxide Semiconductor Thin-Film Transistors", December 2014, PhD Thesis.

Santos, Manuel C., "High-Efficiency Linear Transmitters for Mobile Communication Systems", July 2014, PhD Thesis.

Pereira, Mário .R., "Inverse Scattering Techniques for the Synthesis of Microwave Structures", July 2014, PhD Thesis.

Penha, Rui L., "Modelos de Especialização: Integração no Pensamento Composicional", July 2014, PhD Thesis.

Bernardes Almeida, G., "Composing Music by Selection: Content-based Algorithmic-assisted Audio Composition " 2014.

### **3.3.4 Patents/prototypes (2000 ca.)**

Framework for recognition of musical characters

Framework for Staff line detection

Software for 3D reconstruction

Modules for people detection in retail environments

Modules for people localization in ambient assisted living scenarios

Graphic interface for video annotation in sport scenarios

RAMA for Spotify - an app to explore a network of favourite music artists

earGram - a software for exploration of large databases of audio snippets

Loopalooza - estimates and manipulates rhythmic structures from audio loops

Spatium - a spatialization software for the CARA concerts

Improvasher - a real-time music mashup system

CAMR - Contextualised Multimedia Recommendations in Android devices

Platform to evaluate video recommendation algorithms

Personalised Multiview video streamer

Tag4Vid - a video annotation tool

ns-2 simulator for 802.11-based WMN using directional antennas

ns-3 simulator for Underwater Wireless Networks

ns-3 simulator for Wireless Underground Networks

802.15.4 wireless sensor network for monitoring photo-voltaic power plants

Maritime wireless network for ship-to-shore communications

Green LED transceiver for underwater optical wireless communications

WiFi-over-fiber system

Differential GPS-over-fiber system

UWB LNA

TFT a-GIZO dynamical Models

MPPT and DC/DC converter in PV arrays

TFT Amplifiers

Elliptical antennas for UWB communications

Wired sensor network for capture of human locomotion signals

ASIC for wired sensor networks (CMOS 0.35 um)

Tools for hardware generation for loop accelerators

Prototype of transparent pipelined loop accelerator

Prototype of transparent modulo-scheduled loop accelerator

Telemetry system for monitoring a body implanted pressure sensor

Power-line communication for wired wearable network demonstration chip

Wearable cardiovascular monitoring system

Patent No. 106373, "Methos Of Routing and Resource Assignment for OBS Networks"

Patent No 107537, "Mixed signal bus module for multiple circuit resources management"

### **3.3.5 Organization of Conferences (2000 ca.)**

MobLive 2014 - Mobile Iris Liveness Detection Competition, Clearwater, Florida, USA, Apr. 2014 (A. Sequeira, J. Monteiro, H. Oliveira, J. Cardoso – Organising committee)

IbPRIA 2013 - Iberian Conference on Pattern Recognition and Image Analysis, Funchal, Portugal, Jun. 2013 (J. Cardoso – Local Chair; L. Teixeira, L. Ciobanu, I. Domingues, H. Oliveira, E. Pereira – Organising committee)

ISMIR 2013 – Int. Society for Music Information Retrieval Conference, Curitiba, Brazil Nov. 2013 (F. Gouyon – Program Chair, M. Davies - Program Committee)

ISMIR 2014 – Int. Society for Music Information Retrieval Conference, Taipei, Taiwan, Oct. 2014 (M. Davies - Program Committee)

ACM Immersive Media Experiences 2013 - workshop in the 21st ACM International Conference on Multimedia, 21-15 October 2013, Barcelona, Spain (P. Viana – Program Committee)

ACM Immersive Media Experiences 2014 - workshop in the 22nd ACM International Conference on Multimedia, 3-7 November 2014, Orlando, Florida, USA, (P. Viana – Program Committee)

IFIP WD 2013 - Wireless Days 2013, Valencia, Spain, Nov. 2013 (M. Ricardo - Chair Broadband Wireless Track)

IEEE/IFIP WD 2014 - Wireless Days 2014, Rio de Janeiro, Brazil, Nov. 2014 (M. Ricardo – Chair Simulation Track)

EDA UMS 2014 - 3rd Workshop on European Unmanned Maritime Systems (R. Campos – Organising Committee)

WNS3, Workshop on ns-3, May 7, 2014, Georgia Institute of Technology, Atlanta GA (M. Ricardo – Steering Committee)

DCIS 2013 – XXVIII Conf. on Design of Circuits and Integrated Systems, Avignon, França, Nov. 2013 (J.S. Matos; J. M. Silva – Steering Committee; J. C. Ferreira – co-program chair)

DCIS 2014 – XXIX Conf. on Design of Circuits and Integrated Systems, Madrid, Espanha, Nov. 2014 (J.S. Matos; J. M. Silva – Steering Committee)

IMS3TW 2014 – IEEE Int. Mixed Signals, Sensors and Systems Testing Workshop, Porto Alegre, Brasil, September 2014 (J. M. Silva – Steering Committee)

### **3.3.6 Industry contract research (2000 ca.)**

Direct contracts with the industry:

vCardID – Solução Nacional para identificação Biométrica através de impressões digitais, with INCM

ASSIST – ANALYSIS OF SPORT STATISTICS

HONDA - Research contract between INESC, LIAAC and Honda Research Institute in Japan

Projects with industrial partners in the framework of QREN (Quadro de Referência Estratégico Nacional), either in partnership or under contract:

AAL4ALL – Ambient Assisted Living for ALL

ARENA – Plataforma para Análise da Performance Desportiva

RetailPro - Desenvolvimento de uma Plataforma Integrada de Gestão Estratégica de Ambientes de Retalho

SARA - Sistema de Gestão de Activos de Redes Rodoviárias.

QREN PGlobal

MTGrid - Multi Technology Communication Infrastructure for the Smart Grid

HiperWireless - Point-to-Multipoint Microwave Communications using the 17GHz License-free Band

UniSat - Triple band transceiver for the Ku/Ka band, QREN (Vale ID&T)

TDT-ANACOM - Development of probe network for monitoring Digital Terrestrial Television, scientific supervision of the project. Institutions: Ubiwhere, Wavcom, INESC-Porto.

WiSat - Passive Devices for the S and Ka band QREN (Vale ID&T)

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

The participation in a number of projects funded by research programmes of the European Union (listed below) allowed consolidating the position of the Unit at international level and establishing strategic partnerships with leading R&D institutions in Europe.

PICTURE - Patient Information Combined for the Assessment of Specific Surgical Outcomes in Breast Cancer, FP7 ICT Programme

MPM4CPS - Multi-Paradigm Modelling for Cyber-Physical Systems , ICT COST Action IC1404

CONFINE - Community Networks Testbed for the Future Internet, FP7 ICT programme

SUNNY - Smart UNattended airborne sensor Network for detection of vessels used for cross border crime and irregular entrY, FP7 ICT programme

DAPHNE – Developing Aircraft PHotonic Networks, FP7 ICT programme

OPTICWISE - Optical Wireless Communications-An Emerging Technology, COST Action IC1101

MiMed - Development of a European-based Collaborative Network to Accelerate Technological, Clinical and Commercialisation Progress in the Area of Medical Microwave Imaging, COST action TD1301

WIPE - Wireless Power Transmission, COST action IC1301

EMF-MED - European network for innovative uses of EMFs in biomedical applications, COST Action BM1309

Senseiver – Low-cost and energy-efficient LTCC sensor/IR-UWB transceiver solutions for sustainable healthy environment, Marie Curie programme

### 3.3.8 Other national publications (6000 ca.)

The complete list of publications be consulted in: <http://profile.inescporto.pt>

2013

National conferences

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Pereira, E.J., Cardoso, J., Morla, R., "A Critical Analysis about a Motion-based Approach to Extract Global Trajectories", RECPAD 2013 - The 19th edition of the Portuguese Conference on Pattern Recognition, November 2013, Lisboa, Portugal.

Monteiro, J.C., Mota, E., "An assessment of the potential of distinct facial regions for biometric recognition", RECPAD 2013 - The 19th edition of the Portuguese Conference on Pattern Recognition, November 2013, Lisboa, Portugal.

Khoshrou, S., Cardoso, J., F. Teixeira, L., "Learning from uneven video streams in a multi-camera scenario", RECPAD 2013 - The 19th edition of the Portuguese Conference on Pattern Recognition, November 2013, Lisboa, Portugal.

Domingues, I.C., Cardoso, J., "Mass detection on mammogram images: A first assessment of deep learning techniques", RECPAD 2013 - The 19th edition of the Portuguese Conference on Pattern Recognition, November 2013, Lisboa, Portugal.

Borges Teixeira, F., Campos, R.L., Ricardo, M., Quevedo, J., "Performance Evaluation of IEEE 802.11 Underwater Wireless Networks", CRC 2013 - 13ª Conferência sobre Redes de Computadores, November 2013, Leiria, Portugal.

Sequeira, A.F., Murari, J., Cardoso, J., "Quality measures for iris images in mobile applications", RECPAD 2013 - The 19th edition of the Portuguese Conference on Pattern Recognition, November 2013, Lisboa, Portugal.

Rebelo, A.M., Cardoso, J., "Staffline Detection in Grayscale Domain", RECPAD 2013 - The 19th edition of the Portuguese Conference on Pattern Recognition, November 2013, Lisboa, Portugal.

Carpinteiro, F., Costa, P., Magalhães, F., Oliveira, H.P., "3D Methodology for Leg Prosthesis Modelling", IJUP'13 - Investigação Jovem na U.Porto, February 2013, Porto, Portugal.

Marques, H., Canas Ferreira, J., "A Remote Demonstrator for Dynamic FPGA Reconfiguration", REC 2013 - X Jornadas sobre Sistemas Reconfiguráveis, February 2013, Coimbra, Portugal.

Costa Lima, A., Canas Ferreira, J., "Automatic Generation of Cellular Automata on FPGA", REC 2013 - X Jornadas sobre Sistemas Reconfiguráveis, February 2013, Coimbra, Portugal.

Ferreira, P., Canas Ferreira, J., Alves, J.C., "Computational Block Templates Using Functional Programming Models", REC 2013 - X Jornadas sobre Sistemas Reconfiguráveis, February 2013, Coimbra, Portugal.

Sá, J.C., Canas Ferreira, J., Alves, J.C., "FPGA Implementation of Autonomous Navigation Algorithm with Dynamic Adaptation of Quality of Service", REC 2013 - X Jornadas sobre Sistemas Reconfiguráveis, February 2013, Coimbra, Portugal.

International conferences:

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Andrade, M.T., Almeida, F., "Novel Hybrid Approach to Content Recommendation based on Predicted Profiles", UIC 2013 - The 10th IEEE International Conference on Ubiquitous Intelligence and Computing, December 2013, Vietri sul Mare, Italy.

Teixeira Almeida, N., Pinheiro, V., "RFID ALARM SYSTEM AND TRAJECTORY CORRECTION IN PARALYMPIC ATHLETICS RACES", CETC 2013 - Conference on Electronics, Telecommunications and Computers, December 2013, Lisboa, Portugal.

Campos, R.L., Ricardo, M., "Simple and Backwards Compatible Routing for Multi-technology Personal Area Networks", IEEE GLOBECOM 2013 - Global Communications Conference, Exhibition & Industry Forum, December 2013, Atlanta, USA.

Vargas, H., Carvalho, J.P., Machado da Silva, J., "A Continuous Regulation Step-Up Switched-Capacitor DC-DC Converter", DCIS 2013 - Conference on Design of Circuits and Integrated Systems, November 2013, San Sebastian, Spain.

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Pinto, P.F., Pinto, A., Ricardo, M., "End-to-End Delay Estimation using RPL Metrics in WSN", Wireless Days 2013 - Wireless Days 2013, November 2013, Valencia, Spain.

Vieira Santos, P., Alves, J.C., Canas Ferreira, J., "High-Level Synthesis of Custom Processing Elements for Genetic Algorithms", DCIS 2013 - Conference on Design of Circuits and Integrated Systems, November 2013, San Sebastian, Spain.

Cardoso, M.J., "IN12 INOPERABLE LOCALLY ADVANCED BREAST CANCER: SURGERY - CHALLENGES AND OPPORTUNITIES", ABC2 - Advanced Breast Cancer Second International Consensus Conference, November 2013, Lisboa, Portugal.

Fernandes, H., Filipe, V.M., Costa, P., Barroso, J., "Location based services for the blind supported by RFID technology", DSAI2013 - International Conference on Software Development for Enhancing Accessibility and Fighting Info-Exclusion, November 2013, Vigo, Spain.

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Pinto, A., Calçada, T., Carneiro, G.J., "Data plane efficiency of a hybrid multicast approach for content aware networks ", Future Network and Mobile - Future Network and Mobile Summit 2013, July 2013, Lisboa, Portugal.

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### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

Projects funded by FCT:

3dBCT - 3D Models for Aesthetic Evaluation and Prediction of Breast Cancer Interventions

NeTS - Next Generation Network Operations and Management

MC-WMNs - Multiple Context-based Wireless Mesh Networks

OSP-HNLF - Optical Signal Processing using Highly Non-Linear Fibres, PTDC/EEA-TEL/105254/2008

SELF-PVP Self-organizing power management for photo-voltaic power plants (CMU programme)

CPT: Cartesian Polar Transmitter, FCT PTDC/EEA-TEL/121101/2010

CReATION - Cognitive Radio Tranceiver Design for Energy Efficient Data Transmission, FCT EXCL/EEI-TEL/0067/2012

SIVIC - Portable Integrated System for Cardiovascular Monitoring, FCT PTDC/EEI-ELC/1838/2012

CPT - Cartesian Polar Transmitter, FCT PTDC/EEA-TEL/121101/2010)

Steering – Steering of light in nonlinear waveguides with resonant interactions, FCT PTDC/FIS/112624/2009)

WOWi - Wireless-optical-wireless interfaces for picocellular access networks, FCT PTDC/EEA-TEL/100755/2008

TWave - Phase conjugated twin waves to unlock the potential of future spatial division multiplexed systems, FCT EXPL/EEI-TEL/1748/2013

Projects funded by UP

Computational Vision Applied to the Segmentation and Morphometric Characterization of Nerve Histology in Microscopic Images

Projects funded by ON.2 O Novo Norte



BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL6 - Multimedia Art Technologies

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL3 - NETWORK SENSING FOR CRITICAL SYSTEMS MONITORING

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL4 - Cooperation and perception for augmented autonomy

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL5 – Smartgrids

### 3.1 Group Description – UOSE

Research Group Title	<b>OPTOELECTRONICS AND ELECTRONIC SYSTEMS</b>
Principal Investigator	Paulo Vicente Silva Marques
Research Area	Physics
Home Institution	INESC Porto

### 3.2 Objectives & Achievements - UOSE

#### 3.2.1 Objectives (4000 ca.)

##### FOREWORD

The Coordinator of this Unit during 2013 and 2014 was Prof. Paulo Marques.

##### OBJECTIVES

The roots of this Unit (named UOSE) go back to 1985, when INESC in Porto was funded in the context of the realization of a large project in optical communications. Along the years the activity was developed along several research areas following its established mission to perform internationally recognized research, development and training in Optoelectronics.

The research objectives embrace modelization, design, process development and Optoelectronics integration. The following areas were addressed in a chain that proceeded from technology to systems and applications:

- Fabrication of thin films, planar optical devices and fibre optics components;
- Optical imaging;
- Optical sensing heads and some types of electrical sensing heads based on thin films;
- Optical sensors for real-time dosimetry
- Synthesis of novel glasses for sensing
- Optofluidics sensor system
- Development of chemical (gases) and biochemical (cyanobacteria, for example) sensors
- Fibre lasers for sensing;
- Optical fibre sensing systems; field tests and applications.

Specific objectives involved the acquisition of operational competences in those areas, the establishment of attractive post-graduated programmes, and the development of consultancy and technology transfer initiatives.

The field of optical sensors has been again the main topic of research. In addition, the cooperation within the group between the several areas of expertise has been enhanced. The scientific objectives remain broadly the same but have been a larger effort to create internal critical mass around the projects considered to be the most relevant for the future. The traditional fields of research in traditional fiber sensors (strain, temperature, curvature, etc) has been performing extremely well, the efforts in recent years to enhance the progress in chemical and bio-chemical sensors is showing consistent results, as a result of the acquisition of several multidisciplinary competencies (fibers optics and optoelectronics, materials science, chemistry, microfabrication and instrumentation).

Recently UOSE has been also focused in supporting the implementation and operation of a large microfabrication infrastructure within Porto University. This include a 180m<sup>2</sup> cleanroom ISO6/7 which will have all the microfabrication techniques available (lithography, dry-etching, deposition, mask production, etc). This facility has been design under the responsibility and guidance of INESC Researchers, together with other from UP.

In the last couple of years the Group was particularly active in continuing to strengthen the relations with the local industry, following the nature of the institution centered in the interface between academia and industry.

In addition, the relation with the Group with the other research units has been increased strongly and has a result several joint projects submitted and other running.

Broadly, for the next period, the objectives is to continue to maintain a good balance between research and development; the success is achieved if the Group maintains a good level of participation in international conferences and a high standard of scientific publications allied to a good number of industrial contracts. The group feels the need to increase the participation in European projects and several proposals where submitted during the period.

### **3.2.2 Main Achievements (2000 ca)**

Improvements, as well as novel configurations were obtained in the following areas:

Implementation of Rayleigh scattering for vibration sensing

Integrated refractometers based on single and multimode interference

Fiber Cavity ring down

Demonstration of utility of suspended core fibers in the implementation of high sensitivity optical sensors

Development of new interrogation schemes with long period gratings

Development of tapers based on CO<sub>2</sub> Laser

New Cavity Fabry-Perot based on microstructured tube combined with glass spheres.

Sensors based on hyperspectral processing

FBG in Focused ion beam for high temperature sensor

Laser direct writing of first order gratings with femtosecond pulses (point by point)

Demonstration of optical coherence tomography in different application areas

Novel optical fiber geometry designs for sensing purposes (H-shaped, suspended twin core fiber, as examples)

Fabrication of waveguides in pure silica through femtosecond laser writing

Fabrication of integrated polarizers based on directional couplers fabricated in pure silica plates by direct writing

Fabrication of refractive index sensors in slotted multimode integrated devices for chemical and biochemical sensing

Optical fiber sensor for hydrogen and metals

Development of glasses for biomedical applications (prosthesis)

Sensors for determination of Quaternary Ammonium Compounds

Sensors for determination of crotaline

Sensor for B. cereus and cereulide determination

Microstructured fiber for vapour and liquid sensing

Wearable Macrobending Fiber Optic Sensor for Human Joint Angle Determination

Vibration sensor based on a distributed Bragg reflector fibre laser

Next generation of Fabry-Perot sensors for high-temperature  
Interrogation sensing scheme based on 'Figure-of-Eight' fiber loop mirror configuration  
Temperature-Independent Torsion Sensor Based on 'Figure-of-Eight' Fiber Loop Mirror  
H2 sensor Based on a Pd-Coated Tapered-FBG Fabricated by DUV Femtosecond Laser Technique  
LPG sensor for the detection of *E. Coli* proteins  
Novel dissolved CO2 sensor for utilization in environmental monitoring and aquaculture industry  
Computational models for new fiber optic tweezers  
Development of an electrical current sensor prototype for application in high-power lines  
Wearable Monitoring Unit for Swimming Performance Analysis  
A Fabry-Perot sensor prototype for low-pressure measurements  
Optical Inclinator Based on a Phase-Shifted Bragg Grating in a Taper Configuration  
Low-Cost Wearable Data Acquisition for Stroke Rehabilitation: A Proof-of-Concept Study on Accelerometry for Functional Task Assessment  
Advanced Fiber-Optic Acoustic Sensors  
An all-fiber Fabry-Pérot interferometer for pressure sensing in different gaseous environments  
Evanescent wave DNA-aptamer biosensor based on long period gratings for the specific recognition of *E. coli* outer membrane proteins  
Development of software/simulation code for solving the Generalized Nonlinear Schrodinger equation  
Development of a numerical tool kit based on MEEP for the analysis of electromagnetic waves in nanostructures  
Development of a metamaterial for the detection of H2 Gas

### **3.3 Productivity - UOSE**

#### **3.3.1 Publications in peer review Journals (6000 ca.)**

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12. Oliveira Silva, S., Coelho, L.C., Marques Martins de Almeida, J.M., Frazão, O., Santos, J.L., Malcata, F.X., "H<sub>2</sub> Sensing Based on a Pd-Coated Tapered-FBG Fabricated by DUV Femtosecond Laser Technique", *IEEE Photonics Technology Letters*, February 2013, vol.25, no.4, p.401-403.
13. André, R.M., Marques, M.J., Mego, P., Frazão, O., "Large range linear torsion sensor based on a suspended-core fiber loop mirror", *Optical Engineering*, February 2013, vol.52, no.2, p.20501.
14. Pereira, G., Faria, C., Faria, H., Frazão, O., Marques, A.T., "On the improvement of strain measurements with FBG sensors embedded in unidirectional composites", *Polymer Testing*, February 2013, vol.32, no.1, p.99-105.
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46. Roriz Oliveira, P., Ferreira, J., Santos, J.L., Frazão, O., "Intradiscal pressure variation under spontaneous ventilation", OFS23 - OFS23 2014, SANTANDER, SPAIN.
47. Silva, V., Ramos, I., Moreira, J.A., Marques, M.J., "Magnetic resonance occupational safety zones and standards", ICEH2014 - 3rd International Congress on Environmental Health (ICEH2014) 2014, Porto, Portugal.
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52. Fernandes, P., Leite, I., Teixeira, J., Hierro-rodriguez, A., Araujo, J., Guerreiro, A., "Sensing with metallic nanowires", Proceedings of SPIE - The International Society for Optical Engineering 2014, vol.9157.

### **3.3.3 Ph. D. thesis completed (3000 ca.)**

1. Roriz Oliveira, P., "FIBER OPTIC SENSORS FOR THE BIOMECHANICAL STUDY OF THE INTERVERTEBRAL DISC", December 2013, PhD Thesis.
2. Oliveira Silva, S., "FIBER OPTIC STRUCTURES FOR REFRACTIVE INDEX AND GAS SENSING", December 2013, PhD Thesis.
3. Queirós, R.B., "BIOSENSORS FOR THE DETECTION AND QUANTIFICATION OF AQUATIC BACTERIAL CONTAMINATION IN WATERS FOR HUMAN USE", April 2013, PhD Thesis.
4. Magalhães, F.T., "Compressive Sensing Based Single-Pixel Imaging Systems" 2013, PhD Thesis.
5. Carvalho, J.P., "Optical Sensing: Fiber Structures and Interrogation Techniques " 2013, PhD Thesis.
6. Martins, H.F., "DISTRIBUTED AND REMOTE FIBER SENSING ASSISTED BY RAMAN EFFECT", September 2014, PhD Thesis.
7. Jesus Gouveia, C., "Refractometric Platforms for Label-Free Biochemical Sensing", January 2014, PhD Thesis.

### **3.3.4 Patents/prototypes (2000 ca.)**

PATENTS

N/A

PROTOTYPES

Dosimeter for radiation therapy

Long cavity fiber laser

Optical flowmeter

Integrated polarization beam splitter

Instrumented PVC foil for smart skin

Many different types of sensor heads for temperature, strain, inclination, refractive index

Broadband optical source for low coherence tomography

An internet driven transducer for biosensor measurements

Low cost optoelectronic platform for CO<sub>2</sub> sensing comprising low cost LED based interrogation system and novel polymeric sensing layer for aquaculture applications

Optoelectronic system for label free biosensing for following hybridization of DNA (*vitis vinifera*) and *E. Coli.* detection

Novel laser based magnetic field sensors comprising a fiber laser cavity with spectral filtering element (FBG)

New vibration fiber sensor based on low order optical fiber long period grating

A prototype system was assembled and calibrated for reproducible fabrication of the polymer microlenses. Selection and control of the fabrication parameters such as power, exposure time, fibre modal excitation was optimized and implemented with adequate software

A modular prototype setup to test the fibre optic tweezers was implemented using an inverted microscope setup and a suitable lens camera system together with a laser diode and micro-manipulators. The system was modular and suitable for rapid installation in other microscopes

Novel optical fiber tweezers

### **3.3.5 Organization of Conferences (2000 ca.)**

The Research Group was involved through several of its members in the Committees of SEON 2013 and SEON 2014. The workshops had the participation of around 50 national and international researchers each year. The program included invited speakers and poster sessions.

Also, several UOSE researchers were involved in the organization of International Conference on Applications of Optics and Photonics (AOP'2014). The event had the participation of researchers from Europe, USA, South Africa and Far East countries with distinguished papers and oral presentations from international researchers from both academia and industry. In 2013 a co-joint initiative gathered RIAO/OPTILAS/ETOP at Porto with the collaboration of several UOSE researchers at both the scientific and organizational levels.

### **3.3.6 Industry contract research (2000 ca.)**

The Unit continued the contract with Fibersensing in the framework of its development. Consultancy in monitoring systems for aeronautical applications, namely in-flight structural health monitoring involving a dedicated measurement unit and athermal strain sensors, were the subjects considered.

ThermalMonitor aimed at the development of the company own capabilities in the area of optical fiber sensors manufacturing, testing and characterization according to international standards.

An international R&D contract, TECCON, with Brazilian universities and electrical power companies is the main achievement concerning industry contract research area.

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

Two main actions were strategically adopted during 2013 and continued during 2014: active participation in COST actions (with group members in the respective management committees) and in bi-lateral cooperation schemes involving the group and other international research groups, with special focus on European groups.

As a result, several proposals are under evaluation/study and bilateral researchers exchange is common. Beyond that, 86 conference presentations and papers were published with foreign institutions as result of this internationalization effort.

The strong collaboration with Brazilian groups continued, and an industrial contracted project is being carried out in Brazil, with several R&D proposals being under evaluation.

#### LIST OF COST ACTIONS

BM1205 European Network for Skin Cancer Detection using Laser Imaging

IC0806 Intelligent Monitoring, Control and Security of Critical Infrastructure Systems (IntelliCIS)

IC1101 Optical Wireless Communications - An Emerging Technology

MP0604 Optical Micro-Manipulation by Nonlinear Nanophotonics

MP0803 Plasmonic components and devices

MP1001 Ion Traps for Tomorrow's Applications

MP1005 From nano to macro biomaterials (design, processing, characterization, modeling) and applications to stem cells regenerative orthopedic and dental medicine (NAMABIO)

MP1205 Advances in Optofluidics: Integration of Optical Control and Photonics with Microfluidics

MP1209 Thermodynamics in the quantum regime

MP1401 Advanced fibre laser and coherent source as tools for society, manufacturing and lifescience

MP1403 Nanoscale Quantum Optics

TD1001 Novel and Reliable Optical Fibre Sensor Systems for Future Security and Safety Applications (OFSeSa)

TD1404 Network for Evaluation of One Health (NEOH)

TD1405 European Network for the Joint Evaluation of Connected Health Technologies (ENJECT)

#### BI-LATERAL ACTIONS

During 2013 and 2014 there were integrated actions with Spain, Germany, Hungary and India.

Under all the schemes above the Group received 10 researchers. Also, 6 researchers of our group spent some periods abroad.

One important reason for this effort is the need we feel to have more European projects running, and therefore, the cost actions and the bilateral exchange programs are a great opportunity to establish new partnerships and to fertilize ideas about future applications to funding. As a consequence of this activity several European proposals were submitted during the second semester of 2014.

A FP7 project in the area of biosensors for food security is being carried out with several relevant European partners.

#### **3.3.8 Other national publications (6000 ca.)**

1. Correia, A.M., Hussain, N., Pirraco, R., Carmelo Rosa, C., "infra-red radioluminescent fiber probes for brachytherapy and external radiotherapy", PRS2013 - Protecção Radiológica na Saúde 2013, Lisboa, Portugal.
2. Saraiva, C., Silva, A.C., Moreira, M.J., Nascimento, P., Marques Martins de Almeida, J.M., "APLICAÇÃO DA ESPECTROSCOPIA DE INFRAVERMELHOS NA DIFERENCIAÇÃO DA DETERIORAÇÃO DE CARNES DE CAÇA", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física and 24º Encontro Ibérico para o Ensino da Física, September 2014, vol.1, no.11, Lisboa, Portugal, p.1-2.
3. Silva Mouta, S., Silva, R.M., Silva, C., Noy, D., Vila-Chã, C., Velhote Correia, M., "HUMAN MOTOR RE-LEARNING - THE USE OF SENSOR INFORMATION", 10th BIAL - 10º Simpósio Fundação Bial 'Aquém e além do cérebro', March 2014, Livro de Actas do 10º Simpósio, Porto, Portugal.
4. Rodrigues Carvalho, L., Roriz Oliveira, P., Frazão, O., Marques, M.J., "Avaliação do desempenho de dois aparelhos ortodônticos, por meio de sensores de Bragg", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física and 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
5. Martins, H.F., Marques, M.J., González-Herráez, M., Frazão, O., "CARACTERIZAÇÃO DE UM OTDR SENSÍVEL À FASE USADO PARA MEDIÇÃO DISTRIBUÍDA DE VIBRAÇÕES E SUAS LIMITAÇÕES DEVIDO À INSTABILIDADE DE MODULAÇÃO", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física and 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
6. Monteiro Silva, F., Barbosa, J.P., Aguilar, G., "Electrochemical behavior of novel synthesized ionic liquids", 4PYChem - 4th Portuguese Young Chemists Meeting 2014, Coimbra, Portugal.
7. Mendes, R., Marques, M.J., Pires, S., "Estudio del comportamiento de las abejas (Apis mellifera iberiensis) sometidas a variaciones del campo electromagnético" [ Study of the bees(Apis mellifera iberiensis)behavior under the influence of a electromagnetic field], VII\_CAH - VII CONGRESO APÍCOLA HISPÁNICO 2014, Santiago de Compostela, Espanha.
8. Pinto Moura, J., Santos, J.L., Marques, M.J., Frazão, O., "Evaporação de compostos voláteis em fibras de núcleo suspenso" [Evaporation of volatile compounds on suspended core fibers], Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física e 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
9. André, R.M., Marques, M.J., Frazão, O., "FABRICAÇÃO DE MICROSENSORES USANDO TECNOLOGIA DE FEIXE DE IÕES FOCADO (FIB)", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física and 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
10. Oliveira Silva, S., Silva Passos, D., Marques, M.J., Frazão, O., "Fiber Cavity Ring-down System", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física and 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
11. Monteiro, M., Marques, M.J., "INSTRUMENTOS DE TEMPO NUMA COLECCÃO CIENTÍFICA", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física and 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
12. Sakelaris, T., Medeiros Limede, P., Esposito, A., Costa, F., Cunha, L., Cunha, A., Lencart, J., Sarmiento, S., Carmelo Rosa, C., "IORT: VALIDAÇÃO DA SIMULAÇÃO MONTE CARLO DE FONTE VARIAN CLINAC 2100", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física e 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
13. Ribeiro, A.R., Queirós, R.B., Soppera, O., Viegas, J., Oliva, A., Guerreiro, A., Jorge, P., "MICROMANIPULAÇÃO CELULAR USANDO FIBRAS ÓTICAS" [Micromanipulation of cells using optical fibers], Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física and 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
14. Barbosa, J.P., Aguilar, G., Sottomayor, M.J., "MIPs-based e-tongue for the detection of quaternary ammonium salts.", 4PYChem - 4th Portuguese Young Chemists Meeting 2014, Coimbra, Portugal.

15. Ferreira, M.S., Marques, M.J., Santos, J.L., Frazão, O., "Pós-processamento de fibras ópticas para sensorização", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física e 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.
16. Medeiros Limede, P., Sarmiento, S., Santos, J., Carmelo Rosa, C., "SIMULAÇÃO DE MONTE CARLO DE DISTRIBUIÇÕES DE DOSE EM FLUOROSCOPIA CT (FLUORO-CT) - VALIDAÇÃO COM MEDIDAS CTDI", Física 2014 - FÍSICA 2014 – 19ª Conferência Nacional de Física e 24º Encontro Ibérico para o Ensino da Física 2014, Lisboa, Portugal.

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

During 2013 and 2014 the Unit was involved in 15 R&D national projects. Eight of these projects were concerned with optical fibre sensors principles and applications; two dealt with monitoring of biomedical signals, other two were dedicated to novel materials and the remaining two with medical physics. The sensors projects were dedicated to applications in composite materials systems, characterization of optical fiber sensing heads for civil engineering applications, measurement of dissolved oxygen by fluorescence and biochemical sensors and measurement of hydrogen. The novel materials projects were related to multiferroics and glasses for prosthesis applications. The medical physics projects were dedicated to the radiation monitoring in cancer treatments. Another project dealt with materials synthesis for sensors.

FCT projects (name and coordinator):

AQUAMONITOR - Pedro Jorge

FIBDOSE - Carla Rosa

FLUOROCT - Carla Rosa

Hybrid - José Luís Santos

InCell - Pedro Jorge

IORT - Carla Rosa

MCP - Nandyala Sooraj

Microphyte - Pedro Jorge

Multiferroicos - José Ramiro Fernandes

Spin\_Fonão - José Ramiro Fernandes

SPR - José Luís Santos

WineBioCode - Pedro Jorge

Wood - José Ramiro Fernandes

QREN projects (name and coordinator):

Sensing - Paulo Marques

SmartGrids – Pedro Jorge

### 3.1 Group Description - USE

Research Group Title	Power Systems
Principal Investigator	Manuel António Cerqueira Costa Matos
Research Area	Electrical and Computer Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements - USE

#### 3.2.1 Objectives (4000 ca.)

The Power Systems Unit (USE), is the core research group for the line of research entitled "Sustainable Energy Systems and the Smart Grid".

The mission of the Power Systems Unit is centred on the development of advanced research in emergent modelling, optimization and control techniques applied to Power Systems characterized by large scale integration of renewable power sources, distributed generation and electric vehicles, under the Smart Grid paradigm. In scientific terms, this corresponds to combining the traditional analytical models and tools of power systems with the emergent techniques of operational research and computational intelligence the group has been applying and with economic models of the new organization of the power sector, in order to develop multidisciplinary integrated models and tools useful for the relevant agents (system operators, producers, regulators, government) and for global understanding of the complex phenomena under research. The main objectives for 2013-14 follow and develop the guidelines for the previous period, with the main additional focus issues:

- Contributions to the detailed conceptualisation of the future electric networks organisation, in the framework of the European Projects where INESC TEC is involved.
- Development and evaluation of multi-terminal HVDC transmission solutions, namely for off-shore wind parks integration.
- Addressing the recent tendency for a high penetration of solar photovoltaic dispersed generation due to cost decrease with foreseeable home and grid parity in a nearby future.
- Taking advantage of the new laboratorial infrastructure (Laboratory of Smart Grids and Electric Vehicles) of INESC TEC.

Along with:

- Development of knowledge, studies and tools to support the increase in the integration of renewable energy into the electric power system.
- Development of new control strategies for large scale integration of distributed generation and large off-shore wind farms.
- Development of knowledge and tools to forecast variable energy sources including energy produced in large off-shore wind farms.
- Designing decision support tools for sustainable, reliable and cost-effective energy strategies in cities and industrial complexes to evaluate various long-term energy strategies.
- Development of specific simulation tools.

- Conceptualisation of the remuneration of ancillary services using Distributed Generation.
- Development of new methodologies for market settlement.
- Development of new concepts and tools for operational reserve definition.
- Evaluation of the Security of Supply in the presence of variable energy sources.
- Conceptualisation of new organisation schemes for the electric sector including smart metering, microgrids, multimicrogrids together with the integration of electric vehicles and dispersed stationary storage devices.
- Development of models for components, monitoring, decision and control mechanisms and communication architectures, evaluation tools and market integration models including remuneration schemes.
- Conceptualisation of innovative SCADA systems for low-level control and data acquisition.
- Knowledge extraction from newly available information on detailed consumption and microgeneration.
- Development and testing of prototypes of control devices in laboratorial environments and pilot sites.
- Development of new concepts and definitions of aggregation agents for mass electric vehicle deployment.
- Development of control and remuneration mechanisms for active load control and demand side integration.
- Development of advanced generation coordination solutions for complex systems with stochastic storage and generation.
- Development of new security assessment tools and advanced restoration strategies for the operation of the pan-European network.

More specifically:

- Algorithms and tools for DMS and for industrial application.
- Variable power sources integration: analysis, control, forecasting, operation optimization, system management, off-shore wind generation.
- Electricity markets: load profiling, remuneration schemes, uncertainty modelling, optimization and decision-aid, adequacy evaluation.
- Microgeneration, microgrids and smart metering: conceptualisation, models, specification, control, stability analysis, operation procedures, islanding operation and system restoration.
- Electric vehicles integration: business and technical models, aggregators, communications, network impact, ancillary services provision.
- Forecasting: innovative models applied to load curve prediction, wind power and solar PV forecasting.

The USE Research Group has a strong tradition of technology and know-how transfer to utilities and manufacturing companies and advanced consulting and support to regulatory authorities, public sector and energy agencies. This effort forms an important part of its portfolio of activities and is supported by knowledge generated upstream in the scientific activity. This objective of knowledge valorisation will be pursued both at international level, namely in the European Union and Brazil.

### **3.2.2 Main Achievements (4000 ca)**

Within the Smart Grid paradigm, the Power Systems Unit consolidated the research achievements with different activities, from fundamental research to prototyping and technology transfer. It is important to highlight the relevance of the Smart Grid and Electric Vehicle Laboratory that supported the development and testing of several solutions and prototypes, both for hardware and software modules related to Smart Grid applications. It consists of a test bed that allows an individual and fully integrated development and testing of concepts, algorithms and communication solutions that support the operation of a distribution network under normal and emergency conditions

The main achievements were:

- Definition of Smart Grid reference architectures (including communications and hardware) in the range of the physical electrical system structure up to the global control and management systems, involving the microgrids and virtual power plant concepts. The result of this work resulted in the overall technical architecture that embodies the SuSTAINABLE concept based on the reference architecture already deployed in the main test site of SuSTAINABLE – the InovGrid test site in Évora, Portugal
- Identification and development of management and control solutions for large scale EV and microgeneration deployment with a strong presence of active demand response
- Development of advanced management functionalities for distribution grids with large-scale deployment of DER
- Development and testing of prototypes of new control devices and software modules for smart grid applications in laboratorial environment and pilot sites, namely in the real test pilot in Évora for advanced functionalities, namely Renewable Energy Sources (RES) forecasting at the MV level, grid monitoring / state estimation at the MV level and voltage control At the MV and LV levels
- Development of new concepts and definitions of aggregation agents for mass electric vehicle
- Development and validation of coordinated control strategies exploiting the role of EV, storage devices, microgeneration units and responsive loads, in order to ensure a seamless transition to islanding mode and avoid MG collapse due to reserve and storage capacity shortage.
- Development and validation of MG service restoration procedure including the V2G concepts.
- Development, together with EFACEC, of a charging infrastructure that interacts with the EV and EV charges, designed to manage the electric vehicle charging with the goal of avoiding increasing the peak load in distribution networks and improving the quality of service, namely by reducing line overloading, voltages outside the allowable limits and interruption times
- Development of a MG test bed at the SGEVL and implementation of the MG architecture, where software prototypes of the MG controllers were developed and tested in order to demonstrate the effectiveness of the proposed solutions
- Development of unified control strategies for HVDC grids with respect to the compliance with new grid code requirements
- Identification and development of unified control strategies not resorting in communications that should be able to deal with grid code requirements regarding synthetic inertia and primary frequency regulation from HVDC grids and for FRT capability
- Specification and development of a reduced scale DC-grid test in order to support the proof-of-concept of the control strategies identified through numerical simulation
- Identification of innovative procedures for power system restoration following a general blackout in electric power systems with by a large share of renewable-based energy sources connected the transmission and distribution levels
- Development and validation of dynamic simulation models for variable speed pumped storage units, operating either in turbine or pump mode, together with the definition of control functionalities for the provision of specific grid services
- Development of models for estimation of the amounts of mandatory investments in the distribution network, for each voltage level and region.
- Development of models and tools for assessing the impact of investments on the quality of service, network losses and operational efficiency of the distribution network.
- Impact analysis of the integration of commercial losses in the loss profiles used in the electricity market.

- The loss profiles computed by the USE team were adopted by the Portuguese regulatory agency to be used in the electricity market in the years of 2013 and 2014.
- Platform for supporting decision aid in distribution systems reinforcement planning. This tool is able to compute the long term impact (technical and financial) of network upgrade policies in smart grids, considering the combined effects of load growth, DSM, distributed generation and electric vehicles.
- Software tool to automate the construction of models to estimate the mandatory investments in the distribution network. A complementary tool was developed for the identification of the factors that most affect these investments.
- Development of data structures to deal with data acquisition of LV networks and the corresponding topology processor, considering different kind of distribution energy resources.
- Development of a new algorithm for state estimation on networks without information about their characteristics, using an autoencoder trained using historical data and on real-time only need data from a small percentage of meters
- Development of a new algorithm to generate pseudo-measurement for MV state estimator using real-time data from LV networks using autoencoders
- Development of a new algorithm to do the load and distribution energy resources allocation for unbalanced distribution networks
- Development of a new upscaling algorithm for wind power forecasting aiming to estimate the total wind power generation in Portugal, using a subset of wind farms. This new algorithm was transferred to one company (Prewind), which is now providing the service to EDP.
- Algorithms to forecast the availability and charging requirements of electric vehicles were developed and published in two journal papers.
- Preliminary development of new short-term solar power forecasting algorithms that cover two situations: (a) medium/large-scale solar power plant with a time horizon ranging between 1 hour and 7 days ahead; (b) micro-generation/secondary substation with a time horizon ranging between 15 minutes and 6 hours.
- Development of a new algorithm, inspired by dynamic graph models and state space framework, for very short-term wind power forecasting and corresponding comparison with the Rapid Update Cycle (RUC) weather prediction model.
- Consolidation of existing probabilistic forecasting algorithms and technology transfer in a project with the Portuguese TSO. These algorithms were applied to different renewable energy sources, such as wind, solar and small-hydro.
- The scientific background from previous projects was used in a consultancy project in order to improve the forecasting algorithms of a company (Prewind).
- A short-term solar power forecasting system, which includes a decision-making module for maintenance planning, was developed and transferred to a company (Prewind).
- Developments in the Iberian Electricity Market – design of the market, impact of the eventual elimination of the day ahead market and substitution by a larger number of intraday markets reducing the interval from gate closure and real time operation;
- Impact of the development of new technologies and resources in the market operation – impact of electric vehicles, of storage (namely small and medium scale storage), and DSM;
- Development of innovative models for long term generation and transmission investment planning, namely considering generation systems having a large penetration of hydro resources and using Agent Based Models.
- Evaluation of the long term impact of feed-in generation in the electricity market prices of MIBEL
- Planning the operation of hydro stations including pumping storage using Genetic Algorithms, Particle Swarm Algorithms as well as built in optimization function of Matlab

- Impact of the demand/price elasticity on the MIBEL electricity prices considering feed in generation
- Forecasting of the bid curve of generation agents in the Iberian Electricity Market prices

### 3.3 Productivity - USE

#### 3.3.1 Publications in peer review Journals (6000 ca.)

Total number of publications: 40

The complete list can be consulted in: <http://profile.inescporto.pt>

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5. Bessa, R.J., Matos, M., "Optimization Models for EV Aggregator Participation in a Manual Reserve Market", *IEEE Transactions on Power Systems*, August 2013, vol.28, no.3, p.3085-3095.
6. Botterud, A., Zhou, Z., Wang, J., Sumaili, J., Keko, H., Pereira Mendes, J., Bessa, R.J., Miranda, V., "Demand Dispatch and Probabilistic Wind Power Forecasting in Unit Commitment and Economic Dispatch: A Case Study of Illinois ", *IEEE Transactions on Sustainable Energy*, January 2013, vol.4, no.1, p.250-261.
7. Castro, R., Esteves Araujo, R., Freitas, D., "Wheel slip control of EVs based on sliding mode technique with conditional integrators ", *IEEE Transactions on Industrial Electronics*, August 2013, vol.60, no.8, p.3256-3271.
8. Gouveia, C.S., Moreira, C., Peças Lopes, J., Varajão, D.A., Esteves Araujo, R., "Microgrid Service Restoration: The Role of Plugged-in Electric Vehicles", *IEEE Industrial Electronics Magazine*, December 2013, vol.7, no.4, p.26-41
9. Gouveia, C.S., Moreira, J., Moreira, C., Peças Lopes, J., "Coordinating Storage and Demand Response for Microgrid Emergency Operation", *IEEE Transactions on Smart Grid*, December 2013, vol.4, no.4, p.1898-1908.
10. Krstulovic, J., Miranda, V., Simões Costa, A., Correia Pereira, J., "Towards an auto-associative topology state estimator", *IEEE Transactions on Power Systems*, August 2013, vol.28, no.3, p.3311-3318.
11. Lopes Ferreira, H., Garde, R., Fulli, G., Kling, W., Peças Lopes, J., "Characterisation of electrical energy storage technologies", *Energy International Journal*, March 2013, vol.53, p.288-298.
12. Magalhães Carvalho, L., González-Fernández, R.A., Leite da Silva, A.M., Augusto da Rosa, M., Miranda, V., "Simplified Cross-Entropy Based Approach for Generating Capacity Reliability Assessment", *IEEE Transactions on Power Systems*, May 2013, vol.28, no.2, p.1609-1616.

13. Peças Lopes, J., Guimarães Madureira, A., Moreira, C., "A View of Microgrids", Wiley Interdisciplinary Reviews: Energy and Environment, January 2013, vol.2, no.1, p.86-103.
14. Pereira, A., Tomé Saraiva, J., "A Long Term Generation Expansion Planning Model Using System Dynamics - Case Study Using Data from the Portuguese/Spanish Generation System" [Planeamento a Longo Prazo da Expansão de Sistemas Eletroprodutores Utilizando Sistemas Dinâmicos - Caso de Estudo Utilizando Dados do Sistema Produtor de Portugal e Espanha], Electric Power Systems Research, April 2013, vol.97, p.41-50.
15. Pereira, A., Tomé Saraiva, J., "Long Term Impact of Wind Power Generation in the Iberian Day-Ahead Electricity Market Price", Energy International Journal, June 2013, vol.55, p.1159-1171.
16. Rocha, M., Tomé Saraiva, J., "A Discrete Evolutionary Pso Based Approach To The Multiyear Transmission Expansion Planning Problem Considering Demand Uncertainties", International Journal of Electrical Power & Energy Systems, February 2013, vol.45, no.1, p.427-442.
17. Spertino, F., Sumaili, J., Andrei, H., Chicco, G., "PV Module Parameter Characterization From the Transient Charge of an External Capacitor", IEEE Journal of Photovoltaics, October 2013, vol.3, no.4, p.1325-1333.
18. Vasiljevska, J., Peças Lopes, J., Matos, M., "Integrated micro-generation, load and energy storage control functionality under the multi micro-grid concept", Electric Power Systems Research, February 2013, vol.95, p.292-301.
19. Zhou, Z., Botterud, A., Wang, J., Bessa, R.J., Keko, H., Sumaili, J., Miranda, V., "Application of Probabilistic Wind Power Forecasting in Electricity Markets", Wind Energy, April 2013, vol.16, no.3, p.321-477.
20. Amaral Silva, B., Moreira, C., Leite, H., Peças Lopes, J., "Control Strategies for AC Fault Ride Through in Multiterminal HVDC Grids", IEEE Transactions on Power Delivery 2014, vol.29, no.1, p.395-405.
21. Barros, J., Leite, H., "Coordinating independent non-dispatchable generation and energy storage systems", International Journal of Electrical Power & Energy Systems, November 2014, vol.62, p.212-220.
22. Bessa, R.J., Matos, M., "Optimization Models for an EV Aggregator Selling Secondary Reserve in the Electricity Market", Electric Power Systems Research, January 2014, vol.106, p.36-50.
23. Bessa, R.J., Moreira, C., Amaral Silva, B., Matos, M., "Handling Renewable Energy Variability and Uncertainty in Power Systems Operation", Wiley Interdisciplinary Reviews: Energy and Environment, April 2014, vol.3, no.2, p.156-178.
24. Bremermann, L., Matos, M., Peças Lopes, J., Rosa, M., "Electric Vehicle Models for Evaluating the Security of Supply", Electric Power Systems Research, February 2014, vol.111, p.32-39.
25. Castro, R., Taneli, M., Esteves Araujo, R., Savaresi, S., "Minimum-time manoeuvring in electric vehicles with four wheel-individual-motors", Vehicle System Dynamics, June 2014, vol.52, no.6, p.824-846.
26. Castronuovo, E., Usaola, J., Bessa, R.J., Matos, M., Costa, I.C., Bremermann, L., Lugaro, J., Kariniotakis, G., "An integrated approach for optimal coordination between wind power and hydro pumping storage", Wind Energy, June 2014, vol.17, no.6, p.829-852.
27. Cunha, E., Usaola, J., Bessa, R.J., Matos, M., Costa, L., Bremermann, L., Lugaro, J., Kariniotakis, G., "An integrated approach for optimal coordination of wind power and hydro pumping storage", Wind Energy 2014, vol.17, no.6, p.829-852.
28. De Castro, R., Tanelli, M., Esteves Araujo, R., Savaresi, S., "Design of safety-oriented control allocation strategies for overactuated electric vehicles", Vehicle System Dynamics 2014, vol.52, no.8, p.1017-1046.
29. De Castro, R., Todeschini, F., Esteves Araujo, R., Savaresi, S., Corno, M., Freitas, D., "Adaptive-robust friction compensation in a hybrid brake-by-wire actuator", Proceedings Of The Institution Of Mechanical Engineers Part I-Journal Of Systems And Control Engineering 2014, vol.228, no.10, p.769-786.

30. Delgado Heleno, M., Matos, M., Peças Lopes, J., "Availability and Flexibility of Loads for the Provision of Reserve", IEEE Transactions on Smart Grid 2014, vol.6, no.2, 2014, p.667-674.
31. Delgado Heleno, M., Sumaili, J., Meirinhos, J.L., Rosa, M., "A Linearized Approach to the Symmetric Fuzzy Power Flow for the application to Real Systems", International Journal of Power and Energy Systems, January 2014, no.54, p.610-618.
32. Esteves Araujo, R., Castro, R., Azevedo Pinto, C., Melo, P., Freitas, D., "Combined sizing and energy management in EVs with batteries and supercapacitors", IEEE Transactions on Vehicular Technology, September 2014, vol.63, no.7, p.3062-3076.
33. Farinha, J., Fonseca, I., Oliveira, R., Maciel Barbosa, F., "The convergence between Predictive Maintenance and Augmented Reality to aid Renewable Energy Equipment Availability", International Journal of Engineering Applications 2014, vol.2, no.5, p.2281.
34. Fonseca, I., Farinha, J., Maciel Barbosa, F., "Maintenance planning in wind farms with allocation of teams using genetic algorithms", IEEE Latin America Transactions (Region 9), September 2014, vol.12, no.6, p.1062-1070.
35. Marques, V., Bento, N., Moisés, P., "The 'Smart Paradox': Stimulate the deployment of smart grids with effective regulatory instruments", Energy International Journal, May 2014, no.69, p.96-103.
36. Miranda, V., Hora Martins, J.M., Palma, V., "Optimizing Large Scale Problems With Metaheuristics in a Reduced Space Mapped by Autoencoders - Application to the Wind-Hydro Coordination", IEEE Transactions on Power Systems, May 2014, early on-line, vol.29, no.6, p.3078-3085.
37. Pereira, R., Ferreira, C., Maciel Barbosa, F., "Estudo comparativo do desempenho de STATCOM e SVC na Instabilidade Dinâmica de Tensão em Sistemas de Energia Elétrica com Produção Eólica " [Comparative study of STATCOM and SVC performance on Dynamic Voltage Collapse of an Electric Power System with Wind Generation], IEEE Latin America Transactions (Region 9), March 2014, vol.12.
38. Silva Azevedo, L., Parker, D., Walker, M., Papadopoulos, Y., Esteves Araujo, R., "Assisted assignment of automotive safety requirements", IEEE Software, January 2014, vol.31, no.1, p.62-68.
39. Silva, C., Rossetti, R., Pereira, J., "Automatic simulation calibration: An evaluation of search-based metaheuristics applied to IEC 61131-3 based automation in the power systems domain", - 2014, Modelling and Simulation 2014 - European Simulation and Modelling Conference, ESM 2014, p.429-434.
40. Soares, F.J., Almeida, P., Peças Lopes, J., "Quasi-real-time management of Electric Vehicles charging", Electric Power Systems Research 2014, vol.108, p.293-303.

### **3.3.2 Other international publications (6000 ca.)**

Total number of publications: 108.

The complete list can be consulted in: <http://profile.inescporto.pt>

1. Almeida, S., Esteves Araujo, R., "Fault-Tolerant Control Using Sliding Mode Techniques Applied to Multi-Motor Electric Vehicle", Proceedings of the 39th Annual Conference on IEEE Industrial Electronics Society IECON13 - IECON 2013 - 39th Annual Conference on IEEE Industrial Electronics Society 2013, Vienna, Austria, p.3528-3533.
2. Amaral Silva, B., Moreira, C., Leite, H., "Operation and Control of Multiterminal HVDC Grids Following the Loss of an Onshore Converter", ISGT-LA 2013 - "Innovative Smart Grid Technologies" – IEEE ISGT Latin America, April 2013, São Paulo, Brasil.
3. Azevedo Pinto, C., Castro, R., Esteves Araujo, R., "A Comparative Study between Causal and Non-causal Algorithms for the Energy Management of Hybrid Storage Systems", EPE'13 ECCE Europe - EPE 2013 - 15th European Conference on Power Electronics and Applications 2013, Lille, France.

4. Baptista, J.M., Pires, E., Cerveira, A., "Wind farm distribution network optimization based in a hierarchical GA ", Proceedings of ISAP 2013 - ISAP 2013 - International Conference on Intelligent Systems Applications in Power Systems, July 2013, Tokyo, Japan.
5. Bessa, R.J., "Non-Gaussian Modeling of Wind Power Forecasts", MECC 2013 - International Conference and Advanced School Planet Earth, Mathematics of Energy and Climate Change, March 2013, Lisboa, Portugal.
6. Carvalho Martins, J., Ribeiro da Silva, J., Santos, C.A., Cravo Branco, F., Fidalgo, J.N., Matos, M., Teixeira Couto, M., "ASSESSMENT OF THE INVESTMENT EFFORT IN HV AND MV NETWORKS TO REDUCE ENERGY LOSSES", CIRED 2013 - CIRED 2013 - 22nd International Conference on Electricity Distribution, June 2013, Stockholm, Sweden.
7. Chammas, M., Chiche, A., Fournié, L., Fidalgo, J.N., et al. , "A multi-scale optimization model to assess the benefits of a smart charging policy for electrical vehicles", PowerTech2013 - PowerTech 2013 - Towards carbon free society through smarter grids 2013, Grenoble, France.
8. Costa, I.C., Rosa, M., Magalhães Carvalho, L., Issicaba, D., Sumaili, J., "Composite reliability evaluation combining adequacy and security aspects", PowerTech2013 - PowerTech 2013 - Towards carbon free society through smarter grids, June 2013, Grenoble, France, p.1-6.
9. de Castro, R., Tanelli, M., Esteves Araujo, R., Savaresi, S., "Torque allocation in electric vehicles with in-wheel motors: a performance-oriented approach", CDC2013 - 52nd IEEE Conference on Decision and Control , December 2013, Florence , Italy.
10. de Castro, R., Tanelli, M., Esteves Araujo, R., Savaresi, S., Freitas, D., "Torque Allocation in EVs with 4 In-Wheel Motors: a High-Performance Approach", IAVSD2013 - 23rd International Symposium on Dynamics of Vehicles on Roads and Tracks, August 2013, Qingdao, China.
11. Delgado Heleno, M., Matos, M., Peças Lopes, J., "Availability of Thermal Loads to Provide Reserve Services", PowerTech2013 - PowerTech 2013 - Towards carbon free society through smarter grids, June 2013, Grenoble, France.
12. Domingues dos Santos e Abreu, P., Machado Ferreira, C.M., Maciel Barbosa, F., Pestana, R., "Identification and Influence of the External Elements on the Transmission System Operator's Responsibility Area", PowerTech2013 - PowerTech 2013 - Towards carbon free society through smarter grids, June 2013, Grenoble, France.
13. Escudeiro, P., Escudeiro, N., Reis, R., Maciel Barbosa, F., "Automatic Sign Language Translator Model", TELSATECH 2013 - TELSATECH 2013 - The 2013 Annual International Conference on Advances Technology in Telecommunication, Broadcasting, and Satellite. 2013, Jacarta, Indonésia.
14. Escudeiro, P., Escudeiro, N., Reis, R., Maciel Barbosa, F., "Virtual Sign Translator", ICCNCE 2013 - International Conference on Computer, Networks and Communication Engineering (ICCNCE 2013) 2013, Beijing, China.
15. Fonte, P., Monteiro, C., Maciel Barbosa, F., "Sensing Cloud Optimization applied to a non-convex constrained economical dispatch", Proceedings of the 39th Annual Conference on IEEE Industrial Electronics Society IECON13 - IECON 2013 - 39th Annual Conference on IEEE Industrial Electronics Society, November 2013, Vienna, Austria.
16. Fonte, P., Monteiro, C., Maciel Barbosa, F., "Sensing Cloud Optimization to Solve ED of Units with Valve-Point Effects and Multi-Fuels", DoCEIS'13 - 4th Doctoral Conference on Computing, Electrical and Industrial Systems, April 2013, Costa da Caparica, Portugal.
17. Gonçalves, R., Tomé Saraiva, J., Sousa, J.C., T. Mendes, V., "Impact of Electric Vehicles on the Electricity Prices and on the Load Curves of the Iberian Electricity Market", EEM 2013 - European Electricity Market 2013, May 2013, Estocolmo, Suécia.

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### **3.3.3 Ph. D. thesis completed (3000 ca.)**

Theses supervised by members of the research group:

1. Antero Miguel Lopes Moreira da Silva, "Energy Planning with Electricity Storage and Sustainable Mobility: The Study of an Isolated System", supervisor João Peças Lopes, approved March 2013.
2. Manuel Maria Abranches Travassos Valdez, "Novas Metodologias no Ensino e Aprendizagem na Área da Engenharia Eletrotécnica", supervisor Fernando Maciel Barbosa, approved March 2013.
3. Paula Sofia Pita da Silva e Castro Vide, "Estimação de estado de um sistema elétrico de energia, usando medidas fasoriais sincronizadas", supervisor Fernando Maciel Barbosa, approved November 2013.
4. Ricardo Jorge Gomes de Sousa Bento Bessa, "Methodologies for the participation of an electric vehicles' aggregator in the electricity markets", supervisor Manuel Matos, approved July 2013.
5. Rita Manuela da Fonseca Monteiro Pereira, "Estudo da Estabilidade Dinâmica de Tensão em Redes com Elevada Penetração de Energia Eólica", supervisor Fernando Maciel Barbosa, approved July 2013.
6. Diego Issicaba, "Block-Oriented Agent-Based Architecture to Support the Power Distribution System Operation: System Design and Environment Model", supervisor João Peças Lopes, approved May 2013.
7. Bernardo Marques Amaral Silva, "Multi-terminal HVDC grids: control strategies for ancillary services provision in interconnected transmission systems with offshore wind farms", supervisor Helder Leite, April 2014
8. David Emanuel da Silva Rua, "Last-Mile Communications Systems for Smart Electric Distribution Grids", supervisor João Peças Lopes, approved April 2014.
9. José Alberto da Cunha Barros, "Coordination of Independent Distributed Generation and Controllable Load", supervisor Helder Leite, approved April 2014.
10. Leonardo Elizeire Bremermann, "Impact evaluation of the large scale integration of electric vehicles in the security of supply", supervisor Manuel Matos, approved July 2014.

### **3.3.4 Patents/prototypes (2000 ca.)**

Very short-term Wind Power Forecasting Platform

Developed under ARGUS

Demo Place: U.S.A (Horizon Wind Energy)

Development Period: 2013

#### Solar Power Forecasting Software for Smart Grids

Developed under SuSTAINABLE

Demo Place: Évora, EDP Distribuição

Development Period: 2013-2014

#### Solar Power Forecasting System

Developed under PrevSol

Demo Place: Villares del Saz, Spain

Development Period: 2013-2014

#### Wind Power Upscaling Systems

Developed under Prev\_Agreg

Demo Place: EDP Serviço Universal

Development Period: 2013-2014

#### Probabilistic Renewable Energy Forecasting System

Developed under Prev\_PRE

Demo Place: REN

Development Period: 2014

#### Improved Wind Power Forecasting Software

Developed under ModPrev

Demo Place: Portuguese wind farms, Prewind

Development Period: 2013-2014

#### Software prototypes for the microgrid central controller

Developed under BEST CASE

Demo Place: SGEVL – INESC TEC

Development Period: 2013-2014

#### Medium Behaviour Controller for the emulation of communication characteristics in smart distribution grids

Developed under BEST CASE

Demo Place: SGEVL – INESC TEC

Development Period: 2013-2014

#### Event Scheduler for MicroGrid operation

Developed under BEST CASE

Demo Place: SGEVL – INESC TEC

Development Period: 2013-2014

Data Acquisition Manager

Developed under BEST CASE

Demo Place: SGEVL – INESC TEC

Development Period: 2013-2014

Electric Vehicle Charging Management Module

Developed under EFA-iCharge

Demo Place: SGEVL – INESC TEC

Development Period: 2013-2014

DMS/EMS upgrade modules –Topology Processor (switching devices measurements), Power Flow (running for some voltage levels)

Developed under EFACEC-DMS

Demo Place: EFACEC

Development Period: 2013 – 2014

LV Topology Processor with Modelization of all LV Network Equipments

Developed under SCADA-BT

Demo Place: EFACEC, INESC and EDP

Development Period: 2014

LV State Estimator without network data

Developed under SCADA-BT

Demo Place: EFACEC, INESC and EDP

Development Period: 2014

Pseudo-measurement generator for the MV State Estimator using LV real-time data

Developed under Sustainable

Demo Place: EDP

Development Period: 2014

DER and Load Allocation for an Unbalanced Distribution Networks

Developed under 3Phase

Demo Place: EFACEC

Development Period: 2014

### **3.3.5 Organization of Conferences (2000 ca.)**

Co-organization - LABORA 2014 - Desafios Técnicos Do Setor Elétrico - FÓRUM INTERNACIONAL – 16 October 2014.

Co-organization - Workshop “Energy Storage – from technologies to grids and electricity markets” - 4 July 2014.

### **3.3.6 Industry contract research (2000 ca.)**

MECOORD – Efficient Methodology for Optimal Coordination of Directional Overcurrent Relay in Mashed Systems, P&D ANEEL, USE – USP São Carlos, Brazil, 2011 – 2013

DMS - Development of Advanced Modules for Network Management Systems, EFACEC, since 1997 - ...

ModPrev – Improvement of wind power forecasting algorithms – Consultancy for a forecasting services provider company, Prewind, 2013-2014.

Prev\_PRE – Development of a probabilistic forecasting system for wind, solar, small-hydro and CHP – R&D work (with technology transfer) for the Portuguese Transmission System Operator (TSO), REN, 2014.

Prev\_Agreg – Development of an upscaling wind power forecasting algorithm for the total generation in Portugal – R&D work (with technology transfer) for the Portuguese Last Resort Retailing company, EDP Serviço Universal, 2013-2014.

PrevSol – Development of a solar power forecasting system – R&D work (with technology transfer) for a forecasting services provider company, Prewind, 2014.

MECOORD – Efficient Methodology for Optimal Coordination of Directional Overcurrent Relay in Mashed Systems, P&D ANEEL, USE – USP São Carlos, Brazil, 2011 – 2013

Perfis de Perdas - LOSS PROFILES FOR THE ELECTRICITY MARKET, EDP Distribuição, 2013-2014

AEAI\_LOAD - consulting services on Load Research, USAID, 2013-2014

SIMULESP - Expert system to support the network operator in real time decisions, UNISANTA, 2011-2014

Map\_medidas – Mapping measures on switching devices, EFACEC, 2013

PowerFlow – Powerflow per voltage level, EFACEC, 2013

PROB – Estimation of the mandatory investments in electric distribution networks, EDP, 2012-2015

EFA- iCHARGE – Advanced smart charging systems for EV management, EFACEC (QREN), 2012-2014

SCADA-BT – Development of a control and management system for smart LV distribution networks, EFACEC (QREN), 2012-2014

PrevAgreg – Previsão Agregada de Produção Eólica, EDP-SU, 2013-2014

PredictEV – Mobile Sensing and Reliable Prediction of Electric Vehicle Charging in Smart Grids, CISCO, 2013

IB\_FALCAO – Technical solution for adequate connection of Chão Falcão wind park, IBERWIND, 2012-2013

ENERCON - Studies for the definition of control parameters of wind generators for new wind parks, ENERCON, 2007-2013

REN\_FACTS - Transient Stability and Voltage Control Studies for the Portuguese Transmission Network in 2014, REN, 2014

Energeo – Plataforma de Suporte à Rede de Inovação e Comunicação em Energia e Geologia, LNEG, 2013

3PHASE – Unbalanced 3-PHase State Estimator for distribution networks considering distributed energy resources, EFACEC (QREN), 2014-2015

Madeirerenov\_2014 - Evaluation of existing operation criteria to maximize renewable integration, EEM, 2014

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the international level*

ARGUS – Development of a very short-term wind power forecasting system – R&D work for an U.S.A Laboratory under U.S. Department of Energy funding, Argonne National Laboratory (ANL), 2013-2014.

#### EUROPEAN PROJECTS

CitInES - Design of a decision support tool for sustainable, reliable and cost-effective energy strategies in cities and industrial complexes, 2011-2013

evolvDSO – Development of methodologies and tools for new and evolving DSO roles for efficient DRES integration in distribution networks, EU, 2013-2016

STABALID - STationary Batteries LI-ion safe Deployment, EU, 2012-2015

HYPERBOLE – HYdropower plants PERformance and flexiBle Operation towards Lean integration of new renewable Energies, EU, 2013-2016

SuSAINABLE – Smart distribution System operaTion for mAXimizing the INtegration of renewABLE generation, EU, 2013-2015

TWENTIES - Transmission system operation with large penetration of Wind and other renewable Electricity sources in Networks by means of innovative Tools and Integrated Energy Solutions, EU, 2010-2013

ELECTRA – European Liaison on Electricity grid Committed Towards long-term Research Activities, EU, 2013-2017

ITESLA - Innovative Tools for Electrical System Security within Large Areas, EU, 2012-2015

#### INTERNATIONAL CONTRACTS

SIMULESP - System to support the operation of electric power sub-transmission grids in contingency situations, UNISANTA, Brazil, 2010-2013

#### INTERNATIONAL TRAINING

Coordination of the training activities of the European consortium EES-UETP

Organization of the EES/UETP course “Microgrids – the building block of a smarter grid

June 2nd to 4th, 2014 – INESC Porto – Porto – Portugal

No. of papers in cooperation with authors from foreign institutions: journal – 6, other int - 24

### **3.3.8 Other national publications (6000 ca.)**

1. Ricardo Jorge Bessa, Manuel Matos, Integração da produção eólica na operação do sistema elétrico, EEFoR 2013 - Conferência sobre Energia Elétrica de Fontes Renováveis, Porto, Portugal, Maio, 2013.

2. Filipe Joel Soares, David Emanuel Rua, Clara Sofia Gouveia, João Peças Lopes, Electric Vehicles Charging Management and Control Strategies, VPPC 2014 - Vehicle Power and Propulsion Conference, Coimbra, Portugal, Outubro, 2014.

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

Research projects funded by FAI (Innovation Support Fund) from the Ministry of Economy, Innovation and Development:

SmartGrids, QREN, 2013-2015

Research projects funded by FCT:

DYMONDS - Toward Dynamic Monitoring and Decision-Based Smart Distribution Systems (with IST/UTL and CMU), FCT, 2010-2013 (coord. J. A. Peças Lopes)

SMAGIS - A Smart Energy Grid Integration System Configuration of an Energy Storage System in presence of RES Microgeneration, EDVs and Polygeneration (with IST/UTL), FCT, 2011-2013 (coord. Carlos Moreira)

MG+EV – Identification of Control and Management Strategies for Microgrids with Plugged-in Electric Vehicles (with EFACEC) FCT, 2011-2013 (coord. J. A. Peças Lopes)

Comute-DC - Control and operation of multi-terminal HVDC links in off-shore wind parks, FCT, 2013-2015

### 3.1 Group Description - UITT

Research Group Title	Innovation and Technology Transfer
Principal Investigator	João Alberto Vieira de Campos Pereira Claro
Research Area	Economics and Management
Home Institution	INESC Porto

### 3.2 Objectives & Achievements - UITT

#### 3.2.1 Objectives (4000 ca.)

##### FOREWORD

The on-line form does not maintain fixed the Unit Coordinator names, allowing permanent updating with the effect of changing past reports. The Coordinators of this Unit during 2013 and 2014 were Prof. João Claro and MSc Alexandra Xavier.

##### MISSION

The mission of the Innovation and Technology Transfer Unit (UITT) is to perform R&D, advanced consulting, and executive education in the areas of Technology and Innovation Management, and Technology Entrepreneurship.

##### STRATEGIC OBJECTIVES

In the area of Technology and Innovation Management, the unit's main objectives are: to improve INESC TEC's R&D management practices, in collaboration with the Board of Directors and other R&D units; and to support public and private organizations in their Technology and Innovation Management processes.

In the area of Technology Entrepreneurship, the main objectives are: to support researchers and promoters in technology transfer and knowledge valorisation; to support the Board of Directors in the continuous effort to establish an innovative and entrepreneurial environment and culture at INESC TEC; to support public and private organizations that carry out initiatives to support technology entrepreneurship.

Concerning R&D activities, the main objectives are: to create knowledge in Technology Management, Innovation Management, and Technology Entrepreneurship; to host and support MSc and PhD students carrying out research in the areas outlined above; to promote the valorisation of knowledge through the development of conceptual frameworks, methodologies, tools and executive education programmes, to be provided to private and public organizations.

##### MAIN RESEARCH AND DEVELOPMENT AREAS AND ACTIVITIES

- Technology entrepreneurship. Particular focus is placed on factors that influence early stages of entrepreneurial ventures, and the ways different organisational solutions address the equity gap problem. The design and impact of collaborative environments involving university, industry, and the public sector, to promote entrepreneurship and knowledge transfer and valorisation in Creative Industries, is also considered.

- Technology and Innovation Management. This area focuses on innovation management practices, tools and metrics, building on contributions to the Portuguese Standard for R&D&I Management and subsequent consulting. The research also focuses on multidisciplinary approaches to enabling the Front End of Innovation combining methods and tools that build on state-of-the-art concepts and trends in: enterprise information systems; enterprise integration; information and communication technology and business narrative modelling and analysis.
- Innovation networks. The research in this area involves analysing open innovation in multiple countries and studying the degrees of openness observed in different open innovation initiatives. The impact of framework conditions in the operations of Technology Transfer Offices is also examined. Scientometric tools are used to analyse R&D collaborative networks, such as technology clusters or international collaborations.
- Technology strategy. UITT is examining how uncertainty and flexibility are considered in technology roadmapping. Researchers at UITT also study the interactions between technology strategy and operations strategy.
- Flexibility in engineering design. Methods to design complex products and systems with flexibility, to enhance their performance in relation to uncertain future conditions, are being developed. This includes extending flexible design from individual projects to networked systems, and improvements in design methods aiming at a better integration of engineering, management and social sciences aspects.
- Science and technology policy. This area includes studying the relationship between foreign trade, human capital development, local R&D efforts and economic growth. The role of networks as fundamental enablers of early technology development and commercialization is also examined.

### 3.2.2 Main Achievements (4000 ca)

#### TECHNOLOGY ENTREPRENEURSHIP

UITT partnered with ANJE on a project to foster the development of technology-based entrepreneurial ventures for the software, multimedia, textiles and clothing industries. During 2013 and 2014, the project developed workshops and coaching activities.

CEICI (Centre of Excellence for Creative Industries and Innovation) was a project promoted by INESC TEC, as part of the Centre for Creative Industries (P.INC I), to promote, support, network and disseminate CI businesses. During 2013 and 2014, the project carried out workshops and coaching activities to entrepreneurial projects, and a set of Case Studies about the processes of start up development and knowledge valorisation.

The unit was also involved in a EU funded project aiming at creating an entrepreneurship training and coaching programme focused on university spin-offs. During 2013, the project implemented that training methodology.

A researcher hired by the unit in 2014 completed his PhD in Entrepreneurship Strathclyde and has been developing key relationships with the leading research groups in academic spinoffs in Europe, and the development of a proposal, and the first steps, for the creation of an observatory of academic spin-offs in Portugal.

#### TECHNOLOGY AND INNOVATION MANAGEMENT

Building on its recognition for experience and knowledge in Innovation Management, the unit had continued to carry out consulting to companies in this area. In 2014, the unit developed a set of tools and a workshop model for product idea generation, using Design Thinking methodologies and trends analysis, and implemented it in companies.

In the area of “ENABLING THE FUZZY FRONT END OF INNOVATION” (FFE), the research focuses on the multidisciplinary nature of the FFE and on supporting tools and concepts. Several articles were published in 2013 and 2014, one PhD student graduated, and two others continue their research in this area.

#### INNOVATION NETWORKS

Unit researchers have continued to lead studies for the UTEN initiative, on the professionalization of technology transfer and commercialization in Portugal, and on characteristics of, and recent trends on, academic spin-offs in Portugal.

#### TECHNOLOGY STRATEGY

A research collaboration with ARSN to study implementations of technology innovation in interorganizational networks has been on-going, focusing on the adoption of the screening of retinopathy by healthcare networks in the north of Portugal.

A research collaboration with Produtech and a EU funded project is studying the process of translating manifested priorities in specific R&D activities, as well as the characteristics of technological developments that face difficulties in commercialization.

#### FLEXIBILITY IN ENGINEERING DESIGN

Two key projects in this area were completed in 2013 and 2014. NODES focused on the design of networked infrastructures for uncertainty, and allowed the development of multiple models and applications spanning several areas – energy, automotive supply chain, healthcare supply chains, and airport networks among others. FIRE-ENGINE focused on the design of forest fire management systems, and was carried out with MIT, grupo Portucel Soporcel, ISA and UTAD, in the scope of the MIT Portugal Program. The results of the project have been very well received by its Stakeholder Committee and knowledge transfer activities are on-going.

Two PhD students are enrolled in the dual degree PhD Program in Engineering and Public Policy at FEUP and Carnegie Mellon University, researching in energy network infrastructures.

#### OTHER

UITT has continued to hold its weekly research seminar, and has continued to cooperate with other units in projects, as well as participating in other cross-unit activities. This is reported in the Research Lines report sections.

### 3.3 Productivity

#### 3.3.1 Publications in peer review Journals (6000 ca.)

##### 2013

1. Faria, P., Martins, F.V., Brandão, E., "Executive compensation: Pay-for-performance in high-technology firms", *China-USA Business Review*, November 2013, vol.12, no.11, p.1073-1084.
2. Collins, R.D., de Neufville, R., Claro, J., Oliveira, T., Pereira Pacheco, A., "Forest fire management to avoid unintended consequences: A case study of Portugal using system dynamics", *Journal of Environmental Management*, November 2013, vol.130, p.1-9.
3. Faria, P., Martins, F.V., Brandão, E., "The level of CEO compensation for the short and long-term - a view on high-tech firms", *Proceedings CIBME 2013 - Contemporary Issues in Business, Management and Education '2013*, November 2013, Vilnius, Lithuania.
4. Maia, C., Claro, J., "The role of a Proof of Concept Center in a university ecosystem: an exploratory study", *The Journal of Technology Transfer*, October 2013, vol.38, no.5, p.641-650.
5. Temel, S., Mention, A., Torkkeli, M., "The Impact of Cooperation on Firms' Innovation Propensity in Emerging Economies", *Journal of Technology Management & Innovation* 2013, vol.8, no.1.

##### 2014

1. Au-Yong Oliveira, M., Ferreira, J.J., Ye, Q., van Geenhuizen, M., "Spin-Up: A European Project Aimed at Propelling University Spin-off Growth", *ERCIM NEWS*, April 2014, no.97, p.55-56.
2. Rego, N., Claro, J., Pinho de Sousa, J., "A hybrid approach for integrated healthcare cooperative purchasing and supply chain configuration", *HEALTH CARE MANAGEMENT SCIENCE* 2014, vol.17, no.4, p.303-320.
3. Almodovar, J.j., Teixeira, A., "Assessing the Importance of Local Supporting Organizations in the Automotive Industry: A Hybrid Dynamic Framework of Innovation Networks", *European Planning Studies* 2014, vol.22, no.4, p.841-865.
4. Cruz, S., Teixeira, A., "Assessing the Magnitude of Creative Employment: A Comprehensive Mapping and Estimation of Existing Methodologies", *European Planning Studies* 2014, vol.22, no.10, p.2172-2209.
5. Teixeira, A., Barros, M., "Decentralization of public policies for the promotion of smes' internationalization. a theoretical account1\*", *Revista Portuguesa de Estudos Regionais* 2014, vol.35, no.1, p.15-27.
6. Amorim, E.V., "Energy related information systems and user expectations", *Procedia Technology* 2014, vol.16, p.775-779.
7. Teixeira, A., "Evolution, roots and influence of the literature on National Systems of Innovation: a bibliometric account", *CAMBRIDGE JOURNAL OF ECONOMICS* 2014, vol.38, no.1, p.181-214.
8. Teixeira, A., Tavares-lehmann, A., "Human capital intensity in technology-based firms located in Portugal: Does foreign ownership matter?", *Research Policy* 2014, vol.43, no.4, p.737-748.
9. Mention, A., Torkkeli, M., "Innovation for Financial Services - Editorial", *International Journal of Business Innovation and Research* 2014, vol.8, no.5, p.463-465.
10. Passos, A., Torkkeli, M., "Innovation in footwear companies - does it pay off?", *Journal of Engineering, Design and Technology* 2014, vol.12, no.1, p.128-154.
11. Fiegenbaum, I., Ihrig, M., Torkkeli, M., "Investigating open innovation strategies: a simulation study", *International Journal of Technology Management* 2014, vol.66, no.2, p.183-211.
12. Teixeira, A., Barros, M., "Local municipalities' involvement in promoting the internationalisation of SMEs", *Local Economy* 2014, vol.29, p.141-162.
13. Salampasis, D., Mention, A., Torkkeli, M., "Open innovation and collaboration in the financial services sector: exploring the role of trust", *International Journal of Business Innovation and Research* 2014, vol.8, no.5, p.466-484.
14. Mention, A., Martovoy, A., Torkkeli, M., "Open innovation in financial services: what are the external drivers?", *International Journal of Business Excellence* 2014, vol.7, no.4, p.530-548.
15. Savitskaya, I., Salmi, P., Torkkeli, M., "Outbound open innovation in China and Russia: innovation system approach", *International Journal of Business Innovation and Research* 2014, vol.8, no.2, p.190-209.
16. Pereira Pacheco, A., Claro, J., Oliveira, T., "Simulation analysis of the impact of ignitions, rekindles, and false alarms on forest fire suppression", *Canadian Journal of Forest Research* 2014, vol.44, no.1, p.45-55.

17. Amorim, E.V., "Sustainable energy action plans: project management intercomparison", *Procedia Technology* 2014, vol.16, p.1183-1189.
18. Teixeira, A., Coimbra, C., "The determinants of the internationalization speed of Portuguese university spin-offs: An empirical investigation", *Journal of International Entrepreneurship* 2014, vol.12, no.3, p.270-308.
19. Matos, C., Pereira, S., Amorim, E.V., Bentes, I., Briga-Sá, A., "Wastewater and greywater reuse on irrigation in centralized and decentralized systems - An integrated approach on water quality, energy consumption and CO2 emissions", *Science of the Total Environment* 2014, vol.493, p.463-471.

### 3.3.2 Other international publications (6000 ca.)

#### 2013

1. Au-Yong Oliveira, M., Ferreira, J.J., Ye, Q., van Geenhuizen, M., "Spin Up: A Comprehensive Program Aimed to Accelerate University Spin Off Growth", *ECIE 2013 - 8th European Conference on Innovation and Entrepreneurship*, September 2013, Bruxelas, Bélgica.  
Oliveira, L.C., Pinho de Sousa, J., Claro, J., "Impact of Supply Chain Management in the Recovery of the Automotive Industry", *EurOMA 2013 - EurOMA 2013 Conference*, June 2013, Dublin, Irlanda.
2. Oliveira, L.C., Pinho de Sousa, J., Claro, J., "Dealing with uncertainty in modern supply chains: vulnerability and risk management", *POMS 2013 - 24th Annual Production and Operations Management (POM) Conference*, Denver, May 2013, Denver, Colorado.
3. Faria, P., Martins, F.V., Brandão, E., "Executive compensation: Pay-for-performance in high-technology firms.", *15th IAMB 2013 - The 15th IAMB Conference*, April 2013, Lisboa, Portugal.
4. R. Sardinha, H., M. C. Sousa, J., A. Silva, C., Delgado, D., Claro, J., "Transmission Network Expansion Planning under Uncertainty using the Conditional Value at Risk and Genetic Algorithms", *INTELLI 2013 - The Second International Conference on Intelligent Systems and Applications*, April 2013, 978-1-61208-269-1, Venice , Italy.
5. Claro, J., Pereira Pacheco, A., "Operational Flexibility in Forest Fire Suppression and Prevention", *INFORMS 2013 Annual Meeti - Minneapolis 2013 - INFORMS Annual Meeting* , October 2013, Comunicação sem artigo, Minneapolis, EUA.
6. Au-Yong Oliveira, M., "Núcleo de Estudantes de Gestão - Empregabilidade e Empreendedorismo", May 2013, palestra.
7. Au-Yong Oliveira, M., "Estratégia pessoal Que ferramentas preciso para ser bem sucedido?", March 2013, Palestra.
8. Au-Yong Oliveira, M., "TRAINING - CROSSING THE CHASM SPIN---UP - Creating an Entrepreneurship Coaching and Training Program for University Spin---Offs" 2013, Palestra.
9. Au-Yong Oliveira, M., "TRAINING - INTERNATIONALIZATION SPIN---UP - Creating an Entrepreneurship Coaching and Training Program for University Spin---Offs" 2013, Palestra.

#### 2014

1. Fry, C., Mention, A., Torkkeli, M., "External knowledge sourcing in Turkey: Some empirical evidence", *2014 ISPIM Asia-Pacific I - 2014 ISPIM Asia-Pacific Innovation Forum*, December 2014, 978-952-265-587-5 , Singapura, Singapura.
2. Pereira Pacheco, A., Claro, J., "Flexible planning of the investment mix in a forest fire management system: spatially-explicit intra-annual optimization, considering prevention, pre-suppression, suppression, and escape costs", *VII International Confere - VII International Conference on Forest Fire Research*, November 2014, Coimbra, Portugal.
3. Costa, S., Levie, J., "Effectual and Causal Behaviors, Business Model Change, and Performance of Early-Stage Firms", *AOP2014 - II International Conference on Applications of Optics and Photonics* , August 2014, Aveiro, Portugal.
4. Pereira Pacheco, A., Claro, J., "Flexible planning of the investment mix in a wildland fire management system: spatially-explicit intra-annual optimization, considering preparedness and escape costs", *IFORS*

- 2014 - 20th Conference of the International Federation of Operational Research Societies, July 2014, Barcelona, Espanha.
5. Smet, D., Mention, A., Torkkeli, M., "New financial service developments: The involvement of customers for innovation", EURAM 2014 - 14th European Academy of Management (EURAM) Annual Conference 2014, June 2014, 978-84-697-0377-9, Valência , Espanha.
  6. Faria, P., Martins, F.V., Brandão, E., "CEO compensation in high-tech firms: The choice between performance and innovation", Proceedings 17th IAMB Conference - The 17th IAMB Conference, Sao Paulo, Brazil 2014 , April 2014, S. Paulo, Brazil.
  7. Faria, P., Apelido, N., Apelido, N., "CEO compensation and the relationship between performance and innovation in high-tech firms", EAA 2014 - European Accounting Association 37th Annual Congress 2014, Tallinn, Estónia.
  8. Smet, D., Mention, A., Torkkeli, M., "Knowledge sourcing from customers in new financial service development", XXV ISPIM - XXV ISPIM Conference – Innovation for Sustainable Economy & Society 2014, 978-952-265-591-2 , Dublin, Irlanda.
  9. Leite, V., Silva, C., Claro, J., Sousa, J., "Optimization of power flow with energy storage using genetic algorithms", Proceedings of the IEEE-CEC 2014 - IEEE Congress on Evolutionary Computation 2014, p.2678-2684.
  10. Oliveira, M., Ferreira, J.J., "Interoperability: Working Together To Enhance Innovation" 2014, FUTURIST, vol.48, no.2, p.6-7.
  11. Teixeira, A., "The impact of class absenteeism on undergraduates' academic performance: evidence from an elite Economics school in Portugal" 2014, Innovations in Education and Teaching International.

#### **BOOK**

1. Mention, A., Torkkeli, M., "Innovation in Financial Services: A Dual Ambiguity", December 2014.

#### **3.3.3 Ph. D. thesis completed (3000 ca.)**

1. Lia Oliveira (2009 - 2013). Dealing with uncertainty in supply chain design in the automotive industry. PhD Program in Leaders for Technological Industries, MIT Portugal Program, FEUP.

#### **3.3.4 Patents/prototypes (2000 ca.)**

#### **3.3.5 Organization of Conferences (2000 ca.)**

1. José Manuel Mendonça (co-chair), Aurora Teixeira, João Claro - Organizing Committee, XV Congresso de Gestão de Tecnologia Latino-Iberoamericano - ALTEC 2013, Alfândega do Porto, October, 2013
2. João Claro (chair), Catarina Maia, José Coelho Rodrigues - Organizing committee, 2nd International CAL4INO Conference, 30-31 May 2013, Porto, Portugal.
3. José José Pinto Ferreira - Organizing Committee, IWSMAI2014 - International Workshop on Multidisciplinary Approaches on Innovation, 24th November 2014 - Austrian Federal Economic Chamber - Wiedner Hauptstraße 63, 1045 Vienna, Austria
4. José Coelho Rodrigues - Organizing Committee, IEMS '14 | 5th Industrial Engineering and Management Symposium, January 7th, Porto / Fundação Dr. António Cupertino de Miranda; organized by the Department of Industrial Engineering and Management, Faculty of Engineering, University of Porto.
5. Marko Torkkeli, Organizing Committee, The ISPIM Americas Innovation Forum, Montreal, Canada, 5-8.10.2014, Editors: Huizingh, K.R.E, Conn, S. Torkkeli, M. and Bitran, I.
6. Marko Torkkeli, Organizing Committee, XXV ISPIM Conference - Innovation for Sustainable Economy and Society, Dublin, Ireland, 8-11.6.2014, Editors: Huizingh, K.R.E, Conn, S. Torkkeli, M. and Bitran, I.
7. Marko Torkkeli, Organizing Committee, The ISPIM Asia Innovation Forum, Singapore, 7-10.12.2014, Editors: Huizingh, K.R.E, Conn, S. Torkkeli, M. and Bitran, I.

8. Marko Torkkeli, Organizing Committee, Innovation for financial services conference, Montreal, Canada, 16-17.10.2014, Editors: Mention A-L and Torkkeli M
9. Marko Torkkeli, Organizing Committee, The ISPIAM Americas Innovation Forum (October 2014), Editors: Huizingh, K.R.E, Conn, S. Torkkeli, M. and Bitran, I.

### **3.3.6 Industry contract research (2000 ca.)**

Entrepreneurial coaching:

- under a contract with IAPMEI (“Passaporte do Empreendedorismo”), 28 entrepreneurial projects were given business and technical support;
- in the scope of the TEC EMPREENDE project, 4 Companies (Grabmark, Bewarket, TopResearch and Kognit) were mentored;
- in the scope of the PINC Project, 17 entrepreneurial projects are incubated in UPTEC PINC were supported.

Innovation Management Systems:

- implementation at Flupol;
- audits at Flexipol and Markayakes.

Consulting services in Business Model Innovation and Product Development:

- Heliotextil, Ideavity and Metalduf.

Studies and reports:

- 10 technical reports for companies and entrepreneurial projects receiving specialized advisory support for business model and/or product development under private contracts or public-funded projects (Passaporte para o Empreendedorismo);
- 4 case studies about the process of start up development (Beinteractive, Blip, Claan, Douro Prime)
- 3 case studies of R&D valorisation strategies for other INESC TEC units
  
- Training & Workshops

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

COLLABORATIVE RESEARCH

- longstanding strategic collaboration with Prof. Marko Torkkeli, from the Lappeenranta University of Technology in Finland, who is a visiting researcher at INESC TEC.
- on-going research collaborations with Prof. Richard de Neufville, from the Engineering Systems Division of MIT, Prof. Steve Markham, from North Carolina State University, and Prof. Angus Kingon, from Brown University;

- co-advising of two dual degree PhD students with Paul Fischbeck, from CMU, and Randy Kirchain, from MIT.

#### INTERNATIONAL PROJECTS

- SPIN-UP was an ERASMUS project with Technical University of Delft, Advancis, Leaders2Be, Lappeenranta University of Technology (Kouvola Unit), and University of Lodz.
- STAMAR is an INTERREG project with Marine Institute (IR), AMTEGA (SP), University of Porto ( PT), University of Algarve ( PT), University of Strathclyde ( SCo), Technopole Brest Iroise (FR), GAIN (SP).
- FIRE-ENGINE was a project with MIT, funded by the MIT Portugal Program.
- The unit collaborated with COTEC Portugal in CAL4INO, a Lifelong Learning project with Cambridge Judge Business School, Queen's University Belfast, Laurea University, RISEBA, Emerald, University of Wuppertal and University of Piraeus.

#### TRAINING NETWORKS

- collaboration with UT Austin in UTEN, in particular in a research component of the initiative;
- collaboration with the MIT Portugal Program, hosting PhD students and lecturing in the program;
- collaboration with the CMU Portugal Program, hosting PhD students from the dual degree PhD program in EPP, and contributing to lecturing and leadership in that PhD;
- João Claro is the national director of the CMU Portugal Program since 2013.

### **3.3.8 Other national publications (6000 ca.)**

### **3.3.9 Government/Organization contract research (2000 ca.)**

*(Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice)*

The involvement of the unit in a collaboration with COTEC Portugal led to the proposal of a set of policy recommendations and a handbook of best practices on technology entrepreneurship education for the European Commission.

### 3.1 Group Description - LIAAD

Research Group Title	LIAAD
Principal Investigator	Alípio Mário Guedes Jorge
Research Area	Electrical and Computer Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements - LIAAD

#### 3.2.1 Objectives (4000 ca.)

##### OBJECTIVES

The LIAAD Associate Unit is the core Research Group of the research line "Intelligent and Adaptive Systems and Mathematical Modelling in Decision Support". LIAAD continues the tradition of conducting both fundamental and applied high quality research. The main aim is to develop new methods and techniques in the areas of data mining and modelling and use these for decision support. Many of the activities are carried out by postgraduate students under the supervision of their peers and thus contributing to their training.

The scientific competences associated with this line require a combined effort from researchers, professionals and post-graduate students with competences in diverse areas including artificial intelligence, machine learning, data mining, multi-agent modelling, as well as information systems, information management and retrieval, spatio-temporal information, simulation, optimisation, statistical and mathematical modelling in economics and management science.

The work required to achieve these research goals is described in the following sections.

##### LEARNING AND EXTRACTING INFORMATION

Developing and improving data mining algorithms and methodologies for solving complex decision problems taking into account, for instance, the ability to deal with new data types, new ways of collecting data, new decision problems, new computational models, etc.

Developing and enhancing methods for learning, in real-time, from distributed data streams and evolving data, requiring the ability to adapt decision models in environments with unknown dynamics. Developing and enhancing methods for resource-aware data mining, including distributed online algorithms for change detection, summarisation, classification, regression, clustering, etc.

Developing and enhancing metalearning methods to aid the user in selecting appropriate machine learning / data mining method or sequence/combo of such methods. Exploiting past information to determine which algorithms are likely to produce better results on a new task.

Developing and enhancing ILP relational methods. The aim is to investigate how to speed-up these methods, taking advantage of parallel, distributed approaches and grid computing with application to bioinformatics, and NLP.

Developing methods for automation and personalization of web sites, including recommender systems, maintenance of contents and document classification, extracting information from text/web documents: automatic methods for sentiment analysis.

#### MATHEMATICAL AND STATISTICAL MODELLING AND DECISION SUPPORT

Studying and enhancing methods for statistical modelling, in particular parametric models for interval data that allow for inference and hypothesis testing; clustering methods for symbolic data and methods for variable selection and grouping.

Developing and enhancing methods useful in simulation, modelling and optimisation, focusing on decision problems in management science, among other application areas. Incorporating methods that include meta-heuristics and optimisation techniques based on genetic algorithms, and other bio-inspired systems.

Developing and enhancing methods in mathematical modelling focusing on dynamical systems, game theory and mathematical economy and finances, also applicable to mathematical physics, mathematical biology, time series analysis, and models of industrial organisation. Developing and enhancing methods using AI-based approaches, such as multi-agent framework, by simulating firms for specific industries and locations and studying their interactions and cooperation.

#### RESEARCH GROUP INTERACTION and TECHNOLOGY TRANSFER

The research activities of LIAAD have interacted with other specific competences, such as:

LIAAD has some interactions with companies and organizations that are interested in intelligent solutions. Namely: NOS telecomunicações, Universidade do Porto, Porto Editora.

### 3.2.2 Main Achievements (6000 ca)

#### HIGHLIGHTS

In 2014 the group had a high number of publications (34) in international journals. We also counted 24 articles in highly ranked conferences (CORE $\geq$ B), including CIKM, ECAI, IDA and UMAP. Overall the group published more than 100 articles in journals, conferences and books. A special highlight to the publication in 2014 of 2 articles in the high impact journal ACM Computing Surveys.

Researchers from the group have participated in the organization of many international conferences, as organization committee members, track chairs, area chairs and program committee members

1 new book was published with a collection of articles.

13 PhD theses and 54 MSc dissertations with supervision or co-supervision of LIAAD members were concluded and defended last year.

Paula Brito continued her presidency of IASC - International Association for Statistical Computing (<http://www.iasc-isi.org/node/54>).

Many of our researchers participate as members of editorial boards of scientific journals and scientific committees of international conferences.

LIAAD cooperated in projects with USIG, CRACS, UTM, USE, CESE, UGEI and ROBIS.

#### LEARNING FROM DATA STREAMS

**\*\*Outstanding publication\*\***

João Gama, Indre Zliobaite, Albert Bifet, Mykola Pechenizkiy, Abdelhamid Bouchachia: A survey on concept drift adaptation. ACM Comput. Surv. 46(4): 44:1-44:37 (2014) (41 citations source Google Scholar)

The book "Knowledge discovery from data streams" by João Gama (2010) reached 254 citations (source Google Scholar)

**\*\*Software for the community\*\***

AMRULES available in MOA and SAMOA

**\*\*Awards\*\***

Best student Paper - Discovery Science, 2014 - Pedro Pereira, Rita P. Ribeiro, João Gama: Failure Prediction - An Application in the Railway Industry. Discovery Science 2014: 264-275

MODELING DYNAMIC SYSTEMS

**\*\*Outstanding publication\*\***

Book "Data Mining with R, learning with case studies" by Luís Torgo (2010) has reached 136 citations (source Google Scholar).

**\*\*Software for the community\*\***

R package "performanceEstimation" for performance estimation and comparison of predictive models (<http://cran.r-project.org/web/packages/performanceEstimation>)

WEB AND TEXT MINING

**\*\*Outstanding project\*\***

The European project e-Policy, with the participation of LIAAD AND CRACS, finished in 2014 and was reviewed as "The project has fully achieved its objectives and technical goals for the period and has even exceeded expectations".

**\*\*Outstanding publication\*\***

R Campos, G Dias, AM Jorge, A Jatowt, Survey of temporal information retrieval and related applications, ACM Computing Surveys (CSUR) 47 (2), 15 (2014)

DATA MINING AND DECISION SUPPORT

**\*\*Award\*\***

Best paper award, conference on Advanced Data Mining and Applications (ADMA 2015), Guilin, china, with paper "Merging Decision Trees: a case study in predicting student performance" by Pedro Strecht, João Mendes-Moreira, Carlos Soares (Joint with CESE)

DATA ANALYSIS AND STATISTICAL METHODS

**\*\*Outstanding publication\*\***

Invited paper: Brito, P., "Symbolic Data Analysis: another look at the interaction of Data Mining and Statistics". WIREs Data Mining and Knowledge Discovery, Volume 4, Issue 4, July/August 2014, 281–295.

**\*\* Outstanding Scientific Role \*\***

Paula Brito continued her presidency of IASC - International Association for Statistical Computing (<http://www.iasc-isi.org/node/54>).

SIMULATION, MODELING AND OPTIMIZATION

**\*\*Highly cited publication\*\***

491 citations, 40 of which in 2014 (source Google Scholar)

JF Gonçalves, JJ de Magalhães Mendes, MGC Resende, A hybrid genetic algorithm for the job shop scheduling problem, *European Journal of Operational Research* 167 (1), 77-95 (2005)

#### GAME THEORY AND MATHEMATICAL FINANCE

**\*\*Outstanding publication\*\***

C. A. A. de Carvalho, M. M. Peixoto, D. Pinheiro and A. A. Pinto. An Asymptotic Universal Focal Decomposition for Non-Isochronous Potentials. *Transactions of the American Mathematical Society*, 366 (4), (2014)

**\*\*Outstanding Scientific Role\*\***

Founder and editor in chief, together with Michel Benaim, of the *Journal of Dynamics and Games (JDG)* published by the American Institute of Mathematical Sciences

#### COOPERATION WITH OTHER CENTERS

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

As main results of the cooperation of this research group with other competences we highlight:

CRACS - joint MSc student on recommender systems with a GPU approach;

CESE – a business intelligence solution has been deployed at Universidade do Porto; joint papers published; joint supervision of students;

CEGI - joint papers published.

CPES - co-supervision of an MSc dissertation.

### 3.3 Productivity - LIAAD

#### 3.3.1 Publications in peer review Journals (6000 ca.)

The complete list can be consulted in: <http://profile.inescporto.pt>.

1. Alberto Pinto, Diogo Pinheiro, C.A.A. de Carvalho, M.M. Peixoto, An Asymptotic Universal Focal Decomposition for Non-Isochronous Potentials, *Transactions of the American Mathematical Society*, vol.366, no.4, pp.2227-2263, 2014.

2. Brito, P. (2014) "Symbolic Data Analysis: another look at the interaction of Data Mining and Statistics". *WIREs Data Mining and Knowledge Discovery*, Volume 4, Issue 4, July/August 2014, 281–295. DOI: 10.1002/widm.1133

3. C. A. A. de Carvalho, M. M. Peixoto, D. Pinheiro and A. A. Pinto. Na Asymptotic Universal Focal Decomposition for Non-Isochronous Potentials. *Transactions of the American Mathematical Society*, 366 (4), (2014) 2227-2263.

4. Carla Correia-Gomes, Theodoros Economou, Trevor Bailey, Pavel Brazdil, Lis Alban, João Niza-Ribeiro, Transmission parameters estimated for *Salmonella typhimurium* in swine using susceptible-infectious-resistant models and a Bayesian approach, *BMC veterinary research*, vol.10, no.1, pp.101-112, 2014.

5. Fernando E. Correa, Márcia Barbosa Oliveira, João Gama, Pedro L. P. Corrêa, Jorge Rady, Analyzing the behavior dynamics of grain price indexes using Tucker tensor decomposition and spatio-temporal trajectories, *Computers and Electronics in Agriculture*, 2014.

6. Hadi Fanaee Tork, João Gama, Eigenspace method for spatiotemporal hotspot detection, *Expert Systems: The Journal of Knowledge Engineering*, Setembro, 2014. DOI: 10.1111/exsy.12088

7. I. Duarte, D. Pinheiro, A.A Pinto and S.R. Pliska. Optimal Life Insurance Purchase, Consumption and Investment on a financial market with multidimensional dynamic terms. *Optimization: A Journal of Mathematical Programming and Operations Research*, 63:11 (2014) 1737-1760.
8. João Gama, Indrè Žliobaitė, Albert Bifet, Mykola Pechenizkiy, Abdelhamid Bouchachia; A survey on concept drift adaptation; *ACM Computing Surveys (CSUR)*; Volume 46 Issue 4, p.37; April 2014; DOI: 10.1145/2523813
9. João Gama, Petr Kosina, Recurrent concepts in data streams classification, *Knowledge and Information Systems*, vol.40, no.3, pp.489-503, 2014.
10. João Maia Duarte, João Gama, Ensembles of Adaptive Model Rules from High-Speed Data Streams, *Journal of Machine Learning Research*, vol.36, pp.198-213, 2014.
11. José Fernando Gonçalves, Mauricio G. C. Resende, An extended Akers graphical method with a biased random-key genetic algorithm for job-shop scheduling, *International Transactions in Operational Research*, vol.21, no.2, pp.215-246, Março, 2014.
12. José Fernando Gonçalves, Mauricio G. C. Resende, Miguel Dias Costa, A biased random-key genetic algorithm for the minimization of the open stacks problem, *International Transactions in Operational Research*, Julho, 2014.
13. Luís Roque, Dalila Fontes, Fernando Fontes, A hybrid biased random key genetic algorithm approach for the unit commitment problem, *Journal of Combinatorial Optimization*, vol.28, no.1, pp.140-166, 2014.
14. Luis Torgo, Paula Branco, Rita P. Ribeiro and Bernhard Pfahringer, Re-sampling Strategies for Regression, *Expert Systems: The Journal of Knowledge Engineering*, DOI: 10.1111/exsy.12081, August 2014.
15. Márcia Oliveira, Américo Guerreiro, João Gama, Dynamic communities in evolving customer networks: an analysis using landmark and sliding windows, *Social Network Analysis and Mining* vol.4, no.1, pp.1-19, 2014
16. Márcia Oliveira, Dalila B. M. M. Fontes, Teresa Pereira, Multicriteria decision making: A case study in the automobile industry, *Annals of Management Science – Special Issue on Operations Research and Applications*, vol.3, no.1, pp.109-128, 2014
17. Marcos Domingues, Carlos Manuel Soares, Alípio Jorge, Solange Rezende, A data warehouse to support web site automation, *Journal of the Brazilian Computer Society*, vol.20, no.11, pp.1-16, 2014.
18. Mohamed Gaber, João Gama, outros et al., Data stream mining in ubiquitous environments: state-of-the-art and current directions, *WIREs Data Mining and Knowledge Discovery*, vol.4, no.2, pp.116-138, 2014.
19. Mohammadreza Valizadeh, Pavel Brazdil, Exploring actor-object relationships for query-focused multi-document summarization, *Soft Computing*, vol.1, no.13, 2014.
20. Mohammadreza Valizadeh, Pavel Brazdil, Unsupervised Method for Re-ranking the Initial Retrieval Results of IR Based on a Query-Sensitive Similarity Measure, *Journal of Research and Practice in Information Technology*, vol.45, no.1, 2014.
21. Pedro Henriques Abreu, Daniel Castro Silva, Fernando Almeida, João Mendes-Moreira, Improving a Simulated Soccer Team's Performance Through a Memory-Based Collaborative Filtering Approach, *APPLIED SOFT COMPUTING*, Vol.23, pp.180-193, 2014.
22. Pedro Henriques Abreu, Daniel Castro Silva, João Portela, João Mendes-Moreira, Luis Paulo Reis, Using Model-Based Collaborative Filtering Techniques to Recommend the Expected Best Strategy to Defeat a Simulated Soccer Opponent, *Intelligent Data Analysis*, Vol.18 nº 5, pp.973-991, 2014.
23. Pedro M. R. Mendes-Moreira, João Mendes-Moreira, António Fernandes, Eugénio Andrade, Arnel R. Hallauer, Silas E. Pêgo, M. C. Vaz Patto, Is ear value an effective indicator for maize yield evaluation?, *Field Crops Research*, Vol.161, pp.75-86, 2014.
24. Pedro Pereira Rodrigues, João Gama, Distributed clustering of ubiquitous data streams, *WIREs Data Mining and Knowledge Discovery*, vol.4, no.1, pp.38-54, 2014.
25. R. Sebastião, J. Gama, T. Mendonça. Constructing Fading Histograms from Data Streams. *Progress in Artificial Intelligence*, pp.1-14, April, 2014.

26. R. Soeiro, A. Mousa, T. Oliveira and A. A. Pinto. Dynamics of Human Decisions. *Journal of Dynamics and Games*, Volume 1 (1),(2014) 121-151.
27. Ricardo Campos, Gaël Dias, Alípio Jorge, Adam Jatowt, Survey of Temporal Information Retrieval and Related Applications, *ACM Computing Surveys*, Vol 47(2), pp.1-41, August 2014, ISSN 0360-0300. ISI Impact Factor (2012): 3.543. 5-Year Impact Factor: 7.854. Quartile: Q1.
28. Ricardo M. A. Silva, Diego M. Silva, Mauricio G. C. Resende, Geraldo R. Mateus, José Fernando Gonçalves, Paola Festa, An edge-swap heuristic for generating spanning trees with minimum number of branch vertices, *Optimization Letters*, vol.8, no.4, pp.1225-1243, 2014.
29. Zoran Bosnic, Pedro Pereira Rodrigues, João Gama et al., Enhancing data stream predictions with reliability estimators and explanation, *Expert Systems with Applications*, vol.34, pp.178-192, 2014.

### 3.3.2 Other international publications (6000 ca.)

13 Book Chapters by major international publisher (selection follows)

1. A. A. Pinto and T. Parreira. Complete versus Incomplete Information in the Hotelling Model. In: A. A. Pinto and D. Zilberman, editors. *Modeling, Dynamics, Optimization and Bioeconomics I*, Springer Proceedings in Mathematics and Statistics, Volume 73, (2014) pp 567-583.
2. Carneiro, A.R., Jorge, A.M., Brito, P.Q., and Domingues, M.A. (2014). Measuring the Effectiveness of an E-Commerce Site Through Web and Sales Activity. In A.A. Pinto and D. Zilberman (eds.), *Modeling, Dynamics, Optimization and Bioeconomics I*, Springer Proceedings in Mathematics & Statistics 73, DOI 10.1007/978-3-319-04849-9\_\_10
3. Dalila B. M. M. Fontes, Fernando A. C. C. Fontes, Luís A. C. Roque; Optimal Control Formulations for the Unit Commitment Problem in Dynamics of Information Systems; Springer Proceedings in Mathematics & Statistics Volume 105, 2014, pp 109-127
4. Ferreira H., Gonçalves R., Pinto A.A. (2014), BHP Universality in Energy Sources, In A.A. Pinto and D. Zilberman (eds.), *Modeling, Dynamics, Optimization and Bioeconomics I*, Springer Proceedings in Mathematics & Statistics 73, pp.259-268.
5. Giordano, G., and Brito, P. (2014), "Social Networks as Symbolic Data". In: *Analysis and Modeling of Complex Data in Behavioral and Social Sciences*, D. Vicari, A. Okada, G. Ragozini, and C. Weihs, (Eds.), Springer.
6. J.P. Almeida, A.A. Pinto and D.A. Rand. Renormalization of circle diffeomorphism sequences and Markov sequences. In: C. Grcio, D. Fournier - Prunaret, T. Ueta and Y. Nishio (Eds.). *Nonlinear maps and their applications*, Springer Proceedings in Mathematics and Statistics Volume 57, (2014) Ch. 1, pp 1-8.
7. João Mendes-Moreira, Jorge Freire Sousa, Evaluating Changes in the Operational Planning of Public Transportation, in Jorge Freire Sousa, Riccardo Rossi, *COMPUTER-BASED MODELLING AND OPTIMIZATION IN TRANSPORTATION*, SPRINGER, pp.57-68, 2014.
8. Marta Monteiro, Dalila Fontes, Fernando Fontes, Hop-constrained tree-shaped networks in Examining Robustness and Vulnerability of Networked Systems, pp.192-208, 2014.
9. Dias, A., Campos, P. and Garrido, P. An agent based model of bank failures, in Amblard, F., Miguel, F., Blanchet, A. and Gaudou, B. (eds.), *Advances in Artificial Economics*, LNEMS – 676, (Springer, 2014) pp. 119-130.

20 articles in major conferences referenced in ISI, Scopus or having CORE ranking  $\geq B$  (selection)

1. Alípio Jorge, José Paulo Leal, Sarabjot Anand, A study of machine learning methods for detecting user interest during web sessions, IDEAS 2014 - 18th International Database Engineering & Applications Symposium, Porto, Portugal, Julho, 2014.

2. Campos, R., Dias, G., Jorge, A. and Nunes, C. (2014). GTE-Rank: Searching for Implicit Temporal Query Results. In Proceedings of the 23rd ACM International Conference on Information and Knowledge Management (CIKM 2014) Shanghai, China, November 3 - 7, ISBN 978-1-4503-2598-1, pp 2081 - 2083. DBLP. ACM Press. Scopus.
3. Campos, R., Dias, G., Jorge, A., and Nunes, C. (2014). GTE-Cluster: A Temporal Search Interface for Implicit Temporal Queries. In M. de Rijke et al. (Eds.), Lecture Notes in Computer Science, - 36th European Conference on Information Retrieval (ECIR2014). Amsterdam, Netherlands, 13 - 16 April. (Vol. 8416-2011, pp. 775 - 779). DBLP. Springer. Thomson ISI Web of Knowledge. ACM Press.
4. Cláudia Camila Dias, Cristina Granja, Altamiro Costa-Pereira, João Gama, Pedro Pereira Rodrigues, Using probabilistic graphical models to enhance the prognosis of health-related quality of life in adult survivors of critical illness, CBMS 14 - INTERNATIONAL SYMPOSIUM ON COMPUTER-BASED MEDICAL SYSTEMS, pp.56-61, New York, USA, Maio, 2014.
5. Elsa Gomes, Alípio Jorge, Paulo Jorge Azevedo, Classifying heart sounds using SAX motifs, random forests and text mining techniques, IDEAS 2014 - 18th International Database Engineering & Applications Symposium, Porto, Portugal, 2014.
6. Fábio Pinto, Carlos Soares, João Mendes-Moreira, An Empirical Methodology to Analyze the Behavior of Bagging, in The 10th International Conference on Advanced Data Mining and Applications, pp.199-212, 2014.
7. Fábio Pinto, Carlos Soares, João Mendes-Moreira, Rosaldo J. F. Rossetti, Simulation of the ensemble generation process: the divergence between data and model similarity, in 28th European Simulation and Modelling Conference (ESM'2014), 2014.
8. Fernanda Figueiredo, Adelaide Figueiredo, Maria Ivette Gomes, Comparison of Sampling Plans by Variables using the Bootstrap and Monte Carlo Simulations, ICCMSE - International Conference of Computational Methods in Sciences and Engineering 2014, vol.1618, pp.535-538, Athens, Greece, 2014.
9. João Vinagre, Alípio Mário Jorge, João Gama, Fast Incremental Matrix Factorization for Recommendation with Positive-Only Feedback, UMAP 2014 - 22nd International Conference on User Modeling, Adaptation and Personalization, Aalborg, Denmark, July 11-17, 2014, LNCS v. 8538, pp. 459-470, Springer
10. Luís Moreira-Matias, João Gama, João Mendes-Moreira, Jorge Freire Sousa, An Incremental Probabilistic Model to Predict Bus Bunching in Real-Time, in Avances in Intelligent Data Analysis, pp.227-238, 2014.
11. Mariana Oliveira and Luis Torgo (2014): Ensembles for Time Series Forecasting, in Proceedings of Asian Conference on Machine Learning (ACML'2014). JMLR: Workshop and Conference Proceedings, vol. 39, 360-370.
12. Nuno Moniz, Luis Torgo and Fátima Rodrigues (2014): Resampling approaches to improve news importance prediction, in Advances in Intelligent Data Analysis XIII (IDA'2014), Blockeel et. al. (eds.), pp. 215-226, LNCS vol. 8819, Springer
13. Pedro Mota Pereira, Rita Paula Ribeiro, João Gama, Failure prediction - an application in the railway industry, DS 2014 - Discovery Science 2014, vol.8777, pp.264-275, Bled, Slovenia, 2014.
14. Pedro Strecht, João Mendes-Moreira, Carlos Soares, Merging Decision Trees: a case study in predicting student performance, in The 10th International Conference on Advanced Data Mining and Applications, pp.535-548, 2014.
15. Vânia Gomes Almeida, João Gama, Collaborative Wind Power Forecast, ICAIS'14 - 2014 International Conference on Adaptive and Intelligent Systems, vol.8779, pp.162-171, Bournemouth, UK, 2014.

### **3.3.3 Ph. D. thesis completed (3000 ca.)**

Ana Raquel Ferreira de Almeida Sebastião, Learning From Data Streams: Synopsis and Change Detection, PhD in Applied Mathematics, Supervisor: João Gama, Co-Supervisor: Teresa Mendonça, January 2014.

Belém Ferreira Barbosa, Comunicação passa-palavra recebida por crianças e adolescentes: desenvolvimento e validação de medida, Doutoramento em Ciências Empresariais – FEP, Supervisor: Pedro Quelhas Brito, July 2014.

Carlos Manuel Abreu Gomes Ferreira, Exploring Temporal Patterns from Multi-relational Databases, Programa Doutoral em Ciência de Computadores (FCUP), Supervisor: João Gama, Co-Supervisor: Vítor Santos Costa, June 2014.

Elaine Ribeiro de Faria Paiva; Detecção de novidade em fluxos contínuos de dados multiclasse; Supervisor: Andre P.L. Carvalho, Co-Supervisor: João Gama ICMC, USP, Brasil, November 2014.

Isabel Maria Perdigão Figueiredo, Modelos Matemáticos em Imunologia e em Investigação e Desenvolvimento, PhD in Applied Mathematics, Supervisor: Bruno Oliveira, Co-Supervisor: Alberto A. Pinto, July 2014.

Joana Becker Paulo (Alberto Pinto) - entregou a tese em Março 2013, ainda não defendeu?

Luís Augusto Correia Roque - Optimization Methods for the Unit Commitment Problem in Electric Power Systems. Programa de Doutoramento em Matemática Aplicada, Universidade do Porto. Supervisor: Prof<sup>a</sup> Dalila Fontes, Outubro de 2014.

Márcia Maria Eugénio Gonçalves, Variações na publicidade em videojogos: efeito ao nível das atitudes, memória e sentimentos de adolescentes e pré-adolescentes, Doutoramento em Ciências Empresariais – FEP, Supervisor: Pedro Quelhas Brito, September 2014.

Mohammad Choubdar Soltan Ahmadi, Mathematical Economics Sunspot equilibrium and International trade with tariffs, PhD in Mathematics, Supervisor: Alberto A. Pinto, September 2014.

Mohammadreza Valizadeh, Improving the Performance of Text Summarization, Doctoral Program in Computer Science of the Universities of Minho, Aveiro, and Porto (MAPi), Supervisor: Pavel Brazdil, December 2014.

Sónia Dias, Linear regression with empirical distributions, PhD in Applied Mathematics, FCUP, Supervisor: Paula Brito, June 2014.

Susana Filipa Couto da Silva Salgado de Abreu de Araújo Pinheiro, Dynamics of Holomorphic and Stochastic Differential Equations, PhD in Applied Mathematics, Supervisor: Helena Reis, Co-Supervisor: Alberto A. Pinto,

### **3.3.4 Patents/prototypes (2000 ca.)**

(void)

### **3.3.5 Organization of Conferences (2000 ca.)**

Organization

1. Alípio Jorge, Web and Text Intelligence Track of the 18th International Database Engineering & Applications Symposium (IDEAS 2014), 07-09 July 2014, Porto, Portugal.
2. Dalila Fontes - ECTA 2014 (6th International Conference on Evolutionary Computation Theory and Applications) – Organizing Committee and Scientific Committee - Rome, Italy, October 2014.
3. Dalila Fontes - Optimization Control and Applications in the Information Age, Chalkidiki, Greece, June 2014.
4. Pavel Brazdil et al., MetaSel - Meta-learning & Algorithm Selection, ECAI-2014 Workshop W3, Prague, 19 August 2014
5. Ricardo Campos - Organizing Committee of 18th International Database Engineering & Applications Symposium (IDEAS 2014). Track: Web and Text Intelligence, Porto, Portugal, 07 - 09 July.

As Program Committee member, Senior Program Committee, Area chair or track chair (selection)

KDD 2014  
IJCAI 2014  
BigMine-2014  
DCAI'14  
DS2014  
DSAA'2014  
ICAIS 2014  
Web Intelligence 2014  
KDMILE 2014  
MDM 2014  
IDA 2014  
ACM-SAC 2014  
IBERAMIA 2014  
ECMLPKDD 2014  
ICT Innovations 2014  
SFC2014  
EGC 2014  
ICPRAM 2014  
ICDM-2014  
KDIR-2014  
EPIA 2014  
BRACIS 2014  
SFC2014  
EGC 2014  
ICPRAM 2014

### **3.3.6 Industry contract research (2000 ca.)**

The Unit participated in industry contracted projects, together with other groups of INESC TEC.

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

15 of our Journal papers had authors from foreign countries.

**\*\*Leading roles in scientific societies\*\***

President of the International Association for Statistical Computing (IASC) (2013-2015) - Paula Brito

President of CIM (Centro Internacional de Matemática) - Alberto Pinto

**\*\*International Projects\*\***

ePolicy (FP7) Engineering the POLicy-making Life CYcle - <http://www.epolicy-project.eu/>

MAESTRA (FP7) Learning from Massive, Incompletely annotated, and Structured Data - <http://maestra-project.eu>

**\*\*Leadership in international journals\***

Editor in chief of the Journal of Dynamics and Games (JDG) published by the American Institute of Mathematical Sciences - Alberto Pinto

Guest editors of the special issue of Data Mining and Knowledge Discovery of ECML PKDD 2015 - João Gama, Alípio Jorge

Guest editors of the special issue of the Machine Learning Journal of ECML PKDD 2015- João Gama, Alípio Jorge  
Associate Editor, Progress in Artificial Intelligence, Springer – João Gama

Guest editor of the special issue in "Cutting and Packing" of the International Transactions in Operational Research, 2014 - José Fernando Gonçalves

Associate Editor, International Transactions in Operational Research, José Fernando Gonçalves

Associate Editor of "Advances in Data Analysis and Classification - Paula Brito

**\*\*Participation in Editorial Boards of int. journals\*\***

Machine Learning – João Gama

Data Mining Knowledge Discovery – João Gama

Intelligent Data Analysis – João Gama

New Generation Computer – João Gama

Machine Learning – Pavel Brazdil

International Journal of Computational Intelligence in Bioinformatics and Systems Biology (IJCBSB) – Rui Camacho

Modulad Journal, "La revue Modulad - Paula Brito

Data - Alexandre Faria de Carvalho

**\*\*Senior Research Visitors\*\***

Lubos Popelinsky, Univ. of Masaryk, Czech Republic

Albert Bifet, Huawei, Hong Kong

**\*\*Visiting Post-Graduate Students\*\***

Pawel Matuszyk, Otto-von-Guericke University, Germany

Roberta Sinoara, Universidade de São Paulo, Brazil

Jorge Rebazas, Universidade de São Paulo, Brazil

### **3.3.8 Other national publications (6000 ca.)**

5 articles in books

1. Adelaide Figueiredo, Fernanda Figueiredo, Metodologia STATIS em Controlo Estatístico da Qualidade, JOCLAD 2014 - XXI Jornadas de Classificação e Análise de Dados, pp.93-96, Lisboa, Portugal, 2014.
2. Conceição Nunes Rocha, Alípio Jorge, Márcia Barbosa Oliveira, Paula Brito, João Gama, Carlos Pimenta, Text mining a Portuguese book on Freemasonry: Disclosing network communities' features, INFORUM 2014 - INFORUM 2014 - Simpósio de Informática, Porto, Portugal, 2014.
3. Duarte Silva, A.P., Brito, P. "Discriminant analysis of interval data: Parametric versus distance-based approaches." JOCLAD 2014, Lisbon, Portugal, April 10th-12th 2014.
4. Ichino, M., Brito, P. "A hierarchical conceptual clustering based on the quantile method for mixed data." JOCLAD 2014, Lisbon, Portugal, April 10th-12th 2014.
5. Luís Pimentel Trigo, Pavel Brazdil, Análise de Afinidades entre Investigadores com Text Mining, JOCLAD 2014 - XXI Jornadas de Classificação e Análise de Dados, Lisboa, Portugal, Abril, 2014.
6. Maria Ivette Gomes, Fernanda Figueiredo, Adelaide Figueiredo, Controlo Estatístico da Qualidade em Indústria e Serviços, CCDA 2014 - II Congresso de Ciência e Desenvolvimento dos Açores e VII Congresso de Gestão e Conservação da Natureza, pp.42-52, Angra do Heroísmo, Açores, 2014.
7. Martins, J., H., Campos, P. (2014), Avaliação da semelhança de padrão em séries temporais multivariadas: aplicação ao caso de estudo de fogos florestais em Portugal, Encontro Luso-Galaico de Estatística em Ambiente e Ecologia, Vila Real, (EES2014)
8. Pereira, S., Correia, L., Campos, P. (2014), Estimação do desemprego ao nível NUTS III, JOCLAD, XXI Jornadas de Classificação e Análise de Dados (JOCLAD 2014), INE, Lisboa
9. Raquel Sebastião, Armando J. Pinho. Detecting unknown pattern repeats: first results using a probabilistic approach. Proceedings of the 20th Portuguese Conference on Pattern Recognition, RecPad 2014, Covilhã, Portugal, October 2014.

### **3.3.9 Government/Organization contract research (2000 ca.)**

*(Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice)*

(void)

### 3.1 Group Description - USIG

Research Group Title	INFORMATION SYSTEMS AND COMPUTER GRAPHICS
Principal Investigator	Gabriel David
Research Area	Electrical and Computer Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements - USIG

#### 3.2.1 Objectives (4000 ca.)

##### FOREWORD

The Coordinators of this Unit during 2013 were Prof. Gabriel David and M.Sc. António Gaspar.

##### OBJECTIVES

The Information Systems and Computer Graphics Unit (USIG) mission is to pursue high quality research, strongly linked to industrial partnerships, consultancy and technology transfer, in five main areas: Computer Graphics, Information Management, Software Engineering, Special Purpose Computing Systems, and Accessibility and Support Technologies. The unit is particularly well positioned to address complex and difficult engineering problems faced by industry as it has the expertise to analyse, design, mine and implement large information systems, using best software engineering practices for design, development and testing, and also provide the visual and user interaction components such a solution may require. Furthermore, the unit is also strongly committed to the training of young researchers and professionals. The Special Purpose Computing Systems and Accessibility and Support Technologies areas correspond to new researchers who have joined the centre.

USIG main research goals are organized as follows:

**SOFTWARE DEVELOPMENT METHODOLOGIES** - Improve and innovate on current software development methodologies with particular emphasis on model-driven development with formal methods, agile and collaborative development methodologies, and software quality assurance based on software testing, verification and certification.

**INFORMATION MANAGEMENT, RETRIEVAL AND PROCESSING** - Investigate frameworks for information management, retrieval and processing in contexts such as web mining, recommender systems, social web, semantic web, time aware information retrieval and personalised information retrieval. This leads to the development of innovative systems such as federated libraries of socially assisted annotated documents, digital cultural heritage portfolios and e-learning environments and tools.

**DIGITAL PRESERVATION** - Devise models, methods and tools for digital preservation. At the management level, the establishment of digital preservation plans is studied. Techiques to include the preservation of databases in digital repositories are developed. Research data management is approached in two ways: by building repositories for large monitoring data sets and by developing tools to help adding metadata to research data sets.

**LARGE SCALE INFORMATION SYSTEMS** - Develop innovative models, methodologies and architectures for large-scale information systems. We focus on system integration and interoperability, authentication, access authorisation, security and auditability mechanisms.

**INNOVATIVE METHODS IN COMPUTER GRAPHICS AND VIRTUAL ENVIRONMENTS** - Investigate innovative methods in computer graphics and virtual environments, as well as in natural user interfaces, especially with

applications in serious games, immersive and interactive urban planning based on virtual environments. Special focus has been given to mobile devices, modeling and visualization of large scenes for immersive environments, and image synthesis.

**COMPILATION FOR RECONFIGURABLE COMPUTING ARCHITECTURE** – Build high-performance embedded systems and to develop languages and compilers to leverage such systems, using aspect-orientation, domain specific languages and loop-critical hardware accelerators.

**ACCESSIBILITY AND SUPPORT TECHNOLOGIES** – Research and build systems that improve the performance of disabled or physically impaired people, be it a visual, auditive, motor or cognitive weakness.

USIG activity is also driven by applications with particular emphasis in the areas of public administration (local, regional and central government), healthcare, telecommunications, transport and industry and the commerce and services sectors. The e-Government and e-Health areas expected to be major areas of application in the near future.

## FOREWORD

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## OBJECTIVES

The Information Systems and Computer Graphics Unit (USIG) mission is to pursue high quality research, strongly linked to industrial partnerships, consultancy and technology transfer, in five main areas: Computer Graphics, Information Management, Software Engineering, Special Purpose Computing Systems, and Accessibility and Support Technologies. The unit is particularly well positioned to address complex and difficult engineering problems faced by industry as it has the expertise to analyse, design, mine and implement large information systems, using best software engineering practices for design, development and testing, and also provide the visual and user interaction components such a solution may require, including for disabled users and hardware acceleration of specific parts. Furthermore, the unit is also strongly committed to the training of young researchers and professionals.

USIG main research goals are organized as follows:

**SOFTWARE DEVELOPMENT METHODOLOGIES** - Improve and innovate on current software development methodologies with particular emphasis on model-driven development with formal methods, agile and collaborative development methodologies, and software quality assurance based on software testing, verification and certification.

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### **3.2.2 Main Achievements (4000 ca)**

2013

The group continued to improve the research production. The fastest growing category has been journal papers, with 23 being published. The number of conference papers has also grown to 75, most of them presented at international events with refereeing.

The budget suffered a sharp decrease in European and National projects, since most of them ended, synchronised with the end of public funding programmes (FP7 and QREN). This has been partially compensated by a significant increase in services projects (60%). New partnerships were created or reinforced with: APDL, TRIEDE TTI, IM3DICAL, Monte Adriano, Ordem dos Arquitectos, Portugal Telecom Inovação and IDMEC.

In the area of compilation for reconfigurable computing architecture, the main achievements are high-performance embedded systems and a new, versatile, and powerful, aspect-oriented programming (AOP) language, named LARA. LARA allows developers to capture non-functional requirements from applications in a structured way, leveraging high-level abstractions such as hardware/software design templates and flexible toolchain interfaces. Developers can thus benefit from retaining the original application source while exploiting the automation benefits of various domain-specific and target component-specific compilation/synthesis tools. Another relevant result was the development of a new domain-specific language (DSL) to program loop-critical hardware accelerators targeting FPGAs. The new language and associated compiler are able to achieve superior performance than commercial high-level synthesis tools.

In the area of information management two tools (UPBox and DataNotes) contributed to create a collaborative data management environment for the long tail of research data.

Systems were produced in projects TICE.Mobilidade, AAL4AL, AVESAT, GIE-GNP, MedicalSoft, OARSN and PWA. Prototypes were produced in ERAS, CNG, RAIA.co and OnlineGYM. ECOPLANNER project ended with a pilot installation at a factory.

The group continued its involvement in industrial fora, like CEDT – Excellence Center for Transaction Dematerialization (Membership of the Board of Directors), DANOTEC – New Technologies and Defense Association (Representation of INESC Porto), AIFF – Forest Industries Association (Representation of INESC Porto), ITS Portugal – Intelligent Transportation Systems (Membership of the Board of Directors), ELANET – European Local Authorities Association (Membership of the Board of Directors) and Hillside Group – Non-Profit Corporation for Software Patterns promotion (Vice-Presidency of the Board of Directors).

2014

The group slightly increased its research production, despite the difficult conditions caused by research budget cuts that reduce the number of projects and PhD students. There was an increase to 27 journal papers and 59 conference papers published, with about one third indexed by Springer, ACM, IEEE and/or ISI-Proceedings.

One of the researchers in the Accessibility and Support Technologies area was one of the winners of the 2014 awards for Inclusion and Digital Literacy, awarded by the network ICT and Society.

In 2014 budget was around 1M€. Services increased by 6%, national projects decreased 38%, due to the end of QREN funding cycle and were compensated by European projects which increased 178%, thanks to two new projects: E-COMPARED and LeanBigData, both funded by FP7. Most of the service contracts that had started in 2013 continued in 2014 and were joined by new contracts with INCM, AMBIFOOD, PT Inovação, Porto Municipality, Público newspaper and APDL.

Systems were produced in projects TICE.Mobilidade, GIE-GNP and SARA. Prototypes were produced in MASSIVE, ICARUS, E-COMPARED, LeanBigData, OnlineGYM and MIELE. Pilot installations were deployed in AAL4ALL, OASRN and SIGAP2.

The group continued its involvement in industrial fora, like CEDT – Excellence Center for Transaction Dematerialization (membership of the Board of Directors), DANOTEC – New Technologies and Defense Association (representation of INESC Porto), AIFF – Forest Industries Association (representation of INESC Porto), ITS Portugal – Intelligent Transportation Systems (membership of the Board of Directors), ELANET – European Local Authorities Association (membership of the Board of Directors) and Hillside Group – Non-Profit Corporation for Software Patterns promotion (vice-Presidency of the Board of Directors).

The cooperation with other INESC groups has increased, both through joint participation in R&D projects and by aligning strategies.

### **3.3 Productivity - USIG**

#### **3.3.1 Publications in peer review Journals (6000 ca.)**

2013: Total number of publications: 23

The complete list can be consulted in: <http://profile.inescporto.pt>

1. Correia Melo, M., Bessa, M., Debattista, K., Chalmers, A., "Evaluation of HDR video tone mapping for mobile devices", Signal Processing, October 2013.
2. Cabral, M., Morais, R., Peres Correia, E., Escola, J., "Using Problem-Based Learning to help Portuguese students make the Bologna transition", Journal Computer Graphics Forum, August 2013, Journal of Problem Based Learning in Higher Education (JPBLHE), vol.1, no.1, p.135-150.
3. Azevedo, D., Fonseca, B., Paredes, H., Lukosch, S., Janeiro, J., Owen Briggs, R., "On the Development and Usability of a Diagram-based Collaborative Brainstorming Component", International Journal of Universal Computer Sciences, April 2013, vol.19, no.7, p.873-893.
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9. Pascoal Faria, J., Paiva, A., "Report from the 8th International Conference on the Quality of Information and Communications Technology (QUATIC 2012)", ACM SIGSOFT Software Engineering Notes 2013, vol.38, no.1.
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11. Costa, M., Barroso, J., Soares, S., "Signal Processing Interpolation and Problem Conditioning Educational Workbench", Modern Applied Science Journal, 2013.
12. Paredes, H., Fonseca, B., Cabo, M., Pereira, T., Fernandes, F., "SOSPhone: a mobile application for emergency calls", Universal Access in the Information Society 2013, vol.13.
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14. Nunes, S., Ribeiro, C., David, G., "The impact of time in link-based Web ranking", Information Research 2013.
15. Rocha Silva, J., Ribeiro, C., Correia Lopes, J., "UPBox e DataNotes: um ambiente de suporte à gestão colaborativa de dados científicos", Revista de Ciência da Informação e Documentação 2013, vol.4, no.2, p.95-111.
16. Lopes, C., Dias, D., Ribeiro, C., "Using domain-specific term frequencies to identify and classify health queries", Advances in Intelligent Systems and Computing 2013, vol.206, p.221-226.
17. J. Bispo, J. M. P. Cardoso, and J. C. Monteiro, "Hardware Pipelining of Repetitive Patterns in Processor Instruction Traces," in Journal Integrated Circuits and Systems (JICS), March 2013, vol. 8, no. 1, pp. 22-31. ISSN-1807-1953.
18. João Bispo, Nuno Paulino, João M.P. Cardoso, and João Canas Ferreira, "Transparent Trace-Based Binary Acceleration for Reconfigurable HW/SW Systems," in IEEE Transactions on Industrial Informatics, Vol. 9, Issue 3. Aug. 2013, pp. 1625-1634.
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20. João M.P. Cardoso, João M. Fernandes, Miguel P. Monteiro, Tiago Carvalho, Ricardo Nobre, "Enriching MATLAB with aspect-oriented features for developing embedded systems," in Journal of Systems Architecture - Embedded Systems Design (JSA), Elsevier, Volume 59, Issue 7, July 2013, pp. 412-428, DOI: 10.1016/j.sysarc.2013.04.003.
21. João Bispo, Nuno Paulino, João M.P. Cardoso, and João C. Ferreira, "Transparent Runtime Migration of Loop-Based Traces of Processor Instructions to Reconfigurable Processing Units," in International Journal of Reconfigurable Computing (IJRC), Volume 2013 (2013), Article ID 340316, 20 pages.
22. Luís Sequeira, Leonel Morgado. "Mechanisms of three-dimensional content transfer between the OpenSimulator and the Second Life Grid platforms", Journal of Gaming & Virtual Worlds, vol.5, no.1, pp.41-57, 2013.
23. Isabel Lopez Margarido, João Pascoal Faria, Marco Vieira, and Raul Moreira Vidal. "Challenges in Implementing CMMI High Maturity: Lessons Learned and Recommendations", Software Quality Professional Magazine, Volume 16, Issue 1, December 2013, 2013.

2014: Total number of publications: 29

The complete list can be consulted in: <http://profile.inescporto.pt>

- Pinheiro, A., Fernandes, P., Maia, A., Conde Matos, G., Pedrosa, D., Fonseca, B., Paredes, H., Martins, P., Morgado, L., Rafael, J., "Development of a mechanical maintenance training simulator in OpenSimulator for F-16 aircraft engines", *Entertainment Computing*, December 2014, vol.5, no.4, p.347-355.
- Matos, C., Teixeira, C.A., Bento, R., Varajão, J., Bentes, I., "An exploratory study on the influence of socio-demographic characteristics on water end uses inside buildings", *Science of The Total Environment*, January 2014, *Science of The Total Environment*, vol.466, no.1, p.467-474.
- Silero, N., Amaro Oliveira, M., Sousa, P., Sousa, F., Gonçalves-Seco, L., "Distributed database system of the New Atlas of Amphibians and Reptiles in Europe: the NA2RE project", *Amphibia - Reptilia*, January 2014, vol.35, no.1, p.33-39.
- Reis, M.C., Soares, S., Cardeal, S., Morais, R., Peres, E., Ferreira, P.J.S.G., "Teaching Fourier Series Expansions in Undergraduate Education with the Help of the FouSE Android Application", *International Journal of Interactive Mobile Technologies*, January 2014, vol.8, no.1, p.26-31.
- Santos, A., Paiva Cardoso, J., Diniz, P., Ferreira, D., Petrov, Z., "A DSL for specifying run-time adaptations for embedded systems: an application to vehicle stereo navigation", *JOURNAL OF SUPERCOMPUTING* 2014, vol.70, no.3, p.1218-1248.
- Gaspar, R., Coelho, J., Bastos, G., Figueiredo, M., Quinta, A.P., "A mediação da Leitura através de realidade aumentada - 'O homem da gaita'", *REVISTA IBERO-AMERICANA DE PESQUISA EM EDUCAÇÃO, CULTURA E ARTES* 2014.
- Gonçalves, R., Casto, M., Cota, M.P., Branco, F., Martins, J.L., Barroso, J., "A new concept of 3D DCS interface application for industrial production console operators", *Universal Access in the Information Society* 2014, vol.14, no.3, p.1-1.
- Pascoal Faria, J., Paiva, A.C., "A toolset for conformance testing against UML sequence diagrams based on event-driven colored Petri nets", *International Journal on Software Tools for Technology Transfer* 2014.
- Morgado, L., Varajão, J., Dominguez, C., Oliveira, I., Sousa, F., "Balancing European SME Managers' Training Contents: Perceived Importance & Training Needs", *Business Systems Research Journal* 2014, vol.5, no.2, p.4-22.
- Armando, C., Paredes, H., Fonseca, B., Morgado, L., Martins, P., "Can presence improve collaboration in 3D virtual worlds?", *Procedia Technology* 2014, vol.13, p.47-55.
- Morgado, L., "Cultural Awareness and Personal Customization of Gestural Commands Using a Shamanic Interface", *Procedia Computer Science* 2014, vol.27, p.449-459.
- Coelho, J., Branco, F., Oliveira, T., Leiva, V., "Distribution View: a tool to write and simulate distributions", *Biometrie und medizinische Informatik- Greifswalder Seminarberichte* 2014, vol.23, p.75-97.
- Bianchi Piccinini, G., Rodrigues, C., Leitão, M., Simoes, A., "Driver's behavioral adaptation to Adaptive Cruise Control (ACC): The case of speed and time headway", *Journal of Safety Research* 2014, vol.49, p.77-84.
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Bonato, V., Fernandes, M., Paiva Cardoso, J., "Practical education fostered by research projects in an embedded systems course", *International Journal of Reconfigurable Computing* 2014, vol.2014.

Magalhães, L.G., Sousa, J.J., Bento, R., Pereira, F., Filipe, V.M., Peres, E., "Proposal of an Information System for an Adaptive Mixed Reality System for Archaeological Sites", *Journal of Procedia Technology* 2014.

Rodrigues, N., Magalhães, L.G., Moura, J., Chalmers, A., "Reconstruction and generation of virtual heritage sites", *Digital Applications in Archaeology and Cultural Heritage* 2014, vol.1, p.92-102.

Sequeira, L., Morgado, L., Pires, E., "Simplifying Crowd Automation in the Virtual Laboratory of Archaeology", *Procedia Technology* 2014, vol.13, p.56-65.

Mikropoulos, T., Paredes, H., Barroso, J., Hadjileontiadis, L., "Special Issue on Information & Communication Technologies in Special Needs Education", *Journal of Information and Communication Technologies* 2014, Themes in Science & Technology Education, vol.7, no.2, p.63-66.

Santos, A., Paiva Cardoso, J., Diniz, P., Ferreira, D., Petrov, Z., "Specifying dynamic adaptations for embedded applications using a dsl", *IEEE Embedded Systems Letters* 2014, vol.6, no.3, p.49-52.

Barradas, M.T., Coelho, J., Tavares, M., "Tecn made in' têxtil", *Revista Ibero-Americana DE PESQUISA EM EDUCAÇÃO, CULTURA E ARTES* 2014.

Sousa, J.J., Guimarães, P., Sousa, A., Ruiz, A., Patrício, G., Magalhães, L.G., Pereira, F., "viStaMPS-a Collaborative Project for StaMPS-MTI Results Interpretation", *Journal of Procedia Technology* 2014.

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Pereira, J., Martins, J., Santos, V., Gonçalves, R., "CRUDi framework proposal: financial industry application" 2014, *Behaviour and Information Technology*, vol.33, no.10, p.1093-1110.

### 3.3.2 Other International publications (6000 ca.)

Number of publications: 75

1. Gonçalves, R., Cota, M., "Cloud Computing decisions in Real Enterprises", in *Agile Estimation Techniques and Innovative Approaches to Software Process Improvement*, EUA: IGI Global, p.1-1, 2013.

2. Gonçalves, F., David, G., "Definition of a retrospective health information policy based on (re)use study", in *Handbook of Research in ICTs for Healthcare and Social Service: Development and Applications*, 2013.

3. Rocha Silva, J., Ribeiro, C., Correia Lopes, J., "Managing Research Data at the University of Porto: Requirements, Technologies, and Services. Chapter 10; in *Innovations in XML Applications and Metadata Management: Advancing Technologies*", pp.174-197, 2013.

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9. Fernando Gonçalves, Zlatko Petrov, José Gabriel de F. Coutinho, Razvan Nane, Vlad-Mihai Sima, João M. P. Cardoso, Stephan Werner, Sujit Bhattacharya, Tiago Carvalho, Ricardo Nobre, José de Sá, João Teixeira, Pedro C. Diniz, Koen Bertels, George Constantinides, Wayne Luk, Juergen Becker, José Carlos Alves, João Canas Ferreira, and Gabriel M. Almeida, LARA Experiments, in *Compilation and Synthesis for Embedded Reconfigurable Systems*, João M. P. Cardoso, Pedro Diniz, José Gabriel Coutinho, Zlatko Petrov (eds.), Springer Science+Business Media, New York, USA, pp. 135-180, 2013.
10. João M. P. Cardoso, José Gabriel de F. Coutinho and Pedro C. Diniz, Related Work, in *Compilation and Synthesis for Embedded Reconfigurable Systems*, João M. P. Cardoso, Pedro Diniz, José Gabriel Coutinho, Zlatko Petrov (eds.), Springer Science+Business Media, New York, USA, pp. 181-196, 2013.
11. Pedro C. Diniz, João M. P. Cardoso, José Gabriel de F. Coutinho, and Zlatko Petrov, Conclusions, in *Compilation and Synthesis for Embedded Reconfigurable Systems*, João M. P. Cardoso, Pedro Diniz, José Gabriel Coutinho, Zlatko Petrov (eds.), Springer Science+Business Media, New York, USA, pp. 197-200, 2013.
12. Aldeias, Carlos; David, Gabriel; Ribeiro, Cristina (2013). "Preservation of Data Warehouses: Extending the SIARD System with DWXML Language and Tools" in *Innovations in XML Applications and Metadata Management: Advancing Technologies*, pp.136-159, New York: IGI Publications, 2013. DOI: 10.4018/978-1-4666-2669-0.ch008, WOS:000342666100008, ISBN:978-1-4666-2700-0; 978-1-4666-2669-0
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Goncalves, J., Rossetti, R., Jacob, J., Goncalves, J., Olaverri-monreal, C., Coelho, A., Rodrigues, R., "Testing Advanced Driver Assistance Systems with a serious-game-based human factors analysis suite", Proceedings IV 2014 - IEEE Intelligent Vehicles Symposium 2014, p.13-18.

Flores, N., Aguiar, A., Sereno Ferreira, H., "The Concept of Ba Applied to Software Knowledge", CHASE 2014 - 7th International Workshop on Cooperative and Human Aspects of Software Engineering CHASE 2014 2014, Hyderabad, India.

Coelho, A., Dias, L.J., Almeida, R., Castro, N., Goncalves, P., "The Fifth Empire The reinterpretation of Portuguese and European history in an action adventure game", CISTI2014 - 9th Iberian Conference on Information Systems and Technologies 2014, Barcelona, Spain.

Moreira, R., Paiva, A.C., "Towards a Pattern Language for Model-Based GUI Testing", EuroPLOP 2014 - EuroPLOP - 19th European Conference on Pattern Languages of Programs, 2014, Irsee, Germany.

Emiliano, R., Silva, F., Frazão, L., Barroso, J., Pereira, A., "Traffic Management in Rural Networks.", HCI 2014 - HCI International 2014 2014, HCI (10), vol.8519, Creta, Grécia, p.452-461.

Cabo, M., Fernandes, F., Pereira, T., Fonseca, B., Paredes, H., "Universal access to eCall system", DSAI 2014 2014, vol.27, p.104-112.

Fonseca, B., Paredes, H., Martins, P., Alberto, A., Rego, J., Morgado, L., Santos, A., "VIC - An Interactive Video System for Dynamic Visualization in Web and Mobile Platforms", IFM 2012 - 9th International Conference on Integrated Formal Methods 2014, Pisa, Italia, p.38-49.

Guimarães, P., Patricio, G., Sousa, J.J., Sousa, A., Ruiz, A., Magalhães, L.G., Bastos, L., "viStaMPS: Aplicação Informática para Processamento, Manipulação e Visualização de Séries Temporais de imagens SAR. ", 8ªALEGG - 8ª Assembleia Luso-Espanhola de Geodesia e Geofísica 2014, Evora, Portugal.

Sousa, J.J., Guimarães, P., Sousa, A., Ruiz, A., Patrício, G., Magalhães, L.G., Pereira, F., "viStaMPS-a Collaborative Project for StaMPS-MTI Results Interpretation", Proceedings of CENTERIS'2014 - Conference on ENTERprise Information Systems 2014, Troia, Portugal.

Sacramento, C., Paiva, A.C., "Web Application Model Generation through Reverse Engineering and UI Pattern Inferring", 9th International Conference on the Quality of Information and Communications Technology QUATIC 2014, Guimarães, Portugal, pp. 105-115, 2014.

Pinto da Costa, F., Cunha, A., David, G., "ViBest SHM: an information system and data repository for structural health monitoring", EURODDN 2014 - 9th International Conference on Structural Dynamics 2014, Porto, Portugal.

Gonçalves, F., Gomes, J., David, G., Oliveira, J., "Informação em Saúde: da produção ao acesso no Centro Hospitalar São João", MEDINFOR III - A Medicina na Era da Informação, Salvador 2014, Salvador da Baía, Brasil.

Goehringer, D., Santambrogio, M.d., Paiva Cardoso, J., Bertels, K., "Reconfigurable Computing: Architectures, Tools, and Applications - 10th International Symposium, ARC 2014, Vilamoura, Portugal, April 14-16, 2014. Proceedings" 2014, ARC, vol.8405.

Guerra, Eduardo; Aguiar, Ademar. "Support for Refactoring an Application towards an Adaptive Object Model" in Computational Science and Its Applications - ICCSA 2014 - 14th International Conference, Guimarães, Portugal, June 30 - July 3, 2014, Proceedings, Part V. Lecture Notes in Computer Science 8583, Springer, pp. 73-89, ISBN 978-3-319-09155-6, 2014.

### **3.3.3 Ph. D. thesis completed (3000 ca.)**

2013

Thesis advised by members of USIG: 5

1. Rahman, Arif Ur. "Data Warehouses in the path from databases to archives", July 2013, Programa Doutoral em Informática (MAP-i), FEUP. Supervisor: Gabriel David, Cristina Ribeiro.
2. Barbosa, Fernando. "Generic Rules: Reducing Code Replication", September 2013, Programa Doutoral Engenharia Informática, FEUP. Supervisor: Ademar Aguiar.
3. Lopes, Carla. "Context-Based Health Information Retrieval", July 2013, Programa Doutoral Engenharia Informática, FEUP. Supervisor: Cristina Ribeiro.
4. Urbano, António. "Visualização de Imagens HDR em Dispositivos com Ecrã Pequeno, 2013, PhD in Informatics, UTAD. Supervisor: Luís Magalhães.
5. Marcelino, Rui. "Sorting machines for FPGA-based embedded systems", April 2013, PhD in Electrical and Computer Engineering, IST. Supervisor: João Paiva Cardoso.

2014

1. Coelho, Filipe, "Recuperação de Informação Multimédia em Larga escala: Aplicação na Ilustração de Conteúdos Textuais", Programa Doutoral em Engenharia Informática/FEUP, Cristina Ribeiro (supervisor), 2014.
2. Silva Reis, R.M.d.N., "Engenharia de Software no Design de Mundos Virtuais 3D", PhD/UTAD, Benjamim Fonseca (supervisor), 2014.
3. Bandeira Martins, J.L., "José Luis Bandeira Martins, Adoção de Redes Sociais Online - Um estudo sobre os fatores que afetam a sua adoção ao nível das organizações", PhD/UTAD, Ramiro Gonçalves (supervisor), 2014.
4. Pereira, J., "Maximizing ROI and Agility in IS Investment Decisions - The CRUDi Framework", PhD/UTAD, Ramiro Gonçalves (supervisor), 2014.
5. Vilela Rocha, T., "METÁFORA DE INTERAÇÃO PARA O ACESSO À INFORMAÇÃO DIGITAL DE UMA FORMA AUTÓNOMA POR PESSOAS COM DEFICIÊNCIA INTELECTUAL", PhD/UTAD, Maximino Bessa (supervisor), 2014.
6. Silva Marques, A.M.M., "Modelo Integrador para o Sucesso da Gestão de Projetos", PhD/UTAD, Joaquim Sousa e Emanuel Peres (supervisors), 2014.
7. Branco, F., "Uma Proposta de Arquitetura de Sistema de Informação para as Empresas Agroalimentares do Setor de Produção de Cogumelos - O Caso Grupo Sousacamp", Tese Doutoramento em Informática/UTAD, Ramiro Gonçalves (supervisor), 2014.

### **3.3.4 Patents/prototypes (2000 ca.)**

Several prototypes were developed in 2013:

ERAS - 3D Reconstruction of historic buildings based on textual descriptions and geospatial data.

CNG – Multiplayer 3D video game for mathematics learning, using next generation broadband networks.

RAIA.co – Final version of sensor observation service and catalog service for a web based oceanographic georeferenced sensor network.

OnlineGYM – Online gymnasium implemented with avatars representing personal trainer and trainees, animated using movement captured by KINECT cameras at their homes and synchronised in a virtual world displayed in their PCs.

Several prototypes were developed in 2014:

MASSIVE – Editor of virtual multisensorial experiences.

ICARUS – Serious game for training of search and rescue SUV and UAV operators.

E-COMPARED – Mobile and fixed IT infrastructure for depression data gathering and evaluation.

LEANBIGDATA – Spatial-temporal data retrieval algorithm based in RB-interval trees and visualization prototypes.

ONLINEGYM – Final version of an online gymnasium implemented with avatars representing personal trainer and trainees, animated using movement captured by KINECT cameras at their homes and synchronised in a virtual world displayed in their PCs.

MIELE – Multimodal multicriteria e-logistics marketplace simulator.

### **3.3.5 Organization of Conferences (2000 ca.)**

Some of the events in which members of USIG participated are:

ACM SAC; João Pascoal Faria - PC member

C3S2E'13, Sixth International C\*; Ricardo Costa – Track Chair

DSAI 2013; João Barroso - Steering Committee; Paulo Martins, Hugo Paredes, Benjamim Fonseca – PC Members

EXP'13; Augusto Sousa – PC member and SC member

HCI 2013/MOBACC 2013; João Barroso - Track Chair; Hugo Paredes- PC member; Benjamim Fonseca - SC member

HCist2013; Emanuel Peres - PC member

HDRI 2013 - First International Conference on HDR imaging; Maximino Bessa – Co-Chair; Luís Magalhães - PC member

PCG'2013; Rui Rodrigues - PC member; António Coelho – OC member

PLE 2013; Ademar Aguiar - OC member

PLOP 2013; Ademar Aguiar - OC member

RTE'13; Maximino Bessa - Co-Chair

SeGAH 2013; Rui Rodrigues - PC member; OC member

SLACTIONS 2013; Paulo Martins - Co-Chair; Luis Magalhães – PC member; Paulo Martins, Emanuel Peres – SC member.

2014

Some of the events in which members of USIG participated are:

ACM CHI 2014. Benjamim Fonseca – Scientific Committee

ACM GROUP2014. Benjamim Fonseca – Scientific Committee

ADAPTIVE 2014 – The Sixth International Conference on Adaptive and Self-adaptive Systems and Applications, Venice (Italy), 25-29/May/2014. Paulo Martins – Scientific Committee. [Proceedings Indexed ISI]

ADM 2014 - Congresso Internacional de Administração. Luis Magalhães – Scientific Committee

ARC'2014 - The 10th International Symposium on Applied Reconfigurable Computing, Vilamoura, Portugal, April 14-16, 2014. João Paiva Cardoso – Co-Chair

ARCS'2014: 27th International Conference on Architecture of Computing Systems. Luebeck, Germany, February 25 - 28, 2014. João Paiva Cardoso - Technical Program Committee.

CAPSI- Conferência da Associação Portuguesa de Sistemas de Informação 2014. Ramiro Gonçalves - Scientific committee;

CENTERIS'14 -Conferência Internacional em ENTERnterprise Information Systems: aligning business, technology and people (6th Edition). 15-17 October 2014, Troia, Portugal. Emanuel Peres – Organizing Chair. SARWatch Workshop Joaquim J. Sousa- Organizing Chair

CISTI 2014 – 9.ª Conferência Ibérica de Sistemas e Tecnologias de Informação, Barcelona (Espanha), 18-21/June/2014. Paulo Martins; Hugo Paredes – Scientific Committee [Proceedings Indexed ISI]. Ramiro Gonçalves – Coordinator Committee

CONFOA'14: 5ª Conferência Luso-Brasileira sobre Acesso Aberto. Cristina Ribeiro – Program Committee

COOP2014. Benjamim Fonseca – Scientific Committee

CRIWG. Benjamim Fonseca; Hugo Paredes – Scientific Committee

DASIP2014-8th Conference on Design and Architectures for Signal and Image Processing; October 8-10, 2014, Madrid, Spain. João Paiva Cardoso – Co-Chair

DL'14: ACM/IEEE Joint Conference on Digital Libraries + Theory and Practice of Digital Libraries Conference. Cristina Ribeiro – Program Committee

EPCG- 21º Encontro Português de Computação Gráfica. Luis Magalhães- Scientific Committee

EUC'2014 - The 12th IEEE International Conference on Embedded and Ubiquitous Computing, August 26-28, 2014, Milan, Italy. Self-adaptive and reconfigurable computing. João Paiva Cardoso – Technical Program Committee

EUROPAR 2014 - 20th International European Conference on Parallel Processing, Euro-Par 2014 Porto, Portugal, August 25-29, 2014. João Paiva Cardoso – Local Chair

FPL2014 - 24th International Conference on Field Programmable Logic and Applications, Munich, Germany, Sep. 2 - 4, 2014. João Paiva Cardoso - Steering Committee

HCI Internacional2014. Benjamim Fonseca – Scientific Committee. Special Track- João Barroso

HPCC'2014 - 16th IEEE International Conference on High Performance and Communications, August 20-22, 2014, Paris, France. João Paiva Cardoso – Technical Program Committee

IADIS Ibero-Americana – WWW/Internet 2014, Porto (Portugal), 25-27-October 2014. Paulo Martins – Scientific Committee

IBIMA Conference on Vision 2020: Sustainable Growth, Economic Development, and Global Competitiveness 2014 – Ramiro Gonçalves Scientific Committee;

ICEIS2014, "16th International Conference on Enterprise Information Systems", Lisboa, Portugal, 27 -30 April de 2014. João Correia Lopes- Program Committee

ICFPT'2014 - International Conference on Field-Programmable Technology, Shanghai, China, 10-12 December 2014. João Paiva Cardoso – Technical Program Committee

IDEAS'14: 18th International Database Engineering & Applications Symposium. Cristina Ribeiro; Gabriel David; Sérgio Nunes – Program Committee

IHC2014, XIII Brazilian Symposium on Human Factors in Computing Systems. Hugo Paredes - Scientific Committee

INForum 2014, João Pascoal Faria; Hugo Sereno Ferreira – PC Members; Antonio Coelho- Scientific Committee

Inter-University Programming Marathon (MIUP 2014), Porto@FEUP, Portugal. Hugo Sereno Ferreira – Chair

MCSoc-14 - IEEE 8th International Symposium on Embedded Multicore/Many-core Systems-on-Chip, The University of Aizu, Aizu-Wakamatsu, Japan, September 23-25, 2014. João Paiva Cardoso – Technical Program Committee.

OTM'14: OnTheMove Federated Conferences & Workshops. Cristina Ribeiro – Program Committee

PARMA-DITAM 2014 Workshop, 5th Workshop on Parallel Programming and Run-Time Management Techniques for Many-core Architectures, Vienna, Austria, January 22, 2014. João Paiva Cardoso - Program Co-Chair

PATMOS'14 - 24th International Workshop on Power and Timing Modeling, Optimization and Simulation, Palma de Mallorca, 29th Sept. - 1st Oct., 2014. João Paiva Cardoso – Technical Program Committee

ProjMAN'14. International Conference on Project MANagement (2nd Edition). October 15-17, 2014, Troia, Portugal. Emanuel Peres – OC Member.

PROPOR 2014, International Conference on Computational Processing of Portuguese. Vitor Rocio – PCMember

RAW 2014 - 21st Reconfigurable Architectures Workshop, Phoenix (Arizona) USA, May 19-20, 2014, associated with the 28th Annual International Parallel & Distributed Processing Symposium (IPDPS 2012, IEEE Computer Society's Technical Committee on Parallel Processing. João Paiva Cardoso – Technical Program Committee.

ReConFig'2014 - International Conference on ReConFigurable Computing and FPGA's; December 8-10, 2014, Cancun, Mexico. João Paiva Cardoso – Track Co-Chair

SAC'14 - ACM 2014 Symposium on Applied Computing, March 24-28, 2014 Gyeongju, Korea. "EMBS track: embedded systems: New Perspectives for Hardware, System Software, and Applications". João Paiva Cardoso – Technical Program Committee

SAMOS XIV - International Conference on Embedded Computer Systems: Architectures, MOdeling and Simulation, track: "Modeling, Design, and Design Space Exploration". Agios Konstantinos, Samos Island (Greece), July 14-17, 2014. João Paiva Cardoso – Technical Program Committee

SEDES 2014, João Pascoal Faria – PC Members

SLATE'14, "Symposium on Languages, Applications and Technologies", Bragança, Portugal, 10 - 20 June de 2014. João Correia Lopes; Cristina Ribeiro; Gabriel David -Program Committee

SPL'2014 - IX Southern Programmable Logic Conference, November 5-7, 2014, Buenos Aires – Argentina. João Paiva Cardoso -Technical Program Committee

Software Engineering and Science track at the 6th Symposium on Informatics. (soft-pt @ inforum 2014). Hugo Sereno – Program Committee.

TESTBEDS'14 (Fifth International Workshop on TESTing Techniques & Experimentation Benchmarks for Event-Driven Software). Ana Cristina Paiva – Organizing Committee

Workshop of Agile Software Development Techniques at the 14th International Conference on Computational Science and its Applications (ICCSA 2014). Hugo Sereno – Program Committee.

VLSI-SoC 2014 - 22nd IFIP/IEEE International Conference on Very Large Scale Integration, October 6-8, 2014, Playa del Carmen, Mexico. (Track Reconfigurable SoC Systems for Energy and Reliability). João Paiva Cardoso -Technical Program Committee

9th Int. Conf. on the Quality of Information and Communications Tech. (QUATIC 2014). Hugo Sereno – Program Committee; Ana C. Paiva-Business Day

10th Latin-American Conf. on Pattern Languages of Prog. (sugarloafplop 2014) Hugo Sereno – Program Committee.

IV Jornadas de Informática da Universidade Aberta “A tecnologia digital ao serviço do ensino da informática em regime de e-learning”. March 2014. Leonel Morgado- Organizing Committee

### **3.3.6 Industry contract research (2000 ca.)**

RAIA.co – POCTEP funded project (former INTERREG), under subcontract by Porto University, aiming at creating an Oceanographic Observatory of the Iberian Coast, providing e-Science services for researchers and thematic services for end users, like fishermen, surfers and general public.

Corredor Azul – Development of a regional development benchmarking platform for Corredor Azul, an association of municipalities in southern Portugal, under contract with Quaternaire.

Medicalsoft – Development of mobile and portable medical imaging applications for IOS and MacOS, for IM3DICAL.

SARA – Development of motorway maintenance information system, using automated data gathering based on georeferenced image recognition, for Monte Adriano construction company.

OASRN – Information systems consultancy and portal development for the Architects Professional Association.

OnlineGYM – Research and development of a virtual reality based online gymnasium, under contract with Portugal Telecom Inovação.

WireMarketPlatform – Development of a wemap based tourism platform for Wiremaze.

IPMAPS – Development of a framework for georeferenced information based applications for IPBRICK.

SIOCER – Information systems consultancy for APCER.

SIGAP2 – Development of a webmap based port environmental management system, funded by QREN, under contract from TRIEDE TTI.

PWA – Development of warehouse real estate portal for IMOFILTER.

2014

SARA – Development of motorway maintenance information system, using automated data gathering based on georeferenced image recognition, for Monte Adriano construction company.

OASRN – Information systems consultancy and portal development for the Architects Professional Association.

OnlineGYM – Research and development of a virtual reality based online gymnasium, under contract with Portugal Telecom Inovação.

SIGAP2 – Development of a webmap based port environmental management system, funded by QREN, under contract from TRIEDE TTI.

PWA – Development of warehouse real estate portal for IMOFILTER.

EYEFRY – Development of an information system for quality evaluation of frying oil (polar compounds), composed by an android mobile phone application for data gathering from dedicated optical sensors and a server based application for data evaluation and customer management. System developed for AMBIFOOD under contract funded by QREN.

INNERSE – Evaluation of natural interaction and immersive visualization functionalities using low cost off the shelf equipments, for networked entertainment applications, under contract with Portugal Telecom Inovação.

PGLOBAL – Platform for automated news gathering and selection from several Portuguese speaking foreign newspapers, under contract with Público newspaper, funded by QREN.

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

In 2013, members of USIG have co-authored 8 joint publications resulting from international collaborations. Some of the active collaborations are:

Image synthesis and virtual reality: U. Warwick (UK)

Procedural Modeling: U. Jaén (Spain), ETH Zurich

Serious games: U. Delft (Holland), U. Coventry (UK)

Information retrieval and digital preservation: David Allen (U. Leeds), Savvas A. Chatzichristofis (Cyprus U. T.), Nuno Vasconcelos (U. California San Diego), Mark Sanderson (RMIT U.)

Software Engineering Institute at CMU

Ambient Assisted Living: Telefonica I+D (Spain), U. Limerick (Ireland)

Further evidence can be seen through participation in EU projects and international networks:

ICT4DEPRESSION - First e-Health project applied to mental health, funded by FP7.

ICARUS – Unmanned search and rescue, funded by FP7.

COST IC1005 – COST Action addressing digital capture, storage, transmission and display of real-world lighting.

ELANET - European Local Authorities' Telematic Network, an association promoted by CEMR, with the goal to develop the Information Society at local and regional level.

HILLSIDE Group - Is a private non-profit devoted to the advance of software patterns. One collaborator is Vice-President.

2014

In 2014, members of USIG have co-authored 22 joint publications resulting from international collaborations. Some of the active collaborations are:

- Image synthesis and virtual reality: U. Warwick (UK)
- Procedural Modeling: U. Jaén (Spain), ETH Zurich
- Serious games: U. Delft (Holland), U. Coventry (UK)
- Information retrieval and digital preservation: David Allen (U. Leeds), Savvas A. Chatzichristofis (Cyprus U. T.), Nuno Vasconcelos (U. California San Diego)
- Software Engineering Institute at CMU

- Ambient Assisted Living: Telefonica I+D (Spain), U. Limerick (Ireland)

Another vector of internationalization is the number (47) of conferences in which members of the group served as organizers or program committee members.

Further evidence can be seen through participation in EU projects and international networks:

- ICARUS – Unmanned search and rescue, funded by FP7.
- E-COMPARED – Tools for internet-based depression treatments.
- LEANBIGDATA – Data visualization tools for an ultra-scalable and ultra-efficient integrated big data platform, funded under FP7.
- COST IC1005 – COST Action addressing digital capture, storage, transmission and display of real-world lighting.
- ELANET - European Local Authorities' Telematic Network, an association promoted by CEMR, with the goal to develop the Information Society at local and regional level.
- HILLSIDE Group - Is a private non-profit devoted to the advance of software patterns. One collaborator is Vice-President.

### **3.3.8 Other national publications (6000 ca.)**

National Conference Proceedings with Scientific referees

1. Noval, M.D., Brito, C.B., Magalhães, L.G., Peres Correia, E., Sousa, J.J., Barreira, J.C., "GARBook: Visualização de sólidos e de secções no Cubo com recurso a Realidade Aumentada" [GARBook: Solids and Cube Sections visualization using Augmented Reality], November 2013, Interação'2013, vol.1, no.1, p.106-112.
2. Pascoal Faria, J., Lima, B., Sousa, T.B., Martins, Â., "A Testing and Certification Methodology for an Ambient-Assisted Living Ecosystem", October 2013, IEEE Healthcom'13: 15th International Conference on E-Health Networking, Application & Services.
3. Vasconcelos, V., Silvestre Silva, J., Marques, L., Barroso, J., "Análise da Textura de Padrões Pulmonares em Imagens TCAR Baseada na Lacunaridade", RECPAD 2013 - The 19th edition of the Portuguese Conference on Pattern Recognition 2013, Lisboa, Portugal.
4. Ferreira, J., Nunes, S., "Characterization of DNS Usage Profiles", Atas do 5º Simpósio de Informática INForum 2013 - INFórum 2013 - 5º Simpósio de Informática 2013, Évora, Portugal.
5. Magalhães, T., Nunes, S., "Construção de Amostras de Dados do Twitter", Atas do 5º Simpósio de Informática INForum 2013, Évora, Portugal, 2013.
6. Barbosa, Joana; Coelho, António Fernando. "Ambientes Urbanos Virtuais para a Web". In Atas do Infórum 2013 – Simpósio de Informática, Évora, Portugal, 2013.
7. Diana Rodrigues, Pedro Neves, Ricardo Barroso, Leonel Morgado. "Criar um Serious Game Sobre Bullying Escolar", Videojogos 2013 - 6.ª Conferência de Ciências e Artes dos Videojogos, Coimbra, Portugal, 2013.
8. Pedro A Nogueira, Rui Rodrigues, Eugénio Oliveira, Lennart E Nacke. "A Regression-based Method for Lightweight Emotional State Detection in Interactive Environments", Proceedings of the XVI Portuguese Conference on Artificial Intelligence (EPIA), Angra do Heroísmo, Açores, Portugal, September 2013.
9. Meira, D., Reis, M.G., Aires, A.P., Peres Correia, E., Escola, J., Cabral, M., "A Utilização de LMS no Ensino da Matemática nas Escolas do 3º Ciclo do Ensino Básico e do Ensino Secundário do Distrito de Vila Real: Retrato da Realidade Atual", July 2013, As TIC no ensino: Políticas, Usos e Realidades, p.147-167, 2013.

10. Reis, M.G., Meira, D., Aires, A.P., Peres Correia, E., Escola, J., Cabral, M., "Ensino da Matemática com Crianças com Paralisia Cerebral e Deficiência Mental: um Estudo de Caso no 1º CEB", July 2013, As TIC no ensino: Políticas, Usos e Realidades, pp. 323-344, 2013.
11. Silva Bento, R., Fernandes, P., Miranda, C., Pereiro, X., Varela, E., "Agenda Estratégica dos Territórios de Fronteira Interior/Transmontana", ed. Vigo: Eixo Atlântico do Noroeste Peninsular, p.96-96, 2013.
12. Silva Bento, R., Gonçalves, P., Suárez, E., Fernandes, A., Ramos, L., Mendéz, G., Suárez, M., González, F.P., Jiménez, J.C.d.Á., "Desenvolvimento de Atividades Inovadoras para a Gestão do Território", ed. Vigo: Eixo Atlântico do Noroeste Peninsular, vol.4, p.438-438, 2013.
13. Silva Bento, R., Ramos, L., Azevedo, N., "Territórios de Baixa Densidade: Conceito e Aplicação ao Caso Português" 2013, p.570-584.
14. Oliveira, L., Dias, L.J., Barros, R., Correia Rodrigues, A., "Gestor de uma Infraestrutura de Dados Espaciais (IDE) Regional e Aplicações Setoriais " [Regional Spatial Data Infrastructure (SDI) and Sectorial Applications Manager], 2013.

2014

Number of papers: 4

PAPERS IN PORTUGUESE CONFERENCES/WORKSHOPS, ETC.:

Baptista, R.J., Nobrega, R., Coelho, A., Vaz de Carvalho, C., "Juegos para la certificación de guías turísticos de espacios urbanos" [In-Game Certification for Urban Tourism Guides], Revista de la Asociación de Tecnicos de Informática, December 2014, no.230, p.64-70.

Rodrigues, D., Neves, P., Barroso, R., Morgado, L., "Criar um Serious Game Sobre Bullying Escolar", CISUC Tech Reports 2014, vol.2014, no.4, p.157-162.

Cassola Marques, F., Morgado, L., Paredes, H., Fonseca, B., Martins, P., de Carvalho, F., "Online Gym: um ginásio virtual 3D integrando a Kinect - análise comparativa de bibliotecas de suporte", CISUC Tech Reports 2014, vol.4, p.95-103. Matos, P., Coelho, J., Carapeto, C., "Testes de Software na Redução do Consumo Energético dos Sistemas de Informação", REVISTA DE CIÊNCIAS DA COMPUTAÇÃO 2014, vol.9, no.9, p.63-78.

Carvalho, F., Morgado, L., Coelho, A., "Shamanic Interfaces for computers and gaming platforms", INFORUM 2014 - INFORUM 2014 - Simpósio de Informática 2014, Porto, Portugal, p.158-172. Gomes, R., Amaro Oliveira, M., Carvalho, A., "Visualização de Dados Oceanográficos em Dispositivos Móveis" [Visualization of Oceanographic Data on Mobile Devices], JEH2014 - 3as. Jornadas de Engenharia Hidrográfica 2014, Lisboa, Portugal.

Abreu, R., Pascoal Faria, J., "Foreword of the 5th Portuguese software engineering doctoral symposium (SEDES'2014)" 2014, Guimarães, Portugal, p.274-275.

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

CCDRN-EA – Support of the Atlantic Area platform, a transnational programme funded by the EU and managed by CCDRN, a portuguese regional governmental body.

AVESAT – Part of APSAT, a SUDOE INTERREG IV B project, for the development of innovative applications using satellite technology, under subcontract with CIM do AVE, a regional association of municipalities in northern Portugal.

MIELE - Design of an interoperable middleware platform able to interface ICT systems in Ports, based on the Model Driven Development paradigm. Project supported by Leixões Port Authority under MIELE TEN-T project.

GIE-GNP – Collaborative platform for the euro-region northern Portugal / Galicia, contracted by the European Grouping for Territorial Cooperation Galicia-Norte de Portugal (AECT – GNP)

SMICE – Development of an online platform for an energy behavior monitoring system for AdEPorto, under contract with IDMEC.

ERAS - Virtual Expedite Reconstruction of Cultural Heritage Sites, a FCT project.

2014

CCDRN-EA – Support of the Atlantic Area platform, a transnational programme funded by the EU and managed by CCDRN, a portuguese regional governmental body.

MIELE - Design of an interoperable middleware platform able to interface ICT systems in Ports, based on the Model Driven Development paradigm. Project supported by Leixões Port Authority under MIELE TEN-T project.

GIE-GNP – Collaborative platform for the euro-region northern Portugal / Galicia, contracted by the European Grouping for Territorial Cooperation Galicia-Norte de Portugal (AECT – GNP)

VCARDID – Software verification and validation project, under contract with INCM.

CAP@CIDADE – Enterprise Architecture (Information Architecture and Business Process Architecture) modelling, under contract with Porto Municipality, funded by SAMA.

WIDERMOS – Specification and prototyping of interoperability e-tools for freight exchange in multimodal motorways of the sea, under contract with APDL, funded by TEN-T programme.

### 3.1 Group Description - CRACS

Research Group Title	Center for Research in Advanced Computer Systems
Principal Investigator	Fernando Silva
Research Area	Electrical and Computer Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements - CRACS

#### 3.2.1 Objectives (4000 ca.)

##### OBJECTIVES

The Center for Research in Advanced Computing Systems (CRACS) focuses on developing scalable software systems for challenging, multidisciplinary applications. Towards this goal, we have contributed to, and aim for scientific excellence in, the areas of programming languages, parallel and distributed computing, security and privacy, information mining, and Web based systems. Research is organized in three foundational areas:

##### LANGUAGES AND DISTRIBUTED COMPUTING

Our team leads in the design of high-level programming languages that integrate logical and probabilistic reasoning, supporting tabling and parallelism. YAP Prolog and Logtalk are our flagship systems, used worldwide both for research and in industry. Applications include machine learning and software engineering. Our interest in systems that are “correct-by-design” led us to further target languages for mobile distributed environments, namely wireless sensor networks (WSN). We aim at designing middleware frameworks for large WSN deployments, with a focus on scalability, energy efficiency and seamless management. A major application is in middleware for cloud-computing platforms designed for ad-hoc networks of mobile devices.

##### SECURITY AND PRIVACY

We contribute both to fundamentals in cryptography and complexity theory, and to applied work in improving privacy and security usability in software and systems. Applications include user-controlled identity management systems, secure identity cards, strong authentication and digital signature mechanisms; specialized algorithms and tools for sharing sensitive data while preserving privacy; robust anonymization techniques and protocols for data-sets with specially sensitive personal data; ethical hacking and penetration testing for preemptive vulnerability detection. We collaborate with the Portuguese Data Protection Commission as consultants in national projects, and with the Portuguese National Security Agency on auditing systems and developing solutions to secure mobile communications.

##### KNOWLEDGE IN A WORLD OF DATA

We collaborate with teams from academia and the broader community, focusing throughout in applications that challenge our core technologies. Example work includes author identification, recommendation systems, sentiment discovery, complex network analysis, electronic health records (EHR) analysis, early cancer detection, fetal monitoring, and processing high-throughput genomics data.

## INTERNATIONAL COLLABORATION

Although CRACS members are, for very long, well connected internationally, a transversal goal is to reinforce most recent collaborations, in particular with CMU, in the areas of Logic Programming for large-scale distributed and crowdsourcing of mobile edge clouds, UT-Austin, in high performance graph analytics, text mining and sentiment analysis, U. Wisconsin on machine learning for medical data, K.U. Leuven on probabilistic logic learning, U.T. Dallas on co-induction, U. York on “Adaptive systems security and networking”, and U. Vigo on Bioinformatics.

## COOPERATION WITH INESC-TEC units:

CSIG – on adding secure authentication and identification technologies to online services;

LIAAD – on multi-relational data mining to support the development of large-scale mining systems using inductive logic programming;

CAP – on the development of innovative sensors for measuring environmental variables.

## 3.2.2 Main Achievements (4000 ca)

CRACS was quite successful in consolidating the research team, attracting young talented researchers, sustaining the publication ratio of the team at an excellent level, increasing international cooperation, and participating in program committees of reputable international conferences. Some highlights of 2013-2014 follow:

### RESULTS

CRACS was successful with 9 new projects: 5 FCT projects, all as leader, and 4 QREN ON.2 projects, 1 as leader, totaling over 1,000,000 euros of competitive funding.

CRACS published over 123 publications: 27 in journal, 76 in conferences (51 of which in proceedings by Springer, ACM, or IEEE), 2 technical books, 10 book proceedings, and 7 book chapters.

CRACS members participated in the organization and/or PCs of a good number of relevant conferences, such as AAI, CBMS, DS, ICLP, PADL, ILP, EPIA, EURO-PAR, PPDP and ECML PKDD.

Regarding advanced training: 22 MSc and 3 PhD theses were concluded; there are 15 MSc and 10 PhD ongoing; 20 junior researchers were hired with project funding.

### ACTIVITIES

YAP: a highly reliable and performing Prolog system.

Research is focused on further improvements to tabled and incremental computations; explicit and implicit parallel models of execution; high performance implementation through demand-driven compilation; supporting the next generation constraint systems.

A new open research direction: the integration of YAP in mobile devices.

Logtalk: 3rd generation of Logtalk.

Advancements include an optimized compiler, full compiler and runtime code review, code refactoring in key areas, support for message delegation, support for structured message printing, an extended set of unit tests, and improved reflection support, notably for tools requiring full cross-referencing information.

MACAW: A resource-aware, type-safe, programming language for embedded devices.

The language compiler and runtime system were designed and implemented. The system has been used to program a commercial WSN deployment for remote management of community gardens.

SONAR: a Publish/Subscribe middleware for seamless access to data streams generated by wireless sensor networks (WSN).

WSN are programmed in SONAR using a DSL called STL (for SONAR Task Language) that is portable across WSN architectures and allows dynamic reprogramming of the networks. We have a fully functional prototype for the P/S system and for the STL language compiler and virtual machine.

Development of several hardware sensors based on distinct technologies to measure: gas concentration in the environment, the concentrations of pharmacological pollutants in water treatment stations (under development) and the quality of oils used in the food industry.

Work on the HYRAX project focused on the development of communication layer, for the Hyrax middleware, that seamlessly supports WiFi, WiFi-Direct, Bluetooth and TLDS protocols, and includes discovery services.

Graph Mining: focused on novel sequential algorithms for discovering subgraph patterns. Extended the work to develop parallel algorithms for distributed and shared memory, and also for the GPU. We extended the g-trie data structure to support colored graphs and large scale networks. We also focused on new methods to characterize and compare time evolving networks.

MammoClass: a web tool to predict probability of malignancy based on a selected set of mammography features.

### **3.3 Productivity - CRACS**

#### **3.3.1 Publications in peer review Journals (6000 ca.)**

Total number of publications: 27

1. R. Queirós, J. P. Leal and J. Campos, "Sequencing Educational Resources with Seqins", in Computer Science and Information Systems, vol. 11, pp.1479–1497, October 2014.
2. J. Santos and R. Rocha, "A Team-Based Scheduling Model for Interfacing Or-Parallel Prolog Engines", in Computer Science and Information Systems, vol. 11, pp.1435–1454, October 2014.
3. P. Ribeiro and F. Silva, "G-Tries: a data structure for storing and finding subgraphs", in Data Mining and Knowledge Discovery, vol. 28, pp.337–377, March 2014.
4. E. Bellodi, E. Lamma, F. Riguzzi, V. Santos Costa and R. Zese, "Lifted Variable Elimination for Probabilistic Logic Programming", in Journal of Theory and Practice of Logic Programming, vol. 14, pp.681–695, July 2014.
5. F. Cruz, R. Rocha, S. C. Goldstein and F. Pfenning, "A Linear Logic Programming Language for Concurrent Programming over Graph Structures", in Journal of Theory and Practice of Logic Programming, vol. 14, pp.493–507, July 2014.
6. T. Mantadelis, R. Rocha and P. Moura, "Tabling, Rational Terms, and Coinduction Finally Together!", in Journal of Theory and Practice of Logic Programming, vol. 14, pp.429–443, July 2014.

7. L. A. J. Marzulo, T. Alves, F. M. G. França and V. Santos Costa, "Couillard: Parallel programming via coarse-grained Data-flow Compilation", in *Parallel Computing*, vol. 40, pp.661–680, December 2014.
8. R. Queirós and M. Pinto, "ESEIG Mobile: An M-Learning Approach in a Superior School", in *International Journal of Knowledge-Based Organizations*, vol. 4, pp.22–38, December 2014.
9. P. Peissig, V. Santos Costa, M. Caldwell, C. Rottscheit, R. L. Berg, E. A. Mendonça and D. Page, "Relational machine learning for electronic health record-driven phenotyping", in *Journal of Biomedical Informatics*, vol. 52, pp.260–270, December 2014.
10. M. Areias and R. Rocha, "Batched Evaluation of Linear Tabled Logic Programs", in *Computer Science and Information Systems*, vol. 10, pp.1775–1797, October 2013.
11. C. Monteiro and J. P. Leal, "Managing experiments on cognitive processes in writing with HandSpy", in *Computer Science and Information Systems*, vol. 10, pp.1747–1773, October 2013.
12. J. P. Leal, "Using proximity to compute semantic relatedness in RDF graphs", in *Computer Science and Information Systems*, vol. 10, pp.1727–1746, October 2013.
13. T. Loureiro, R. Camacho, J. Vieira and N. A. Fonseca, "Improving the performance of Transposable Elements detection tools", in *Journal of Integrative Bioinformatics*, vol. 10, November 2013.
14. A. R. Araújo, M. Reis, H. Rocha, B. Aguiar, R. Morales-Hojas, S. Ribeiro, N. A. Fonseca, et al., "The *Drosophila melanogaster* methuselah Gene: A Novel Gene with Ancient Functions", in *PLoS ONE*, vol. 8, pp.e63747, May 2013.
15. M. A. Domingues, F. Gouyon, A. M. Jorge, J. P. Leal, J. Vinagre, L. Lemos and M. Sordo, "Combining usage and content in an online recommendation system for music in the Long Tail", in *International Journal of Multimedia Information Retrieval*, vol. 2, pp.3–13, March 2013.
16. N. A. Fonseca, R. Morales-Hojas, M. Reis, H. Rocha, C. P. Vieira, et al., "*Drosophila americana* as a Model Species for Comparative Studies on the Molecular Basis of Phenotypic Variation", in *Genome Biology and Evolution*, vol. 5, pp.661–679, March 2013.
17. T. Henriques, L. Antunes, J. Bernardes, M. Matias, D. Sato and C. Costa-Santos, "Information-based measure of disagreement for more than two observers: a useful tool to compare the degree of observer disagreement", in *BMC Medical Research Methodology*, vol. 13, March 2013.
18. K. R. Bradnam, J. N. Fass, A. Alexandrov, P. Baranay, M. Bechner, N. A. Fonseca, et al., "Assemblathon 2: evaluating de novo methods of genome assembly in three vertebrate species", in *GigaScience*, vol. 2, July 2013.
19. V. S. Costa and D. Vaz, "BigYAP: Exo-compilation meets UDI", in *Journal of Theory and Practice of Logic Programming*, vol. 13, pp.799–813, July 2013.
20. R. Queirós and J. P. Leal, "BabeLO - An Extensible Converter of Programming Exercises Formats", in *IEEE Transactions on Learning Technologies*, vol. 6, pp.38–45, January 2013.
21. L. Antunes, A. Matos, A. Pinto, A. Souto and A. Teixeira, "One-Way Functions Using Algorithmic and Classical Information Theories", in *Theory of Computing Systems*, vol. 52, pp.162–178, January 2013.
22. J. Costa, C. Silva, M. J. Antunes and B. Ribeiro, "Customized Crowds and Active Learning to Improve Classification", in *Expert Systems with Applications*, vol. 40, pp.7212–7219, December 2013.
23. T. Henriques, H. Gonçalves, L. Antunes, M. Matias, J. Bernardes and C. Costa-Santos, "Entropy and compression: two measures of complexity", in *Journal of Evaluation in Clinical Practice*, vol. 19, pp.1101–1106, December 2013.
24. R. Queirós and J. P. Leal, "crimsonHex: a learning objects repository for programming exercises", in *Journal of Software: Practice and Experience*, vol. 43, pp.911–935, August 2013.
25. R. Queirós and J. P. Leal, "Ensemble - an E-Learning Framework", in *Journal of Universal Computer Science*, vol. 19, pp.2127–2149, August 2013.

26. B. Aguiar, J. Vieira, A. E. Cunha, N. A. Fonseca, D. Reboiro-Jato, et al., "Patterns of evolution at the gametophytic self-incompatibility *Sorbus aucuparia* (Pyrinae) S-pollen genes support the 'non-self recognition by multiple factors' model", in *Journal of Experimental Botany*, vol. 64, pp.2423–2434, April 2013.

109.J. Devezas and Á. Reis Figueira, "The Community Structure of a Multidimensional Network of News Clips", in *International Journal of Web Based Communities*, vol. 9, pp.411–429, 2013.

### 3.3.2 Other International publications (6000 ca.)

Edited Proceedings + Book Chapters (4 of 17):

1. G Zaverucha, VS Costa, A Paes, ILP2013, LNCS 8812, 2014
2. F Silva, I Dutra, VS Costa, Euro-Par2014, LNCS 8632
3. L Lopes et al., Euro-Par2014 Workshops, LNCS 8805 & 8806, 2014
4. M Hanus, R Rocha, KDPD2013, LNCS 8439, 2014

In Proceedings by Springer, ACM and IEEE (49 of 73):

- 110.J Costa, C Silva, MJ Antunes et al. Concept Drift Awareness in Twitter Streams, ICMLA2014, IEEE
- 111.E Almeida, PM Ferreira, I Dutra et al. ExpertBayes: Automatically Refining Manually Built Bayesian Networks, ICMLA2014, IEEE
- 112.J Côte-Real, I Dutra, R Rocha, A Hybrid MapReduce Model for Prolog, ISIC2014, IEEE
- 113.C Machado et al. An Adjustable Sensor Platform Using Dual Wavelength Measurements For Optical Colorimetric Sensitive Films, IEEE Sensors2014
- 114.P Bloem, F Mota, L Antunes et al. A Safe Approximation for Kolmogorov Complexity, ALT2014, LNCS 8776
- 115.R Camacho, R Ramos, NA Fonseca, AND Parallelism for ILP: the APIS System, ILP2013, LNCS 8812, 2014
- 116.M Araújo et al. Beyond Blocks: Hyperbolic Community Detection, ECML/PKDD2014, LNCS 8724
- 117.F Kuusisto, VS Costa et al. Support Vector Machines for Differential Prediction, ECML/PKDD2014, LNCS 8725
- 118.F Cruz, R Rocha, SC Goldstein, Design and Implementation of a Multithreaded Virtual Machine for Executing Linear Logic Programs, PPDP2014, ACM
- 119.A Pereira et al. USB Connection Vulnerabilities on Android Smartphones: Default and Vendors' Customizations, CMS2014, LNCS 8735
- 120.D Aparício, P Ribeiro, F Silva, Parallel Subgraph Counting for Multicore Architectures, ISPA2014, IEEE
- 121.D Aparício, P Paredes, P Ribeiro, A Scalable Parallel Approach for Subgraph Census Computation, MuCoCos2014, LNCS 8806
- 122.R Queirós, JP Leal, A survey of E-Learning Content Aggregation Standards, KMEL2014, LNCS 8699
- 123.CA Martínez-Angeles, I Dutra, VS Costa et al. A Datalog Engine for GPUs, KDPD2013, LNCS 8439, 2014
- 124.T Costa, JP Leal, Challenges in computing semantic relatedness for large semantic graphs, IDEAS2014, ACM
- 125.AM Jorge, JP Leal et al. A study of machine learning methods for detecting user interest during web sessions, IDEAS2014, ACM
- 126.C Amaral, M Florido, VS Costa, PrologCheck – Property-Based Testing in Prolog, FLOPS2014, LNCS 8475

127. M Araújo et al. Com2: Fast Automatic Discovery of Temporal ('Comet') Communities, PAKDD2014, LNCS 8444
128. A Gonçalves, IM Ong, JA Lewis, VS Costa, Discovering Differentially Expressed Genes in Yeast Stress Data, CBMS2014, IEEE
129. A Gonçalves, IM Ong, JA Lewis and VS Costa, Towards Using Probabilities and Logic to Model Regulatory Networks, CBMS2014, IEEE
130. A Ferreira et al. Envisioning secure and usable access control for patients, SeGAH2014, IEEE
131. MJ Antunes et al. A Distributed Architecture for Remote Validation of Software Licenses Using USB/IP Protocol, WorldCIST2014, AISC 276
132. P Ribeiro, F Silva, Discovering Colored Network Motifs, CompleNet2014, SCI 549
133. M Areias, R Rocha, On the Correctness and Efficiency of Lock-Free Expandable Tries for Tabled Logic Programs, PADL2014, LNCS 8324
134. J Costa, C Silva, B Ribeiro, MJ Antunes, CrowdTargeting: Making Crowds More Personal, SMAP2013, IEEE
135. F Kuusisto, I Dutra et al. Using Machine Learning to Identify Benign Cases with Non-Definitive Biopsy, HEALTHCOM2013, IEEE
136. AP Tomás, JP Leal, Automatic Generation and Delivery of Multiple-Choice Math Quizzes, CP2013, LNCS 8124
137. J Côte-Real, I Dutra, R Rocha, Prolog Programming with a Map-Reduce Parallel Construct, PPDP2013, ACM
138. H Nassif, VS Costa et al. Score As You Lift (SAYL): A Statistical Relational Learning Approach to Uplift Modeling, ECML/PKDD2013, LNCS 8190
139. JP Leal, Testing the perception of time, state and causality to predict programming aptitude, FedCSIS2013, IEEE
140. P Paredes, P Ribeiro, Towards a Faster Network-Centric Subgraph Census, ASONAM2013, ACM
141. F Mota, S Aaronson, L Antunes et al. Sophistication as Randomness Deficiency, DCFS2013, LNCS 8031
142. E Cunha, ÁR Figueira, ÓE Mealha, Clustering documents using tagging communities and semantic proximity, CISTI2013, IEEE
143. R Martins, AB Augusto, ME Correia, A Potpourri of Authentication Mechanisms - The Mobile Device Way, CISTI2013, IEEE
144. H Rodrigues, L Antunes, ME Correia, Proposal of a secure electronic prescription system, i-Society2013, IEEE
145. PM Ferreira, TTV Vinhoza, A Castro, I Dutra et al. Knowledge on Heart Condition of Children based on Demographic and Physiological Features, CBMS2013, IEEE
146. C Santos-Pereira, AB Augusto, R Cruz-Correia, ME Correia, A secure RBAC mobile agent access control model for Healthcare Institutions, CBMS2013, IEEE
147. H Rodrigues, L Antunes, CC Santos, ME Correia et al. Physician's awareness of e-prescribing security risks, CBMS2013, IEEE
148. T Loureiro, R Camacho, J Vieira, NA Fonseca, Boosting the Detection of Transposable Elements Using Machine Learning, PACBB2013, AISC 222
149. N Cravino, ÁR Figueira, Community Detection by Local Influence, WorldCIST2013, AISC 206
150. S Soares, ÁR Figueira, Creating Interoperable e-Portfolios for Different Educational Levels, EDUCON2013, IEEE

- 151. R Martins, L Lopes, F Silva, P Narasimhan, Stheno, a Real-Time Fault-Tolerant P2P Middleware Platform for Light-Train Systems, SAC2013, ACM
- 152. N Angelopoulos, VS Costa et al. Integrative Functional Statistics in Logic Programming, PADL2013, LNCS 7752
- 153. J Santos, R Rocha, On the Efficient Implementation of Mode-Directed Tabling, PADL2013, LNCS 7752
- 154. P Moura, A Portable and Efficient Implementation of Coinductive Logic Programming, PADL2013, LNCS 7752
- 155. S Castro, K Mens, P Moura, LogicObjects: Enabling Logic Programming in Java Through Linguistic Symbiosis, PADL2013, LNCS 7752
- 156. J Costa, C Silva, MJ Antunes et al. Defining Semantic Meta-Hashtags for Twitter Classification, ICANNGA2013, LNCS 7824
- 157. T Gomes, VS Costa, Evaluating Inference Algorithms for the Prolog Factor Language, ILP2012, LNCS 7842
- 158. R Queirós, JP Leal, A Survey on eLearning Content Standardization, WSKS2011, CCIS 278, 2013

### **3.3.3 Ph. D. thesis completed (3000 ca.)**

Theses advised or co-advised.

PhD completed: 3

- 159. Elisabete Cunha, Scalability in Semantic Digital Libraries, PhD in Information and Communication in Digital Platforms, Univ. of Aveiro, Jul 2014, Advisors: Á. Figueira and Ó. Mealha (UA)
- 160. Carlos Ferreira, Exploring Temporal Patterns from Multi-relational Databases, PhD in Computer Science, FCUP, Jun 2014, Advisors: J. Gama (LIAAD) and V.S. Costa
- 161. Mário Alves, Adaptive Hypertext. The shattered documents approach, PhD in Computer Science, FCUP, Jul 2013, Advisors: A. Jorge (LIAAD) and J.P. Leal

MSc completed: 22

- 162. João Silva, High-Level Primitives for Solution Searching in Or-Parallel Prolog Systems, MSc in Network and Information Systems Engineering (MIERSI), FCUP, Dec 2014
- 163. Gustavo Augusto, Computer Aided Diagnosis for Breast Cancer Detection, MSc in Computer Science (MCC), FCUP, Dec 2014
- 164. Mário Pinto, Design and implementation of an algorithmic trading system for the Sifox application, MCC, FCUP, Dec 2014
- 165. André Rodrigues, Paralelização de algoritmos de fatorização de matrizes para recomendação usando GPU, MCC, FCUP, Dec 2014
- 166. Liliana Dores, Análise de dados de cancro da mama de duas populações geograficamente diferentes: EUA e Portugal, MSc in Medical Informatics (MIM), UP, Nov 2014
- 167. Sérgio Moreira, Monitorização de Redes e Sistemas Informáticos, MCC, FCUP, Oct 2014
- 168. David Aparício, Pattern Discovery in Complex Networks using Parallelism, MCC, FCUP, Jul 2014
- 169. Edgard Neto, Towards Out-of-the-Box Programming of Wireless Sensor Networks, MCC, FCUP, Jul 2014
- 170. André Pereira, USB connection vulnerabilities on Android smartphones, MIERSI, FCUP, Jul 2014
- 171. Ricardo Ferreira, Visualization of Passively Extracted HL7 Production Metrics, MIERSI, FCUP, Jul 2014

172. Diogo Teixeira, A Computational Platform for Gene Expression Analysis, MSc in Informatics and Computing Engineering (MIEC), FEUP, Jul 2014
173. Daniela Cardeano, Data Mining em aplicações de Desenho Racional de Fármacos, MIEC, FEUP, Jul 2014
174. Kiran Ali, Performance Analysis of data transfers in grid computing environments, MCC, FCUP, Mar 2014
175. Luís Maia, On the Integrity and Trustworthiness of web produced data, MIERSI, FCUP, Dec 2013
176. Ana Isabel Dias, Construção de uma base de dados e repositório de casos clínicos em Cardiologia, MCC, FCUP, Nov 2013
177. Xu Yi, Análise de algoritmos de particionamento de restrições, MCC, FCUP, Nov 2013
178. Hugo Sousa, Handspy: Melhoramentos a um Sistema de Gestão de Experiências em Processos Cognitivos da Escrita, MIERSI, FCUP, Nov 2013
179. Sílvia Almeida, Aplicação Web para Cálculo de Métricas de Avaliação da Verdura de Reações Químicas em Laboratório, MSc in Physics and Chemistry for School Teachers, FCUP, Nov 2013
180. Hugo Rodrigues, (in)Segurança na Prescrição Eletrónica, MIM, UP, Oct 2013
181. Teresa Costa, Publishing Relational Data as Linked Data, MIERSI, FCUP, Sep 2013
182. Joana Côrte-Real, A MapReduce Construct for Yap Prolog, MSc in Electrical and Computers Engineering, FEUP, Jul 2013
183. Francisco Mota, A Monotone Modal Logic for Algorithmic Statistics, MCC, FCUP, Jul 2013

### 3.3.4 Patents/prototypes (2000 ca.)

Software prototypes and systems (year indicates year of 1st version):

YAP Prolog System, a high performance Prolog compiler. It is part of several Linux distributions and used worldwide, especially by the machine learning practitioners (latest version 6.2.1). Yap also includes YapTab, a tabling LP system, YapOr and ThOr, or-parallel Prolog systems, and OPTYap, an or-parallel tabling system.

Authenticus: an author identification tool for scientific publications, 2010.

Mooshak: a system for managing programming contests on the Web, v1.5.2.

E OID: OpendID 2.0 Server with extensions for secure attributes management and smart card interactions, 2008.

Logtalk: Open-Source Object-Oriented Logic Programming Language, 1998, v3.00.Orc9 in 2014.

Lineage Sequence Discovery (LSD) - discovery of patterns within biological sequences, 2010.

MammoClass: an online application to classify mammograms, 2011

PopAffiliator: an online calculator for predicting individual affiliation to a major population group, 2011

LogCHEM: a prototype for discriminative interactive mining of chemical fragments, 2011.

L-FLAT: Logtalk Toolkit for Formal Languages and Automata Theory, 2011.

VivoMind Prolog Unicode Resources, 2013.

gtrieScanner - A command line tool for efficient discovery of network motifs, 2012.

MACAW - A resource-aware programming language for embedded devices.

SONAR - Publish/Subscribe middleware for seamless access to data streams from wireless sensor networks.

STL/SONAR Task Language - programming language for wireless sensor networks

SVM - Operating system and virtual machine installed in wireless sensor networks allowing multitasking and dynamic reprogramming of the nodes.

Modular colorimetric sensor for measuring gas concentration in the environment.

Electrochemical sensor based on doped graphene to determine the concentrations of pharmacological pollutants in water treatment stations (under development).

A sensor to determine the quality of oils used in the food industry.

### **3.3.5 Organization of Conferences (2000 ca.)**

- 184. INForum 2014, Portugal: J.P. Leal [Co-Organizer]; L. Lopes, M.E. Correia, V.S. Costa, P. Ribeiro [PC Members]
- 185. Euro-Par 2014, Portugal: F. Silva, I. Dutra, V.S. Costa [PC Co-Chairs]; L. Lopes [PC Member and Workshops Co-Chair]; P. Ribeiro, R. Rocha [PC Members]
- 186. SLATE 2014, Portugal: J.P. Leal [PC Co-Chair]; R. Queirós, R. Rocha [PC Members]
- 187. INAP 2013, Germany: R. Rocha [PC Co-Chair]; V.S. Costa [PC Member]
- 188. ILP 2013, Brazil: V.S. Costa [PC Co-chair, Track Chair and Proc. Manager]
- 189. CICLOPS 2013, Turkey: R. Rocha [PC Co-Chair]
- 190. CBMS 2013, Portugal: A. Augusto, C. Pereira, I. Dutra, L. Antunes, M.E. Correia [Special Track PC Co-Chairs]; R. Correia [PC member]
- 191. SLATE 2013, Portugal: J.P. Leal, R. Rocha [PC Co-Chairs]
- 192. Breast Cancer Workshop, Portugal: I. Dutra [Workshop Chair]; P. Ferreira [Co-Organizer]

As PC Members:

- 1. ICCSM 2014, Oct, UK: M.E. Correia, M. Antunes
- 2. MPP 2014, Oct, France: I. Dutra, V.S. Costa
- 3. BRACIS/ENIAC 2014, Oct, Brazil: I. Dutra, V.S. Costa
- 4. WSCAD 2014, Oct, Brazil: F. Silva, I. Dutra, V.S. Costa
- 5. SUM 2014, Sep, UK: V.S. Costa
- 6. ECML PKDD 2014, Sep, France: I. Dutra, V.S. Costa
- 7. ILP 2014, Sep, France: I. Dutra, N. Fonseca, V.S. Costa
- 8. StaRAI 2014, Jul, Canada: V.S. Costa
- 9. KR 2014, Jul, Austria: V.S. Costa
- 10. ICLP 2014, Jul, Austria: V.S. Costa
- 11. PLP 2014, Jul, Austria: V.S. Costa
- 12. CBMS 2014, May, USA: V.S. Costa
- 13. WSCAD 2013, Oct, Brazil: F. Silva, I. Dutra, V.S. Costa
- 14. KDIR-SNAM 2013, Sep, Portugal: P. Ribeiro
- 15. ECML PKDD 2013, Sep, Czech Republic: I. Dutra, V.S. Costa
- 16. DS 2013, Oct, Singapore: V.S. Costa
- 17. PPDP 2013, Sep, Spain: V.S. Costa
- 18. EPIA 2013, Sep, Portugal: I. Dutra, V.S. Costa

19. INForum 2013, Sep, Portugal: L. Lopes, V.S. Costa
20. WLPE 2013, Aug, Turkey: V.S. Costa
21. ICLP 2013, Aug, Turkey: R. Rocha
22. FSKD 2013: Jul, China: F. Silva
23. StaRAI 2013, Jul, USA: V.S. Costa
24. AAI-13, Jul, USA: V.S. Costa
25. PADL 2013, Jan, Italy: V.S. Costa

### **3.3.6 Industry contract research (2000 ca.)**

Security, Access Control and Auditability of Information Systems

Cooperation with the Central Services of the University of Porto in: deployment of the University of Porto Public Key Infrastructure (PKI) supported by smart-cards, de-materialization of course grades reported by faculty (with electronic signatures), and advise the University on the acquisition of a large hardware secure module.

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

Members of CRACS maintain active international collaborations that resulted in 24 joint papers in 2013-2014. Here are some of those collaborations:

#### LANGUAGES AND DISTRIBUTED COMPUTING

Middleware for Distributed Systems: Priya Narasimhan, CMU (USA)

Logic Programming and Tabling: T. Swift, Johns Hopkins Univ. (USA); Taisuke Sato, Tokyo IT (Japan); Jan Wielemaker, Univ. Amsterdam (The Netherlands)

Probabilistic Prolog & ILP: Angelika Kimmig, Luc de Raedt, Bart Demoen, Hendrik Blockeel, Tom Schrijvers, Jesse Davis and Gerda Janssens, K. U. Leuven (Belgium)

Coinductive Logic Programming, G. Gupta, Univ. Texas @ Dallas (USA)

Programming Language Symbiosis, University Catholique of Louvain-La-Neuve (Belgium).

Parallel Programming: K. Pingali, Univ. Texas @ Austin (USA)

Distributed Programming of Large Ensembles: F. Pfenning, Seth Goldstein, M. Ashley-Rollman, Carnegie Mellon (USA)

#### SECURITY AND PRIVACY

Information security: Chris Mitchell and Jason Crampton, Univ. London (UK)

Computational complexity: L. Fortnow, Georgia Tech (USA)

#### KNOWLEDGE IN A WORLD OF DATA

e-Health: David Page, Jude Shavlik and Elizabeth Burnside, Univ. Wisconsin, Madison (USA)

Complex Networks: Luis-Francisco Revilla, UT@Austin, (USA), Marcus Kaiser, Univ. Newcastle (UK), S. Parthasarathy, Ohio State U. (USA)

### **3.3.8 Other national publications (6000 ca.)**

Books (2):

- 193.R Queirós, Desenvolvimento de Aplicações Profissionais em Android, FCA - Editora de Informática, Lda., Jun 2014
- 194.R Queirós, Android - Introdução ao Desenvolvimento de Aplicações, FCA - Editora de Informática, Lda., Apr 2013

In National Conferences (3):

- 195.J Costa, C Silva, MJ Antunes and B Ribeiro, Learning with Drift in Twitter, in 20th Portuguese Conference on Pattern Recognition (RecPad 2014), Covilhã, October 2014
- 196.PM Ferreira, TTV Vinhoza, A Castro, F Mourato, T Tavares, S Mattos, I Dutra and M Coimbra, Knowledge on Heart Condition of Children based on Demographic and Physiological Features, in 19th Portuguese Conference on Pattern Recognition (RecPad 2013), Lisbon, November 2013
- 197.A Afonso, MJ Antunes and FM Pinto, Validação remota de aplicações de informática forense com recurso a dongles por USB/IP, in 13ª Conferência sobre Redes de Computadores (CRC 2013), Leiria, pp.131–133, November 2013

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

Members of CRACS have served as consultants for the Portuguese Ministry of Health, Portuguese National Security Agency, and Portuguese Data Protection Commission on issues related with information security and data privacy.

CRACS members are collaborating with INCM on developing innovative solutions for secure identity cards and authentication.

### 3.1 Group Description - ROBIS

Research Group Title	ROBOTICS AND INTELLIGENT SYSTEMS
Principal Investigator	António Paulo Gomes Mendes Moreira
Research Area	Electrical and Computer Engineering
Home Institution	INESC Porto

## **3.2 Objectives & Achievements - ROBIS**

### **3.2.1 Objectives (4000 ca.)**

#### **FOREWORD**

The Coordinators of this Unit during 2013 and 2014 were Prof. António Paulo Moreira and Eduardo Silva.

#### **OBJECTIVES**

The main goal of the Unit ROBIS is the development of innovative robotic solutions and intelligent systems for different application areas where standard platforms are not optimal. Research activities address not only relevant problems in robotics but also application areas where technologies used in robotics play an important role, like control, automation, simulation, modeling, intelligent systems, etc.

The main activity areas include: Mobile Robotics, Marine Robotics, Industrial Manipulators, Control Algorithms, Automation Systems integration and Consulting Services.

The Unit's activity is grounded in research in the following scientific domains:

Mobile Robotics: Robotic platform architectures; Control of mobile platforms; Smart and Lean AGVs for logistics.

Marine Robotics: Design of surface and underwater autonomous vehicles; underwater positioning and navigation, multiple platform systems, supervision of autonomous platforms, robotic based environment monitoring.

Cooperative robotics: Warehouses and Logistics applications.

Industrial Manipulators: Rapid teaching and programming interfaces; Hyper-flexible cells; Co-Worker scenarios; Mobile manipulators;

Intelligent sensors: Smart sensors and image processing; Applications in robotics and automation; adaptive sampling strategies in environment monitoring.

Intelligent control and simulation: control algorithms for complex dynamics systems. Simulation applications for complex dynamic electro/mechanical systems

Intelligent systems and technologies in precision agriculture applications involves several competences of ROBIS, directed to the system development integrating sensors, actuators, signal communication, intelligent decision making, management and control.

The ROBIS UNIT is engaged in discovering and developing fundamental scientific principles and practices, such as perception, control and planning, which are applicable to intelligent robot systems and other complex dynamic systems. In addition, it is the goal of this group to facilitate technology transfer of its research results to yield solutions to real world problems for a wide range of application domains, namely, robots that navigate through complex indoor and outdoor spaces and advanced flexible manufacturing support systems.

### **3.2.2 Main Achievements (4000 ca)**

CARLoS - CooperAtive Robot for Large Spaces manufacturing (2013-2015) - 7th Framework Programme for Research, Funding Scheme : Research for SMEs: a mobile robot as co-worker for fit-out operations inside blocks of ship superstructures.

FOCUS - Advances in FOestry Control and AUtimation Systems in Europe; 7th Framework Programme for Research; Funding Scheme : SME-targeted collaborative projects: advancing forestry control and automation through the development of an integrated technological solution that combines predictive control with processing and planning processes.

STAMINA - Sustainable and Reliable Robotics for Part Handling in Manufacturing Automation; 7th Framework Programme for Research; Funding Scheme : ICT – Information and communication technologies: holistic approach by partnering with experts in each necessary key fields, thus building on previous R&D to develop a fleet of autonomous and mobile industrial robots with different sensory, planning and physical capabilities for jointly solving three logistic and handling tasks: De-palletizing, Bin-Picking and Kitting.

CLARISSA - Cooperative Dual-Arm Robot for Structural Steel fAbriCation; 7th Framework Programme for Research; Funding Scheme SMERobotics: path planning for dual arm robotic welding.

ICARUS - Integrated Components for Assisted Rescue and Unmanned Search operations; FP7: unmanned SAR technologies for detecting, locating and rescuing humans.

SUNNY - Smart UNmanned aerial vehicle sensor Network for detection of border crossing; FP7: new tool for collecting real-time information in operational scenarios, capable of improving the effectiveness of the EU border monitoring.

QREN - TURTLE – Autonomous Support System for SubSea Operations: robotic ascend and descent energy efficient technologies to be incorporated in robotic vehicles used for dual-use (civil and military).

SCAN – Aquaculture Calibration System- aims to develop a robotic system for biomass and calibration of Pleuronectiformes species in underwater aquaculture tanks. The system works completely autonomous and its partially submerge, being the first non-intrusive and without fish injuries. It can be adjust dynamically and is built using laser and computer vision techniques to obtain underwater perception capabilities.

FCT – RobArq - Robotic Technologies for Non-Standard Design and Construction in Architecture: robotic fabrication of complex geometries and variable customized assemblies employing Portuguese materials (e.g. cork, ceramics, wood);

FCT – OCHERA - Optimal Control: Health, Energy and Robotics Applications: analyze, simulate and solve numerically various problems modeling situations in areas as different as health, energy and robotics.

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts; Research Line 4 – Cooperation and perception for augmented autonomy: application of new concepts of autonomous systems (robots).

Produtech – Systems and applications for mobile and flexible robotics, organized in three activities.

Rapid teaching and programming of industrial manipulators. The robotic system is able to acquire this programming by rapid learning. This learning system is based on Sincrovision System. Allows a non-expert operator can teach the handler by demonstration.

Robotic automation is usually related to rigid processes. Based on new sensors, actuators and its integration, the development of low cost industrial applications that provide automatic detection and adjustment of objects are the main topics for this activity.

Technologies for mobile robotics, aims the develop modules that can be incorporated into existing robotic systems on the market (eg AGVs), in order to significantly increase their potential for use into new areas in the industry.

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

### **3.3 Productivity - ROBIS**

#### **3.3.1 Publications in peer review Journals (6000 ca.)**

#### **3.3.2 Other International publications (6000 ca.)**

#### **3.3.3 Ph. D. thesis completed (3000 ca.)**

198.Miguel Armando Migueis Pinto, SLAM for 3D map building to be used in a matching localization algorithm, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de

- Engenharia da Universidade do Porto. (Orientador em co-orientação com o Prof. Anibal Matos – Departamento de Engenharia Electrotécnica e de Computadores - FEUP), concluída em Janeiro de 2013
199. Marcelo Roberto Petry, A Vision-based Approach Towards Robust Localization for Intelligent Wheelchairs, Programa Doutoral em Engenharia Informática, FEUP. (Orientador em co-orientação com o Prof. Luís Paulo Reis – Departamento de Engenharia Informática - FEUP) ), concluída em Setembro de 2013
200. Marcos André Magalhães Ferreira, Programação de Alto Nível para Células Robotizadas Industriais / High Level Programming of Industrial Robotic Cells, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação com o Prof. J. Norberto Pires – Departamento de Engenharia Mecânica da F.C.T. da Universidade de Coimbra), concluída em Janeiro de 2014.
201. Bruno Miguel Mateus Ferreira, Controlo de equipas de robots sob restrições de comunicação / Control of teams of robots under restrictions of communication, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Co-orientador com orientação do Prof. Anibal Matos – Departamento de Engenharia Electrotécnica e de Computadores - FEUP) ), concluída em Fevereiro de 2014.
202. Filipe Baptista Neves Dos Santos, Sistema de Localização colaborativo e não invasivo com mapeamento semântico, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Co-orientador com orientação do Prof. Paulo Gomes da Costa – Departamento de Engenharia Electrotécnica e de Computadores - FEUP), concluída em Março de 2014.
203. Luís André Freitas da Rocha, Programação de Robôs Industriais em Células Robotizadas Flexíveis, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação do Prof. Vitor Manuel Ferreira dos Santos, Departamento de Engenharia Mecânica da Universidade de Aveiro, concluída em Abril de 2014
204. Andry Maykol Gomes Pinto, Visual Motion Analysis based on a Robotic Moving System, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação com o Prof. Paulo Gomes da Costa – Departamento de Engenharia Electrotécnica e de Computadores - FEUP), concluída em Julho de 2014.
205. Jorge Miguel Marques Ribeiro, Algorithms and technologies for an automatic quality control system in inspection places: transferring human knowledge into an automated inspection system, Course: Engineering Design and Advanced Manufacturing - Leaders for Technical Industries - MIT Portugal Program, in collaboration with Continental Mabor, Indústria de Pneus, S.A. (Orientador com co-orientação do Prof. Gil Lopes - Departamento de Electrónica Industrial da Universidade do Minho), concluída em Setembro de 2014.
206. Hugo Miguel Gomes da Silva, A probabilistic Approach for Stereo Visual Egomotion, Programa Doutoral em Engenharia Electrónica e de Computadores Instituto Superior Técnico Universidade de Lisboa, (Orientador Prof. Alexandre Bernardino do ISTE co-orientação de Prof. Eduardo Silva) concluída em Março de 2014 .

### **3.3.4 Patents/prototypes (2000 ca.)**

#### **Prototypes**

- 1-TIGRE – An Autonomous Ground Robot for Outdoor Exploration
- 2-Hex- cooperate field robot
- 3-PRODUTECH - “Sincrovision” marker for programming by demonstration
- 4-REDi - Robô Didactic Educational robot
- 5-RobArq - Cable Robot para operações de pick and place

6-GroundTruth System for Underwater Benchmarking

7-Turtle- Deep sea Observer

8-Swift -Small Waterjet intelligent Flexible Transport System

9- Robotic capsule for rescue - prototype developed under the projectFP7 ICARUS.

7-PRODUTECH – Robotic adaptive system for automatic shoes picking

8-PRODUTECH – AGV prototype for localization algorithms tests

### **3.3.5 Organization of Conferences (2000 ca.)**

FAIM 2013 – 23th International Conference on Flexible Automation & Intelligent Manufacturing, 26-28 June 2013, Porto, Portugal.

IROBOT'2013 - 6th International Thematic Track on Intelligent Robotics, enquadrado no EPIA 2013, 9 a 13 de Setembro de 2013, Angra do Heroísmo, Portugal.

ROBÓTICA 2014 – 14º Festival Nacional de Robótica, que decorreu em Espinho, Portugal, de 19 a 21 de Maio de 2014.

IEEE International Conference on Autonomous Robot Systems and Competitions – ICARSC 2014, 14 e 15 de Maio de 2014, Espinho, Portugal.

CONTROLO' 2014 - 11th Portuguese Conference on Automatic Control, 21 a 23 de Julho de 2014, Porto, Portugal

UMS 2014 - 3rd Workshop on European Unmanned Maritime Systems, 29-30 May, Porto, Portugal, 2014

### **3.3.6 Industry contract research (2000 ca.)**

The Unit ROBIS has a very strong link with industry, regularly collaborating with technology suppliers for industry, on the design and development of new products they put on the market. For industrial companies the group supplies consulting services on innovation and industrial management. For industrial companies, the group also offers RTD services to meet specific requirements that cannot be answered by available commercial solutions. This section refers only to national contracts.

Contract research with industry referred to in the sections Internationalization and Government/Organization contracts, where projects with industry funded by QREN are listed.

Direct contract with industry

SCAN – Aquaculture Calibration System- aims to develop a robotic system for biomass and calibration of Pleuronectiformes species in underwater aquaculture tanks. The system works completely autonomous and its partially submerge, being the first non-intrusive and without fish injuries. It can be adjust dynamically and is built using laser and computer vision techniques to obtain underwater perception capabilities.

Consultancy

“Low cost ASV viability study”, 2014 for Marine Instruments, Vigo, Spain

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

Joint Research

I3S, University of Nice, France: Information theory, adaptive sampling

University of Dundee, U.K.: Fluid mechanics

Georgia Institute of Technology, U.S.A.: Hydrodynamic dispersion models

Universidade Federal de Juiz de Fora: Mobile Robotics, Control

PhD student in Carnegie Mellon University, U.S.A.: cooperative robotics (CMU-Portugal program)

Research project (FCT) with Royal Institute of Technology, Stockholm

Co-supervision of PhD and student at Federal University of Juiz de Fora, Brasil: Mobile robotics

### **European Projects**

CARLoS - CooperAtive Robot for Large Spaces manufacturing (2013-2015) - 7th Framework Programme for Research, Funding Scheme: Research for SMEs.

Partners: Asociación de Investigación Metalúrgica del Noroeste (AIMEN), Spain; AALBORG UNIVERSITET (AAU), Denmark; ROBOTNIK AUTOMATION SLL (ROBOTNIK), Spain; C.A.T. Progetti srl (CAT), Italy; ATEIN NAVAL, S.A. (ATENASA), Spain.

FOCUS - Advances in FOestry Control and AUtomation Systems in Europe; 7th Framework Programme for Research;

Partners: Simosol Oy, SME, Finland; Bern University of Applied Sciences, RTD, Switzerland; Research Studios Austria FG – Studio iSPACE, RTD, Austria; Holzcluster Steiermark GmbH, RTD, Austria; University of Leuven, RTD, Belgium; VTT Technical Research Centre of Finland, RTD, Finland; HSM, SME, Germany; MHG Systems, SME, Finland; Kanton Luzern, SME, Switzerland.

STAMINA - Sustainable and Reliable Robotics for Part Handling in Manufacturing Automation; 7th Framework Programme for Research; Funding Scheme : ICT – Information and communication technologies. Partners: AALBORG UNIVERSITET (AAU), Denmark; PSA - Peugeot Citroën Automobiles S.A. , France; BA Systèmes SAS, France; ALU-FR - Albert-Ludwigs-Universität Freiburg, Germany; UBO - Rheinische Friedrich-Wilhelms-Universität Bonn, Germany; UEDIN - The University of Edinburgh, United Kingdom.

ICARUS - Integrated Components for Assisted Rescue and Unmanned Search operations; FP7: unmanned SAR technologies for detecting, locating and rescuing humans.

Partners: ECOLE ROYALE MILITAIRE - KONINKLIJKE MILITAIRE SCHOOL (Belgium); SPACE APPLICATIONS SERVICES NV (Belgium); ESTUDIOS GIS S.L. (Spain); Aerospace Technology Centre (ASCAMM Foundation) (Spain); The Fraunhofer Institute for Reliability and Microintegration IZM (Germany); INSTYTUT MASZYN MATEMATYCZNYCH (Poland); JMDTHEQUE SARL (France); TECHNISCHE UNIVERSITAET WIEN (Austria); INTEGRASYS, S.A. (Spain); Skybotix AG (Switzerland); QUOBIS NETWORKS SL (Spain); INESC PORTO - INSTITUTO DE ENGENHARIA DE SISTEMAS E COMPUTADORES DO PORTO (Portugal); UNIVERSITE DE NEUCHATEL (Switzerland); Eidgenössische Technische Hochschule Zürich (Switzerland); ATOS SPAIN SA (Spain); TECHNISCHE UNIVERSITAET KAISERSLAUTERN (Germany); NATO Centre for Maritime Research and Experimentation (Italy); CALZONI SRL (Italy); METALLIANCE SA (France); ESRI PORTUGAL - SISTEMAS E INFORMACAO GEOGRAFICA SA (Portugal); SPACETEC PARTNERS SPRL (Belgium); ESCOLA NAVAL (Portugal); BELGIAN FIRST AID AND SUPPORT TEAM (Belgium); ECOLE POLITECHNIQUE FEDERALE DE LAUSANNE (Switzerland);

SUNNY - Smart UNmanned aerial vehicle sensor Network for detection of border crossing; FP7: new tool for collecting real-time information in operational scenarios, capable of improving the effectiveness of the EU border monitoring.

Partners: BMT GROUP LIMITED, United Kingdom, METASENSING BV (Netherlands) Xenics nv (Belgium), QUEEN MARY UNIVERSITY OF LONDON (United Kingdom), FUNDACION TECNALIA RESEARCH & INNOVATION (Spain), INESC PORTO • INSTITUTO DE ENGENHARIA DE SISTEMAS E COMPUTADORES DO PORTO (Portugal), TECHNICAL UNIVERSITY OF CRETE (Greece), Ministério da Defesa Nacional (Portugal), "SPECIM, SPECTRAL IMAGING OY" (Finland), ALENIA AERMACCHI SPA (Italy), "TTI NORTE, S.L." (Spain), CENTER FOR SECURITY STUDIES (Greece), MARLO AS (Norway), Vitrociset spa (Italy), "NATIONAL CENTER FOR SCIENTIFIC RESEARCH

""DEMOKRITOS"" (Greece), CONSORZIO NAZIONALE INTERUNIVERSITARIO PER LE TELECOMUNICAZIONI (Italy), SAAB AKTIEBOLAG (Sweden), ALTUS LSA COMMERCIAL AND MANUFACTURING SA (Greece)

#### **International papers in cooperation with foreign institutions:**

“A set of novel modifications to improve algorithms from the A\* family applied in mobile robotics”, Tiago Pereira do Nascimento, Pedro Costa, Paulo G. Costa, António Paulo Moreira & André Gustavo Scolari Conceição, Journal of the Brazilian Computer Society, ISSN 0104-6500, June 2013, Volume 19, Issue 2, pp 167-179, DOI 10.1007/s13173-012-0091-5 (SCOPUS)

“Increasing Illumination Invariance of SURF Feature Detector Through Color Constancy”, M. Petry, A. P. Moreira and L. P. Reis, in Progress in Artificial Intelligence - EPIA 2013 / Lecture Notes in Computer Science, L. Correia, L. P. Reis and J. Cascalho, Eds., Vol. 8154, pp. 259–270, 2013. DOI: 10.1007/978-3-642-40669-0\_23 (SCOPUS)

“Multi-robot nonlinear model predictive formation control: Moving target and target absence”, Tiago P. Nascimento, António Paulo Moreira, André G. Scolari Conceição, RAS – Robotics and Autonomous Systems, Elsevier, vol. 61, Issue 12, December 2013, pp. 1502–1515, DOI: 10.1016/j.robot.2013.07.005 (ISI Web of Science Accession Number: WOS:000328178200020) (SCOPUS)

“Iterative Weighted Tuning for a Nonlinear Model Predictive Formation Control”, Tiago P. Nascimento, André G. S. Conceição, António Paulo Moreira, 2014 IEEE International Conference on Autonomous Robot Systems and Competitions (ICARSC), pp. 2-7, May 14-15, Espinho, Portugal, ISBN: 978-1-4799-4254-1 (XPLORE COMPLIANT), 978-1-4799-4255-8 (USB), IEEE Catalog Numbers: CFP1482X-ART, CFP1482X-USB, ISI WOS:000343584000002

“Comprehensive Review of the Dispatching, Scheduling and Routing of AGVs”, Kelen C.T. Vivaldini, Luís F. Rocha, Marcelo Becker, and António Paulo Moreira, CONTROLO’2014 -Proceedings of the 11th Portuguese Conference on Automatic Control, pp. 505-514, July 21-23, 2014, Porto, Portugal, DOI 10.1007/978-3-319-10380-8, ISBN 978-3-319-10379-2

“Coordination for Multi-robot Exploration Using Topological Maps”, Tiago Pereira, António Paulo Moreira, Manuela Veloso, CONTROLO’2014 -Proceedings of the 11th Portuguese Conference on Automatic Control, pp. 515-524, July 21-23, 2014, Porto, Portugal, DOI 10.1007/978-3-319-10380-8, ISBN 978-3-319-10379-2

“Multi-Robot Systems Formation Control with Obstacle Avoidance”, Tiago P. Nascimento, André G. S. Conceicao, António Paulo Moreira, 19th IFAC World Congress, The International Federation of Automatic Control, pp. 5703-5708, Cape Town, South Africa, August 24-29, 2014

#### **3.3.8 Other national publications (6000 ca.)**

#### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

National programs – FCT: 2; QREN: 3; CONTRACTS: 1;

International programs - FP7:6

AUTOCLASS PROJECT - Automatic Classification and Quality Control for Car Tyres; Research Affiliate: CONTINENTAL – MABOR

PRODUTECH PTI – PPS4 - SISTEMAS E APLICAÇÕES PERIFÉRICAS PARA A ROBOTIZAÇÃO FLEXÍVEL E MÓVEL, QREN – Sistema de Incentivos à Investivação e desenvolvimento Tecnológico - Projectos Mobilizadores

TURTLE – Autonomous Support System for SubSea Operations.

INTEGRAÇÃO DE VEÍCULO AUTÓNOMO EM SISTEMA LOGÍSTICO FLEXÍVEL, (DELTAMATIC – Engenharia e Automação Industrial, S.A.), Contrato de Concessão de Incentivos Financeiros no âmbito dos Sistemas de Incentivos à Qualificação e Internacionalização de PME – Vale Inovação.

CARLoS - CooperAtive Robot for Large Spaces manufacturing (2013-2015) - 7th Framework Programme for Research, Funding Scheme : Research for SMEs.

FOCUS - Advances in FOestry Control and AUtomation Systems in Europe; 7th Framework Programme for Research; Funding Scheme,

STAMINA - Sustainable and Reliable Robotics for Part Handling in Manufacturing Automation; 7th Framework Programme for Research; Funding Scheme : ICT – Information and communication technologies.

CLARISSA - Cooperative Dual-Arm Robot for Structural Steel fAbriCation; 7th Framework Programme for Research; Funding Scheme SMERobotics;

ICARUS - Integrated Components for Assisted Rescue and Unmanned Search operations; FP7;

SUNNY - Smart UNmanned aerial vehicle sensor Network for detection of border crossing; FP7;

SCAN – Aquaculture Calibration System- aims to develop an autonomous robot system for calibration and measuring biomass in fish production ponds of high added value.

FCT – RobArq - Robotic Technologies for Non-Standard Design and Construction in Architecture: robotic fabrication of complex geometries and variable customized assemblies employing Portuguese materials (e.g. cork, ceramics, wood);

FCT – OCHERA - Optimal Control: Health, Energy and Robotics Applications: analyze, simulate and solve numerically various problems modeling situations in areas as different as health, energy and robotics.

### 3.1 Group Description – HASLAB

Research Group Title	HIGH ASSURANCE SOFTWARE LABORATORY
Principal Investigator	Jorge Miguel de Matos Sousa Pinto
Research Area	Electrical and Computer Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements – HASLAB

#### 3.2.1 Objectives (4000 ca.)

##### FOREWORD

The investigation of HASLab - High-Assurance Software Laboratory is focused on the design and development of software for critical systems, where a failure, either by surrounding factors, human error, or even attacks by hostile entities, can have catastrophic consequences.

Fit into this concept the essential services to actual society, in particular, the basic infrastructure, transport, health, communications, public administration and, in general, the service networks. These systems are controlled by computer programs whose correct operation, continued and safe is to ensure.

The coordinator of this unit during 2014 was Professor Rui Carlos Mendes de Oliveira.

##### OBJECTIVES

To achieve software reliability, the HASLab realizes research on three pillars of Information Technology: Software Engineering, the Distributed Systems and Cryptography and Information Security.

##### Software Engineering

With the ultimate goal of raising software engineering to the standards of other traditional engineering disciplines, the HASLab conducts research in methods, techniques and tools crucial for trustworthy software development. Our research covers all phases of the software development process, ranging from the requirements analysis and formal architecture and interface design, to the validation of the implemented solutions via advanced testing and code verification techniques.

##### Distributed Systems

In order to fight the poor performance, the occurrence of failures and the variability of the software system to be built, HASLab focus its research on reliable and scalable solutions for data management in cloud computing, scientific data environments and, also the dissemination of data and aggregation in distributed systems. The activity of HASLab aims to improve the reliability and criticality of these software components exploring properties inherent to the distribution and replication of computer systems.

##### Cryptography and Information Security

The control of access to information, of its integrity and authenticity are crucial aspects in the development of software applications for critical systems. The HASLab works to minimize the vulnerability to hostile attacks of

each software component in modern computer systems, by providing theoretical specifications and practical implementations of cryptographic schemes and protocols whose security properties are formally proven.

### **3.2.2 Main Achievements (4000 ca)**

The HASLab steadily produces fundamental and applied research that satisfies the quality standards of the top rated journal and conferences (rated A\*, the best of the best in the popular computer science CORE venue ranking) in each of its areas of research. In 2014 we have published 30 journal articles and 75 full papers in international conferences rated at least B in the CORE ranking.

Major outcomes of our research in 2014 were:

- A detailed analysis and classification of Storage Deduplication Systems that has been published in the ACM Computer Surveys journal, followed by the design and implementation of a novel and highly efficient dependable and fully-decentralized deduplication system for cloud computing infrastructures.
- A new version of our open source framework to help validate, query, and refactor spreadsheets using model-driven software engineering principles. In 2014 this work was published in the IEEE Transactions on Software Engineering, the top journal in this research area, and several other highly ranked journals and conferences.
- An open source implementation of a domain-specific compiler for cryptography has been released and presented at Principles of Security and Trust 2014. The foundations of a verification tool for the same language have been published in Science of Computer Programming. In parallel, an optimisation of a classical construction of block-ciphers that provides stronger security under tampering has been proposed in Fast Software Encryption 2014.

#### Projects

- 2 ongoing EC-funded projects
- 1 EC-funded project kicked-off in 2014
- 1 IA- funded project kicked-off in 2014
- 5 ongoing FCT-funded projects
- 3 FCT-funded projects completed in 2014
- 1 IA- funded projects competed in 2014
- 4 ongoing CCDR-N (QREN) funded projects
- 1 ongoing IA funded project

#### Publications

- 30 papers in international peer-reviewed journals
- 75 papers in international conferences with peer reviewing
- 1 paper in national conference with peer reviewing
- 3 book chapters
- 2 PhD thesis
- 18 MsC thesis
- 4 others publications

## Awards

HASLab postdoc researcher Alexandre Madeira was honored with the 2013 IBM Scientific Award.

Three best paper awards (SBCARS'2014, DX'2014 (2)).

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

## 3.3 Productivity - HASLAB

### 3.3.1 Publications in peer review Journals (6000 ca.)

Total number of publications: 30

The complete list can be consulted in: <http://haslab.uminho.pt>

1. ABREU, Rui; HOFER, B.; PEREZ, A.; WOTAWA, F, On the empirical evaluation of similarity coefficients for spreadsheets fault localization. *Automated Software Engineering*:1–28 (2014)
2. ABREU, Rui; HOFER, B.; PEREZ, A.; WOTAWA, F, Using constraints to diagnose faulty spreadsheets. *Software Quality Journal* (2014)
3. ABREU, Rui; PEREZ, Alexandre; RIBOIRA, André, A Dynamic Code Coverage Approach to Maximize Fault Localization efficiency. *Journal of Systems and Software* 90: 18-28 (2014)
4. AZEVEDO, Paulo Jorge; MAGALHÃES, André, Contrast Set Mining in Temporal Databases. *Expert Systems* (2014)
5. BAQUERO, Carlos; D, H; D, J; D, L, Link Community Detection Using Generative Model and Nonnegative Matrix Factorization. *PLoS ONE* 9 (1) (2014)
6. BARBOSA, Luís Soares; MARTINS, Manuel A.; CARRETEIRO, Marta, A Hilbert- Style Axiomatisation for Equational Hybrid Logic. *Journal of Logic, Language and Information* 23(1): 31-52 (2014)
7. BARBOSA, Luis Soares; SHAIK, Siraj Ahmed, Selected Contributions from the Open Source Software Certification (OpenCert) Workshops. *Science of Computer Programming* 91: 139- 140 (2014)
8. BARBOSA, Luis Soares; LUMPE, Markus, Formal Aspects of Component Software. *Science of Computer Programming* 94: 253-254 (2014)
9. BARBOSA, Luis Soares; JUNIOR, Francisco Heron de Carvalho, Selected and Extended papers of the Brazilian Symposium on Programming Languages 2012. *Science of Computer Programming* 96: 175-176 (2014)
10. BARBOSA, Luis Soares; Sanchez, A.; OLIVEIRA, N.; HENRIQUES, P., A perspective on architectural re-engineering. *Science of Computer Programming* (2014)
11. CAMPOS, José Creissac; GOMES, Tiago; ABADE, Tiago; HARRISON, Michael D.; SILVA, José Luís, A Virtual Environment Based Serious Game to Support Health Education. *ICST Tran. Ambient Systems* 3 (2014)
12. CAMPOS, José Creissac; DOHERTY, GAVIN J.; HARRISON, Michael D., Analysing Interactive Devices Based on Information Resource Constraints. *Int. J. Hum. – Comput. Stud.* 72 (3): 284- 297 (2014)
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15. CUNHA, Jácome; MENDES, Jorge; SARAIVA, João; VISSER, Joost, Model-based Programming Environments for Spreadsheets. *Science of Computer Programming* 96: 254- 275 (2014)

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19. MADEIRA, Alexandre; NEVES, Renato; MARTINS, Manuel, An institution for alloy and its translation to second-order logic. Advances in Intelligent Systems and Computing (263): 45-75 (2014)
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21. MADEIRA, Alexandre; MARTINS, Manuel; NEVES, Renato; BARBOSA, Luis Soares, A Dynamic Logic for Every Season. Lecture Notes in Computer Science 10 (2014)
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24. PAULO, João; PEREIRA, José Orlando, A Survey and Classification of Storage Deduplication Systems. ACM Computing Surveys 47(1): 11 (2014)
25. PINTO, Jorge Sousa; ALMEIDA, José Bacelar; BARBOSA, Manuel; VIEIRA, Bárbara; FILIÂTRE, Jean- Christophe, CAOverif: Na Open- Source Deductive Verification Platform for Cryptographic Software Implementations. Science of Computer Science 91: 216-233 (2014)
26. RODRIGUES, Nuno F.; NEVES, SC.; PINHO, A.; FONSECA, JC.; HENRIQUES- COELHO, T.; CORREIA- PINTO, J.; VILAÇA, JL, Finite element analysis of pectus carinatum surgical correction via a minimally invasive approach. Computer Methods in Biomechanics and Biomedical Engineering (2014)
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### **3.3.2 Other International publications (6000 ca.)**

Total number of publications: 75

The complete list can be consulted in: <http://haslab.uminho.pt>

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4. ABREU, Rui; CARDOSO, Nuno, Enhancing Reasoning Approaches to Diagnose Functional and Non- Functional Errors. 25th International Workshop on Principles of Diagnosis (DX) (2014)
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6. ABREU, Rui; CASANOVA, Paulo; GARLAN, David; SCHMERL, Bradley R., Diagnosing Unobserved Components in Self- Adaptive Systems. SEAMS: 75-84 (2014)
7. ABREU, Rui; PEREZ, Alexandre, A Diagnosis- Based Approach to Software Comprehension. ICPC: 37-47 (2014)
8. ABREU, Rui; MEDEIROS, José Carlos; ARCURI, Andrea; FRASER, Gordon, Continuous test Generation: Enhancing Continuous Integration With Automated Test Generation. ASE: 55-66 (2014)
9. ABREU, Rui; CUNHA, Jácome; FERNANDES, João Paulo; MARTINS, Pedro; PEREZ, A.; SARAIVA, João, Semelling Faults in Spreadsheets. Proceedings of the 30th IEEE International Conference of Software Manutence and Evolution (2014)
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12. AZEVEDO, Paulo Jorge; GOMES, Elsa Ferreira; JORGE, Alípio Mário, Classifying Heart Sounds Using SAX Motifs, Random Forests and Text Mining Techniques. IDEAS: 334-337 (2014)
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14. BAQUERO, Carlos; SHOKER, Ali; ALMEIDA, Paulo Sérgio, Efficient State- Based CRDTs by Decomposition. EuroSys: 3 (2014)
15. BAQUERO, Carlos; ALMEIDA, Paulo Sérgio; GONÇALVES, Ricardo; PREGUIÇA, Nuno; FONTE, Victor, Scalable ans Accurate Causality Tracking for Eventually Consistent Stores. DAIS: 67-81 (2014)
16. BAQUERO, C.; GONÇALVES, N.; JOSÉ, R.; Collaborative and privacy-aware sensing for observing urban movement patterns. Lecture Notes in Computer Science: 51-65 (2014)
17. BARBOSA, Luis Soares; OLIVEIRA, Nuno; RODRIGUES, Flávia, ReCooPLa: a DSL for Coordination- Based Reconfiguration of Software Architectures. SLATE: 61-76 (2014)
18. BARBOSA, Luis Soares; FERNANDES, S.; CERONE, A.; PAPADOPOULOS, PM., FLOSS in technology-enhanced learning. Lecture Notes in Computer Science: 121- 132 (2014)
19. BARBOSA, Luis Soares; FERNANDES, S.; CERONE, A., A preliminary analysis of learning awareness in FLOSS projects. Lecture Notes in Computer Science: 133-139 (2014)
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22. BARBOSA, Manuel; CASTRO, David; SILVA, Paulo F., Compiling CAO: From Cryptographic Specifications to C Implementations. POST: 240- 244 (2014)
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27. CAMPOS, José Creissac; ARCURI, A.; FRASER, G.; ABREU, Rui, Continuous Test Generation: Enhancing Continuous Integration With Automated Test Generation. Proceedings Automated Software Engineering (ASE) (2014)
28. CAMPOS, José Creissac; SAMPAIO, Ana Isabel, Towards a Framework for Adaptive Web Applications. HCI (26): 240-245 (2014)
29. CAMPOS, José Creissac; GOMES, Tiago; ABADE, Tiago; SILVA, José Luís, Design and Evaluation of Smart Library Using the APEX Framework. HCI (21): 307-318 (2014)
30. CAMPOS, José Creissac; ABADE, Tiago; GOMES, Tiago; HARRISON, Michael D.; SILVA, José Luís, Rapid Development of First Person Serious Games Using the APEX Platform: The Asthma Game. SAC: 169-174 (2014)
31. CAMPOS, José Creissac, High assurance interactive computing systems. HCI Engineering: Charting the Way towards Methods and Tools for Advanced Interactive Systems: 39-42 (2014)
32. CARÇÃO, Tiago, Measuring and visualizing energy consumption within software code. Proceedings of IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC): 181-182 (2014)
33. CASAL, J.; CLEDOU, G, Understanding students' mobility habits towards the implementation of an adaptive ubiquitous platform. ACM International Conference Proceeding Series: 67-72 (2014)
34. CUNHA, Alcino; SOUSA, NR; PACHECO, Hugo; MACEDO, Nuno, Bidirectional spreadsheet formulas. VL/ HCC – IEEE Symposium on Visual Language and Human- Centric Computing, Melbourne, Australia (2014)
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37. CUNHA, Alcino; ANJORIN, Anthony; GIESE, Holger; HERMANN, Frank; RENSINK, Arend; SCHURR, Andy, BenchmarX. EDBT/ICDT Workshops, Athens, Greece: 82-8 (2014)
38. CUNHA, Alcino; MACEDO, Nuno; GUIMARÃES, Tiago, Target Oriented Relational Model Finding. FASE, Grenoble, France: 17-31 (2014)
30. CUNHA, Jácome; FERNANDES, João Paulo; PEREIRA, Rui; SARAIVA, João, Graphical Querying of Model- driven Spreadsheets. HCI 12: 419-430 (2014)
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43. CUNHA, Jácome; FERNANDES, João Paulo; MENDES, Jorge; PEREIRA, Rui; SARAIVA, João, ES- SQL: Visually Querying Spreadsheets. Proceedings of the Symposium on Visual Languages and Human- Centric Computing (VL/ HCC) (2014)

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45. CUNHA, Jácome; FERNANDES, João Paulo; MENDES, Jorge; PEREIRA, Rui; SARAIVA, João, MDSheet Model-Driven Spreadsheet. 1st Workshop on Software Engineering Methods in Spreadsheets (SEMS) (2014)
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47. CUNHA, Jácome; ABREU, Rui; FERNANDES, João Paulo Fernandes; MARTINS, Pedro; PEREZ, Alexandre; SARAIVA, João, FaultySheet Detective: When Smells Meet Fault Localization. Proceedings of the 30th IEEE International Conference on Software Maintenance and Evolution: 625-628 (2014)
48. CRUZ, Francisco; MAIA, Francisco; OLIVEIRA, Rui; VILAÇA, Ricardo, Workload-aware Table Splitting for NoSQL. SAC: 399-404 (2014)
49. FERREIRA, João F.; MARTENS, C.; BOSSER, A-G.; CAVAZZA, M., Generative Story Worlds as Linear Logic Programs. Intelligent Narrative Technologies 7 (INT7) (2014)
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53. MADEIRA, Alexandre; BARBOSA, Luis Soares; NEVES, Renato; MARTINS, Manuel, Introducing Hierarchical Hybrid Logic. Proceedings of AiML – 10th International Conference on Advances in Modal Logic (2014)
54. MADEIRA, Alexandre; NEVES, Renato; BARBOSA, Luis Soares; MARTINS, Manuel, Logics for Robotics?. Aip Conference Proceedings (2014)
55. MAIA, Francisco; PASQUET, Mathieu; RIVIÈRE, Etienne, SCHIAVONI, Valerio, Autonomous Multi-dimensional Slicing for Large-Scale Distributed Systems. DAIS: 141-155 (2014)
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57. MATOS, Miguel; ABAD, Alberto; ASTUDILLO, Ramón Fernandez; TRANCOSO, Isabel, Recognition of Distant Voice Commands for Home Applications in Portuguese. IberSPEECH: 178-188 (2014)
58. MATOS, Miguel; SCHIANOVI, Valerio; OLIVEIRA, Rui; RIVIÈRE, Etienne; FELBER, Pascal, LAYSTREAM: Composing Standard Gossip Protocols for Live Video Streaming. P2P: 1-10 (2014)
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60. MARTINS, Pedro; CARÇÃO, Tiago, A Visual DSL for the Certification of Open Source Software. 14th of ICCSA (2014)
61. OLIVEIRA, Rui; COELHO, Fábio; MATOS, Miguel; VILAÇA, Ricardo; FELBER, P.; PASIN, M.; RIVIÈRE, E.; SCHIANOVI, V.; SUTRA, P., On the Support of Versioning in Distributed Key-Value Stores. 33rd IEEE International Symposium on Reliable Distributed Systems (SRDS) (2014)
62. OLIVEIRA, Rui; COELHO, Fábio; CRUZ, Francisco; VILAÇA, Ricardo; PEREIRA, José Orlando, Ph1: A Transactional Middleware for NoSQL. 33rd IEEE International Symposium on Reliable Distributed Systems (SRDS) (2014)
63. OLIVEIRA, José Nuno, Preparing Relational Algebra for “Just Good Enough” Software. RAMICS 119-138 (2014)

64. PAULO, João; PEREIRA, José, Distributed Exact Deduplication for Primary Storage Infrastructures. DAIS: 52-66 (2014)
65. PINTO, Jorge Sousa; PINHO, LM.; PEREIRA, D.; PEDRO, AM., Towards a Runtime Verification Framework for the Ada Programming Language. 19th International Conference on Reliable Software Technologies (2014)
66. PINTO, Jorge Sousa; PEDRO, André de Matos; PEREIRA, David; PINHO, Luís Miguel, A Compositional Monitoring Framework for Hard Real- Time Systems. NASA Formal Methods: 16-30 (2014)
67. PINTO, Jorge Sousa; CARVALHO, Nuno; SOUSA, Cristiano da Silva; TOMB, Aaron, Formal Verification of kLIBC with the WP Frama- C Pug-in. NASA Formal Methods: 343-358 (2014)
68. RIBEIRO, António Nestor; CAMPOS, José Creissac; COUTO, Rui, Application of Ontologies in Identifying Requirements Pattern in Use Cases. 11th International Workshop on Formal Engineering Approaches to Software Components and Architecture (FESCA) (147): 62-76, Grenoble, France (2014)
69. RIBEIRO, António Nestor; CAMPOS, José Creissac; COUTO, Rui, The Modelery: A Collaborative Web Based Repository. 14th International Conference on Computational Science and its Applications (ICCSA) (2014)
70. RIBEIRO, António Nestor; CAMPOS, José Creissac Campos; COUTO, Rui, A Study on the Viability of Formalizing Use Cases. 9th International Conference on the Quality of Information and Communication Technology (QUATIC) (2014)
71. SARAIVA, João; MARTINS, Pedro; FERNANDES, João Paulo, A Web Portal for the Certification of Open Source Software. Proceedings of the 6th International Workshop on Foundations and Techniques for Open Source Software Certification (OPENCERT) (2014)
72. SARAIVA, João; MARTINS, Pedro; FERNANDES, João Paulo; WYK, Eric Van, Generating Attribute Grammar-Based Bidirectional Transformations From Rewrite Rules. PEPM: 63-70 (2014)
73. SILVA, Alexandra; BONCHI, Filippo; MILIUS, Stefan; ZANASI, Fabio, How to Kill Epsilons with a Dagger – A Coalgebraic Take on Systems with Algebraic Label Structure. CMCS: 53-74 (2014)
74. SILVA, Alexandra; GONCHAROV, Sergey; MILIUS, Stefan, Towards a Coalgebraic Chomsky Hierarchy. IFIP TCS: 265-280 (2014)
75. SILVA, Alexandra; OLIVEIRA, Nuno; BARBOSA, Luis Soares, Quantitative Analysis of Reo-Based Service Coordination. SAC: 1247- 1254 (2014)

### **3.3.3 Ph. D. thesis completed (3000 ca.)**

1. MACEDO, Nuno Filipe Moreira, A Relational Approach to Bidirectional Transformations (2014)
2. MARTINS, Pedro Miguel Ribeiro, Embedding Attribute Grammars and their Extensions using Functional Zippers (2014)

### **3.3.4 Patents/prototypes (2000 ca.)**

(void)

### **3.3.5 Organization of Conferences (2000 ca.)**

ICEGOV - 8th International Conferences on Theory and Practice of Electronic Governance

HCI Engineering 2014 - Charting the Way towards Methods and Tools for Advanced Interactive Systems

SAC 2014 - Computer Security Track

INForum 2014

COST Summer School on Cryptographic Attacks

Workshop on Middleware for Next Generation Internet Computing (MW4NG)

W-PSDS 2014

8th International Conference on Theory and Practice of Electronic Governance, Guimarães, Portugal, 27-30 October 2014.

First Workshop on Molecular Logic (with UAveiro, UChile and INRIA)

### **3.3.6 Industry contract research (2000 ca.)**

Portugal Telecom Inovação – Operation Support Systems as a Service

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

The UNU-EGOV unit is expected to become a full-fledged research institute within two years, fostering collaboration between a number of international research institutions, and high profile international forums and committees. A number of HASLab members have been playing and are expected to keep playing a vital role in the planning and operation of this Operational Unit, contributing in this way to further internationalisation of HASLab theoretical and applied research.

European projects:

CoherentPaaS – A Coherent and Rich PaaS with a Common Programming Model (FP7 611068)

PRACTICE: Privacy-enhanced and Secure Computations on Potentially Malicious Clouds (FP7 609611)

LeanBigData - Ultra-Scalable and Ultra-Efficient Integrated and Visual Big Data Analytics (FP7 619606)

Other projects:

European Networks:

European Network of Excellence in Cryptology II ICT-2007-216676 (associated membership)

International contracts:

Verificação e Validação de Sistemas Software para Projetos Espaciais [consulting for Instituto de Aeronáutica e Espaço / AEB, 2011-2014]

Working Group memberships:

IFIP Working Group 1.3 on Foundations of System Specification

IFIP working group 2.7 / 13.4 on User Interface Engineering

IFIP Working Group 2.1 on Algorithmic Languages and Calculi

IFIP Working Group 6.1 on Architectures and Protocols for Distributed Systems

Publications in cooperation:

16 journal papers and 26 other papers were published in 2014 in cooperation with authors from foreign institutions.

### **3.3.8 Other national publications (6000 ca.)**

1. CAMPOS, Filipe; MATOS, Miguel, PEREIRA, José Orlando, Coordenação de Serviços Web Heterógenos Com Tolerância a Faltas. INFORUM (2014)

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

Research projects funded by FCT:

APEX - Prototipagem Rápida de Experiência de utilização [2011 – 2014]

STRATUS: Uma abordagem em camadas para a gestão de dados em Cloud Computing [2011 – 2014]

FATBIT: Fundamentos, Aplicações e Ferramentas para Transformação Bidireccional [2012 – 2014]

AutoSeer: Oráculos Automáticos para Detecção de Erros em Software [2012 – 2015]

QAIS: Análise quantitativa de sistemas reactivos: fundamentos e algoritmos [2012 – 2015]

Testes de Interfaces gráficas com o utilizador baseado em padrões (PBGT) [2012 – 2015]

Análise e Verificação de Programas Concorrentes Críticos (AVIAAC) [2012 – 2015]

NASONI - Coordenação de Software heterogéneo: fundamento, métodos e ferramentas [2013 – 2015]

Research projects funded by Agência da Inovação:

PROVA - Platform for Software Verification and Validation [2012 – 2014]

GreenSSCM - Framework de Poupança de Energia para Software Aeroespacial [2013 -2015]

Research projects funded by CCDR- N:

Network Sensing for Critical Systems Monitoring (Best Case - RL3) [2013- 2015]

Smartgrids (Best Case - RL5) [2013 – 2015]

Languages and Tools for Critical Real Time Systems (Best Case - RL8) [2013 – 2015]

Cooperation and Perception for Augmented Autonomy (Best Case - RL4) [2013- 2015]

Research projects funded by EC:

CoherentPaaS - A Coherent and Rich PassS with a Common Programming Model [2013 – 2016]

PRACTICE: Privacy-Preserving Computation in the Cloud [2013- 2016]

LeanBigData - Ultra-Scalable and Ultra-Efficient Integrated and Visual Big Data Analytics [2014 – 2017]

Research projects funded by industry:

OSSaaS - Operation Support Systems as a Service [2014- 2015]



### 3.1 Group Description – UGEI

Research Group Title	UNIDADE DE GESTÃO E ENGENHARIA INDUSTRIAL
Principal Investigator	Bernardo Sobrinho Simões de Almada Lobo
Research Area	Mechanical Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements – UGEI

#### 3.2.1 Objectives (4000 ca.)

##### FOREWORD

The on-line form does not maintain fixed the Unit Coordinator names, allowing permanent updating with the effect of changing past reports. The Coordinator of this Unit during 2011 was Prof. José António Sarsfield Cabral.

This Unit is an autonomous Associate Unit of INESC TEC.

##### OBJECTIVES

UGEI aims to produce problem driven knowledge focusing on three main fields: Service Engineering and Design, Decision Support and Intelligent Systems, and Performance Management and Business Intelligence. UGEI focuses on the areas where engineering, management and social sciences meet, at the cutting edge between theory and practice, around multidisciplinary projects mainly in Health, Retail, Mobility and Manufacturing.

Unit members are encouraged to carry out research projects based upon real-world problems. This application / problem solving attitude - which obviously encompasses the development of innovative theoretical work - is specially valued by the Unit, which has a strong and long lasting connection with both Portuguese and foreign organizations.

Moreover, it aims to establish direct links with renowned foreign research groups and to promote the dissemination of research in leading international journals and conferences.

The UGEI research objectives encompass the following dimensions:

##### Service Engineering and Design

- a) Design Complex Service Systems with multiple stakeholders (e.g. Health)
- b) Service Design for sustainability: developing new service design methods that explicitly incorporate sustainability concerns into the design of new services
- c) Design for the Customer Experience: Designing services and products service systems for the customers experience, involving a human-centered design approach that feeds the design process with customer experience input.
- d) Human-machine interaction: Understanding the influence of pervasive mobile devices, social networks and increasingly dynamic information and payment models on behavior of people; Proposing new frameworks, models and systems for improving quality of interaction and service, both in business and

in social responsibility areas; Identifying medium and long term trends and needs for multidisciplinary research involving ICT.

#### Decision support and Intelligent Systems

- a) Solution Approaches: Mathematical modeling and programming (combine new stronger models and valid inequalities based on the polyhedral structure of these problems to tighten linear relaxations and speed up the solution process); Robust and efficient optimization algorithms to produce resilient solutions, adaptable to frequent changes in the operating conditions; Matheuristics: Exploiting mathematical programming techniques in (meta)heuristic frameworks; Simulation-based Optimization: integrating optimization techniques into simulation analysis
- b) Intelligent Systems and Agent-Based Modeling and Simulation: Design and development of systems that integrate massive (often real time) data, optimization tools and visualization techniques to support decisions in tactical and operational levels.
- c) Agent-Based Modeling and Simulation (ABMS): ABMS approach to model business elements in supply chains. Developing each agent as an independent microscopic simulator, and Designing a framework to integrate independent agents. The framework provides network communication and language support for exchanging business messages using XML.

#### Performance Management and Business Intelligence

- a) Performance assessments: Performance assessments exploring Data Envelopment Analysis, econometric and statistical techniques; Developing new efficiency and productivity measurement models, that can identify the drivers of good performance in companies; Enhancing Organizational Performance in different sectors (e.g. Health, Construction industry) and Promoting Robust benchmarking; Exploring new methodologies to assess and improve quality of life, livability and attractiveness of urban areas, as they are essential to the development of countries given their role in the attractiveness of human capital.
- b) Data Mining, Data Analysis and Statistical methods: Data Mining applied to companies management. In order to address the needs of business to extract knowledge from data that could be leveraged to increase revenues, new analytical techniques are required. The challenges placed by large data sets lead to a redefinition of the process of data analysis to find patterns and relationships between data elements in large and noisy data sets.
- c) Demand Planning: Predicting the future as accurately as possible given all the information available: time series (exponential smoothing, Box-Jenkins) and explanatory models (neural networks).

### 3.2.2 Main Achievements (4000 ca)

In 2011, twelve papers related with the main research topics of UGEI have been published in international peer-review leading journals (10 of have ISI) and four ISI Proceedings. The number (twelve) of published proceedings of important international conferences is of worth note. Moreover, three special issues in international peer-review journals have been edited by members of UGEI, namely in the International Journal of Production Research, the Journal of Service Design and the Managing Service Quality Journal.

The members of UGEI Unit also contributed with two book chapters and three proceedings in national conferences.. They were invited to review over a dozen of papers in seven different top journals.

They were members of the scientific and programme committee of over 10 international conferences and members of the organizing committee of 1 international conferences.

Members of UGEI unit were enrolled in seven industry contract research projects. Throughout 2011, researchers of UGEI have also coordinated and participated in sixteen (16) research projects funded by QREN, FCT, ADI and European Commission.

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

### **3.3 Productivity - UGEI**

#### **3.3.1 Publications in peer review Journals (6000 ca.)**

Total number of publications: 12

List can be consulted in: <http://profile.inescporto.pt>

1. Almeder, C., Almada-Lobo, B. Synchronization of Scarce Resources for a Parallel Machine Lotsizing Problem, *International Journal of Production Research*, vol.49, nº24, pp.7315-7335, 2011
2. Amorim, P., Antunes, C., Almada-Lobo, B. Multi-Objective Lot-Sizing and Scheduling Dealing with Perishability Issues, *Industrial & Engineering Chemistry Research*, , vol.50, nº6, pp.3371-3381, 2011
3. Clark, A., Almada-Lobo, B., Almeder, C. Editorial on Lot Sizing and Scheduling: Industrial extensions and research opportunities, *International Journal of Production Research*, vol.49, nº9, pp.2457-2461, 2011
4. Fisk, R.P., Patrício, L. A brief history of SERVSIG, *Managing Service Quality Journal*, vol.21 nº 4, pp.328-330, 2011
5. Fisk, R.P., Patrício, L. Sixth SERVSIG international research conference 2010, Porto, Portugal - special issue *Journal of Service Management*, vol.22, nº 4, pp.440-442, 2011
6. Guimarães, L., Santos, R., Almada-Lobo, B. Scheduling wafer slicing by multi-wire saw manufacturing in photovoltaic industry: a case study, *International Journal of Advanced Manufacturing Technology*, vol.53, nº9, pp.1129-1139, 2011
7. James, R.J.W., Almada-Lobo, B.. Single and Parallel Machine Capacitated Lotsizing and Scheduling: New Iterative MIP-based Neighborhood Search Heuristics, *Computers and Operations Research*, vol.38, nº12, pp.1816-1825, 2011
8. Menezes, A., Clark, A., Almada-Lobo, B. Capacitated Lotsizing and Scheduling with Sequence-dependent, Period Overlapping and Non Triangular Setups, *Journal of Scheduling*, vol.14, nº2, pp.2457-2461, 2011
9. Morais, P., Camanho, A.S. Evaluation of performance of european cities with the aim to promote quality of life improvements, *OMEGA, The International Journal of Management Science*, vol.39, nº4, pp.398-409, 2011
10. Patrício, L., Fisk, R.P., Cunha, J.F., Constantine, L. Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting, *Journal of Service Research*, vol.14, nº 2, pp.180-200, 2011
11. Patrício, L. and Fisk, R.P. Synthesizing Service Design and Service Science for Service Innovation, *Touchpoint: The Journal of Service Design*, vol. 3, nº2, pp. 14-16, 2011
12. Portela, M.C., Camanho, A.S., Borges, D. BESP - Benchmarking of Portuguese Secondary Schools, *Benchmarking: An International Journal*, vol.18, nº 2, pp.240-260, 2011

#### **3.3.2 Other International publications (6000 ca.)**

Total number of publications: 38

The complete list can be consulted in: <http://profile.inescporto.pt>

Due to the limited space made available in this form, only selected papers are listed.

1. Miguéis, V.L., Camanho, A.S., Cunha, J.F. Mining customer loyalty card programs: The improvement of service levels enabled by innovative segmentation and promotions designing Lecture Notes in Business Information Processing, vol. 82, pp.83-97, 2011
2. Gomes, C., Sperandio, F., Borges, J.L., Almada-Lobo, B., Brito, A.C. A Decision Support System for Surgery Theatre Scheduling Problems in ENTERprise Information Systems - Communications in Computer and Information Science vol. 221, Springer, pp.213-222, 2011
3. Mourinho, J., Dias, T.G., Cunha, J.F. Spider Maps for Location-Based Services Improvement in Lecture Notes in Business Information Processing, vol. 82, pp.16-29, 2011
4. Santos, M., Almada-Lobo, B., Massago, S. New Evolutionary Algorithm for Highly Capacitated Lotsizing and Scheduling in Metaheuristics: Intelligent Decision Making, Operations Research/Computer Science Interfaces Series, Vol. 50, pp.309-324, 2011
5. Nunes, A., Dias, T.G., Cunha, J.F., Pitt, J. Using social networks for exchanging valuable real time public transport information among travellers, in Proceedings of the IEEE 13th Conference on Commerce and Enterprise Computing (CEC), pp.365-370, 2011
6. Mourinho, J., Dias, T.G., Cunha, J.F. GRASP algorithm for the Automated Generation of Spider Maps in MIC2011, pp.-, 2011
7. João Mourinho, Dias, T.G., Cunha, J.F. A Software Framework for the Automated Production of Schematic Maps in Proceedings of the CAISE Forum 2011, pp.57-64, 2011
8. Teixeira, J., Patrício, L., Nunes, N.J., Nóbrega, L.: Customer Experience Modeling: Designing Interactions for Service Systems. in Proceedings of INTERACT 2011, 13th Conference on Human-Computer Interaction 2011: 136-143
9. Almada-Lobo, B., Borges, J.L., Brito, A.C., Stocco, M., Sperandio, F., Gomes, C. Simulating a Portuguese Hospital Master Surgery Schedule in Proceedings of the 1st International Conference on Serious Games and Applications for Health - SeGAH 2011, pp.1-4, 2011
10. Pedro Amorim, Carlos Henggeler Antunes, B. Almada-Lobo, A dual mutation operator to solve the multi-objective production planning of perishable goods, in Proceedings of IX Metaheuristics International Conference, pp.21-30, 2011
11. Pedro Amorim, Hans-Otto Günther, B. Almada-Lobo, Tackling Freshness in Supply Chain Planning of Perishable Products in Proceedings of VII ALIO/EURO Workshop on Applied Combinatorial Optimization, pp.184-187, 2011
12. Luis Guimarães, Diego Klabjan, B. Almada-Lobo, Capacitated lotsizing and scheduling: Tackling sequence dependent setups using column generation in Proceedings of the 2nd International Workshop on Lot Sizing IWLS'11, pp.35-40, 2011
13. Luis Guimarães, Diego Klabjan, Bernardo Almada Lobo, Combining column generation and MIP-based heuristics to solve the capacitated lotsizing and scheduling problem in Proceedings of IX Metaheuristics International Conference, pp.591-593, 2011
14. Anderson Meneses, Pedro Amorim, B. Almada-Lobo, Christian Almeder, Integrating lot sizing and scheduling with the vehicle routing problem: A special look into perishable products in Proceedings of the 2nd International Workshop on Lot Sizing IWLS'11, pp.55-58, 2011
15. Deisemara Ferreira, Alistair Clark, B. Almada-Lobo, Reinaldo Morabito, Comparação entre duas estratégias de eliminação de subtours para um modelo de dimensionamento e sequenciamento de lotes baseado no modelo ATSP in Proceedings of XLII SBPO - Simpósio Brasileiro de Pesquisa Operacional, pp.1-10, 2011

16. Florian Seeanner, B. Almada-Lobo, Herbert Meyr, Combining the principles of Variable Neighborhood Decomposition Search and Fix & Optimize heuristic to solve multi-level lot-sizing and scheduling problems in Proceedings of the 2nd International Workshop on Lot Sizing IWLS'11 , pp.61-65, 2011

### **3.3.3 Ph. D. thesis completed (3000 ca.)**

1. Paulo Teixeira de Morais, Evaluation of Performance of European Cities With the Aim of Increasing Quality of Life, Industrial Engineering and Management Doctoral Program, Supervisors: Ana Camanho e José A. Cabral., 2011
2. Maria Gabriela Beirão dos Santos, Exploring Attitudes in Travel Behaviour, Industrial Engineering and Management Doctoral Program, Supervisors: José A. Cabral., 2011
3. Bruno de Athayde Prata, Uma Nova Abordagem para a Programação Integrada de Veículos e Tripulações, Industrial Engineering and Management Doctoral Program, Supervisors: T.G.Dias, J.P.Sousa., 2011

### **3.3.4 Patents/prototypes (2000 ca.)**

(void)

### **3.3.5 Organization of Conferences (2000 ca.)**

Program Committee of 9th workshop on intelligent techniques for web personalization & recommender systems (ITWP 11) Barcelona, 2011

Euro Working Group on DSS–Workshop. London, 2011.06

15º APDIO Congress, Coimbra, 2011.04

Associate-chair INTERACT 2011-13th Conference on Human-Computer Interaction, Lisbon, 2011.09

Steering Committee IWLS'11–International Workshop on lotsizing, Istanbul, Turkey, 2011.08

Chair, IEMS'11-2nd Symposium on Industrial Engineering and Management, Porto, 2011.01

Reviewer Computer Human Interaction CHI Conference 2011, Vancouver,Canada, 2011

Reviewer Services Marketing Track, European Marketing Academy Conference (EMAC), Ljubljana, 2011

Scientific Committee of 14th EWGT Conference “Transportation/Logistics”. Poznan, Poland, 2011.09

13th IEEE Conference on Commerce and Enterprise Computing Luxembourg, 2011.09

TEAR 2011-6th Trends in Enterprise Architecture Research Workshop; in conjunction with the EDOC'2011, 15th International Enterprise Computing Conference, Helsinki, Finland, 2011.08

SoEA4EE'2011–3rd Workshop on Service Oriented Enterprise Architecture for Enterprise Engineering; in conjunction with the EDOC'2011, 15th International Enterprise Computing Conference, Helsinki, 2011.08

JISBD 2011, XVI Jornadas de Ingeniería del Software y Bases de Datos, A Coruña,Espanha, 2011.09

IESS1.1,2nd International Conference on Exploring Services Sciences, Genebra,Switzerland, 2011.02

ICSOB'2011,2nd International Conference on Software Business, Brussels, Belgium, 2011.06

ICSEM'11,2nd International Conference on Services in Emerging Markets, Mumbai, India, 2011.09

FSTI-2011, 1st First International Workshop on Frontiers in Service Transformations and Innovations, Tirana, Albania, 2011.09



CLEI 2011, “XXXVII Conferência Latino Americana de Informática”, Quito,Ecuador, 2010.10

CibSE'11, XIV Conferencia Iberoamericana en Software Engineering, Rio de Janeiro,Brasil, 2011.04

CAISE'11, 23rd Conference on Advanced Information Systems Engineering, London, 2011.06

### 3.3.6 Industry contract research (2000 ca.)

Analysis of Retail Store Atmospherics for Customers behaviour.

Funded by InovRetail (2011.03.01-2011.12.31); Areas of Science: Performance Management and Business Intelligence; Areas of Technology Transfer: Retail.

Replenishment Algorithms for Wholesale WIPRO RETAIL Framework

Funded by Wipro Retail (2010.05.01-2011.02.28); Area of Science: Decision Support and Intelligent Systems; Area of Technology Transfer: Retail.

Replenishment Algorithms for Wholesale WIPRO RETAIL Framework

Funded by Transdev and CaetanoBus (2007.01.09-2012.03.01); Area of Science: Service Engineering and Design; Area of Technology Transfer: Mobility and Manufacturing.

Designing the Mobile Service Experience

Funded by Cardmobili (2008.03.01-2012.03.01); Area of Science: Service Engineering and Design; Area of Technology Transfer: Mobility.

Towards the development of communities oriented to services

Funded by Sonae (2008.06.01-2012.12.01); Area of Science: Service Engineering and Design; Area of Technology Transfer: Retail.

Designing a sustainable Electronic Health Record: from Service Ecosystem to Information Architecture

Funded by Ministry of Health (2010.09.01-2013.09.01); Area of Science: Service Engineering and Design; Area of Technology Transfer: Health.

Segmented Promotion Monitorization System

Funded by Sonae MC (2010.05.04-2013.07.31); Area of Science: Performance Management and Business Intelligence; Area of Technology Transfer: Retail.

### 3.3.7 Internationalization (2000 ca.)

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

8 papers (75% of the total) in international peer-review journals and 8 proceedings in international conferences (50% of the total) with authors from foreign institutions, namely: Imperial College London Northwestern University, University of West of England, University of Vienna, University of São Paulo, Europa-Universität, Texas State University, University of Canterbury, Technical University of Berlin, Technical University of Darmstadt and Universidade Federal do Triângulo Mineiro.

Visiting Researchers at UGEI

Christian Almeder, Europa-Universität, Frankfurt (Oder), Germany, June 2011

Maristela Oliveira Santos, University of São Paulo, Institute of Mathematics and Computer Sciences, Brazil. January-February 2011

Sophie Parragh, Department of Business Administration, University of Vienna, Austria

January - June 2011.

Franklina Toledo, Institute of Mathematics and Computer Sciences, University of São Paulo, Brazil, February – July 2011

Alysson Costa, Institute of Mathematics and Computer Sciences, University of São Paulo, Brazil, June – July 2011

### **3.3.8 Other national publications (6000 ca.)**

1. Isabel Horta, A. S. Camanho, Jorge Moreira Da Costa, Assessment of performance and innovation of Portuguese construction companies in Livro de Actas do 15º Congresso da APDIO - IO2011, pp.115-127, 2011
2. Andreia Zanella, A. S. Camanho, Teresa Galvão Dias, Countries environmental performance assessment, in Livro de Actas do 15º Congresso da APDIO - IO2011, pp.37-51, 2011
3. C. B. Vaz, A. S. Camanho, Evolução do desempenho de lojas de retalho ao longo do tempo utilizando o índice de Malmquist in Livro de Actas do 15º Congresso da APDIO - IO2011, pp.65-77, 2011

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

(void)

### 3.1 Group Description – CISTER

Research Group Title	CENTRO DE INVESTIGAÇÃO EM SISTEMAS CONFIÁVEIS E DE TEMPO REAL
Principal Investigator	Eduardo Manuel de Médicis Tovar
Research Area	Electrical and Computer Engineering
Home Institution	INESC Porto

### 3.2 Objectives & Achievements – CISTER

#### 3.2.1 Objectives (4000 ca.)

This Unit is an autonomous Associate Unit of INESC TEC.

#### OBJECTIVES

CISTER (Research Centre in Real-Time and Embedded Computing Systems) is a Research Centre based at the School of Engineering (ISEP) of the Polytechnic Institute of Porto (IPP), Portugal and autonomous Associate Unit of INESC TEC. Since it was created, CISTER has grown to become one of the leading European research units in the area, contributing with seminal research works in a number of subjects: real-time communication networks and protocols; wireless sensor networks (WSN); cyber-physical systems (CPS); real-time programming paradigms and operating systems; distributed embedded systems; cooperative computing and QoS-aware applications; scheduling and schedulability analysis (including multiprocessor systems). CISTER was, in 2004 and 2007 awarded the classification of Excellent by FCT evaluation.

Monitoring and controlling the behaviour of embedded computing systems, (systems where computers are part of other systems) is one of the strategic research areas in Europe. This area has an impact in very important sectors such as industrial automation, automotive, aerospace, consumer electronics, communication system or medical systems. Europe is seen as an international outstanding example for many of these are sectors, which is, however, not the case for general-purpose computing systems, which are traditionally dominated by non-European organisations. Embedded computing systems is one of the areas with higher growth in ICT, where > 95% of the current processors are embedded (embedded systems are everywhere: cars, aeroplanes, factories, electrical networks, mobile phones, keys, smart cards, electronic games or PDA's).

The global market for embedded processors was worth €125 billion in 2014 with future annual growth rates higher than 6% up to 2020 when it is expected to reach € 190 billion. As these computer systems become pervasive and ubiquitous, due to being embedded everywhere, they are also becoming inherently distributed and interconnected. These systems are thus the nervous system of our society, and it is no coincidence that they always appear when a smart environment is put forward. Nevertheless, and being transversal to smart-\* topics, these embedded computing systems present their own research challenges which are independent of particular application areas or domains. Furthermore, in the vast majority of its applications, the adequacy of the system depends not only on the logical result of computation, but also on the time at which the results are produced; thus adequacy and performance are very tightly interrelated. This has makes real-time very significant and it is indiscernibly connected to the existing research challenges.

Future research activities will reflect the experience gained in recent years and the key competences of the Research Group, but it will also strategically explore some new, emerging lines of research. These activities will focus on the following themes.

## **PROGRAMMABILITY**

Next generation of Real-Time Embedded Systems will be based on heterogeneous parallel architectures, and will need to consider multiple dimensions of complexity such as performance, energy efficiency, time-criticality, dependability, cost-effectiveness, etc. It is thus necessary to research new paradigms of programming that can increase productivity and robustness, whilst reducing complexity. CISTER has a proven record of impactful work in real-time and embedded programming models, and is working with a special focus on real-time parallel programming, seamless programming of WSN and new approaches for verification.

## **MODELLING AND ANALYSING THE TEMPORAL BEHAVIOUR**

CISTER has an international reputation in the field of real-time scheduling. We are addressing new problems resulting from the integration of distributed, and many-core architectures in today's platform. CISTER is working on scheduling of parallel tasks in distributed, multi- and many-core platforms, the sharing of resources (memories, communication networks, etc.), the use of dedicated computing accelerators such as GPGPUs, and task-to-processor mapping. Investigated solutions also include probabilistic approaches to provide efficient results where classical analyses yield pessimistic results.

## **MIXED-CRITICALITIES**

Today, industry faces a new challenge with the integration of multiple applications with different levels of criticality in the same system. CISTER is building upon previous results obtained for the problem of mixed-criticality systems in two ARTEMIS projects (CONCERTO and EMC2), and developing scheduling techniques to respect timing constraints of high criticality tasks and to recover from unexpected behaviours. Work is also undergoing on the analysis and design tools that enable a safe integration of applications of different criticalities in the same computing platform, eventually facilitating their certification.

## **ENERGY-AWARE COMPUTATION**

Europe has a strong leadership in energy-aware embedded computing, thus it is not a surprise that low-power is one of the objectives of its research agenda. Now that multi-core platforms are becoming mainstream there is a need to facilitate heterogeneous multi-cores, which perform operations in a low-cost and efficient manner. On the one hand energy consumed in peripherals has become on par with that of cores. On the other hand, this needs to be paired with mechanisms for temporal isolation. CISTER addresses these challenges in a holistic manner, based on a proven track record in the area.

## **UBIQUITOUS SENSING AND ACTUATION**

CISTER has been leading international research in ubiquitous/networked embedded systems, with a special emphasis on quality of service (QoS) in low-power & low-cost wireless networks. We are focused on the QoS properties that make these networks and systems more dependable, functional and scalable. Studying properties such as timeliness, reliability, energy-efficiency and mobility, under stringent application requirements and environmental conditions is one of the areas of this work. The focus is currently on designing efficient, reliable and real-time mechanisms, particularly in the unlicensed and over-populated ISM band.

## **CO-DESIGN APPROACHES FOR CPS**

CISTER has research expertise in relevant fields such as scalable data aggregation, low power and embedded communication, and analysis of temporal behaviour of complex systems. CISTER is well positioned to continue to tackle Cyber-Physical Systems (CPS)-related challenges, namely dealing with the massive increase in sensor data. At CISTER, researchers have adopted innovative co-design approaches to address scalable data aggregation in large-scale CPS, and is currently further exploring these concepts to propose novel distributed algorithms for CPS.

## **RESOURCE AND QOS MANAGEMENT**

The notion of Quality of Service (QoS) contracts and Service Level Agreements (SLA) is essential in order to handle the reliable and safe management of embedded distributed systems resources. Our focus is in the context of guaranteeing that the applications are able to get their desired resources, specified on SLA. Architectures/mechanisms being proposed and/or analysed range from complex distributed systems (e.g. middlewares for the Internet of Things) to resource constrained nodes (e.g. sensor nodes).

### 3.2.2 Main Achievements (4000 ca)

#### **Calls:**

CISTER has successfully participated in the recent ECSEL JU calls and participated in the submission of nine proposals. The proposals are on various CPS-related topics including, smart city infrastructure and applications, safety assurance, security, maintenance and testing. CISTER's intended research contributions include issues in runtime monitoring, timing, schedulability, verification and testing, communication, security, middleware and various pilot demonstrators. The proposal MANTIS (Management of critical knowledge to support maintenance decision making) was submitted in collaboration with INESC-TEC CESE, and proposal GUARD (Guaranteed Security verification for connected intelligent critical systems) with INESC-TEC HASLab.

In the scope of the European R&D program H2020, in the topic "New ICT-based solutions for energy efficiency", CISTER participated in the project proposal EnerGAware (Energy Game for Awareness of energy efficiency in social housing communities), which has been selected for a grant.

In 2014, the ARTEMIS projects EMC2 (Embedded multi-core systems for mixed criticality applications in dynamic and changeable real-time environments) and DEWI (Dependable Embedded Wireless Infrastructure) were initiated. CISTER hosted the general assembly project meetings from P-SOCRATES, DEWI, ENCOURAGE, CarCoDe, with more than 150 participants in total from all over Europe.

#### **Events:**

CISTER organized CiWork 2014 that aims to bring together researchers and practitioners from the industry and academia and provide them with a platform to report on recent advances and developments in the newly emerging areas of real-time and embedded technologies, as well as actual and potential applications to industrial systems.

A new 3-month BIC internship program for students of FEUP and ISEP was started. During this time frame, the students contributed to a set of practical challenging multi-disciplinary projects under the supervision of CISTER researchers.

CISTER will host the 12th edition of the highly reputed European Wireless Sensor Network conference (EWSN). Being one of the leading international conferences in this area, EWSN has played a prominent role in the dissemination of innovative research and provides a high quality discussion forum. In 2015 CISTER will also host the 28th GI/ITG International Conference on Architecture of Computing Systems (ARCS'15) in Porto. The ARCS series of conferences is one of the most important and oldest scientific events for computer architecture research in Europe. The focus of the 2015 conference will be on reconciling, in mixed-critical systems, the parallel execution paradigm borrowed typically from the high-performance computing world and the time-predictability requirement peculiar to the embedded computing market segment.

CISTER was visited by representatives of Embraer, one of the world's leading aircraft manufacturers with its headquarters in Brazil. CISTER seized the opportunity offered by this visit to organize a workshop day during which CISTER gave an overview of the projects and international efforts in which the team is involved.

#### **Smart-Cities:**

Within the objectives of the Arrowhead project CISTER, together with Aalborg University and Neogrid, successfully demonstrated the flex-offer framework software in two pilots. CISTER also completed with great success the ENCOURAGE project, in which we were the main responsible for the design and development of the middleware.

Analysis of energy saving by smart grids on a prototype installed in Terrassa campus, analysis of feasibility and regulations of smart grids. New approach to mobility models for simulations of vehicular communications.

Confirmed in the editorial boards of Research Journal Social Technologies (Mykolas Romeris University) and of Transactions on Emerging Telecommunications Technologies (Wiley).

Invited paper in plenary session (similar to keynote speech) of International Academic Conference on Social Technologies in Vilnius, Lithuania, regarding how social intelligence emerges out of smart grid approaches.

### **Multi/Many-Core Processors:**

José Augusto Santos-Jr, PhD student of Prof. George Lima (UFBA, Brazil) visited CISTER for 6 months, under Brazilian scholarship, in order to work with CISTER co-supervisor.

Strengthen the usage of the multi/many-core processors in the industry and provide the analysis for Network-on-Chip (NoC) technologies in order to ensure time predictability. Specifically, the challenge of time-predictability in modern many-core architectures has been investigated and a framework to compute the worst-case communication delay for many-cores using a Limited Migrative Model has been proposed. The latter contribution was selected among the best papers at RTCSA'14 and was invited to the Journal of Signal Processing Systems (JSPS).

Proposed a new algorithm to tightly estimate the maximum end-to-end latency of a packet transmission over a Network-On-Chip, which is the de facto mainstream communication fabric in modern many-core architectures. We have also proposed a new framework to budget the execution of a real-time task and manage all these pre-assigned task execution budgets at runtime. The proposed framework allow tasks to preempt each other only if the preempting task is able to compensate for the damage caused to the preempted task. That is, the preemption is allowed only if the amount of time corresponding to the maximum delay incurred by the preempted task can be transferred from the execution budget of the preempting task to that of the preempted task. Transactions between tasks budgets turned out to be a very flexible mean that also allow tasks to (sometimes) violate the constraint imposed on their minimum inter-arrival time. We then focused on parallel applications and studied how to deal with control-flow information when computing their response time on a multicores. This led us to study the WCET of such parallel applications when deployed on a multicores, an activity that we are still pursuing today.

Invited speaker to the 14th International Workshop on Worst-Case Execution Time Analysis (WCET 2014), held in Madrid, to give a recap of the main challenges of time-predictability in modern many-core architectures.

### **Wireless Sensor Networks:**

CISTER presented XDense, an architecture for large interconnected wireless sensor networks, developed for the application to turbulence analysis in aircraft wings, where a network of embedded sensors embedded exchange information in a nearest neighbor manner to perform in-network image processing and data aggregation.

We proposed to batch the transmissions together by defining a harmonizing period to align the transmissions from multiple applications at periodic boundaries. This harmonizing period is then leveraged to design a protocol that coordinates the transmissions across nodes and provides real-time guarantees in a multi-hop network. This protocol, which we call Network-Harmonized Scheduling (NHS), takes advantage of the periodicity introduced to assign offsets to nodes at different hop- levels such that collisions are always avoided, and deterministic behavior is enforced. NHS is a lightweight and distributed protocol that does not require any global state-keeping mechanism.

## **3.3 Productivity - CISTER**

### **3.3.1 Publications in peer review Journals (6000 ca.)**

[1] Ullah, S, Li, C, "Energy-efficient MAC protocols for WBANs: Opportunities and challenges", Telecommunication Systems, Springer. 5, Dec, 2014.

[2] Macarulla, M, Albano, M, "Smarter grid through collective intelligence: user awareness for enhanced performance", Social Technologies (Social Technologies), Mykolas Romeris University, Edited: Aelita Skaržauskien. Dec 2014, Volume 4, Issue 2, pp 385-400.

[3] Fotouhi, H, Moreira, D, Alves, M, "mRPL: Boosting mobility in the Internet of Things", Journal on Ad Hoc Networks, Elsevier. 22, Nov, 2014.

- [4] Caldeira, J, Rodrigues, J, Lorenz, P, Ullah, S, "Impact of sensor nodes scaling and velocity on handover mechanisms for healthcare wireless sensor networks with mobility support", *Computers in Industry (COMPUT IND)*, Elsevier. 11, Nov, 2014, Volume In Press.
- [5] Awan, M, Petters, S, "Race-to-halt energy saving strategies", *Journal of Systems Architecture (JSA)*, Elsevier, Edited: I.J. Bate. Nov 2014, Volume 60, Issue 10, pp 796-815.
- [6] Nelissen, G, Bletsas, K, Goossens, J, "CPMD-mindful task assignment for NPS-F", *Real-Time Systems*, Springer US. Nov 2014, Volume 50, Issue 5-6, pp 585-591.
- [7] Raravi, G, Nélis, V, "Task assignment algorithms for heterogeneous multiprocessors", *ACM Transactions on Embedded Computing (TECS)*, ACM. Nov 2014, Volume 13, Issue 5s, Article No 159, 26 pages. New York, NY, U.S.A..
- [8] Fotouhi, H, Alves, M, Zuniga, M, Koubâa, A, "Reliable and fast hand-offs in low-power wireless networks", *IEEE Transactions on Mobile Computing (TMC)*, IEEE. Nov 2014, Volume 13, Issue 11, pp 2620-2633.
- [9] Andersson, B, Raravi, G, "Provably Good Task Assignment for Two-type Heterogeneous Multiprocessors using Cutting Planes", *ACM Transactions on Embedded Computing (TECS)*, ACM. Sep 2014, Volume 13, Issue 5s.
- [10] Severino, R, Pereira, N, Tovar, E, "Dynamic cluster scheduling for cluster-tree WSNs", *Communication Networks*, SpringerPlus. 31, Aug, 2014, Volume 3, Issue 493.
- [11] Albano, M, Ferreira, L, Pinho, L, Alkhawaja, A, "Message-oriented middleware for smart grids", *Computer Standards and Interfaces (CSI)*, Elsevier. 21, Aug, 2014.
- [12] Ullah, S, Vasilakos, A, Chao, H, Suzuki, J, "Cloud-assisted Wireless Body Area Networks", *Information Science (INS)*, Elsevier. Aug 2014, Volume 284, pp 81-83.
- [13] Chaari, I, Koubâa, A, Bennaceur, H, Ammar, A, Al-Shalfan., K, "smartPATH: An Efficient Hybrid ACO-GA Algorithm for Solving the Global Path Planning Problem of Mobile Robots", *the International Journal of Advanced Robotic Systems (Impact Factor 0.821) (IJARS)*, InTech Publisher. 4, Jul, 2014, Volume 11, Issue 94.
- [14] Nelissen, G, Su, H, Guo, Y, Zhu, D, Nélis, V, Goossens, J, "An optimal boundary fair scheduling", *Real-Time Systems*, Springer US. 1, Jul, 2014, Volume 50, Issue 4, pp 456-508. U.S.A..
- [15] Sousa, P, Bletsas, K, Tovar, E, Souto, P, Åkesson, B, "Unified Overhead-aware Schedulability Analysis for Slot-based Task-splitting", *Real-Time Systems journal*, Springer US. Jul 2014, Volume 50, Issue 4, pp 1-56.
- [16] Dias, J, Rodrigues, J, Shu, L, Ullah, S, "Performance evaluation of a cooperative reputation system for vehicular delay-tolerant networks", *EURASIP Journal on Wireless Communications and Networking (EURASIP JWCN)*, Springer. 29, May, 2014, Volume 2014:88.
- [17] Hayajneh, T, Almashaqbeh, G, Ullah, S, Vasilakos, A, "A survey of wireless technologies coexistence in WBAN: analysis and open research issues", *Wireless Networks*, Springer US. May 2014. U.S.A..
- [18] Burmyakov, A, Bini, E, Tovar, E, "Compositional Multiprocessor Scheduling: the GMPR interface", *Real-Time Systems*, Springer US. May 2014, Volume 50, Issue 3, pp 342-376. U.S.A..
- [19] Andersson, B, Raravi, G, "Real-Time Scheduling with Resource Sharing on Heterogeneous Multiprocessors", *Real-Time Systems*, Springer US. Mar 2014, Volume 50, Issue 2, pp 270-314. U.S.A..

- [20] Dasari, D, Nikolic, B, Nélis, V, Petters, S, "NoC Contention Analysis using a Branch and Prune Algorithm", Transactions in Embedded Computing Systems (DCMP 12), ACM. Mar 2014, Volume 13, Issue 3s, Article No 113, 26 pages. New York, NY, U.S.A..
- [21] Raravi, G, Andersson, B, Nélis, V, Bletsas, K, "Task assignment algorithms for two-type heterogeneous multiprocessors", Real-Time Systems (RTS), Springer. Jan 2014, Volume 50, Issue 1, pp 87-141. Outstanding Paper Award
- [22] Teixeira, C, Albano, M, Skou, A, Dueñas, L, Antonacci, F, Ferreira, R, Pedersen, K, Scalari, S, "Convergence to the European Energy Policy in European countries: case studies and comparison", Social Technologies (Social Technologies), Mykolas Romeris University, Edited: Aelita Skaržauskien. 2014, Volume 4, Issue 1, pp 7-18.
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- [24] Gupta, V., Pereira, N., Tovar, E., Rajkumar, R., "A Harmony of Sensors Achieving Determinism in Multi-Application Sensor Networks", (Poster Session), 13th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN'14). 15 to 17, April, 2014

### **3.3.2 Other International publications (6000 ca.)**

- [1] Nélis, V, Yomsi, P, Pinho, L, Bernat, G, "Another look at the pWCET estimation problem", Work in Progress Session, IEEE Real-Time Systems Symposium (RTSS 2014). 2 to 5, Dec, 2014. Rome, Italy.
- [2] Blomstedt, F, Ferreira, L, Klisics, M, Chrysoulas, C, Soria, I, Morin, B, Zabasta, A, Eliasson, J, Johansson, M, Varg, P, "The Arrowhead Approach for SOA Application Development and Documentation", 40th Annual Conference of the IEEE Industrial Electronics Society (IECON 2014). 29, Oct to 1, Nov, 2014, Industrial Informatics, pp 2631-2637. Dallas, U.S.A..
- [3] Albano, M, Macarulla, M, "Smarter grid through collective intelligence: user awareness for enhanced performance", International Academic Conference on Social Technologies '14 (SocTech14). 23 to 24, Oct, 2014, Plenary Session. Vilnius, Lithuania.
- [4] Taft, S, Moore, B, Pinho, L, Michell, S, "Safe Parallel Programming in Ada with Language Extensions", High Integrity Language Technology ACM SIGAda's Annual International Conference (HILT 2014). 20 to 22, Oct, 2014. Portland, U.S.A..
- [5] Nikolic, B, Petters, S, "EDF as an Arbitration Policy for Wormhole-Switched Priority-Preemptive NoCs - Myth or Fact?", International Conference on Embedded Software (EMSOFT 2014). 12 to 17, Oct, 2014. New Delhi, India.
- [6] Maia, C, Bertogna, M, Nogueira, L, Pinho, L, "Response-Time Analysis of Synchronous Parallel Tasks in Multiprocessor Systems", 22nd International Conference on Real-Time Networks and Systems (RTNS 2014). 8 to 10, Oct, 2014. Versailles, France.
- [7] Baldovin, A, Nelissen, G, Vardanega, T, Tovar, E, "SPRINT: Extending RUN to Schedule Sporadic Tasks", 22nd International Conference on Real-Time Networks and Systems (RTNS 2014). 8 to 10, Oct, 2014. Versailles, France.
- [8] Esper, A, Tovar, E, "Resource Sharing Under a Server-based Semi-Partitioned Scheduling Approach", 22nd International Conference on Real-Time Networks and Systems (RTNS 2014). 8 to 10, Oct, 2014. Versailles, France.

- [9] Berezovskyi, K, Santinelli, L, Bletsas, K, Tovar, E, "WCET Measurement-based and Extreme Value Theory Characterisation of CUDA Kernels", 22nd International Conference on Real-Time Networks and Systems (RTNS 2014). 8 to 10, Oct, 2014. Versailles, France.
- [10] Ferreira, L, Siksnys, L, Pedersen, P, Stluka, P, Chrysoulas, C, Guilly, T, Albano, M, Skou, A, Teixeira, C, Pedersen, T, "Arrowhead Compliant Virtual Market of Energy", 9th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2014). 19 to 21, Sep, 2014, Flexible And Interoperable Automation Systems. Barcelona, Spain.
- [11] Plósz, S, Farshad, A, Tauber, M, Lesjak, C, Ruprecht, T, Pereira, N, "Security Vulnerabilities And Risks In Industrial Usage Of Wireless Communication", 19th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA2014). 16 to 19, Sep, 2014. Barcelona, Spain.
- [12] Marinho, J, Nélis, V, Petters, S, "Temporal Isolation with Preemption Delay Accounting", 19th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA 2014). 16 to 19, Sep, 2014. Barcelona, Spain.
- [13] Pinho, L, Quiñones, E, Bertogna, M, Marongiu, A, Carlos, J, Scordino, C, Ramponi, M, "P-SOCRATES: a Parallel Software Framework for Time-Critical Many-Core Systems", Euromicro Conference on Digital System Design (DSD) (DSD 2014). 27 to 29, Aug, 2014. Verona, Italy.
- [14] Pedro, A, Pereira, D, Pinho, L, Pinto, J, "Towards a Runtime Verification Framework for the Ada Programming Language", Lecture Notes in Computer Science, Reliable Software Technologies – Ada-Europe 2014 (LNCS), Springer International Publishing. 23 to 27, Aug, 2014, 8454, pp 58-73.
- [15] Gupta, V, Pereira, N, Gaur, S, Tovar, E, Rajkumar, R, "Network-Harmonized Scheduling for Multi-Application Sensor Networks", The 20th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA 2014). 20 to 22, Aug, 2014. Chongqing, China.
- [16] Allard, Y, Nelissen, G, Goossens, J, Milojevic, D, "A Context Aware Cache Controller to Bridge the Gap Between Theory and Practice in Real-Time Systems", The 20th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA 2014). 20 to 22, Aug, 2014. Chongqing, China.
- [17] Nélis, V, Yomsi, P, Pinho, L, Fonseca, J, Bertogna, M, Quiñones, E, Vargas, R, Marongiu, A, "The challenge of time-predictability in modern many-core architectures", 14th International Workshop on Worst-Case Execution Time Analysis (WCET 2014). 8, Jul, 2014. Madrid, Spain.
- [18] Garibay-Martínez, R, Ferreira, L, Nelissen, G, Pinho, L, "Towards Holistic Analysis for Fork-Join Parallel/Distributed Real-Time Tasks", Work in Progress Session, 26th Euromicro Conference on Real-Time Systems (ECRTS 2014). 8 to 11, Jul, 2014, pp 21-24. Madrid, Spain.
- [19] Tovar, E, "Information processing for extreme dense sensing: timeliness and scalability issues", 13th International Workshop on Real-Time Networks (RTN 2014). 8, Jul, 2014. Madrid, Spain.
- [20] Fonseca, J, Nélis, V, Raravi, G, Pinho, L, "How to deal with control-flow information in parallel real-time applications?", 5th Real-Time Scheduling Open Problems Seminar (RTSOPS 2014). 8, Jul, 2014. Madrid, Spain.
- [21] Pereira, D, Pinho, L, Lindgren, P, Eriksson, J, Lindner, M, "RTFM-lang Static Semantics for Systems with Mixed Criticality", Proc of Workshop on Mixed Criticality for Industrial Systems (WMCIS'2014), Ada User Journal, 35(2):128–132, 2014. (WMCIS 2014). 23 to 26, Jun, 2014. Paris, France.

- [22] Pinho, L, Moore, B, Michell, S, "Parallelism in Ada: Status and Prospects", 19th International Conference on Reliable Software Technologies - Ada-Europe 2014 (Lecture Notes in Computer Science), Springer International Publishing. 23, Jun, 2014, pp 91-106. Paris, France.
- [23] Gaddour, O, Koubâa, A, R., R, Tovar, E, "Co-RPL: RPL Routing for Mobile Low Power Wireless Sensor Networks using Corona Mechanism", 9th IEEE International Symposium on Industrial Embedded Systems (SIES 2014). 15 to 17, Jun, 2014, pp 200-209. Italy.
- [24] Garibay-Martínez, R, Nelissen, G, Ferreira, L, Pinho, L, "On the Scheduling of Fork-Join Parallel/Distributed Real-Time Tasks", 9th IEEE International Symposium on Industrial Embedded Systems (SIES 2014). 15 to 17, Jun, 2014, Real-time scheduling. Pisa, Italy.
- [25] Beckert, M, Neukirchner, M, Ernst, R, Petters, S, "Sufficient Temporal Independence and Improved Interrupt Latencies in a Real-Time Hypervisor", The 51st Annual Design Automation Conference on Design Automation Conference (DAC '14), ACM New York. 1 to 5, Jun, 2014, pp 86:1-86:6. San Francisco, CA, U.S.A..
- [26] Vahabi, M, Gupta, V, Albano, M, Tovar, E, "Feature Extraction in Densely Sensed Environments", IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS 2014), IEEE. 27, May, 2014. Marina Del Rey, U.S.A..
- [27] Cheikhrouhou, O, Koubâa, A, Bennaceur, H, "Move and Improve: A Distributed Multi-Robot Coordination Approach for Multiple Depots Multiple Travelling Salesmen Problem", the IEEE International Conference on Autonomous Robot Systems and Competitions (IEEE ICARSC | ROBÓTICA 2014). 14 to 15, May, 2014, pp 28-35. Espinho, Portugal.
- [28] Pedro, A, Pereira, D, Pinho, L, Pinto, J, "A Compositional Monitoring Framework for Hard Real-Time Systems", NASA Formal Methods Symposium 2014 (NFM14), Springer International Publishing. 29, Apr, 2014, LNCS 8430, pp 16-30. Houston, TX, U.S.A..
- [29] Groesbrink, S, Almeida, L, Sousa, M, Petters, S, "Towards Certifiable Adaptive Reservations for Hypervisor-based Virtualization", 20th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS 2014), IEEE. 15, Apr, 2014. Berlin, Germany.
- [30] Kotaba, O, Nowotsch, J, Paulitsch, M, Petters, S, Theiling, H, "Multicore in Real-Time Systems – Temporal Isolation Challenges due to Shared Resources", Workshop on Industry-Driven Approaches for Cost-effective Certification of Safety-Critical, Mixed-Criticality Systems (WICERT 2013). 10, Mar, 2014. Grenoble, France.
- [31] Barros, A, Pinho, L, "Non-preemptive scheduling of Real-Time Software Transactional Memory", the Conference on Architecture of Computing Systems (ARCS 2014). 25 to 28, Feb, 2014. Lubeck, Germany.
- [32] Koubâa, A, "A Service-Oriented Architecture for Virtualizing Robots in Robot-as-a-Service Clouds", the Conference on Architecture of Computing Systems (ARCS 2014). 25 to 28, Feb, 2014. Lubeck, Germany.
- [33] Pinho, L, Bertogna, M, Quiñones, E, Benini, L, Carlos, J, Ramponi, M, Scordino, C, "Time Criticality Challenge in the Presence of Parallelised Execution", 2nd Workshop on High-performance and Real-time Embedded Systems (HiRES 2014). 20, Jan, 2014. Vienna, Austria.
- [34] Nikolic, B, Yomsi, P, Petters, S, "Worst-Case Communication Delay Analysis for Many-Cores using a Limited Migrative Model", 20th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA 2014). 2014, Real-Time Systems Track. Chongqing, China.

(posters & demo)

[35] Baldovin, A, Zovi, A, Tovar, E, Nelissen, G, Vardanega, T, "Modelling Avionics Applications with CONCERTO", Demo in RTSS@Work 2014 –Open Demo Session of Real-Time Systems, IEEE Real-Time Systems Symposium (RTSS 2014). 2 to 5, Dec, 2014. Rome, Italy.

[36] Esper, A, Tovar, E, "Resource Sharing Under a Server-based Semi Partitioned Scheduling Approach", Poster presented in 22nd International Conference on Real-Time Networks and Systems (RTNS 2014). 8 to 10, Oct, 2014. Versailles, France.

[37] Pinho, L, Marín\_Carrión, I, Ferreira, L, "On Program Restructuring for Cluster-based Highly Parallel Embedded Architectures", Poster presented in INFORUM - Simpósio de Informática (INFORUM 2014). 4 to 5, Sep, 2014. Porto, Portugal.

[38] Gupta, V, Pereira, N, Tovar, E, Rajkumar, R, "A Harmony of Sensors: Achieving Determinism in Multi-Application Sensor Networks", Poster presented in 13th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN'14). 15 to 17, Apr, 2014, pp 299-300. Berlin, Germany.

### **3.3.3 Ph. D. thesis completed (3000 ca.)**

Muhammad Ali Awan, Energy and Temperature Aware Real-Time Systems, PhD thesis, July 2014, (supervisor: Stefan M. Petters)

Dakshina Dasari, Timing Analysis of Real-Time Systems Considering the Contention on the Shared Interconnection Network in Multicores, PhD thesis, May 2014 (supervisor: Vincent Nélis)

Gurulingesh Raravi, Real-Time Scheduling on Heterogeneous Multiprocessors, PhD thesis, March 2014 (supervisor: Vicent Nélis)

David Pereira, Towards Certified Program Logics for the Verification of Imperative Programs, PhD thesis, April 2013 (supervisors: Nelma Moreira, Simão Melo de Sousa)

Vikram Gupta, On the Optimization of Multiple Applications for Sensor Networks, PhD Thesis, October 2014 (supervisor: Eduardo Tovar, Ragunathan Rajkumar)

#### **inished in 2015:**

Many-Core Platforms in the Real-Time Embedded Computing Domain, Borislav Nikolic

Real-time Limited Preemptive Scheduling, José Marinho

Reliable Mobility Support in Low-Power Wireless Networks, Hossein Fotouhi

#### **Ongoing PhD work:**

Dynamic Contracts for Verification and Enforcement of Real-Time Systems Properties, André Pedro

Real-Time Software Transactional Memory, António Barros

Resource Abstraction via a Real-Time Interface, Artem Burmyakov

Reliability and Time Bounded Delays in Wireless Sensor Networks, Claro Noda

Dynamic Parallel Real-Time Embedded Systems in Multiprocessor Platforms, Cláudio Maia

Integrating Dataflow and Non-Dataflow Real-Time Application Models on Multi-Core Platforms, Hazem Ali

Networked Embedded Systems for Active Flow Control in Aircraft, João Loureiro

Efficiency and Time-Driven Mapping and Scheduling Techniques for Many-Core Architectures, José Fonseca

Analysis of General-Purpose Graphics Processing Units for Real-Time Systems: Models and Analyses, Kostiantyn Berezovskyi

Computing Aggregate Quantities in Large-Scale and Dense Sensor Networks, Maryam Vahabi

A Framework for the Development of Parallel and Distributed Real-Time Embedded Systems, Ricardo Garibay-Martínez

Improving QoS for Large-Scale Wireless Sensor Networks, Ricardo Severino

### **3.3.4 Patents/prototypes (2000 ca.)**

(void)

### **3.3.5 Organization of Conferences (2000 ca.)**

Organizing Committee:

CiWork 2014, Porto, Portugal

INForum 2014, Porto, Portugal

ISCIT 2014, Incheon, South Korea

Conference / Program / Track Chair:

RTSS 2014, Rome, Italy

RSC 2014, Niagara Falls, Canada

RTAS 2014, Belin, Germany

DATE 2014, Desden, Germany

ARCS 2014, Luebeck, Germany

Special Session Organizer:

ETF A 2014 – SS04, Barcelona, Spain

Tutorial/Workshop Chair:

IEEE CAMAD 2014, Athens, Greece

JRWRTC 2014, Versailles, France

WMCIS'2014, Paris, France

Program Committee:

WMC 2014, Rome, Italy

HILT 2014, Portland, USA

RTNS 2014, Versailles, France

LCN 2014, Edmonton, Canada  
IEEE PIMRC'14, Washington, USA  
SEAA 2014, Verona, Italy  
ECRTS 2014, Madrid, Spain  
Ada-Europe 2014, Paris, France  
E2Nets 2014, Sydney, Australia  
IEEE ICC 2014, Sydney, Australia  
SEUS 2014, Reno, USA  
PWSN 2014, Marina Del Rey, USA  
EWSN 2014, Oxford, UK

### **3.3.6 Industry contract research (2000 ca.)**

(Void)

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level*

International Projects:

EMC<sup>2</sup> (Embedded multi-core systems for mixed criticality applications in dynamic and changeable real-time environments) JU grant nr. 621429 | ARTEMIS/0001/2013

DEWI (Dependable Embedded Wireless Infrastructure) JU grant nr. 621353 | ARTEMIS/0004/2013

Arrowhead (Ahead of the future) JU grant nr. 332987 | ARTEMIS/0001/2012

P-SOCRATES (Parallel Software framework for time-CRitical mAny-core systEmS) FP7-ICT-611016

CONCERTO (Guaranteed Component Assembly with Round Trip Analysis for Energy Efficient High-integrity Multi-core Systems) JU grant nr. 333053 | ARTEMIS/0003/2012

CarCoDe (Platform for Smart Car to Car Content Delivery) ITEA2 N° 11037, QREN N° 30345

ENCOURAGE (Embedded iNtelligent COntrols for bUIldings with Renewable generAtion and storaGE) JU grant nr. 269354 | ARTEMIS/0002/2010

International educational programs:

Active participation in the CMU Portugal Program (CMU-PT), namely in the doctoral programs in Electrical and Computer Engineering.

International Associations:

Member of HiPEAC 3 (European Network of Excellence on High Performance and Embedded Architecture and Compilation)

### **3.3.8 Other national publications (6000 ca.)**

(Void)

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

National Programs:

CISTER (13-14) (Projeto-Estratégico | Unidade de Investigação) FEDER (COMPETE) / FCT

BEST-CASE (New frontiers on embedded ICT & applications) NORTE-07-0124-FEDER-000063

PATTERN (Programming AbsTracTions for wireless sensor Networks) FCOMP-01-0124-FEDER-028990 | PTDC/EI-SCR/2171/2012

V-SIS (Sistema de Validação de Sistemas Críticos) QREN - SI I&DT Nr. 38923

AVIACC (Analysis and Verification of Concurrent Critical Programs) FCOMP-01-012244-FEDER-020486 | PTDC/EIA-CCO/117590

REGAIN (Real-time scheduling on general purpose graphics processor units) FCOMP-01-0124-FEDER-020447 | PTDC/EIA-CCO/118080/2010

SMARTS (Slack Management in Hierarchical Real-Time Systems) FCOMP-01-0124-FEDER-020536 | PTDC/EIA-CCO/121904/2010

Smartskin (Densely Instrumented Physical Infrastructures) FCOMP-01-0124-FEDER-020312 | PTDC/EEA-ELC/121753/2010

MASQOTS (Mobility mAnagement in wireless Sensor networks under Quality-of-service constraints using standard and Off-The-Shelf technologies) FCOMP-01-0124-FEDER-014922 | PTDC/EEA-TEL/112220/2009

VipCore (Virtual Processor-based Multicore Scheduling) FCOMP-01-0124-FEDER-015006 | PTDC/EIA-CCO/111799/2009

RePoMuC (Real-time Power management on partitioned MultiCores) FCOMP-01-0124-FEDER-015050 | PTDC/EIA-EIA/112599/2009

### 3.1 Group Description – C-BER

Research Group Title	Center for Biomedical Engineering Research
Principal Investigators	A. Campilho; J. Paulo Cunha
Research Area	Electrical and Computer Engineering
Home Institution	INESC TEC

### 3.2 Objectives & Achievements

#### 3.2.1 Objectives (4000 ca.)

##### FOREWORD

In 2013, INESC TEC created the group BRAIN - **Biomedical Research And INnovation**. The research herein developed had contributions of other INESC centers or units. The researchers in this area had strong contributions in the period of 2008-2012, particularly in Brain Imaging, Movement Quantification in Neurological Diseases and Wearable Wireless Vital Signs Monitoring. They participated in several projects at national and international level and also were co-founders of an international company.

In 2014, INESC TEC created a new Centre for Biomedical Engineering Research (C-BER), where researchers coming from the Bioimaging group from INEB – Biomedical Engineering Institute. joined researchers from the BRAIN and other INESC TEC researchers from the Bioinstrumentation field. The INEB Bioimaging group had strong contributions in image analysis and classification methodologies for lesion detection, segmentation and identification, useful for aiding the diagnosis process in several diseases, as retinal, genetic, pulmonary and vascular diseases. The Bioinstrumentation researchers developed expertise in Hyperspectral Single-pixel Imaging, Body Motion Characterization, and Bio-inspired Visual perception. They participated in several projects and also were co-founders of an international company, integrating knowledge and technology developed in the institute. In the mid of 2014, other researchers from UTAD Universidade de Trás-os-Montes e Alto Douro) integrated C-BER, opening the cooperation with an University of the North Region of Portugal.

This Centre benefits, furthermore, from the INESC TEC environment and from the active interaction with other research groups, namely in the areas of the cluster NIS – Network Intelligent Systems.

##### OBJECTIVES

The mission of C-BER is to promote knowledge through applied research, advanced training and innovation in Biomedical Engineering. The major goals of C-BER are:

- 1) to create interdisciplinary knowledge enabling the innovation and technology transfer with economic impact; the interdisciplinary aspect is intrinsic to BME (Biomedical Engineering) by the cooperation among engineers, physicists, medical doctors and other healthcare professionals; the interdisciplinary component is reinforced within INESC TEC environment through high level expertise in engineering, physics and mathematics domains.
- 2) to develop technological products, tools and methods for the prevention and early detection of different types of diseases, such as cancer (lung, breast), major prevalent diseases (diabetes, hypertension, cardiovascular), aging related impairments (Alzheimer, Parkinson or macular degeneration), or for human rehabilitation, physiotherapy or functional assessment.
- 4) to contribute to the development of advanced neurotechnologies at the frontier of engineering and neurology.

5) to promote strategic partnerships with: a) other centers of INESC TEC; b) clinical partners, from the main hospitals in the region; c) research institutes, particularly INEB and I3S; d) and with other international institutions.

Supported by the previous experience of the researchers of C-BER and aiming at achieving the goals above, the objectives of the 3 Labs are:

1) BioInstrumentation Lab (key papers (KPs): J. Applied Physiology 112 (1) , pp. 54-63, 2012; Optical Eng. 51 (7), 2012)

- Wearable Monitoring Systems - To develop methods and technologies for human rehabilitation and physiotherapy, active and independent living and sport performance by using advanced embedded and wearable technologies for personalized healthcare and long-term daily use.

- Embedded Visual Sensing - To develop new methods for human visual perception modelling, bioinspired vision sensors for human behaviour analysis, visual aids for human impairments or mobile robotics.

2) Biomedical imaging Lab (KPs: IEEE TMI 25 (9), pp. 1200-1213, 2006; IEEE IP, 23(3), pp. 1073-1083, 2014; Image Vision Comp. 28 (4), pp. 614-625, 2010; Disability and Rehabilitation: Assistive Tech., 1-8, 2013)

- Retina CAD – To design innovative methods and tools for the early detection/characterization of prevalent eye pathologies, supported by the detection of characteristic features and lesions in fundus layers, as retina and choroid, and the combination of data from distinct modalities (retinography, angiography, OCT – Optical Coherence Tomography)

- Carotid CAD: To measure macrovascular markers of arteriosclerosis as the intima-media thickness and plaque burden from carotid ultrasound images. The relation of these markers to the presence of cerebral small vessel diseases will be studied.

- Lung CAD – To create CAD and content-based image retrieval systems for pulmonary pathologies, relying on previous experience in lung nodule (particularly subtle nodules or non-solid nodules as ground glass opacities) detection and characterization of interstitial lung disease.

3) NeuroEngineering Lab

The NELab is organized in the following teams:

- NeuroMove – Movement quantification in neurological diseases (KP: Medical Eng. & Phys., 34(7), pp. 938-45, 2012).

- NeuroImaging – Brain imaging multimodal analysis and fusion (MRI, EEG, etc.); Reinforce the National Brain Imaging Research Network (<http://www.brainimaging.pt>), of which we constitute the UPorto node; Image guided and evaluation of neurosurgery procedures; neuro-prosthetics and brain stimulation devices; New optogenetics imaging systems for living neural tissues; Confocal neural imaging analysis (KP: Neuroimage, 84, pp. 435-42, 2014)

- Brain-Computer Interfaces (BCI) – new interaction paradigms based on EEG and other biosignals; wearable mobile interfaces; (KP: IEEE Trans. Intelligent Transportation Systems, 2015 (in Press)).

Common to the three research labs, there is a line of research to develop methods and tools for patient rehabilitation at home for the recovery of the motor function and the automatic assessment of functional abilities.

### **3.2.2 Main Achievements (4000 ca)**

2014 is the first year of activity of C-BER. Naturally, it has an impact on the achievements herein reported, some of them being a result of activities developed in a different environment.

During 2014 the following important achievements can be highlighted in different areas of activity as in publications, in supervision, projects and others.

#### PUBLICATIONS

High-Impact papers of C-BER:

Rozanski, V., C. Vollmar, J. P. S. Cunha, S. Tafula, S. A. Ahmadi, M. Patzig, J.-H. Mehrkens and K. Boetzel (2014). "Connectivity patterns of pallidal DBS electrodes in focal dystonia: a diffusion tensor tractography study." *Neuroimage* **84**: 435-442. [ISI IFactor = 6.252]

Donnet, S., R. Bartolo, J. M. Fernandes, J. P. S. Cunha, L. Prado and H. Merchant (2014). "Monkeys time their pauses of movement and not their movement-kinematics during a synchronization-continuation rhythmic task." *Journal of Neurophysiology* **111**(10): 2138-2149. [ISI IFactor = 3.301]

Behdad Dashtbozorg, Ana Maria Mendonça, and Aurélio Campilho, (2014) An Automatic Graph-based Approach for Artery/Vein Classification in Retinal Images, IEEE Trans. on Image Processing, Vol.23, no 3, pp. 1073-1083 [ISI IFactor = 3.111]

Aurélio Campilho authored **1** book and co-edited **3** books:

- Aurélio Campilho, Instrumentação Eletrónica. Métodos e Técnicas de Medição, 2nd edition, FEUP Edições, 2014.
- E Y K Ng, U Rajendra Acharya, Aurelio Campilho, Jasjit S. Suri (eds), Image Analysis and Modeling in Ophthalmology, CRC Press, 2014.
- Aurélio Campilho, Mohamed Kamel, Image Analysis and Recognition, Lecture Notes in Computer Science 2014, LNCS 8814, Part I, 2014

<http://link.springer.com/book/10.1007/978-3-319-11758-4>

- Aurélio Campilho, Mohamed Kamel, Image Analysis and Recognition, Lecture Notes in Computer Science 2014, LNCS 8815, Part II, 2014.

<http://link.springer.com/book/10.1007/978-3-319-11755-3>

Researchers of C-BER co-authored the following book chapters:

- Rui Rocha, Jorge Silva and Aurélio Campilho, Segmentation of carotid ultrasound images, Springer, L. Saba et al. (eds.), Multi-Modality Atherosclerosis Imaging and Diagnosis, Springer New York, pp. 269-286, 2014 (DOI 10.1007/978-1-4614-7425-8 21, © Springer ScienceCBusiness Media, LLC 2014.
- Ana Maria Mendonça, Behdad Dashtbozorg, Aurélio Campilho, Segmentation of the Vascular Network of the Retina, in E Y K Ng, U Rajendra Acharya, Aurelio Campilho, Jasjit S. Suri (eds), Image Analysis and Modeling in Ophthalmology, CRC Press, pp. 85-109, 2014.

Researchers of C-BER received a best poster award for the presentation:

Behdad Dashtbozorg, Ana Maria Mendonça, Susana Penas, Jorge Polónia, Aurélio Campilho, "RetinaCAD - Retinal Computer-Aided Diagnosis System", RecPad 2014, pp 46-47, 2014.

## SUPERVISION

C-BER researchers are supervising the two Post-doctoral grants:

Title: “Automatic characterization of atherosclerotic plaque in ultrasound images”, Bolsa de pós-doutoramento da FCT, contrato SFRH/BPD/79154/2011.

Researcher: José Rouco Maseda

Starting date: 1-Jan-2012; End date: 31-Dec-2014

Title: “3D detection and segmentation of pulmonar nodules in computerized tomography images”, Bolsa de pós-doutoramento da FCT, com o contrato DFRH - SFRH/BPD/85663/2012.

Investigador: Jorge Novo Buján

Researcher: Bolsa Pos-doutoramento

Starting date: 1-April-2013; End date: 31-Oct-2014.

C-BER researchers are supervising fifteen (15) PhD students and supervised eleven (11) M.Sc. students who concluded their thesis in 2014.

One of the PhD students engaged is a joint FEUP/CMU dual degree U.S. citizen student. He is currently at the Robotics Institute of CMU, Pittsburgh, PA.

## PROJECTS

A CMU-Portugal grant of \$1.2m was leaded by a C-BER member and started in 2014.

## OTHER

Aurélio Campilho is Associate Editor of the Machine Vision and Applications Elsevier Journal and is a member of Editorial Advisory Board of JTACS - Journal of Theoretical and Applied Computer Science, Polish Academy of Science. <http://www.itacs.org/sciboard>.

“RetinaCAD – Retinal Computer-Aided Diagnosis System” was presented in the competition iUP25K – and it was selected as one of the 10 best ideas for business (presented by Behdad Dashtbozorg, Ana Maria Mendonça, and Aurélio Campilho).

During the year, several initiatives have been launched to strengthen the interaction with other research groups within the INESC TEC universe. It worths mentioning the participation of several C-BER research groups in the INESC TEC Health Open Day.

## 3.3 Productivity

### 3.3.1 Publications in peer review Journals (6000 ca.)

Total number of publications: **11**

1. José Ramos, Thessa T. J. P. Kockelkorn, Isabel Ramos, Rui Ramos, Jan Grutters, Bram van Ginneken, Max A. Viergever, and Aurélio Campilho, Content Based Image Retrieval by Metric Learning from Radiology Reports: Application to Interstitial Lung Diseases, IEEE Journal of Biomedical and Health Informatics (online), 2014.
2. Rui Rocha, Jorge Silva, Aurélio Campilho, Automatic detection of the carotid lumen axis in B-mode ultrasound images, Computer Methods and Programs in Biomedicine 115 (2014), pp. 110-118.

3. Behdad Dashtbozorg, Ana Maria Mendonça, and Aurélio Campilho, An Automatic Graph-based Approach for Artery/Vein Classification in Retinal Images, *IEEE Trans. on Image Processing*, Vol.23, no 3, pp. 1073-1083, 2014.
4. Rozanski, V., C. Vollmar, J. P. S. Cunha, S. Tafula, S. A. Ahmadi, M. Patzig, J.-H. Mehrkens and K. Boetzel (2014). "Connectivity patterns of pallidal DBS electrodes in focal dystonia: a diffusion tensor tractography study." *Neuroimage* **84**: 435-442.
5. Donnet, S., R. Bartolo, J. M. Fernandes, J. P. S. Cunha, L. Prado and H. Merchant (2014). "Monkeys time their pauses of movement and not their movement-kinematics during a synchronization-continuation rhythmic task." *Journal of Neurophysiology* **111**(10): 2138-2149.
6. Soraia Pereira, Cláudia C Silva, Sílvia Ferreira, Cláudia Silva, Nuno Oliveira, Rubim Santos, John P. Vilas-Boas, and Miguel V. Correia. Anticipatory postural adjustments during sitting reach movement in post-stroke subjects. *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology*, 24(1):165-71, March 2014.
7. Andry Maykol Pinto, Miguel V. Correia, A. Paulo Moreira, and Paulo G. Costa. Unsupervised flow-based motion analysis for an autonomous moving system. *Image and Vision Computing*, 32(6-7):391-404, April 2014.
8. Andry Maykol Pinto, Paulo G. Costa, Miguel V. Correia, and A. Paulo Moreira. Enhancing dynamic videos for surveillance and robotic applications: The robust bilateral and temporal filter. *Signal Processing: Image Communication*, 29(1):80-95, January 2014.
9. Antonio J. Salazar, Ana S. Silva, Claudia Silva, Carla M. Borges, Miguel V. Correia, Rubim S. Santos, and João P. Vilas-Boas. Low-cost wearable data acquisition for stroke rehabilitation: a proof-of-concept study on accelerometry for functional task assessment. *Topics in stroke rehabilitation*, 21(1):12-22, 2014.
10. Antonio José Salazar Escobar, José Machado da Silva, Miguel Velhote Correia, and Bruno José Mendes. Built-in self-testing methodology and infrastructure for an EMG monitoring sensor module. *International Journal on Advances in Systems and Measurements*, 7(1):68-79, 2014.
11. Cláudia C Silva, Augusta Silva, Andreia Sousa, Ana Rita Pinheiro, Catarina Bourlinova, Ana Silva, António Salazar, Carla Borges, Carlos Crasto, Miguel Velhote Correia, João Paulo Vilas-Boas, and Rubim Santos. Co-activation of upper limb muscles during reaching in post-stroke subjects: An analysis of the contralesional and ipsilesional limbs. *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology*, 24(5):731-8, October 2014.

### 3.3.2 Other international publications (6000 ca.)

Total number of publications: **24**

**1** Book and **2** Proceeding volumes by major international publishers

1. E Y K Ng, U Rajendra Acharya, Aurelio Campilho, Jasjit S. Suri (eds), *Image Analysis and Modeling in Ophthalmology*, CRC Press, 2014.
2. Aurélio Campilho, Mohamed Kamel, *Image Analysis and Recognition, Lecture Notes in Computer Science 2014, LNCS 8814, Part I*, 2014

<http://link.springer.com/book/10.1007/978-3-319-11758-4>

3. Aurélio Campilho, Mohamed Kamel, *Image Analysis and Recognition, Lecture Notes in Computer Science 2014, LNCS 8815, Part II*, 2014.

<http://link.springer.com/book/10.1007/978-3-319-11755-3>

## 2 Book Chapters by major international publishers

- 1 Rui Rocha, Jorge Silva and Aurélio Campilho, Segmentation of carotid ultrasound images, Springer, L. Saba et al. (eds.), Multi-Modality Atherosclerosis Imaging and Diagnosis, Springer new York, pp 269-286, 2014 (DOI 10.1007/978-1-4614-7425-8 21, © Springer ScienceCBusiness Media, LLC 2014.
- 2 Ana Maria Mendonça, Behdad Dashtbozorg, Aurélio Campilho, Segmentation of the Vascular Network of the Retina, in E Y K Ng, U Rajendra Acharya, Aurelio Campilho, Jasjit S. Suri (eds), Image Analysis and Modeling in Ophthalmology, CRC Press, pp. 85-109, 2014.

## 19 full paper articles and 3 abstracts in international conferences

1. Behdad Dashtbozorg, Ana Maria Mendonça, Susana Penas, and Aurélio Campilho, Computer-aided Diagnosis System for the Assessment of Retinal Vascular Changes, MICCAI 2014 Ophthalmic Medical Image Analysis Workshop, pp 9-16, 2014.
2. José Rouco, Jorge Novo, Aurélio Campilho, On the Automatic Normalization of Plaque Regions in Ultrasound Images of the Carotid, Image Analysis and Recognition, Lecture Notes in Computer Science 2014, LNCS 8815, pp 177-184, 2014.
3. J. Novo, J. Rouco, A. Mendonça, Aurélio Campilho, Reliable Lung Segmentation Methodology by Including Juxtapleural Nodules, Image Analysis and Recognition, Lecture Notes in Computer Science 2014, LNCS 8815, pp 227-235, 2014.
4. F. Sattar, Aurélio Campilho, M. Kamel, Optic Disk Localization for Gray-Scale Retinal Images Based on Patch Filtering, Image Analysis and Recognition, Lecture Notes in Computer Science 2014, pp 277-284, 2014.
5. Behdad Dashtbozorg, Ana Maria Mendonça, and Aurélio Campilho, Assessment of Vascular Changes in Retinal Images, MeMea - IEEE International Symposium on Medical Measurements and Applications, Lisbon, Portugal, pp. 19-22, 2014.
6. Behdad Dashtbozorg, Ana Maria Mendonça, Susana Penas, Aurélio Campilho, RetinaCAD, a system for the assessment of retinal vascular changes, Engineering in Medicine and Biology Society (EMBC), 2014 36th Annual International Conference of the IEEE, Chicago, USA, pp. 6328-6331, 2014.
7. Daniela Campos, André Simões, Isabel Ramos, Aurélio Campilho, Feature-Based Supervised Lung Nodule Segmentation, The International Conference on Health Informatics, Vol. 42, pp. 23-26, 2014.
8. Daniel Dezan De Bona, Maria A. Marques, and Miguel V. Correia. Instrumentation of a surfboard to evaluate surfing performance. In 11th International Conference on Remote Engineering and Virtual Instrumentation (REV), pages 339-343. IEEE, February 2014.
9. Daniel Dezan de Bona, Maria Arcelina Marques, Marcio Borgonovo-Santos, and Miguel Velhote Correia. Monitoring of plantar forces and surfboard's movement: Alternative to understand the injuries mechanism. 2014 IEEE International Symposium on Medical Measurements and Applications (MeMeA), pages 1-4, June 2014.
10. Mario Saenz Espinoza and Miguel Velhote Correia. Setting the Criteria for the MATHOV + QAVS Tool - Qualitative and Quantitative Aspects for Wearable Fall Prediction. In Proceedings of the International Conference on Bio-inspired Systems and Signal Processing, pages 69-75, Angers, March 2014. SCITEPRESS - Science and Technology Publications.
11. C. M. B. Rodrigues, M. V. Correia, J. M. C. S. Abrantes, J. Nadal, and M. A. B. Rodrigues. A sensibilidade dos testes paramétricos vs robustez dos não paramétricos e as diferenças na comparação de parâmetros discretos do movimento do cg em diferentes cae's. In XXIV Congresso Brasileiro de Engenharia Biomédica - CBEB 2014, pages 2908-2911, Uberlândia - MG, Brasil, October 2014.

12. C. M. B. Rodrigues, M. V. Correia, J. M. C. S. Abrantes, J. Nadal, and M. A. B. Rodrigues. Diferenças entre a comparação intra e inter-sujeitos de parâmetros biomecânicos discretos. In XXIV Congresso Brasileiro de Engenharia Biomédica “CBEB 2014”, pages 2895-2898, Uberlândia - MG, Brasil, October 2014.
13. C. M. B. Rodrigues, M. V. Correia, J. M. C. S. Abrantes, J. Nadal, and M. A. B. Rodrigues. O efeito da normalização e outros fatores de escala na comparação de parâmetros biomecânicos discretos. In XXIV Congresso Brasileiro de Engenharia Biomédica “CBEB 2014”, pages 2904-2907, Uberlândia - MG, Brasil, October 2014.
14. C. M. B. Rodrigues, M. V. Correia, J. M. C. S. Abrantes, J. Nadal, and M. A. B. Rodrigues. Variabilidade inter-sujeitos da força de reação do solo em diferentes saltos como medida de controle postural. In XXIV Congresso Brasileiro de Engenharia Biomédica “CBEB 2014”, pages 2862-2865, Uberlândia - MG, Brasil, October 2014.
15. C. M. B. Rodrigues, M. V. Correia, J. Nadal, C. M. P. Carvalho, and J. M. C. S. Abrantes. Phase space analysis of whole body movement for different human lower limb SSC. In 7th World Congress of Biomechanics, page abstract, Boston, Massachusetts, USA, July 2014.
16. A. P. Rocha, H. Choupina, J. M. Fernandes, M. J. Rosas, R. Vaz, and J. P. Silva Cunha, "Parkinson's disease assessment based on gait analysis using an innovative RGB-D camera system," in *Engineering in Medicine and Biology Society (EMBC), 2014 36th Annual International Conference of the IEEE*, 2014, pp. 3126-3129.
17. S. M. Neves Tafula, N. Moreira da Silva, V. E. Rozanski, and J. P. Silva Cunha, "ABrIL - Advanced Brain Imaging lab.: A cloud based computation environment for cooperative neuroimaging projects," in *Engineering in Medicine and Biology Society (EMBC), 2014 36th Annual International Conference of the IEEE*, 2014, pp. 534-537.
18. N. Moreira da Silva, R. Rego, and J. P. S. Cunha, "3D multimodal visualization of subdural electrodes with cerebellum removal to guide epilepsy resective surgery procedures," presented at the ICIAR 2014, 2014.
19. F. A. Carpinteiro, P. M. Costa, M. S. Espinoza, I. M. Silva, and J. P. S. Cunha, "NeuronDynamics: A Method for Neurotransmitter Vesicle Movement Characterization in Neurons," presented at the 2014 IEEE International Symposium on Biomedical Imaging (ISBI 2014), Beijing, China, 2014.
20. Behdad Dashtbozorg, Ana Maria Mendonça, Aurélio Campilho, Artery/Vein Classification in Retinal Images, Bioimaging 2014 | 3rd International Symposium in Applied Bioimaging | Life in a Pixel, pp 32, 16-17 Oct, 2014.
21. M. Duarte, J. Rouco, C. Ferreira, E. Azevedo, J. Polónia, A. Campilho, Automatic measurement of atherosclerotic plaque burden in B-mode ultrasound images of the carotid, Bioimaging 2014 | 3rd International Symposium in Applied Bioimaging | Life in a Pixel, pp 51, 16-17 Oct, 2014.
22. G. Aresta, T. Finisterra, J. Rouco, C. Ferreira, E. Azevedo, A. Campilho, Movement analysis of the human carotid wall on medical ultrasounds using an optical flow based approach, Bioimaging 2014 | 3rd International Symposium in Applied Bioimaging | Life in a Pixel, pp 52, 16-17 Oct, 2014.

### 3.3.3 Ph.D. thesis completed (3000 ca.)

Title: Wearable sensors systems for human motion analysis: sports and rehabilitation

Student: Ana Sofia Matos Silva

Degree: Doctoral Program in Biomedical Engineering

Supervisor: Miguel Velhote Correia

Conclusion date: 25-JUL-2014

On-going PhD work: **13**

Title: Content Based Image Retrieval in Biomedical Images

Student: José Ricardo Ferreira de Castro Ramos

Degree: Doctoral Program in Electrical and Computer Engineering

Role: Aurélio Campilho (Supervisor)

Title: Advanced Image Analysis for the Assessment of Retinal Vascular Changes

Student: Behdad Dasht Bozorg

Degree: Doctoral Program in Electrical and Computer Engineering

Role: Ana Maria Mendonça (Supervisor) Aurélio Campilho (Co-supervisor)

Title: Segmentação e Classificação de Imagem Médica: Caracterização de nódulos pulmonares não sólidos e parcialmente sólidos

Student: Daniela Marisa da Silva Campos

Degree: Doctoral Program in Electrical and Computer Engineering

Role: Aurélio Campilho (Supervisor)

Title: Advanced Methods for Optical Coherence Tomography Choroidal Image Analysis

Student: Raul de Medina Prata Pinheiro

Degree: Doctoral Program in Electrical and Computer Engineering

Role: Ana Maria Mendonça (Supervisor) Jorge Silva (Co-supervisor)

Title: Computational algorithms for image analysis: Applications on human vocal tract and silhouette

Student: Maria João Medeiros de Vasconcelos

Degree: Doctoral Program in Informatics Engineering

Co-supervisor: Miguel Velhote Correia

Conclusion date: 23-MAR-2015

Title: Mixed-signal Test and Measurement Framework for Wearable Monitoring System

Student: António José Salazar Escobar

Degree: Doctoral Program in Electrical and Computer Engineering

Supervisor: Miguel Velhote Correia

Conclusion date: 07-JAN-2015

Title: On-chip vision processing based on sparse coding and dictionary learning

Student: Hugo Daniel Rodrigues Gonçalves

Degree: Doctoral Program in Electrical and Computer Engineering

Supervisor: Miguel Velhote Correia

Title: Wearable fall assessment and prediction system

Student: Mario Rodolfo Sáenz Espinoza

Degree: Doctoral Program in Biomedical Engineering

Supervisor: Miguel Velhote Correia

Title: Motion recognition: a biologically inspired approach

Student: Daniel Monteiro Basso

Degree: Doctoral Program in Electrical and Computer Engineering

Supervisor: Miguel Velhote Correia

Title: Movement patterns of the upper limb in human subjects using accelerometry and electromyography

Student: Carla Mariana Borges da Silva

Degree: Doctoral Program in Biomedical Engineering

Supervisor: Miguel Velhote Correia

Title: The exaltation of a sense - haptic art

Student: Sandra Mónia Couto Coelho

Degree: Doctoral Program in Digital Media

Supervisor: Miguel Velhote Correia

Title: Detection, characterization and evaluation of posture, and upper-limbs movements in stroke patients by means of sensor fusion

Student: Pedro Filipe Pereira da Fonseca

Degree: Doctoral Program in Biomedical Engineering

Supervisor: Miguel Velhote Correia

Title: Bio-signal analysis for neuromuscular control assessment: application to the stretch-shortening cycle in the human locomotion system

Student: Carlos Manuel Barbosa Rodrigues

Degree: Doctoral Program in Biomedical Engineering

Supervisor: Miguel Velhote Correia

Title: Motor impairment assessment in TTR Familial Amyloid Polyneuropathy

Student: Maria do Carmo Sousa Cardoso Vilas-Boas

Degree: Doctoral Program in Biomedical Engineering

Supervisor: João Paulo Silva Cunha

Title: Personalized stress and fatigue monitoring with wearable human sensing

Student: Dustin Axman

Degree: Dual degree in ECE, CMU-Portugal (ECE PhD program CMU, Pittsburgh / Doctoral Program in ECE, FEUP)

Supervisor: João Paulo Silva Cunha

### 3.3.4 Patents/prototypes (2000 ca.)

- List of Patents

V. Tedim, J. P. S. Cunha, V. Bento, "System and method for proprioceptive stimulation, movement, monitoring and characterization", Patent WO 2014/006563 A2, 2014.

- List of Prototypes

- RetinaCAD – Retinal Computer-Aided Diagnosis System
- Wivern – A clinical framework for advanced data analysis in vascular research
- Developed under the project: Vascular Image Analysis in Carotid and Retinal Images
- Plaque Segmentation
- Reduction of false candidates in nodule detection in CT lung images
- Vital Responder platform
- KinectEpilep – RGB-D Epileptic Seizure Movement Quantification
- NeuroKinect - RGB-D Neurological Diseases Movement Quantification
- ABriL – Advanced Brain Imaging Lab
- NeuronDyn - Live Neurotransmitter Vesicle Movement Dynamics in Living Neurons
- SenseMyHeart – HRV and cardiac intensity webservice

### 3.3.5 Organization of Conferences (2000 ca.)

- Aurélio Campilho, VI Jornadas de Bioengenharia, Faculdade de Engenharia da Universidade do Porto, 21-22 November 2014 (Scientific Committee, Session Chair of Tech in Health: from Substitution to Diagnosis).
- Aurélio Campilho, ICIAR 2014 - International Conference on Image Analysis and Recognition, Vilamoura, Portugal, 22-24 October 2014 (General Chair).  
<http://www.aimiconf.org/iciar14/index.php>
- Aurélio Campilho, ICPR 2014 – International Conference on Image Analysis, Track: Biomedical Image Analysis – Area Chair  
<http://www.icpr2014.org/track-and-area-chairs.htm>
- Aurélio Campilho, Bioimaging 2014 | 3<sup>rd</sup> International Symposium in Applied Bioimaging | Life in a Pixel, 16-17 outubro, 2014. (Scientific Committee)

[http://www.bioimaging2014.ineb.up.pt/SCIENTIFIC\\_COMMITTEE.html](http://www.bioimaging2014.ineb.up.pt/SCIENTIFIC_COMMITTEE.html)

- Aurélio Campilho, RecPad 2014 – 20<sup>th</sup> ed of the Portuguese Conference on Pattern Recognition, (Technical Committee), <http://recpad2014.di.ubi.pt/>
- Jorge Silva, ICIAR 2014 - International Conference on Image Analysis and Recognition, Vilamoura, Portugal, 22-24 October 2014 (Organizing Committee & Scientific Committee)

Other program Committees

- CIARP 2014 19 th Iberoamerican Congress on Pattern Recognition

### **3.3.6 Industry contract research (2000 ca.)**

National direct RTD contracts: **2**

EcoDrive, Card4B SA

Hermes, Tech4Home Lda

### **3.3.7 Internationalization (2000 ca.)**

*Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the international level*

International projects: none; International consultancy: none

International educational programs

Active participation in the Carnegie Mellon | Portugal Program (MPP), namely in the doctoral program on Electrical and Computer Engineering. This participation is an important opportunity for the exchange of information and experiences.

Aurélio Campilho is the Director of the Doctoral Program in Electrical and Computer Engineering, one of the degrees integrated in the dual doctoral program under the Carnegie Mellon | Portugal Program.

João Paulo Cunha is serving as “Scientific Director” of the Carnegie Mellon | Portugal program.

Aurélio Campilho participated in the Erasmus Intensive Program 2014, “BioElectronics for Medical Engineering (BELEM), Bordeaux, France, April 7, 2014.

International Associations

Vice-President da AIMI – Association for Image and Machine Intelligence, Canadá, since October, 2006.

Senior Member of IEEE – Institute of Electrical and Electronics Engineers.

Number of books in cooperation with authors from foreign institutions: **03**

Number of papers in journals in cooperation with authors from foreign institutions: 03 in 2014

### **3.3.8 Other national publications (6000 ca.)**

1. Behdad Dashtbozorg, Ana Maria Mendonça, Susana Penas, Jorge Polónia, Aurélio Campilho, “RetinaCAD - Retinal Computer-Aided Diagnosis System”, RecPad 2014, pp 46-47, 2014 (Best poster award).

### **3.3.9 Government/Organization contract research (2000 ca.)**

*Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice*

National programs – FCT:

QREN:

Participation in sectorial initiatives

## 4 RESEARCH LINES

*In this section you can see the individual Research Lines reported in the last form as well as the Research Groups involved in each RL. They can be accessed by clicking the Research line's name or its unique identifier.*

Reference	Research Line Title
RL-FIS-LA14-182	Networked Multimedia Systems and Services in Scenarios of Convergence
RL-EEI-LA14-183	Photonics for Life Sciences: Optical Biochemical Sensing and Imaging
RL-EEI-LA14-184	Sustainable Energy Systems and the Smart Grid
RL-EEI-LA14-185	Enterprise Collaborative Networks, Operations Management and Decision Support Systems
RL-EEI-LA14-186	Digital Society – Software, Information and Interaction Technology, Services and Policies
RL-FIS-LA14-187	Robotics, Intelligent and Autonomous Systems for Complex Environments
RL-EEI-LA14-188	Intelligent and Adaptive Systems and Mathematical Modeling in Decision Support
RL-EEI-LA14-189	Architectures, Languages and Systems for Advanced Computing
RL-EEI-LA14-190	Real-Time Embedded Systems for Smart Environments
RL-EEI-LA14-191	Critical Information Systems – Dependable Software, Development Methods and Tools
RL-EGE-LA14-192	Technology and Innovation Management
RL-EME-LA14-193	Industrial Engineering and Service Management

#### 4.1 General Description (RL-FIS-LA14-182)

Research Line Title	NETWORKED MULTIMEDIA SYSTEMS AND SERVICES IN SCENARIOS OF CONVERGENCE
Principal Investigator	Manuel Alberto Pereira Ricardo
Research Area	Electrical and Computer Engineering

#### 4.2 Objectives and Achievements (RL-FIS-LA14-182)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 General Objectives (1000 ca.)

This Research Line (RL) envisions a lively and sustainable world where networked intelligence enables ubiquitous interaction with sensory-rich content. The RL defines as its mission the development of advanced systems and technologies enabling high capacity, efficient, and secure communications, media knowledge extraction, and immersive ubiquitous multimedia applications. This mission will be accomplished by directing the research activities towards (a) the extraction and processing of knowledge from media, (b) the development of pervasive multimedia applications by combining context-aware technology with creative skills and empowering social engagement, (c) the development of self-manageable, scalable, secure, and context-aware wireless networks, and (d) the development of technologies for optical and wireless communication systems, supported in signal processing techniques, radio devices, design and test of circuits, and reconfigurable digital systems.

##### 4.2.2 Main Achievements (2000 ca.)

###### RESEARCH GROUP INTERACTION AND CROSS-RG COOPERATION

This RL is tied to the research activities carried out by the Centre for Telecommunications and Multimedia Unit (CTM). Interaction with other Units was achieved in the following projects that required cooperation among several RG:

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL3 - NETWORK SENSING FOR CRITICAL SYSTEMS MONITORING, cooperation with CAP

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL4 - Cooperation and perception for augmented autonomy, cooperation with CROB

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL5 – Smartgrids, cooperation with CPES

SUNNY - Smart UNattended airborne sensor Network for detection of vessels used for cross border crime and irregular entrY, cooperation with CROB

CNG – Content for Next Generation Networks, with USIG

Escolinhas Criativas – Creative Spaces for Creative Kids, with USIG

PGlobal - Publico Global, with USIG

MAIN RESULTS – just a few examples are given, selected from projects mentioned above:

SUNNY - specification of SUNNY communications architecture and functional model based on information flows for maritime surveillance employing different sensors onboard unmanned aerial vehicles (UAVs).

CNG - a client-server prototype for personalised immersive environments. A system that presents 3D multi-view video content to users, transparently adapting the perspective of the scene according to the focus of attention of the viewer, using eye-gaze and head tracking information.

Escolinhas Criativas - a collaborative tool for annotating multimedia content based on the concepts of Game With a Purpose.

### **4.3 Research Line Output (RL-FIS-LA14-182)**

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### **4.3.1 Collaborative Publications in peer review Journals (2000 ca.)**

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter and intra-Centre.

ABREU, C., MIRANDA, F., RICARDO, M., MENDES, P. M., QoS-based management of biomedical wireless sensor networks for patient monitoring, SpringerPlus 2014, 3:239, doi:10.1186/2193-1801-3-239.

COSTA, D., SILVA, I., GUEDES, L., VASQUES, F., PORTUGAL, P., Availability Issues in Wireless Visual Sensor Networks, Sensors 2014, vol. 14, no. 2, pp. 2795-2821.

IORGA, R., BORCOCI, E., MIRUTA, R., PINTO, A., CARNEIRO, G., CALCADA, T., Management driven hybrid multicast framework for content aware networks, IEEE Communications Magazine, vol.52, no.1, pp.158-165, Jan. 2014.

ABREU, C., RICARDO, M., MENDES, P.M., Energy-Aware Routing for Biomedical Wireless Sensor Networks, in Journal of Network and Computer Applications, Vol. 40 (2014), pp. 270–278.

PINTO, A. R., MONTEZ, C., ARAÚJO, G., VASQUES, F., PORTUGAL, P., An Approach to Implement Data Fusion Techniques in Wireless Sensor Networks using Genetic Machine Learning Algorithms, Information Fusion, 2013.

COSTA, D., GUEDES, L., VASQUES, F., PORTUGAL, P., Energy-Efficient Packet Relaying in Wireless Image Sensor Networks Exploiting the Sensing Relevancies of Source Nodes and DWT Coding, Journal of Sensor and Actuator Networks, 2013.

Pedro Silva , Maria Teresa Andrade , Pedro Carvalho , Jorge Mota, A Structured and Flexible Language for Physical Activity Assessment and Characterization, journal of sports medicine, pp.-, 2013.

Dimensions as Virtual Items: Improving the Predictive Ability of Top-N Recommender Systems (M. Domingues, A. Jorge, C. Soares), In Information Processing & Management, volume 49, 2013.

Combining usage and content in an online recommendation system for music in the Long Tail (M. Domingues, F. Gouyon, A. Jorge, J. Leal, J. Vinagre, L. Lemos, M. Sordo), In International Journal of Multimedia Information Retrieval, volume 2, 2013.

#### **4.3.2 Collaborative Other Publications (2000 ca.)**

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.

TEIXEIRA, F., FREITAS, P., PESSOA, L., CAMPOS, R., RICARDO, M., Evaluation of IEEE 802.11 Underwater Networks Operating at 700 MHz, 2.4 GHz and 5 GHz, in Proc. of WUWNet'14, Rome, Italy, Nov. 2014.

MÓNICA, P. et al., TEC4SEA - A Modular Platform for Research, Test and Validation of Technologies Supporting a Sustainable Blue Economy, in Proc. of OCEANS'14, St. John's, Canada, Sep. 2014.

LOPES, M., TEIXEIRA, F., MAMEDE, J., CAMPOS, R., Wi-Fi Broadband Maritime Communications Using 5.8 GHz Band, in Proc. of UComms'14, Sestri Levante, Italy, Sep. 2014.

RUA, D., LOPES, J. A., RUELA, J., Communications Uncertainties in Isolated Multi-Microgrid Control Systems, in Proc. of the 18th Power Systems Computation Conference (PSCC 2014), Wroclaw, Poland, August 2014.

ABDELLATIF, M., OLIVEIRA, J., RICARDO, M., Neighbors and Relative Location Identification Using RSSI in a Dense Wireless Sensor Network, in Proc. of the 13th IEEE IFIP Annual Mediterranean Ad Hoc Networking Workshop - Med-Hoc-Net 2014

ABDELLATIF, M., OLIVEIRA, J., RICARDO, M., The Effect of Data Aggregation on the Performance of a Wireless Sensor Network Employing a Polling Based Data Collecting Technique, in Proc. of the IFIP Wireless Days 2013, Valencia, Spain, 13-15 Nov. 2013.

RIBEIRO, F., CAMPOS, R., RUA, D., PINHO, C., RUELA, J., PACE: Simple Multi-hop Scheduling for Single-radio 802.11-based Stub Wireless Mesh Networks, in Proc. of the IEEE WiMob CNBuB'13 workshop, Lyon, France, Oct. 2013.

#### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative theses within the framework of the RL.

G. Bernardes, Composing Music by Selection: Content-Based Algorithmic-Assisted Audio Composition, PhD thesis, Faculty of Engineering, University of Porto, 2014

Andre Miguel Passos Baltazar, "Zatlab: Recognizing gestures for artistic performance interaction", Univ. Catolica, 2014

Helder Filipe Pinto de Oliveira, "3D Computational Models for the Evaluation of the Aesthetic Result of Breast Cancer Interventions", Faculty of Engineering, University of Porto, 2013

Calçada, T., Topology Aware Channel Assignment in Single-radio Stub Wireless Mesh Networks, January 2013.

Duarte dos Santos, C.M., "High-Efficiency Linear Transmitters for Mobile Communication Systems", July 2014

Bahubalindrani, P.G.M., "Analog/Mixed Signal Circuit Design with Transparent Oxide Semiconductor Thin-Film Transistors", Dec. 2014.

Mário Rui Silveira Pereira, "Inverse Scattering Techniques for the Synthesis of Microwave Structures", Jul. 2014

Luís Manuel Couto Oliveira, "The effect of optical clearing in the optical properties of skeletal muscle tissue", Nov. 2014

OANCEA, D., "An adaptive cross-layer framework for multimedia delivery over heterogeneous networks", December 2014.

#### 4.1 General Description (RL-EEI-LA14-183)

Research Line Title	PHOTONICS FOR LIFE SCIENCES: OPTICAL BIOCHEMICAL SENSING AND IMAGING
Principal Investigator	Paulo Vicente Silva Marques
Research Area	Physics

#### 4.2 Objectives and Achievements (RL-EEI-LA14-183)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 Objectives (1000 ca.)

Coordinator in 2013 and 2014: Prof. Paulo Marques.

Optical sensing and imaging technologies have been the main activity of UOSE throughout the last decade resulting in the creation of an advanced dedicated infrastructure and trained human resources with great expertise in material science, optical fibre, integrated optics technology and imaging systems. The strategic goal of this RL is to optimise these multidisciplinary assets, directing them towards research and technology valorisation, in the following areas.

##### SENSORS DEVELOPMENT

- Novel sensing mechanisms
- Extreme environments applications
- Biochemical sensing
- OPTICAL IMAGING
- Development of Differential Optical Coherence Tomography
- Compressive imaging and Hyper-spectral analysis

##### MICROFABRICATION & INTEGRATED OPTICS

- Direct writing with femtosecond laser pulses.

##### TECHNOLOGY TRANSFER

While the main focus of the activity of the RL is upstream in the knowledge production chain, nevertheless strategic partnerships with national and international companies will be pursued.

##### 4.2.2 Main Achievements (2000 ca.)

New FDTD based theoretical models for the study and evaluation of new optical fiber tweezers geometries and the manipulation of complex cell shapes

Test and comparison of the polymer tweezers with tweezers fabricated by chemical etching

Fabrication of new fiber micro structures using focused ion beam suitable for trapping and transfer of angular

momentum to the cells (introducing the ability to spin the cells).

Preliminary results were obtained indicating the ability to combine trapping with sensing using the same fibre probe. Such results are an important step towards single cell analytics.

Two different systems for femtosecond laser processing of materials were assembled: one for laser direct writing on planar substrates and the other for device fabrication on optical fibers. The devices fabricated include first order Bragg gratings written by point by point in both in planar and fiber formats. A full characterization of the process was done (pulse frequency, power, writing velocity, focal point depth).

Optical fiber sensor for hydrogen and metals

Microstructured fiber for vapour and liquid sensing

### **4.3 Research Line Output (RL-EEI-LA14-183)**

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### **4.3.1 Collaborative Publications in peer review Journals (2000 ca.)**

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

1. Martins, H.F., Martin-Lopez, S., Corredera, P., L. Filigrano, M., Frazão, O., González-Herráez, M., "Coherent noise reduction in high visibility phase sensitive optical time domain reflectometer for distributed sensing of ultrasonic waves", *Journal of Lightwave Technology*, December 2013, vol.31, no.23, p.3631-3637.
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5. Pereira, G., Frias, C., Faria, H., Frazão, O., T. Marques, A., "Study of strain-transfer of FBG sensors embedded in unidirectional composites", *Polymer Testing*, September 2013, vol.36, no.6, p.1006-1010.
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9. Mota, D., Romaguera, Y., Tkach, A., Cruz, J., Vilarinho, P., Tavares, P., Moreira, J.A., Almeida, A., "Substrate-induced polar ground state in KTaO<sub>3</sub> thin films up to high temperatures", *Journal of Applied Physics*, July 2013, vol.114, no.3, p.34101-34101.
10. Martins Lopes, C., Fernandes, J.R., Martins-Lopes, P., "Application of Nanotechnology in the Agro-Food Sector", *Food Technology and Biotechnology*, June 2013, vol.51, no.2, p.183-197.

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12. M. Silva, R., Layeghi, A., I. Zibaii, M., Latifi, H., Santos, J.L., B. Lobo Ribeiro, A., Frazão, O., "Interrogation sensing scheme based on 'Figure-of-Eight' fiber loop mirror configuration", *IEEE Photonics Technology Letters*, April 2013, vol.25, no.8, p.745-748.
13. Martins, H.F., Martins-Lopez, S., Corredera, P., Salgado, P., Frazão, O., González-Herráez, M., "Modulation instability-induced fading in phase-sensitive optical time-domain reflectometry", *OPTICS LETTERS*, March 2013, vol.38, no.6.
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36. Perez-Rivero, A., Ricote, J., Bretos, I., Calzada, M., Cruz, J., Fernandes, J.R., Jimenez, R., "Morphotropic phase boundary in solution derived (Bi<sub>0.5</sub>Na<sub>0.5</sub>)<sub>1-x</sub>Ba<sub>x</sub>TiO<sub>3</sub> thin films: Functional properties II.", *Journal of the American Ceramic Society*, April 2014, vol.97, no.4, p.1276-1282.
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39. Roriz Oliveira, P., Ferreira, J., Potes, J., Oliveira, M.T., Frazão, O., Santos, J.L., Simoes, J., "In vivo measurement of the pressure signal in the intervertebral disc of an anesthetized sheep", *Journal of Biomedical Optics*, March 2014, vol.19, no.3, p.370061-370066.
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49. Marques Martins de Almeida, J.M., Machado, N., Gouvinhas, I., Cunha, M., Barros, A., "Quantification of Chemical Characteristics of Olive Fruit and Oil of cv Cobrançosa in Two Ripening Stages Using MIR Spectroscopy and Chemometrics", *Food Analytical Methods* 2014, Food Analytical Methods.
50. Correia, A., Carmelo Rosa, C., Santos, P., Falcao, A., Lorentz, K., "Real-time dosimeter targeted to nuclear applications", *Proceedings of SPIE - The International Society for Optical Engineering* 2014, vol.9286.
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#### 4.3.2 Collaborative Other Publications (2000 ca.)

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

1. Ferreira, M.S., Bierlich, J., Unger, S., Schuster, K., Santos, J.L., Frazão, O., "Post-Processed Fabry-Pérot Microcavity Tip Sensors for Temperature Measurement", *WSOF-2013 - workshop on specialty optical fibers*, August 2013, Sigtuna, , Sweden,.
2. André, R.M., Marques, M.J., Mergo, P., Frazão, O., "Simple micro-interferometers based on twin-core fiber", *WSOF-2013 - workshop on specialty optical fibers*, August 2013, Sigtuna, , Sweden,.
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5. Martins, H.F., Martin-Lopez, S., Corredera, P., L. Filograno, M., Frazão, O., González-Herráez, M., "Characterization of a phase-sensitive optical time domain reflectometer used for distributed sensing of vibrations and its performance limits due to modulation instability", *OPTOEL2013 - Reunión Española de Optoelectrónica*, July 2013, Alcalá de Henares, Spain.

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9. Rodriguez-Cobo, L., T. Marques, A., M. Lopez-Higuera, J., Santos, J.L., Frazão, O., "Simplified sensor design for temperature-strain discrimination using Fiber Bragg Gratings embedded in laminated composite", EWOFs 2013 - 5th European Workshop on Optical Fibre Sensors, May 2013, vol.8794, no.1, Kraków, Poland, p.1-4.
10. Nascimento, I.M., Chesini, G., Sousa, M., Osório, J., Baptista, J.M., Cordeiro, C., Jorge, P., "Application of a Photonic Crystal Fiber LPG for vibration monitoring", EWOFs 2013 - 5th European Workshop on Optical Fibre Sensors, May 2013, Kraków, Poland.
11. Brígida, A.C., Nascimento, I.M., Chesini, G., Hayashi, J., Baptista, J.M., Costa, J., Martinez, M., Jorge, P., Cordeiro, C., "Fabrication of a spun elliptically birefringent photonic crystal fiber and its characterization as an electrical current sensor", EWOFs 2013 - 5th European Workshop on Optical Fibre Sensors, May 2013, Kraków, Poland.
12. Ferreira, M.S., Bierlich, J., Schuster, K., Santos, J.L., Frazão, O., "Fabry-Pérot Microcavity Tip Temperature Sensor based on Post-Processing", EWOFs 2013 - 5th European Workshop on Optical Fibre Sensors, May 2013, Kraków, Poland.
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22. André, R.M., Kobelke, J., Schuster, K., Bartlet, H., Marques, M.J., Frazão, O., "Parallel Fabry-Pérot interferometer in suspended twin-core fiber Ricardo", EWOFs 2013 - 5th European Workshop on Optical Fibre Sensors 2013, Kraków, Poland.
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24. Romaguera, Y., Moreira, J.A., Almeida, A., Cruz, J., "Structural, electrical and magnetic properties of EuMnO<sub>3</sub> doped magnetolectric thin films", EUROMAT2013 - European Congress and Exhibition on Advanced Material and Processes 2013, Sevilha, Espanha.
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29. Martins, H.F., Bierlich, J., Wondraczek, K., Unger, S., Kobelke, J., Schuster, K., Marques, M.J., Gonzalez-Herraez, M., Frazão, O., "Dual core fiber interferometer as in-line Mach-Zehnder interferometer sensor", AOP2014 - II International Conference on Applications of Optics and Photonics, May 2014, Aveiro, Portugal.
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31. Ribeiro, A.R., Queirós, R.B., Guerreiro, A., G. Oliva, A., Ecoffetd, C., Soppera, O., Jorge, P., "FIBER TIP MICROFABRICATION TECHNIQUES FOR TRAPPING AND SENSING APPLICATIONS", XII EUROPTRODE - EUROPT(R)ODE - XII Conference on Optical Chemical & Biosensors, April 2014, Athens, Greece.
32. Balogh, K., Jesus Gouveia, C., Queirós, R.B., Kovacs, B., Pereira, C.M., Borges, M.T., Jorge, P., "Optical fiber dissolved CO<sub>2</sub> sensor for application in aquaculture industry", XII EUROPTRODE - EUROPT(R)ODE - XII Conference on Optical Chemical & Biosensors, April 2014, Athens, Greece.

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36. Rota-rodrigo, S., Lopez-amo, M., Kobelke, J., Schuster, K., Santos, J.L., Frazão, O., "Control of the strain sensitivity using a suspended core photonic crystal fiber sensing head", Proceedings of SPIE - The International Society for Optical Engineering 2014, vol.9157.
37. Magalhães, F., Velhote Correia, M., Farahi, F., Pereira do Carmo, J., Araújo, F., "CYCLOPS - SINGLE-PIXEL IMAGING LIDAR SYSTEM BASED ON COMPRESSIVE SENSING", ICSO 2014 - International Conference on Space Optics 2014, Tenerife, Espanha.
38. Monteiro Silva, F., M. G. Silva, A., Torroba, T., Aguilar, G., "Electrochemical properties of rhodamine-derived fluorophores", IC3EM2014 - 1st International Caparica Conference on Chromogenic and Emissive Materials 2014, Caparica, Portugal.
39. Pinto Moura, J., Baierl, H., Auguste, J., Jamier, R., Roy, P., Santos, J.L., Frazão, O., "Evaporation of fluids in suspended-core fibres", MePhoCo - Third Mediterranean Photonics Conference 2014, Trani, Italy.
40. Nascimento, I.M., Brígida, A.C., Chesini, G., Hayashi, J., Baptista, J.M., Costa, J., Martinez, M., Jorge, P., Cordeiro, C., "Fabrication and characterization of spun HiBi PCF fibers for current sensing applications", OFS23 - OFS23 2014, SANTANDER, SPAIN.
41. Carvalho, L., Roriz, P., Simoes, J., Santos, J.L., Frazão, O., "Fabry-Perot cavity hydrostatic pressure sensors", Proceedings of SPIE - The International Society for Optical Engineering 2014, vol.9157.
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48. Ferreira, M.S., Lee, G., Santos, J.L., Sugden, K., Frazão, O., "Phase-shifted fiber Bragg grating for strain measurement at extreme conditions", OSA Meeting 2014 - OSA Meeting 2014 2014, Barcelona, Spain.

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50. Correia, A., Carmelo Rosa, C., Santos, P., Falcao, A., Lorentz, K., "Real-time dosimeter targeted to nuclear applications", AOP2014 - II International Conference on Applications of Optics and Photonics 2014, Aveiro, Portugal.
51. Monteiro Silva, F., M. G. Silva, A., Torroba, T., Aguilar, G., "Rhodamine-derived fluorophores: photophysical and electrochemical properties ", XX Encontro Luso-Galego - XX Encontro Luso-Galego de Química 2014, Porto, Portugal.
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53. Cenamo, N., Coelho, L.C., Guerreiro, A., Jorge, P., Zeni, L., "SPR sensors in POF: a new experimental configuration for extended refractive index range and better SNR", OFS23 - OFS23 2014, SANTANDER, SPAIN.
54. Apelido, N., Romaguera, Y., Tkach, A., Apelido, N., Vilarinho, P., Moreira, A., Almeida, A., "UNRAVELING THE EFFECT OF OXYGEN DEFICIENCY IN KTaO3 THIN FILMS", IMF13 IMF13 - 13th International Meeting on Ferroelectrics 2013, Katowice, Poland.

#### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

1. Roriz Oliveira, P., "FIBER OPTIC SENSORS FOR THE BIOMECHANICAL STUDY OF THE INTERVERTEBRAL DISC", December 2013, PhD Thesis.
2. Queirós, R.B., "BIOSENSORS FOR THE DETECTION AND QUANTIFICATION OF AQUATIC BACTERIAL CONTAMINATION IN WATERS FOR HUMAN USE", April 2013, PhD Thesis.
3. Martins, H.F., "DISTRIBUTED AND REMOTE FIBER SENSING ASSISTED BY RAMAN EFFECT", September 2014, PhD Thesis.

#### 4.1 General Description (RL-EEI-LA14-184)

Research Line Title	SUSTAINABLE ENERGY SYSTEMS AND THE SMART GRID
Principal Investigator	Manuel António Cerqueira Costa Matos
Research Area	Electrical and Computer Engineering

#### 4.2 Objectives and Achievements (RL-EEI-LA14-184)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 Objectives (1000 ca.)

Coordinator in 2011: Prof. Manuel Matos.

The aim of the research line is to address the issue of sustainability, namely through the Smart Grid paradigm. EU goals require the development of knowledge and tools to support the massive integration of renewable energy into the electric power system, new control strategies for large scale integration of DER and off-shore wind farms and forecasting and decision support tools.

Through the Smart Grid paradigm, new organisation schemes for power system emerge, including smart metering, load response, microgrids, integration of Electric Vehicles and dispersed storage. This requires new models, control mechanisms and communication architectures. Knowledge extraction from newly available information and testing of prototypes in laboratorial environments and pilot sites is also an objective.

##### RESEARCH GROUP INTERACTION

The Power Systems Unit is the core research group for this research line.

An objective of the RL is to achieve a high degree of multidisciplinary and RG interaction.

##### 4.2.2 Main Achievements (2000 ca.)

Development of models to simulate the operation of electricity markets using Nash Equilibria concepts (collaboration with UESP) – in the framework of OIL (Optimisation Inter-Unit Line)

A complete approach to Electric Vehicles integration in electric networks, including a smart charging procedure that allows EV to participate in the provision of primary and secondary frequency control, the development of the concept of aggregator

Contribution on general requirements for EV charging stations, namely through the impacts of having EV participating in primary frequency control on standard IEC61851-1.

Advances in Cross-entropy Method applied to generation capacity reliability evaluation

New methodology for reconfiguration and voltage Var Control of distribution networks using the EPSO and graph theory

New solution to the problem of recomposing missing information at the SCADA of energy/distribution management systems (EMS/DMS), through the use of offline trained autoencoders.

##### RESEARCH GROUP INTERACTION AND CROSS-RG COOPERATION

This RL is tied to the research activities carried out by the Power Systems Unit (USE). Large interaction with other Units was achieved.

Projects carried out in cooperation among several RG:

SIMULESP - System to support the operation of electric power sub-transmission grids in contingency situations of ELECTROPAULO, Brazil), UNISANTA, Brazil [collaboration LIAAD]

NER 300 - Specification of the Control Centers of Non-Interconnected Greek Islands, Greek Operator of the Non Interconnected Islands, 2010-2011 [collaboration USIG]

REIVE - Smart electrical grids with electrical vehicles, FAI [collaboration UTM]

MARTIFER CV - Studies regarding large scale renewable energy sources integration in Cape Verde Islands up to 2020 and specification of advanced SCADA systems. GeSto Energy, 2010-11 [collaboration USIG]

INOVGRID - Development of an advanced smart metering project for EDP Distribuição [collaboration UTM]

### **4.3 Research Line Output (RL-EEI-LA14-184)**

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### **4.3.1 Collaborative Publications in peer review Journals (2000 ca.)**

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.

1. LOPES, J.A.P., SOARES, F. J., ALMEIDA, P. M. R., "Integration of Electric Vehicles in the Electric Power System", THE PROCEEDINGS OF THE IEEE, vol.99, no.1, pp.168-183, January, 2011.
2. MADUREIRA, A., PEREIRA, J., GIL, N., LOPES, J.A.P., KORRES, G., HATZIARGYRIOU, N., "Advanced Control and Management Functionalities for Multi-MicroGrids", European Transactions on Electrical Power, vol.21, no.2, pp.1159-1177, March, 2011.
3. MIRANDA, V., KRSTULOVIC, J., KEKO, H., MOREIRA, C., PEREIRA, J., "Reconstructing missing data in State Estimation with autoencoders", IEEE Transactions on Power Systems, 2011.
4. SARAIVA, J.T., PEREIRA, M. L., MENDES, V. T., SOUSA, J.C., "A Simulated Annealing Based Approach to Solve the Generator Maintenance Scheduling Problem", Electric Power Systems Research, vol.81, no.7, pp.1283-1291, July, 2011.
5. RESENDE, F., GIL, N., LOPES, J.A.P., "Service restoration on distribution systems using Multi-MicroGrids", European Transactions on Electrical Power, vol.21, no.2, pp.1327-1342, March, 2011.
6. SCHWEICKARDT, G., MIRANDA, V., WIMAN, G., "A comparison of metaheuristics algorithms for combinatorial optimization problems. Application to phase balancing in electric distribution systems", Latin American Applied Research, vol.41, no.2, pp.113-120, 2011.
7. SILVA, S.M.S., FIDALGO, J., FONTES, D., "A Simulation Based Decision Aid Tool for Setting Regulation of Energy Grids with Distributed Generation", Operational Research International Journal, Volume 11, Issue 1, Pages 41-57, 2011.
8. WANG, J., BOTTERUD, A., BESSA, R. J., KEKO, H., CARVALHO, L., ISSICABA, D., SUMAILI, J., MIRANDA, V., "Wind Power Forecasting Uncertainty and Unit Commitment", Applied Energy, vol.88, no.11, pp.4014-4023, November, 2011.

### 4.3.2 Collaborative Other Publications (2000 ca.)

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language~*

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.

1. BARIN, A., CANHA, L. N., MAGNAGO, K. M., MATOS, M. A., WOTTRICH, B., "A Novel Fuzzy-Based Methodology for Biogas Fuelled Hybrid Energy Systems Decision Making" in K. Gopalakrishnan et al. (Eds.): Soft Comput. in Green & Renew. Ener. Sys. STUDFUZZ 269 pp.183–198, Springer-Verlag Berlin, Heidelberg, 2011
2. BESSA, R.J., BREMERMAN, L., MATOS, M., PESTANA, R., MACHADO, N., WALDL, H., WICHMANN, C., "Reserve and Congestion Management Using Wind Power Probabilistic Forecasting: A Real Case-Study", European Wind Energy Association Annual Event (EWEA 2011), 2011.  
CARVALHO, M.M., PEDROSO, J. P. , SARAIVA, J. T. , "Nash Equilibria in Electricity Markets", in Proceedings of the VII ALIO/EURO, Workshop on Applied Combinatorial Optimization, Porto, Portugal, 4 – 6 May 2011.
3. FERREIRA, R., MIRANDA, L.M., ARAÚJO, R.E., PEÇAS LOPES, J., "A new Bi-Directional Charger for Vehicle-to-Grid Integration" ,ISGT 2011 - IEEE PES ISGT 2011, Europe, December,2011.
4. RUA, D.E., PEREIRA, L.F., GIL, N.J., PEÇAS LOPES, J., "Impact of Multi-Microgrid Communication Systems in Islanded Operation", ISGT 2011 - IEEE PES ISGT 2011 Europe, December 2011.
5. DE CASTRO, R., MELO,P., PACHECO, P., ARAÚJO, R. E., FREITAS, D.; , "A control allocation approach to manage multiple energy sources in EVs," Vehicle Power and Propulsion Conference (VPPC), 2011 IEEE , vol., no., pp.1-6, 6-9 Sept. 2011
6. PHULPIN, Y., LUCANI, D., BARROS, J., "Network coding in smart grids",SmartGridComm 2011, Second IEEE International Conference on Smart Grid Communications, pp.37-42, October 2011.
7. SUMAILI, J., KEKO, H., MIRANDA, V., CHICCO, G., "On the Use of Information Theoretic Mean Shift for Electricity Load Patterns Clustering", IEEE PowerTech 2011, June 2011.

### 4.3.3 PhD thesis completed (3000 ca.)

*Co-supervision or clearly multidisciplinary projects are allowed here*

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative thesis projects within the framework of the RL.

Theses supervised by members of the research line:

Approved

1. António José Ferreira da Silva, "Application of Artificial Intelligent techniques and Adaptive Control to Wind Parks Management", supervisor J. Nuno Fidalgo, co-supervisor Fernando Castro (ISEP/IPP), approved January 2011

Submitted

1. Pedro Miguel Pousada da Rocha Almeida, Impact of Vehicle to Grid in the Power System Dynamic Behaviour, supervisor J. Peças Lopes, submitted November 2011
2. Roque Filipe Mesquita Brandão, Assinatura Digital de Geradores Eólicos, supervisor F. Maciel Barbosa, submitted November 2011

3. Manuel José Costeira da Rocha, Transmission Expansion Planning – A Multiyear Approach Considering Uncertainties, supervisor J. Tomé Saraiva, submitted December 2011
4. Julija Vasiljevskaja, Evaluation of Technical, Economic and Environmental Impacts Resulting From Large Scale Integration of Microgrids, Including Responsive Demand, in Electrical Grids, supervisor J. Peças Lopes, co-supervisor Manuel Matos, submitted December 2011
5. Filipe Joel Nunes Soares, Impact of the deployment of electric vehicles in grid operation and expansion, supervisor J. Peças Lopes, submitted December 2011.

## 4.1 General Description (RL-EGE-LA14-185)

Research Line Title	ENTERPRISE COLLABORATIVE NETWORKS, OPERATIONS MANAGEMENT AND DECISION SUPPORT SYSTEM
Principal Investigator	Jorge Manuel Pinho de Sousa
Research Area	Electrical and Computer Engineering

## 4.2 Objectives and Achievements (RL-EGE-LA14-185)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

### 4.2.1 General Objectives (1000 ca.)

Coordinator in the period: Prof. J. Pinho de Sousa.

This RL aims at contributing for the performance improvement of industrial companies, through R&D projects, consultancy, technology transfer and training; and at promoting high quality research initiatives in specific areas.

Research is structured around 4 main vectors: Operations Management and Logistics; Collaborative Networks; Decision Support and Business Analytics; Enterprise Information Systems.

The first research vector covers a broad set of topics such as operations strategy, operations management, performance management, layouts design, supply chain management, logistics, and transportation systems. The second of these vectors forms a strong interdisciplinary research area that covers topics such as networked business models, supply-chain management, virtual organizations or organizational networks, collaboration and network governance, or collaborative performance management.

The third research vector deals with methods and techniques such as structuring of decision-making problems, mathematical programming, multi-criteria decision analysis, combinatorial optimization and meta-heuristics, simulation, decision support systems, business intelligence, and data mining. The fourth vector plays an important role on the research activities of the centre, particularly in what concerns the design of advanced information systems, the design of information systems supporting new organisational paradigms, systems integration and inter-operability.

### 4.2.2 Main Achievements (2000 ca.)

During the period 2013/2014, 13 PhD theses were successfully finished, 26 papers were published in peer review journals, and 56 in international conference proceedings subject to a refereeing process. Moreover several papers have been accepted for publication in peer review journals, and some out of these were published or are expected to be published during 2015. Due to a significant increase of PhD students in recent years, there are currently 26 on-going doctoral projects, with 13 concluded or expected to be concluded during 2015.

The centre has a strong tradition of participation in large European research projects. These projects have highly contributed to achieving critical mass in the fields of Enterprise Collaborative Networks and Operations Management and to strengthening partnerships with leader research organisations in Europe. During this period the group has participated in 11 projects, representing a total funding of about 900 K Euro.

The very active participation in the MANUFUTURE and Footwear European Technology Platforms led to the establishment of important partnerships at a European level. These partnerships have played an important role in the preparation and set-up of several European projects that strongly contributed to the results of the group.

In total, 11 European projects were active during 2013/2014. An important critical mass has been achieved in the fields of Enterprise Collaboration Networks and Operations Management.

A large number of projects has also been pursued at a national level, including research projects funded by FCT, RTD projects in partnership with technology based companies and consultancy firms funded by the QREN programme. A total of 15 projects were executed, representing a total funding of 959 K Euros.

During the period under analysis a total of 18 research and technology transfer projects directly contracted by companies were active, representing a total income of 815 k Euros.

A number of relevant outcomes should be highlighted:

- a new framework was designed to support the definition and implementation of hierarchic and compound performance measurement systems (VFF - Virtual Factory Framework, European project), and this framework was implemented at VW Autoeuropa plant with quite good results.
- within several projects with IKEA, a new simulation system has been developed to represent production lines and evaluate different scenarios according to multiple perspectives. This framework was used to support decisions concerning layouts, lot sizes, sequencing, etc., and the good results achieved so far are motivating the design of new projects.
- Innovative business analytics, recommender systems and software to manage market trends, using information from social networks, were designed in projects such as Creative Retail, Corenet and PT21.
- Research and developments on the multi-objective optimisation “scheduler” have been pursued, leading to an innovative up-graded software tool that has been integrated with several ERP systems, with a considerable commercial success (more than 30 licences have already been sold internationally).
- In the European projects FOCUS (Advances in Forestry Control and Automation Systems in Europe) and MOFSS (Make to Order Fast and Smart Scheduler), both having started in January 2014, new innovative approaches are being developed, to exploit the integrated use of simulation and optimization techniques in advanced production and logistic systems.

During these 2 years, several initiatives have been launched to strengthen the interaction with other research groups within the INESC TEC universe, as reported in other points of this document.

In this context, a special reference should here be made to the BEST CASE project (research line “Smart Manufacturing and Logistics”) coordinated by CESE, but integrating multiple research teams at INESC TEC.

This 30-month project (“NORTE-07-0124-FEDER-000057”) is financed by the North Portugal Regional Operational Programme (ON.2 – O Novo Norte), started in January 2013 and went on in 2014. The main objective of this initiative was to establish an innovative framework for research in various relevant topics on production management and logistics, with the development of new models, techniques and applications.

The project was structured around 6 work-packages on: Advanced Design and Strategies for Manufacturing Systems; Collaboration and Knowledge Management in Manufacturing Networks; Scheduling and Planning for Manufacturing Systems; Logistics and Robotics; Improved Manufacturing through Optimized Cutting and Packing; Modelling, Optimization and Simulation

Significant developments in terms of mathematical programming models and heuristics were achieved, and interesting results and innovative approaches in hybrid implementations were obtained. Some successful applications of these techniques took place in planning problems in production and operations scheduling (“scheduling”), or problems of cutting and packing. The integration of simulation to optimization in their multiple variations was also deeply explored.

The other INESC TEC groups strongly involved in these joint research activities were: CEGI, CROB, LIAAD and CSIG.

### 4.3 Research Line Output (RL-EGE-LA14-185)

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### 4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

Edgar Ramiro Jimenez, João Claro, Jorge Pinho de Sousa, "The airport business in a competitive environment", *European Journal of Transport and Infrastructure Research*, vol.13, no.4, November, 2013, pp.315-335.

Ana Cristina Barros, Ana Paula Barbosa-Póvoa, Edgar Blanco, "Selection of tailored practices for supply chain management", *International Journal of Operations & Production Management*, <http://www.emeraldinsight.com/journals.htm?articleid=17095270&ini=aob>, vol.33, no.8, September, 2013, pp.1040-1074.

Ahm Shamsuzzoha, Timo Kankaanpaa, Luís Carneiro, Ricardo João Almeida, Andrea Chiodi, Rosanna Fornasiero, "Dynamic and collaborative business networks in the fashion industry", *International Journal of Computer Integrated Manufacturing*, vol.26, no.1, 2013, pp.125-139.

Alexandra Marques, J G Borges, Jordi Garcia-Gonzalo, Beatriz Lucas, "A participatory approach to design a toolbox to support forest management planning at regional level", *Forest Systems*, vol.22, no.2, July, 2013, pp.340-358.

A F Marques, A Ficko, A Kangas, C Rosset, F Ferreti, J Rasinmaki, T Packalen, S Gordon, "Empirical guidelines for forest management decision support systems based on the past experiences of the expert's community", *Forest Systems*, vol.22, no.2, July, 2013, pp.320-339.

T. Packalen, Alexandra Sofia Marques, outros et al., "Review. A brief overview of forest management decision support systems (FMDSS) listed in the FORSYS wiki", *Forest Systems*, July, 2013.

Franklina Toledo, Maria Antónia Carravilla, Cristina Ribeiro, José Fernando Oliveira, A. Miguel Gomes, "The Dotted-Board Model: a new MIP model for nesting irregular shapes", *International Journal of Production Economics*, vol.145, no.2, 2013, pp.478-487.

Marcos Aurélio Domingues, Carlos Soares, Alípio Mário Jorge: Using statistics, visualization and data mining for monitoring the quality of meta-data in web portals. *Inf. Syst. E-Business Management* 11(4): 569-595 (2013)

Jimenez, E.R., Claro, J., Pinho de Sousa, J., "The airport business in a competitive environment (proceeding)", *Procedia - Social and Behavioral Sciences*, February 2014, vol.111, p.947-954.

Marques, A.S., Rosset, C., Rasinmaki, J., Vacik, H., Gordon, S., Nobre, S., Falcao, A., Ape Weber, D., Granitzer, M., Eriksson, L., "Collaborative development of a semantic wiki on forest management decision support", *Scandinavian Journal of Forest Research* 2014, vol.29, no.1, p.30-43.

Marques, A., Pinho de Sousa, J., Ronnqvist, M., Jafe, R., "Combining optimization and simulation tools for short-term planning of forest operations", *Scandinavian Journal of Forest Research* 2014, vol.29, p.166-177.

Rossi, A., De carvalho, A., Soares, C.M., De souza, B., "MetaStream: A meta-learning based method for periodic algorithm selection in time-changing data", *Neurocomputing* 2014, vol.127, p.52-64.

Carneiro, L., Shamsuzzoha, A., Almeida, R., Azevedo, A., Fornasiero, R., Ferreira, P., "Reference model for collaborative manufacturing of customised products: applications in the fashion industry", *Production Planning & Control* 2014, vol.25, p.1135-1155.

Miranda, P., Prudencio, R., De carvalho, A., Soares, C.M., "A hybrid meta-learning architecture for multi-objective optimization of SVM parameters", *Neurocomputing* 2014, vol.143, p.27-43.

Nazaré Rego, João Claro, Jorge Pinho de Sousa. "A hybrid approach for integrated healthcare cooperative purchasing and supply chain configuration", *Health Care Management Science*, Vol.17 nº 4, pp.303-320, 2014

#### 4.3.2 Collaborative Other Publications (2000 ca.)

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

Simon Fischer, Ingo Mierswa, João Mendes Moreira, and Carlos Soares, editors. Proc. of the 4th RapidMiner Community Meeting And Conference (RCOMM 2013) 2013

João Cabrita, Hugo Ferreira, A. Miguel Gomes, and Rui Rebelo. 2013. "Recommender System for the Footwear Industry." In Proceedings of the 4th RapidMiner Community Meeting and Conference (RCOMM 2013), edited by Simon Fischer, Ingo Mierswa, João Mendes Moreira, and Carlos Soares, 209–217. Shaker Verlag. ISBN: 978-3-8440-2145-5.

Pedro Abreu , Carlos Soares , João Bastos, Michel Byvoet, João Mendes-Moreira, Alípio Jorge, Álvaro Caldas, Américo Azevedo, "Business Intelligence and Data Mining in the Customized Fashion Industry: A Solution Combining Pentaho and RapidMiner", RCOMM 2013 - 4th RapidMiner Community Meeting and Conference, August, 2013, pp.197-207.

Gil Gonçalves, Catarina Azevedo, César Toscano, outros et al., "Assisting SMEs to integrate digital Food Supply Chains", EFITA2013 - EFITA 2013 Conference, June, 2013.

Ahm Shamsuzzoha, Filipe David Ferreira, Américo Azevedo, José Faria, outros et al., "Business Process Monitoring and Management in Virtual Enterprise through Interactive User Interface Layer", FAIM 2013 - 23rd International Conference Flexible Automation and Intelligent Manufacturing, June, 2013.

Luís Carneiro, Pedro Cunha, Pedro Sena Ferreira, Ahm Shamsuzzoha, "Conceptual framework for non-hierarchical business networks for complex products design and manufacturing", CIRP2013 - 46th CIRP Conference on Manufacturing Systems, May, 2013.

Cláudio Rebelo Sá, Carlos Manuel Soares, Arno Knobbe, Paulo Jorge Azevedo, Alípio Jorge, "Multi-interval Discretization of Continuous Attributes for Label Ranking", DS 2013 - The 16th International Conference on Discovery Science, 2013.

Patrícia Ramos, Nicolau Santos, Rui Rebelo and Bernardo Almada Lobo, "A comparative performance study of state space models and ARIMA models for aggregate retail sales forecasting", FAIM'13 – 23rd International Conference on Flexible Automation & Intelligent Manufacturing, The Challenge of Sustaining Global Competitive Manufacturing Systems, 26-28 June 2013, Porto, Portugal.

Pedro Rocha, Rui Rodrigues, Franklina M.B. Toledo, A. Miguel Gomes, "Circle Covering Using Medial Axis", 11th IFAC Workshop on Intelligent Manufacturing Systems, May, 2013, pp.402-407. [http://www.ifac-papersonline.net/Intelligent\\_Manufacturing\\_Systems/11th\\_IFAC\\_Workshop\\_on\\_Intelligent\\_Manufacturing\\_Systems\\_\\_2013/more3.html](http://www.ifac-papersonline.net/Intelligent_Manufacturing_Systems/11th_IFAC_Workshop_on_Intelligent_Manufacturing_Systems__2013/more3.html)

Nazaré Rego, João Claro, Jorge Pinho de Sousa, "An innovative framework for the simulation of manufacturing systems: an application to the footwear industry" em Azevedo, A. (editor), Advances in Sustainable and Competitive Manufacturing Systems, 23th International Conference on Flexible Automation & Intelligent Manufacturing, Springer, pp. 219-231, doi: 10.1007/978-3-319-00557-7\_18, 2013.

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Edgar Jimenez, João Claro, Jorge Pinho de Sousa, "The airport business in a competitive environment", em Proceedings do EWGT 2013 - 16th Euro Working Group on Transportation, Porto, Portugal, Setembro, 2013.

Pedro Fernandes, Carla Pereira, and Armando Barbosa. 2013. "BTTE - An Automated Timetabling Software for Higher Education." In Atas Da 8a Conferência Ibérica de Sistemas e Tecnologias de Informação, edited by Álvaro Rocha, Luís Paulo Reis, Manuel Pérez Cota, Marco Painho, and Miguel Castro Neto, II:90–93. Lisboa, Portugal. <http://www.aisti.eu/cisti2013/>.

Ana Monte, Carlos Soares, Pedro Brito, Michel Byvoet, 2013. Clustering for Decision Support in the Fashion Industry. In Proc. of the Int. Conf. Flexible Automation and Intelligent Manufacturing (FAIM 2013), pp 997-1008.

Arthur F. M. Sousa, Ricardo B. C. Prudêncio, Carlos Soares, Teresa Bernarda Ludermit: Active selection of training instances for a random forest meta-learner. IJCNN 2013: 1-7

Joaquin Vanschoren, Pavel Brazdil, Carlos Soares, Lars Kotthoff: Proceedings of the International Workshop on Meta-learning and Algorithm Selection co-located with 21st European Conference on Artificial Intelligence, MetaSel@ECAI 2014, Prague, Czech Republic, August 19, 2014. CEUR Workshop Proceedings 1201, CEUR-WS.org 2014

Patrícia Ramos and José Manuel Oliveira (2014), "Supply chain management of consumer goods based on linear forecasting models", 21st EurOMA Conference – Operations Management in an Innovation Economy, 20-25 June, Palermo, Italy.

Ahm Shamsuzzoha, Filipe Ferreira, Sven Abels, Americo Azevedo and Petri Helo5 , "Visualization functionality of virtual factories: an enhancement to collaborative business process management", 16th International Conference on Enterprise Information Systems (ICEIS 2014), At Lisbon, Portugal

Filipe Ferreira, Ahm Shamsuzzoha and Americo Azevedo, "Predictive industrial maintenance: a collaborative approach", 7th International Conference on Interoperability for Enterprise Systems and Applications, At Albi, France

Pinto, F; Mendes-Moreira, JM; Soares, C; Rossetti, RJF; "Simulation of the ensemble generation process: The divergence between data and model similarity", Modelling and Simulation 2014 - European Simulation and Modelling Conference, ESM 2014, PAGES: 5, PUBLISHED: 2014

Tiago Cunha, Rosaldo J. F. Rossetti, Carlos Soares. Analysing Collaborative Filtering algorithms in a Multi-Agent Environment in Proceedings of the 28th European Simulation and Modelling Conference, p. 135 - 139, 2014.

Alexandra S Marques, Jean François Audy, Sophie D'Amours, Mikael Ronqvist. "Chapter 7. Tactical and operational harvestplanning". in Borges J.G., Diaz-Balteiro L., McDill M., Rodriguez L.C. (Eds.). The management of Industrial Plantations. Theoretical foundations and applications. Springer Verlag. pp 239-267. 2014.

Jean François Audy, Alexandra S Marques, Mikael Ronqvist, Rafael Epstein, Andres Weintraub. "Chapter 8. Transportation and routing". in: Borges J.G., Diaz-Balteiro L., McDill M., Rodriguez L.C. (Eds.). The management of Industrial Plantations. Theoretical foundations and applications. Springer Verlag. pp 269-295. 2014.

José G Borges, Alexandra S Marques, Ljusk Ola Eriksson, Manuel F Marey. "Chapter 9. Integrating management planning levels with decision support systems. in Borges J.G., Diaz-Balteiro L., McDill M., Rodriguez L.C. (Eds.). The management of Industrial Plantations. Theoretical foundations and applications. Springer Verlag. pp 299-319. 2014.

### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

Reza Fazeli, A combined multi-criteria and system dynamics methodology for mid-term planning of light duty vehicle fleets, PhD thesis, Programa Doutoral em Sistemas Sustentáveis de Energia, March 2013 (supervisors: Jorge Pinho de Sousa, Vítor Leal)

Rui Gomes, Dynamic Vehicle Routing for Demand Responsive Transportation Systems, PhD thesis, Programa Doutoral em Sistemas de Transportes, March 2013 (supervisors: Jorge Pinho de Sousa, Teresa Galvão Dias)

Vitor Santos, Human and Technological Dynamics in Complex Research and Development Projects, PhD thesis, Programa Doutoral em Sistemas e Tecnologias de Informação (U Minho), April 2013 (supervisors: João Álvaro Carvalho, António Lucas Soares)

Manuel Silva, Localização de ontologies de domínio no contexto de redes colaborativas, PhD thesis, Programa Doutoral em Linguística, Lexicologia, Lexicografia e Terminologia (U Nova de Lisboa) May 2013 (supervisors: Rute Costa, António Lucas Soares)

André Rossi, Meta-aprendizado aplicado a fluxos contínuos de dados PhD thesis, Programa Doutoral em Ciências de Computação e Matemática Computacional (U São Paulo), December 2013 (supervisors: André Carvalho, Carlos Soares)

Samuel Moniz, Scheduling of Multipurpose Batch Plants - Towards the Development of a Decision-Making Tool for the Chemical-Pharmaceutical Industry, PhD thesis, Programa Doutoral em Líderes para Indústrias Tecnológicas, March 2014 (supervisors: Jorge Pinho de Sousa, Ana Barbosa Póvoa)

Michael Donauer, Identification of cost effective inspection strategies by means of tailored quality tools, cost modeling and simulation, PhD thesis, Programa Doutoral em Líderes para Indústrias Tecnológicas, July 2014 (supervisor: Américo Azevedo)

#### 4.1 General Description (RL-EGE-LA14-186)

Research Line Title	DIGITAL SOCIETY – SOFTWARE, INFORMATION AND INTERACTION TECHNOLOGY, SERVICES AND POLICIES
Principal Investigator	Gabriel David
Research Area	Electrical and Computer Engineering

#### 4.2 Objectives and Achievements (RL-EGE-LA14-186)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 General Objectives (1000 ca.)

Coordinator in 2013: Prof.Gabriel David.

This research line is the focus of the USIG/INESC TEC unit.

The ability to organize, manage, and retrieve useful information plays a crucial role in today's digital society. This line of research addresses complex and difficult multidisciplinary problems faced by industry requiring expertise in the analysis, design and implementation of large software systems, using best software engineering practices for design, development and testing, as well as visual and user interaction components to enable their widespread use. The addition of researchers in the Special Purpose Computing Systems area and Accessibility and Support Technologies area expands the competences to the ability to incorporate embedded components in the system and to use inclusive technologies that enlarge the potential audience. Our focus is on major application areas with high social impact, namely e-Government, e-Health, and transport systems that, together with other groups, enable INESC-TEC to successfully achieve strong industrial partnerships and technology transfer.

Coordinator in 2014: Prof.Gabriel David.

This research line is the focus of the USIG/INESC TEC unit.

The ability to organize, manage, and retrieve useful information plays a crucial role in today's digital society. This line of research addresses complex and difficult multidisciplinary problems faced by industry requiring expertise in the analysis, design and implementation of large software systems, using best software engineering practices for design, development and testing, as well as visual and user interaction components to enable their widespread use, the ability to incorporate embedded components in the system and to use inclusive technologies that enlarge the potential audience. Our focus is on major application areas with high social impact, namely e-Government, e-Health, and transport systems. Our results, together with other groups, enable INESC-TEC to successfully achieve strong industrial partnerships and technology transfer.

##### 4.2.2 Main Achievements (2000 ca.)

MAIN RESULTS – a few examples:

ERAS - 3D Reconstruction of historic buildings based on textual descriptions and geospatial data.

CNG – Multiplayer 3D video game for mathematics learning using next generation broadband networks.

OnlineGYM – Online gymnasium implemented with avatars representing personal trainer and trainees, animated using movement captured by KINECT cameras at their homes and synchronised in a virtual world displayed in their PCs.

The 3D modelling know-how of ERAS, the interaction techniques of OnlineGYM and the gaming background of CNG can be combined into effective serious games with a rich interface, ready to be tried in innovative educational, e-learning, and training environments.

RAIA.co – Final version of sensor observation service and catalog service for a web based oceanographic georeferenced sensor network.

This project, together with the other research data management and data preservation projects are building the expertise to deal with Open Data Government projects.

#### RESEARCH GROUP INTERACTION

This RL is closely tied to the research activities developed by the Information Systems and Computer Graphics Unit (USIG), taking advantage of this group expertise in handling large software systems from end to end. This is demonstrated by the extended interaction with other INESC groups in several projects:

- With UTM: networking services, signal processing and new digital educational content in projects CNG, SARA, AAL4ALL;
- With ROBIS: ICARUS – robotics for unmaned search and rescue;
- With CRACS: SIBILA - information retrieval, research data management and digital preservation.

Actually, a collaboration pattern is emerging in several proposals (ICARUS, TEC4SEA, OMAN) among USIG, ROBIS, UTM and UOSE, where each has a clear role:

- USIG - graphical interfaces, information processing and visualization, software integration;
- ROBIS - robotics;
- UTM - communications;
- UOSE - sensors.

MAIN RESULTS – a few examples:

LEANBIGDATA – Spatial-temporal data retrieval algorithm based in RB-interval trees and visualization prototypes.

ONLINEGYM – Final version of an online gymnasium.

ICARUS – Serious game for training of search and rescue.

MASSIVE – Laboratory of virtual multisensorial experiences.

The competences on visualization, interaction and serious games already displayed in ONLINEGYM and ICARUS will be expanded in the MASSIVE laboratory.

Several successful projects demonstrate the proven experience in the public sector:

- GIE-GNP – Public presentation of new interregional collaborative Portal (Galicia/Northern Portugal).
- OASRN – Deployment of IS for the Portuguese Architects professional association.

A similar statement can be made for the transports sector:

- MIELE – Multimodal multicriteria e-logistics marketplace simulator.
- SIGAP2 – Deployment of first module of 3PORT port management IS at APDL.
- TICE-Mobilidade- Successful demonstration of application for on-demand car insurance.
- SARA – Demonstration of road management system.

Finally, in the health sector:

- AAL4ALL – Deployment of pilot supporting the trials of the Portuguese AAL eco-system composed by 30 partners.
- APDIC – Project on the preparation of a digital preservation plan for a hospital.

#### RESEARCH GROUP INTERACTION

This RL is closely tied to the core research activities of USIG but also represents extended interaction with other INESC groups:

- UTM - SARA, AAL4ALL, VCARDID, PGLOBAL
- ROBIS - ICARUS
- UOSE –EYEFY
- HASLAB –LEANBIGDATA, VCARDID
- UESP – CAP@CIDADE
- CRACS – APDIC, VCARDID.

In 2014, a new collaboration trend started to get shape among the computer science groups at INESC TEC, as can be seen, for instance, in projects VCARDID, LEANBIGDATA, and APDIC:

- USIG - graphical interfaces, information processing and visualization, software integration;
- HASLAB – distributed systems;
- CRACS - security;
- LIAAD – data mining.

### 4.3 Research Line Output (RL-EGE-LA14-186)

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### 4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

(void)

#### 4.3.2 Collaborative Other Publications (2000 ca.)

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

1. Ali, K., Amaro Oliveira, M., Dutra, I., "Grid Scheduling Strategies For Applications That Need Data Transfer" [Estratégias de Escalonamento em Grid para Aplicações que Requerem Transferências de Dados], IBERGRID2014 - 8th Iberian Grid Infrastructure Conference, September 2014, Aveiro, Portugal.

#### 4.3.3 PhD thesis completed (3000 ca.)

*Co-supervision or clearly multidisciplinary projects are allowed here*

(void)

#### 4.1 General Description (RL-EGE-LA14-187)

Research Line Title	ROBOTICS, INTELLIGENT AND AUTONOMOUS SYSTEMS FOR COMPLEX ENVIRONMENTS
Principal Investigator	António Paulo Gomes Mendes Moreira
Research Area	Electrical and Computer Engineering

#### 4.2 Objectives and Achievements (RL-EGE-LA14-187)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 General Objectives (1000 ca.)

This research line is the focus of the ROBIS/INESC TEC unit.

The activity of ROBIS addresses research on fundamental and applied scientific principles and practices with the aim of developing innovative intelligent and robotic solutions. Research activities focus on aerial, land and marine robotics, industrial robotics and intelligent systems and sensors.

##### NAVIGATION AND OPERATION

Innovative approaches for navigation and positioning of autonomous vehicles.

Tools to assist the operation of autonomous robots (automatic configuration of navigation and mission). Human/Robots interaction, including rapid teaching of manipulators; Hyper-flexible cells; Co-working;

##### CONTROL AND COORDINATION

Multi-robot systems with approaches for coordination, control and perception for complex and cluttered environments applications.

Intelligent control and smart sensors, adaptive sampling strategies.

##### TECHNOLOGY TRANSFER

As Robotics is an area of intensive knowledge integration and with direct impact in its application, RG will develop an intensive effort in technology transfer and completing projects.

##### 4.2.2 Main Achievements (2000 ca.)

This RL is tied to the research activities carried out by the Robotics and Intelligent Systems Unit (ROBIS). Large interaction with other Units was achieved.

Projects carried out in cooperation among several RG:

FOCUS - Advances in FOestry Control and AUtomatic Systems in Europe; 7th Framework Programme for Research; Funding Scheme : SME-targeted collaborative projects: advancing forestry control and automation through the development of an integrated technological solution that combines predictive control with

processing and planning processes. The CESE unit is the coordinator of the project, and is also responsible for the research in planning for the FOCUS project.

STAMINA - Sustainable and Reliable Robotics for Part Handling in Manufacturing Automation; 7th Framework Programme for Research; Funding Scheme : ICT – Information and communication technologies: CESE unit participates in the STAMINA project developing the vertical integration of the fleet of robots in the IT system of the end-user.

ICARUS - Integrated Components for Assisted Rescue and Unmanned Search operations; FP7: unmanned SAR technologies for detecting, locating and rescuing humans. (CTM???)

SUNNY - Smart UNmanned aerial vehicle sensor Network for detection of border crossing; FP7: new tool for collecting real-time information in operational scenarios, capable of improving the effectiveness of the EU border monitoring.

### **4.3 Research Line Output (RL-EGE-LA14-187)**

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### **4.3.1 Collaborative Publications in peer review Journals (2000 ca.)**

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.

#### **4.3.2 Collaborative Other Publications (2000 ca.)**

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

#### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative thesis projects within the framework of the RL.

Miguel Armando Migueis Pinto, SLAM for 3D map building to be used in a matching localization algorithm, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação com o Prof. Anibal Matos – Departamento de Engenharia Electrotécnica e de Computadores - FEUP), concluída em Janeiro de 2013

Marcelo Roberto Petry, A Vision-based Approach Towards Robust Localization for Intelligent Wheelchairs, Programa Doutoral em Engenharia Informática, FEUP. (Orientador em co-orientação com o Prof. Luís Paulo Reis – Departamento de Engenharia Informática - FEUP ), concluída em Setembro de 2013

Marcos André Magalhães Ferreira, Programação de Alto Nível para Células Robotizadas Industriais / High Level Programming of Industrial Robotic Cells, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação com o Prof. J. Norberto Pires – Departamento de Engenharia Mecânica da F.C.T. da Universidade de Coimbra), concluída em Janeiro de 2014.

Bruno Miguel Mateus Ferreira, Controlo de equipas de robots sob restrições de comunicação / Control of teams of robots under restrictions of communication, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Co-orientador com orientação do Prof. Anibal Matos – Departamento de Engenharia Electrotécnica e de Computadores - FEUP ), concluída em Fevereiro de 2014.

Filipe Baptista Neves Dos Santos, Sistema de Localização colaborativo e não invasivo com mapeamento semântico, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Co-orientador com orientação do Prof. Paulo Gomes da Costa – Departamento de Engenharia Electrotécnica e de Computadores - FEUP), concluída em Março de 2014.

Luís André Freitas da Rocha, Programação de Robôs Industriais em Células Robotizadas Flexíveis, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação do Prof. Vitor Manuel Ferreira dos Santos, Departamento de Engenharia Mecânica da Universidade de Aveiro, concluída em Abril de 2014

Andry Maykol Gomes Pinto, Visual Motion Analysis based on a Robotic Moving System, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação com o Prof. Paulo Gomes da Costa – Departamento de Engenharia Electrotécnica e de Computadores - FEUP), concluída em Julho de 2014.

Jorge Miguel Marques Ribeiro, Algorithms and technologies for an automatic quality control system in inspection places: transferring human knowledge into an automated inspection system, Course: Engineering Design and Advanced Manufacturing - Leaders for Technical Industries - MIT Portugal Program, in collaboration with Continental Mabor, Indústria de Pneus, S.A. (Orientador com co-orientação do Prof. Gil Lopes - Departamento de Electrónica Industrial da Universidade do Minho), concluída em Setembro de 2014.

Hugo Miguel Gomes da Silva, A probabilistic Approach for Stereo Visual Egomotion, Programa Doutoral em Engenharia Electrónica e de Computadores Instituto Superior Técnico Universidade de Lisboa, concluída em Março de 2014.

#### 4.1 General Description (RL-EGE-LA14-188)

Research Line Title	INTELLIGENT AND ADAPTIVE SYSTEMS AND MATHEMATICAL MODELING IN DECISION SUPPORT
Principal Investigator	Alípio Mário Guedes Jorge
Research Area	Electrical and Computer Engineering

#### 4.2 Objectives and Achievements (RL-EGE-LA14-188)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 General Objectives (1000 ca.)

This research line is the focus of the LIAAD/INESC TEC unit.

It is our aim to produce both fundamental and applied research, developing new methods and techniques in the areas of data mining, artificial intelligence, statistical data analysis, operations research, optimization and mathematical modelling and use these for decision support. Many of the activities are carried out by postgraduate students thus contributing to their training.

A considerable part of our work is to develop and enhance algorithms and methodologies, contributing to the state of the art in our research areas.

We aim to apply some of our research results in projects with companies that can benefit from them. We are interested in the areas of power systems, web industry, urban transports, and water supply, among others.

It is also our aim to pursue cooperation with researchers from other national and foreign institutions, namely the University of São Paulo from Brazil.

##### RESEARCH GROUP INTERACTION

An objective of the RL is to achieve a high degree of multidisciplinary and interaction among several RG.

CRACS - participation in joint proposals for projects; joint MSc student on recommender systems with a GPU approach; development ILP/relational methods in bioinformatics.

CESE – a business intelligence solution has been deployed at Universidade do Porto; joint papers published; joint supervision of students; collaboration in the smart manufacturing effort; optimisation and decision support; data mining in industrial applications; modelling industrial networks; metalearning and transfer learning; recommender systems.

CEGI - joint papers published.

CPES - collaboration in the smart grids effort; co-supervision of an MSc dissertation.

Haslab - joint project proposals.

CTM - joint effort for promoting knowledge transfer in the area of smart media.

##### 4.2.2 Main Achievements (2000 ca.)

In 2014 the group had a high number of publications (34) in international journals. We also counted 24 articles in highly ranked conferences (CORE $\geq$ B), including CIKM, ECAI, IDA and UMAP. Overall the group published more

than 100 articles in journals, conferences and books. A special highlight to the publication in 2014 of 2 articles in the high impact journal ACM Computing Surveys.

Researchers from the group have participated in the organization of many international conferences, as organization committee members, track chairs, area chairs and program committee members

1 new book was published with a collection of articles.

13 PhD theses and 54 MSc dissertations with supervision or co-supervision of LIAAD members were concluded and defended last year.

Paula Brito continued her presidency of IASC - International Association for Statistical Computing (<http://www.iasc-isi.org/node/54>).

Many of our researchers participate as members of editorial boards of scientific journals and scientific committees of international conferences.

#### COOPERATION WITH OTHER UNITS

CRACS - joint MSc student on recommender systems with a GPU approach;

CESE – a business intelligence solution has been deployed at Universidade do Porto; joint papers published; joint supervision of students;

CEGI - joint papers published.

CPES - co-supervision of an MSc dissertation.

### 4.3 Research Line Output (RL-EGE-LA14-188)

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### 4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

1. Marcos Domingues, Carlos Manuel Soares, Alípio Jorge, Solange Rezende, A data warehouse to support web site automation, Journal of the Brazilian Computer Society, vol.20, no.11, pp.1-16, 2014

#### 4.3.2 Collaborative Other Publications (2000 ca.)

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.

1. Alípio Jorge, José Paulo Leal, Sarabjot Anand, A study of machine learning methods for detecting user interest during web sessions, IDEAS 2014 - 18th International Database Engineering & Applications Symposium, Porto, Portugal, Julho, 2014.
2. Catarina Félix, Carlos Soares, Alípio Jorge, João Vinagre, Monitoring Recommender Systems: A Business Intelligence Approach, ICCSA 2014 - 14th International Conference on Computational Science and Its Applications, Guimarães, Portugal, June 30 - July 3, 2014, LNCS v. 8584, pp 277-288, Springer
3. Elsa Gomes, Alípio Jorge, Paulo Jorge Azevedo, Classifying heart sounds using SAX motifs, random forests and text mining techniques, IDEAS 2014 - 18th International Database Engineering & Applications Symposium, Porto, Portugal, 2014.
4. Fábio Pinto, Carlos Soares, João Mendes-Moreira, An Empirical Methodology to Analyze the Behavior of Bagging, in The 10th International Conference on Advanced Data Mining and Applications, pp.199-212, 2014.

5. Fábio Pinto, Carlos Soares, João Mendes-Moreira, Rosaldo J. F. Rossetti, Simulation of the ensemble generation process: the divergence between data and model similarity, in 28th European Simulation and Modelling Conference (ESM'2014), 2014.
6. Luís Moreira-Matias, João Gama, João Mendes-Moreira, Jorge Freire Sousa, An Incremental Probabilistic Model to Predict Bus Bunching in Real-Time, in Avances in Intelligent Data Analysis, pp.227-238, 2014.
7. Pedro Strecht, João Mendes-Moreira, Carlos Soares, Merging Decision Trees: a case study in predicting student performance, in The 10th International Conference on Advanced Data Mining and Applications, pp.535-548, 2014.
8. João Mendes-Moreira, Jorge Freire Sousa, Evaluating Changes in the Operational Planning of Public Transportation, in Jorge Freire Sousa, Riccardo Rossi, COMPUTER-BASED MODELLING AND OPTIMIZATION IN TRANSPORTATION, SPRINGER, pp.57-68, 2014.

### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

*Co-supervision or clearly multidisciplinary projects are allowed here*

PhD Thesis co-supervised with members of other INESC groups

1. Carlos Manuel Abreu Gomes Ferreira, Exploring Temporal Patterns from Multi-relational Databases, Programa Doutoral em Ciência de Computadores (FCUP), Supervisor: João Gama, Co-Supervisor: Vítor Santos Costa, June 2014. (LIAAD / CRACS)

MSc Dissertations co-supervised with members of other INESC groups

1. André Valente Rodrigues, Paralelização de algoritmos de fatorização de matrizes para recomendação usando GPU, Tese de Mestrado em Ciência de Computadores, Dezembro 2014. (LIAAD / CRACS)
2. Daniela Filipa Neves Cardeano, Data Mining em aplicações de Desenho Racional de Fármacos, Mestrado Integrado em Engenharia Informática e Computação, Supervisor: Rui Camacho, Co-Supervisor: Nuno Fonseca, July 2014. (LIAAD / CRACS)
3. Mestrado Integrado em Engenharia Informática e Computação, Supervisor: Rui Camacho, Co-supervisor: Nuno Fonseca, July 2014. (LIAAD / CRACS)
4. João Pedro Carvalho da Ponte, Detecção de falhas em Servidores de Video on Demand, Análise de redes de servidores, Mestrado Integrado em Engenharia Informática e Computação, Supervisor: João Mendes Moreira, Co-supervisor: Ricardo Morla (FEUP), July 2014. (LIAAD/CTM)
5. Johny Gueirez. "Árvores de Decisão Desequilibradas para Detecção de Erros em Transações de Comércio Externo usando Técnicas de Data Mining", 2014. Dissertação do Mestrado Integrado em Engenharia Informática - Faculdade de Engenharia, Universidade do Porto (Co-Supervisor: Rita Ribeiro). (LIAAD / CESE)
6. Pedro Manuel Santos Borges na empresa Shiftforward, Lda. Online Advertising: Forecasting and Synthesising Web Activity Based On Historical Data, Mestrado Integrado em Engenharia Informática e Computação, Supervisor: João Mendes Moreira, Co-supervisor: Hugo José Sereno Lopes Ferreira. (LIAAD / CSIG)
7. Simão José Batista Ferreira, O Comportamento dos Consumidores Adolescentes e a Sua Evolução no Facebook, Mestrado em Gestão Comercial, Supervisor: Pedro Quelhas Brito, November 2014.
8. Sofia Leonor Castelo Branco Martins Oliveira, O Impacto Económico dos Blogues de Moda e das "It-Girls" na Indústria da Moda: A realidade Portuguesa, Mestrado em Economia e Administração de Empresas, Supervisor: Pedro Quelhas Brito, November 2014.
9. Tiago Marques Dias da Mota, Identificação e Quantificação de Células Oncocíticas em Imagens Microscópicas, Mestrado Integrado em Engenharia Informática e Computação, Supervisor: Rui Camacho, Co-supervisor: Luisa Pereira, July 2014.

#### 4.1 General Description (RL-EGE-LA14-189)

Research Line Title	ARCHITECTURES, LANGUAGES AND SYSTEMS FOR ADVANCED COMPUTING
Principal Investigator	Fernando Manuel Augusto Silva
Research Area	Electrical and Computer Engineering

#### 4.2 Objectives and Achievements (RL-EGE-LA14-189)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 General Objectives (1000 ca.)

The core of our work stems from our expertise in high-level languages design and implementation, secure systems development, as well as in parallel and distributed systems and frameworks. In the last few years, we have been able to both maintain a strong position in our foundational areas and leverage our expertise to open new directions of research in competitive areas such as Information Mining and Web-based Systems. In the next step, our goal is to achieve a balance between Computer Science research and challenging multidisciplinary applications arising from the life sciences, engineering, the Web, and the broad area of social networking.

The effort in the last years has only been possible through support from a network of international collaborators. As a case in point, our contributions in Security and health Informatics, started with international collaboration, have led to strong publications, and have raised high interest outside academia, with INESCTEC providing the ideal vehicle to establish the necessary bridges.

##### 4.2.2 Main Achievements (2000 ca.)

MAIN RESULTS – a few examples:

New competitive funding raised within this RL totaled over 500,000€ with three new projects funded:

ABLE: Advice-Based Learning for Health Care (PTDC/EEI-SII/2094/2012), FCT, (2013/15)

HYRAX: Crowd-Sourcing Mobile Devices to Develop Edge Clouds (CMUP-ERI/FIA/0048/2013), FCT, CMU-Portugal, (2014/17)

REMINDS: RElevance MINing and Detection System (UTAP-ICDT/EEI-CTP/0022/2014), FCT, UTAustin-Portugal (2015/16)

New research contracts with industry and QREN within this RL totaled over 950,000€ with 5 contracts with QREN ON.2, 1 with INCM, 1 with FCT/FCCN.

The publication record of CRACS was maintained at a high standard with a significant increase in journal publications. In 2013/14, CRACS has published 27 refereed journal papers, 2 technical books, 10 book proceedings, 7 book chapters, and 76 conference papers, 51 of which in proceedings with international diffusion (Springer, ACM, or IEEE), and mostly indexed by ISI and Scopus. This corresponds to circa 5 publications on average per senior researcher.

International collaboration is a strong commitment of this RL, achieving 24 joint publications with international collaborators. Some of the most important collaborations are with CMU, UT-Austin, Wisconsin-Madison, UT-Dallas in the US, Amsterdam, Leuven, Imperial College, York, Newcastle, UPM in Europe, Tokyo IT in Japan, and COPPE in Brazil.

A considerable number of software systems developed within this RL are available online for download and at least three of the systems, Yap Prolog, Logtalk, and Mooshak, are very mature and used worldwide by a large community of users, both academic and industrial.

### **4.3 Research Line Output (RL-EGE-LA14-189)**

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### **4.3.1 Collaborative Publications in peer review Journals (2000 ca.)**

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

With LIAAD:

1. T. Loureiro, R. Camacho, J. Vieira and N. A. Fonseca, "Improving the performance of Transposable Elements detection tools", in Journal of Integrative Bioinformatics, vol. 10, November 2013
2. M. A. Domingues, F. Gouyon, A. M. Jorge, J. P. Leal, J. Vinagre, L. Lemos and M. Sordo, "Combining usage and content in an online recommendation system for music in the Long Tail", in International Journal of Multimedia Information Retrieval, vol. 2, pp.3–13, March 2013

#### **4.3.2 Collaborative Other Publications (2000 ca.)**

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

With LIAAD:

1. R Camacho, R Ramos and NA Fonseca, AND Parallelism for ILP: the APIS System, ILP 2013 - Revised Selected Papers, LNCS 8812, 93–106, Sep 2014
2. AM Jorge, JP Leal, SS Anand and H Dias, A study of machine learning methods for detecting user interest during web sessions, IDEAS 2014, ACM, 149–157, Jul 2014
3. T Loureiro, R Camacho, J Vieira and NA Fonseca, Boosting the Detection of Transposable Elements Using Machine Learning, PACBB 2013, Springer AISC 222, 85–91, May 2013
4. N Angelopoulos, VS Costa, J Azevedo, J Wielemaker, R Camacho et al. Integrative Functional Statistics in Logic Programming, PADL 2013, LNCS 7752, 190–205, Jan 2013

With CAP:

1. C Machado, C Gouveia, J Ferreira, B Kovacs, P Jorge and L Lopes, An Adjustable Sensor Platform Using Dual Wavelength Measurements For Optical Colorimetric Sensitive Films, IEEE Sensors 2014, IEEE, 398–401, Nov 2014

#### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

Ph.D. theses with LIAAD:

1. Carlos Manuel Abreu Gomes Ferreira, Exploring Temporal Patterns from Multi-relational Databases, PhD in Computer Science, FCUP, Supervisor: João Gama (LIAAD); Co-supervisor: Vítor Santos Costa (CRACS), June 2014
2. Mário Amado Alves, Adaptive Hypertext. The shattered documents approach, PhD in Computer Science, FCUP, Supervisor: Alípio Jorge (LIAAD); Co-Supervisor: José Paulo Leal (CRACS), July 2013

M.Sc. dissertations with LIAAD:

1. André Valente Rodrigues, Paralelização de algoritmos de fatorização de matrizes para recomendação usando GPU, MSc in Computer Science, FCUP, Supervisor: Alípio Jorge (LIAAD); Co-supervisor: Inês Dutra (CRACS), December 2014
2. Diogo André Rocha Teixeira, A Computational Platform for Gene Expression Analysis, MSc in Informatics and Computing Engineering (MIEC), FEUP, Supervisor: Rui Camacho (LIAAD), Co-Supervisor: Nuno Fonseca (CRACS), Concluded in July 2014
3. Daniela Filipa Neves Cardeano, Data Mining em aplicações de Desenho Racional de Fármacos, MSc in Informatics and Computing Engineering (MIEC), FEUP, Supervisor: Rui Camacho (LIAAD), Co-Supervisor: Nuno Fonseca (CRACS), Concluded in July 2014

#### 4.1 General Description (RL-EGE-LA14-190)

Research Line Title	REAL-TIME EMBEDDED SYSTEMS FOR SMART ENVIRONMENTS
Principal Investigator	Eduardo Manuel de Médicis Tovar
Research Area	Electrical and Computer Engineering

#### 4.2 Objectives and Achievements (RL-EGE-LA14-190)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 General Objectives (1000 ca.)

Coordinator in 2015: Prof. Eduardo Tovar.

This research line is the focus of the CISTER/INESC TEC associate unit.

Embedded computing systems (ECS) is a strategic research area in Europe, incorporating > 98% of the processors. ECS are also becoming inherently distributed and interconnected, paving the way for smart-\* applications.

The main objective of this RL is to address the challenges related to guaranteeing the logical and temporal correctness of ECS for smart environments and cyber-physical systems, addressing topics such as real-time networks/protocols (e.g. sensor/actuator networks, real-time software (e.g. languages and operating systems), adaptive real-time systems (e.g. power management), multicore systems (e.g. scheduling).

This RL is tied to the research activities carried out by the Research Centre in Real-Time and Embedded Computing Systems (CISTER), an LA Associate Unit, but it broadens its scope by integrating other specific competences of the Research Group as well as strengthening synergies and incorporating the skills available in other Research Groups, such as: ROBIS – on the real-time issues and platforms for robotic applications; CRACS – on the fundamental theory of real-time languages and operating systems; HASLab – on the verification of embedded software.

##### 4.2.2 Main Achievements (2000 ca.)

(Void)

#### 4.3 Research Line Output (RL-EGE-LA14-190)

*This section allows you to provide the productivity of the Research Line during the reporting period.*

##### 4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

With HASLAB:

“Logic-based schedulability analysis for compositional hard real-time embedded systems”, Pedro, A., Pereira, D., Pinho, L., Pinto, J., SIGBED Review (SIGBED Rev.), ACM. Feb 2015, Volume 12, Issue 1, pp 56-64.

##### 4.3.2 Collaborative Other Publications (2000 ca.)

With HASLAB:

"Towards a Runtime Verification Framework for the Ada Programming Language" Pedro, A., Pereira, D., Pinho, L., Pinto, J., Lecture Notes in Computer Science, Reliable Software Technologies – Ada-Europe 2014 (LNCS), Springer International Publishing. 23 to 27, Aug, 2014, 8454, pp 58-73.

"A Compositional Monitoring Framework for Hard Real-Time Systems", Pedro, A., Pereira, D., Pinho, L., Pinto, J., NASA Formal Methods Symposium 2014 (NFM14), Springer International Publishing. 29, Apr, 2014, LNCS 8430, pp 16-30. Houston, TX, U.S.A..

"Logic-based Schedulability Analysis for Compositional Hard Real-Time Embedded Systems", Pedro, A., Pereira, D., Pinho, L., Pinto, J., 6th International Workshop on Compositional Theory and Technology for Real-Time Embedded Systems (CRTS 2013). 3, Dec, 2013. Vancouver, Canada. Co-located within the IEEE Real-Time Systems Symposium (RTSS'13).

#### **4.3.3 Collaborative Other Publications (2000 ca.)**

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

(Void)

#### **4.3.4 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

(Void)

## 4.1 General Description (RL-EGE-LA14-191)

Research Line Title	CRITICAL INFORMATION SYSTEMS – DEPENDABLE SOFTWARE, DEVELOPMENT METHODS AND TOOLS
Principal Investigator	Rui Carlos Oliveira
Research Area	Electrical and Computer Engineering

## 4.2 Objectives and Achievements (RL-EGE-LA14-191)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

### 4.2.1 General Objectives (1000 ca.)

Coordinator in 2014: Prof. Rui Carlos Mendes de Oliveira.

This research line is the focus of the HASLab/INESC TEC unit.

Some of the pillars of our society are currently based on information systems that are expected to be trustworthy. Paradoxically, it is widely accepted that these information systems, many of which support critical infrastructures, will fail from time to time. The focus of this line of research is the production of high-assurance software for trustworthy systems: software whose adequacy, responsiveness, predictability, robustness and security have been carefully considered during development.

This is clearly a hard problem that, with the increasingly asymmetric and unstable nature of environments, requires looking at previously disjoint scientific fields as a whole. This RL exploits synergies between competencies in three main aspects of trustworthy systems: rigorous software development, data and systems dependability, and information security. The RL focuses on safety-critical systems, cloud computing, and smartgrids, as application areas in which trustworthiness is particularly relevant.

### 4.2.2 Main Achievements (2000 ca.)

The HASLab steadily produces fundamental and applied research that satisfies the quality standards of the top rated journal and conferences (rated A\*, the best of the best in the popular computer science CORE venue ranking) in each of its areas of research. In 2014 we have published 30 journal articles and 75 full papers in international conferences rated at least B in the CORE ranking.

Major outcomes of our research in 2014 were:

- A detailed analysis and classification of Storage Deduplication Systems that has been published in the ACM Computer Surveys journal, followed by the design and implementation of a novel and highly efficient dependable and fully-decentralized deduplication system for cloud computing infrastructures.
- A new version of our open source framework to help validate, query, and refactor spreadsheets using model-driven software engineering principles. In 2014 this work was published in the IEEE Transactions on Software Engineering, the top journal in this research area, and several other highly ranked journals and conferences.
- An open source implementation of a domain-specific compiler for cryptography has been released and presented at Principles of Security and Trust 2014. The foundations of a verification tool for the same language have been published in Science of Computer Programming. In parallel, an optimisation of a classical construction of block-ciphers that provides stronger security under tampering has been proposed in Fast Software Encryption 2014.

#### Projects

- 2 ongoing EC-funded projects
- 1 EC-funded project kicked-off in 2014
- 1 IA- funded project kicked-off in 2014
- 5 ongoing FCT-funded projects
- 3 FCT-funded projects completed in 2014
- 1 IA- funded projects competed in 2014
- 4 ongoing CCDR-N (QREN) funded projects
- 1 ongoing IA funded project

#### Publications

- 30 papers in international peer-reviewed journals
- 75 papers in international conferences with peer reviewing
- 1 paper in national conference with peer reviewing
- 3 book chapters
- 2 PhD thesis
- 18 MsC thesis
- 4 others publications

#### Awards

HASLab postdoc researcher Alexandre Madeira was honored with the 2013 IBM Scientific Award.

Three best paper awards (SBCARS'2014, DX'2014 (2)).

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

### **4.3 Research Line Output (RL-EGE-LA14-191)**

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### **4.3.1 Collaborative Publications in peer review Journals (2000 ca.)**

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

#### **4.3.2 Collaborative Other Publications (2000 ca.)**

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

#### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

1. MACEDO, Nuno Filipe Moreira, *A Relational Approach to Bidirectional Transformations* (2014)
2. MARTINS, Pedro Miguel Ribeiro, *Embedding Attribute Grammars and their Extensions using Functional Zippers* (2014)

#### 4.1 General Description (RL-EGE-LA14-192)

Research Line Title	TECHNOLOGY AND INNOVATION MANAGEMENT
Principal Investigator	Joao Alberto Vieira de Campos Pereira Claro
Research Area	Economics and Management

#### 4.2 Objectives and Achievements (RL-EGE-LA14-192)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 General Objectives (1000 ca.)

Coordinator in 2013-2014: Prof. João Claro.

This research line is the focus of the UITT/INESC TEC unit.

The Innovation and Technology Transfer Unit is the core RG for this RL. The RL explores research opportunities in Technology and Innovation Management, mainly associated with INESC TEC role at the university-industry interface, and collaborations with COTEC and UT Austin | Portugal in technology commercialization:

- Technology Entrepreneurship, focusing on early stages of academic new ventures;
- Innovation Management, studying practices, tools, and metrics, and multidisciplinary approaches to the Front End of Innovation;
- Innovation Networks, specifically Open Innovation and technology transfer;
- Technology Strategy, concentrating on roadmapping and the interface of technology and operations;
- Engineering Systems Design, focusing on flexibility and the integration of management and social concerns;
- Science and Technology policy, examining the economics of knowledge.

##### 4.2.2 Main Achievements (2000 ca.)

Unit researchers are co-advising several PhD students with researchers from UESP. The first of these co-advised PhD students graduated in 2013, and three more are expected to graduate in 2015.

A collaboration with UESP, C-BER, Instituto de Telecomunicações, and CMU, in a CMU Portugal Program-funded Entrepreneurial Research Initiative, VR2MARKET, is on-going since 2014.

The unit has also been instrumental in the reorganization of the infrastructure services of INESC TEC, in particular in the creation of a Technology Licensing Office and an Industry Liaison Office, and the definition of key instruments to strengthen INESC TEC's activity in science based innovation, such as its policies for Intellectual Property, Spin-offs, Conflicts of Interest and Commitment, Ethics, or Entrepreneurial Testbeds, a new mechanism for interaction with companies.

### **4.3 Research Line Output (RL-EGE-LA14-192)**

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### **4.3.1 Collaborative Publications in peer review Journals (2000 ca.)**

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

#### **4.3.2 Collaborative Other Publications (2000 ca.)**

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

#### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

#### 4.1 General Description (RL-EGE-LA14-193)

Research Line Title	INDUSTRIAL ENGINEERING AND SERVICE MANAGEMENT
Principal Investigator	Bernardo Sobrinho Simões de Almada Lobo
Research Area	Mechanical Engineering

#### 4.2 Objectives and Achievements (RL-EGE-LA14-193)

*This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.*

##### 4.2.1 General Objectives (1000 ca.)

Coordinator in 2011: Prof. José António Sarsfield Cabral.

This research line is the focus of the UGEI/INESC TEC associate unit.

This Associate Unit, the Unit of Management and Industrial Engineering (UGEI) is the core research group for this line of research.

UGEI aims to produce problem-driven knowledge focusing on three main fields, as reported in the RG section:

1. Service Engineering and Design
2. Decision Support and Intelligent Systems
3. Performance Management and Business Intelligence

The objective of this RL is to promote a high degree of multidisciplinary and RG interaction. This RL broadens the scope of UGEI activity by integrating other specific competences of the Research Group as well as strengthening synergies and incorporating the skills available in other Research Groups.

Its research projects are based upon real-world problems: Application / problem solving oriented stance - which obviously encompasses the development of innovative theoretical work leading to multidisciplinary projects mainly in Health, Retail, Mobility and Manufacturing, not only within UGEI research team, but also across different INESC TEC units.

##### 4.2.2 Main Achievements (2000 ca.)

###### MAIN COLLABORATIVE RESULTS

Within the Decision Support and Intelligent Systems research dimension applied to mobility, members from UGEI and UESP have worked on the dial-a-ride problem with split requests and profits. Demand responsive transportation systems are a means to complement standard transportation networks. For the first time in literature, routing problems have been optimized with pickups and deliveries, time windows, request splitting and selection.

A PhD work on “Integrated Vehicle and crew scheduling based on Multiobjective metaheuristics” supervised by members of UGEI and UESP was completed.

Members of UGEI and UESP have launched and co-ordinated Optimization Interunit Line (OIL), an inter-unit line created at INESC Porto LA to promote and cross-fertilize research on optimization. The main activities of the OIL during this period were: the organization of the Weekly Optimization

Workshop (WOW); the promotion of joint multidisciplinary project proposals and publications; the joint supervision of graduate students by researchers from different Units.

UGEI has also collaborated with UESP on the research project ShoelD related to supply chain management in the shoe industry. The contribution of UGEI was focused on demand forecasting and planning.

Moreover, members from LIAAD have participated in the UGEI multidisciplinary research project related to the optimization of operating room planning and scheduling and on the proposal that was approved “Solving Management Decision Problems by Genetic Programming”.

Projects carried out in cooperation among several RG:

An integrated framework for operating room capacity planning and scheduling Funded by FCT (FCT, PTDC/EGE-GES/102681/2008): UGEI, LIAAD

PPEExt—Industrial Extensions to Production Planning and Scheduling, UGEI, UESP Funded by European Commission – call FP7-PEOPLE-2009-IRSES, Proposal n° 24688

Industrial Extensions to Production Planning, Funded by FCT/CAPES 4.4.1.00, UGEI, UESP

Solving Management Decision Problems by Genetic programming. Funded by FCT (FCT, PTDC/EGE-GES/117692/2010): LIAAD, UGEI, UESP

ShoelD

### **4.3 Research Line Output (RL-EGE-LA14-193)**

*This section allows you to provide the productivity of the Research Line during the reporting period.*

#### **4.3.1 Collaborative Publications in peer review Journals (2000 ca.)**

*Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language*

1. Morais, P., Camanho, A.S. Evaluation of performance of european cities with the aim to promote quality of life improvements, OMEGA, The International Journal of Management Science, vol.39, nº4, pp.398-409, 2011
2. Patrício, L., Fisk, R.P., Cunha, J.F., Constantine, L. Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting, Journal of Service Research, vol.14, nº 2, pp.180-200, 2011
3. Amorim, P., Antunes, C., Almada-Lobo, B. Multi-Objective Lot-Sizing and Scheduling Dealing with Perishability Issues, Industrial & Engineering Chemistry Research, , vol.50, nº6, pp.3371-3381, 2011
4. Portela, M.C., Camanho, A.S., Borges, D. BESP - Benchmarking of Portuguese Secondary Schools, Benchmarking: An International Journal, vol.18, nº 2, pp.240-260, 2011

#### **4.3.2 Collaborative Other Publications (2000 ca.)**

*Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language*

1. Miguéis, V.L., Camanho, A.S., Cunha, J.F. Mining customer loyalty card programs: The improvement of service levels enabled by innovative segmentation and promotions designing Lecture Notes in Business Information Processing, vol. 82, pp.83-97, 2011
2. Gomes, C., Sperandio, F., Borges, J.L., Almada-Lobo,B., Brito, A.C. A Decision Support System for Surgery Theatre Scheduling Problems in ENTERprise Information Systems - Communications in Computer and Information Science vol. 221, Springer, pp.213-222, 2011
3. Mourinho, J., Dias, T.G., Cunha, J.F. Spider Maps for Location-Based Services Improvement in Lecture Notes in Business Information Processing, vol. 82, pp.16-29, 2011

4. Teixeira, J., Patrício, L., Nunes, N.J., Nóbrega, L.: Customer Experience Modeling: Designing Interactions for Service Systems. in Proceedings of INTERACT 2011, 13th Conference on Human-Computer Interaction 2011: 136-143
5. Almada-Lobo, B., Borges, J.L., Brito, A.C., Stocco, M., Sperandio, F., Gomes, C. Simulating a Portuguese Hospital Master Surgery Schedule in Proceedings of the 1st International Conference on Serious Games and Applications for Health - SeGAH 2011, pp.1-4, 2011

#### **4.3.3 PhD thesis completed (3000 ca.)**

*Co-supervision or clearly multidisciplinary projects are allowed here*

1. Bruno de Athayde Prata, Uma Nova Abordagem para a Programação Integrada de Veículos e Tripulações, Industrial Engineering and Management Doctoral Program, Supervisors: T.G.Dias, J.P.Sousa., 2011 (UGEI and UESP)