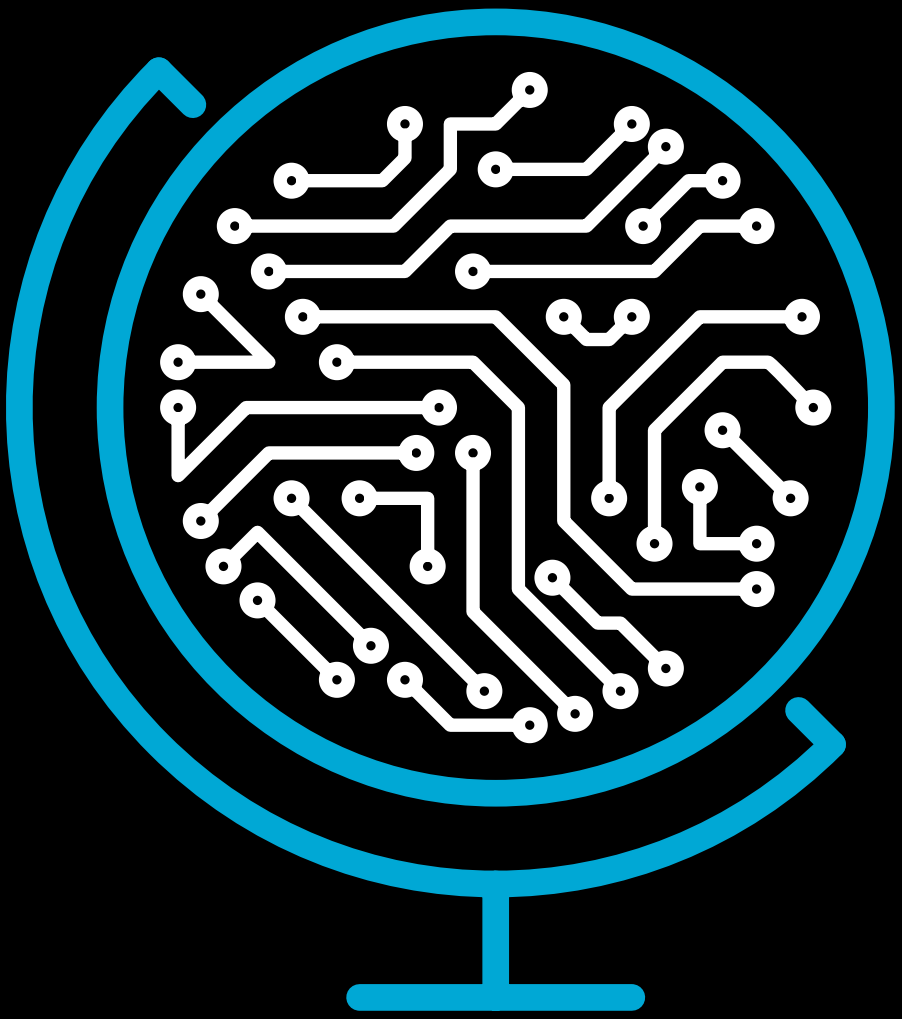
INSTITUTO DE ENGENHARIA
DE SISTEMAS E COMPUTADORES,
TECNOLOGIA E CIÊNCIA

INESCTEC



ACTIVITY REPORT 2017

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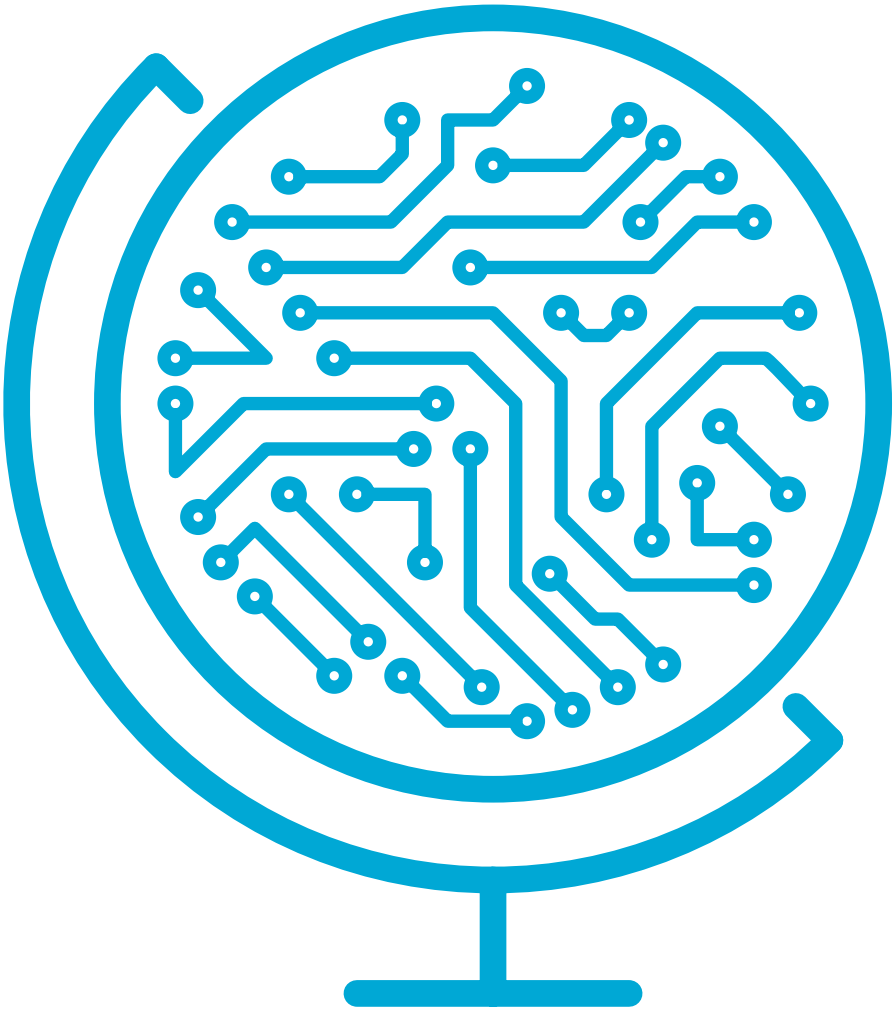

ACTIVITY REPORT 2017

GLOBAL ACTIVITY REPORT 2017

1 INTRODUCTION

This Activity Report describes INESC TEC activity and main achievements in 2017. Specific indicators portraying the institution and its activity are presented and a selection of the tangible results obtained are described.

Section 2 offers a brief presentation of INESC TEC, including its scope, mission, vision, strategy and organisational model. Section 3 presents the institution main activity indicators for 2017, namely those regarding Human Resources, Activity in Projects and Publications.

Research at INESC TEC is developed in 13 Research Centres, organised in four structures denoted as Clusters: Computer Science (CS), Industry and Innovation (II), Networked Intelligent Systems (NIS), and Power and Energy (PE). Section 4 presents these four Clusters, their objectives and their main achievements in 2017.

Section 5 presents the Scientific and Technological Activities developed along 2017 by the Research Centres, including also their objectives, main achievements and activity indicators.

Section 6 focuses on the TEC4 initiatives, plataforms that articulate INESC TEC's activity towards market and society impact, presenting their objectives and achievements in 2017.

Section 7 introduces two "special" projects running at INESC TEC - the Carnegie Mellon Portugal Program and the Digital Competences Initiative to highlight the contributions of the institute to public policies in education and science.

Finally, Section 8 presents INESC TEC Support Services, including the Business Development Services, the Organisation and Management Services and Technical Support Services.

2 INESC TEC PRESENTATION

2.1 Scope and Mission

INESC TEC is a private, non-profit research and innovation institution, dedicated to scientific research and technological development, technology transfer, advanced consulting and training, and pre-incubation of new technology-based companies.

The University of Porto, INESC and the Polytechnic Institute of Porto are INESC TEC's associates. The University of Minho and the University of Trás-os-Montes e Alto Douro are privileged partners of the institution. Presently, INESC TEC's main sites are located in the cities of Porto, Braga and Vila Real.

The 13 R&D Centres of INESC TEC are structured in four Clusters, corresponding to four thematic domains - Computer Science, Industry and Innovation, Networked Intelligent Systems, and Power and Energy. At the end of 2017, the Centres hosted 804 integrated researchers (367 PhDs), including staff researchers, researchers from Higher Education Institutions, grant holders and affiliated researchers. INESC TEC's team also includes trainees and technical and administrative support staff.

As an institution operating at the interface between the academic and business worlds, bringing closer together academia, companies, public administration, and society, INESC TEC leverages the knowledge and results generated as part of its research, in technology transfer projects, seeking value creation and immediate social relevance.

The mission of INESC TEC is to achieve advancement in science and technology and to enable science-based innovation through the transfer of new knowledge and technologies to industry, services and public administration.

2.2 Vision

INESC TEC's vision is to be a leading Science and Technology institution at international level, perceived as an important world player, in the domains of Computer Science, Industry and Innovation, Networked Intelligent Systems, and Power and Energy.

The instituion's scientific objectives for 2018-2022 are in line with the response to the CHALLENGE OF PERVASIVE INTELLIGENCE that INESC TEC continues to face head on. This response is made possible by the structures and processes put in place at INESC TEC to promote and facilitate multi-disciplinary cooperation, which can therefore link sensors, communications, systems, data, knowledge, models, decision and action.

In a very brief summary, INESC TEC's goals per Cluster include (more details can be found in the Clusters and Centres sections below):

- POWER AND ENERGY - Service-oriented energy management systems for a cyber-secure and dynamic energy system; hybridization of artificial intelligence techniques with distributed and parallel architectures and processes for operation and forecasting; advanced dynamic behaviour modelling and analysis including synthetic inertia to assure systems robustness and survival for large scale intermittent renewables scenarios.
- NETWORKED INTELLIGENT SYSTEMS - Prediction, detection and diagnosis in cancer by combining computer vision and artificial intelligence; new photonic sensors in fibre and planar platforms, wearable devices, and hyperspectral imaging; deep sea challenges overcome with the development of new vehicles, the integration of sensors and new subsystems for navigation, broadband wireless communications, and wireless energy transfer underwater.
- COMPUTER SCIENCE - Management, analytics and novel visualisation techniques for stationary and streamed big data; usable and scalable techniques of computation over encrypted data, and multi-party and verifiable outsourced computation; intelligent immersive virtual environments and inclusive HCI with multi-sensorial immersion in augmented and virtual reality.

- INDUSTRY AND INNOVATION - Customer-centric production optimisation 'on the fly' in real time, decentralization of decisions, mass customization and use of collaborative robots; novel vertical IoT-based information architectures; collaborative mobile manipulators and human-robot collaboration, integrated in the IoT paradigm; conditions and enablers for the adoption of new business concepts and models of Cyber-Physical Production Systems.

These scientific targets are complemented by knowledge valorisation and technology transfer targets, structured by INESC TEC in the form of the TEC4 initiatives. These are presented and materialise the effect of the market pull driver into R&D, as opposed (or complementarily) to the science push drivers referred to above. Six TEC4 initiatives are organised to address challenges in different market domains (Sea, Agro-food, Energy, Industry, Health and Media), all cross-cutting the R&D organisation in Centres and Clusters. They are primarily seen as drivers for social and economic relevance of the science developed, instead of science challenges. Their success is measured not only by the number of direct contracts with industry transferring technology, but also by the number of multi-disciplinary and multi-Centre projects promoted.

2.3 Strategy

INESC TEC's strategy is driven by the following main axes:

- Excellence – in science, talent development, technology transfer and collaboration with industry;
- Full coverage of the knowledge-to-value chain;
- Multi-disciplinarity;
- Scale, density, critical mass and integration;
- International visibility and presence.

2.3.1 Excellence in science

Excellence is essential in INESC TEC's aspiration to world recognition and relevant impact in leading companies. Therefore, the institution's resolve in promoting a robust culture of demanding responsibility, quality, accountability, and productivity of advanced science, and in providing appropriate incentives and recognition to high level science and researchers, is a permanent and absolute priority. A continued effort in pursuing and valuing excellence as the trademark of INESC TEC is one of the foundations of the institution.

2.3.2 Excellence in talent development

The deep involvement in Doctoral Programmes is an underlying condition to attract young talent to INESC TEC, which is essential for conducting and disseminating excellent research. INESC TEC strives continuously to bring valuable contributions to the Doctoral Programmes in the several institutions that it is associated with. The particular case of the close and successful relationship with the MAP (Minho-Aveiro-Porto) programmes in computer science and in telecommunications, which join the strongest schools in the north of Portugal in a multi-institutional base model in line with INESC TEC's, suggests the potential extension of that model to other academic domains as a specific area of future strategic contribution, as INESC TEC naturally strengthens its strategic partnerships with associated Department, Schools, and Universities.

2.3.3 Excellence in technology transfer and collaboration with industry

The other side of the coin representing INESC TEC - as an interface organisation - is the capacity to produce socially relevant results and to transfer them to bring impact to the economy. The relations with companies are crucial and INESC TEC focuses relentlessly on being perceived as a partner of excellence, able to provide unique knowledge and relevant technology for product, process, service and business model innovation in organisations. This requires the contribution of all Research Centres – either autonomously or by integrating processes of knowledge transfer with other Centres.

2.3.4 Knowledge-to-value chain

INESC TEC's management and operational model implements the concept of the knowledge-to-value chain, driving knowledge generation research to its valorisation through a mix of processes of technology transfer, from technology licensing to collaborative development, advanced consulting, training and spin-off launching.

This concept is illustrated in a very simplified manner in the figure below, which depicts the division of the chain into four stages: basic knowledge production, applied research, development, and technology transfer and valorisation.

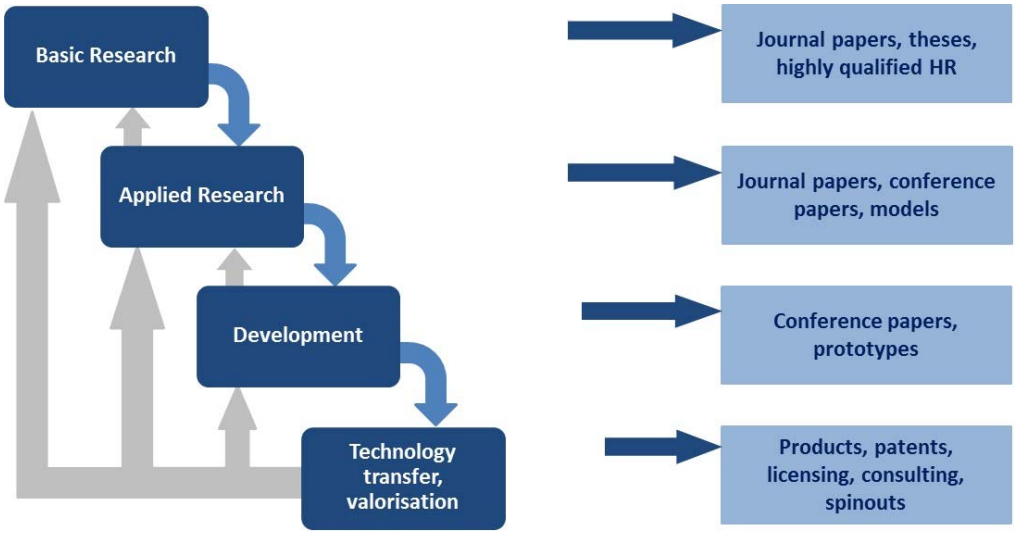

Figure 1 - Knowledge production and valorisation chain concept

The figure also shows some of the relevant outputs produced at each stage and the feedback links from downstream to upstream activities. The outputs at each stage also serve as performance indicators for the corresponding activity. As with any model depicting a complex reality, the divisions between the stages are fluid and not rigid.

The valorisation of research results through technology transfer and advanced consulting activities is essential to the economic sustainability of the institute, and the interaction and collaboration with industry is essential for the identification of new research lines.

Each of the 13 INESC TEC Centres presents a distinct coverage of this chain. Some Centres are more research oriented and are therefore better positioned at the early stages, while others are more market oriented and thus their activity has a higher share in the later stages. The aim is not that each Centre encompasses the whole value chain, but that their organisation allows for knowledge to flow, not only within each Centre but also between Centres, so that INESC TEC as a whole, and its four Clusters, are able to perform socially relevant research and transfer its results to established companies, start-ups or other organisations. This means that INESC TEC focuses on both science and technology transfer.

The success of this model relies on the ability to enable easy flows from upstream to downstream and feedbacks in the reverse direction. In order to achieve this, individual researchers are not required to act on every stage of the chain, but instead to focus where they feel comfortable to excel, whereas Centres have an incentive to achieve a dimension that is large enough to accommodate a broad spectrum of activities with critical mass.

2.3.5 Multi-disciplinarity

In alignment with its focus on practical applications, INESC TEC seeks to facilitate the multi-disciplinary work that those applications typically require.

A special emphasis is placed on generating and supporting interaction among the several Centres. While the Clusters and the TEC4 initiatives, described in the Managed Science Model section, play a key infrastructural role towards this purpose, other measures have been implemented, which include, among others: incentive for research projects bringing together more than one Centre; encouragement of cooperation in co-authorship of papers with authors from different Centres; special actions, called Internal Seed Projects, put in place to allow inter-Center research and junior researcher development ; support to contract research with industry by teams constituted by members from several Centres; management and accounting procedures allowing a Centre to use resources (including researchers) from other Centres.

2.3.6 Scale, density, critical mass

INESC TEC's ambitious vision and mission require a level of scale and density that can only be made possible through its multi-institutional base model.

The resource endowment collaboratively brought to INESC TEC by its associates and privileged partners is continuously leveraged by the institution to sustain a level of growth and densification in the areas of knowledge that are critical for its activity, which is not only unique in the country, but also increasingly relevant in the international arena.

The challenge for the future will be a consistent effort to focus the activities and attract leading researchers to further reinforce INESC TEC's critical mass.

2.3.7 Integration

INESC TEC pays constant attention to its integration dynamics, as the institution and its context evolve, and its resources are accordingly renewed, strengthened and recombined.

The Clusters and the TEC4 initiatives are key instruments to support INESC TEC's policy for achieving institutional cohesion and maximising synergies, differentiation and impact. Overall, this policy seeks to strengthen the ties among Centres, by deepening cross-border fertilization, originating new science by fusion of knowledge and skills, and conducting multi-disciplinary research by truly multi-disciplinary teams. At the same time, it counterbalances a potential propensity of larger Centres to become more self-contained and assume a looser and more independent position within the institution.

2.3.8 International visibility and presence

Excellence in science and technology nowadays requires collaboration and strong partnerships with leading international research institutions. INESC TEC's international projects and activities are crucial to securing the status of international player, assuring the institution's effective participation and recognition in the international arena. The institution permanently directs significant efforts to its international activities, so that they continue to play a major role in the institution's overall activity, measured through scientific output as well as financial indicators.

In this context, the first and foremost undertaking is the consolidation of the massive presence in European research. A second step is the strengthening of a base of operations outside Portugal, to gain access to projects, funding, human resources and ultimately to conquer the status of multi-national organisation. The operation in Brazil, with the constitution of INESC P&D Brasil and its recognition by the Brazilian S&T agencies as a Brazilian ICT (Institution of Science and Technology) must be understood under this perspective. The India Office aims to develop relevant bridges with important companies and public actors and support the attraction of students and post-docs.

2.4 Managed Science Model

2.4.1 Management

The management of INESC TEC is undertaken by a Board of Directors, composed of nine individuals. The Board acts in coordination with the Council of the Coordinators of R&D Centres, Clusters and Support

Services, meeting every other week. This ensures cross-Centre coherence in vision and policy and joint responsibility and commitment, both in strategic and operational management decisions.

The external Scientific Advisory Board is another important body, whose composition reflects the diversity of areas and interests within INESC TEC. It has always had a relevant role in permanently auditing the institute's scientific activity and providing guidance to the Board. Its highly valued recommendations have been appreciated and implemented. The Business Advisory Board supports the Board in business development and industrial relations issues.

A group of advisors on specific scientific areas and business development completes the management team. Performance is assessed at the end of each quarter, considering both economic and scientific perspectives. The deployment of the annual Plan of Activities is equally monitored. Each researcher is subject to an evaluation process every year and all the grant holders every quarter. In order to provide the appropriate incentives, INESC TEC has in place a set of rewards from supplementary payments to publication prizes.

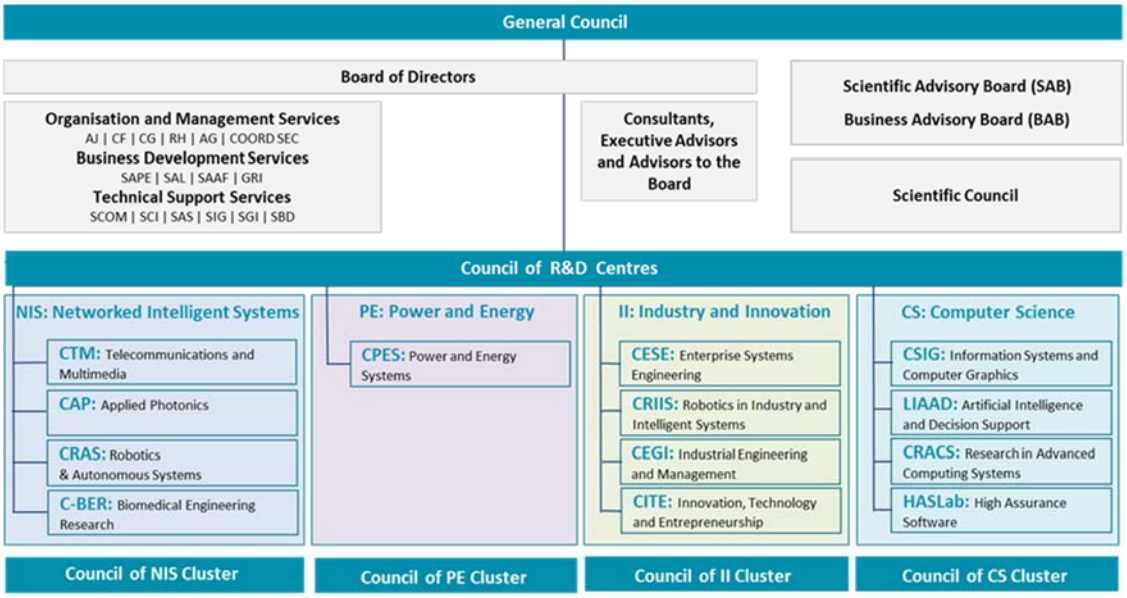

Figure 2 - INESC TEC Organisational Structure

2.4.2 Clusters

The research at INESC TEC is undertaken by its 13 Research Centres, organised in four stable structures called Clusters (see the organisational chart above): Networked Intelligent Systems (NIS), Power and Energy (PE), Industry and Innovation (II) and Computer Science (CS).

The Clusters are responsible for the research and development strategy and long-term planning of each thematic domain. They bring together "core" Centres in their specific domain, and articulate and interface with other relevant Centres, referred to as "associated" Centres. The strategy in a Cluster is formulated in collaboration between the Core and associated Centres. Each Cluster is coordinated by a Cluster leader and a Cluster Council. Performance indicators are consolidated at Cluster level to enable the proper planning for the next periods. Each Centre is nevertheless responsible for its own planning, strategy and resources and answers directly to the Board regarding its budget and performance indicators. Each Cluster is followed closely by two Members of the Board.

2.4.3 The TEC4 initiatives

The TEC4 initiatives articulate INESC TEC's activity towards the market, defining market strategies and planning INESC TEC's interaction with its main market application areas. A TEC4 differs from a Cluster in the fact that it implements a market pull vision and does not have a rigid core of Research Centres.

Instead, a TEC4 initiative structures and provides coherence to INESC TEC's activity towards specific markets, integrating and articulating the competencies of the relevant Centres and Clusters.

A TEC4 is fundamentally driven by a market application domain perspective, where multidisciplinary interventions are usually necessary, instead of a science perspective. A TEC4 initiative establishes a network of external contacts and dialogue with industrial partners and brings back major challenges and the identification of opportunities to the multiple Centres.

The TEC4s are flexible, evolving and adaptive to external conditions and internal response, seeking to avoid becoming rigid or permanent structures. They. Presently six TEC4 initiatives are operating with different levels of maturity: TEC4Sea, TEC4Health, TEC4Agro-food, TEC4Media, TEC4Energy and TEC4Industry.

2.4.4 Support services

A streamlined and dynamic team of highly qualified technical and administrative personnel provides support to INESC TEC's activities, aiming to alleviate researchers from as much administrative and bureaucratic burden as possible.

A set of services are organised to support the researchers across the following domains: legal, project management, accounting, information management, human resources management, computing and communications, and communication and media. Furthermore, each research Centre has its autonomous administrative support, also with highly qualified staff.

Area	Service Name
Business Development Services	Industry Partnerships Technology Licencing Office Funding Opportunities Office International Relations Office
Organisation and Management Services	Finance and Accounting Management Control Human Resources Legal Support Management Support Secretarial Coordination
Technical Support Services	Communication Management Information Systems Networks and Informatics Systems Administration Infrastructure Management

3 RESULTS ACHIEVED IN 2017

This section presents a short summary of INESC TEC results achieved during 2017, including the main indicators for human resources, activity in projects and scientific publications. The presentation of each Cluster and R&D Centre and the detailed discussion of its objectives, activities and results are carried out in Sections 4 and 5, respectively for Clusters and Centres. Section 6 presents the multidisciplinary initiatives TEC4, Section 7 presents special projects and Section 8 the Support Services.

3.1 Strategic priorities and objectives for 2017

The strategic priorities and objectives defined for 2017 have been timely presented to and discussed with INESC TEC's General Council:

i) Scientific development

Consolidating the scientific excellence in INESC TEC research domains is the first strategic line. INESC TEC's clusters are the structures responsible for defining and monitoring the implementation of the long-term scientific strategy.

The ongoing integrated R&D projects, which address new scientific commitments, will contribute to renew skills and to develop critical masses, complementing the more upstream research supported by the projects and pluri-annual funding from FCT. These projects are an institutional investment in strategic areas that should promote scientific leadership's and in the future enable new European projects and contracts with companies.

ii) Valorisation and transfer of technology

The realization of INESC TEC funding model, with a clear equilibrium between different funding sources, surely on a global level but also ideally in each Cluster and R&D Centre whenever possible, will be the result of an increased effort in promoting European projects, contract research, consultancy and training for companies and other organisations.

The TEC4 platforms (planned to be fully operational during 2017) and the Business Advisory Board (whose start was planned for the 1st quarter of 2017) will be key instruments to achieve this objective.

The significant ongoing effort in the protection of Intellectual Property, the preincubation activities and the launch of spinoff companies, which will be strengthened in 2017, complete the planned efforts to increase the knowledge valorisation and transfer.

iii) Relationship with academic institutions

When it comes to the relationship with higher education institutions, it should be noted the protocol with the University of Porto aiming to clarify the relation with its institutes.

Considering the dimension and diversity of the University of Porto (UP) universe and the fact that INESC TEC integrates faculties from different schools, it is believed that the experience in developing the collaboration protocols with UP will be a rich and useful experience in the possible review of the protocols with the Polytechnic Institute of Porto (IPP) and with the strategic partners such as the University of Trás-os-Montes and Alto Douro (UTAD), University of Minho (UM), the Polytechnic Institute of Bragança (IPBragança), the Universidade Aberta and with other academic institutions, preserving the strategic guidelines of those institutions.

iv) Governance model and internal organisation

In the governance model of the institution, two new and important instruments were defined: the Conflict of Interests Management Policy and the Intellectual Property internal Regulation - which were created after a long and extensive work over a period of more than one year, including its internal consultation.

The continuous requirement to increase the efficiency of internal processes demands for its improved automation and IT support, not only for economy of means, but also for an improved flexibility and quick response, and also to support the measurement of performance indicators at different aspects and levels of the institute. These indicators will allow the support of the operational management in all its activities, contributing to continuous improvement, supporting all strategic decisions and ensuring the institution's economic and financial stability.

The work in the communication and science promotion, with particular attention to the development of a new website, the work with the media and the INESC TEC Forum were other highlighted objectives for 2017.

v) International activity

Reinforcing international activity is crucial for the growth experienced during the last few years, especially supported by national funding programmes, even though with the help of European FEDER funds.

The increase of European programmes participation, the consolidation of the activity in Brazil and the opening up to new horizons, namely Asia, were the priority areas of activity defined for 2017.

3.2 Highlights in 2017

Following the strategy presented above it was possible to reach or, in some cases, surpass, the established goals. The following are some of INESC TEC main achievements during 2017:

1. The successful launch of new projects and activities supported an increase in activity of about 16%, consolidating previous year's growths of 14% in 2014, 26% in 2015 and 6% in 2016. This shows evidence of resilience and capability for compensating the often-strong oscillations brought in by the cyclic nature of national and international financing programs, which cause variations in the individual funding sources.
2. The organic growth of the different R&D Centres, organised in the above-mentioned clusters, consolidated the hosting environment for 787 integrated researchers. The Core research team includes 312 researchers with a Ph.D. degree of which 203 are academic staff.
3. The 10% increase in the number of integrated researchers, (the number of faculty has increased by 2%), was partly due to the increase in activity in projects, but also the result of a higher level of attractiveness of the institute Strategy, critical mass and governance model, differentiative INESC TEC research and tech-transfer esco-system.
4. The financing level of the Integrated R&D Projects financed by Norte 2020 has raised considerably, following to a slow start in 2015. FCT Projects and Projects in Cooperation with companies have also significantly increased following the broad implementation of the P2020 Programme.
5. Excellent results have been achieved in FCT competitive financing, with more than 20 projects approved. This will impact in 2018 activity, embedding a significant support to the Ministry scientific employment policies, since many of these projects have foreseen contracts for post-docs.
6. The activity in Consortia R&D projects with companies increased in 2017, due to the start of Portugal P2020 program supporting both consortia R&D projects and large-scale Mobilizing projects.
7. However, the late start and delays in the evaluation of R&D projects promoted by individual companies, put companies on hold expecting public support to their R&D activities, constraining the increase (12%) of the 2017 financing from contract research and consulting with Portuguese companies. This has been partly compensated by the 24% increase in contract research and consulting with international companies.
8. The support to more upstream research and other activities through the FCT Pluriannual Financing Program has reached in 2017 about 18% of all INESC TEC income. The strategic importance of this Program, highly relevant for the financing rates, the flexibility and the effectiveness of the payment cycles cannot be overlooked.

9. The increase in financing of more upstream research has supported the continuous growth of INESC TEC scientific production. The number of papers in indexed journals (318) consolidated the growth and the number of selected conference papers has increased to 491. These numbers have been obtained using different indexing sources (ISI, SCOPUS and DBLP) and have been gathered with the help of the Authenticus and CORE Platforms. Regarding quality and impact of the research, one should emphasize that the large majority (58%) of the papers have been published in first quartile (Q1) journals (according to SCOPUS).
10. In spite of the decrease in European Programs funding, resulting mainly from the end of the Framework Programme 7 and a slow rump-up of Framework Programme H2020, EU is still the most important project-funding source.
11. Regarding IP protection, it is important to highlight the valuable outcome of the researcher's activities but also the grown work under development by SAL (Technology Licensing Office). During 2017, 5 patent applications were submitted and INESC TEC was the second best institution in Portugal in terms of EPO applications.
12. Inasmuch, as non-EU international relations are concerned, the Brazil Office has worked industriously to keep up with the increase of projects with INESC P&D Brazil. The new office for international relations has followed the activity in Brazil and started work on the promotion to attract high quality researchers' and foster projects with Indian institutions.
13. Considerable effort has been put in the increase of institutional visibility and recognition, by communicating the social and economic impacts of the research undertaken. In the annual event, INESC TEC October Forum, near 200 attendants gathered to discuss the theme "Ocean Engineering: Challenges and Opportunities". Besides the active participation in multiple events, such as: Hannover Messe, Business2Sea 2017, Ocean Business in Lisbon, Porto Water Innovation Week 2017, Agri Innovation Summit 2017 or IPL 4.0., INESC TEC researchers have participated in the organisation of 71 international conferences and in 219 Program Committees of international events. A new website and institutional image was deployed.
14. The scientific achievements are detailed in the later sections on Clusters and Centres, but the following deserve highlight:
    - A weakly-supervised framework for interpretable diabetic retinopathy detection on retinal images, a multiple instance learning framework for abnormality detection, end-to-end adversarial retinal image synthesis, and algorithms for image registration with applications in mosaicking of retinal images.
    - A robot for situation awareness in mining activities in flooded mines, a fleet of ten unmanned surface vehicles (FLEXUS USVs) to support experiments of the "Internet of the moving things", a docking station for autonomous underwater vehicles, a solution for the monitoring and mapping of electrical assets based on an unmanned aerial vehicle, procedures for the automatic off-line planning and real-time re-planning of trajectories of autonomous underwater vehicles in sweeping operations, data fusion algorithms for navigation in underwater environments, and algorithms for stereo egomotion estimation.
    - Dynamic simulation platforms for inverter-dominated islanded power systems were developed, thus allowing the study of dynamic stability phenomena in these type of grids and the identification of mitigation strategies. This was used to define the connection requirements for renewable based generation systems to be installed in the Madeira Island.
    - A work platform was developed for SIEMENS AG, including the definition of use cases and elaboration of technical procedures for steady state and dynamic stability studies in islanded Microgrid systems.
    - In the context of the so-called Industry 4.0, a maturity analysis framework was developed to support the assessment of maturity and identification of opportunities in companies from different sectors. Significant scientific advances and successful partnerships with comapnies were

also registered in the design and planning of factories and supply chains. Furthermore, INESC TEC successfully coordinated the creation of a Digital Innovation Hub in the Northern Region of Portugal called iMan Norte Hub - Digital Innovation Hub for Customer-Driven Manufacturing @ Norte. The mission of the iMan Norte Hub is to foster the digital transformation of manufacturing companies of the Northern Region of Portugal and to nurture the respective innovation ecosystem.

- A biometric fingerprint MoC algorithm for Javacard was developed, that is currently being deployed into the Portuguese citizen card, under a contract with the Portuguese Mint and National Press - INCM. An efficient fingerprint minutiae format was also specified, appropriate for secure and accurate MoC operations on smartcards and developed specialized tools supporting smartcard personalization with biometric data.
- The MASSIVE lab was inaugurated with the presence of the Minister of Science, Technology and Higher Education, as well the Dean of UTAD and other dignitaries and invitees from industry.
- A start-up company called SafeCloud Technologies Sarl was created, to exploit key results of the H2020 SafeCloud European project.

3.3 Human Resources

3.3.1 Global Indicators

Table 3.1 and Figure 3.1 show the breakdown of INESC TEC Human Resources by type of contractual relation with INESC TEC and its evolution since 2015. The number of PhDs is also shown (381 at the end of 2017).

Table 3.1 - Evolution of INESC TEC Human Resources

Type of Human Resources			2015	2016	2017	Δ 2016-17	
Integrated HR	Core Research Team	Employees	56	56	71	15	27%
		Academic Staff	196	200	203	3	2%
		Grant Holders and Trainees	307	400	449	49	12%
		Total Core Researchers	**559**	**656**	**723**	**67**	**10%**
		Total Core PhD	**267**	**283**	**312**	**29**	**10%**
	Affiliated Researchers		62	59	64	5	8%
	Management, Administrative and Technical	Employees	53	59	69	10	17%
		Academic Staff	8	8	8		0%
		Grant Holders and Trainees	17	25	23	-2	-8%
		Total Manag, Admin and Tech	**78**	**92**	**100**	**8**	**9%**
	Total Integrated HR		**699**	**807**	**887**	**80**	**10%**
	Total Integrated PhD		**329**	**347**	**381**	**34**	**10%**

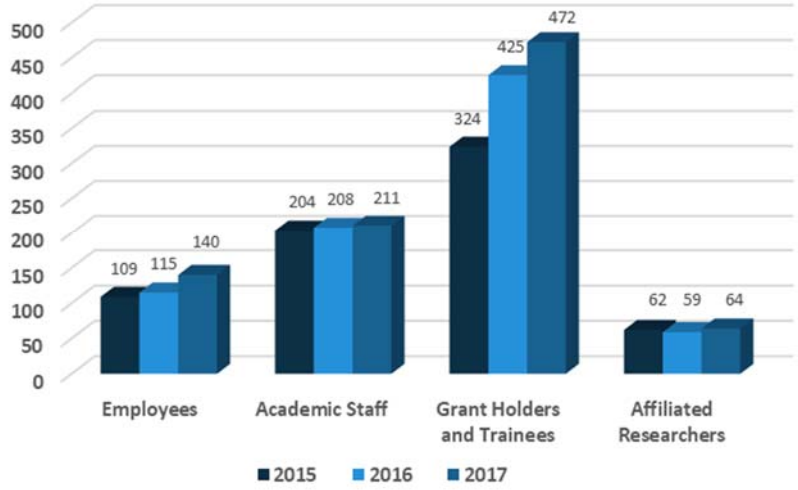

Figure 3.1 - Evolution of INESC TEC Human Resources

It can be seen in Figure 3.2 that grant holders and trainees are the largest group of human resources (53%).

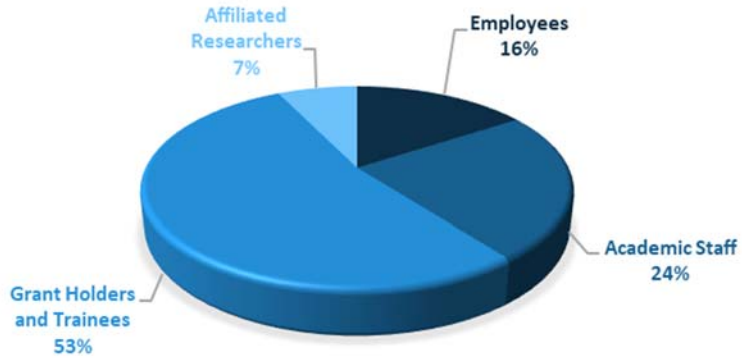

Figure 3.2 - Distribution of Human Resources

The core research team increased 10% to support the higher activity level, reflecting the institute capability to design successful new projects and seize funding opportunities both at national, European and International levels. There is also an increase in the number of human resources of the Support Services, to respond to the increased activity level.

Curricular trainees and external collaborators allocate to INESC TEC activities a small percentage of their time, thus having a negligible financial impact.

3.3.2 R&D Centres Indicators

The number of Human Resources of each R&D Centre is detailed by type in Table 3.2.

Table 3.2 - Human Resources by type and R&D Centre

Type of Human Resources			Total R&D Centres	R&D Centres														Special Projects
				CTM	CAP	CRAS	CBER	CPES	CESE	CRIIS	CEGI	CITE	CSIG	LIAAD	CRACS	HASLAB	
Integrated HR	Core Research Team	Employees	**71**	7	5	8	3	14	14	5		3	10		1	1	
		Academic Staff	**203**	22	9	10	6	12	10	21	19	1	30	28	14	21	
		Grant Holders & Trainees	**447**	49	18	31	21	48	34	19	37	5	56	50	38	41	2
		Total Core Researchers	**721**	**78**	**32**	**49**	**30**	**74**	**58**	**45**	**56**	**9**	**96**	**78**	**53**	**63**	**2**
		Total Core PhD	**312**	**34**	**16**	**14**	**11**	**25**	**16**	**25**	**28**	**4**	**42**	**41**	**22**	**34**	
	Affiliated Researchers		**62**	8	8		4	3	3		5	7	16	6	1	1	
	Administrative & Technical	Employees	**15**	1	2	2		2	2	3	1		1		1		3
		Grant Holders & Trainees	**6**			1				2					1	2	4
		Total Admin & Tech	**21**	1	2	3		2	2	5	1		1		2	2	7
	Total Integrated HR		**804**	**87**	**42**	**52**	**34**	**79**	**63**	**50**	**62**	**16**	**113**	**84**	**56**	**66**	**9**
	Total Integrated PhD		**367**	**41**	**21**	**14**	**15**	**28**	**18**	**25**	**33**	**10**	**56**	**47**	**24**	**35**	
Curricular Trainees			**26**			**1**	**1**		**9**	**1**	**3**	**3**	**4**	**3**	**1**		
External Research Collaborators			**105**	**7**	**1**		**4**	**11**	**7**	**8**	**10**	**6**	**8**	**20**	**13**	**10**	**5**
External Administrative and Technical Staff			**8**					**1**		**1**	**2**					**4**	
External Students			**102**	**20**	**10**		**8**	**9**	**1**	**3**	**5**	**1**	**5**	**13**	**8**	**19**	
Total			**1 045**	**114**	**53**	**53**	**47**	**100**	**80**	**63**	**82**	**26**	**130**	**120**	**78**	**99**	**14**

R&D Centres:

CTM	Centre for Telecommunications and Multimedia
CAP	Centre for Applied Photonics
CRAS	Centre for Robotics and Autonomous Systems
C-BER	Centre for Biomedical Engineering Research
CPES	Centre for Power and Energy Systems
CESE	Centre for Enterprise Systems Engineering
CRIIS	Centre for Robotics in Industry and Intelligent Systems
CEGI	Centre for Industrial Engineering and Management
CITE	Centre for Innovation, Technology and Entrepreneurship
CSIG	Centre for Information Systems and Computer Graphics
LIAAD	Laboratory of Artificial Intelligence and Decision Support
CRACS	Centre for Research in Advanced Computing Systems
HASLAB	High-Assurance Software Laboratory

3.3.3 Support Services Indicators

Table 3.3 presents the number of Human Resources for the Management Board and each Support Service.

Table 3.3 - Human Resources by type and Service

Type of Human Resources		Total	Board and Advisors	Support Services													
				Organisation and Management Services					Business Development Services				Technical Support Services				
				AG	AJ	CF	CG	RH	SAAF	SAPE	SAL	GRI	SCOM	SCI	SIG	SAS	SGI
Integrated HR	Employees	51	7	2	2	6	8	4		4	1		4	2	4	3	4
	Academic Staff	8	8														
	Grant Holders and Trainees	13				3	2		1	1	2	1	3				
	Affiliated Researchers	2	2														
	Total Integrated HR	**74**	**17**	**2**	**2**	**9**	**10**	**4**	**1**	**5**	**3**	**1**	**7**	**2**	**4**	**3**	**4**
	Total Integrated PhD	**14**	**10**			**1**				**2**	**1**						
External Collaborators		7		1						2		3		1			
Total		**81**	**17**	**3**	**2**	**9**	**10**	**4**	**1**	**7**	**3**	**4**	**7**	**3**	**4**	**3**	**4**

Support Services:

AJ	Legal Support
CF	Finance and Accounting
CG	Management Control
RH	Human Resources
AG	Management Support [1]
SAAF	Funding Opportunities
SAPE	Industry Partnership
SAL	Technology Licensing
GRI	International Relations
SCOM	Communication
SCI	Networks and Informatics
SIG	Management Information Systems
SAS	Systems Administration
SGI	Infrastructures Management

3.4 Activity in Projects

3.4.1 Global Indicators

Table 3.4 shows the breakdown of INESC TEC funding sources and its evolution between 2013 and 2017.

[1] Includes Secretarial Coordination

Table 3.4 - Funding sources and evolution

Sources			Value (k€)					Δ (k€ | %)	
			2013	2014	2015	2016	2017	2016-17	
Firm Projects	PN-FCT	National R&D Programmes - FCT	985	867	775	490	1 143	653	133%
	PN-PICT	National R&D Programmes - S&T Integrated Projects	657	1 170	785	1 464	2 644	1 180	81%
	PN-COOP	National Cooperation Programmes with Industry	610	551	316	263	1 060	798	304%
	PUE-FP	EU Framework Programmes	1 868	2 751	4 040	4 494	3 306	-1 188	-26%
	PUE-DIV	EU Cooperation Programmes - Other	117	114	290	632	686	54	9%
	SERV-NAC	R&D Services and Consulting - National	1 322	2 672	3 033	2 259	2 538	279	12%
	SERV-INT	R&D Services and Consulting - International	410	259	173	287	355	68	24%
	OP	Other Funding Programmes	735	531	802	703	1 040	337	48%
		Total Active Projects	**6 705**	**8 914**	**10 214**	**10 592**	**12 773**	**2 180**	**21%**
Closed Projects			77	34	229	418	140	-279	-67%
National Strategic Programme - Pluriannual			1 654	881	2 191	2 615	3 003	388	15%
National Strategic Programmes - Other			339	125	140	112	130	18	16%
Other Revenues			371	491	411	270	260	-10	-4%
		Total Revenues	**9 147**	**10 445**	**13 184**	**14 008**	**16 305**	**2 297**	**16%**

Figure 3.3 illustrates the funding distribution from projects in 2017 and the evolution since 2013. The activity level has steadily grown, with oscillations in the different funding sources, reflecting the respective programmes lifecycles.

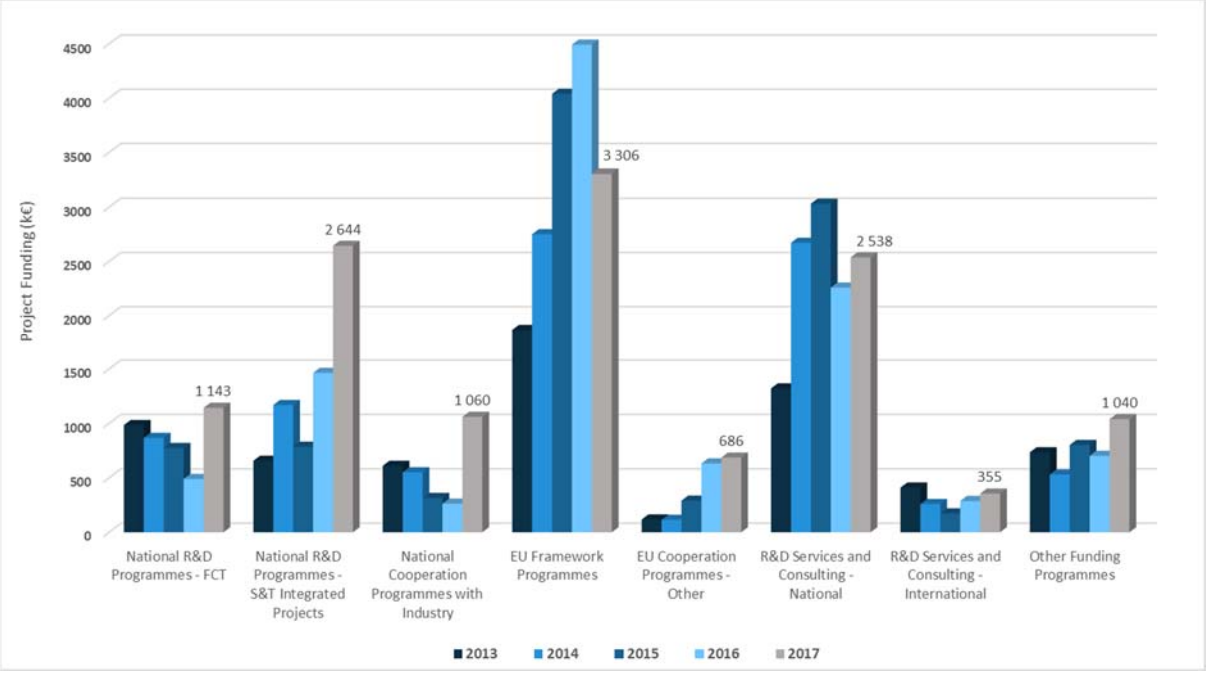

Figure 3.3 - Evolution of Funding Sources from Projects (k Euros)

Figure 3.4 shows the correspondent distribution from funding sources of projects, and the comparison with the previous years.

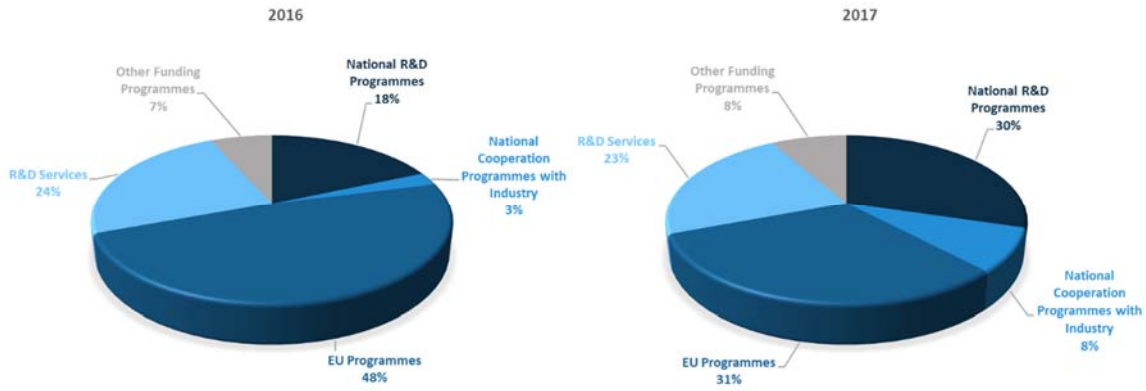

Figure 3.4 - Distribution of Funding Sources from Projects - 2016 (left) and 2017 (right)

The insight into the number of active projects per source and the average funding per project is also of interest, and is shown in Table 3.5.

Table 3.5 - Number of Projects by Type and Average Funding

Type of Project		Number of Active Projects					Δ (%)	Average Funding (k€)	
		2013	2014	2015	2016	2017	2016-17	2016	2017
PN-FCT	National R&D Programmes - FCT	56	41	32	22	28	6	22	41
PN-PICT	National R&D Programmes - S&T Integrated Projects	6	6	10	10	10	0	146	264
PN-COOP	National Cooperation Programmes with Industry	13	11	13	13	22	9	20	48
PUE-FP	EU Framework Programmes	31	26	35	37	35	-2	121	94
PUE-DIV	EU Cooperation Programmes - Other	4	4	9	12	20	8	53	34
SERV-NAC	R&D Services and Consulting - National	67	71	72	67	84	17	34	30
SERV-INT	R&D Services and Consulting - International	13	8	6	11	10	-1	26	36
OP	Other Funding Programmes	10	11	13	19	30	11	37	35
	Total	**200**	**178**	**190**	**191**	**239**	**48**	**55**	**53**

The main conclusions that can be drawn from the previous tables and graphs are the following:

The successful launch of new projects and activities supported an increase in activity of about 16%, consolidating previous year's growths of 14% in 2014, 26% in 2015 and 6% in 2016.

Funding from National Programmes presented a significant increase and was in 2017 the most significant funding source (38% in 2017), reflecting a high effort and success rate in the calls launched at national level.

In fact, all types of national projects presented a relevant growth. In particular, the funding from the Integrated Projects shows a large increase after its start in 2015 as also FCT projects and projects in cooperation with companies (including large scale mobilizing projects) have increased following the broad implementation of the P2020 Programme.

3.4.2 R&D Centres Indicators

A detailed view of the total funding sources per R&D Centre is given in Table 3.6 and Figure 3.5.

Table 3.6 - Project Funding per R&D Centre

	Funding Source	Total (k€)	R&D Centre														
			CTM	CAP	CRAS	CBER	CPES	CESE	CRIIS	CEGI	CITE	CSIG	LIAAD	CRACS	HASLAB	Special Projects
Firm Projects	PN-FCT	**1 143**	31	9	94	147	254	122	72	115	0	117	46	126	11	0
	PN-PICT	**2 644**	497	238	127	199	28	143	62	162	33	294	355	317	189	0
	PN-COOP	**1 060**	160	0	183	0	65	367	139	10	0	80	41	0	16	0
	PUE-FP	**3 306**	223	80	845	0	642	221	274	11	54	262	74	65	554	0
	PUE-DIV	**686**	22	7	115	0	292	114	35	0	36	64	0	0	0	0
	SERV-NAC	**2 538**	129	16	97	26	821	431	432	150	37	214	19	78	60	27
	SERV-INT	**355**	29	0	131	0	182	13	0	0	0	0	0	0	0	0
	OP	**1 040**	100	3	11	0	55	0	0	22	126	111	4	0	19	588
	Total Active Projects	**12 773**	**1 191**	**354**	**1 603**	**371**	**2 339**	**1 411**	**1 015**	**471**	**286**	**1 142**	**539**	**585**	**850**	**615**
	Total Closed Projects	**140**	**7**	**24**	**0**	**1**	**23**	**24**	**3**	**0**	**0**	**38**	**0**	**0**	**19**	**1**
	Total Funding	**12 912**	**1 199**	**378**	**1 603**	**372**	**2 362**	**1 435**	**1 018**	**471**	**286**	**1 180**	**539**	**585**	**869**	**616**

Legend:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programmes
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	R&D Services and Consulting - National
SERV-INT	R&D Services and Consulting - International
OP	Other Funding Programmes

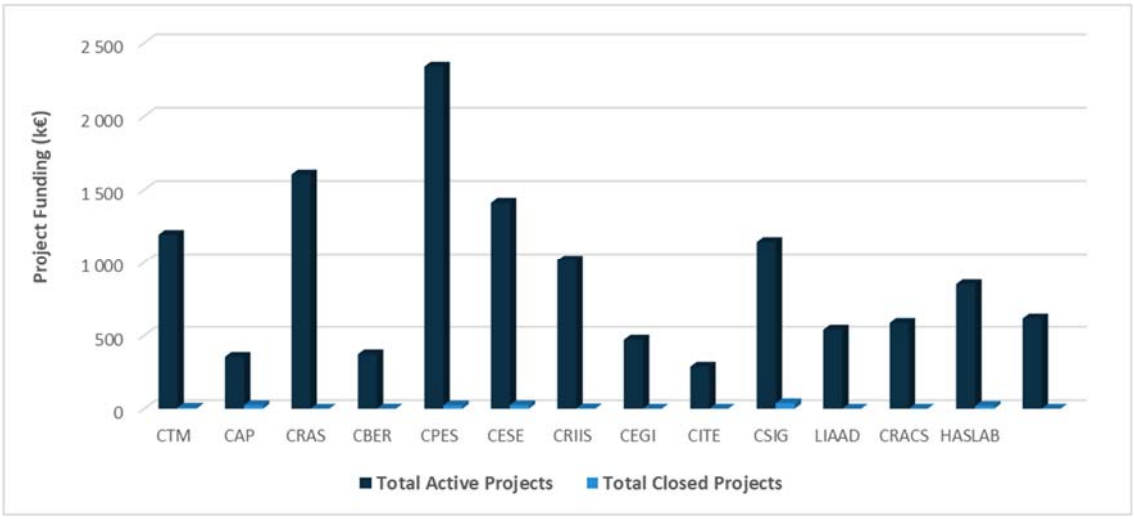

Figure 3.5 - Project Funding by R&D Centre

3.5 Publications

3.5.1 Global Indicators

Table 3.7 and Figure 3.6 show the number of INESC TEC publications in 2017 and its evolution since 2014.

The number of publications for 2017 was obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and from CORE (Computing Research and Education Association of Australasia). Publications with authors from different Centres are counted individually in each Centre of the authors, but the institutional total removes repetitions of the same publication in more than one Centre, whenever it occurs.

It is important to highlight the steady increase in the number of indexed publications over the last years, both in journals and conferences, reflecting the quality and relevance of the research work at INESC TEC.

Table 3.7 - Number of INESC TEC Publications

Publication Type	2014	2015	2016	2017
Indexed Journals	234	247	311	318
Indexed Conferences	393	440	476	491
Books	5	5	1	1
Book Chapters	50	40	37	27
PhD Theses - Members	45	26	38	34
PhD Theses - Supervised	56	66	56	56

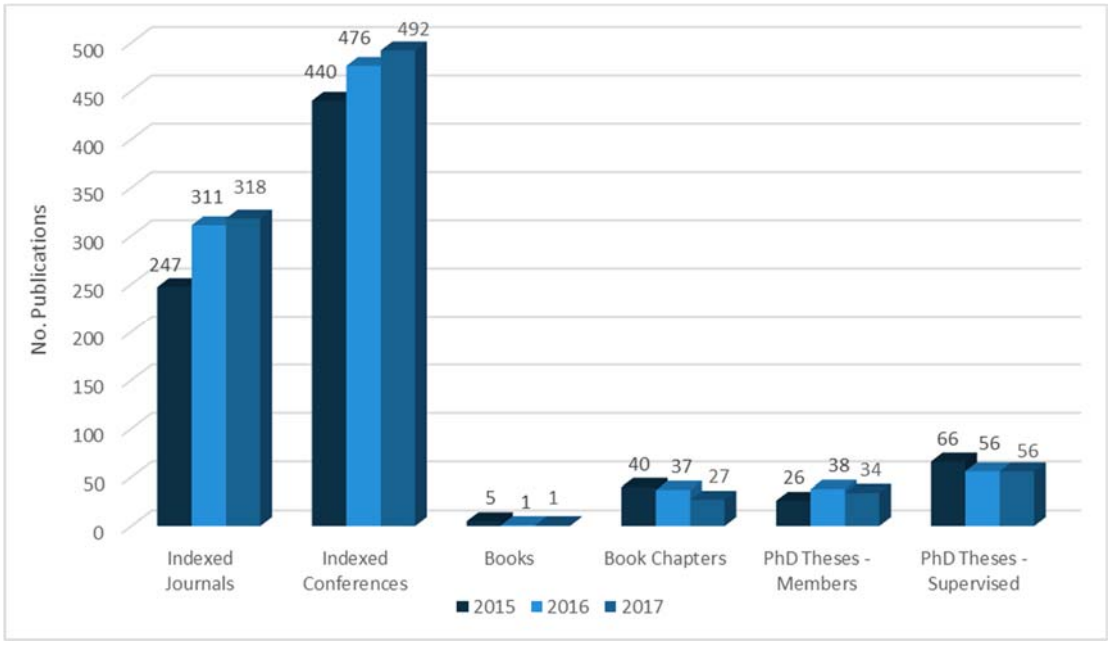

Figure 3.6 - Evolution of INESC TEC Publications

3.5.2 R&D Centres Indicators

Figure 3.7 presents the number of indexed publications in journals and conferences per R&D Centre. The analysis of the evolution of the publications per R&D Centre in presented in later sections in the context of each Centre.

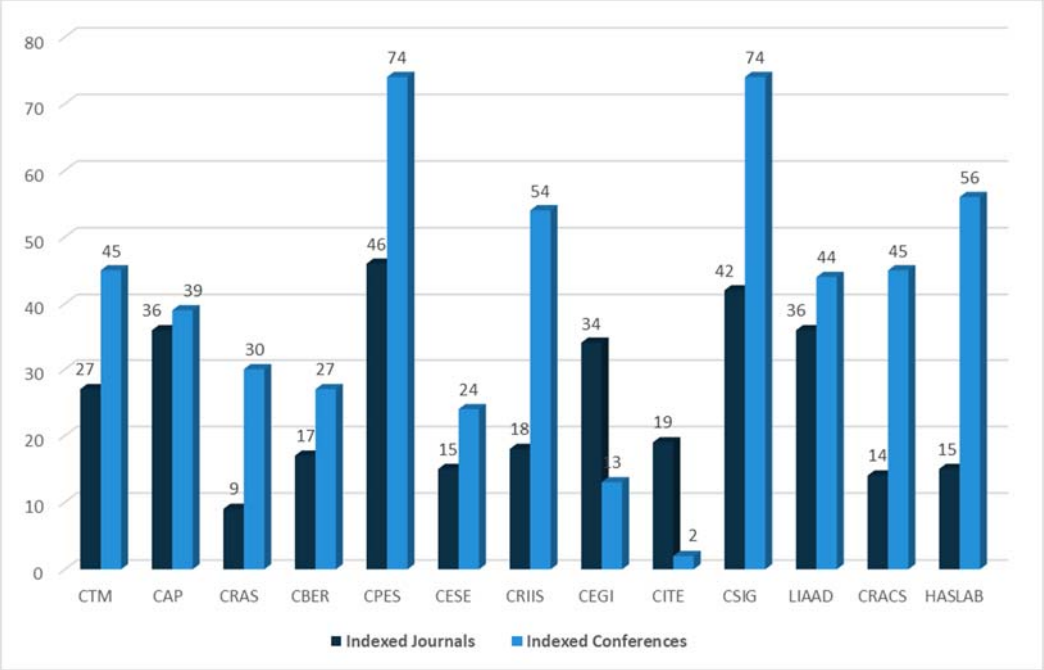

Figure 3.7 - Indexed Publications in Journals and Conferences per R&D Centre

For the publications in journals indexed by Scopus, Figure 3.8 shows the distribution of the number of publications in each impact factor quartile. As it can be seen, that 58% of INESC TEC publications are ranked in the first quartile and only a smaller proportion (19%) are ranked below the second quartile.

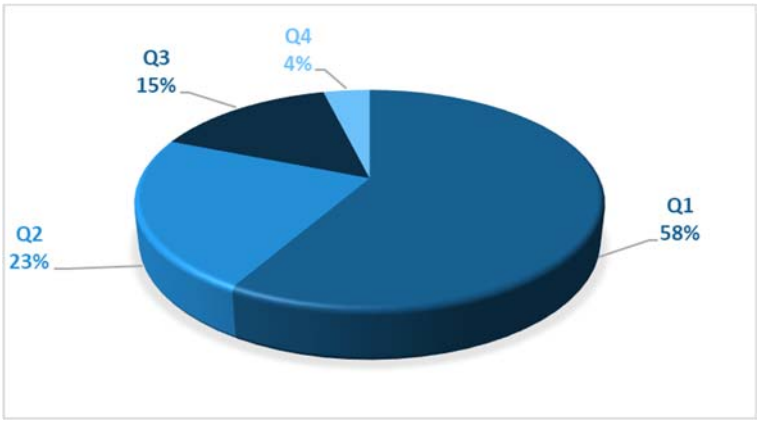

Figure 3.8 - Journal Impact Factor Quartile Distribution (Scopus)

3.6 IP Protection, Exploitation and Technology Transfer

Table 3.8 - Results related with IP Protection, Exploitation and Technology Transfer

Type of Result	2017
Invention disclosures	8
Patent applications	5
Licence agreements	2

3.7 Dissemination Activities

Table 3.9 - Results related with Dissemination activities

Type of Activity	2017
Participation as principal editor, editor or associated editor in journals	40
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	71
International events in which INESC TEC members participate in the program committees	219
Participation in events such as fairs, exhibitions or similar	40
Advanced training courses	32

4 INESC TEC CLUSTERS

As mentioned in Section 2, research at INESC TEC is structured in four Clusters - Networked Intelligent Systems (NIS), Power and Energy (PE), Industry and Innovation (II) and Computer Science (CS). Next sections present those four Clusters, their objectives and results during 2017.

4.1 NETWORKED INTELLIGENT SYSTEMS

Coordinator: Manuel Ricardo
Core Centres: Centre for Applied Photonics (CAP), Centre for Biomedical Engineering Research (C-BER), Centre for Robotics Autonomous Systems (CRAS), and Centre for Telecommunications and Multimedia (CTM).

4.1.1 Presentation of the Cluster

The Cluster on Networked Intelligent Systems (NIS) consists of 4 INESC TEC Centres addressing complementary scientific and technological domains:

- CAP, addressing optical sensing and imaging, and microfabrication.
- C-BER, addressing bioinstrumentation, biomedical imaging, and neuro-engineering.
- CRAS, addressing robotics and autonomous systems operating in complex environments for data gathering, inspection, mapping, surveillance and intervention.
- CTM, addressing radio and optical communications, electronics, communications networks, multimedia technologies, computer vision, and intelligent information processing.

The Cluster NIS carries out activities aligned with the following vision:

"We aim to create autonomous networked intelligent hybrid systems enabled by ubiquitous sensing and processing of information."

These systems should be able to operate also in extreme environments such as the deep sea or inside the human body. Examples of networked intelligent systems include the following: underwater robotics for environment protection and resource exploitation, flying or terrestrial robotics for surveillance of borders, distributed robotics for monitoring intelligent cities, micro-robotics for monitoring human health, distributed robotics for provisioning of adaptive telecom infrastructures. The development of such systems will lead to new results in the NIS Centres.

4.1.2 Objectives

For the cluster NIS in 2017 the objective was to work towards futuristic scenarios in which collections of cooperative autonomous systems, communications enabled and carrying advanced sensors, collect information in extreme environments such as the deep sea or the human body, and process it by using artificial intelligent tools. For the medium term 3 main research lines are active in the cluster: Computer Vision, Sensing, and Autonomous Systems. The detailed short time objectives associated to these research lines are identified within each centre. The rationale and medium term objectives of the NIS cluster are identified as follows:

COMPUTER VISION. We will address a human health scenario. Considering that cancer is a life threatening disease and a major obstacle for the increase of human life expectancy, NIS researchers will work on the prediction, early detection and diagnosis of cancer by using holistic data and epidemiological information, by adopting computer vision and artificial intelligence methodologies. We will use multi-modality big data approaches, based on images, liquid biopsy and biological data. We will take as case studies the lung and breast cancers. This will enable us to learn powerful features and understand relationships between multisensing settings.

SENSING. We will develop a new set of sensors including antennas, miniaturized and rugged photonic sensors in fiber and planar platforms, low power implantable sensing and neurostimulation microsystems, wearable and human implementable devices, and compact hyperspectal imaging. Besides developing these sensors, we will work towards their integration in autonomous systems and their ability to generate data usable by artificial intelligence tools; we will consider mostly the scenarios addressed by our current UAVs, including the SEA scenario.

AUTONOMOUS SYSTEMS. We will address mainly the SEA scenario although we expect also to start characterizing the challenges associated to miniaturized robotics. In the SEA and water environments, we will overcome the challenges associated to deep sea, including high pressures, perception, navigation, and communications. Besides the integration of new payloads of sensors, we will develop and integrate accurate navigation sub-systems, wireless communications sub-systems for broadband data exchange and real time communications, and wireless energy transfer sub-systems. Cooperation between robots will also be addressed.

4.1.3 Main Achievements in 2017

In the **Computer Vision** research line, the main achievements were obtained in the following fields:

- Ophthalmology and Radiology. We developed a weakly-supervised framework for interpretable diabetic retinopathy detection on retinal images, a multiple instance learning framework for abnormality detection, end-to-end adversarial retinal image synthesis, and algorithms for image registration with applications in mosaicking of retinal images.
- Breast cancer. We developed algorithms for defining histology images using convolutional neural networks, prediction of breast deformities, registration of multi-modal data from breast and complete segmentation, registration of breast surface data before and after surgical intervention, and techniques for mass segmentation in mammograms.
- Biometrics. We developed techniques for multi-source deep learning applied to cross-sensor biometrics, biometric using ECG and driver monitoring in cars, heartbeat biometric identity based on electrocardiogram wave morphology, and stress detection based on ECG.
- Video. We developed algorithms for identification of advertisements in broadcasted content, video segmentation and background extraction, using metadata to enhance YouTube content, and enhancing semantic and syntactic relationships of metadata for media description.

In the **Sensing** research line, the main achievements were obtained in the following fields:

- **Antennas and communications.** We developed a compact on-chip integrated antenna for IoT, a 300 GHz elliptical monopole planar antenna suitable for integration with RTDs, resonant tunnelling diodes (RTDs) used as electro-optical transceivers, algorithms for spectrum sensing and dynamic spectrum management and learning, short range RF high-speed communications for underwater mining scenarios, and a reconfigurable array for biomedical signal processing.
- **Fiber sensors.** We developed an interference-based fiber sensor in a cavity ring-down system for refractive index measurement, optical fiber tweezers, single Particle Differentiation through 2D Optical Fiber Trapping, a system for real time evaluation of ore grade in mining operations, an OTDR interrogation approach supported on the Cavity Ring Down technique, vibration and Magnetic Field Sensing Using a Long-Period Grating, optical fiber sensor for early warning of corrosion of metal structures, SPR optimization using metamaterials in a D-type PCF refractive index sensor, microfiber Knot with Taper Interferometer for temperature and refractive index discrimination, and an hollow microsphere Fabry-Perot cavity for sensing applications.

In the **Autonomous Systems** research line, the main achievements were obtained in the following fields:

- **Communications networks.** We developed a wireless communications solution enabling long range broadband communications offshore, a multi-technology solution for UAV-UAV and UAV-Ground communications using TV White Spaces and the 2.3 GHz frequency band together with a Layer-2.5 routing protocol, a topology control and routing algorithms for flying networks, a MAC protocol running over standard IEEE 802.11 wireless cards for long-range broadband ship-to-shore communications in alternative to Satellite communications, an energy-efficient algorithm for green Wi-Fi networks, and a technique for replication of real experiments in ns-3 environment in the same exact conditions as the actual experiment.
- **Robotics.** We developed a robot for situation awareness in mining activities in flooded mines, a fleet of ten unmanned surface vehicles (FLEXUS USVs) to support experiments of the "Internet of the moving things", a docking station for autonomous underwater vehicles, a solution for the monitoring and mapping of electrical assets based on an unmanned aerial vehicle, procedures for the automatic off-line planning and real-time re-planning of trajectories of autonomous underwater vehicles in sweeping operations, data fusion algorithms for navigation in underwater environments, and algorithms for stereo egomotion estimation.

4.2 POWER AND ENERGY

Coordinator: Manuel Matos
Core Centres: CPES
Associated Centres: Centre for Industrial Engineering and Management (CEGI), Centre for Telecommunications and Multimedia (CTM), Centre for Enterprise Systems Engineering (CESE), Artificial Intelligence and Decision Support Laboratory (LIAAD), Centre for Robotics and Autonomous Systems (CRAS), Centre for Information and Computer Graphics Systems (CSIG), High-Assurance Software Laboratory (HASLab), Centre for Applied Photonics (CAP).

4.2.1 Presentation of the Cluster

The cluster is focused on traditional and emergent areas of Power and Energy Systems, for planning and operation purposes, with an emphasis on renewable energy sources (RES) integration, electric vehicles deployment, distributed energy resources (DER) management, demand response (DR), smart grids and energy analytics, through steady state and dynamic network analysis, reliability models and tools, optimization and soft computing and forecasting.

CPES is the core Centre of the cluster but many of the emergent areas benefit from the involvement of associated Centres (CEGI, CESE, CTM, LIAAD, CRAS, CSIG, HASLab and CAP), due to their areas of expertise and of the multidisciplinary nature of the problems to address. There are already examples of this collaboration and joint projects, in the areas of communications (CTM), datamining (LIAAD), cybersecurity (HASLab) and Asset Management (CEGI) and Combined Energy and Process Optimization in Industry (CESE). Rather than just sharing projects, the goal is to promote a multidisciplinary approach and have a strong team involvement to create new knowledge at low TRL and favour new developments and tools at higher TRL.

The cluster council is presently composed of: Carlos Moreira, Jorge Pereira, Luís Seca, Manuel Matos, Ricardo Bessa (all from CPES). Representatives of the associated clusters will participate in the meetings of the cluster.

4.2.2 Objectives

Structural objectives

One of the key objectives for cluster PE was to continue the process of integrating other clusters of INESC TEC, addressing different topics related with the energy system where the scientific competences of other clusters, will maximize the impact of the research and innovation in this field.

This effort is already giving its first results, with a set of think tank groups with clear objectives to generate methodologies and advances that can push more innovative concepts that can address the main challenges foreseen in the coming years in the sector. Digitalization, more efficient conversion systems, distributed and cyber secure systems and design of fibre optic sensors as non intrusive mean to include added value information, are some of the topics that the cluster has been working to address the more challenging operation of the electrical systems in the coming years.

The cluster is also working on the autonomisation of the area of Power Electronics, creating a more stable critical mass that has been challenged to design autonomous and relevant objectives for the coming years, independently of the requirements coming from the grid operation. This has been reinforced in 2017 with 1 more full time researcher and several initiatives on advanced inverters for storage applications and also for EV charging power modulation.

The area of Oil and Gas has made some developments, namely in prospective mapping to drilling and core analysis. The focus was on the development of Intelligent Systems for derisking, through the analysis and integration of large volumes of seismic and petrophysical data acquired during these activities, using data science and machine learning techniques.

Strategic areas

The cluster designed a list of strategic areas for present and future activity. This list covers the major challenges foreseen in the next 2 years, being of the outmost importance to create scientific knowledge to address them, as is described in the following paragraphs.

Co-simulation in Electrical Networks

Simulation of the joint operation of telecommunication and electrical networks, including the transmission-distribution grids coordination and protection systems coordination. This analysis will consider the actual discussion on the use of utility owned solutions (basically PLC PRIME) or telecom infrastructure.

Multi-energy networks

Joint modelling of electricity, gas and heat network considering active demand-side management (residential and building level), energy storage and renewable energy sources. This also includes the joint modelling of transmission and distribution electrical networks.

Large-scale modelling of energy systems

- Modelling spatial-temporal dependency structures of time-series with two goals: uncertainty modelling and forecasting.
- Definition of methods and strategies for real-time monitoring and support the operation of networks by considering DER (renewable energy, storage and flexible loads) and the types of information available, at HV, MV and LV level independently or integrated. This includes knowledge extraction from synchro-phasors units installed in electric power transmission and distribution systems.
- Solve large-scale non-convex optimization and learning problems with decomposition techniques and distributed computing. Definition of methods and strategies for operation distributed energy resources (DER) locally or globally.
- Renew the concepts of load profile for analysis at LV, MV and HV levels by using different sources of information, including human behaviour, sensors, and using techniques of classification and clustering, that will be used on planning, in operation, and in reliability studies.

Weather Intelligence Applied to Power Systems

Integrate information generated from numerical weather prediction systems in power system operation and planning tasks, electricity markets and demand response actions.

Stochastic Optimization of Energy Systems

Integration of forecast uncertainty information in grid operational tools, with a human-in-the-loop approach, which aim to evaluate the future network conditions and derive a set of optimal control actions.

Predictive Maintenance and Asset Management

Multi-disciplinary approach that combines big data platforms, statistical learning and power systems theory (reliability, electric modelling, etc.) to design a probabilistic framework to support the decision-making process of asset management and renew of electrical power systems and power plants.

Towards 100% RES integration and Massive integration of power electronic-based interfaces

- Identification of challenges resulting from the massive connection of power electronic based generators in electric power systems and development of new operational methodologies for assuring system stability.

- Development of predictive algorithms for enabling the participation of renewable generation in synthetic inertia provision and frequency containment control (it requires the development of on-line tools to estimate the available inertia and primary reserve levels).

Smart-grid hardware

- Development of intelligent and autonomous control devices for smart grids network, including lab tests of integration with different components in the network and substation automation.
- Explore the hardware and software in the loop capability for testing hardware devices and software control modules for future smart grids. Take advantage of the OPAL system, available in the Smart Grid and Electric Vehicles Laboratory, to perform Real Time Digital Siumulation (RTDS). Enhancing RTDS through connection with similar simulators.
- Specific developments for enhancing system behavior (inverters, protections).
- Development of technological solutions for electrical mobility.

New marketplaces for energy services

New solutions for network operation and planning in an active market environment with several players and rules considering data transmission, data privacy and data security issues, including data and market hubs. Development and test of new tariff options for network use and energy (retail market options).

Cybersecurity of the grid

Define an overall security architecture for a trustful ICT environment, which covers the whole communication chain. Standard communication protocols and associated security solutions are analysed (e.g. IEC 60870-5-104, IEC 61850, OpenADR, OPC etc.) and the most appropriated selected to assure interoperability. Analyse the internet threats for the power systems and means to avoid, early detect and combat cyber attacks with a multi-disciplinary approach (information systems, data mining, software engineering).

System resilience

Procedures for black-start, self-healing and islanding operations in systems dominated by grid inverter generation.

Power system planning

- Development of algorithms for intelligent planning considering the smart grid implementation, operation and management costs, the benefits of using smart grids (flatter diagrams, the option of investment deferral, etc.) and the potential drawbacks (higher losses, higher risk, etc.).
- Development of tools for reliability analysis, namely for security of supply evaluation and reserves adequacy evaluation

Energy efficiency

Identification of the synergies between the traditional energy efficiency area and smart grid developments, originating new tools and opportunities for consulting. Explore artificial intelligence techniques to exploit information connected by internet-of-things platforms from domestic and industrial loads, aiming at optimization the energy consumption and automate energy efficiency actions. Inclusion of Applied behaviour analysis as a mean to leverage a more user-centric operation of the energy system.

The design of these areas of development included important inputs of associated Centres, namely HASLab, CESE and CEGI.

4.2.3 Main Achievements in 2017

In the Horizon 2020 UPGRID project, CPES and HASLab concluded the demonstration of the market hub platform in Parque das Nações, Lisbon. This platform operated as a market hub for the home energy management systems flexibility, in terms of consumption shift under dynamic retailing tariffs and contracted power limitation requests in response to technical problems.

In collaboration with LIAAD, CPES developed a methodology and software prototype for the detection of anomalous consumption behavior, aiming at identifying uncharacteristic system operation conditions or energy theft. The algorithms, based on clustering and data streams, were transferred to EDP Distribuição.

The project SmarterEMC2 (H2020) has successfully created a methodology and a tool to deal with local constraints that may appear in distribution grids as a consequence of integrating high levels of renewable generation. It works as a planning tool that evaluates the performance of communications systems in distribution grids in scenarios with local problems (voltage, congestion) and determines the best control approach that is able to deal with the potential uncertainties from the communications networks. Real MV networks were used to test the tool and demonstrate the advantages of considering the characteristic of the communications network. A laboratory experimentation was carried out using the OPAL system to fully emulate a MV network where the tool was validated. Project in cooperation with CTM.

Dynamic simulation platforms for inverter-dominated islanded power systems were developed, thus allowing the study of dynamic stability phenomena in these type of grids and the identification of mitigation strategies. This was used to define the connection requirements for renewable based generation systems to be installed in the Madeira Island.

A work platform was developed for SIEMENS AG, including the definition of use cases and elaboration of technical procedures for steady state and dynamic stability studies in islanded Microgrid systems.

CPES developed the algorithmic base and the code for a new DMS module for EFACEC, the Validation of Optimized Solutions application, to determine a feasible switching procedure which will reconfigure the network according to a final optimized topology.

4.3 INDUSTRY AND INNOVATION CLUSTER

Coordinator: António Lucas Soares
Core Centres: Centre for Enterprise Systems Engineering (CESE), Centre for Robotics in Industry and Intelligent Systems (CRIIS), Centre for Industrial Engineering and Management (CEGI), Centre for Innovation, Technology and Entrepreneurship (CITE)
Associated Centres: Laboratory of Artificial Intelligence and Decision Support (LIAAD)

4.3.1 Presentation of the Cluster

The Cluster Industry and Innovation at INESCTEC (c_I+I@INESCTEC) aims to research and innovate in systems and services applied to the management of value streams, from the individual organisation to networks and chains. The activities of the c_I+I@INESCTEC result in high impact systems for decision support, operations automation, management and intelligence and in the provision of technology transfer and innovative consultancy services for applications in Industry, Retail, Healthcare, Energy, Mobility and Transports, and Agriculture.

The goal is to make INESC TEC internationally recognised as a leading research centre in the industry and innovation domain and as a first choice for supporting organisations to achieve high-levels of sustainable innovation and performance.

The Cluster Industry and Innovation (I+I) consists of 4 INESC TEC centres addressing complementary scientific and technological domains:

- CESE, addressing Manufacturing and Services Operations Management, Enterprise and Industrial ICT, Collaborative Networks and Supply Chains, Manufacturing Intelligence;
- CRIIS, addressing of Industrial Robotics, Collaborative Robots and Intelligent Sensors and Dynamical Systems;
- CEGI, addressing Service Design, Decision Support, Performance Assessment, Asset Management, Prescriptive and Predictive Analytics;
- CITE, addressing Innovation Management, Fuzzy Front End of Innovation, Technology Management, Technology Entrepreneurship.

The four core centres of c_I+I@INESCTEC undertake research, knowledge/technology transfer, and consultancy services in complementary research domains (see Figure 4.1) strongly coupled and coordinated through the following collaboration axis: Innovation and Development of New Product/Services; Information Management and Knowledge Discovery; Robotics, Automation, Internet of Things and Cyber-Physical Systems; Design, Planning, Control and Improvement of Operations; Transportation and Mobility.

The cluster uses a range of research approaches to fulfil its mission, namely: Systems Design, Modelling, Mathematical Programming, Optimization, Simulation, Analytics, Information Management, Data Mining, Knowledge Discovery, Machine Learning, Model Based Predictive Control, 3D and Active Perception, Augmented Reality, Artificial Intelligence Multimodal Sensor Fusion, Design Science and Explanatory Research, Creative Thinking and Problem Structuring.

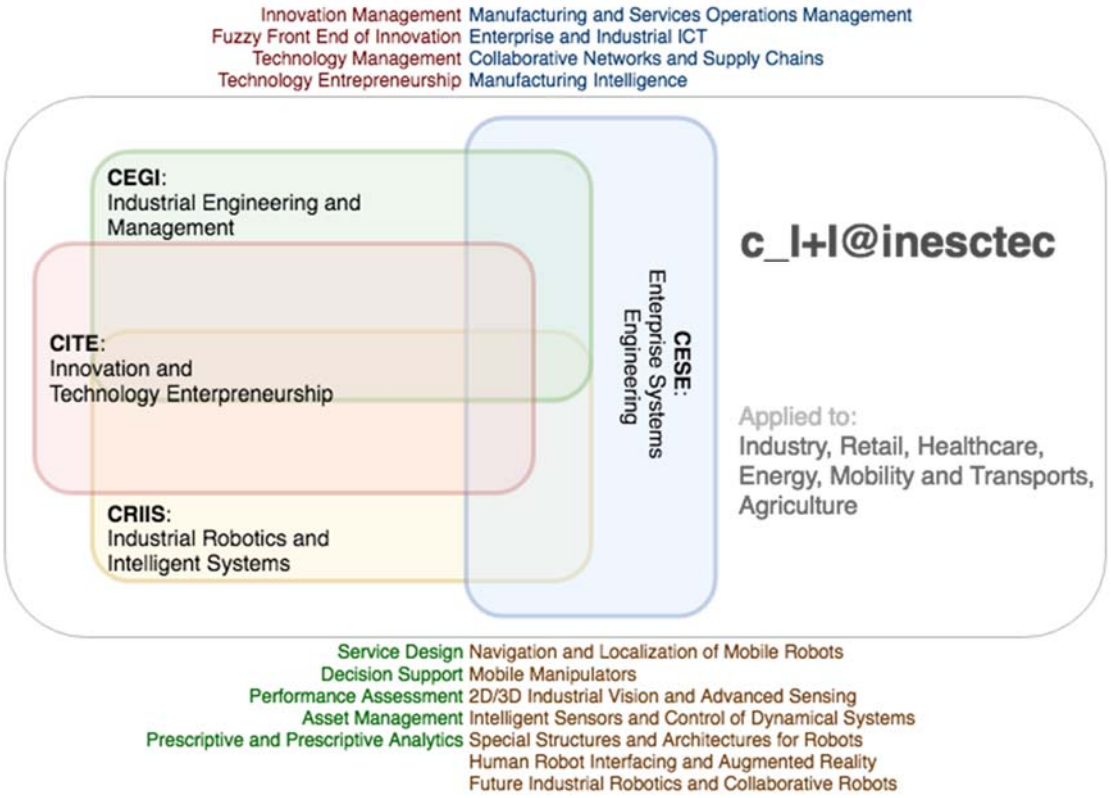

Figure 4.1: c_ I+I@INESCTEC research domains

4.3.2 Objectives

The cluster reached a maturity level where it is challenged with the unique opportunity to create a high impact research program towards a sustainable production paradigm. This will answer the growing demand of manufacturing companies to have efficient tools enabling them to optimize the organization of their production 'on the fly'. This research will lead to an open, scalable production system framework to visualize, virtualize, construct, control, maintain and optimize production, bringing closer several research lines ranging from intelligent systems and robots to analytics and decision support.

Another challenge is to take the digital transformation of industry beyond productivity improvement, clearly contributing to social and environmental sustainability. The remarkable interdisciplinary capability of the cluster is enabling coordinated research leading to novel vertical IOT based information architectures supporting risk and asset management, collaborative networks design, multi-dimensional performance management and crowd-servicing based services.

Innovation & Technology management research will continue to produce high impact results in the North region through the diffusion of new business concepts and models. Research will be focused on (i) developed innovation management processes and tools as well as frameworks to measure innovation; (ii) the conditions and enablers for the diffusion and adoption of CPPS and on the servitization of manufacturing to extend the scope of manufacturer's offerings into services. This will be complemented by the launch of different accelerator programmes in order to sustain the exploitation of the Industry 4.0 technologies.

The following objectives intend to address further integration of practices, improve and balance the scientific production and rationalise consultancy:

- Continue to improve the alignment between basic research, applied research and consultancy;
- Implement joint strategies to attract high quality PhD students and scholarship holders;
- TDefine a strategy for the technology transfer and consultancy projects portfolio;
- Consolidate a strategic communication plan that includes the establishment of the Cluster's web presence, including a youtube channel, in articulation with the communication strategy of INESC TEC;
- Have a cluster's "Research with us" (digital) flyer as an entry point for attracting prospective, highly qualified researchers.

4.3.3 Main Achievements in 2017

Research in the areas of optimization and simulation achieved some major results in 2017. New routing algorithms – Adaptive Large Neighborhood Searches – led to publications in leading journals, advancing the state-of-the-art in optimization and in optimization-simulation approaches. The later were applied to design facilities and planning of operations that have a significant variability and uncertainty, dealing with complex routings and bill of materials, and deciding between the mix between push and pull production strategies. Further applications led to perform AS IS and TO BE analysis in order to understand the impact of the new production mix, to recommend an optimized design of the production line and to propose a practical and balanced design of the production system - in terms of layout, buffers and machines capacities. The 2017 results led to new developments, namely the definition of multi-year planning strategies and the extended design of the factories. Optimization-simulation research at higher TRL levels (6-8) resulted in significant economic impact. Substantial economic gains were attained by a pharmaceutical wholesaler through the application of the recommendations emerging from this research line that helped the wholesaler to make the best decisions regarding product-warehouse-outlet assignment, product delivery modes planning and fleet sizing. Furthermore, in 2017 the cluster has achieved four years of continued collaboration with the IKEA company in the areas of factory design and operations planning, which has been effectively sustained by the research work of European and national projects.

During 2017 the cluster I+I expanded its intervention in the Agro-Food sector. In the Robotics for Agriculture and Forestry application field, five projects were approved (two national FDControlo, GoTecFor, two direct contracts SistemaDPA, DroneTool and one international BiotecFor). This is the result of the research on advanced solutions for agricultural and forestry monitoring systems. Invited talks in relevant agricultural conferences (AgroSummit, SBIAGRO2017, CLBHORT2017) and more than a dozen of articles on the main national media (referring the Agrob V14 and Agrob V16 platforms) show the academic recognition for this effort. In 2017, INESC TEC through the c_I+I@INESCTECI+I is seen as a national reference on robotics R&D for Agriculture and Forestry. In this year were submitted and accepted more than 6 papers in relevant ISI conference/journals (IROS, JINT).

Moreover, important advances were achieved with exploratory research aimed to comprehensively address the quantitative gap in the supply chain design and planning of food industries, integrating the strategic and tactical decisions levels, by developing a framework where all key complexities of food supply chain management are accounted for. Several relevant papers emerged in this stream; one of the key contributions made clear the importance of incorporating perishability concerns in multi-level production planning. This achievement is in line with a previous one in which it was proven that to do better supplier selection in the process food industry, improving profit and customer service level, local food suppliers have to be deeply involved.

In the borders of the Agro-Food area, the cluster has been developing instruments (as part of project FIRE-ENGINE - Designing flexible management systems for forest fires) to help authorities prevent and suppress fires. Because Portugal is the European country that suffers the most with forest fires each year, this research has the potential for great impact.

Industry 4.0 has been a very active intervention area in 2017. From research in higher TRLs (6-8) to management of innovation, several achievements must be highlight. In the area of collaborative robots, the developments made in the cluster regarding projected augmented reality saw is first application in a production environment. Following the developments in previous projects (FP7 CArloS project and FP7 CLARiSSA project), INESC-TEC integrated the CoopWeld Consortium, providing machine vision and a projected augmented reality system for the collaborative robotic assembly of structural steel components. This high TRL (8) project shows the maturity of the technologies as well as the potential of the its use in production environments. In 2017 the STAMINA project came to an end. This flagship project consisted on the development of a mobile manipulator for picking operation in the automotive industry. INESC-TEC long term focus on mobile manipulation played an important role in the project, namely through the vertical integration of a skill-based robot and the algorithms for multi-robot coordination.

The cluster I+I, based on its proven experience in a number of traditional sectors, developed and consolidated in 2017 the offering of new added value services to companies seeking to develop their competitiveness in a sustainable way. One of the key services is the maturity analysis of the target organization concerning industry 4.0 reference framework. In that context, several artefacts have been created to enrich the CESE's maturity analysis framework. The application in different sectors, through advanced consulting services, has been demonstrating the suitability of this bundle of methodologies and tools. Also in the scope of the Industry 4.0 intervention, but expanding its scope, the cluster I+I successfully coordinated the creation of a Digital Innovation Hub in the Northern Region of Portugal called iMan Norte Hub - Digital Innovation Hub for Customer-Driven Manufacturing @ Norte. The mission of the iMan Norte Hub is to foster the digital transformation of manufacturing companies of the Northern Region of Portugal and to nurture the respective innovation ecosystem. The iMan Norte Hub is part of the European network of Digital Innovation Hubs recognized by the European Commission in its Smart Specialization platform and its scope and activities completely align with the NORTE 2020 Smart Specialization Regional Strategy in its priority area of Advanced Manufacturing Systems.

The intervention in the scope of Industry 4.0 is being complemented and advanced by developments on management of innovation approaches e.g., the Business Ignition Programme - a ERDF co-funded project from U.Porto Inovação, CIIMAR and INESC TEC, that developed a state-of-the-art programme for build and test alternative business models for the exploitation of technologies developed in academia. Twenty technologies have been submitted and evaluate during two editions of the programme.

In the academic side, a major achievement in this area was the launching of the Journal of Innovation Management. This journal encourages the submission of papers addressing the multidisciplinary nature of the innovation process combining principles and concepts originating from a myriad of scientific areas, from social sciences to technology research and development. This Journal is Indexed by ProQuest as Scholarly Journal at ABI/Inform, under the Subject Business and Economics

4.4 COMPUTER SCIENCE

Coordinator: António Gaspar
Core Centres: Centre for Information Systems and Computer Graphics (CSIG), Laboratory of Artificial Intelligence and Decision Support (LIAAD), Centre for Research in Advanced Computing Systems (CRACS), High-Assurance Software Laboratory (HASLab)

4.4.1 Presentation of the Cluster

The Computer Science Cluster aims at excelling in the management, analytics and novel visualisation techniques for stationary and streamed big data; usable and scalable techniques of computation over encrypted data, multi-party and verifiable outsourced computation; intelligent immersive virtual environments and inclusive HCI with multi-sensorial immersion in augmented and virtual reality.

The Cluster is composed of 4 Centres with mostly complementary scientific and technological activities:

- CRACS on programming languages, scalable and distributed computing, security and privacy, and information mining,
- CSIG on computer graphics and virtual environments, software engineering, information systems, embedded systems and assistive technologies,
- HASLab on the design and implementation of high-assurance (HA) software systems, and
- LIAAD on methods and techniques for data mining, machine learning and mathematical modelling.

The Cluster is strongly involved in Technology Transfer activities, either as Advanced ICT Consulting or Innovative Systems Development in areas such as Agriculture, Electronic Government, Energy, Healthcare, Industry, Telecommunications, Transport and Services.

The Cluster is served by significant laboratory infrastructures, namely cluster and cloud computing resources located in Porto and Braga, and a multi sensorial immersive virtual reality laboratory based in Vila Real.

4.4.2 Objectives

Most of the Cluster objectives for 2017 have been set towards the reinforcement of the intra-cluster collaborations regarding the identification of joint research challenges on the crossroads of the Centres activities, the complementarily engagement on project proposals and knowledge and technology transfer initiatives. And, as much as possible, extend these goals to collaboration with other INESC TEC Centres.
To this end, several support actions were envisaged to accelerate the consolidation of the Cluster and the publication level kept increasing both in terms of indexed journals (6%) and indexed conferences (5%).

4.4.3 Main Achievements in 2017

In 2017, three large R&D projects involving multiple Centres have successfully finished with important results and societal impact.

The Maestra FP7 FET project (Learning from Massive, Incompletely annotated, and Structured Data), was awarded an excellent grade by the reviewers. The project ceonceived and developed predictive modeling methods to deal with complex and structured data flows generated by non-stationary processes with a high degree of uncertainty. These methods can be extremely useful in different problems and in a varied set of areas (molecular biology, sensor networks, multimedia, and social networks).

The Lean Big Data FP7 project (Ultra-Scalable and Ultra-Efficient Integrated and Visual Big Data Analytics) was also concluded with an excellent grade, with very good science results achieved, according to the reviewers. LeanBigData delivered an ultra-scalable big data management system allowing the realtime analysis of streamed and stationary data thus avoiding the inefficiencies and delays introduced by current ETL-based integration approaches of disparate technologies. The project results achieved TRL 7.

Of major relevance and national impact was the conclusion of the VCardID project that developed a biometric fingerprint MoC algorithm for Javacards that is currently being deployed into the Portuguese citizen card, under a contract with the Portuguese Mint and National Press - INCM. The products developed reached therefore TRL 9. The project involved Centres from the Computer Science Cluster as well as the Centre for Telecommunications and Multimedia from the NIS Cluster.

In 2017, several researchers from the Cluster received distinctions and awards:

- João Barreira, “Professor José Luís Encarnação” 2017 Award;
- Vitor Cerqueira and Fábio Pinto, Best Student Machine Learning Paper Award, ECML-PKDD 2017;
- Ricardo Nunes, Best Paper Award, WAlgProg/2017;
- Pedro Monteiro, Best Student Paper, EPCGI’2017;
- José Melo and Gabriel David, ISOC PT Award, INForum 2017;
- Fábio Coelho, José Pereira and Rui Oliveira, Best Paper Award, DAIS 2017;
- João Tiago Paulo and Hadi Tork, ERCIM 2017 Cor Baayen Young Researcher Award finalists;
- Miguel Araújo, Pedro Ribeiro and Christos Faloutsos, Best Paper Award, ICDM 2017;
- Rui Pereira, Silver Medal ACM Student Research Competition, ICSE 2017;
- Abdelrahim Said Mousa, First Distinguished Professor Award 2016/2017, Birzeit University - Palestine;
- Rogério Pontes, Best Student Paper Award, SYSTOR 2017.
- Nuno Moniz, Fraunhofer Challenge 2017 - Best PhD Thesis Contest - Second Place.

Of particular remark, is the inauguration of the MASSIVE laboratory at UTAD, an infrastructure devoted to the multidisciplinary study of the relationship between virtual reality technologies and the different dimensions of human performance and the creation of the SafeCloud Technologies Sàrl company to exploit key results from the SafeCloud European H2020 project.

4.5 Main Indicators by Cluster

This section includes the Cluster main indicators, presenting an overview of their relative size and results achieved in 2017.

4.5.1 Human Resources

Table 4.1 - Human Resources indicators by Cluster

Type of Human Resources			Clusters			
			NIS	PE	II	CS
Integrated HR	Core Research Team	Employees	23	14	22	12
		Academic Staff	47	12	51	93
		Grant Holders and Trainees	119	48	95	185
		Total Core Researchers	**189**	**74**	**168**	**290**
		Total Core PhD	**75**	**25**	**73**	**139**
	Affiliated Researchers		20	3	15	24
	Administrative and Technical	Employees	5	2	6	2
		Grant Holders and Trainees	1	0	2	3
		Total Admin and Tech	**6**	**2**	**8**	**5**
		Total Integrated HR	**215**	**79**	**191**	**319**
		Total Integrated PhD	**91**	**28**	**86**	**162**
Curricular Trainees			2	0	16	8
External Research Collaborators			12	11	31	51
External Administrative and Technical Staff			0	1	3	4
External Students			38	9	10	45
		Total	**267**	**100**	**251**	**427**

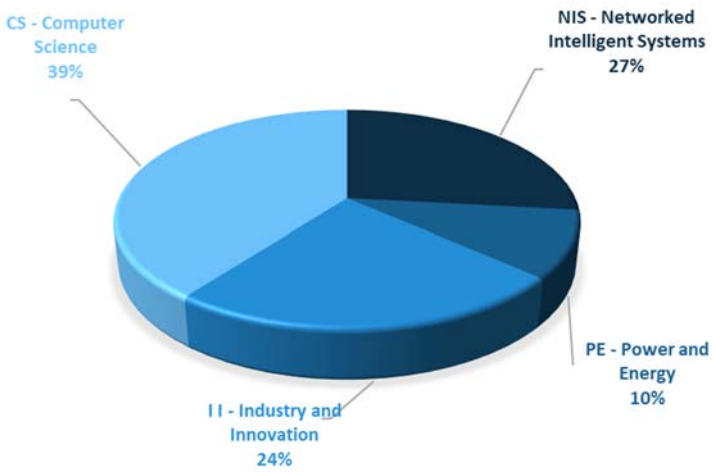

Figure 4.2 - Human Resources by Cluster

4.5.2 Activity in Projects

Table 4.2 - Activity in Projects by Cluster

Funding Source			Clusters			
			NIS	PE	II	CS
Firm Projects	PN-FCT	National R&D Programmes - FCT	281	254	309	299
	PN-PICT	National R&D Programmes - S&T Integrated Projects	1 062	28	400	1 155
	PN-COOP	National Cooperation Programmes with Industry	343	65	515	137
	PUE-FP	EU Framework Programmes	1 148	642	560	956
	PUE-DIV	EU Cooperation Programmes - Other	144	292	186	64
	SERV-NAC	R&D Services and Consulting - National	268	821	1 051	371
	SERV-INT	R&D Services and Consulting - International	160	182	13	0
	OP	Other Funding Programmes	115	55	149	134
		Total Active Projects	3 520	2 339	3 182	3 116
		Total Closed Projects	32	23	27	56
		Total Funding	**3 552**	**2 362**	**3 210**	**3 173**

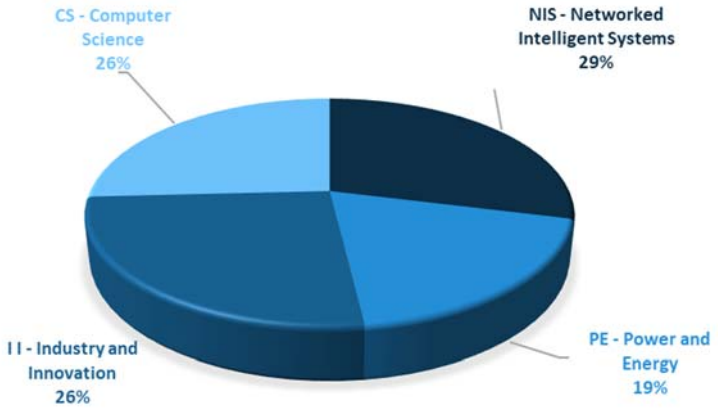

Figure 4.3 - Project Funding by Cluster

4.5.3 Publications

The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 4.3 - Summary of Publications by Cluster

Funding Source	Clusters			
	NIS	PE	II	CS
Indexed Journals	89	46	86	107
Indexed Conferences	141	74	93	219
Books	0	0	1	1
Book Chapters	5	2	8	14
PhD Theses - Members	9	1	11	16
PhD Theses - Supervised	9	4	20	23

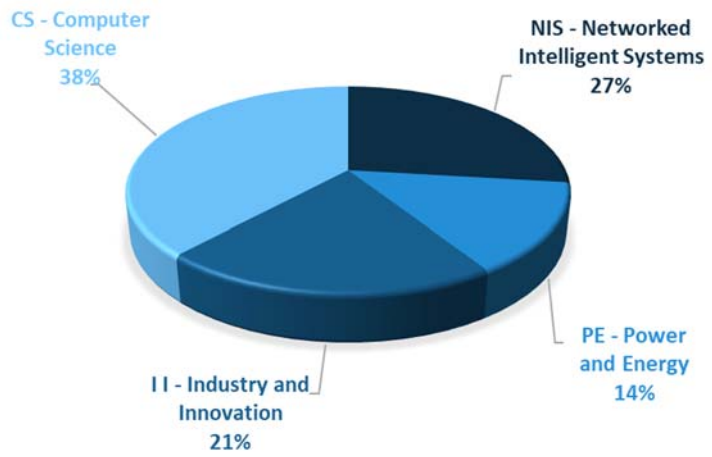

Figure 4.4 - Indexed Articles by Cluster

5 RESEARCH AND DEVELOPMENT CENTRES

5.1 CTM - CENTRE FOR TELECOMMUNICATIONS AND MULTIMEDIA

Coordinator: Manuel Ricardo

5.1.1 Presentation of the Centre

The Centre for Telecommunications and Multimedia (CTM) consists of 100+ researchers addressing scientific and technologic topics related to the fields of telecommunications and multimedia. CTM is fully committed and aligned with the vision and mission of INESC TEC and specializes them as follows:

- **Vision:** A lively and sustainable world where networked intelligence enables ubiquitous interaction with sensory-rich content.
- **Mission:** Development of advanced systems and technologies enabling high capacity, efficient, and secure communications, media knowledge extraction, and immersive ubiquitous multimedia applications.

CTM accomplishes its mission, within the Cluster NIS - Networked Intelligent Systems, by directing its activities towards 4 main areas of research: Optical and Electronic Technologies; Wireless Networks; Multimedia and Communications Technologies; Information Processing and Pattern Recognition.

5.1.2 Research and Technology Development

OET - Optical and Electronic Technologies

The main goal of this area is to technologically devise solutions for communications and intelligent systems of the future, based on the integration of advanced skills in optical communications and microwaves, signal processing, microelectronics and programmable logic.

Research activities in optical communications and microwaves address the development of optical and wireless communication systems, including the convergence between both wireless and optical systems, targeting future high-speed wired and wireless communication systems, in both terrestrial and maritime environments, supported in advanced modulation formats and signal processing techniques as well as on R&D of novel radio devices and antennas. Research in microelectronics and programmable logic addresses design, testability, characterization and adaptive correction of performance, RF design and transparent electronics, A/D and D/A conversion, dedicated computing applications in reconfigurable logic and adaptive transparent acceleration, and VLSI design.

WiN - Wireless Networks

The main goal of this area is to design and evaluate new networking solutions for extreme environments such as aerial and maritime. The focus is on wireless networks and mobile communications, extending infrastructure networks and enabling 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 medium access control, radio resource management, context-aware optimization using cross-layer techniques, and self-configuration of static and mobile multi-hop wireless networks.

MCT - Multimedia Communication Technologies

The main goal of this area is to devise solutions for capturing, producing, sharing and accessing multimedia information from users' own perspectives and experiences, over the Internet, in social media, through on demand services, or even in large spaces like a theatre or a football stadium. This includes the integration of different media formats, the ways of constructing different narratives,

human-media interaction mechanisms or the possibility of delivering and accessing distributed multimedia resources in heterogeneous environments to any user in a seamless and adaptable way.

The main research topics include the following: technologies to enable personalized access and consumption of multimedia content through context awareness; immersive multi-view experiences; content description approaches and metadata model and tools for sensing, representing and reproducing multi-sensorial real-life experiences; efficient search and content analysis methods; image, video, sound and music content analysis and knowledge extraction; pattern recognition.

IPPR - Information Processing and Pattern Recognition

IPPR pursues a never-ending information learning system to empower the next generation of intelligent systems, aiming to develop computer-based algorithms and systems by proposing computer vision and machine learning architectures to explain the input data by exploiting prior similar data. The new advances are being validated on the areas of biometry, medical image analysis, human sensing, and networks, contributing to a more enjoyable, secure and healthy environment.

5.1.3 Technology transfer

OET - Optical and Electronic Technologies

In the optical and electronics area, CTM is able to transfer technology and provide consulting services on:

- Design and characterisation of Optical and Microwave Communication Systems. Telecommunication solutions based on wireless technology, research and development in compact multi-band/integrated antennas for mobile networks, developing, testing and characterisation of RF/microwave devices, antennas and waveguides. Simultaneously we address aspects dealing with technological solutions for optical and microwave communications where researchers can test and characterise optoelectronic devices, RF/microwave circuits and waveguides. This laboratory makes it possible to develop and test optical and wireless communication systems and develop optical fibre based solutions for present and future broadband wireless applications.
- Design of (Micro)electronic Systems for Communications. Semi/full-custom designing and testing of analogue, digital and mixed (A/D) circuits and digital systems based on microprocessors and reconfigurable logic. CTM has specialised in the design of analogue and digital electronic circuits in silicon-monolithic substrates, printed circuits and reconfigurable platforms, as well as on the development of analogue or mixed-signal circuits for low and radio frequency applications, namely in the biomedical domain. Testing and built-in self-testing solutions for integrated circuits and systems, design for dependability of wearable systems, reconfigurable logic processing and computing solutions and/or embedded systems and implementing adaptive systems based on dynamic reconfiguration, are also some of the areas we focus on for technology transfer.

WiN - Wireless Networks

In the wireless networks area, CTM is able to transfer technology and provide consulting services on:

- Planning and design of broadband networks capable of supporting multimedia applications and services, including video.
- Planning and design of wireless multi-hop networks for network infrastructure extension.
- Planning and design of communications networks for autonomous vehicles (aerial, surface, and underwater).

MCT - Multimedia Communication Technologies

In the Multimedia Systems area, CTM is able to transfer technology and provide consulting services on:

- Context-aware multimedia applications in heterogeneous environments, metadata and content description approaches, content adaptation and personalization.
- Image, video, sound and music analysis, including cross-media knowledge extraction.

IPPR - Information Processing and Pattern Recognition

In information processing and pattern recognition area, CTM is able to transfer technology and provide consulting services on:

- Intelligent Recognition Products and Systems based on Vision.
- Solutions to medical decision support systems, heath-being systems, biometrics, automatically process manuscript documents and automatic surveillance systems.

5.1.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CTM - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

		Areas of Technology Transfer --> relationships (3)							
Areas of Research and Technology Development	**Status (2)**	Optical and Microwave Systems	(Micro)electronic Systems	Wireless Mesh Networks	Networks for robotics	Multimedia applications	Video and music analysis	Recognition Systems based on Vision	Medical and biometrics solutions
Optical and Electronic Technologies	I	H	H	M	M				H
Wireless Networks	I			H	H				
Multimedia and Communications Technologies	I					H	H		
Information Processing and Pattern Recognition	I							H	H

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer

(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership

(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.1.5 Main Achievements in 2017

The main broad achievements obtained by CTM in 2017 were the following:

- 27 articles published in relevant scientific journals, the majority of them in journals classified by SCOPUS as "1st Quartile".
- 9 new research projects have been initiated in partnership with companies, what demonstrates the CTM commitment to collaborate with relevant partners and transfer results to society; a considerable number of new projects were also proposed.
- Participation in 8 international projects where CTM researchers actively collaborated with international partners and produced relevant research results, as described below.

- CTM researchers have been general chairs of two relevant international events and have organised an international summer school; the 3 events took place in Porto.
- 10 research projects have been developed by CTM researchers in cooperation with researchers from other Centres of the cluster NIS.
- The CTM Open week was organised by CTM researchers in the week of April 3rd. MSc students from neighbour universities have been invited to visit CTM and participated in activities conducted by CTM researchers.

The main achievements obtained by the OET area in 2017 were the following:

- Demonstration of cognitive radio algorithms for spectrum sensing, dynamic spectrum management and learning in the context of satellite applications.
- Design of a compact on-chip integrated antenna for IoT.
- Demonstration of resonant tunnelling diodes (RTDs) as electro-optical transceivers for high speed wireless communications targeting beyond 5G scenarios.
- Design, simulation and experimental validation of a 300 GHz elliptical monopole planar antenna suitable for integration with RTDs.
- Development of a wireless power transfer prototype for AUV battery recharging in salt-water underwater environment.
- Demonstration of a new approach for designing the matching networks for the driver and rectifier of an underwater WPT system, based on third harmonic resonance.
- Demonstration of short range RF high-speed communications in underwater mining application scenarios.
- Development of a 2.4GHz to 100 MHz up-downconverter for the demonstration of underwater radio communications up to 10Mbit/s.
- Design and fabrication of a full UWB transmitter in CMOS for IoTs, including analog to time conversion.
- Design and fabrication of wide-band LNA in CMOS for UWB IoT systems.
- Extension to IJTAG of learning systems for hardware security.
- Design and testing of a novel TFT driver.
- Coarse-grained Reconfigurable Array for Biomedical Signal Processing.
- Dynamically Reconfigurable Dual-Waveform Baseband Modulator for Wireless Communications.

The main achievements obtained by the WiN area in 2017 were the following:

- Development of a novel wireless communications solution enabling long range, broadband communications offshore, which takes advantage of TV White Spaces and new algorithms and network architectures based on flying platforms such as balloons and drones. The prototype tested in maritime environment achieved ranges beyond 50 km and up to 1.5 Mbit/s. This was a breakthrough when it comes to broadband Internet access for humans and systems offshore.
- Design of novel topology control and routing algorithms for flying networks, which enable on-demand network infrastructure deployment for temporary events such as music festivals and disaster areas.
- Development of a novel MAC protocol running over standard IEEE 802.11 wireless cards for long-range, broadband ship-to-shore communications in alternative to Satellite communications.
- Design of a novel energy-efficient algorithm for green Wi-Fi networks, addressing the reduction of the energy consumption of Wi-Fi access points by dynamically configuring their operation mode according to the user traffic demand.

- Development of a multi-technology solution for UAV-UAV and UAV-Ground communications using TV White Spaces and the 2.3 GHz frequency band together with a Layer-2.5 routing protocol.
- Development of the Offline Experimentation approach enabling the replication of real experiments in ns-3 environment in the same exact conditions as the actual experiment, with a potential huge impact in the networking community when it comes to the repeatability and reproducibility of networking experiments, namely in emerging networking scenarios such as flying networks and maritime networks.
- Organisation of two international scientific events: IEEE/IFIP Wireless Days 2017 conference and the Workshop on ns-3 2017.
- Submission of new project proposals enabling the continuation of the work being developed along our strategic research lines, including flying networks, maritime networks, and green networks.

The main achievements obtained by the MCT area in 2017 were the following:

- Development of algorithms for the identification of advertisements in broadcasted content.
- Development of algorithms for video segmentation and background extraction.
- Development of algorithms for music analysis and feature extraction.
- Development of a platform for metadata enhancement of YouTube content.
- Development of a framework for enhancing semantic and syntactic relationships of metadata for media description.
- Organisation of two international scientific events, namely CMMR 2017 and the Signal Processing Cup at ICASSP 2017.
- Co-organisation of VISUM 2017 Summer School.
- Approval of H2020 project in the area of smart digital content in the creative industries.
- Submission of a patent concerning technology for colour similarity evaluation.
- Submission of new project proposals enabling the continuation of the work being developed along our strategic research lines, namely immersive multimedia applications, digital television and new media services, sound and music computing, image and video processing.

The main achievements obtained by the IPPR area in 2017 were the following:

- Development of algorithms for prediction of breast deformities to help on planning the aesthetic results after breast surgery.
- Development of algorithms for registration of multi-modal data from breast and complete segmentation.
- Development of algorithms for special aliasing artefacts detection on MRI data.
- Development of algorithms for segmentation of rectus abdominis muscle anterior fascia for the analysis of Deep Inferior Epigastric Perforators.
- Development of algorithms for registration of breast surface data before and after surgical intervention.
- Development of algorithms combining ranking with traditional methods for ordinal class imbalance.
- Development of algorithms for sign language recognition using multimodal learning.
- Development of algorithms for automated detection and categorization of genital injuries using digital colposcopy.
- Development of transfer learning algorithms with partial observability applied to cervical cancer screening.
- Development of mass segmentation algorithms in mammograms.

- Development of a cross-layer classification framework for automatic social behavioural analysis in surveillance scenario.
- Development of multi-source deep learning approaches for cross-sensor biometrics.
- Development of algorithms for biometric using ECG and driver monitoring in cars.
- Co-organisation of VISUM 2017 Summer School.
- Participate in the organisation of three international scientific events: "Machine learning in imbalanced domains" in 14th International Work-Conference on Artificial Neural Networks (IWANN 2017), “Breast Image Analysis” in the IEEE International Symposium on Biomedical Imaging (ISBI 2017) and MICCAI-DLMIA 2017 - 3rd Workshop on Deep Learning in Medical Image Analysis.
- Submission of a patent concerning method and apparatus for segmentation of blood vessels.
- 2nd place at Business Ignition Programme, U. Porto Inovação, CIIMAR, INESC TEC, December, 2017
- Silver Medal in Kaggle Competition “Intel & MobileODT Cervical Cancer Screening”, 2017.
- Best paper was awarded to the work entitled “The Potential of Multimodal Learning for Sign Language Recognition” at RECPAD 2017.
- Participation in four invited talks as keynote speaker:
- “A Pathway to Creating Planning Tools for Breast Cancer Surgeries”, ISBI 2017-International Symposium on Biomedical Imaging - Special Session: Breast Image Analysis, Melbourne, Australia, 19 April, 2017.
- “Deep Learning: Variations on the Theme and Current Trends”, Data Science Portugal, Porto, Feb 2017.
- “From screening to rehabilitation in breast cancer: a computer aided analysis”, III Semana da Bioengenharia, IST, Mar 2017.
- “Breast Cancer: from surgery Planning to surgery grading”, II Jornadas de Bioengenharia, UTAD, Feb 2017.
- Submission of new project proposals enabling the continuation of the work being developed along our strategic research lines, including medical image analysis, machine and deep learning, biometrics and image and video analysis and processing.

5.1.6 Centre Organisational Structure and Research Team

The Centre for Telecommunications and Multimedia is coordinated by Prof. Manuel Ricardo and is organised in the following Areas:

- OET - Optical and Electronics Technologies - Responsible: Henrique Salgado
- WiN - Wireless Networks - Responsible: Rui Campos
- MCT - Multimedia Communication Technologies - Responsible: Paula Viana
- IPPR - Information Processing and Pattern Recognition - Responsible: Hélder Oliveira

The Centre has two councils: the **CTM Coordination Council** and the **CTM Scientific Council**.

The CTM Coordination Council meets every two weeks and it is composed by the CTM Coordinator, the 4 Area Leaders, the CTM Assessor, and the CTM secretary; in these meetings strategic and management decisions are made.

The CTM Scientific Council meets every two months and it is composed of the senior CTM researchers, mostly PhD researchers; this is a consultative council and strategic topics are discussed in the meetings.

The Centre research team present composition and evolution is presented in Table 5.2.

Table 5.2 - CTM - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	5	7	7	
		Academic Staff	22	21	22	1
		Grant Holders and Trainees	44	46	49	3
		Total Core Researchers	**71**	**74**	**78**	**4**
		Total Core PhD	**35**	**36**	**34**	**-2**
	Affiliated Researchers		11	8	8	
	Admin. & Tech	Employees	1	1	1	
		Grant Holders and Trainees				
		Total Admin and Tech	**1**	**1**	**1**	
	Total Integrated HR		**83**	**83**	**87**	**-2**
	Total Integrated PhD		**43**	**43**	**41**	**-2**
Curricular Trainees			12	2		-2
External Research Collaborators			7	8	7	-1
External Administrative and Technical Staff						
External Students			6	6	20	14
Total			**108**	**99**	**114**	**15**

5.1.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - CTM - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	73	28	31	3
PN-PICT	National R&D Programmes - S&T Integrated Projects	162	333	497	165
PN-COOP	National Cooperation Programmes with Industry	14	70	160	90
PUE-FP	EU Framework Programmes	662	431	223	-208
PUE-DIV	EU Cooperation Programmes - Other	27	104	22	-82
SERV-NAC	R&D Services and Consulting - National	288	120	129	9
SERV-INT	R&D Services and Consulting - International	25	75	29	-46
OP	Other Funding Programmes	22	18	100	82
Closed Projects		17	46	7	-39
Total Funding		**1.291**	**1.225**	**1.199**	**-26**

Table 5.4 - CTM - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	32	31	27
International conference proceedings indexed by ISI, Scopus or DBLP	51	47	45
Books (author)	0	0	0
Chapter/paper in books	5	1	1
PhD theses concluded by members of the Centre	7	6	4
Concluded PhD theses supervised by members of the Centre	10	9	4

Table 5.5 - CTM - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	1
Patent applications	2
Licence agreements	1

Table 5.6 - CTM - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	2
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	10
International events in which INESC TEC members participate in the program committees	28
Participation in events such as fairs, exhibitions or similar	3
Advanced training courses	2

5.1.8 List of projects

Type of Project	Short Name	Leader	Starting date	Ending date
PN-FCT	CompMash	Matthew Davies	2017-10-01	2021-11-30
PN-FCT	EVOXANT	André Marçal	2016-06-15	2019-06-14
PN-FCT	TEC4SEA-1	Rui Lopes Campos	2017-09-01	2020-08-30
PN-FCT	WISE	Manuel Ricardo	2016-06-01	2019-05-31
PN-PICT	CORAL-TOOLS-1	Rui Lopes Campos	2016-01-01	2018-12-31
PN-PICT	FOUREYES	Paula Viana	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL1-3	Henrique Salgado	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL5	Jaime Cardoso	2015-07-01	2018-12-31

Type of Project	Short Name	Leader	Starting date	Ending date
PN-PICT	SMILES-6	Manuel Ricardo	2015-07-01	2018-12-31
PN-COOP	BCCT.Plan	Hélder Filipe Oliveira	2016-11-01	2019-10-31
PN-COOP	CHIC	Artur Pimenta Alves	2017-10-01	2020-09-30
PN-COOP	Cloud-Setup	Pedro Miguel Carvalho	2016-07-01	2018-12-31
PN-COOP	MareCom	Rui Lopes Campos	2016-03-01	2018-08-31
PN-COOP	ROMOVI-1	Manuel Cândido Santos	2017-01-07	2019-08-31
PN-COOP	WI-GREEN	Rui Lopes Campos	2016-10-01	2018-12-31
PUE-FP	AnyPLACE-1	Rui Lopes Campos	2015-01-01	2018-06-30
PUE-FP	iBROW	Luís Manuel Pessoa	2015-01-01	2018-06-30
PUE-FP	SmarterEMC2-1	José Ruela	2015-01-01	2018-03-31
PUE-FP	STRONGMAR-1	Rui Lopes Campos	2016-01-01	2018-12-31
PUE-FP	SUNNY-1	Manuel Ricardo	2014-01-01	2018-06-30
PUE-FP	TERAPOD	Luís Manuel Pessoa	2017-09-01	2020-08-31
PUE-FP	VAMOS-2	Luís Manuel Pessoa	2015-02-01	2018-07-31
PUE-DIV	BLUECOM+	Rui Lopes Campos	2015-07-17	
PUE-DIV	ENDURE	Luís Manuel Pessoa	2015-07-17	
SERV-NAC	Arquitetura_IoT	Filipe André Ribeiro	2017-12-01	2018-05-31
SERV-NAC	ASSIST	Pedro Miguel Carvalho	2012-11-01	
SERV-NAC	Consultoria	Manuel Ricardo	2010-01-01	
SERV-NAC	IBC2017	Pedro Miguel Carvalho	2017-07-01	
SERV-NAC	SURGEONMATE	Pedro Miguel Carvalho	2017-09-01	
SERV-NAC	UGREEN	Rui Lopes Campos	2017-10-01	2019-09-30
SERV-NAC	vCardID-1	Jaime Cardoso	2014-01-01	
SERV-NAC	vCardID2-2	Ana Maria Rebelo	2016-12-01	
SERV-NAC	Where.is	Luís Pessoa	2017-12-01	2019-11-30
SERV-INT	RAWFIE-1	Rui Lopes Campos	2016-09-01	2019-02-28
OP	CMMR2017	Matthew Davies	2017-04-01	
OP	Visum_2017	Ana Maria Rebelo	2017-02-01	
OP	WD17	Manuel Ricardo	2017-01-01	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.1.9 List of Publications

International Journals with Scientific Referees

1. Araujo, T, Aresta, G, Castro, E, Rouco, J, Aguiar, P, Eloy, C, Polonia, A, Campilho, A, “Classification of breast cancer histology images using Convolutional Neural Networks", PLOS ONE, vol.12, pp.e0177544, 2017
2. Azad, MA, Morla, R, “Early identification of spammers through identity linking, social network and call features", Journal of Computational Science, vol.23, pp.157-172, NOV, 2017
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5. Costa, DG, Vasques, F, Portugal, P, “Enhancing the availability of wireless visual sensor networks: Selecting redundant nodes in networks with occlusion", Applied Mathematical Modelling, vol.42, pp.223-243, FEB, 2017
6. da Silva, PM, Dias, J, Ricardo, M, “Mistrustful P2P: Deterministic privacy-preserving P2P file sharing model to hide user content interests in untrusted peer-to-peer networks", Computer Networks, vol.120, pp.87-104, 2017
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8. Kandaswamy, C, Monteiro, JC, Silva, LM, Cardoso, JS, “Multi-source deep transfer learning for cross-sensor biometrics", Neural Computing & Applications, vol.28, pp.2461-2475, SEP, 2017
9. Leao, E, Montez, C, Moraes, R, Portugal, P, Vasques, F, “Alternative Path Communication in Wide-Scale Cluster-Tree Wireless Sensor Networks Using Inactive Periods", Sensors, vol.17, pp.1049, MAY, 2017
10. Leao, E, Montez, C, Moraes, R, Portugal, P, Vasques, F, “Superframe Duration Allocation Schemes to Improve the Throughput of Cluster-Tree Wireless Sensor Networks", Sensors, vol.17, pp.249, FEB, 2017
11. Leao, E, Moraes, R, Montez, C, Portugal, P, Vasques, F, “CT-SIM: A simulation model for wide-scale cluster-tree networks based on the IEEE 802.15.4 and ZigBee standards", International Journal of Distributed Sensor Networks, vol.13, pp.155014771769847, 2017
12. Lobo, J, Ferreira, L, Ferreira, AJ, “CARMIE: A conversational medication assistant for heart failure", International Journal of E-Health and Medical Communications, vol.8, pp.21-37, 2017
13. Marques, B, Ricardo, M, “Energy-efficient node selection in application-driven WSN", Wireless Networks, vol.23, pp.889-918, APR, 2017
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23. Rosado, L, Correia da Costa, JMC, Elias, D, Cardoso, JS, “Mobile-Based Analysis of Malaria-Infected Thin Blood Smears: Automated Species and Life Cycle Stage Determination", SENSORS, vol.17, pp.2167, OCT, 2017
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43. Vieira, VF, Pessoa, LM, Carvalho, MI, “Evaluation of SAR induced by a planar inverted-F antenna based on a realistic human model", IFMBE Proceedings, vol.65, pp.599-602, 2017

44. Wang, C, Kim, H, Morla, R, “Identifying Persistent and Recurrent QoE Anomalies for DASH Streaming in the Cloud", IEEE International Conference on Cloud Computing Technology and Science, CloudCom 2017, Hong Kong, December 11-14, 2017, pp.263-271, 2017

45. Zolfagharnasab, H, Monteiro, JP, Teixeira, JF, Borlinhas, F, Oliveira, HP, “Multi-modal Complete Breast Segmentation", Pattern Recognition and Image Analysis - 8th Iberian Conference, IbPRIA 2017, Faro, Portugal, June 20-23, 2017, Proceedings, vol.10255, pp.519-527, 2017

Books

Blank

Chapter/Paper in Books

1. Lobo, J, Ferreira, L, Ferreira, AJS, “CARMIE: A conversational medication assistant for heart failure", Health Care Delivery and Clinical Science: Concepts, Methodologies, Tools, and Applications, pp.628-644, 2017

5.1.10 PhD Theses

1. Da Silva, P. “Mistrustful P2P: Peer-to-Peer File Sharing Model to Hide User Content Interests”
2. Khoshrou, S., “Learning in evolving video streams”
3. Marques, B., “Application-driven Wireless Sensor Networks”
4. Monteiro, J., “Multimodal Biometric Recognition under Unconstrained Settings”

5.2 CAP - CENTRE FOR APPLIED PHOTONICS

Coordinators: Paulo Marques and Ireneu Dias

5.2.1 Presentation of the Centre

CAP accomplishes its mission within the Cluster NIS - Networked Intelligent Systems, by directing its activities towards 3 main research areas: optical sensors; integrated optics and microfabrication; advanced optical imaging. In this arrangement, optical sensors comprise Chemical/Biosensors and Physical sensors. This organisation is non-hermetic and the development of solutions implies multidisciplinarity and cooperative work from the different fields of the available expertise.

A good example is the Microfabrication section, which will explore traditional top-down microfabrication techniques and non-traditional based on laser direct writing processes to support the activities of other areas. For example, microfluidics chips will be produced to implement biosensors and micro and nanostructures; Bragg gratings will be made by laser direct writing to implement new sensing heads that will lead to the development of better and more reliable sensing heads.

CAP has a task force devoted to R&D outreach activities, which deals with all the news related to the CAP research activities, the organisation of scientific meetings, the collaboration with the Department of Physics and Astronomy (DFA) of the Faculty of Science of University of Porto, the scientific dissemination to the general public, etc.

Of particular importance is the insertion of the Group and the dissemination within the universe of the DFA (Department of Physics and Astronomy of the University of Porto) that hosts the Research Group. In the past, the CAP Group set up a lab, which provides advanced optics experiments available to both CAP researchers and for advanced laboratory lectures of MSc and PhD teaching programs. These activities lead to better prepared students in these topics and an enhancement and widespread interest on many related subjects.

5.2.2 Research and Technology Development

INTEGRATED OPTICS AND MICROFABRICATION

- Enhancement of tri-dimensional laser direct writing station based on a femtosecond fiber laser system (second and third harmonics). Improvement of third axis and software control of the apparatus.
- Monolithic integrated optic devices in pure silica mainly for integrated sensors and communications. However, other materials, such as chalcogenide glasses, Lithium Niobate, etc. and applications such as astronomical interferometry, quantum cryptography, etc. are areas of possible work
- Hybrid devices that combine optical layers will fluids handling capabilities (opto-fluidics made by femtoetching) for sensing. The fabrication of tri-dimensional structures using multi-photon polymerization or suspended cores within channels will be investigated.
- Structures supporting whispery gallery modes are very interesting for sensing but coupling to these structures is typically based on fragile fiber tapers or similar. Alternative robust solutions based on integrated optics for excitation of whispery gallery modes will be developed.
- Implementation of a second apparatus for specialized Bragg grating fabrication mainly on optical fibers, including possibility of handling special fibers.
- Fabrication of Bragg and long period gratings and also explore “fiber-integrated optics”, i.e., using the fiber cladding as the media to write waveguides and devices. Explore multi-core fibers.

ADVANCED OPTICAL IMAGING

- Compressive sensing based imaging based in single-pixel cameras, targeting applications such as Security and defence, Quality control: spectroscopic/hyperspectral imaging, 3D LIDAR imaging, Pharmaceutics, Astronomical imaging;
- Reinforce local capabilities in high precision optical imaging, grounded on the knowledge acquired in white light interferometry imaging;
- Explore medical and bio-sciences using techniques such as Narrow Band Imaging.

PHYSICAL SENSORS

The new strategic plan in nanosensors field is proposed for the next five years, targeting ultra-high sensitivity sensors. In this part, active devices will be designed in order to improve the precision of physical parameters measurement and to apply in new platforms for new areas of research.

- Fabrication of nano/microfibers through different fabrication techniques. The CO2 laser is one of the techniques to be explored during the next years.
- Study and development of nanostructures (Bragg gratings and Fabry-Perot interferometer) fabricated through FIB technique.
- Modelling of photonic crystal structures in waveguides incorporated in special optical fibers.
- Development of Microfiber Knot Resonators as Sensors.
- Development of nano-active and nano tapers targetting very high resolution and accuracy employing metamaterials and SPR.
- Study and development of sensors based on polymer fiber.
- Study of Raman Effect for future applications in reactors for pharmaceutics.
- Expand the application of ionizing radiation dosimeters from the radiotherapy scenario to the monitoring of radiation in industrial facilities and reinforce medical physics capabilities and sensing.

BIOSENSORS

The main goal of this research plan is to explore applications in new areas using optical of Biosensors technologies that are already consolidated:

- Improve long period grating refractometric sensors, for operational conditions, exploring their potential as chemical and biological sensors in specific applications (genomic sensors for identification of species, corrosion monitoring, detection of chemical analytes with differential detection methods);
- Improve the established interrogation methods by implementing robust prototype platforms (PWM LED based colorimetric sensing, differential white light interferometric interrogation, fluorescence lifetime determination).

It is also a main priority the consolidation of emerging areas in the group:

- Optofluidics: development of monolithic optofluidic platforms combining waveguides and microfluidic channels fabricated by 3D fs laser microfabrication, in fiber tips and in planar platforms. Use of advanced sensing techniques in these platforms such as microresonators, interferometers and plasmonic sensors.

Improvement of fiber tip microstructures targeting single cell diagnostic and manipulation (analytical tweezers).

Implementations of real time composition analysis by Laser induced breakdown spectroscopy. Test of new configurations using fiber lasers. Implement robust pattern recognition strategies for identification and quantification in trace analysis.

DISSEMINATION & INTERNATIONALIZATION

The participation in doctoral programmes, namely MAP-FIS.
Continue to support the 200m2 cleanroom (ISO6/ISO7) of CEMUP-MNTEC.

However, internationalization is where the Group will make the strongest effort since our international relations have to be enhanced in order to increase the participation in European international consortiums. Participation in short term visits, sponsored by bilateral collaboration projects and others, such as COST projects, will be the key aspects leading to more European projects under the Horizon 2020 programme.

5.2.3 Technology transfer

Electronics and Photonics Integration

In the electronics and photonics area, CAP is able to transfer technology and provide consulting services on:

- Electronic PCB design, implementation, test and characterization;
- Micro and nanofabrication techniques;
- Optoelectronics assembly and packaging;
- Photonic systems implementation, test and characterization.

5.2.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CAP - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development	Status (2)	Areas of Technology Transfer --> relationships (3) Electronics and Photonics Integration
Integrated optics and Microfabrication	I	H
Advanced Optical Imaging	I	M
Physical Sensors	I	M
Biosensors	I	M

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.2.5 Main Achievements in 2017

The following were the Centre main achievements during 2017:

- Fabrication of an integrated Add-Drop filter for WDM systems at 100GHz channel separation;
- Simultaneous plasmonic measurement of refractive index and temperature based on a D-type fiber sensor with gold wires;
- SPR optimization using metamaterials in a D-type PCF refractive index sensor;
- Microfiber Knot with Taper Interferometer for temperature and refractive index discrimination;
- Hollow microsphere Fabry-Perot cavity for sensing applications;
- Fabry-Perot cavity based on polymer FBG as refractive index sensor;
- Multimode interference-based fiber sensor in a cavity ring-down system for refractive index measurement;
- Development of “intelligent” or “analytical” optical fiber tweezers;
- Single Particle Differentiation through 2D Optical Fiber Trapping and Back-Scattered Signal Statistical Analysis;
- Validation of an Intelligent LIBS system in Field trials for mining applications;
- Development of a new system based on LIBS for real time evaluation of ore grade in mining operations, enabling identification and quantification of different elements in different minerals, with associated errors smaller than existing market technologies, with potential application in environmental, industrial and medical fields (patent applications);
- Development in the context of OTDR, of innovative interrogation approaches supported on the Cavity Ring Down technique, which allows a new level of sensitivity and very large range interrogation (100s Km), crucial for environmental monitoring;
- Vibration and Magnetic Field Sensing Using a Long-Period Grating;
- Real-time Early Warning Strategies for Corrosion Mitigation in Harsh Environments;
- Optical fiber sensor for early warning of corrosion of metal structures;
- Implementation of an automated setup and signal processing algorithms for SLM calibration;
- Development of a fully functional prototype for frying oil quality monitoring (optical measurement);
- established the laboratory basis for new optical imaging setups: towards lensless imaging;
- Development of an integrated simulation platform that combines solvers of the Maxwell, Vlaosov, Boch and Landau-Lifshitz equations for the simulation of light-matter interaction in atomic fluids;
- Development of a solver of the Einstein-Vlasov equations in the weak field regime;
- Proposal of control scheme of effective nonlinear effects in atomic gases/Bose-Einstein condensates confined in electromagnetic optical traps.

5.2.6 Centre Organisational Structure and Research Team

The researchers responsible for the Areas and Sub-Areas within CAP are:

- Integrated optics and microfabrication - Paulo Marques
- Advanced optical imaging - Carla Rosa
- Sensors: physical sensors - Orlando Frazão; biosensors - Pedro Jorge
- Dissemination & internationalization - Manuel Joaquim Marques

The internal organisation of the Centre follows the general model adopted at INESC TEC. It will be governed by a Coordinator and a Coordinating Council (CC). The CC is composed of 3 to 5 PhDs with responsibilities over areas of work and research. The project leaders will respond to the Coordinating Council in what refers to the execution of projects and meeting financial sustainability goals, as well as

scientific productivity targets. This Coordinating Council will also suggest to the Board of INESC TEC on CAP's participation within the NIS cluster coordination.

Each of the research areas has an appointed leader. Ordinary management meetings are held every fortnight to discuss matters related to the research Group daily issues, which include acquisitions, travel, staff and student movements, and project management. The regular attendants to these meetings are the Research Group leader and co-leader together with the leaders of the research areas. Depending on the subjects to be evaluated during the meetings other research group members could be present.

The CAP has a scientific council, which is composed of all researchers holding a PhD. The scientific council will meet in quarterly meetings to analyse the progress made on the different areas of research and to discuss future work. It is also incumbency of the scientific council to propose new strategic actions.

The Centre research team present composition and evolution is presented in Table 5.2.

Table 5.2 - CAP - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	5	5	5	
		Academic Staff	9	9	9	
		Grant Holders and Trainees	12	15	18	3
		Total Core Researchers	**26**	**29**	**32**	**3**
		Total Core PhD	**16**	**16**	**16**	
	Affiliated Researchers		8	7	8	1
	Admin. & Tech	Employees	2	2	2	
		Grant Holders and Trainees				
		Total Admin and Tech	**2**	**2**	**2**	
	Total Integrated HR		**36**	**38**	**42**	**1**
	Total Integrated PhD		**22**	**22**	**21**	**-1**
Curricular Trainees			3			
External Research Collaborators			2	2	1	-1
External Administrative and Technical Staff						
External Students			15	13	10	-3
Total			**56**	**53**	**53**	

5.2.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - CAP - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	52		9	9
PN-PICT	National R&D Programmes - S&T Integrated Projects	62	155	238	83
PN-COOP	National Cooperation Programmes with Industry				
PUE-FP	EU Framework Programmes	28	117	80	-37
PUE-DIV	EU Cooperation Programmes - Other	24	27	7	-21
SERV-NAC	R&D Services and Consulting - National	30		16	16
SERV-INT	R&D Services and Consulting - International		40		-40
OP	Other Funding Programmes	28	7	3	-3
Closed Projects		28	23	24	1
Total Funding		**252**	**369**	**378**	**9**

Table 5.4 - CAP - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	30	36	36
International conference proceedings indexed by ISI, Scopus or DBLP	29	15	39
Books (author)			
Chapter/paper in books		1	
PhD theses concluded by members of the Centre	1	4	3
Concluded PhD theses supervised by members of the Centre	2	4	3

Table 5.5 - CAP - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	1
Patent applications	1
Licence agreements	

Table 5.6 - CAP - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	2
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	4
International events in which INESC TEC members participate in the program committees	4
Participation in events such as fairs, exhibitions or similar	4
Advanced training courses	1

5.2.8 List of Projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	TEC4SEA-2	Pedro Jorge	2017-09-01	2020-08-30
PN-PICT	CORAL-SENSORS	Pedro Jorge	2016-01-01	2018-12-31
PN-PICT	CORAL-TOOLS-2	Pedro Jorge	2016-01-01	2018-12-31
PN-PICT	NanoStima-RL1-1	Carla Carmelo Rosa	2015-07-01	2018-12-31
PUE-FP	STRONGMAR-2	Ireneu Dias	2016-01-01	2018-12-31
PUE-FP	VAMOS-1	Pedro Jorge	2015-02-01	2018-07-31
PUE-DIV	AGRINUPES-1	Pedro Jorge	2017-04-01	2020-03-31
PUE-DIV	CostActions	José Luís Santos	2008-01-01	
PUE-DIV	MarineEye-2	Pedro Jorge	2015-07-30	
SERV-NAC	Consultoria	Ireneu Dias	2017-01-01	
SERV-NAC	INFANTE	Ireneu Dias	2017-05-01	
SERV-NAC	TunLas	José Luís Santos	2009-01-01	
SERV-INT	TECCON2	Pedro Jorge	2016-01-01	2018-12-31
OP	Coop-Transnacional	José Luís Santos	2010-01-01	
OP	Femto3D	Paulo Vicente Marques	2016-01-01	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.2.9 List of Publications

International Journals with Scientific Referees

1. Amorim, VA, Maia, JM, Alexandre, D, Marques, PVS, “Optimization of Broadband Y-Junction Splitters in Fused Silica by Femtosecond Laser Writing", IEEE Photonics Technology Letters, vol.29, pp.619-622, 2017
2. Ascorbe, J, Coelho, L, Santos, JL, Frazao, O, Corres, JM, “Temperature Compensated Strain Sensor Based on Long Period Gratings and Microspheres", IEEE Photonics Technology Letters, pp.1-1, 2017
3. Brito, A, Roriz, P, Silva, P, Duarte, R, Garganta, J, “Effects of pitch surface and playing position on external load activity profiles and technical demands of young soccer players in match play", International Journal of Performance Analysis in Sport, vol.17, pp.902-918, 2017
4. Carvalho, TT, Figueiras, FG, Pereira, SMS, Fernandes, JRA, Perez de la Cruz, JP, Tavares, PB, Almeida, A, Agostinho Moreira, JA, “Deposition parameters and annealing key role in setting structural and polar properties of Bi0.9La0.1Fe0.9Mn0.1O3 thin films", Journal of Materials Science-Materials in Electronics, vol.28, pp.12690-12697, SEP, 2017

5. Chiavaioli, F, Gouveia, CAJ, Jorge, PAS, Baldini, F, “Towards a Uniform Metrological Assessment of Grating-Based Optical Fiber Sensors: From Refractometers to Biosensors", Biosensors, vol.7, pp.23, 2017
6. Coelho, L, Agostinho Moreira, JA, Tavares, PB, Santos, JL, Viegas, D, de Almeida, JMMM, “Monitoring of oxidation phases of copper thin films using long period fiber gratings", Sensors and Actuators A-Physical, vol.253, pp.69-74, 2017
7. Costa Coelho, LCC, Soares dos Santos, PSS, da Silva Jorge, PAD, Santos, JL, Marques Martins de Almeida, JMMM, “Real-time Early Warning Strategies for Corrosion Mitigation in Harsh Environments", Journal of Lightwave Technology, pp.1-1, 2017
8. De, M, Gangwar, RK, Singh, VK, “Designing of highly birefringence, dispersion shifted decagonal photonic crystal fiber with low confinement loss", Photonics and Nanostructures - Fundamentals and Applications, vol.26, pp.15-23, 2017
9. El Hosiny Ali, HE, Jimenez, R, Ramos, P, de la Cruz, JP, Fernandes, JRA, Bretos, I, Calzada, ML, Ricote, J, “The role of PbTiO3 layers in piezoelectric multilayer composite films based on Pb(Mg1/3Nb2/3)O-3-PbTiO3", Thin Solid Films, vol.636, pp.730-736, 2017
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11. Fachada, N, Lopes, VV, Martins, RC, Rosa, AC, “Model-independent comparison of simulation output", Simulation Modelling Practice and Theory, vol.72, pp.131-149, MAR, 2017
12. Fachada, N, Lopes, VV, Martins, RC, Rosa, AC, “Parallelization Strategies for Spatial Agent-Based Models", International Journal of Parallel Programming, vol.45, pp.449-481, JUN, 2017
13. Ferreira, MFS, Statkiewiez Barabach, G, Kowal, D, Mergo, P, Urbanczyk, W, Frazao, O, “Fabry-Perot cavity based on polymer FBG as refractive index sensor", Optics Communications, vol.394, pp.37-40, 2017
14. Friaes, S, Silva, AM, Boto, RE, Ferreira, D, Fernandes, JR, Souto, EB, Almeida, P, Vieira Ferreira, LFV, Reis, LV, “Synthesis, spectroscopic characterization and biological evaluation of unsymmetrical aminosquarylium cyanine dyes", Bioorganic & Medicinal Chemistry, vol.25, pp.3803-3814, 2017
15. Gangwar, RK, Pathak, AK, Priyadarshani, P, Singh, VK, “Effect of ethanol infiltration on the zero dispersion wavelength of solid core photonic crystal fiber", Optik, vol.147, pp.197-203, 2017
16. Gangwar, RK, Singh, VK, “Highly Sensitive Surface Plasmon Resonance Based D-Shaped Photonic Crystal Fiber Refractive Index Sensor", Plasmonics, vol.12, pp.1367-1372, 2017
17. Gomes, AD, Frazao, O, “Microfiber Knot With Taper Interferometer for Temperature and Refractive Index Discrimination", IEEE Photonics Technology Letters, vol.29, pp.1517-1520, 2017
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21. Monteiro, C, Silva, S, Frazao, O, “Hollow Microsphere Fabry Perot Cavity for Sensing Applications", IEEE Photonics Technology Letters, vol.29, pp.1229-1232, 2017
22. Nascimento, IM, Chesini, G, Baptista, JM, Cordeiro, CMB, Jorge, PAS, “Vibration and Magnetic Field Sensing Using a Long-Period Grating", IEEE Sensors Journal, vol.17, pp.6615-6621, 2017

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3. Alves, RA, Silva, NA, Costa, JC, Gomes, M, Guerreiro, A, “The Analogue Quantum Mechanical of Plasmonic Atoms", 3rd International Conference on Applications of Optics and Photonics, vol.10453, 2017
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Books

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Chapter/paper in Books

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PhD Theses

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2. Dos Santos, D., “A numerical approach into new designs for SPR sensors in D-type optical fibers”
3. Ribeiro, A., “Optical fiber tools for single cell trapping and manipulation”

5.3 CRAS - CENTRE FOR ROBOTICS AND AUTONOMOUS SYSTEMS

Coordinators: Eduardo Silva and Aníbal Matos

5.3.1 Presentation of the Centre

The Centre for Robotics and Autonomous Systems (CRAS) aggregates more than 40 researchers addressing scientific and technological topics associated to field robotics and autonomous systems. Its mission addresses the development of innovative robotic solutions for operation in complex environments for multiple operations, including data gathering, inspection, mapping, surveillance, or intervention.

CRAS accomplishes its mission within the Cluster NIS - Networked Intelligent Systems, by directing its activities towards 4 main areas of research: autonomous navigation; long term deployments; sensing, mapping, and intervention; multiple platform operations.

5.3.2 Research and Technology Development

The activities of the Centre are organised along the following major research areas:

Autonomous navigation
The major goal of this area is related to the development of solutions that allow autonomous robots to operate in dynamic and complex environments or where global positioning aiding systems are not available. Research activities address advanced navigation algorithms based on data fusion techniques, algorithms for simultaneous navigation and mapping, underwater acoustic positioning systems, situation awareness systems, obstacle detection algorithms, obstacle avoidance systems, path planning algorithms, obstacle avoidance systems, close range operations in maritime robotics, and safety behaviours.

Long term deployments
The main goal of these lines is the development of technologies and solutions that enable the long-term deployment of robotic platforms. Research activities include design of efficient propulsion systems for underwater or surface vehicles, development of long range navigation algorithms, development of energy harvesting systems for robotic platforms, and development of auxiliary systems for long term deployments (e.g. docking stations, energy transfer systems).

Sensing, mapping, and intervention
This area addresses the use of autonomous robotic systems in sensing, mapping, and intervention operations. Research activities include computer vision techniques and algorithms, sensing strategies for single or multiple robotic systems, adaptive sampling techniques, multi sensor data fusing for underwater or overwater mapping, hyperspectral, electro-optic and acoustic image processing, autonomous intervention for robotic platforms.

Multiple platform operations
This area addresses the development of technologies and solutions that take advance of the use of multiple robotics platforms that cooperate in the accomplishment of a given tasks. Activities in this area include the development of command and control solution for the coordinated operation of multiple (possibly heterogeneous) platforms, development of mobile beacons for underwater positioning and communication networks, and coordinated operations of underwater, surface, and aerial platforms.

5.3.3 Technology Transfer

Autonomous navigation
In this area, CRAS is able to transfer technology and provide consulting services on:

- Design, development, and implementation of navigation systems for autonomous systems (aerial, land, surface, or underwater);
- Design, development, and implementation of underwater acoustic positioning systems;

- Design, development, and implementation of obstacle detection and avoidance systems.

Long term deployments

In this area, CRAS is able to transfer technology and provide consulting services on:

- Design and development of robotic platforms or subsystems for long term deployments;
- Design, development, and implementation of efficient propulsion systems for marine platforms.

Sensing, mapping, and intervention

In this area, CRAS is able to transfer technology and provide consulting services on:

- mplement a multi-trophic sensor;
- Design, development, and implementation of computer vision algorithms for robotics and robotic based sensing applications;
- Design, development and implement 3D acoustic image processing system;
- Design, development, and implementation of data processing and fusion strategies and algorithms for single or multiple cooperating robots;
- Design, development, and implementation of adaptive sampling algorithms;
- Design, development, and implementation of multi sensor data fusion systems for inspection and mapping.

Multiple platform operations

In this area, CRAS is able to transfer technology and provide consulting services on:

- Design and development of command and control systems for coordinated robotic platforms;
- Design, development, and implementation of mobile beacons for underwater positioning;
- Design, development, and implementation of mobile beacon for communication networks.

5.3.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CRAS - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

		Areas of Technology Transfer --> relationships (3)											
Areas of Research and Technology Development	**Status (2)**	Navigation	Acoustic positioning	Obstacle detection & avoidance	Robotic platforms	Underwater propulsion	Computer vision	Data fusion	Adaptive sampling	Inspection and mapping	Command and control	Mobile beacons
Autonomous navigation	I	H	H	H			M	M		H		
Long term deployments	I	M	H		H	H						
Sensing, mapping, and intervention	I						H	H	H	H		
Multiple platform operations	I	M									H	H

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer

(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership

(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.3.5 Main Achievements in 2017

CRAS won the 3rd edition of the EDPartners awards in the category of Innovation. The award was granted to the project whose goal is to monitor electrical assets using drones, developed by CRAS in partnership with EDP-Labelec. CRAS contribution was a drone with rotary wings that inspects and monitors assets. The institute developed a system that monitors electric components, such as power lines, substations and wind turbines, with greater autonomy and lower costs.

In cooperation with a UK equipment manufacturer, CRAS developed the concept and built EVA (Exploration VAMOS AUV), a robot for supporting mining activities in flooded mines. EVA is a hybrid ROV/AUV solution with heterogeneous sensors for environment mapping and robot perception. This robot is capable of autonomously navigate in a flooded mine providing real time data about the mining process, therefore contributing to the optimisation of the mining process, and it has already been successfully tested in a complete demonstration of an underwater mining operation in 2017. This EVA concept is also a step into feasible future deep-sea mining. The prototype also includes contributions from CAP and CTM research groups and it has a TRL of 7.

5.3.6 Centre Organisational Structure and Research Team

The Centre for Robotics and Autonomous Systems is coordinated by Eduardo Silva and Aníbal Matos. The Centre has a coordination council (CRAS Coordination Council) composed by the Centre coordinators and by 4 other senior researchers: Alfredo Martins, José Carlos Alves, José Miguel Almeida, and Nuno Cruz. This council is responsible for the discussion, definition, and implementation of the Centre research, development and innovation strategy.

The Centre research team present composition and evolution is presented in Table 5.2. The Centre was established in 2016 as a split from the previous Centre CROB (Centre for Robotics and Intelligent Systems) - figures for 2015 apply for the group within CROB that emerged as CRAS.

Table 5.2 - CRAS - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	3	5	8	3
		Academic Staff	10	10	10	
		Grant Holders and Trainees	17	25	31	6
		Total Core Researchers	**30**	**40**	**49**	**9**
		Total Core PhD	**8**	**7**	**14**	**7**
	Affiliated Researchers					
	Admin. & Tech	Employees	1	2	2	
		Grant Holders and Trainees		1	1	
		Total Admin and Tech	1	3	3	
	Total Integrated HR		**31**	**31**	**43**	**52**
	Total Integrated PhD		**8**	**8**	**7**	**14**
Curricular Trainees			2	3	3	5
External Research Collaborators				1	10	10
External Administrative and Technical Staff					17	25
External Students				2		-2
Total			**33**	**49**	**53**	**4**

5.3.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The

information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - CRAS - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT			94	94
PN-PICT	National R&D Programmes - S&T Integrated Projects		33	127	94
PN-COOP	National Cooperation Programmes with Industry		19	183	164
PUE-FP	EU Framework Programmes		1.143	845	-298
PUE-DIV	EU Cooperation Programmes - Other		103	115	12
SERV-NAC	R&D Services and Consulting - National		95	97	3
SERV-INT	R&D Services and Consulting - International			131	131
OP	Other Funding Programmes		19	11	-8
Closed Projects					
	Total Funding		**1.412**	**1.603**	**191**

Table 5.4 - CRAS - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	9	2	9
International conference proceedings indexed by ISI, Scopus or DBLP	30	24	30
Books (author)	1		0
Chapter/paper in books	1	3	4
PhD theses concluded by members of the Centre	1	1	1
Concluded PhD theses supervised by members of the Centre	1	1	1

Table 5.5 - CRAS - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	1
Patent applications	0
Licence agreements	0

Table 5.6 - CRAS - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	1
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	4
International events in which INESC TEC members participate in the program committees	6
Participation in events such as fairs, exhibitions or similar	4
Advanced training courses	2

5.3.8 List of Projects

Table 5.7 - CRAS - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	EMSO-PT	Aníbal Matos	2017-07-01	2020-06-29
PN-FCT	MyTag	Eduardo Silva	2016-06-01	2019-05-31
PN-FCT	ROSM	André Dias	2017-10-01	2019-04-02
PN-FCT	TEC4SEA	Eduardo Silva	2017-09-01	2020-08-30
PN-PICT	CORAL-SENSORS-1	Eduardo Silva	2016-01-01	2018-12-31
PN-PICT	CORAL-TOOLS	Eduardo Silva	2016-01-01	2018-12-31
PN-COOP	DeepFloat	Eduardo Silva	2016-03-09	2018-06-30
PN-COOP	SIDENAV	Eduardo Silva	2016-12-01	2018-05-30
PUE-FP	EMSODEV	Aníbal Matos	2015-09-01	2018-08-31
PUE-FP	STRONGMAR	Eduardo Silva	2016-01-01	2018-12-31
PUE-FP	SUNNY	Eduardo Silva	2014-01-01	2018-06-30
PUE-FP	UNEXMIN	Eduardo Silva	2016-02-01	2019-10-31
PUE-FP	VAMOS	Eduardo Silva	2015-02-01	2018-07-31
PUE-DIV	BLUECOM+-1	Eduardo Silva	2015-07-17	
PUE-DIV	ENDURE-1	Eduardo Silva	2015-07-17	
PUE-DIV	MarineEye	Eduardo Silva	2015-07-30	
PUE-DIV	PROTOATLANTIC	Eduardo Silva	2017-09-01	2019-05-31
PUE-DIV	SpilLess	Eduardo Silva	2017-02-01	2019-01-31
SERV-NAC	Consultoria	Eduardo Silva	2016-01-01	
SERV-NAC	Demo_Drone	José Miguel Almeida	2015-05-01	2018-04-30
SERV-NAC	Fmanagement	Aníbal Matos	2016-05-10	
SERV-INT	AutoMon	Aníbal Matos	2017-04-01	2019-03-31
SERV-INT	EDA-SAVEWATE	Nuno Cruz	2012-01-25	2018-12-24
SERV-INT	Evologics	Nuno Cruz	2013-05-01	2018-04-30
SERV-INT	HAIFA	Nuno Cruz	2016-09-01	
SERV-INT	RAWFIE	Aníbal Matos	2016-09-01	2019-02-28
OP	CINMarS	Eduardo Silva	2015-03-12	

Type of Project:

PN-FCT National R&D Programmes - FCT
PN-PICT National R&D Programmes - S&T Integrated Projects

PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.3.9 List of Publications

International Journals with Scientific Referees

1. Coelho, L, Agostinho Moreira, JA, Tavares, PB, Santos, JL, Viegas, D, de Almeida, JMMM, “Monitoring of oxidation phases of copper thin films using long period fiber gratings", Sensors and Actuators A-Physical, vol.253, pp.69-74, 2017
2. Holliday, A, Barekatain, M, Laurmaa, J, Kandaswamy, C, Prendinger, H, “Speedup of deep learning ensembles for semantic segmentation using a model compression technique", Computer Vision and Image Understanding, vol.164, pp.16-26, NOV, 2017
3. Kandaswamy, C, Monteiro, JC, Silva, LM, Cardoso, JS, “Multi-source deep transfer learning for cross-sensor biometrics", Neural Computing & Applications, vol.28, pp.2461-2475, SEP, 2017
4. Leal, F, Malheiro, B, Vélez, HG, Burguillo, JC, “Trust-based Modelling of Multi-criteria Crowdsourced Data", Data Science and Engineering, vol.2, pp.199-209, 2017
5. Melo, J, Matos, A, “Survey on advances on terrain based navigation for autonomous underwater vehicles", Ocean Engineering, vol.139, pp.250-264, 2017
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International Conference Proceedings with Scientific Referees

1. Abreu, N, Cruz, N, Matos, A, “Accounting for uncertainty in search operations using AUVs", 2017 IEEE OES International Symposium on Underwater Technology, UT 2017, 2017
2. Abreu, N, Matos, A, “Case-based replanning of search missions using AUVs", Oceans 2017 - ABERDEEN, vol.2017-October, pp.1-10, 2017
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4. Areias, N, Malheiro, B, “TourismShare, Recent Advances in Information Systems and Technologies” - Volume 2 [WorldCIST'17, Porto Santo Island, Madeira, Portugal, April 11-13, 2017]., vol.570, pp.62-72, 2017
5. Augustyns, L, Pogoda, M, Milesi, M, Kang, M, Valls, P, Duarte, A, Malheiro, B, Ferreira, F, Ribeiro, MC, Silva, MF, Ferreira, PD, Guedes, PB, “Sustainable desalinator - an EPS@ISEP 2016 project",

Proceedings of the 45th SEFI Annual Conference 2017 - Education Excellence for Sustainability, SEFI 2017, pp.491-498, 2017

6. Azevedo, F, Oliveira, A, Dias, A, Almeida, J, Moreira, M, Santos, T, Ferreira, A, Martins, A, Silva, E, “Collision avoidance for safe structure inspection with multirotor UAV", 2017 European Conference on Mobile Robots (ECMR), 2017
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Blank

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2. Cubber, GD, Doroftei, D, Rudin, K, Berns, K, Matos, A, Serrano, D, Sanchez, J, Govindaraj, S, Bedkowski, J, Roda, R, Silva, E, Ourevitch, S, “Introduction to the Use of Robotic Tools for Search and Rescue", Search and Rescue Robotics - From Theory to Practice, 2017

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4. Matos, A, Silva, E, Almeida, J, Martins, A, Ferreira, H, Ferreira, B, Alves, J, Dias, A, Fioravanti, S, Bertin, D, Lobo, V, “Unmanned Maritime Systems for Search and Rescue", Search and Rescue Robotics - From Theory to Practice, 2017

PhD Theses

1. Abreu, N., “Planning search missions using a small size AUV”

5.4 C-BER - CENTRE FOR BIOMEDICAL ENGINEERING RESEARCH

Coordinators: Aurélio Campilho and João Paulo Cunha

5.4.1 Presentation of the Centre

The Centre for Biomedical Engineering Research aggregates researchers and research activity under a common mission and it is guided by specific goals.

Mission:
To promote knowledge through applied research advanced training and innovation in Biomedical Engineering.

Goals:

- To create interdisciplinary knowledge enabling the innovation and technology transfer with economic impact;
- To develop products, tools and methods for the prevention and early detection of different types of diseases, aging related impairments, or for human rehabilitation, physiotherapy or functional assessment;
- To contribute to the development of advanced neuro-technologies at the frontier of engineering, neurology and Psychophysiology;
- To promote strategic partnerships with other Centres of INESC TEC, clinical partners, research institutes and foster international cooperation;

C-BER accomplishes its mission within the Cluster NIS - Networked Intelligent Systems, by directing its activities towards areas of research organised under three Research Labs: Biomedical Imaging Lab, Bioinstrumentation Lab and Neuroengineering Lab.

5.4.2 Research and Technology Development

Biomedical Imaging Lab
Coordinator: Aurélio Campilho

The focus of the Biomedical Imaging Lab is the development of advanced image processing and analysis methodologies, particularly medical and biological images, with the aim of creating computer-aided diagnosis tools to support medical decision making. The research activities at the Lab use several imaging modalities addressing different clinical departments including in Ophthalmology, Neurology, Radiology, Gynecology and Obstetrics and Gastroenterology.

The Biomedical Imaging Lab is organised in three main lines of research: Ophthalmology CAD, Lung CAD and Ultrasound CAD.

Ophthalmology CAD

The research activities under this line are:

- Screening of Diabetic Retinopathy, including the automatic detection of image quality, the automatic detection of images with pathology and the grading of retinopathy. Advanced image analysis and machine learning methodologies, including generic approaches are/will be used. The input data are retinograms.
- Analysis of eye fundus images for early detection of prevalent eye pathologies, including diabetics and hypertension. This involves the detection and segmentation of main anatomical structures and its characterization in order to derive image-based biomarkers. Advanced image analysis methodologies, including generic approaches are/will be used. The input data are retinograms.

- To determine choroid thickness and changes in the layer's structure in Optical Coherence Tomography (OCT) images and to correlate with clinical status.

Lung CAD

- Segmentation of lung structures, as lung lobes, airways and vasculature network.
- Early detection of lung pathologies in chest CT scans, with a reduced number of false positives.
- Segmentation and characterization of lung lesions.
- Computer-aided diagnosis of lung cancer and prediction of malignancy likelihood.

Ultrasound CAD

- Measurement of macro vascular characteristics, as calibers, layer thicknesses (as IMT - Intima-to-media Thickness), plaque burden and other markers in ultrasound images of the carotid.
- Characterisation of Ultrasound Images in 2D, 3D and 4D and its application in Gynecology and Obstetrics.

The modular design, will allow to set-up web-based and cloud-based solutions in the research areas defined above. This will enable innovation and facilitate tech-transfer to the high-tech clinical market, either in hospital environment or business companies in medical devices.

NeuroEngineering Lab
Coordinator: João Paulo Cunha

The main goal of the NeuroEngineering lab is to perform high-level interdisciplinary R&D in engineering and computational approaches applied to basic and clinical neuroscience, namely crossing several areas, such as Physics; Engineering (Electronics; Computation; etc.); Neurology; Neurosurgery; Neurophysiology; Neuroradiology; Neurobiology and Psychophysiology.

Furthermore, we also aim to innovate and facilitate tech-transfer to the high-tech market.

The main research activity lines in the lab are:

- Brain imaging (&signals)
- Man-computer symbiosis (e.g. Brain-Computer Interfaces)
- Quantified Movement analysis in neurological diseases
- Neurosurgery Aiding Systems
- Psychophysiology Technologies

BioInstrumentation lab
Coordinator: Miguel Velhote Correia

The main goal of the BioInstrumentation lab is to perform high-level interdisciplinary R&D in engineering and computational approaches applied to health, well-being, sports performance and rehabilitation namely crossing several areas, such as Physics; Engineering (Electronics; Computation; etc.); Physiology, Physiotherapy and Sports science.

Furthermore, there is also the aim to innovate and facilitate tech-transfer to the high-tech market.

The main research activity lines in the lab are:

- Sensing and biosignal acquisition technologies
- Medical electronics and devices
- Wearable monitoring systems
- Human movement analysis

5.4.3 Technology transfer

Biomedical Imaging Lab

In order to ease the technology transfer our approaches are organised in modules of direct applicability in specific clinical or general-purpose domains. The researchers are asked to fill in a module lab chart, identifying the module (name, input and output), give a 3-line description and application targeted. In Biomedical Imaging C-BER is able to transfer technology and provide consulting services in:

- Planning and design Ophthalmology CAD, particularly involving image analysis of eye images, as eye fundus images and Optical Coherence Tomography eye images.
- Ultrasound (US) image analysis techniques in order to develop tools for image enhancement, lesion detection, biomarkers measurements from 2D, 3D and 4D US images.
- Planning and design Lung CAD for early detection and characterisation of lung pathologies in chest CT scans.
- Two software applications have been submitted for registration: 1) “Choroidal Thickness App” for the measurement of choroidal thickness in Optical Coherence hey fundus images; 2) “EchoCAD - Carotid” for the analysis of carotid ultrasound images.

NeuroEngineering Lab

- We have submitted a patent for stress detection based on ECG morphology that is a direct result from our Psychophysiology Technologies research activity, with close relation with the Bioinstrumentation Lab. This patent is now under evaluation for licensing to a start-up.
- We have participated with a business idea in the CMU-Portugal “Entrepreneurship in Residence” (in-Res) program held from June to December 2017, which included 2 months in Pittsburgh and Silicon Valley. We are now in the process to start the spin-off start-up from the achieved patents looking for different possible paths (licensing, selling, etc.).
- Our previous patent on Wrist Rigidity based on a wearable device (in cooperation with the Bioinstrumentation Lab) and resulting from our line of research on “Quantified Movement analysis in neurological diseases” is now under licensing process to a start-up backed-up by a UK based company.

BioInstrumentation Lab

We have been following the tech-transfer methodology by:

- Establish R&D collaborations with companies and industry clusters.
- File for patents or other exploitation paths of higher TRL developments.
- Actively search for opportunities for exploitation of the achieved patents and developments.

In recent years, we have been active in producing several patents requests, namely:

- “Medical Device with Rotational Flexible Electrodes”, 25.08.2016, INPI (This patent is the first IP result from the R&D Program Contract with Biodevices SA)
- “Biometric Method ad Device For Identifying A Person Through An Electrocardiogram (ECG)”, Pedido Provisório de Patente 20161000028874, 29.04.2016, INPI
- Control module for multiple mixed-signal resources management, patent request PT107537; PCT/IB2015/052141; WO/2015/145347A1, Pub date 2015/10/01

We are also open to provide consulting services in the Biomedical Engineering area, although we do not yet sense a large demand for this type of services in the Portuguese market.

5.4.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-C-BER - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development		Areas of Technology Transfer --> relationships (3)									
		Status (2)	Ophthalmology	Neurology	Vascular Medicine	Radiology	Obstetrics/Gynecology	Geriatrics	Rehabilitation	Health and Well-being	Sports technology
Biomedical Imaging Lab		I	H	L	H	M	L				
BioInstrumentation Lab		I		M				L	H	H	H
NeuroEngineering Lab		I		H		M		L		H	

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.4.5 Main Achievements in 2017

A new neuroimaging technique has been published in the top #1 journal in the area:

- N. Moreira da Silva, S. A. Ahmadi, S. Tafula, J. P. S. Cunha, K. Boetzel, C. Vollmar, et al., "A diffusion-based connectivity map of the GPi for optimised stereotactic targeting in DBS " Neuroimage, vol. 144, pp. 83-91, 2017.

Beat-ID development has resulted in a high-impact paper in PLoS ONE:

- J. S. Paiva, D. Dias, and J. P. S. Cunha, "Beat-ID: Towards a computationally low-cost single heartbeat biometric identity check system based on electrocardiogram wave morphology," PLOS ONE, vol. 12, p. e0180942, 2017.

Submission of a patent that is now under the process of licensing to a start-up.

A new patent on stress detection based on ECG morphology was submitted and is now part of a portfolio that is being considered for a spin-off start-up company.

Participation in the CMU-Portugal "Entrepreneurship in Residence" (in-Res) program held from June to December 2017, which included 2 months in Pittsburgh and Silicon Valley, preparing one future spin-off start-up tech company that will license some of our patents and should be setup in 2018.

Development of transversal deep information learning based on supervised learning and multiple instance learning framework for abnormality detection. This generic methodology has been applied with success to different image data, published in top-ranked journals (see papers (1), (2) and (3)) and achieved top-10 performance on histology, retinal segmentation and skin and eye surgery topics, in international competitions. The successful participation in these competitions is very relevant, as it is recognized by the community as a demonstration of expertise of the competitors in addressing real problems with state-of-the-art winning approaches. Further descriptions may be found in the high-

impact paper (1) (it has received received in this short period of time more than 32 citations in Google Scholar):

1. Teresa Araújo, Guilherme Aresta, Eduardo Castro, José Rouco, Paulo Aguiar, Catarina Eloy, António Polónia and Aurélio Campilho, Classification of Breast Cancer Histology Images Using Convolutional Neural Networks, PLOS ONE, 2017.
2. P Costa, A Galdran, A Smailagic, A Campilho, A Weakly-Supervised Framework for Interpretable Diabetic Retinopathy Detection on Retinal Images, IEEE Access, 6, 18747-18758, 2018 ((early access in 2017).
3. P Costa, A Galdran, MI Meyer, M Niemeijer, M Abràmoff, AM Mendonça, A Campilho, End-to-end adversarial retinal image synthesis, IEEE transactions on medical imaging, 37 (3), 781-791, 2018 (early access in 2017).

Successful participation in the challenges:

1. CATARACTS: Challenge on AutomaticTool Annotation for cataRACTS (two C-BER teams in the top 10) https://cataracts.grand-challenge.org/results/ (the results will be published in Medical Image Analysis journal, a top Biomedical Engineering journal).
2. Skin Lesion Analysis Towards Melanoma Detection: (one C-BER team in the top 10) https://challenge.kitware.com/#phase/584b0afacad3a51cc66c8e24
3. IDRIB - Diabetic Retinopathy Segmentation and Grading Challenge: (one C-BER team in the top 10) https://idrid.grand-challenge.org/leaderboard/

During 2017, we were able to start the mobilizing project with the Textile Industry Cluster, designated TexBoost - less Commodities more Specialties, were we aim to provide innovative solutions to digitize and dematerialize the physical prototypes in the process of developing technical clothing for sports. Based on motion capture and biosignal sensors, a smart sensorized suit and mobile app will gather information on the shape, movement and physiological parameters of athletes to optimize fitting and comfort of the garments.

The patent request: Control module for multiple mixed-signal resources management, patent request nr PT107537; PCT/IB2015/052141; WO/2015/145347A1, Pub date 2015/10/01, has now been granted in:

- USA - 2018-03-20, US9921835B2
- South Korea - 2018-03-27, KR101842540B1

Pending, with intention to grant in:

- Europe - 2017-02-01, EP3123348A1
- Japan - 2017-07-06, JP2017518585A
- China - 2017-03-01, CN106471483A

5.4.6 Centre Organisational Structure and Research Team

The Centre research team present composition and evolution is presented in Table 5.2.

Table 5.2 – C-BER - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	1	1	3	2
		Academic Staff	6	6	6	
		Grant Holders and Trainees	5	15	21	6
		Total Core Researchers	**12**	**22**	**30**	**8**
		Total Core PhD	**8**	**8**	**11**	**3**
	Affiliated Researchers		4	3	4	1
	Admin & Tech	Employees				
		Grant Holders and Trainees				
		Total Admin and Tech				
		Total Integrated HR	**16**	**25**	**34**	**4**
		Total Integrated PhD	**11**	**11**	**15**	**4**
Curricular Trainees			5	3	1	-2
External Research Collaborators			3	2	4	2
External Administrative and Technical Staff						
External Students			5	2	8	6
Total			**29**	**32**	**47**	**15**

5.4.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - C-BER - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	126	85	147	62
PN-PICT	National R&D Programmes - S&T Integrated Projects		76	199	123
PN-COOP	National Cooperation Programmes with Industry	44			
PUE-FP	EU Framework Programmes				
PUE-DIV	EU Cooperation Programmes - Other				
SERV-NAC	R&D Services and Consulting - National	41	20	26	6
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes	17			
Closed Projects			6	1	-5
Total Funding		**227**	**187**	**372**	**185**

Table 5.4 - C-BER - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	7	15	17
International conference proceedings indexed by ISI, Scopus or DBLP	17	18	27
Books (author)	1		0
Chapter/paper in books		1	0
PhD theses concluded by members of the Centre			1
Concluded PhD theses supervised by members of the Centre	3	1	1

Table 5.5 - C-BER - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	2
Patent applications	1
Licence agreements	0

Table 5.6 - C-BER - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	2
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	2
International events in which INESC TEC members participate in the program committees	5
Participation in events such as fairs, exhibitions or similar	1
Advanced training courses	1

5.4.8 List of Projects

Table 5.7 - C-BER - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	LNDetector	Aurélio Campilho	2016-06-01	2019-05-31
PN-FCT	SCREEN-DR	Aurélio Campilho	2016-04-01	2020-03-31
PN-FCT	VR2Market	João Paulo Cunha	2014-07-15	2018-12-31
PN-PICT	NanoStima-RL1	João Paulo Cunha	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL5-1	Aurélio Campilho	2015-07-01	2018-12-31
PN-PICT	SMILES-1	João Paulo Cunha	2015-07-01	2018-12-31
PN-COOP	TexBoost	Miguel Velhote Correia	2017-07-01	2020-06-30
SERV-NAC	Bio-Early	João Paulo Cunha	2015-10-01	2018-06-30
SERV-NAC	Consultoria	João Paulo Cunha	2016-01-01	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.4.9 List of Publications

International Journals with Scientific Referees

1. Ahmedt Aristizabal, D, Fookes, C, Dionisio, S, Nguyen, K, Cunha, JPS, Sridharan, S, “Automated analysis of seizure semiology and brain electrical activity in presurgery evaluation of epilepsy: A focused survey", EPILEPSIA, vol.58, pp.1817-1831, NOV, 2017
2. Al Rawi, MS, Freitas, A, Duarte, JV, Cunha, JP, Castelo Branco, M, “Permutations of functional magnetic resonance imaging classification may not be normally distributed", Statistical Methods in Medical Research, vol.26, pp.2567-2585, DEC, 2017
3. Alves Pinnenta, S, Colaco, B, Fernandes, AM, Goncalves, L, Colaco, J, Melo Pinto, P, Ginja, MM, “Radiographic assessment of humeroulnar congruity in amedium and a large breed of dog", Veterinary Radiology & Ultrasound, vol.58, pp.627-633, 2017
4. Araujo, T, Aresta, G, Castro, E, Rouco, J, Aguiar, P, Eloy, C, Polonia, A, Campilho, A, “Classification of breast cancer histology images using Convolutional Neural Networks", PLOS ONE, vol.12, pp.e0177544, 2017
5. Costa, P, Galdran, A, Meyer, MI, Niemeijer, M, Abramoff, M, Mendonca, AM, Campilho, “A End-to-end Adversarial Retinal Image Synthesis", IEEE Transactions on Medical Imaging, pp.1-1, 2017
6. Costa, Pedro, Campilho, Aurelio, “Convolutional bag of words for diabetic retinopathy detection from eye fundus images", IPSJ Trans. Computer Vision and Applications, vol.9, pp.10, 2017
7. da Silva, NM, Ahmadi, SA, Tafula, SN, Silva Cunha, JPS, Botzel, K, Vollmar, C, Rozanski, VE, “A diffusion-based connectivity map of the GPi for optimised stereotactic targeting in DBS", Neuroimage, vol.144, pp.83-91, 2017
8. Galdran, A, Vazquez Corral, J, Pardo, D, Bertalmio, M, “Fusion-Based Variational Image Dehazing", IEEE Signal Processing Letters, vol.24, pp.151-155, FEB, 2017
9. Novo, J, Rouco, J, Barreira, N, Ortega, M, Penedo, MG, Campilho, A, “Wivern: a Web-Based System Enabling Computer-Aided Diagnosis and Interdisciplinary Expert Collaboration for Vascular Research", Journal of Medical and Biological Engineering, vol.37, pp.920-935, DEC, 2017
10. Paiva, JS, Dias, D, Cunha, JPS, “Beat-ID: Towards a computationally low-cost single heartbeat biometric identity check system based on electrocardiogram wave morphology", PLOS ONE, vol.12, pp.e0180942, 2017
11. Pereira, T, Almeida, PR, Cunha, JPS, Aguiar, A, “Heart rate variability metrics for fine-grained stress level assessment", Computer Methods and Programs in Biomedicine, vol.148, pp.71-80, SEP, 2017
12. Pereira, T, Almeida, PR, Cunha, JPS, Aguiar, A, “Validation of a low intrusiveness heart rate sensor for stress assessment", Biomedical Physics & Engineering Express, vol.3, pp.017004, FEB, 2017
13. Pinheiro, A, Cappelli, C, Maciel, C, “Designing Auditability in Social Networks to Prevent the Spread of False Information", IEEE Latin America Transactions, vol.15, pp.2282-2289, 2017

14. Pinto, AM, Costa, PG, Correia, MV, Matos, AC, Moreira, AP, “Visual motion perception for mobile robots through dense optical flow fields", Robotics and Autonomous Systems, vol.87, pp.1-14, JAN, 2017

15. Rodrigues, S, Kaiseler, M, Queirós, C, Basto Pereira, M, “Daily stress and coping among emergency response officers: a case study", International Journal of Emergency Services, vol.6, pp.122-133, 2017

16. Rozanski, VE, da Silva, NM, Ahmadi, SA, Mehrkens, J, Cunha, JD, Houde, JC, Vollmar, C, Botzel, K, Descoteaux, M, “The Role of the Pallidothalamic Fibre Tracts in Deep Brain Stimulation for Dystonia: A Diffusion MRI Tractography Study", Human Brain Mapping, vol.38, pp.1224-1232, MAR, 2017

17. Silva, J, Arantes Rodrigues, R, Pinto Leite, R, Faustino Rocha, AI, Fidalgo Gonçalves, L, Santos, L, Oliveira, PA, “Synergistic effect of carboplatin and piroxicam on two bladder cancer cell lines", Anticancer Research, vol.37, pp.1737-1745, 2017

International Conference Proceedings with Scientific Referees

1. Al Rawi, M, Galdran, A, Elmgren, F, Rodriguez, J, Bastos, J, Pinto, M, “Landmark detection from sidescan sonar images", 2017 IEEE Jordan Conference on Applied Electrical Engineeering and Computing Technologies (AEECT), 2017

2. Al Rawi, M, Galdran, A, Isasi, A, Elmgren, F, Carbonara, G, Falotico, E, Real Arce, DA, Rodriguez, J, Bastos, J, Pinto, M, “Cubic spline regression based enhancement of side-scan sonar imagery", OCEANS 2017 - Aberdeen, 2017

3. Araujo, T, Aresta, G, Lobo, BA, Mendonça, AM, Campilho, AJC, “Improving convolutional neural network design via variable neighborhood search", Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), vol.10317 LNCS, pp.371-379, 2017

4. Araujo, T, Mendonça, AM, Campilho, A, “Estimation of retinal vessel caliber using model fitting and random forests", Medical Imaging 2017: Computer-Aided Diagnosis, Orlando, Florida, United States, 11-16 February 2017, vol.10134, pp.101341K, 2017

5. Aresta, G, Cunha, A, Campilho, A, “Detection of juxta-pleural lung nodules in computed tomography images ", Medical Imaging 2017: Computer-Aided Diagnosis, 2017

6. Axman, D, Paiva, JS, de La Torre, F, Cunha, JPS, “Beat-to-beat ECG features for time resolution improvements in stress detection", 2017 25th European Signal Processing Conference (EUSIPCO), 2017

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Books

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5.5 CPES - CENTRE FOR POWER AND ENERGY SYSTEMS

Coordinators: Manuel Matos and Luís Seca

5.5.1 Presentation of the Centre

The Centre for Power and Energy Systems (CPES) accomplishes its mission within the Cluster ES - Energy systems. CPES is the core Centre of the Cluster Power and Energy. Within this Cluster, CPES holds specific expertise in power systems analysis (steady-state and dynamic), probabilistic and fuzzy modelling, reliability, optimization and decision-aid, computational intelligence, energy analytics and forecasting, with special focus on large scale integration of Renewable Energy Sources (RES), Distributed Energy Resources (DER) operation, Electric Vehicles (EV) deployment and Energy and Flexibility management, under the Smart Grid paradigm.

CPES activity is organised in five areas:

- DMS/EMS & System Operation
- System Planning and Reliability
- Network Studies and RES & DER integration
- Electricity Markets and Regulation
- Energy Analytics and Forecasting

Part of the activity of the group is developed in its Laboratory of Smart Grids and Electric Vehicles that supports real environment validation of major developments.

Over the last 4 years, this Centre has made several developments in the electrical network planning and operation, namely the inclusion of distributed energy resources forecasting and network optimization tools embedded in different voltage layers, exploiting the MicroGrid hierarchical concept. Relevant steps were given on the inclusion of computational intelligence in control algorithms that were demonstrated under real conditions in several pilots.

This Centre is a world reference in large scale integration of Distributed Energy Resources. CPES includes 2 IEEE Fellows (one is in the IEEE Distinguished Lecturer Program) and is a strong player in EU H2020 (leader in some projects) and contracts with national and international companies, with a robust track record in technology transfer and consulting. One researcher received the IEEE PES Renewable Energy Excellence Award 2103. Another received a recognition award 2013 from CIGRE. Yet other researchers won the 2014 and 2017 IEEE PES competitions in meta-heuristics applications to difficult power systems problems. Post-graduation students won the Portugal best MSc thesis prizes by REN-ISO of Portugal in 2014/15/16, by APREN-Renewable GENCOs association in 2015 and by APRP-Pattern recognition association in 2017. Because of this expertise, INESC TEC won the recognition of best 2016 innovation partner of EDP (national utility).

The research outputs are in the range of TRL 3-8.

Members of CPES are in the Board of Societies or Steering Committees responsible for organizing some of the most important world conferences in power systems (IEEE PowerTech, PSCC, ISAP, PMAPS, IREP.

5.5.2 Research and Technology Development

The Centre addresses the following main research areas:

Decision Making, Optimisation and Computational Intelligence

Classic and emerging optimisation methods with applications in energy systems, methodologies for multi-criteria decision support, including risk models and methodologies based on metaheuristics and evolutionary computation for optimisation and decision making. Computational intelligence based models (e.g. fuzzy systems, neural networks, autoencoders) for applications in energy systems.

Forecasting
Statistical learning algorithms for univariate and multivariate time series; forecasting error analysis with probabilistic descriptions of uncertainties; distributed learning and parallel computing; classical data mining algorithms and deep learning techniques for dimension reduction and feature extraction; data-driven power system management, control and planning functions; modelling of energy systems, such as storage, renewable technologies and controllable loads.

Static and Dynamic analysis of Energy Grids
Classic and fuzzy models for steady state analysis of electricity grids, modelling and analysis of the dynamic behaviour in isolated and interconnected networks, dynamic models for energy conversion systems, dynamic simulation models for microgeneration systems and microgrids and the design of advanced system support functions/ancillary services for Distributed Energy Resources integration into electric power systems.

Reliability
Models to analyse reliability in energy systems, reliability in static, spinning and operational capacity power systems looking at renewable and variable energy production, reliability of composite distribution systems (Generation + Transmission), microgeneration and microgrids, models to represent maintenance and the transmission network.

Power Electronics
Research and development activities ranging from the fundamental technology investigation up to advanced demonstration pilot sites related to power electronic energy conversion units, conditioning and control for microgeneration units and energy storage devices with advanced grid support functionalities.

Optimization of Energy Use
Multi-temporal optimization strategies to allow a dynamic exchange of energy services between end-users of energy and market participants. Definition of energy models for devices, systems and buildings that start from imperfect initial models based on default characteristics that are able to be perfected with the use of data-driven modelling techniques to create adaptable models based on local information. Design of energy management algorithms for resource constrained computational platforms.

5.5.3 Technology transfer

DMS/EMS & System Operation
The main focus of this area is the specification, development and integration of advanced computational tools for network management systems for all voltage levels, such as: topology processors, smart data management, load allocation and power flow and fuzzy state estimation, voltage and reactive power control, preventive management and voltage control, fault location, isolation and restauration (FDIR), optimal network reconfiguration, validation of switching optimized solutions, self-healing, optimal power flow, multi-period optimal power flow, contingency analysis, economic dispatch, unit commitment, dispatch training system, distribution state estimator including unbalanced networks.

System Planning and Reliability
The technology transfer activities developed in this area are mainly directed to transmission and distribution system planning and reliability analysis, including security of supply and reserves adequacy. Another major topic involves load research, load pattern analysis, classification and management, and the development of load and loss profiles for electricity markets. This area also addresses loss studies, comprising estimation and allocation of technical losses, and strategy scheming for the reduction of technical losses. Finally, it also focusses on the detection of non-technical losses and consumption behaviour anomalies.

Network Studies and RES & DER integration

The central focus of the Network Studies and RES & DER integration Area is the steady state, dynamic and transient modelling, analysis and control of interconnected and isolated electric power systems with increasing shares of Renewable Energy Sources (RES). The mains activities are related to RES integration studies, identification of system support functions/ancillary services from RES and the exploitation of new technologies for increasing the controllability and flexibility of transmission and distribution grids (transmission and distribution FACTS, energy storage and associated power converters, HVDC). These activities are supported by a laboratorial infrastructure where reduced-scale models can be implemented and extensively tested in a power-hardware-in-the-loop set-up. The work developed in this area has been largely carried out in collaboration with the industry through consultancy services and applied research as well as through national and European public research bodies, whose financial support enables the developed of fundamental R&D activities.

Electricity Markets and Regulation

This area addresses the organisation, operation and expansion planning of power systems under market conditions as well as the development of tariff schemes to support regulated transmission and distribution activities. On one hand, it aims at developing market structures to bring gate closure closer to real time, to progressively integrate reserve markets in active power markets and to expand them into transnational mechanisms. On the other hand, it applies optimization methods and metaheuristics to develop long term expansion generation and transmission planning under uncertain conditions namely due to the presence of multiple generation agents. Finally, it addresses regulatory issues related to transmission and distribution network activities in order to incorporate dynamic tariff options in the tariff codes and to study the reshaping of network tariffs in view of the expected reduction network usage as local micro and mini generation spread in the systems.

Energy Analytics and Forecasting

This area applies statistical learning and optimization techniques to power system related problems, electricity markets and end-users. The main core activities are the development of time series forecasting algorithms for load, renewable energy and electricity prices. These techniques are the basic framework to tackle new problems like distributed and data-driven demand response strategies and knowledge extraction (data mining) from different power system data, such as phase measurement units, smart meters data and other sensors. The final goal is to embed integrate extracted knowledge in decision-aid methods problems under risk and create new paradigms for power system control and market participation and planning. The results from the R&D activities are, in general, transferred to industrial partners (system operators, retailers, consumers) and the operationalization of the computational modules is made by INESC TEC or by the final client.

Energy management is one of the areas in which energy analytics are applied to define flexibility schemes in allowing energy efficiency actions to be more effectively implemented taking into account external incentives like dynamic price tariffs and/or integration of local RES.

Advanced Training

Organising lectures and training activities on emerging issues as part of projects with international consortia, European projects or on request from companies / utilities.

5.5.4 Knowledge valorisation chain

Table 5.1-CPES - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development		Status (2)	Areas of Technology Transfer --> relationships (3)					
			DMS/EMS System Operation	System Planning and Reliability	Network Studies and RES & DER integration	Electricity Markets and Regulation	Energy Analytics and Forecasting	Advanced Training
Decision Making, Optimisation and Computational Intelligence		I	H	H	M	H	M	
Forecasting		I	H	M		H	H	H
Static and Dynamic analysis of Energy Grids		I	M	L	H		L	H
Reliability		I	M	H		M	L	M
Power Electronics		I		L	M			
...		I						
Other Areas (1)	Communication networks (CTM)	O	H				M	
	Data Mining (LIAAD)	O	L	M			H	
	Service Design and Engineering (CEGI)	O		L			M	

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.5.5 Main Achievements in 2017

For wind and solar power forecasting, a new statistical methodology was developed to extract information from a spatial grid of numerical weather predictions in order to improve the deterministic and probabilistic forecasting skill. A probabilistic price forecasting algorithm was developed for the day-ahead and intraday sessions of the Iberian electricity market. This work was published in two journal papers.

In the framework of IEA Task 36 (Forecasting for Wind Energy) two journal papers were produced to improve the industry understanding of wind power forecast uncertainty and modelling by establishing a common terminology and reviewing the methods to determine, estimate, and communicate the uncertainty in weather and wind power forecasts. A set of recommendations for standardization and improved training of operators are provided along with examples of best practices.

Deep learning methods, i.e. convolutional neural networks, were applied to successful recognition of four different classes of events (generator tripping, load disconnection, line tripping, inter-area oscillation) from a pool of phase measurement units' data, with 100% accuracy, just by "looking" at images constructed from the time-varying signals.

The Horizon 2020 AnyPlace project concluded the prototype of a home energy management system (HEMS) that is a flexible and modular HW and SW platform, capable of supporting a wide variety of features and energy management functionalities the allow end-users to take advantage of existing

incentives and define a customizable operation schedule of controllable appliances (energy optimization and automation). A computational intelligence methodology was developed to efficiently learn and define the feasibility flexibility space from controllable resources connected to an HEMS and produce multi-period flexibility forecasts. This work was published in one journal paper.

Deep reinforcement learning was applied to optimize the energy consumption of wastewater pumps by applying a data-driven predictive approach. CPES, together with Águas do Tejo Atlântico, is studying the possibility of submitting a patent request to protect this control method.

CPES developed the algorithmic base and the code for a new DMS module for EFACEC, the Validation of Optimized Solutions application, to determine a feasible switching procedure which will reconfigure the network according to a final optimized topology.

In collaboration with LIAAD, CPES developed a methodology and software prototype for the detection of anomalous consumption behavior, aiming at identifying uncharacteristic system operation conditions or energy theft. The algorithms, based on clustering and data streams, were transferred to EDP Distribuição.

CPES developed models and tools for assessing the impact of investments on the quality of service, network losses and operational efficiency of the distribution network (EDP Distribuição).

Dynamic simulation platforms for inverter-dominated islanded power systems were developed, thus allowing the study of dynamic stability phenomena in these type of grids and the identification of mitigation strategies. This was used to define the connection requirements for renewable based generation systems to be installed in the Madeira Island.

A work platform was developed for SIEMENS AG, including the definition of use cases and elaboration of technical procedures for steady state and dynamic stability studies in islanded Microgrid systems.

CPES developed studies on sizing hybrid storage systems (reversible hydro power plants and battery energy storage systems) for São Miguel and Terceira islands, together with a methodological approach for addressing the dynamic stability analysis of these systems regarding the installation of a reversible hydro power plant for increasing renewable energy integration.

5.5.6 Centre Organisational Structure and Research Team

The Centre for Power and Energy Systems is coordinated by Manuel Matos and Luís Seca and is organised in the following Areas:

- DMS/EMS & System Operation - Responsible: Jorge Pereira
- System Planning and Reliability - Responsible: José Nuno Fidalgo
- Network Studies and RES & DER integration - Responsible: Carlos Moreira
- Electricity Markets and Regulation - Responsible: João Tomé Saraiva
- Energy Analytics and Forecasting - Responsible: Ricardo Bessa

The Centre research team present composition evolution is presented in Table 5.2.

Table 5.2 - CPES - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	13	12	14	2
		Academic Staff	11	12	12	
		Grant Holders and Trainees	36	51	48	-3
		Total Core Researchers	**60**	**75**	**74**	**-1**
		Total Core PhD	**21**	**22**	**25**	**3**
	Affiliated Researchers		3	3	3	
	Admin.& Tech	Employees	2	2	2	
		Grant Holders and Trainees				
		Total Admin and Tech	**2**	**2**	**2**	
		Total Integrated HR	**65**	**80**	**79**	**3**
		Total Integrated PhD	**24**	**25**	**28**	**3**
Curricular Trainees			2	2		-2
External Research Collaborators			8	9	11	2
External Administrative and Technical Staff					1	1
External Students			1	1	9	8
Total			**76**	**92**	**100**	**8**

5.5.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - CPES - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	79	62	254	192
PN-PICT	National R&D Programmes - S&T Integrated Projects	93	8	28	19
PN-COOP	National Cooperation Programmes with Industry			65	65
PUE-FP	EU Framework Programmes	1.253	1.279	642	-636
PUE-DIV	EU Cooperation Programmes - Other		62	292	230
SERV-NAC	R&D Services and Consulting - National	608	631	821	190
SERV-INT	R&D Services and Consulting - International	68	114	182	68
OP	Other Funding Programmes	23	57	55	-2
Closed Projects		52	106	23	-83
Total Funding		**2.176**	**2.318**	**2.362**	**44**

Table 5.4 - CPES - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	13	36	46
International conference proceedings indexed by ISI, Scopus or DBLP	33	70	74
Books (author)			0
Chapter/paper in books	5	3	2
PhD theses concluded by members of the Centre		3	1
Concluded PhD theses supervised by members of the Centre	4	5	4

Table 5.5 - CPES - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	0
Patent applications	0
Licence agreements	0

Table 5.6 - CPES - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	6
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	2
International events in which INESC TEC members participate in the program committees	12
Participation in events such as fairs, exhibitions or similar	5
Advanced training courses	1

5.5.8 List of Projects

Table 5.7 - CPES - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	ESGRIDS	João Peças Lopes	2017-01-01	2019-12-31
PN-FCT	INFUSE	Vladimiro Miranda	2016-04-01	2019-03-31
PN-FCT	SGEVL	Luís Seca	2017-07-01	2020-06-29
PN-FCT	SusCity	Manuel Matos	2015-01-01	2018-06-30
PN-PICT	CORAL-TOOLS-4	Carlos Moreira	2016-01-01	2018-12-31

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-PICT	iMAN-5	Luís Seca	2015-07-01	2018-12-31
PN-COOP	NEXTSTEP	Clara Sofia Gouveia	2016-12-01	2019-11-30
PUE-FP	AnyPLACE	David Emanuel Rua	2015-01-01	2018-06-30
PUE-FP	EleCtra	José Nuno Fidalgo	2013-12-01	2018-02-28
PUE-FP	EU-SysFlex	Bernardo Amaral Silva	2017-11-01	2021-10-31
PUE-FP	FEEdBACk	Filipe Joel Soares	2017-11-01	2020-10-31
PUE-FP	Hyperbole	Carlos Moreira	2013-09-01	
PUE-FP	InteGrid	Ricardo Jorge Bessa	2017-01-01	2020-06-30
PUE-FP	SENSIBLE	Ricardo Jorge Bessa	2015-01-01	2018-06-30
PUE-FP	SmarterEMC2	David Emanuel Rua	2015-01-01	2018-03-31
PUE-FP	TDX-ASSIST	Leonel Magalhães Carvalho	2017-10-01	2020-09-30
PUE-FP	UPGRID	Luís Seca	2015-01-01	2018-03-31
PUE-DIV	GReSBAS	Filipe Joel Soares	2016-04-01	2019-03-31
PUE-DIV	INDuGRID	Carlos Moreira	2016-09-01	2019-08-31
PUE-DIV	REStable	Carlos Moreira	2016-04-01	2019-03-31
PUE-DIV	Smares	Carlos Moreira	2016-04-01	2018-09-30
PUE-DIV	SmartGuide	André Guimarães Madureira	2016-04-01	2019-03-31
SERV-NAC	ADMS4LV	Clara Sofia Gouveia	2016-04-01	2018-03-31
SERV-NAC	Automacao_Faial	Clara Sofia Gouveia	2016-01-01	2018-04-30
SERV-NAC	Automacao_PST	André Guimarães Madureira	2016-04-30	
SERV-NAC	Cidade_sustentavel	Filipe Joel Soares	2016-01-01	2018-06-30
SERV-NAC	Consultoria	Manuel Matos	2008-01-01	
SERV-NAC	CP_T_Dinamicas	João Tomé Saraiva	2015-02-01	2018-06-30
SERV-NAC	eeseiM	Manuel Matos	2017-01-01	
SERV-NAC	EFACEC-DMS	Jorge Correia Pereira	2001-04-15	
SERV-NAC	Estim_Invest_Dist	José Nuno Fidalgo	2015-09-01	
SERV-NAC	EstinvestQoS	José Nuno Fidalgo	2017-12-01	2018-07-31
SERV-NAC	FARad	João Peças Lopes	2017-01-01	
SERV-NAC	Generation_RAM	João Peças Lopes	2016-11-30	2018-03-29
SERV-NAC	Graciosa	João Peças Lopes	2016-11-25	2018-05-24
SERV-NAC	Hidrica_reversivel	João Peças Lopes	2016-03-01	2018-04-30

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
SERV-NAC	IMPACT_AUTOCONSUMO	João Peças Lopes	2017-04-01	
SERV-NAC	INFRA_PT	João Peças Lopes	2017-07-20	2018-11-06
SERV-NAC	INTERLIG_PT_MA	Bernardo Amaral Silva	2017-03-01	2018-08-31
SERV-NAC	MIBEL	Filipe Joel Soares	2017-09-11	2018-03-10
SERV-NAC	MORA	Leonel Magalhães Carvalho	2016-04-05	2018-04-04
SERV-NAC	OTGEN3	João Peças Lopes	2017-09-01	2018-05-31
SERV-NAC	PANACea	José Nuno Fidalgo	2016-08-08	2018-03-07
SERV-NAC	Perfis_Perdas_2017	José Nuno Fidalgo	2016-11-01	
SERV-NAC	Perfis_Perdas_2018	José Nuno Fidalgo	2017-11-30	2018-03-01
SERV-NAC	Prob2	José Nuno Fidalgo	2017-12-01	2018-07-31
SERV-NAC	REV_PDIRT	João Peças Lopes	2017-07-07	
SERV-NAC	SACC	Filipe Joel Soares	2016-01-01	2018-06-30
SERV-NAC	SOLAR4DR	Ricardo Jorge Bessa	2017-05-01	2018-06-30
SERV-NAC	Tarif_Dinam_Acores	João Saraiva	2015-12-01	2018-01-31
SERV-NAC	Tarif_Dinam_Madeira	João Tomé Saraiva	2016-02-01	2018-06-30
SERV-NAC	VOS	Jorge Correia Pereira	2017-01-01	
SERV-NAC	Wind_curteil_soft	Leonel Magalhães Carvalho	2016-05-12	
SERV-INT	Itesla_IPST	Helena Vasconcelos	2017-06-01	2018-05-31
SERV-INT	Med_TSO	Leonel Magalhães Carvalho	2017-04-28	2018-04-27
SERV-INT	SECRETS	Luís Seca	2013-12-01	2018-05-31
SERV-INT	STABLING	Carlos Moreira	2016-09-01	
SERV-INT	StatProbWind	Ricardo Jorge Bessa	2016-05-01	
OP	CoordEES-UETP	João Peças Lopes	2007-04-01	
OP	IREP'2017	João Peças Lopes	2017-01-01	2018-03-31

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.5.9 List of Publications

International Journals with Scientific Referees

1. Alam, MM, Leite, H, Liang, J, da Silva Carvalho, A, Effects of VSC based HVDC system on distance protection of transmission lines", International Journal of Electrical Power and Energy Systems, vol.92, pp.245-260, 2017
2. Andrade, JR, Bessa, RJ, “Improving Renewable Energy Forecasting With a Grid of Numerical Weather Predictions", IEEE Transactions on Sustainable Energy, vol.8, pp.1571-1580, OCT, 2017
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5.6 CESE - CENTRE FOR ENTERPRISE SYSTEMS ENGINEERING

Coordinators: Américo Lopes Azevedo and António Lucas Soares

5.6.1 Presentation of the Centre

CESE accomplishes its mission, within the Cluster I+I - Industry and Innovation, by undertaking multi-disciplinary, system-oriented research and technology development for the strategic and operational management of industrial enterprises and networks. It uses the knowledge generated in research to provide high value-added niche services to the industrial enterprises in areas such as Manufacturing Systems Design, Manufacturing Systems Planning and Management, Collaborative Platforms, Supply Chain Strategy, Manufacturing Intelligence or Construction Information Management.

CESE mission is to advance the scientific knowledge in enterprise systems engineering, fostering high impact management and ICT systems and generating innovative services for industrial organisations. CESE wants to be recognised as a leading research Centre in enterprise systems engineering and as a first choice in helping industrial organisations to achieve sustainable, high-performance levels.

CESE uses the following research approaches to fulfil its mission: Systems Design, Operational Research (Modelling and Optimization and Simulation), Information Management and Analytics, Design Science and Explanatory Research, and Creative Thinking and Problem Structuring. These approaches support CESE RTD activities which are organised in the following research domains: Manufacturing and Services Operations Management, Enterprise and Industrial ICT, Collaborative Networks and Supply Chains, Business Analytics and Decision Support Systems and Transports, Logistics and Mobility.

5.6.2 Research and Technology Development

Manufacturing and Services Operations Management

CESE research activities in the Manufacturing and Services Operations Management research domain address applied research in operations management encompassing Factories Design and Operation, Production Planning, Scheduling and Control and Business Processes Management.

Factories Design and Operation: Industries of the future must be driven by adaptability of the factory design and of its processes. This requires innovative and multidisciplinary approaches to address the increasing complexity and scale of decision-making. CESE research in this line is centered on intelligent manufacturing technologies and methodologies, developed on top of analytical modelling approaches such as simulation and optimization. The research efforts are aimed at (i) the conceptual factory design and layout planning; (ii) integrated design and operation of smart manufacturing systems; (iii) virtual commissioning and operators training; and (iv) real-time performance monitoring and optimization.

Production Planning, Scheduling and Control: This line is a major research area of CESE over the past 15 years. It involves the development of planning and scheduling methods and IT tools for complex production processes. Application areas include footwear, metalwork, and forestry.

Two specific topics are currently researched:

- to advance existing optimization models and heuristics to dealt with tailored production processes, for small series, high-customization; this is particularly important in the case of new installed footwear assembly lines demand a sophisticated planning of resources, namely in what concerns the balancing of mixed model lines and the real-time sequencing of operations. Resources and materials saving in cutting and packing problems will also be studied;
- to evolve planning & scheduling tools to work with other data collection tools within an Internet of Things environment. In fact, the myriad of sensors are other data collection technologies existing today enable remote monitoring of production processes and should be the basis for real-time planning.

Business Processes Management: Business processes in industrial organisations and networks need are characterised by being partly documented and executed with the partial support of a wide range of

information systems. Furthermore, organisations increasingly need to deal with unstructured processes that ordinary Business Process Management (BPM) solutions were not designed to cope with. Research in this line aims at coping with the challenge of managing unstructured or semi-structured processes that are collaborative, knowledge and content-intensive, and subject to constant change.

Research activities are focused on:

- improvement of business processes management by exploiting the linking between operations management, operations research and six sigma methodologies; and
- cost and risk management methodologies for business process environments.

Enterprise and Industrial ICT

The Enterprise and Industrial ICT research domain addresses the design and use of ICT in industrial organisations and networks along the instrumental, architectural and impact dimensions.

In the instrumental dimension, research is focused on the creation of design knowledge for industrial information systems; this is materialised in innovative design concepts and prototypes that cover the upper decision-making levels - performance management, information management, supply-chain management, business process management - as well as the lower levels - manufacturing operations management (including, among-others, production planning systems and manufacturing execution systems);

The architectural dimension addresses research along two lines:

- novel architectures for Cyber-Physical Systems and (Industrial) Internet-of-Things; the focus is on devising new ways of integrating computing and communication with physical and virtual processes across all levels of production, from processes through machines up to production and logistics networks;
- architectures for efficient large amounts of streaming data collected from machines and processes; combination of off-the-shelf big data technology and in-house developments to support different types of data sources, including IoT, as well as other decision support technologies, including analytics, optimization and simulation, delivered as part of enterprise and industrial systems.

The impact dimension addresses the ex-ante and ex-post assessment of instrumental systems and architectures in industrial organisations and networks. The activities within this dimension also run along two lines:

- technological evaluation: characterisation of the available architectures, technologies and solutions covering the MOM domain (including MES); evaluation of the different possibilities around integration technologies for Industrial Information Systems; and the development of frameworks for the selection and implementation of information systems in enterprises and supply chains.
- socio-technical studies of industrial ICT: empirical studies on the adoption and impact of information systems in industrial organisations and networks.

Collaborative Networks and Supply Chains

Collaborative Networks and Supply-Chains is a multi-disciplinary research domain covering the design of collaborative and supply networks, network business models and processes and the study and design of information and knowledge management in collaborative networks.

Design of Collaborative and Supply Networks: The design of collaborative networks involves determining which structural governance forms would be most appropriate for network success, implementing and managing the structure and recognizing when structure should change based on network and participant needs. Digital platforms have a strong role in shaping the behaviour and sustainability of collaboration

in the network. One research line along these needs is to create design knowledge on how digital platforms can be used instrumentally to transform networks in sustainable collaborative networks. Another research line is focused on global supply networks. Current research includes information management for risk management in supply-chains and the design supply networks towards increasing the technological capabilities of regions.

Knowledge and Collaboration Management in collaborative networks: Successful management of enterprise networks strongly depends on the ability of the network members to collaborate towards solving increasingly complex problems. If it is consensual that collaboration is a means to an end, it is not the case in what concerns to how collaboration should be governed within a network. Collaboration nowadays is intertwined with powerful information and communication (digital) platforms whose diversity poses demanding problems of socio-technical optimisation. The research topics addressed in this line are (i) new concepts for the design of collaborative spaces for decision making involving complex information and sense making; (ii) new concepts, models, methods and tools for information and knowledge management in collaborative networks and (iii) to explain information behaviour and knowledge representation processes in collaborative networks.

Business Models and Processes Design: The sharing economy enabled the creation of new business models that leveraged scattered knowledge and spare capacities linked through websites. The objective of this research line is to extend this concept to industry, by studying novel business models for product-services systems that tap into the under-utilized prototyping and manufacturing capacity. The implementation of these business models requires enhanced collaboration and information exchange among the members of the extended value chain to map the existing technology infrastructure, spare capacity, and scattered knowledge.

Business Analytics and Decision Support Systems

Business Analytics and Decision Support Systems research domain involves three research lines: Manufacturing Intelligence and Analytics Systems, Performance Management Systems and Decision Support Systems.

Manufacturing Intelligence and Analytics Systems: As IoT becomes more predominant the need for process improvement based on data arises naturally. Research in this line deals with the application and adaptation of traditional machine learning and data mining methods to the opportunities and challenges raised in this context, including new application areas (e.g. predictive performance management systems and predictive maintenance), new algorithms (e.g. anomaly detection methods) and integration with other approaches (e.g. with simulation and optimization, to design flexible maintenance planning solutions). Recommender systems are another important topic that includes the use spatial context data (from general space coordinates to business-specific information such as the closest shelf to the customer) and product characteristics (e.g. colour of fashion product).

Performance Management Systems: There is an increasingly important challenge for manufacturing organisations to find the strategic decisions that best fit the underlying organisation complexity, and the need to evaluate the impact that the strategic decisions will have in the future performance. Research in this line addresses the development of hybrid methods for improved performance management, focusing on exploring the use of hybrid simulation approaches to predict the operational performance, namely for quantifying the impact of operational decisions in the future system's performance. Hybrid approaches, with combined qualitative and quantitative methods, allow for a better understanding of the past operational choices made by the manufacturing organisation and of the decisions, the organisation intends to make in the future. These approaches also help to predict how future operational choices will impact the system's performance.

Decision Support Systems: The ever-growing utilization of more advanced business analytics approaches, along with sophisticated optimization and simulation tools, naturally creates the need for integrated and innovative forms of Decision Support Systems (DSS) that will hopefully complement quantitative methods and algorithms with an active "participation" of human decision-makers. Interfaces design and other ways to address the "human dimension" in DSS development is still an important research topic world-wide. Related with the latter, another important research topic is the use of DSS in a multiple decision-maker environment, including collaborative planning and decision-making processes. It is key

to make use of novel collaborative planning methods, that provide a fair distribution of the benefits generated by the collaboration.

Transport, Logistics and Mobility

Transport, Logistics and Mobility is a new domain research at CESE, arising from the challenges that globally distributed industrial organisations and networks pose. It encompasses three research lines, from the natural extension of logistics to the application of CESE's expertise in simulation, optimizations and information and knowledge management.

Transportation Systems and Logistics: Modern manufacturing and supply networks are becoming more and more complex, geographically distributed and fragmented. This is the natural result of the increasing complexity of products and the benefits of specialization associated with new, more efficient forms of collaboration. Sophisticated, complex products involve quite disperse manufacturing and logistic actors, with a huge component of moving raw materials, parts and components, and therefore with a higher role of transportation systems and logistics. Due to this complexity, research in this area is obviously of a multi-disciplinary nature, and with quite dynamic demand patterns, uncertainty (at different levels and with different sources) becomes an important factor to consider in the design or operation of logistic services.

Urban Logistics and Mobility: Mobility of people in urban and metropolitan areas has an enormous importance in the organisation of cities and in the quality of life. Huge costs are involved in daily commuting, with a large weight for private cars. Environmental impacts of transport in cities are also at an unacceptable level. Better designing and operating transport services is therefore critical, especially in a time when demand patterns are more and more diverse, and when inter-modality is the basis of urban mobility. Still in the city context, in urban logistics multiple interesting research topics have emerged, to design more efficient services and to better manage operations.

Intelligent Transportation Systems: Embedded "intelligence" in vehicles and in transportation systems has since a long time been an important topic of research, from different perspectives and in various scientific disciplines. However, recent, extraordinary technological advances have created a still more promising landscape for multi-disciplinary research, particularly concerning urban mobility systems. Sensors networks, the co-creation of knowledge, information sharing, big data, or the Internet-of-Things paradigm, are creating the ground for new, promising research projects, strongly aligned with the interests and competences of CESE.

5.6.3 Technology transfer

An important part of the Centre's mission is dedicated to provide innovative, high value-added technology based services to industrial companies and networks. These services are sustained by the RTD activities described above.

A major priority of CESE is to transfer to IT companies - technology up takers - the knowledge and technology resulting from the RTD activities undertaken in the scope of the research domains. For this purpose, the collaborative projects commonly include at least one technology up taker company with interest in the commercial exploitation of the research results generated in the project. However, additional actions are needed for successful transfer of the technology related with manufacturing systems planning, including

- new collaborative research projects to produce market-ready products based on CESE research results;
- new commercial agreements with technology up takers, foreseeing the royalties schema related with the CESE property rights over the exploitable results;
- support to the commercialization efforts of our partners technology up takers, including the parameterization of the CESE developed modules to new clients/end-users as pre-selling initiatives; or adapting the CESE modules to evolving needs of existing end-users. An example is the long-lasting relationship with developers of ERP systems, that incorporate our research

results and gives us access to large final clients; partnerships with MES/MOM providers are also being done; and

- initiatives to disseminate research results and seek for new partnerships with technology up takers and end-users, including the participation in sectorial associations, such as Produtech and AIFF and the participation in national and international fairs and seminars.

The more active areas of knowledge and technology transfer and services providing are the following:

Manufacturing Systems Management: Consultancy services in Manufacturing Systems Design including conceptual and functional design of resource-efficient factories, modelling and simulation of manufacturing systems and resource-constrained production processes, development of ICT solutions for designing and managing high-performance manufacturing systems. Business Processes Management as well as Information Systems specification and implementation management are also an important share of the services provided in this area. The Centre is also beginning to provide services at a more strategic level regarding operations and technology management. An example is a strategic roadmap for Industry 4.0 developed for a sectorial association.

Logistics Systems: The Centre develops intra and inter-organisational logistics systems. Furthermore, it provides services to enable companies to integrate IoT components and orchestrate manufacturing modules, such as planning, scheduling, balancing with internal logistics to increase the flexibility of the manufacturing systems. In the inter-organisational area, novel methods for transportation/distribution planning, combined with other upstream and downstream supply chain processes. Examples are applications in biomass and wood-based products distribution across forest-based supply chains. CESE also develops multi-disciplinary approaches (based on advanced decision support tools) to design transport networks or inter-modal logistic solutions, integrated in broader distributed manufacturing systems. This includes problems such as: fleet sizing and management; vehicle routing planning (for product distribution or collection); or the design of logistic networks.

Digital platforms for networks and supply chains: Levered in the research domain of Collaborative Networks and Supply-Chains, the Centre is providing consultancy and development services on digital platforms for managing several types of collaborative networks. Contracts are being made with enterprise associations and sectorial clusters to develop collaborative platforms for managing information, communication and collaboration together with networks and collaboration governance models. The distinctive aspect of the Centre's offer is the integrated approach to network governance and digital platform development.

Business Intelligence: The research line Manufacturing Intelligence and Analytics Systems together with the research in Enterprise and Industrial ICT domain is producing results that are being used to setup services in Business Intelligence for several types of organisations. Furthermore, recommender systems are now raising interest on several industrial companies, mainly in the areas of predictive maintenance and performance and customer oriented services.

Urban Mobility: CESE provides consultancy services and develop customized decision support systems to help municipalities, authorities, public agencies, transport operators, and logistic providers, in designing and managing transport and logistic services. Specific services and decision support tools can be designed for urban mobility, based on the principles and techniques of data science, knowledge management, optimization and simulation, or multi-criteria analysis. Particularly interesting applications can be developed in areas such as: demand responsive transport (DRT) services; vehicle and crew scheduling systems; demand data management; urban logistics services.

Construction Information and Knowledge Management: The lifecycle management of large civil construction buildings and facilities requires complex computer information systems the deal simultaneously with teamwork over the internet, relational and non-relational data, large datasets, synchronous and asynchronous document generation, certification, tight security, among others. Having developed and worked more than a decade with conventional multi-tier applications, we became aware of some of its limitations and we're now developing a novel architecture and framework that will allow fast development of new apps and streamline the access and treatment of information. Consultancy services in this area are being provided to the Portuguese central administration.

5.6.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CESE - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development		Areas of Technology Transfer --> relationships (3)						
		Status (2)	Manufacturing Systems	Logistics Systems	Digital Platforms for Networks and Supply Chains	Business Intelligence	Urban Mobility	Construction Information and Knowledge
Manufacturing and Services Operations Management		I	H	M	L	L	M	L
Enterprise and Industrial ICT		I	H	M	M	H	L	H
Collaborative Networks and Supply Chain		I	M	L	H	L	M	M
Business Analytics and Decision Support Systems		I	H	M	L	H	M	L
Transport, Logistics and Mobility		I	M	H	L		H	
Other areas (1)	CEGI	O	M	H	M	H	H	L
	CRIIS	O	M	H	L	L	L	L
	CITE	O	M	L	H	M	L	M
	LIAAD	O	L	L	M	H	L	M
	CSIG	O	L	L	H	H	L	H

1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.6.5 Main Achievements in 2017

The adoption of economically and efficiently strategies addressing mass customization business environments, involves a multidisciplinary approach either from business and technology perspective. CESE, based on its proven experience in a number of traditional sectors, developed and consolidated in 2017 the offering of new added value services to companies seeking to develop their competitiveness in a sustainable way. Supported by a reference framework based on 4.0 industry concepts and technologies, CESE has developed specific methodologies and tools that can support companies, namely manufacturing enterprises, to achieve a significant increase in cost efficiency, time productivity, and flexibility, by aligning and integrating their manufacturing processes and technology landscape with their business strategy, which is the vision of Industry 4.0. One of the key services is the maturity analysis of the target organisation concerning industry 4.0 reference framework. In that context, several artefacts have been created to enrich the CESE's maturity analysis framework. The application in different sectors, through advanced consulting services, has been demonstrating the suitability of this bundle of methodologies and tools.

During 2017, INESC TEC successfully coordinated the creation of a Digital Innovation Hub in the Northern Region of Portugal called iMan Norte Hub - Digital Innovation Hub for Customer-Driven Manufacturing @ Norte. The mission of the iMan Norte Hub is to foster the digital transformation of manufacturing companies of the Northern Region of Portugal and to nurture the respective innovation ecosystem. The

iMan Norte Hub is part of the European network of Digital Innovation Hubs recognized by the European Commission in its Smart Specialization platform (http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs) and its scope and activities completely align with the NORTE 2020 Smart Specialization Regional Strategy in its priority area of Advanced Manufacturing Systems. The Hub focus on the most significant industrial sectors of the region, such as metalworking, textile, footwear, automotive, agri-food and forestry. The coordinated members of the iMan Norte Hub - PRODUTECH, INESC TEC, UPTEC, CATIM, CITEVE, CTCP, and CTCOR - will sign a Memorandum of Understanding in January 2018. The iMan Norte Hub aims to foster the adoption of advanced technologies by industrial companies, specifically in the areas of digitalization, internet of things and robotics, in order to make the industry more customer focused with distinctive services, more sustainable, and with an even greater impact on the region's economy and employment. It is composed of research institutions, industrial technological centers, industrial associations, incubators, science and technology parks, technology and industrial companies, Institutions of higher education and professional training and government agencies.

In 2017 CESE has achieved four years of continued collaboration with the IKEA company in the areas of factory design and operations planning, which has been effectively sustained by the research work of European and national projects. These projects addressed optimization of the production lines through mathematical and simulation models to design facilities and to plan and operate operations that have a significant variability and uncertainty, dealing with complex routings and bill of materials, and deciding between the mix between push and pull production strategies. They are grounded in a simulation and optimization approach to perform AS IS and TO BE analysis to understand the impact of the new production mix, to recommend an optimized design of the production line and to propose a practical and balanced design of the production system - in terms of layout, buffers and machines capacities. The 2017 results led to new developments, namely the definition of multi-year planning strategies and the extended design of the factories.

5.6.6 Centre Organisational Structure and Research Team

The Centre for Enterprise Systems Engineering is coordinated by Américo Azevedo and António Lucas Soares and is organised in the following Areas:

- Manufacturing and Services Operations Management - Responsible: Américo Azevedo and Alexandra Marques
- Enterprise and Industrial ICT - Responsible: César Toscano
- Collaborative Networks and Supply Chains - Responsible: António Lucas Soares and Ana Barros
- Business Analytics and Decision Support Systems - Responsible: Carlos Soares
- Transport, Logistics and Mobility - Responsible: Jorge Pinho de Sousa
-

The Centre has a coordination board and a scientific board that assist the coordinators.

The Centre research team present composition evolution is presented in Table 5.2.

Table 5.2 - CESE - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	12	12	14	2
		Academic Staff	11	11	10	-1
		Grant Holders and Trainees	33	33	34	1
		Total Core Researchers	**56**	**56**	**58**	**2**
		Total Core PhD	**20**	**16**	**16**	
	Affiliated Researchers		4	4	3	-1
	Admin. & Tech	Employees	2	2	2	
		Grant Holders and Trainees				
		Total Admin and Tech	**2**	**2**	**2**	
	Total Integrated HR		**62**	**62**	**63**	**-1**
	Total Integrated PhD		**22**	**19**	**18**	**-1**
Curricular Trainees			9	7	9	2
External Research Collaborators			5	8	7	-1
External Administrative and Technical Staff						
External Students				1	1	
Total			**76**	**78**	**80**	**2**

5.6.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - CESE - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	63	76	122	46
PN-PICT	National R&D Programmes - S&T Integrated Projects	126	101	143	42
PN-COOP	National Cooperation Programmes with Industry	129	118	367	249
PUE-FP	EU Framework Programmes	449	391	221	-170
PUE-DIV	EU Cooperation Programmes - Other	77	108	114	6
SERV-NAC	R&D Services and Consulting - National	435	259	431	173
SERV-INT	R&D Services and Consulting - International	44	58	13	-45
OP	Other Funding Programmes		37		-37
Closed Projects		48	41	24	-17
Total Funding		**1.370**	**1.187**	**1.435**	247

Table 5.4 - CESE - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	12	18	15
International conference proceedings indexed by ISI, Scopus or DBLP	21	38	24
Books (author)			0
Chapter/paper in books	4	3	2
PhD theses concluded by members of the Centre	2	4	3
Concluded PhD theses supervised by members of the Centre	3	5	4

Table 5.5 - CESE - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	2
Patent applications	0
Licence agreements	0

Table 5.6 - CESE - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	1
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	0
International events in which INESC TEC members participate in the program committees	3
Participation in events such as fairs, exhibitions or similar	3
Advanced training courses	0

5.6.8 List of Projects

Table 5.7 - CESE - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	3SLM	António Lucas Soares	2017-08-10	2019-02-05
PN-FCT	DM4Manufacturing-1	César Toscano	2016-11-01	2019-10-31
PN-FCT	E2Web	Ana Cristina Barros	2014-06-01	2018-05-31
PN-FCT	EasyFlow	Alexandra Sofia Marques	2016-06-01	2019-05-31
PN-FCT	VR2Market-1	Ana Cristina Barros	2014-07-15	2018-12-31

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-PICT	iMAN	Américo Azevedo	2015-07-01	2018-12-31
PN-PICT	SMILES-4	Américo Azevedo	2015-07-01	2018-12-31
PN-COOP	3GEnergy	António Lucas Soares	2016-09-01	2018-08-31
PN-COOP	AdaptPack	Pedro Ribeiro	2016-09-01	2019-08-31
PN-COOP	ADIRA_I4.0	António Correia Alves	2016-09-01	2019-08-31
PN-COOP	ATM	António Correia Alves	2016-09-01	2018-02-28
PN-COOP	FAMEST	Rui Diogo Rebelo	2017-11-01	2020-10-31
PN-COOP	FASCOM	Rui Diogo Rebelo	2015-10-01	
PN-COOP	GOTECFOR-1	Alexandra Sofia Marques	2017-01-01	2020-12-31
PN-COOP	MAPPLE	António Correia Alves	2016-09-01	2018-02-28
PN-COOP	PERSONA-1	Rui Diogo Rebelo	2017-03-01	2019-06-30
PN-COOP	PrecisionCork	Pedro Ribeiro	2016-05-15	2018-11-14
PN-COOP	PRODUTECH_SIF	António Correia Alves	2017-10-01	2020-09-30
PUE-FP	BEinCPPS	César Toscano	2015-11-01	2018-10-31
PUE-FP	Fasten	Samuel Moniz	2017-11-01	2020-10-31
PUE-FP	Futuring	António Lucas Soares	2016-09-01	2018-02-28
PUE-FP	NEXT-NET	Ana Cristina Barros	2017-10-01	2019-09-30
PUE-FP	ScalABLE4.0-1	César Toscano	2017-01-01	2020-06-30
PUE-FP	STAMINA-1	César Toscano	2013-10-01	
PUE-DIV	BIOTECFOR-1	Alexandra Sofia Marques	2017-01-01	2018-12-31
PUE-DIV	MANTIS	Hugo Miguel Ferreira	2015-05-01	2018-04-30
PUE-DIV	MANUFACTUR4.0-1	Ana Cristina Barros	2017-04-17	2019-12-31
SERV-NAC	BI4UP2	António Lucas Soares	2016-08-01	
SERV-NAC	Carpa	Rui Diogo Rebelo	2017-02-14	
SERV-NAC	CFERRA	António Correia Alves	2017-12-01	2018-11-30
SERV-NAC	Chatbot_Intelligence	Luís Guardão	2017-06-01	
SERV-NAC	CMLDM	Carlos Soares	2016-05-16	
SERV-NAC	Consultoria	Luís Carneiro	2009-01-01	
SERV-NAC	COOL	Jorge Pinho de Sousa	2013-12-01	
SERV-NAC	MDIGIREC	Rui Diogo Rebelo	2017-12-01	2018-11-30
SERV-NAC	MESAI	Rui Diogo Rebelo	2016-11-12	

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
SERV-NAC	PAINT_APS	Luís Guardão	2017-03-16	
SERV-NAC	Palcus-1	António Correia Alves	2017-03-15	
SERV-NAC	ParqueEscolar	Luís Guardão	2009-11-01	2018-12-31
SERV-NAC	PERS_TOMI-1	Rui Diogo Rebelo	2017-12-19	2019-12-18
SERV-NAC	PlantSetup	Samuel Moniz	2016-05-01	
SERV-NAC	PRODOMOI	Rui Diogo Rebelo	2017-10-20	2018-06-28
SERV-NAC	PRODUTECH_Plan	António Correia Alves	2015-06-01	
SERV-NAC	PROGROW2	Pedro Ribeiro	2016-11-17	
SERV-NAC	PTECH_SERV_i40	António Lucas Soares	2017-05-24	
SERV-NAC	PTECH_VASERV	António Lucas Soares	2017-05-15	
SERV-NAC	RIDDIG	António Correia Alves	2017-05-03	2018-08-31
SERV-NAC	RPS	António Correia Alves	2017-05-09	
SERV-NAC	SilosL	Samuel Moniz	2017-02-01	
SERV-NAC	SimBoF	Rui Diogo Rebelo	2017-03-14	
SERV-NAC	SimIntra	Rui Diogo Rebelo	2017-02-01	
SERV-NAC	SmartRetail	Rui Diogo Rebelo	2016-12-13	2018-06-12
SERV-NAC	SmartSL	Rui Diogo Rebelo	2015-07-01	
SERV-NAC	Viladeste	Jorge Pinho de Sousa	2017-01-12	
SERV-INT	IzaroGrey	António Correia Alves	2007-01-01	
SERV-INT	ROGER	Samuel Moniz	2016-12-05	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.6.9 List of Publications

International Journals with Scientific Referees

1. Arrais, R, Oliveira, M, Toscano, C, Veiga, G, “A mobile robot based sensing approach for assessing spatial inconsistencies of a logistic system", Journal of Manufacturing Systems, vol.43, pp.129-138, 2017
2. Azevedo, A, Faria, J, Ferreira, F, “Supporting the entire life-cycle of the extended manufacturing enterprise", Robotics and Computer-Integrated Manufacturing, vol.43, pp.2-11, FEB, 2017
3. Azevedo, MM, Crispim, JA, de Sousa, JP, “A dynamic multi-objective approach for the reconfigurable multi-facility layout problem", Journal of Manufacturing Systems, vol.42, pp.140-152, JAN, 2017
4. Bandeira, JM, Fernandes, P, Fontes, T, Pereira, SR, Khattak, AJ, Coelho, MC, “Exploring multiple eco-routing guidance strategies in a commuting corridor", International Journal of Sustainable Transportation, pp.1-13, 2017
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5.7 CRIIS - CENTRE FOR ROBOTICS IN INDUSTRY AND INTELLIGENT SYSTEMS

Coordinator: António Paulo Moreira

5.7.1 Presentation of the Centre

CRIIS accomplishes its mission, within the Cluster I+I - Industry and Innovation, by designing and implementing innovative solutions within the areas of industrial robotics and intelligent systems.

The Centre works in close cooperation with Companies, other INESC TEC Centres and other Institutes and Universities, following the lemma from Research and Development to Innovation, passing through Design, Prototyping and Implementation.

5.7.2 Research and Technology Development

Navigation and Localization of Mobile Robots
Industrial and service robots (indoor and ourdoor) robotics, industrial robotic manipulators, Automated Guided Vehicles (AGVs), navigation solutions for indoor and outdoor environments.

The Centre for Robotics and Intelligent Systems (CRIIS) develops mobile robotic systems that can be applied in industry, indoor and outdoor environments.

Intelligent Sensors and Control of Dynamical Systems
Research in Dynamics and Control can be applied in several systems from robots to industrial process and is crucial to the efficient control and design of complex and optimized systems. Using the mathematics and physics laws, we build a model based approach, namely model based predictive controllers, and apply it to a wide range of systems from process control to robotics and industrial production lines. To have a correct and cost-effective monitoring and control the use of sophisticated sensors is mandatory. The development of smart-sensors, software-sensors and networked sensors is also a main research topic for CRIIS.

2D/3D Industrial Vision and Advanced Sensing
Sensing is a key component on modern industrial robotics systems. The advent of 3D point-cloud based perception systems opens a wide variety of opportunities to deal not only with dynamic environments, where parts are placed in unknown places, but also to deal with robot accuracy limitations and part dimensional deviations. Furthermore the widespread use of different sensing technologies, including force-sensing, laser range finders or sonar, for example, are key element in the development of upcoming robotics systems. The research line followed by the Centre is focused on the development of algorithms tailored for industrial use, robotics in particular, with special emphasis on multimodal sensor fusion, integrated machine learning, active perception among others.

Mobile Manipulators
During the last years, the Centre had a strong focus on the development of Mobile Manipulators. These robotics systems present high flexibility and are particularly adapted to the needs of existing production systems, where layout reconfiguration are difficult. The application of such systems goes from internal logistics to novel applications such as on-site construction. This research line had been developed with extensive international collaborations in the context of 3 European projects (FP7 - CARLoS, FP7-STAMINA and H2020 ColRobot) with reference end-users such as PSA - Peugeot Citroen, Renault or Thales-Alenia Aerospace. For the upcoming years, the goal is to push the mobile manipulators systems closer full production systems, either through the development of basic technologies, but also the development of higher TRL projects namely through the application of the previous developments industrial settings.

Special Structures and Architectures for Robots
Many robotics applications still require novel robotic structures to fulfil its requirements. The unit has experience in the development of completely new robotics structures, such as cable robots e.g. and will continue to explore such systems with novel robotic systems in mind.

Human Robot Interfacing and Augmented Reality

Together with machine vision, human robot interfacing is a key element on the development of flexible robotics systems. Although a topic of extensive research in the past, also by the Centre, the potential of applications unleashed by the human intervention in robotic systems is still very significant. The approach will explore previous developments on Programming-by-demonstration, CAD based programming but will put a strong emphasis on techniques for uncertainty handling on robotic systems, namely through the combination of augmented reality (projection mapping) in which the Centre has proven expertise.

Future Industrial Robotics and Collaborative Robots

Future industrial robotics will move from a robot Centred perspective of a robotics work cell, to an integrated approach that involves perception, multiple sources of information (either sensors or IT support systems), close collaboration with humans and continuous process learning. This requires a multidisciplinary work that includes the above-mentioned development of Human Robot interfaces and advanced 2D / 3D sensing but also the in depth evaluation of the strengths and weaknesses of the use of safe collaborative robots.

Collaborative robotics are commonly evaluated as a game-changing technology in the future of industrial robotised operations. However, for these robots to be used spread out in industry, there is still the need for applied research applications that would show the success of the concept. The research approach will be the development of accessing tools that include the safety analysis according to the ISO technical standard 15066 and the related norms ISO 10218-1, and also on the economic analysis of the use of such systems.

Vertical Integration, IoT, Industry 4.0

The success of industrial and mobile robotics application is heavily dependent on the integration with the connected factory of the future. In this regard, the Centre will further develop integration tools with a network of partners, namely within INESC TEC with the CESE and CEGI Centres. The role of robotics in the Industry 4.0 is an open challenge that requires a change of approach from a work-cell integration to a factory or even inter-factory level integration. In a connected factory scenario, advanced mobile robots play a differentiated role from other Industry 4.0 actors, namely due to the advanced sensing capabilities, CPU/GPU processing power inherent to the robot. Therefore, in the mobile robotics sector, the approach will explore the concept of a robot as a mobile sensor that can dynamically populate the digital shadow of the manufacturing plant. Concerning collaborative robots, the approach will explore the impact of such systems in the upper layers of the connected factory, namely through the development of decision-making strategies that consider the new capabilities/limitations of collaborative robots and their balance with the human operators. The Centre previous experience in vertically integrated projects, namely the STAMINA project, is the foundation for the Centre offer of consultancy services.

5.7.3 Technology transfer

Internal Logistics

The Centre has a strong activity in internal logistic system that goes from the development of simple AGV systems in partnership with Portuguese companies, to the development of advanced mobile manipulators in Flagship European projects such as STAMINA and ColRobot. The Centre offers consultancy services for the installation of existing and mature robotics systems, such as the LeanAGV, but is also capable of developing novel robotics systems, namely mobile manipulators for high flexible logistics operations. The Centre developed a well-proven network of competences, both internally at INESC TEC as well as with external companies, that provides the Centre with the capabilities to provide complete logistics systems that vertically integrate the robotic system in the production environment.

Robotics for Agriculture and Forestry

The Agriculture and Forestry R&D line has a 10-year road-map, considering the Portuguese reality (needs and desires) and the European Robotics agenda. It is focused on three application topics: Vineyards (Steep Slope), Forest biomass harvesting, and Greenhouses (urban and traditional). Our main efforts are

concentrated to develop cost effective visual-based sensors, manipulators and small machinery with advanced localization, mapping, control and perception algorithms (where we believe that can occur technology transference). This R&D line has started in 2015, and in 2017 we will have 2 active national projects in co-promotion with national companies/associations (Tekever, ADVID, Prodfarmer, Herdade do Esporão, Herdade Maria da Guarda) and 2 international projects in co-promotion with international companies/associations (Wageningen University & Research, Aveleda, isardSAT, AIB University, IMAMOTER). In addition to these ongoing projects, other ones with reference institutions/companies (INIAV, Forestis, CTAG, ENERMETER, FERTIPRADO, WHITUS, HIDROSOPH, CERSUL, INCREASE and ELAIA 2) are being evaluated under P2020, POCTEP, and PDR2020 programs. We are working together with Pulverizadores Rocha, Herculano Alfaias Agrícolas, Aveleda and WiseCrop in order to set new goals and common projects. The technology transference by intellectual property, start-up/spin-off creation is targeted to the midterm of 2018.

Flexible Production using Robotics

The Centre presents a proven track record of successful robotics based Flexible production systems that were installed and transferred to the market. The use of Industrial robotic systems on SME's is a strong demand on the Portuguese and European markets, and requires novel approaches that combine Advanced sensing, human machine interfacing, high level programming, augmented reality, among others. The Centre accumulated expertise in the different scientific/technological areas and a well-established network of partnerships, gives the Centre a large set of tools to answer to the most demanding challenges.

Inspection, Control and Embedded Systems

Machine vision is widely applied in quality control (non-conformity detection, dimensional control, ...) using or not industrial robotics systems. Some success projects have already been developed and applied in the industry (CONTINENTAL, GISLOTICA, Rail-Inspect) and others are in progress.

The application of the control theory for Dynamics Systems is now used in a wide range of different systems, from classic process control systems to production lines and logistic systems all using similar dynamical models. With these models, we use model based predictive controllers (project FOCUS).

To the efficient control, modelling and monitoring of complex and optimized systems it is mandatory the acquisition of large amounts of information (sensors data and inputs from operators) and so the development of the appropriate devices that facilitates the integration with the connected factory of the future is under progress, following the paradigms of the Industry 4.0.

New challenges in Robotics

The Centre has a strong track record on the development of novel robotics systems for new application sectors, such as Surveillance (RobVigil), Architecture and construction (RobArc) or the health sector (TriHo). The Centre broad range of expertise allows multidisciplinary approaches for the development of software and hardware customized for specific applicationsKnowledge valorisation chain.

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

5.7.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CRIIS - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development		Status (2)	Areas of Technology Transfer --> relationships (3)				
			Internal Logistics	Robotics for Agriculture and Forestry	Flexible Production using Robotics	Inspection, Control and Emb. Systems	New challenges in Robotics
Navigation and Localization of Mobile Robots		I	H	H	H	L	M
Intelligent Sensors and Control of Dynamical Systems		I	L	H	M	H	M
2D/3D Industrial Vision and Advanced Sensing		I	L	H	H	H	H
Mobile Manipulators		I	H	M	H	L	H
Special Structures and Architectures for Robots		I	L	M	H	M	H
Human Robot interfacing and Augmented Reality		I	L	M	H	M	H
Future Industrial Robotics and Collaborative Robots		I	M	L	H	M	H
Other areas (1)	Vertical Integration, IoT, Industry 4.0 (CESE, CEGI)	O	H	M	H	H	H

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer

(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership

(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.7.5 Main Achievements in 2017

Augmented reality for collaborative robots

In 2017, the developments made by INESCTEC regarding projected augmented reality saw is first application in a production environment. Following the developments in previous projects (FP7 CArloS project and FP7 CLARiSSA project), INESCTEC integrated the CoopWeld Consortium, providing machine vision and a projected augmented reality system for the collaborative assembly of structural steel components. This high TRL (8) project shows the maturity of the technologies as well as the potential of its use in production environments.

Mobile manipulator for the Automotive sector

In 2017, the STAMINA project came to an end. This flagship project consisted on the development of a mobile manipulator for picking operation in the automotive industry. INESCTEC long term focus on mobile manipulation played an important role in the project, namely through the vertical integration of a skill based robot and the algorithms for multi-robot coordination.

Robotics for Agriculture and Forestry

In the Robotics for Agriculture and Forestry application field, the Centre has proposed twelve projects and got the projects approved (two national FDControlo, GoTecFor, two direct contracts SistemaDPA, DroneTool and one international BiotecFor). This is aligned to the first goal of our Agriculture and Forestry robotics roadmap, proposed advanced solutions for agricultural and forestry monitoring systems. The Centre/INESCTEC received a three special invitations for the invited talks in relevant agricultural conferences (AgroSummit, SBIAGRO2017, CLBHORT2017) and got more than a dozen of articles on the main national media (referring the Agrob V14 and Agrob V16 platforms). In 2017, INESC TEC is seen as a national reference on robotics R&D for Agriculture and Forestry. In this year were submitted and accepted more than 6 papers in relevant ISI conference/journals (IROS, JINT).

5.7.6 Centre Organisational Structure and Research Team

The Centre for Robotics in Industry and Intelligent Systems is coordinated by António Paulo Moreira and is organised in the following Areas:

- Navigation and Localization of Mobile Robots - Responsible: Paulo Costa / Héber Sobreira
- Collaborative Robots - Responsible: J. Lima / Luis Rocha
- Intelligent Sensors and Control of Dynamical Systems - Responsible: J. Boaventura / Filipe Santos
- 2D/3D Industrial Vision - Responsible: Hélio Mendonça / Luís Rocha
- Mobile Manipulators - Responsible: Germano Veiga / Héber Sobreira
- Special Structures and Architectures for Robots - Responsible: Manuel Silva / Filipe Santos
- Human Robot Interfacing - Responsible: Germano Veiga / Rafael Arrais
- Future Industrial Robotics - Responsible: Pedro Costa / Germano Veiga
- Vertical Integration, IoT, Industry 4.0 - Responsible: Hélio Mendonça / Rafael Arrais

The Centre research team present composition and evolution is presented in Table 5.2. The Centre was established in 2016 as a split from the previous Centre CROB (Centre for Robotics and Intelligent Systems) - figures for 2015 apply for the group within CROB that emerged as CRIIS.

Table 5.2 - CRIIS - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	3	3	5	2
		Academic Staff	20	21	21	
		Grant Holders and Trainees	10	15	19	4
		Total Core Researchers	**33**	**39**	**45**	**6**
		Total Core PhD	**24**	**26**	**25**	**-1**
	Affiliated Researchers					
	Admin. & Tech	Employees	2	2	3	1
		Grant Holders and Trainees	1	1	2	1
		Total Admin and Tech	**3**	**3**	**5**	**2**
		Total Integrated HR	**36**	**42**	**50**	**1**
		Total Integrated PhD	**24**	**26**	**25**	**-1**
Curricular Trainees				1	1	
External Research Collaborators			3	5	8	3
External Administrative and Technical Staff				1	1	
External Students			4	4	3	-1
Total			**43**	**53**	**63**	**10**

5.7.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - CRIIS - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT		4	72	**68**
PN-PICT	National R&D Programmes - S&T Integrated Projects		63	62	**-1**
PN-COOP	National Cooperation Programmes with Industry		54	139	**84**
PUE-FP	EU Framework Programmes		313	274	**-38**
PUE-DIV	EU Cooperation Programmes - Other			35	**35**
SERV-NAC	R&D Services and Consulting - National		169	432	**263**
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes				
Closed Projects			54	3	**-51**
Total Funding			**657**	**1 018**	**361**

Table 5.4 - CRIIS - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	22	27	18
International conference proceedings indexed by ISI, Scopus or DBLP	79	62	54
Books (author)	1	1	0
Chapter/paper in books	3	6	2
PhD theses concluded by members of the Centre			1
Concluded PhD theses supervised by members of the Centre	4	5	6

Table 5.5 - CRIIS - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	2
Patent applications	0
Licence agreements	0

Table 5.6 - CRIIS - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	0
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	1
International events in which INESC TEC members participate in the program committees	2
Participation in events such as fairs, exhibitions or similar	2
Advanced training courses	0

5.7.8 List of Projects

Table 5.7 - CRIIS - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	DM4Manufacturing	Germano Veiga	2016-11-01	2019-10-31
PN-PICT	iMAN-3	António Paulo Moreira	2015-07-01	2018-12-31
PN-COOP	AdaptPack-1	Manuel Santos Silva	2016-09-01	2019-08-31
PN-COOP	ATM-1	António Paulo Moreira	2016-09-01	2018-02-28
PN-COOP	CoopWeld	Germano Veiga	2015-12-28	
PN-COOP	FAMEST-1	Héber Miguel Sobreira	2017-11-01	2020-10-31
PN-COOP	GOTECFOR	Filipe Neves Santos	2017-01-01	2020-12-31
PN-COOP	PrecisionCork-1	Hélio Mendonça	2016-05-15	2018-11-14
PN-COOP	PRODUTECH_SIF-1	António Paulo Moreira	2017-10-01	2020-09-30
PN-COOP	ROMOVI	Filipe Neves Santos	2017-01-07	2019-08-31
PN-COOP	SmartFarming	Filipe Neves Santos	2016-10-01	2018-09-30
PUE-FP	ColRobot	Germano Veiga	2016-02-01	2019-01-31
PUE-FP	Fasten-1	Rafael Lírio Arrais	2017-11-01	2020-10-31
PUE-FP	ScalABLE4.0	Germano Veiga	2017-01-01	2020-06-30
PUE-FP	STAMINA	Germano Veiga	2013-10-01	
PUE-DIV	AGRINUPES	José Boaventura	2017-04-01	2020-03-31
PUE-DIV	BIOTECFOR	Filipe Neves Santos	2017-01-01	2018-12-31
PUE-DIV	MANUFACTUR4.0	Luís Freitas Rocha	2017-04-17	2019-12-31
PUE-DIV	Water4Ever	Filipe Neves Santos	2017-04-01	2020-03-31
SERV-NAC	AutoClassII	António Paulo Moreira	2015-01-01	2018-08-31
SERV-NAC	Consultoria	António Paulo Moreira	2014-01-01	
SERV-NAC	Inspectum	Manuel Santos Silva	2016-09-01	
SERV-NAC	Palcus	Pedro Gomes Costa	2017-03-15	2018-03-14
SERV-NAC	RAIL_INSPECT	António Paulo Moreira	2016-01-01	
SERV-NAC	RIDDIG-1	Germano Veiga	2017-05-03	2018-08-31
SERV-NAC	SistemaDPA	Filipe Neves Santos	2017-05-01	2018-02-28
SERV-NAC	TEXTILPRINT	Hélio Mendonça	2016-01-04	2018-05-28
SERV-NAC	TRiHo	Germano Veiga	2016-07-01	2018-03-31
SERV-NAC	UnVirtual	Filipe Neves Santos	2017-01-01	2018-03-31
SERV-INT	DroneTool	Filipe Neves Santos	2017-11-01	2019-04-30

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.7.9 List of Publications

International Journals with Scientific Referees

1. Adao, T, Hruska, J, Padua, L, Bessa, J, Peres, E, Morais, R, Sousa, JJ, Hyperspectral Imaging: “A Review on UAV-Based Sensors, Data Processing and Applications for Agriculture and Forestry", Remote Sensing, vol.9, pp.1110, NOV, 2017
2. Arrais, R, Oliveira, M, Toscano, C, Veiga, G, “A mobile robot based sensing approach for assessing spatial inconsistencies of a logistic system", Journal of Manufacturing Systems, vol.43, pp.129-138, 2017
3. Bakon, M, Oliveira, I, Perissin, D, Sousa, JJ, Papco, J, “A Data Mining Approach for Multivariate Outlier Detection in Postprocessing of Multitemporal InSAR Results", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol.10, pp.2791-2798, JUN, 2017
4. Briga Sa, A, Boaventura Cunha, J, Lanzinha, JC, Paiva, A, “Experimental and analytical approach on the Trombe wall thermal performance parameters characterization", Energy and Buildings, vol.150, pp.262-280, 2017
5. Costa, V, Rossetti, R, Sousa, A, “Simulator for Teaching Robotics, ROS and Autonomous Driving in a Competitive Mindset", International Journal of Technology and Human Interaction, vol.13, pp.19-32, 2017
6. Eddine, BD, dos Santos, FN, Boulebtateche, B, Bensaoula, S, “EyeLSD a Robust Approach for Eye Localization and State Detection", Journal of Signal Processing Systems, pp.1-27, 2017
7. Freire, H, Moura Oliveira, PBM, Solteiro Pires, EJS, “From Single to Many-objective PID Controller Design using Particle Swarm Optimization", International Journal of Control Automation and Systems, vol.15, pp.918-932, APR, 2017
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10. Oliveira, J, Oliveira, PM, Boaventura Cunha, J, Pinho, T, “Chaos-based grey wolf optimizer for higher order sliding mode position control of a robotic manipulator", Nonlinear Dynamics, vol.90, pp.1353-1362, OCT, 2017
11. Padua, L, Hruska, J, Bessa, J, Adao, T, Martins, LM, Goncalves, JA, Peres, E, Sousa, AMR, Castro, JP, Sousa, JJ, “Multi-Temporal Analysis of Forestry and Coastal Environments Using UASs", Remote Sensing, vol.10, pp.24, 2017
12. Padua, L, Vanko, J, Hruska, J, Adao, T, Sousa, JJ, Peres, E, Morais, R, “UAS, sensors, and data processing in agroforestry: a review towards practical applications", International Journal of Remote Sensing, vol.38, pp.2349-2391, 2017

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14. Pinho, TM, Coelho, JP, Oliveira, JB, Cunha, JB, “Comparative Analysis between LDR and HDR Images for Automatic Fruit Recognition and Counting", Journal of Sensors, vol.2017, pp.1-12, 2017

15. Pinto, AM, Costa, PG, Correia, MV, Matos, AC, Moreira, AP, “Visual motion perception for mobile robots through dense optical flow fields", Robotics and Autonomous Systems, vol.87, pp.1-14, JAN, 2017

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International Conference Proceedings with Scientific Referees

1. Adao, T, Padua, L, Hruska, J, Peres, E, Sousa, JJ, Morais, R, Magalhaes, LG, “Bringing together UAS-based land surveying and procedural modelling of buildings to set up enhanced VR environments for cultural heritage", 2017 24º Encontro Português de Computação Gráfica e Interação (EPCGI), 2017

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7. César, MB, Gonçalves, J, Coelho, J, De Barros, RC, “Brain emotional learning based control of a SDOF structural system with a MR damper", Lecture Notes in Electrical Engineering, vol.402, pp.547-557, 2017

8. Coelho, JP, Gonçalves, J, Braz César, M, Dias, J, “A new plant growth system rig based on thermodynamic solar energy: A study for energy efficiency assessment", Lecture Notes in Electrical Engineering, vol.402, pp.607-616, 2017

9. Coelho, JP, Pinho, TM, Boaventura Cunha, J, de Oliveira, JB, “A new brain emotional learning Simulink ® toolbox for control systems design. This work was funded by the ERDF European Regional Development Fund through the COMPETE Programme and by Portuguese funds through the FCT Fundação para a Ciência e a Tecnologia within the project POCI-01-0145-FEDER-006961.", IFAC-PapersOnLine, vol.50, pp.16009-16014, 2017

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Books

Blank

Chapter/Paper in Books

1. Magalhães, LG, Adão, T, Peres, E, “Reconstructing the Past”, Handbook of Research on Technological Developments for Cultural Heritage and eTourism Applications - Advances in Hospitality, Tourism, and the Services Industry, pp.140-172, 2017
2. Meira, D, Magalhães, L, Pereira, F, Peres, E, “E-Commerce", Mobile Commerce, pp.59-67, 2017

PhD Theses

1. Sobreira, H., “Fiabilidade e robustez da localização de robôs móveis”

5.8 CEGI - CENTRE FOR INDUSTRIAL ENGINEERING AND MANAGEMENT

Coordinators: Ana Viana and Pedro Amorim

5.8.1 Presentation of the Centre

CEGI integrates the Cluster Industry and Innovation (I&I). This Research Centre is an international reference in business analytics, contributing also in service design, performance assessment and asset management. Business analytics is at the core of CEGI, having several researchers acting as editors of international journals (e.g., European Journal of Operations Research and International Transactions in Operational Research), the coordination of three EURO Working Groups in the fields of Retail Operations, Production Planning and Cutting Problems, and the vice-chairing of a COST Action line. In the Mobility area, CEGI includes the Portuguese delegate to the European Union Horizon 2020 committee on Smart, Green and Integrated Transport. Regarding the service design area, a CEGI member is the executive member of a global and cross-disciplinary team that defined the "Service research priorities 2015". Recently, a group of CEGI researchers were finalists of the "Wagner Prize award", for Excellence in Operations Research Practice, by The Institute for Operations Research and the Management Sciences.

Core areas of application of CEGI include Mobility/Transports, Retail/Industry and Healthcare, with significant contributions also in the Energy Sector and a strengthened collaboration with CPES. In the last years, CEGI made a substantial contribution to Industry 4.0 initiatives (improving scheduling rules based on the additional information available in manufacturing systems). In the upcoming years, the work in Industry 4.0 and the cross-fertilization of analytics fields will continue.

5.8.2 Research and Technology Development

SERVICE DESIGN

In the service design knowledge field, there are three intertwined goals to be addressed:

- Design and engineering of complex service systems and value networks, creating new services in the context of distributed and interconnected value co-creating actors, such as health care.
- Design for the customer experience, pursuing a holistic understanding of the customer experience and a human-centered design approach that continuously feeds the service design process with customer experience input.
- Design and engineering of technology enabled services, integrating multiple disciplines such as ICT (Information and Communication Technologies), Human Computer Interaction, Service Design and Service Management, to support the transition from technology development to creation of innovative services that create value for customers and organisations, particularly in the areas of mobile services, smart services, and social networks.

BUSINESS ANALYTICS

In this knowledge field, researchers design, develop and implement quantitative models, methods and tools to solve operations management problems. These problems involve different decision making procedures, planning horizons, entities and objectives, and are usually classified according to their hierarchical level:

- Strategic (e.g., Capacity Planning)
- Tactical (e.g., Resource Allocation)
- Operational (e.g., Scheduling and Control)

Focus of research is Business Intelligence and Prescriptive Analytics. Activity in Business Intelligence includes Data Mining, Data Analysis and Statistical methods (applied to companies' management). The goal is to conveniently extract knowledge from data that could be leveraged to increase, for example, revenues of a business. To that end, new analytical techniques are required. Currently, the challenges placed by large data sets lead to a redefinition of the processes of data analysis to find patterns and relationships between data elements in large and noisy data sets. Prescriptive analytics have a place of its own at CEGI. The RG is particularly focused of addressing challenges in the following four streams:

- Mathematical modelling and programming;
- Robust and efficient optimization algorithms to produce resilient solutions, adaptable to frequent changes in the operating conditions;
- Matheuristics that exploit the hybridization of mathematical programming techniques in (meta)heuristic frameworks;
- Simulation-based Optimization that integrate optimization techniques into simulation analysis.

PERFORMANCE ASSESSMENT

Regarding the performance assessment stream, there are several goals to be addressed:

- Performance assessment exploring Data Envelopment Analysis, econometric and statistical techniques.
- Development of enhanced efficiency and productivity measurement models that can identify the drivers of good performance in companies.
- Enhancement of Organisational performance in different sectors, and promotion of robust benchmarking.
- Exploration of new methodologies to assess and improve quality of life and livability of urban areas, as they are essential to the sustainable development of countries given their role in the attractiveness of human capital.

ASSET MANAGEMENT

CEGI core competences on asset management and reliability can be divided in the following two areas:

- Predictive maintenance and asset management.
- Power system planning, in particular in the development of tools for reliability analysis, for security of supply evaluation and reserves adequacy evaluation.

CEGI has been involved in several R&D projects with utilities companies in asset management. Its expertise has already been shared and discussed with several stakeholders and there is a large potential for future collaboration.

5.8.3 Technology transfer

ENERGY

The Energy sector is a core area for CEGI in terms of technology transfer. Both asset management, decision support and prescriptive analytics have been used to significantly improve processes in this industry.

RETAIL

The retail area is also a core area for CEGI. Prescriptive analytics, decision support and business analytics have contributed significantly to the advance of business processes in this area.

INDUSTRY

The Industry sector is the sector where CEGI has historically been more active, and covers both the industrial and the service sectors. CEGI provides services for this area that build on top of the distinct research areas.

HEALTHCARE

The healthcare area has evolved due to the close collaboration between CEGI and several entities of the public sector, namely hospitals and central regulatory entities.
Both Service Design and Decision Support/Prescriptive Analytics have contributed with best practices to this sector.

MOBILITY AND TRANSPORTS

CEGI has historically lead several research projects in the area of Mobility, connecting research streams so diverse as Operations Research, Human-Machine Interface and Information Technology. Recently,

CEGI has also collaborated in several Transports related projects covering mainly optimization problems in this field.

5.8.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CEGI - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development		Status (2)	Areas of Technology Transfer --> relationships (3)				
			Energy	Mobility and Transports	Retail	Industry	Health
Service Design		I	M	M	L	H	M
Business Analytics		I	H	M	H	H	H
Performance Management		I				M	M
Asset Management		I	H			M	
Other areas (1)	Energy (CPES)	O	M	L			
	Operations (CESE)	O		L (?)		M	

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship/ ontribution

5.8.5 Main Achievements in 2017

NEW MODELS FOR ENHANCING THE KIDNEY TRANSPLANTATION PROCESS (TRL 2-5)

The research behind this achievement positioned the research team as a reference group at world level in the area. Research outputs and the social impact of the project were highly valued by the scientific community and society in general, with several publications in top-ranked journals and involvement of PhD students (both national and international).

Follow-up projects ensued, including COST action ENCKEP - European Network for Collaboration on Kidney Exchange Programs, that currently involves 27 European and 4 non-European Countries. RG members are Vice-chair and Working Group leader of the Action.

MAJOR ADVANCEMENT IN FOOD SUPPLY CHAIN MANAGEMENT (TRL 2-5)

Important advances were achieved with exploratory research aimed to comprehensively address the quantitative gap in the supply chain design and planning of food industries, integrating the strategic and tactical decisions levels, by developing a framework where all key complexities of food supply chain management are accounted for.

Several relevant papers emerged in this stream; one of the key contributions made clear the importance of incorporating perishability concerns in multi-level production planning. This achievement is in line with a previous one in which it was proved that to perform better supplier selection in the process food industry, improving profit and customer service level, local food suppliers have to be deeply involved.

MAJOR IMPACT ACHIEVED IN NETWORK DESIGN OF A PHARMACEUTICAL WHOLESALER (TRL 3-7)

Substantial economic gains were attained by a pharmaceutical wholesaler through the application of the recommendations emerging from R&D led by CEGI.

Pharmaceutical wholesales have to deal with a complex distribution network with multiple distribution centers, different temperature requirements, and a vast range of product formats. CEGI used an optimization-simulation approach to help a pharmaceutical wholesaler make the best decisions regarding product-warehouse-outlet assignment, product delivery modes planning and fleet sizing.

This achievement was built upon new routing algorithms - Adaptive Large Neighborhood Searches - that were developed by researchers from CEGI and published in leading journals, advancing the state-of-the-art in optimization-simulation approaches. This applied research also lead to a publication that appeared in 2017.

CONSOLIDATION OF THE ASSET MANAGEMENT AREA (TRL 6-7)

In 2017, the area of Asset Management increased and consolidated its collaboration with several industrial partners. It successfully contributed with relevant technology transfer to companies such as EDP Distribuição and REN Portgás.

The projects addressed included the implementation of a risk-based maintenance strategy for the gas distribution network and the estimation of health indexes for power transformers combining expert knowledge and quantitative methods. There is one ongoing PhD in the area and two MSc.

PRIZES

Three prizes awarded to CEGI researchers by the Portuguese Society for Operations Research:

1. Prize Isabel Themido, for best paper in Operations Research: “Robust mixed-integer linear programming models for the irregular strip packing problem”, http://doi.org/10.1016/j.ejor.2016.03.009).
2. Prize APDIO/IO2017, for best PhD thesis: ex-aequo for Maria Margarida da Silva Carvalho - “Computation equilibria on integer programming games”, and António Galrão Ramos - “Analysis of cargo stability in container transportation”.
3. Prize Augusto Queiróz Novais in “Process Systems Engineering” (honorable mention) for “A decision support system for the operational production planning and scheduling of an integrated pulp and paper mill”, http://doi.org/10.1016/j.compchemeng.2015.03.017

5.8.6 Centre Organisational Structure and Research Team

The Centre for Industrial Engineering and Management is coordinated by Ana Viana and Pedro Amorim and is organised in the following Areas:

- Service Design - Responsible: Lia Patrício and Jorge Teixeira
- Performance Assessment - Responsible: Ana Camanho
- Asset Management: Luis Guimarães Business Intelligence - Responsible: José Luís Borges and Vera Miguéis
- Business Analytics - Responsible: José Fernando Oliveira, João Pedro Pedroso

Moreover, there is an advisory board to assist the coordination.

The evolution of the Centre research team from 2015 to 2017 is presented in Table 5.2.

Table 5.2 - CEGI - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees				
		Academic Staff	19	19	19	
		Grant Holders and Trainees	25	34	37	3
		Total Core Researchers	**44**	**53**	**56**	**3**
		Total Core PhD	**24**	**29**	**28**	**-1**
	Affiliated Researchers		4	3	5	2
	Admin. & Tech	Employees			1	1
		Grant Holders and Trainees				
		Total Admin and Tech			1	1
	Total Integrated HR		**48**	**56**	**62**	**2**
	Total Integrated PhD		**28**	**32**	**33**	**1**
Curricular Trainees			12	5	3	-2
External Research Collaborators			10	8	10	2
External Administrative and Technical Staff			2	2	2	
External Students			1	3	5	2
Total			**73**	**74**	**82**	**8**

5.8.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - CEGI - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	18	24	115	91
PN-PICT	National R&D Programmes - S&T Integrated Projects	25	65	162	97
PN-COOP	National Cooperation Programmes with Industry			10	10
PUE-FP	EU Framework Programmes	19	43	11	-32
PUE-DIV	EU Cooperation Programmes - Other				
SERV-NAC	R&D Services and Consulting - National	330	181	150	-30
SERV-INT	R&D Services and Consulting - International	36			
OP	Other Funding Programmes			22	22
Closed Projects			55		-55
Total Funding		**428**	**367**	**471**	103

Table 5.4-CEGI - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	32	32	34
International conference proceedings indexed by ISI, Scopus or DBLP	16	16	13
Books (author)			1
Chapter/paper in books	8	5	2
PhD theses concluded by members of the Centre	6	3	4
Concluded PhD theses supervised by members of the Centre	9	4	7

Table 5.5-CEGI - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	0
Patent applications	0
Licence agreements	1

Table 5.6-CEGI - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	7
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	7
International events in which INESC TEC members participate in the program committees	18
Participation in events such as fairs, exhibitions or similar	0
Advanced training courses	1

5.8.8 List of Projects

Table 5.7-CEGI - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	DM4Manufacturing-2	Pedro Amorim	2016-11-01	2019-10-31
PN-FCT	EasyFlow-1	Pedro Amorim	2016-06-01	2019-05-31
PN-FCT	HHRPLAN	Almada Lobo	2016-04-01	2018-09-30
PN-FCT	mKEP	Ana Viana	2016-04-01	2019-03-31
PN-PICT	CORAL-TOOLS-6	João Pedro Pedroso	2016-01-01	2018-12-31
PN-PICT	iMAN-2	Luís Guimarães	2015-07-01	2018-12-31

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-PICT	SMILES-8	João Pedro Pedroso	2015-07-01	2018-12-31
PN-COOP	KnowLOGIS	Ana Viana	2017-04-01	2019-09-27
PUE-FP	UPGRID-1	Lia Patrício	2015-01-01	2018-03-31
SERV-NAC	ANPCARE	Mário Amorim Lopes	2017-04-26	
SERV-NAC	BestWare	Pedro Amorim	2015-03-01	
SERV-NAC	Consultoria	Almada Lobo	2014-01-01	
SERV-NAC	LTP	Gonçalo Reis Figueira	2016-01-01	2017-08-31
SERV-NAC	Path	Luís Guimarães	2017-01-01	
SERV-NAC	PricingSdL	Maria Antónia Carravilla	2017-01-28	2018-04-30
SERV-NAC	SIMOPT	Ana Viana	2017-01-01	
SERV-NAC	UPGASII	Luís Guimarães	2017-06-26	2018-06-08
SERV-NAC	WinePallet	Elsa Marília Silva	2017-09-19	
OP	Atena	Maria Antónia Carravilla	2016-10-14	2019-10-13
OP	Euro2017	Pedro Amorim	2016-11-01	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.8.9 List of Publications

International Journals with Scientific Referees

1. Arabi, B, Doraisamy, SM, Emrouznejad, A, Khoshroo, A, “Eco-efficiency measurement and material balance principle: an application in power plants Malmquist Luenberger Index", Annals of Operations Research, vol.255, pp.221-239, AUG, 2017
2. Azevedo, I, Horta, I, Leal, VMS, “Analysis of the relationship between local climate change mitigation actions and greenhouse gas emissions - Empirical insights", Energy Policy, vol.111, pp.204-213, DEC, 2017
3. Baldo, TA, Morabito, R, Santos, MO, Guimarães, L, “Alternative Mathematical Models and Solution Approaches for Lot-Sizing and Scheduling Problems in the Brewery Industry: Analyzing Two Different Situations", Mathematical Problems in Engineering, vol.2017, pp.1-18, 2017
4. Beirao, G, Patricio, L, Fisk, RP, “Value cocreation in service ecosystems Investigating health care at the micro, meso, and macro levels", Journal of Service Management, vol.28, pp.227-249, 2017

5. Carneiro, N, Figueira, G, Costa, M, “A data mining based system for credit-card fraud detection in e-tail", Decision Support Systems, vol.95, pp.91-101, MAR, 2017

6. Carvalho, M, Lodi, A, Pedroso, JP, Viana, A, “Nash equilibria in the two-player kidney exchange game", Mathematical Programming, vol.161, pp.389-417, JAN, 2017

7. Costa, N, Patricio, L, Morelli, N, Magee, CL, “Bringing Service Design to manufacturing companies: Integrating PSS and Service Design approaches", Design Studies, 2017

8. de Armas, J, Juan, AA, Marques, JM, Pedroso, JP, “Solving the deterministic and stochastic uncapacitated facility location problem: from a heuristic to a simheuristic", Journal of the Operational Research Society, vol.68, pp.1161-1176, OCT, 2017

9. Gdowska, K, Ksiazek, R, “A Random Search Algorithm for Cyclic Delivery Synchronization Problem", LOGFORUM, vol.13, pp.263-272, 2017

10. Horta, IM, Keirstead, J, “Downscaling Aggregate Urban Metabolism Accounts to Local Districts", Journal of Industrial Ecology, vol.21, pp.294-306, APR, 2017

11. Laengle, S, Merigo, JM, Miranda, J, Slowinski, R, Bomze, I, Borgonovo, E, Dyson, RG, Oliveira, JF, Teunter, R, “Forty years of the European Journal of Operational Research: A bibliometric overview", European Journal of Operational Research, vol.262, pp.803-816, 2017

12. Magalhaes, SMC, Leal, VMS, Horta, IM, “Modelling the relationship between heating energy use and indoor temperatures in residential buildings through Artificial Neural Networks considering occupant behavior", Energy and Buildings, vol.151, pp.332-343, 2017

13. Mairesse Siluk, JCM, Kipper, LM, Benitez Nara, EOB, Neuenfeldt Junior, AL, Dal Forno, AJ, Soliman, M, da Silva Chaves, DMD, “A performance measurement decision support system method applied for technology-based firms suppliers", Journal of Decision Systems, vol.26, pp.93-109, 2017

14. Martins, S, Amorim, P, Figueira, G, Almada Lobo, B, “An optimization-simulation approach to the network redesign problem of pharmaceutical wholesalers", Computers & Industrial Engineering, vol.106, pp.315-328, APR, 2017

15. Migueis, VL, Camanho, AS, Borges, J, “Predicting direct marketing response in banking: comparison of class imbalance methods", Service Business, vol.11, pp.831-849, DEC, 2017

16. Migueis, VL, Novoa, H, “Exploring Online Travel Reviews Using Data Analytics: An Exploratory Study", Service Science, vol.9, pp.315-323, 2017

17. Mundim, LR, Andretta, M, Carravilla, MA, Oliveira, JF, “A general heuristic for two-dimensional nesting problems with limited-size containers", International Journal of Production Research, pp.1-24, 2017

18. Neto, T, Constantino, M, Martins, I, Pedroso, JP, “Forest harvest scheduling with clearcut and core area constraints", Annals of Operations Research, vol.258, pp.453-478, NOV, 2017

19. Oliveira, BB, Carravilla, MA, Oliveira, JF, “Fleet and revenue management in car rental companies: A literature review and an integrated conceptual framework", Omega-International Journal of Management Science, vol.71, pp.11-26, SEP, 2017

20. Oliveira, MM, Camanho, AS, Walden, JB, Migueis, VL, Ferreira, NB, Gaspar, MB, “Forecasting bivalve landings with multiple regression and data mining techniques: The case of the Portuguese Artisanal Dredge Fleet", Marine Policy, vol.84, pp.110-118, OCT, 2017

21. Oliveira, R, Camanho, AS, Zanella, A, “Expanded eco-efficiency assessment of large mining firms", Journal of Cleaner Production, vol.142, pp.2364-2373, 2017

22. Paquay, C, Limbourg, S, Schyns, M, Oliveira, JF, “MIP-based constructive heuristics for the three-dimensional Bin Packing Problem with transportation constraints", International Journal of Production Research, pp.1-12, 2017

23. Pires, M, Pratas, J, Liz, J, Amorim, P, “A framework for designing backroom areas in grocery stores", International Journal of Retail & Distribution Management, vol.45, pp.230-252, 2017

24. Ramos, AG, Leal, J, “ILP model for energy-efficient production scheduling of flake ice units in food retail stores", Journal of Cleaner Production, vol.156, pp.953-961, 2017

25. Ramos, AG, Silva, E, Oliveira, JF, “A new Load Balance Methodology for Container Loading Problem in Road Transportation", European Journal of Operational Research, 2017

26. Real, AC, Borges, J, Cabral, JS, Jones, GV, “A climatology of Vintage Port quality", International Journal of Climatology, vol.37, pp.3798-3809, AUG, 2017

27. Santos, C, Mehrsai, A, Barros, AC, Araújo, M, Ares, E, “Towards Industry 4.0: an overview of European strategic roadmaps", Procedia Manufacturing, vol.13, pp.972-979, 2017

28. Santos, N, Tubertini, P, Viana, A, Pedroso, JP, “Kidney exchange simulation and optimization", Journal of the Operational Research Society, vol.68, pp.1521-1532, DEC, 2017

29. Silva, MC, Horta, IM, Leal, V, Oliveira, V, “A spatially-explicit methodological framework based on neural networks to assess the effect of urban form on energy demand", Applied Energy, vol.202, pp.386-398, 2017

30. Teixeira, JG, Patricio, L, Huang, KH, Fisk, RP, Nobrega, L, Constantine, L, “The MINDS Method: Integrating Management and Interaction Design Perspectives for Service Design", Journal of Service Research, vol.20, pp.240-258, AUG, 2017

31. Teles, MD, de Sousa, JF, “Linking fields with GMA: Sustainability, companies, people and Operational Research", Technological Forecasting and Social Change, 2017

32. Vogel, T, Almada Lobo, B, Almeder, C, “Integrated versus hierarchical approach to aggregate production planning and master production scheduling", OR Spectrum, vol.39, pp.193-229, JAN, 2017

33. Wei, WC, Guimaraes, L, Amorim, P, Almada Lobo, B, “Tactical production and distribution planning with dependency issues on the production process", Omega-International Journal of Management Science, vol.67, pp.99-114, MAR, 2017

34. Witell, L, Gebauer, H, Jaakkola, E, Hammedi, W, Patricio, L, Perks, H, “A bricolage perspective on service innovation", Journal of Business Research, vol.79, pp.290-298, OCT, 2017

International Conference Proceedings with Scientific Referees

1. Araujo, T, Aresta, G, Lobo, BA, Mendonça, AM, Campilho, AJC, “Improving convolutional neural network design via variable neighborhood search", Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), vol.10317 LNCS, pp.371-379, 2017

2. De Fátima Teles, M, De Sousa, JF, “A General Morphological Analysis to Support Strategic Management Decisions in Public Transport Companies", Transportation Research Procedia, vol.22, pp.509-518, 2017

3. Ferreira, MC, Costa, V, Dias, TG, Falcão E Cunha, J, “Understanding commercial synergies between public transport and services located around public transport stations", Transportation Research Procedia, vol.27, pp.125-132, 2017

4. Ferreira, MC, Fontes, T, Costa, V, Dias, TG, Borges, JL, Falcao e Cunha, JFE, “Evaluation of an integrated mobile payment, route planner and social network solution for public transport", 3RD Conference on Sustainable Urban Mobility (3rd CSUM 2016), vol.24, pp.189-196, 2017

5. Fontes, T, Correia, J, De Sousa, JP, De Sousa, JF, Galvão, T, “A Multi-User Integrated Platform for Supporting the Design and Management of Urban Mobility Systems", Transportation Research Procedia, vol.27, pp.35-42, 2017

6. Fontes, T, Costa, V, Ferreira, MC, Li, SX, Zhao, PJ, Dias, TG, “Mobile payments adoption in public transport", 3rd Conference on Sustainable Urban Mobility (3RD CSUM 2016), vol.24, pp.410-417, 2017
7. Hora, J, Dias, TG, Camanho, A, Sobral, T, “Estimation of Origin-Destination matrices under Automatic Fare Collection: The case study of Porto transportation system", Transportation Research Procedia, vol.27, pp.664-671, 2017
8. Mehrsai, A, Figueira, G, Santos, N, Amorim, P, Almada Lobo, B, “Decentralized Vs. Centralized Sequencing in a Complex Job-Shop Scheduling", IFIP Advances in Information and Communication Technology, vol.513, pp.467-474, 2017
9. Morais, P, Migueis, VL, Camanho, A, “Exploring the relationship between corruption and health care services, education services and standard of living", Lecture Notes in Business Information Processing, vol.279, pp.87-100, 2017
10. Ramos, AG, Jacob, J, Justo, JF, Oliveira, JF, Rodrigues, R, Gomes, AM, “Cargo dynamic stability in the container loading problem - a physics simulation tool approach", International Journal of Simulation and Process Modelling, vol.12, pp.29-41, 2017
11. Santos Pereira, C, Cruz Correia, R, Brito, AC, Augusto, AB, Correia, ME, Bento, MJ, Antunes, L, “A qualitative research evaluation of a Portuguese computerized cancer registry", Iberian Conference on Information Systems and Technologies, CISTI, 2017
12. Silva, DV, Migueis, VL, “Combining data analytics with layout improvement heuristics to improve libraries service quality", Lecture Notes in Business Information Processing, vol.279, pp.223-234, 2017
13. Sobral, T, Galvao, T, Borges, J, “Semantic integration of urban mobility data for supporting visualization", 3rd Conference on Sustainable Urban Mobility (3rd CSUM 2016), vol.24, pp.180-188, 2017

Books

1. Sarmento, R, Costa, V, “Comparative approaches to using R and Python for statistical data analysis", Comparative Approaches to Using R and Python for Statistical Data Analysis, pp.1-197, 2017

Chapter/Paper in Books

1. Dragoicea, M, Falcao e Cunha, J, Alexandru, MV, Constantinescu, DA, “Modelling and Simulation Perspective in Service Design", Handbook of Research on Strategic Alliances and Value Co-Creation in the Service Industry - Advances in Hospitality, Tourism, and the Services Industry, pp.374-399, 2017
2. Horta, IM, Varum, C, “Evaluation of Strengthening Techniques Using Enhanced Data Envelopment Analysis Models", Strengthening and Retrofitting of Existing Structures - Building Pathology and Rehabilitation, pp.321-334, 2017

PhD Theses

1. Brandão, F., “Cutting & Packing Problems: General Arc-flow Formulation with Graph Compression”
2. Costa, N., “Designing Product-Service System solutions for value co-creation - Integrating Product-Service System and Service Design approaches”
3. Curcio, E., “Integrating Lot-Sizing Problems Under Uncertainty”
4. Lopes, M., “Assessing and planning for the future needs of the health care workforce”

5.9 CITE - CENTRE FOR INNOVATION, TECHNOLOGY AND ENTREPRENEURSHIP

Coordinator: Alexandra Lobo Xavier

5.9.1 Presentation of the Centre

CITE is part of the Cluster Industry and Innovation. CITE's specific expertise in Innovation and Technology Management & Policy and Technology Entrepreneurship, fosters a crosscutting approach to all INESC TEC's Clusters. CITE's activities promote the development of conceptual frameworks, methodologies and tools used both in advanced consulting and executive training programs for private and public organizations.

The CITE was created in 2007 to consolidate the significant investments and experience of INESC Porto in the development of internal processes and tools to manage R&D results, and organize the resulting knowledge and competences in order to enable a higher level of responsibility and leadership of the process of knowledge valorisation. In this context, the main goal of the Group at the time of its creation was to develop and promote innovation management practices, acting directly in the internal processes, and supporting entrepreneurship activities helping business development as well as incubation.

CITE relies on state-of-art methodologies and tools and experienced partners to build the best approaches to innovation and technology management and technology entrepreneurship, contributing towards the economic and social development of society.

CITE has been developing and exploiting a set of national and international research opportunities in the area of Innovation and Technology Management and Technology Entrepreneurship. A collaboration with international partners such as EASME, ISO/TC 279 - Innovation Management; UT Austin Portugal ; MIT Portugal in Engineering Systems and Carnegie Mellon Portugal in Engineering and Public Policy have been stablished and several projects emerge from those collaborations.

5.9.2 Research and Technology Development

Innovation and Technology Management:

Innovation and technology management is widely recognized as a key issue in strategic approach and management efforts of any organization. It has become an area of interest from academia and industry.

Following the trend and with a focus on technological innovation, CITE research activities aims to continue develop a better understanding of innovation as well as management process and tools that can enable innovation capabilities and practices in all type of organizations.

Building on its recognition for experience and knowledge in Innovation and Technology Management, CITE had continued to carry out consulting services and executive training to all type of organizations on this area. As an evolution, CITE develop a set of tools and workshop models focus on ideation and concept development, using user center methodologies, problem solving approaches and trends analysis.

The main research and innovation areas are focus on:

- Better understanding of innovation management practices, process and tools;
- Development of innovative frameworks to measure innovation;
- Development of ideation methodologies and tools based on user centered innovation and problem solving approaches;
- Combination of methods and tools based on advanced concepts in various areas, such as, business integration, information and communication technologies and business analysis and modelling, to develop multidisciplinary approaches suited to the Fuzzy Front End of Innovation.
- look into the ways companies create, appropriate, and deliver value from technology, to improve the understanding of how it can be used to create and sustain competitive advantage;
- study strategies and policies for the use and control of technology for the benefit of communities; priority is to be given to the design of complex networked infrastructures with flexibility, to

enhance their performance in relation to uncertain future conditions of operation, and to improving methods for the design of engineering systems aiming at achieving a better integration of engineering, management and social sciences aspects that are traditionally considered individually.

Technology Entrepreneurship

Improving the knowledge of how new technological businesses form, survive and grow; a focus is placed on understanding the factors that support, delay, or block entrepreneurial intentions and activities of university researchers, in the earliest stages of entrepreneurial ventures, and the ways different organisational solutions, such as pre-incubation and proof-of-concept centres address the equity gap problem in the early stages of commercialisation:

- Definition and implementation of acceleration programmes supported by new methodologies and tools to foster the development of technological entrepreneurial projects;
- Create entrepreneurial awareness through the organization of training actions, development of tools, and giving direct support to entrepreneurs in the process of turning ideas and technologies into business;
- Develop open innovation approaches to facilitate the relationship between companies and researchers, in order to facilitate knowledge and technology exploitation.

Complementing the technology management focus on how technology is delivered to customers, there is a second focus on the way operations are organized by academic spin-offs to be able to properly create, appropriate and deliver the value to customers, and how they change along the several stages of evolution of the start-ups as its business model is adapted to achieve the best product-market fit.

5.9.3 Technology transfer

LET in: An umbrella project for Technology Entrepreneurship

Following the strategy that begins in 2007 for promoting academic entrepreneurship, LET-in is INESC TEC's proof of concepts innovation lab which develop a range of activities from R&D to accelerators programmes to mentor and coach technology-based projects with high innovation profile.

Building long term experience through systematic collaboration, LET-In is a service promoted by CITE that offers mentoring, coaching, technological and business consultancy, supporting the development of technology-based entrepreneurial projects related to the institution's core areas.

Executive programmes

CITE's R&D activities related to technology entrepreneurship result in the design of new conceptual frameworks, tools, and executive programs to be provided to private and public organizations fostering their innovation potential.

CITE's R&D activities related to technology management result in the design of new conceptual frameworks, tools, and executive programs to be provided to private and public organizations.

Consulting

CITE's R&D activities related to innovation management result in the design of new conceptual frameworks, tools, to be applying by our consulting team to private and public organizations.

EEN Portugal and EEN Innovation

Participate in European Enterprise Network to facilitate the access of SMEs to international markets and to enhance their innovation capacities.

Innovation Labs

CITE will go on organizing Innovation Labs for companies interested in strengthening their innovation culture and innovation management process or new concepts for products, services and business models.

5.9.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CITE - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development	Areas of Technology Transfer --> relationships (3)					
	Status (2)	LET IN	Executive programmes	EEN Portugal and EEN Innovation	Innovation Labs	Consulting
Innovation Management	I	M	H	H	M	H
Technology Management	I	M	L	M	L	F
Technology Entrepreneurship	I/E	H	M	M	M	M

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.9.5 Main Achievements in 2017

LET in: An umbrella project for Technology Entrepreneurship

Following the strategy that begins in 2007 for promoting academic entrepreneurship, LET-in is INESC TEC's proof of concepts innovation lab which develop a range of activities from R&D to accelerators programmes to mentor and coach technology-based projects with high innovation profile.

Building long term experience through systematic collaboration, LET-In is a service promoted by CITE that offers mentoring, coaching, technological and business consultancy, supporting the development of technology-based entrepreneurial projects related to the institution's core areas.

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CITE's R&D activities related to technology management result in the design of new conceptual frameworks, tools, and executive programs to be provided to private and public organizations.

Consulting

CITE's R&D activities related to innovation management result in the design of new conceptual frameworks, tools, to be applying by our consulting team to private and public organizations.

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Innovation Labs

CITE will go on organizing Innovation Labs for companies interested in strengthening their innovation culture and innovation management process or new concepts for products, services and business models.

5.9.6 Centre Organisational Structure and Research Team

The Centre CITE is coordinated by Alexandra Xavier and is organised in the following areas:

- Innovation Management - Responsible: Alexandra Xavier & João José Pinto Ferreira
- Technology Management - Responsible: João Claro
- Technology Entrepreneurship - Responsible: Alexandra Xavier & João Claro

The Centre research team present composition and evolution is presented in Table 5.2.

Table 5.2 - CITE- Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	2	2	3	1
		Academic Staff	1	1	1	
		Grant Holders and Trainees	5	4	5	1
		Total Core Researchers	**8**	**7**	**9**	**2**
		Totel Core PhD	**2**	**2**	**4**	**2**
	Affiliated Researchers		6	6	7	1
	Admin.& Tech	Employees				
		Grant Holders and Trainees				
		Total Admin and Tech				
	Total Integrated HR		**14**	**13**	**16**	**3**
	Total Integrated PhD		**6**	**6**	**10**	**4**
Curricular Trainees			2	1	3	2
External Research Collaborators			2	6	6	
External Administrative and Technical Staff						
External Students			4	6	1	-5
Total			**22**	**26**	**26**	

5.9.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS

and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3-CITE - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	2			
PN-PICT	National R&D Programmes - S&T Integrated Projects		12	33	21
PN-COOP	National Cooperation Programmes with Industry				
PUE-FP	EU Framework Programmes	31	46	54	8
PUE-DIV	EU Cooperation Programmes - Other	53	34	36	3
SERV-NAC	R&D Services and Consulting - National	63	3	37	33
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes		17	126	109
Closed Projects		-5	-5	12	
	Total Funding	**144**	**123**	**286**	**163**

Table 5.4-CITE - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	7	8	19
International conference proceedings indexed by ISI, Scopus or DBLP	1		2
Books (author)	1		0
Chapter/paper in books	3	2	2
PhD theses concluded by members of the Centre		2	3
Concluded PhD theses supervised by members of the Centre	3	2	3

Table 5.5-CITE - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	0
Patent applications	0
Licence agreements	0

Table 5.6-CITE - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	1
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	0
International events in which INESC TEC members participate in the program committees	1
Participation in events such as fairs, exhibitions or similar	2
Advanced training courses	3

5.9.8 List of Projects

Table 5.7-CITE - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	SCREEN-DR-1	Catarina Maia	2016-04-01	2020-03-31
PN-FCT	VR2Market-2	Catarina Maia	2014-07-15	2018-12-31
PN-PICT	CORAL-SENSORS-2	João Claro	2016-01-01	2018-12-31
PN-PICT	FOUREYES-1	João Claro	2015-07-01	2018-12-31
PN-PICT	iMAN-1	João Claro	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL1-2	João Claro	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL2-1	João Claro	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL3-1	João Claro	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL4-1	João Claro	2015-07-01	2018-12-31
PN-PICT	SMILES-2	João Claro	2015-07-01	2018-12-31
PUE-FP	EEN-InnovatePT	Alexandra Xavier	2017-01-01	2018-12-31
PUE-FP	SafeCloud-1	João Claro	2015-09-01	2018-08-31
PUE-DIV	EEN2017/2018	Alexandra Xavier	2017-01-01	2018-12-31
PUE-DIV	ScaleUp-PORTUGAL	Alexandra Xavier	2017-07-01	2018-12-31
PUE-DIV	TouriSMEShare	Alexandra Xavier	2017-12-15	2019-11-30
SERV-NAC	Consultoria	Alexandra Xavier	2008-01-01	
OP	BIP	Alexandra Xavier	2016-02-01	2018-05-31
OP	IN&OUT	Alexandra Xavier	2015-12-01	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.9.9 List of Publications

International Journals with Scientific Referees

1. Almeida, AIS, Teixeira, AAC, “On the work values of entrepreneurs and non-entrepreneurs: A european longitudinal study", Journal of Developmental Entrepreneurship, vol.22, pp.1750010, 2017
2. Almeida, F, Monteiro, JA, “Approaches and Principles for UX Web Experiences: A Case Study Approach", International Journal Of Information Technology And Web Engineering, vol.12, pp.49-65, 2017
3. Almeida, F, Monteiro, JA, “The role of responsive design in web development", Webology, vol.14, pp.48-65, 2017
4. Almeida, F, Silva, P, Leite, J, “Proposal of a carsharing system to improve urban mobility", Theoretical and Empirical Researches in Urban Management, vol.12, pp.32-44, 2017
5. Almeida, FL, Santos, JD, Monteiro, JA, “A survey of innovation performance models and metrics", Journal of Applied Economic Sciences, vol.12, pp.1732-1750, 2017
6. da Silva, MR, Linhares, D, Vasconcelos, DM, Alves, CJ, Neves, N, Costa, G, Lamghari, M, “Neuroimmune expression in hip osteoarthritis: a systematic review", Bmc Musculoskeletal Disorders, vol.18, 2017
7. Dias, A, Teixeira, AAC, “The anatomy of business failure A qualitative account of its implications for future business success", European Journal Of Management And Business Economics, vol.26, pp.2-20, 2017
8. Ferreira, J, Almeida, F, Monteiro, J, “Building an Effective Data Warehousing for Financial Sector", CoRR, vol.abs/1709.05874, pp.16-25, 2017
9. Governo, F, Teixeira, AAC, Brochado, AM, “Social Multimedia Computing: An Emerging Area of Research and Business for Films", Journal Of Creative Communications, vol.12, pp.31-47, MAR, 2017
10. Jimenez, E, Claro, J, de Sousa, JP, de Neufville, R, “Dynamic evolution of European airport systems in the context of Low-Cost Carriers growth", Journal Of Air Transport Management, vol.64, pp.68-76, SEP, 2017
11. Nagarajan, R, Teixeira, AAC, Silva, S, “The Impact Of Population Ageing On Economic Growth: A Bibliometric Survey", Singapore Economic Review, vol.62, pp.275-296, JUN, 2017
12. Oliveira, TM, Guiomar, N, Oliveira Baptista, FO, Pereira, JMC, Claro, J, “Is Portugal's forest transition going up in smoke?", Land Use Policy, vol.66, pp.214-226, JUL, 2017
13. Renuga Nagarajan, N, Teixeira, AAC, Silva, ST, “An Empirical Analysis of the Demographic Trends in Least Developed Countries", Ageing International, pp.1-23, 2017
14. Schell, KR, Claro, J, Guikema, SD, “Probabilistic cost prediction for submarine power cable projects", International Journal Of Electrical Power & Energy Systems, vol.90, pp.1-9, SEP, 2017
15. Teixeira, AAC, Forte, RP, “Prior education and entrepreneurial intentions: the differential impact of a wide range of fields of study", Review Of Managerial Science, vol.11, pp.353-394, MAR, 2017
16. Teixeira, AAC, Renuga Nagarajan, N, Silva, ST, “The Impact of Ageing and the Speed of Ageing on the Economic Growth of Least Developed, Emerging and Developed Countries, 1990-2013", Review of Development Economics, vol.21, pp.909-934, 2017
17. Teixeira, AAC, Sharifu, HA, “Female Entrepreneurship And Access To Bank Loans In Tanzania: A Double-Hurdle Model Approach", Journal Of Developmental Entrepreneurship, vol.22, SEP, 2017
18. Teixeira, AAC, Vieira, PC, Abreu, AP, “Sleeping Beauties and their princes in innovation studies", Scientometrics, vol.110, pp.541-580, FEB, 2017

19. van Kemenade, T, Teixeira, AAC, “Policy Stringency And (Eco)-Innovation Performance: A Cross Country Analysis", Risus-Journal On Innovation And Sustainability, vol.8, pp.34-55, 2017

International Conference Proceedings with Scientific Referees

1. Barros, AC, Simões, AC, Toscano, C, Marques, A, Rodrigues, JC, Azevedo, A, “Implementing cyber-physical systems in manufacturing", Proceedings of International Conference on Computers and Industrial Engineering, CIE, 2017
2. Simas, O, Rodrigues, JC, “The implementation of industry 4.0: A literature review", Proceedings of International Conference on Computers and Industrial Engineering, CIE, 2017

Books

Blank

Chapter/Paper in Books

1. Almeida, F, Simões, J, Serious Games in Entrepreneurship Education", “Encyclopedia of Information Science and Technology“, Fourth Edition, pp.800-808, 2017
2. Teixeira, AAC, “The economic performance of Portuguese academic spin-offs: Do science & technology infrastructures and support matter?", The World Scientific Reference on Entrepreneurship, vol.4-4, pp.281-308, 2017

PhD Theses

1. Loureiro, M., “Transmission and interconnection planning in power systems: Contributions to investment under uncertainty and cross-border cost allocation”
2. Pacheco, A., “Flexible design of forest fire management systems”
3. Pereira, A., “Shaping an Integrative Front End of Innovation (FEI) in a Design Science Approach”

5.10 CSIG - CENTRE FOR INFORMATION SYSTEMS AND COMPUTER GRAPHICS

Coordinators: António Gaspar and Ângelo Martins

5.10.1 Presentation of the Centre

The Centre for Information Systems and Computer Graphics (CSIG) mission, accomplished within the Computer Science Cluster, is to pursue high quality research, strongly linked to industrial partnerships, consultancy and technology transfer, in five main areas: Computer Graphics and Virtual Environments, Information Management and Information Systems, Software Engineering, Accessibility and Assistive Technologies and Special Purpose Computing Systems/Embedded Systems.

The Centre excels in Systems Engineering (SysE) and technology transfer, taking the central role of systems architect and integrator in a wide range of international and national projects and as contractor.

The Centre 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 Centre is also strongly committed to the training of young researchers and professionals.

Presently its researchers originate from the University of Porto, Polytechnic of Porto, University of Trás-os-Montes e Alto Douro, Universidade Aberta and University of Minho.

5.10.2 Research and Technology Development

Computer Graphics and Virtual Environments

The Computer Graphics and Virtual Environments research area is focused on Image Synthesis and Visual Perception, Human Computer Interaction, Geospatial Systems, Virtual Environments and Digital Games.

In the area of Virtual Environments, the main focus of research is Multisensory Virtual Reality, Augmented Reality, Multimodal Interaction, Procedural Modelling of Urban Environments and Virtual Environments for Learning/Training.

In the area of Digital Games, special focus has been given to Serious Games, particularly in training, education and health. This includes Authoring tools, Procedural Content Generation, Pervasive/Location-based Games and Game/Learning Analytics.

Within Geospatial Systems, research topics include geospatial and sensor Web semantics, time-space rationalisation and visualisation, which can be applied in spatial data infrastructures and environment sensor networks, as well as Ambient Assisted Living.

There are also two transversal areas of research regarding Usability, User Experience and Parallel Processing and GPU programming.

Information Management and Information Systems

The Information Management and Information Systems research area has its research focus in the areas of Information Management, Information Retrieval, Information Processing, Digital Preservation and Research Data Management. These areas include work in frameworks for information management, retrieval and processing in contexts such as Web Mining, Social Web, Semantic Web, and Text Mining for Health. Work in digital preservation includes models, methods and tools for digital preservation, particularly in the area of Database Preservation, Research Data Repository Management and e-Science.

Software Engineering

The Software Engineering research area is focused in the areas of Software Test Automation, Software Process Engineering and Knowledge Management, Software Architecture and Design, and Gamification in software engineering. This area includes work on automated pattern-based testing of interactive applications (mobile, web and desktop), model-based development and testing of real-time distributed and heterogeneous systems for IoT, automated software process performance analysis and improvement recommendation, recommender systems for requirements maintenance, platforms for

collaborative framework understanding, software documentation with adaptive software artefacts, and serious games for software engineering education.

Accessibility and Assistive Technologies

The Accessibility and Assistive Technologies research area investigates in the domain of Human Computer Interaction in particular the areas of Accessibility, Usability, Assistive and Collaborative Technologies, Sports, health and wellbeing. This research area includes the design and development of technologies to help people with special needs, with particular focus on people with disabilities and the elderly, enhancing their life and autonomy, health and wellbeing.

Special Purpose Computing Systems/Embedded Systems

The Special Purpose Computing Systems area focuses its activities on research and development of Domain-Specific Languages, tools, and methods, to develop and map applications to heterogeneous computer architectures consisting of multi-/many-cores and hardware accelerators. The research mainly addresses compiler transformations and the efficient mapping (in terms of performance, power and energy consumptions) of computations to hardware accelerators using GPGPUs and FPGAs.

5.10.3 Technology transfer

Advanced ICT Consulting

Advanced ICT consulting activities are performed typically for enterprises and institutions that require technical support in their decision processes or for coordinating complex projects. Whenever needed, additional competences from other INESC TEC Centres are incorporated.

Innovative Systems Development

These activities take place whenever a partner has specific systems development needs not addressed by the market and requiring an innovative approach. It has been mostly based on competencies in information systems and software engineering, but a large involvement is foreseen in the use of multisensorial immersive virtual reality systems.

The main areas of technology transfer have been public administration, namely local authorities and transport, particularly ports.

5.10.4 Knowledge valorisation chain

The following table presents the contribution of the “Research and Technology” areas to the “Technology Transfer” areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CSIG - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development		Status (2)	Areas of Technology Transfer --> relationships (3)	
			Advanced ICT Consulting	Innovative Systems Development
Computer Graphics and Virtual Environments		I	H	H
Software Engineering		I	H	H
Information Management and Systems		I	H	H
Accessibility		I	L	M
Special Purpose Computing Systems		I	L	M
Other areas (1)	Communication Networks (CTM)	O	M	-
	Machine Learning	O	-	M

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) “blank” - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.10.5 Main Achievements in 2017

FCT funded research was reinforced by two new projects, part of Portuguese Roadmap of Research Infrastructures: C4G - Collaboratory for Geosciences and WindScanner. Also a new project in the Polytechnic R&D funding line was approved: NIE - Natural Interfaces for Elderly.

A new trans-border research project with Spain in the area of coastal risk management was initiated: MARRISK.

Launch of SIMPROVE, a collaborative R&D project with STI Medical and Porto Medical Faculty, to develop a medical simulation system for training rare and critical medical procedures.

European research was also reinforced with three new projects: RECAP, MELOA and FEEDBACK. The first two are part of a decade-long stream of EU-funded projects in the e-health and e-infrastructures for scientific environmental data (ocean and earth).

Consultancy services activities was diversified with two new projects with main national power operator EDP (AUTOTESTSW - automated software testing consultancy and SIGPPC - semi-automation of customer ombudsman queries), S.João hospital (RCD - Data Clinical Records repository) and Maia Municipality (SIGMAIA - consultancy for GIS implementation).

The E-Compared, LeanBigData and SeaBioData projects resulted in successful prototypes.

The EUDAT pilot, a contract for the EUDAT2020 project was successfully implemented. The pilot uses the Dendro platform previously developed at CSIG in the context of other projects.

The MASSIVE lab was inaugurated with the presence of the Minister of Science, Technology and Higher Education, as well the Dean of UTAD and other dignitaries and invitees from industry. This event provided the opportunity for publicising MASSIVE and CSIG activities at national level, including in several television channels.

5.10.6 Centre Organisational Structure and Research Team

The Centre for Information Systems and Computer Graphics is coordinated by António Gaspar and Ângelo Martins and is organised in the following scientific areas:

- Computer Graphics and Virtual Environments - Responsible: António Coelho
- Information Management and Information Systems - Responsible: Cristina Ribeiro
- Software Engineering - Responsible: João Pascoal Faria
- Accessibility - Responsible: João Barroso
- Special Purpose Computing Systems - Responsible: João Paiva Cardoso

The Centre research team present composition and evolution is presented in Table 5.2.

Table 5.2 - CSIG - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	10	7	10	3
		Academic Staff	24	26	30	4
		Grant Holders and Trainees	38	35	56	21
		Total Core Researchers	**72**	**68**	**96**	**28**
		Total Core PhD	**27**	**32**	**42**	**10**
	Affiliated Researchers		14	15	16	1
	Admin.& Tech	Employees	1	1	1	
		Grant Holders and Trainees				
		Total Admin and Tech	**1**	**1**	**1**	
	Total Integrated HR		**87**	**84**	**113**	**11**
	Total Integrated PhD		**40**	**45**	**56**	**11**
Curricular Trainees			8	4	4	
External Research Collaborators			5	10	8	-2
External Administrative and Technical Staff						
External Students			1	4	5	1
Total			**101**	**102**	**130**	**28**

5.10.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - CSIG - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	181	46	117	70
PN-PICT	National R&D Programmes - S&T Integrated Projects	5	189	294	105
PN-COOP	National Cooperation Programmes with Industry	16		80	80
PUE-FP	EU Framework Programmes	202	226	262	37
PUE-DIV	EU Cooperation Programmes - Other	109	178	64	-114
SERV-NAC	R&D Services and Consulting - National	620	541	214	-327
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes	39	16	111	96
Closed Projects		70	71	38	-34
Total Funding		**1.242**	**1.267**	**1.180**	**-87**

Table 5.4 - CSIG - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	26	33	42
International conference proceedings indexed by ISI, Scopus or DBLP	72	87	74
Books (author)			0
Chapter/paper in books	4	5	5
PhD theses concluded by members of the Centre		9	7
Concluded PhD theses supervised by members of the Centre	13	16	13

Table 5.5 - CSIG - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	0
Patent applications	0
Licence agreements	0

Table 5.6 - CSIG - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	9
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	15
International events in which INESC TEC members participate in the program committees	86
Participation in events such as fairs, exhibitions or similar	11
Advanced training courses	4

5.10.8 List of Projects

Table 5.7 - CSIG - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	C4G	Artur Rocha	2017-06-15	2020-06-13
PN-FCT	CONTEXTWA	João Paiva Cardoso	2016-06-01	2019-05-31
PN-FCT	Icarefordepression	Artur Rocha	2016-06-01	2019-05-31
PN-FCT	NIE	João Barroso	2017-10-18	2019-04-15
PN-FCT	TAIL	Cristina Ribeiro	2016-05-30	2019-05-29
PN-FCT	WindScanner	João Correia Lopes	2017-10-23	2020-10-21
PN-PICT	CORAL-SENSORS-3	Susana Alexandra Barbosa	2016-01-01	2018-12-31
PN-PICT	CORAL-TOOLS-3	Artur Rocha	2016-01-01	2018-12-31
PN-PICT	FOUREYES-2	Sérgio Nunes	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL2	João Barroso	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL3-2	Ângelo Martins	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL4-3	Carla Lopes	2015-07-01	2018-12-31
PN-PICT	SMILES-5	João Paiva Cardoso	2015-07-01	2018-12-31
PN-COOP	Simprove	António Gaspar	2017-03-15	2019-03-14
PUE-FP	BEACONING	António Coelho	2016-01-01	2018-12-31
PUE-FP	E-Compared	Artur Rocha	2014-01-01	
PUE-FP	FEEdBACk-1	António Coelho	2017-11-01	2020-10-31
PUE-FP	InteGrid-2	António Gaspar	2017-01-01	2020-06-30
PUE-FP	LeanBigData-1	Alexandre Carvalho	2014-02-01	
PUE-FP	Meloa	Artur Rocha	2017-12-01	2021-02-28
PUE-FP	RECAP	Artur Rocha	2017-01-01	2021-03-31
PUE-DIV	GReSBAS-1	António Coelho	2016-04-01	2019-03-31
PUE-DIV	MarRisk	Artur Rocha	2017-07-01	2020-06-30
PUE-DIV	RELECT	Susana Alexandra Barbosa	2017-06-01	
PUE-DIV	SeaBioData	Artur Rocha	2015-07-01	
SERV-NAC	ARQNET	José Correia	2016-10-26	2019-01-31
SERV-NAC	AUTOTESTSW	João Pascoal Faria	2017-07-01	2018-01-31
SERV-NAC	CCDRN-EA	António Gaspar	2010-10-21	
SERV-NAC	Consultoria	António Gaspar	2008-01-01	
SERV-NAC	IMOPORTAL	José Correia	2016-07-01	2018-07-31
SERV-NAC	PWA	José Correia	2013-06-17	
SERV-NAC	RCD	Ricardo Henriques	2017-06-01	2018-06-30
SERV-NAC	SIGAMP	Lino Oliveira	2016-01-01	
SERV-NAC	SIGMAIA	Lígia Silva	2017-07-01	2018-06-30
SERV-NAC	SIGPPC	José Coelho	2017-07-01	
SERV-NAC	vCardID	José Correia	2014-01-01	

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
OP	ACESSWEB	Ramiro Gonçalves	2015-01-01	
OP	Atena-1	Carla Lopes	2016-10-14	2019-10-13
OP	AV360-DNI	Rui Pedro Rodrigues	2017-03-01	2018-08-31
OP	EuroVis2019	António Coelho	2017-09-27	2019-06-26
OP	ISEABlind	João Barroso	2016-10-01	
OP	PilotoEUDAT	Cristina Ribeiro	2017-07-01	2018-07-31
OP	Tele-Media-Arte	Leonel Morgado	2016-10-01	
OP	TPDL/DublinCore	Cristina Ribeiro	2017-10-23	2018-09-22

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.10.9 List of Publications

International Journals with Scientific Referees

1. Almeida, JE, Rossetti, RJF, Pinheiro Neto Jacob, JTPN, Faria, BM, Coelho, AL, “Serious games for the human behaviour analysis in emergency evacuation scenarios", Cluster Computing-The Journal Of Networks Software Tools And Applications, vol.20, pp.707-720, MAR, 2017
2. Amalfitano, D, Riccio, V, Paiva, ACR, Fasolino, AR, “Why does the orientation change mess up my Android application? From GUI failures to code faults", Software Testing, Verification and Reliability, pp.e1654, 2017
3. Amorim, RC, Castro, JA, da Silva, JR, Ribeiro, C, “A comparison of research data management platforms: architecture, flexible metadata and interoperability", Universal Access In The Information Society, vol.16, pp.851-862, NOV, 2017
4. Barbosa, SM, Miranda, P, Azevedo, EB, “Short-term variability of gamma radiation at the ARM Eastern North Atlantic facility (Azores)", Journal of Environmental Radioactivity, vol.172, pp.218-231, 2017
5. Barreira, J, Bessa, M, Barbosa, L, Magalhaes, L, A “Context-Aware Method for Authentically Simulating Outdoors Shadows for Mobile Augmented Reality", IEEE Transactions on Visualization and Computer Graphics, pp.1-1, 2017
6. Barroso, Joao, Cota, ManuelPerez, Paredes, Hugo, Hadjileontiadis, LeontiosJ., “Technologies for enhancing accessibility and fighting info-exclusion", Universal Access in the Information Society, vol.16, pp.529-531, 2017
7. Bessa, J, Branco, F, Costa, AR, Martins, J, Goncalves, R, “Information Management Through a Multidimensional Information Systems Architecture: A University of Tras-os-Montes e Alto Douro Case Study", International Journal Of Technology And Human Interaction, vol.13, pp.1-18, 2017
8. Bispo, J, Cardoso, JMP, “A MATLAB subset to C compiler targeting embedded systems", Software-Practice & Experience, vol.47, pp.249-272, FEB, 2017

9. Brito, PQ, Stoyanova, J, Coelho, A, “Augmented reality versus conventional interface: Is there any difference in effectiveness?", Multimedia Tools and Applications, pp.1-30, 2017

10. Carneiro, LSF, Mota, MP, Vieira Coelho, MA, Alves, RC, Fonseca, AM, Vasconcelos Raposo, J, “Monoamines and cortisol as potential mediators of the relationship between exercise and depressive symptoms", European Archives Of Psychiatry And Clinical Neuroscience, vol.267, pp.117-121, MAR, 2017

11. Carvalho, D, Bessa, M, Magalhaes, L, Carrapatoso, E, “Performance evaluation of different age groups for gestural interaction: a case study with Microsoft Kinect and Leap Motion", Universal Access in the Information Society, pp.1-14, 2017

12. Correia, A, Paredes, H, Fonseca, B, “Scientometric analysis of scientific publications in CSCW", Scientometrics, pp.1-59, 2017

13. Devezas, J, Nunes, S, “Graph-Based Entity-Oriented Search: Imitating the Human Process of Seeking and Cross Referencing Information", ERCIM News, vol.2017, 2017

14. Diogo, CC, Camassa, JA, Pereira, JE, da Costa, LM, Filipe, V, Couto, PA, Geuna, S, Mauricio, AC, Varejao, AS, “The use of sheep as a model for studying peripheral nerve regeneration following nerve injury: review of the literature", Neurological Research, vol.39, pp.926-939, 2017

15. Diogo, CC, da Costa, LM, Pereira, JE, Filipe, V, Couto, PA, Magalhaes, LG, Geuna, S, Armada da Silva, PA, Mauricio, AC, Varejao, AS, “Dynamic feet distance: A new functional assessment during treadmill locomotion in normal and thoracic spinal cord injured rats", Behavioural Brain Research, vol.335, pp.132-135, 2017

16. Faria, AR, Almeida, A, Martins, C, Goncalves, R, Martins, J, Branco, F, “A global perspective on an emotional learning model proposal", Telematics And Informatics, vol.34, pp.824-837, SEP, 2017

17. Flores, N, Aguiar, A, “Learning Frameworks in a Social-Intensive Knowledge Environment - An Empirical Study", International Journal Of Software Engineering And Knowledge Engineering, vol.27, pp.699-725, JUN, 2017

18. Giesteira, B, Mesquita, J, Fernandes, M, Silva, A, “Framework 4 relief pictograms", International Journal of Interdisciplinary Social and Community Studies, vol.12, pp.1-11, 2017

19. Gouveia, S, Rebelo, J, Lourenco Gomes, L, Guedes, A, “International demand for the Douro (Portugal) river cruises: A gravity model approach", Tourism Economics, vol.23, pp.1679-1686, DEC, 2017

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4. Melo, M, Bessa, M, Debattista, K, Chalmers, A, “HDR Video on Small Screen Devices", High Dynamic Range Video, pp.173-188, 2017

5. Peixoto, C, Branco, F, Martins, J, Gonçalves, R, “A multi-perspective theoretical analysis to web accessibility", Research Paradigms and Contemporary Perspectives on Human-Technology Interaction, pp.117-139, 2017

PhD Theses

1. Azevedo, D., “A communication channels dynamic switching model for always-connected availability of service oriented mobile applications”

2. Baptista, R., “Jogos Sérios para Treino e Certificação de Competências”
3. Fernandes, H., “Modelo e orientação de cegos baseado em visão por computador e informação contextual”
4. Morgado, I., “Automated Pattern-Based Testing of Mobile Applications”
5. Nobre, R., “Efficient target and application specific selection and ordering of compiler passes”
6. Raza, M., “Automated Software Process Performance Analysis and Improvement Recommendation”
7. Sousa, A., “Adaptação dinâmica e sensível em contexto de interfaces móveis em ambiente ubíquo”

5.11 LIAAD - ARTIFICIAL INTELLIGENCE AND DECISION SUPPORT LABORATORY

Coordinator: Alípio Jorge

5.11.1 Presentation of the Centre

LIAAD accomplishes its mission within the Computer Science Cluster focusing on Intelligent and Adaptive Systems and Mathematical Modelling in Decision Support.

LIAAD aims to produce high quality cutting-edge research, to be in the international forefront of our research areas and promote transfer of knowledge and technology. This Centre is in the very strategic area of Data Science that has a growing importance in the world and is critical to all areas of human activity. The huge amounts of collected data (Big Data) and the ubiquity of devices with sensors and/or processing power offer opportunities and challenges to scientists and engineers. On the other hand, the demand for complex models for objective decision support is spreading in business, health, science, e-government and e-learning, motivating our investment in different approaches to modelling. Our overall strategy is to take advantage of the data flood and data diversification and invest in research lines that will help shorten the gap between collected data and useful data, as well as offering diverse modelling solutions.

The scientific foundations of LIAAD are machine learning, statistics, optimization and mathematics.

5.11.2 Research and Technology Development

Data Streams
Allow the treatment of continuous and voluminous streams of data generated by sensors or other sources. Actionable patterns can be found in different contexts, such as: Internet-of-Things, Industry, Transportation and the Web.

Temporal and Spatial data analysis
The ubiquitous and permanent data collection implies awareness of time and space; new algorithms are needed for prediction and monitoring of unusual events within spatio-temporal context converting predictions into useful decisions in subsequent decision-making steps.

Web, Text and Media data analysis
The growth of the size and importance of the Web and social networks, and the increasing variety of contents require increasing data analysis capabilities of huge and complex data that enable powerful applications (including: information extraction, sentiment analysis, information retrieval, recommender systems, social network analysis).

Complex data analysis
Data comes in varied and new formats, containing more and more information, from domains ranging from genetics to urban mobility (including ILP, symbolic data analysis, network data, data fusion, variable selection and grouping, active learning).

Meta learning
The growing dynamics of data requires systems that are self-aware and capable of adapting to new problems with little human intervention.

Simulation and optimization
Focusing on solutions for decision problems in management science and other application areas; Exploiting meta-heuristics and optimization techniques based on genetic algorithms, ant colony systems, among others; methods using AI-based approaches, such as multi-agent framework, that enable the simulation of the society or the economy and the interplay between their agents.

Mathematical modelling
Focusing on dynamical systems and game theory: applicable to mathematical physics, mathematical biology, time series analysis, mathematical economy and finances and models of industrial organisation.

5.11.3 Technology transfer

Recommender systems and personalization
We have extensive experience in recommender systems and personalization: the algorithms and the applications. We are able to put recommendation algorithms to work in production in various domains such as music recommendation, e-learning and commerce. The variety of data about products, customers, consumers coming from web browsing, shopping and movement can be exploited to understand and predict user behaviour as well as to support users in coping with vast amounts of choices.

Data science in action
Data mining and machine learning are our core areas. We can help businesses and services to make sense of the growing pools of data they collect to improve their actions. We have experience in algorithm development and evaluation, data transformation and system deployment. We help companies and institutions to integrate data science and machine learning into their production flow and Business Intelligence from Business Understanding to Deployment. We currently work in domains such as telecommunications, agriculture, commerce, urban transports and power management, using a variety of data mining algorithms and techniques.

Consultancy in Data science
We are able to help companies and institutions in their effort to develop their own data science teams. We can advise on hiring specialized personnel and in help in the supervision of the data science team. We are able to identify opportunities for data valorisation and provide recommendations on the best practice to follow.

Surveys and Data Analysis
We have competencies in statistical data analysis, including survey design, data collection, data cleaning and understanding, exploratory data analysis, development of predictive models and reporting. These are particularly useful for market studies, analysis of treatments and to measure any specific set of indicators.

Extracting information from text
Much of the data in companies and services is stored as text. People express their views as consumers and citizens on social networks. Relevant information emerges everyday in news, reports, scientific articles and on the Web. We are able to extract information from texts, including named entities, topics, relevant dates and sentiment. This information can be integrated in the data science workflow, exploited for decision making processes or used for producing new content.

Event and Anomaly detection
We develop algorithms for the detection of events and anomalies. We are able to design and deploy solutions in domains such as predictive maintenance, commercial fraud, telecommunications, smart cities, ecological systems and water management.

5.11.4 Knowledge valorisation chain

The following table presents the contribution of the “Research and Technology” areas to the “Technology Transfer” areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1 - LIAAD - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development		Status (2)	Areas of Technology Transfer --> relationships (3)				
			RecSys	Data Science	Data Analysis	Text mining	Anomaly detection
Data Streams		I	H	H	L	M	H
Temporal and Spatial data analysis		I		H	H	H	H
Web, Text and Media data analysis		I	H			H	L
Complex data analysis		I	M		H		M
Meta learning		I		M			
Simulation and optimization		I		M			M
Mathematical modelling		I		M	L		M
Other areas (1)	Business Intelligence (CESE)	O	M	H			L

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.11.5 Main Achievements in 2017

LIAAD researchers have published 18 papers in Journals that are in the first quarter (Q1) of either ISI or Scopus indexes and 12 in Q2 (out of 42). We had one CORE A* conference paper (SIGIR) co-authored by Ricardo Campos and five papers in CORE A conferences (out of 48). LIAAD researchers have also published two books, one on using R and Python for statistical data analysis (co authored by Rui Sarmento) and another on Modeling, Dynamics, Optimization and Bioeconomics (Alberto Pinto was one of the editors).

João Gama was Chair of the conference Progress in Artificial Intelligence - 18th EPIA Conference on Artificial Intelligence, EPIA 2017, Porto, Portugal, and in the organizing committee of 13 other scientific conferences. Our members have organized a number of International Workshops co-located with major machine learning conferences on the following topics: "Data Science for Social Good", "Automatic Selection, Configuration and Composition of Machine Learning Algorithms", "Data Mining for Oil and Gas", "IoT Large Scale Learning from Data Streams" and "Learning with Imbalanced Domains: Theory and Applications".

As guest editor João Gama published one special issue on on Computational Models for Social and Technical Interactions for the New Generation Computing Journal. One other special issue on Data Mining for Geosciences (Data Mining and Knowledge Discovery journal) was launched in 2017 with Alípio Jorge and Rui Lopes as guest editors but will be published only in 2018.

The Maestra FP7 project where we participated ended in 2017 and was awarded an excellent grade by the reviewers. The H2020 Project RECAP started in January. We have participated in a record number of project proposals with companies.

5.11.6 Centre Organisational Structure and Research Team

The Centre has one coordinator, a management board, a management assistant and is organised in the following Areas:

- Machine Learning and Data Mining - João Gama / João Moreira
- Data Mining from Structured Data - Alípio Jorge / Pavel Brazdil / Rui Camacho
- Data Analysis and Statistical Methods - Maria Paula Brito
- Modeling & Optimization - Dalila Fontes / Alberto Pinto

The Centre research team present composition and evolution is presented in Table 5.2.

Table 5.2 - LIAAD - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees				
		Academic Staff	29	29	28	-1
		Grant Holders and Trainees	17	38	50	12
		Total Core Researchers	**46**	**67**	**78**	**11**
		Total Core PhD	**33**	**36**	**41**	**5**
	Affiliated Researchers		5	5	6	1
	Admin.& Tech	Employees				
		Grant Holders and Trainees				
		Total Admin and Tech				
		Total Integrated HR	**51**	**72**	**84**	**6**
		Total Integrated PhD	**37**	**41**	**47**	**6**
Curricular Trainees			10	5	3	-2
External Research Collaborators			15	15	20	5
External Administrative and Technical Staff						
External Students			13	10	13	3
Total			**89**	**102**	**120**	**18**

5.11.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - LIAAD - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	1	24	46	22
PN-PICT	National R&D Programmes - S&T Integrated Projects	49	127	355	228
PN-COOP	National Cooperation Programmes with Industry		1	41	40
PUE-FP	EU Framework Programmes	73	100	74	-26
PUE-DIV	EU Cooperation Programmes - Other		16		-16
SERV-NAC	R&D Services and Consulting - National	72	20	19	-1
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes	64	41	4	-37
Closed Projects		2			
	Total Funding	**262**	**329**	**539**	**210**

Table 5.4 - LIAAD - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	44	36	36
International conference proceedings indexed by ISI, Scopus or DBLP	39	48	44
Books (author)			1
Chapter/paper in books	3	5	7
PhD theses by members of the Centre	2	2	2
Concluded PhD theses supervised by members of the Centre	7	3	6

Table 5.5 - LIAAD - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	0
Patent applications	0
Licence agreements	0

Table 5.6 - LIAAD - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	4
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	14
International events in which INESC TEC members participate in the program committees	12
Participation in events such as fairs, exhibitions or similar	0
Advanced training courses	0

5.11.8 List of Projects

Table 5.7 - LIAAD - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	Dynamics2	Alberto Pinto	2016-06-01	2019-05-31
PN-FCT	FOTOCATGRAF-1	Luís Torgo	2015-06-01	2018-05-31
PN-PICT	CORAL-TOOLS-5	Luís Torgo	2016-01-01	2018-12-31
PN-PICT	FOUREYES-3	Alípio Jorge	2015-07-01	2018-12-31
PN-PICT	iMAN-4	Dalila Fontes	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL3-3	Rui Camacho	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL4-2	Rui Camacho	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL5-2	Carlos Ferreira	2015-07-01	2018-12-31
PN-PICT	SMILES-7	João Gama	2015-07-01	2018-12-31
PN-COOP	PERSONA	Alípio Jorge	2017-03-01	2019-06-30
PN-COOP	SmartFarming-1	Carlos Ferreira	2016-10-01	2018-09-30
PUE-FP	MAESTRA	João Gama	2014-02-01	
PUE-FP	NEXT-NET-1	Pedro Campos	2017-10-01	2019-09-30
PUE-FP	RECAP-1	Rui Camacho	2017-01-01	2021-03-31
PUE-DIV	MarineEye-1	Luís Torgo	2015-07-30	
SERV-NAC	BI4UP2-1	Carlos Soares	2016-08-01	
SERV-NAC	Consultoria	Alípio Jorge	2017-01-01	
SERV-NAC	MDIGIREC-1	Alípio Jorge	2017-12-01	2018-11-30
SERV-NAC	PANACea-1	João Gama	2016-08-08	2018-03-07
SERV-NAC	PERS_TOMI	Alípio Jorge	2017-12-19	2019-12-18
OP	ECML/ PKDD	João Gama	2014-07-31	
OP	MDM_2016	João Gama	2016-01-01	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.11.9 List of Publications

International Journals with Scientific Referees

1. Accinelli, E, Martins, F, Oviedo, J, Pinto, A, Quintas, L, “Who controls the controller? A dynamical model of corruption", Journal Of Mathematical Sociology, vol.41, pp.220-247, 2017
2. Baia, L, Torgo, L, “A comparative study of approaches to forecast the correct trading actions", EXPERT SYSTEMS, vol.34, pp.e12169, FEB, 2017
3. Brito, PQ, Stoyanova, J, Coelho, A, “Augmented reality versus conventional interface: Is there any difference in effectiveness?", Multimedia Tools and Applications, pp.1-30, 2017
4. Campos, R, Dias, G, Jorge, AM, Nunes, C, “Identifying top relevant dates for implicit time sensitive queries", Inf. Retr. Journal, vol.20, pp.363-398, 2017
5. Cardoso, DO, Franca, FMG, Gama, J, “WCDS: A Two-Phase Weightless Neural System for Data Stream Clustering", New Generation Computing, vol.35, pp.391-416, OCT, 2017
6. Cardoso, DO, Gama, J, Franca, FMG, “Weightless neural networks for open set recognition", Machine Learning, vol.106, pp.1547-1567, OCT, 2017
7. Cushing, JM, Martins, F, Pinto, AA, Veprauskas, A, “A bifurcation theorem for evolutionary matrix models with multiple traits", Journal Of Mathematical Biology, vol.75, pp.491-520, AUG, 2017
8. de Souza e Silva, RDDE, de Oliveira, RC, de Lima Tostes, MED, “Analysis of the Brazilian Energy Efficiency Program for Electricity Distribution Systems", ENERGIES, vol.10, SEP, 2017
9. Dias, S, Brito, P, “Off the beaten track: A new linear model for interval data", European Journal Of Operational Research, vol.258, pp.1118-1130, 2017
10. Fateixa, S, Wilhelm, M, Jorge, AM, Nogueira, HIS, Trindade, T, “Raman imaging studies on the adsorption of methylene blue species onto silver modified linen fibers", Journal Of Raman Spectroscopy, vol.48, pp.795-802, JUN, 2017
11. Figueiredo, A, “Bootstrap and permutation tests in ANOVA for directional data", Computational Statistics, vol.32, pp.1213-1240, DEC, 2017
12. Fonseca, T, Monteiro, L, Enes, T, Cerveira, A, “Self-thinning dynamics in cork oak woodlands: providing a baseline for managing density", Forest Systems, vol.26, pp.e006, 2017
13. Freitas, D, Oliveira, BMPM, Correia, F, Pinhao, S, Poinhos, R, “Eating behaviour among nutrition students and social desirability as a confounder", Appetite, vol.113, pp.187-192, 2017
14. Hron, Karel, Brito, Paula, Filzmoser, Peter, “Exploratory data analysis for interval compositional data", Adv. Data Analysis and Classification, vol.11, pp.223-241, 2017
15. Krawczyk, B, Minku, LL, Gama, J, Stefanowski, J, Wozniak, M, “Ensemble learning for data stream analysis: A survey", Information Fusion, vol.37, pp.132-156, SEP, 2017
16. Lopes, RL, Jorge, AM, “Assessment of predictive learning methods for the completion of gaps in well log data", Journal of Petroleum Science and Engineering, 2017

17. Mani, V, Delgado, C, Hazen, BT, Patel, P, “Mitigating Supply Chain Risk via Sustainability Using Big Data Analytics: Evidence from the Manufacturing Supply Chain", Sustainability, vol.9, pp.608, APR, 2017

18. Martins, J, Pinto, A, “Bistability of Evolutionary Stable Vaccination Strategies in the Reinfection SIRI Model", Bulletin Of Mathematical Biology, vol.79, pp.853-883, APR, 2017

19. Mendes Moreira, P, Satovic, Z, Mendes Moreira, J, Santos, JP, Nina Santos, JPN, Pego, S, Vaz Patto, MCV, “Maize participatory breeding in Portugal: Comparison of farmer's and breeder's on-farm selection", Plant Breeding, vol.136, pp.861-871, DEC, 2017

20. Moniz, N, Torgo, L, Eirinaki, M, Branco, P, “A Framework for Recommendation of Highly Popular News Lacking Social Feedback", New Generation Computing, vol.35, pp.417-450, OCT, 2017

21. Moniz, Nuno, Branco, Paula, Torgo, Luis, “Resampling strategies for imbalanced time series forecasting", I. J. Data Science and Analytics, vol.3, pp.161-181, 2017

22. Nikhalat Jahromi, H, Fontes, DBMM, Cochrane, RA, “Future liquefied natural gas business structure: a review and comparison of oil and liquefied natural gas sectors", Wiley Interdisciplinary Reviews-Energy And Environment, vol.6, pp.e240, 2017

23. Norton De Matos, A, Sousa, CN, Almeida, P, Teles, P, Loureiro, L, Teixeira, G, Rego, D, Teixeira, S, “Radio-cephalic fistula recovered with drainage to forearm basilic vein", Hemodialysis International, vol.21, pp.E63-E65, OCT, 2017

24. Oliveira Brochado, A, Brito, PQ, Oliveira Brochado, F, “Correlates of adults’ participation in sport and frequency of sport [Corrélats de la participation des adultes en sport et de la fréquence avec laquelle ils le pratiquent]", Science and Sports, vol.32, pp.355-363, 2017

25. Poinhos, R, Oliveira, BMPM, van der Lans, IA, Fischer, ARH, Berezowska, A, Rankin, A, Kuznesof, S, Stewart Knox, B, Frewer, LJ, de Almeida, MDV, “Providing Personalised Nutrition: Consumers' Trust and Preferences Regarding Sources of Information, Service Providers and Regulators, and Communication Channels", Public Health Genomics, vol.20, pp.218-228, 2017

26. Proenca, T, Torres, A, Sampaio, AS, “Frontline employee empowerment and perceived customer satisfaction", Management Research-The Journal Of The Iberoamerican Academy Of Management, vol.15, pp.187-206, 2017

27. Roque, LAC, Fontes, DBMM, Fontes, FACC, “A Metaheuristic Approach to the Multi-Objective Unit Commitment Problem Combining Economic and Environmental Criteria", Energies, vol.10, pp.2029, 2017

28. Sarmento Dias, M, Santos Araujo, C, Poinhos, R, Oliveira, B, Sousa, M, Simoes Silva, L, Soares Silva, I, Correia, F, Pestana, M, “Phase Angle Predicts Arterial Stiffness And Vascular Calcification In Peritoneal Dialysis Patients", Peritoneal Dialysis International, vol.37, pp.451-457, 2017

29. Sebastião, R, Gama, J, Mendonça, T, “Fading histograms in detecting distribution and concept changes", I. J. Data Science and Analytics, vol.3, pp.183-212, 2017

30. Silva, JD, Hruschka, ER, Gama, J, “An evolutionary algorithm for clustering data streams with a variable number of clusters", Expert Systems With Applications, vol.67, pp.228-238, JAN, 2017

31. Sousa, CN, Marujo, P, Teles, P, Lira, MN, Leite Mota Novais, “MELM, Self-Care on Hemodialysis: Behaviors With the Arteriovenous Fistula", Therapeutic Apheresis And Dialysis, vol.21, pp.195-199, APR, 2017

32. Tavares, AH, Raymaekers, J, Rousseeuw, PJ, Silva, RM, Bastos, CAC, Pinho, A, Brito, P, Afreixo, V, “Comparing Reverse Complementary Genomic Words Based on Their Distance Distributions and Frequencies", Interdisciplinary Sciences: Computational Life Sciences, 2017

33. Teixeira, G, Almeida, P, Sousa, CN, Teles, P, De Sousa, P, Loureiro, L, Teixeira, S, Rego, D, Almeida, R, de Matos, AN, “Arteriovenous access banding revisited", Journal Of Vascular Access, vol.18, pp.225-231, 2017

34. Teles, P, Sousa, PSA, “The effect of temporal aggregation on the estimation accuracy of time series models", Communications In Statistics-Simulation And Computation, vol.46, pp.6738-6759, 2017

35. Torres, AC, Lopes, A, Valente, JMS, Mouraz, A, “What catches the eye in class observation? Observers' perspectives in a multidisciplinary peer observation of teaching program", Teaching In Higher Education, vol.22, pp.822-838, 2017

36. Zubelli, JP, Pinto, AA, Martins, F, “Nash And Social Welfare Impact In An International Trade Model", Journal Of Dynamics And Games, vol.4, pp.149-173, APR, 2017

International Conference Proceedings with Scientific Referees

1. Almeida, J, Ferreira, J, Camacho, R, Pereira, L, “Co-expression networks between protein encoding mitochondrial genes and all the remaining genes in human tissues", 2017 IEEE International Conference on Bioinformatics and Biomedicine, BIBM 2017, Kansas City, MO, USA, November 13-16, 2017, pp.70-73, 2017

2. Branco, P, Torgo, L, Ribeiro, RP, “Exploring Resampling with Neighborhood Bias on Imbalanced Regression Problems", Progress in Artificial Intelligence - 18th EPIA Conference on Artificial Intelligence, EPIA 2017, Porto, Portugal, September 5-8, 2017, Proceedings, vol.10423, pp.513-524, 2017

3. Branco, P, Torgo, L, Ribeiro, RP, Frank, E, Pfahringer, B, Rau, MM, “Learning Through Utility Optimization in Regression Tasks", 2017 IEEE International Conference on Data Science and Advanced Analytics, DSAA 2017, Tokyo, Japan, October 19-21, 2017, pp.30-39, 2017

4. Branco, P, Torgo, L, Ribeiro, RP, “SMOGN: a Pre-processing Approach for Imbalanced Regression", First International Workshop on Learning with Imbalanced Domains: Theory and Applications, LIDTA@PKDD/ECML 2017, 22 September 2017, Skopje, Macedonia, vol.74, pp.36-50, 2017

5. Branco, Paula, Torgo, Luis, Ribeiro, RitaP., “Relevance-Based Evaluation Metrics for Multi-class Imbalanced Domains", Advances in Knowledge Discovery and Data Mining - 21st Pacific-Asia Conference, PAKDD 2017, Jeju, South Korea, May 23-26, 2017, Proceedings, Part I, vol.10234, pp.698-710, 2017

6. Cachada, M, Abdulrahman, SM, Brazdil, P, “Combining Feature and Algorithm Hyperparameter Selection using some Metalearning Methods", Proceedings of the International Workshop on Automatic Selection, Configuration and Composition of Machine Learning Algorithms co-located with the European Conference on Machine Learning & Principles and Practice of Knowledge Discovery in Databases, AutoML@PKDD/ECML 2017, Skopje, Macedonia, September 22, 2017., vol.1998, pp.69-83, 2017

7. Cavadas, B, Ferreira, J, Camacho, R, Fonseca, NA, Pereira, L, “QmihR: Pipeline for Quantification of Microbiome in Human RNA-seq", 11th International Conference on Practical Applications of Computational Biology & Bioinformatics, PACBB 2017, Porto, Portugal, 21-23 June, 2017, vol.616, pp.173-179, 2017

8. Cerqueira, V, Torgo, L, Oliveira, M, Pfahringer, B, “Dynamic and Heterogeneous Ensembles for Time Series Forecasting", 2017 IEEE International Conference on Data Science and Advanced Analytics, DSAA 2017, Tokyo, Japan, October 19-21, 2017, pp.242-251, 2017

9. Cerqueira, V, Torgo, L, Pinto, F, Soares, C, “Arbitrated Ensemble for Time Series Forecasting", Machine Learning and Knowledge Discovery in Databases - European Conference, ECML PKDD 2017, Skopje, Macedonia, September 18-22, 2017, Proceedings, Part II, vol.10535, pp.478-494, 2017

10. Cerqueira, V, Torgo, L, Smailovic, J, Mozetic, I, “A Comparative Study of Performance Estimation Methods for Time Series Forecasting", 2017 IEEE International Conference on Data Science and Advanced Analytics, DSAA 2017, Tokyo, Japan, October 19-21, 2017, pp.529-538, 2017

11. Cerqueira, V, Torgo, L, Soares, C, “Arbitrated Ensemble for Solar Radiation Forecasting", Advances in Computational Intelligence - 14th International Work-Conference on Artificial Neural Networks, IWANN 2017, Cadiz, Spain, June 14-16, 2017, Proceedings, Part I, vol.10305, pp.720-732, 2017

12. Cerveira, A, Correia, E, Cristelo, N, Miranda, T, Castro, F, Fernandez Jimenez, A, “Statistical Analysis of the Influence of Several Factors on Compressive Strength of Alkali Activated Fly Ash", Procedia Structural Integrity, vol.5, pp.1116-1122, 2017

13. Costa, J, Neto, J, Alves, R, Escudeiro, P, Escudeiro, N, “Neurocognitive Stimulation Game: Serious Game for Neurocognitive Stimulation and Assessment", Serious Games, Interaction And Simulation, vol.176, pp.74-81, 2017

14. Cunha, R, Veloso, B, Malheiro, B, “Renegotiation of Electronic Brokerage Contracts", Recent Advances in Information Systems and Technologies - Volume 2 [WorldCIST'17, Porto Santo Island, Madeira, Portugal, April 11-13, 2017]., vol.570, pp.41-50, 2017

15. Duarte, J, Gama, J, “Feature ranking in hoeffding algorithms for regression", Proceedings of the Symposium on Applied Computing, SAC 2017, Marrakech, Morocco, April 3-7, 2017, pp.836-841, 2017

16. Escudeiro, N, Escudeiro, P, Soares, F, Litos, O, Norberto, M, Lopes, J, “Recognition of hand configuration: a critical factor in automatic sign language translation", 2017 12th Iberian Conference On Information Systems And Technologies (CISTI), 2017

17. Escudeiro, P, Escudeiro, N, Norberto, M, Lopes, J, “VirtualSign Game Evaluation", Serious Games, Interaction And Simulation, vol.176, pp.117-124, 2017

18. Jatowt, A, Campos, R, “Interactive System for Reasoning about Document Age", Proceedings of the 2017 ACM on Conference on Information and Knowledge Management - CIKM '17, 2017

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PhD Theses

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2. Soeiro, R., “Social and Economic Games”

5.12 CRACS - CENTRE FOR RESEARCH IN ADVANCED COMPUTING SYSTEMS

Coordinator: Fernando Silva

5.12.1 Presentation of the Centre

CRACS integrates the Computer Science Cluster with the mission of pursuing scientific excellence in the areas of programming languages, parallel and distributed computing, information mining, security and privacy, with a focus on scalable software systems for challenging multidisciplinary applications in Engineering, Life Sciences, Social Networks and the Internet of Things (IoT). The research team is currently composed by 53 members, of which 14 are senior researchers, mostly faculty at the CS department at FCUP, and 5 post-docs. The research environment is enriched with junior talented researchers that together with senior researchers build the necessary critical mass and scientific competences to fulfil our mission.

5.12.2 Research and Technology Development

The CRACS research group has a world leading role on the design and implementation of sequential and parallel LP and ILP systems, with YAP Prolog being their flagship system. It has been enriched to support large-scale parallelism, probabilities, negation and tabling towards Data Science and Big Data applications. Considerable progress was made in these areas, with work on large datasets on author identification, semantic relatedness, sentiment discovery, motifs discovery and medical diagnosis, by using new techniques in complex networks, processing sensor data streams and high-throughput genomics data. Research focused also on mobile edge computing and sensor networks, towards IoT. DSLs, VMs and middleware were developed to harness the combined resources of large networks of mobile devices and sensors. The ubiquity of such devices introduces new opportunities for game-changing applications but also privacy and security issues. Techniques and tools were developed, for scalable context-aware identity management in large networks and for lightweight secure autonomous communication, and new policies and mechanisms at application and services level that ensure an adequate level of privacy and user empowerment. In more detail, the research and technology development interests of CRACS are grouped as follows:

Languages and Distributed Computing

Our team leads in the design of high-level programming languages that integrate logical and probabilistic reasoning, supporting negation, tabling, and parallelism; languages for mobile distributed environments that are *correct-by-design*, namely, in wireless sensor networks (WSN), aiming to simplify programming and debugging; middleware frameworks capable of supporting sensing and actuation in large WSN deployments, with a focus on scalability, energy efficiency and seamless management; innovative middleware for crowd-sensing and crowd-sourcing applications running on top of edge-clouds. A synopsis of our main intervention areas is:

- Programming Languages Theory and Implementation
- Parallel and Distributed Computing
- Middleware for WSN and Edge-Clouds

Security and Privacy

We focus on algorithms and methodologies to improve the usability of privacy and security in software and systems, namely on user-controlled identity management systems that respect user privacy and protect personally identifiable information; secure identity cards and authentication mechanisms with a view to ensure access control to physical locations or networks, as well as to enable identity verification in online transactions or governmental services communications to guarantee its data integrity and non-repudiation properties; specialized algorithms and tools for sharing sensitive data while preserving privacy; ethical hacking and penetration testing for pre-emptive vulnerability detection. We have been collaborating with the Portuguese Data Protection Commission as consultants in national projects and

with Portuguese National Security Agency on auditing systems and developing solutions to secure mobile communications. A synopsis of our main intervention areas is:

- Identity Management Systems
- Secure Tokens for eID
- Privacy Enhancing Technologies

Knowledge in a World of Data

We work on the bridge between logic, probabilities, data structures and learning. Our focus is on applications that tie our work together with domains such as author identification, semantic relatedness, sentiment discovery, complex networks, motifs discovery, sensor data streams, medical records data, and high-throughput genomics data. A synopsis of our main intervention areas is:

- Machine Learning and Discovery
- Big Data Applications
- e-Learning Environments and Tools

5.12.3 Technology transfer

YAP Prolog

We are a leading group on the implementation of sequential and parallel logic programming systems. Yap Prolog is a highly regarded system in the research community, especially for machine learning, being distributed with the Fedora Linux distribution. It supports just-in-time compilation, multiple forms of parallelism, multithreading, tabling, constraints handling, probabilistic inductive logic programming, etc. It is widely used as a teaching, research and development tool.

Authenticus

We developed the Authenticus national repository of scientific publications metadata authored by researchers from Portuguese institutions. The system automatically uploads publications from multiple indexing databases, automatically associates publication authors with known researchers and institutions, provides specialised interfaces to researchers and institutions to confirm or dismiss proposed associations, allows interoperability with other CRIS systems, provides synchronisation with ORCID, both for import and export, among many other functionalities. It currently has 2,700 registered active users and over 420,000 publication records from 4 sources (ISI, Scopus, DBLP, and Crossref). It has been supported by FCT, University of Porto and INESC TEC.

FotoCatGraf

In FOTOCATGRAF, in cooperation with REQUIMTE, we developed a small, cheap, electrochemical sensor that allows the measurement of the concentrations of a class of emerging pollutants — pharmaceutical substances and their metabolites. The sensor is designed to be seamlessly integrated into wireless sensor networks to be deployed in wastewater treatment plants for automatic, high cadence, collection of data to monitor the concentration of the most harmful pollutants. The resulting data-sets can then be mined to detect patterns that allow a deeper understanding of the usage and life-cycle of these pollutants in the environment and, also, to support environmental and public health policy decisions. Currently, we are looking for an industrial partner to take over this technology.

vCardID - Match-On-Card (MoC) for the Portuguese Citizen Card.

CRACS developed and implemented a biometric fingerprint MoC algorithm for Javacard, that is currently being deployed into the Portuguese citizen card, in the context of a contract from INCM. We have also specified an efficient fingerprint minutiae format, appropriate for secure and accurate MoC operations on smartcards and developed specialized tools supporting smartcard personalization with biometric

data. The implementation consists on a Javacard applet that is capable of performing fast and accurate MoC operations on any standard Javacard2.1 compliant smartcard. CRACS was also responsible for the development of software supporting the modular integration of several different biometric image acquisition readers from different vendors, into the Portuguese Government back office systems, that are responsible for the acquisition of personalization data for each individual citizen card.

Edge-Computing and Edge-Clouds

Mobile devices have become ubiquitous and traditionally viewed as "thin clients" or "edge devices" that serve primarily as user-input devices. More recently, with their increased computing and storage capabilities, their potential is now viewed as "thick clients," and going even further, to rethink them as "thin servers". Given the proliferation and enhanced capabilities of mobile devices, it is now a real possibility for a "wireless cloud of nearby smartphones" to pose an interesting-enough collective computational/storage resource. Our group has expertise in the development of middleware for edge computing and for building innovative proximity-aware applications that pool nearby devices data and processing power to construct hyperlocal edge clouds. HYRAX is project in the context of the CMU-Portugal initiative that addresses the crowdsourcing of mobile devices for edge computing.

Cloud Computing Services

Our group has experience in the design and deployment reliable cloud infrastructures using OpenStack and Ovirt, comprising both storage and infrastructure-as-a-service (IaaS). We were responsible for the setup of INESC TEC Cloud-CA, a cloud comprising 280 computing cores, 1.5TB of main memory and 16TB of storage that was built to be fully redundant and fault tolerant from the network to the service layers.

Privacy Enhancing Technologies and eID

Our group has expertise in privacy enhancing technologies as described in (EU 2007), namely on the "design of information and communication systems and services in a way that minimises the collection and use of personal data and facilitates compliance with data protection rules making breaches more difficult and/or helping to detect them". We have a long history of collaboration with the Portuguese Data Protection Authority, exemplified with the C3Priv project whose main goal was to return the control of the data to the users, and the Break-the-Glass work that originated a PhD thesis that won the Fraunhofer best PhD thesis with practical application, later its implementation on the second largest hospital won the CNPD privacy prize. Some of our researchers collaborate on the International Working Group on Data Protection in Telecommunications and are actively involved in the new European General Data Protection Regulation and may provide some guidance and consultancy on its implementation.

5.12.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-CRACS - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development	Status (2)	Areas of Technology Transfer --> relationships (3)							
		Yap Prolog	Mooshak	vCardID	Authenticus	FotoCatGraf	HLTSYS	ADYTA	INTERRELAT E
Programming Languages Theory and Implementation	I	H	M		L	L			
Parallel and Distributed Computing	I	H	L		L	M			
Middleware for Mobile Computing	I					M			
Identity Management Systems	I						H		
Secure Tokens for eID	I			H				H	
Privacy Enhancing Technologies	I						H		
Machine Learning and Discovery	I	H			M				H
Big Data Applications	I	H			L				M
e-Learning Environments and Tools	I		H						

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.12.5 Main Achievements in 2017

Hyrax: continued development of the Hyrax middleware for programming crowd-sourcing applications. The link and communication layers have fully functional prototypes and have been used in several PhD and MSc projects, exploring various scenarios in which edge-clouds can be advantageous, e.g., video-dissemination, distributed face-recognition, distributed storage and computing platforms, gathering local intelligence. We demonstrated the feasibility of the middleware and edge-cloud architectures for almost real-time dissemination of video replays during a volleyball championship game at Nave de Espinho sports venue.

REMINDS: an international project to design and develop a system that automatically crawls and identifies potential relevant information, from a journalistic perspective, in social media, by filtering personal, trivial or fake information, and focusing on trendy or controversial topics. Several relevancy models were built having the training of 10k posts as a base. Each model uses between 20 and 30 features. The system's precision, depending on the features available on each post (feedback, entities, cross-checking, etc), ranged between 60% up to 92%. A fully usable prototype was also developed.

SMILES: we developed a crowd-sensing infrastructure that allows the injection of sensing tasks into mobile devices within certain abstract regions through the use of a low footprint virtual machine running over Android. The infrastructure also features publish/subscribe services that allow the data streams produced at the devices to be forwarded to Web clients for on-the-fly or post-mortem analysis and/or storage.

FOTOCATGRAF: further development of the hardware/software prototype sensor for monitoring pharmacological compounds in residual waters. Integration experiments with a view to using the device in wireless sensor networks deployed at treatment stations. Continued looking for an industry partner.

Angerona, Privacy Preserving Middleware Platform for IoT: a CMU-Portugal exploratory project for developing a novel middleware platform that autonomously combines different privacy-preserving

techniques to support end-to-end privacy, focusing on solutions directed to low resources devices. We aim for a non-PKI solution that gives users the possibility to configure their own privacy-policies. The platform will place the user as an active player in the data market, behaving as its own data broker for the potential data end users.

Yap Prolog: (i) implementation of probability estimators aimed to avoid the computational cost of probabilistic theory evaluation by providing an estimate of the value of the combination of subtheories in probabilistic logic programming systems; (ii) extension of the tabling engine to support multi-dimensional lock-free arrays in multithreaded mode-directed tabling; and (iii) design and implementation of a prototype for a fully automated test bench environment aimed to assist developers in the development and CI of Prolog systems.

Type-inhabitation: definition of a new notion of pre-grammar of a type, that captures the inherent structure of the type allowing the definition of several methods to deal with type-inhabitation related problems (type-checking, counting, generation, etc). The notion of pre-grammars, together with the inhabitation machines presented by Schubert et al. in 2015, allowed for the definition of methods to process inhabitants in a deterministic way, as well as to address the more complex problem of principal inhabitation.

Graph based access control: a graph-based framework for the analysis of access control policies for specifying and verifying policy properties and its application in the context of emergency situations. This framework considers policies in the category-based access control model, which has been shown to subsume many of the most well-known access control models (e.g., MAC, DAC, RBAC). This graphical representation of category-based policies, allows answering policy administrator queries and check access control policy properties.

5.12.6 Centre Organisational Structure and Research Team

The Centre is coordinated by Fernando Silva, who ensures scientific coordination jointly with Luís Antunes. The Centre is organised in the following Areas:

- Languages and Distributed Computing - Responsible: Luís Lopes and Ricardo Rocha
- Security and Privacy - Responsible: Luís Antunes
- Knowledge in a World of Data - Responsible: Vítor Santos Costa

The Centre research team present composition and evolution is presented in Table 5.2.

Table 5.2 - CRACS - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees	2	2	1	-1
		Academic Staff	13	14	14	
		Grant Holders and Trainees	31	41	38	-3
		Total Core Researchers	**46**	**57**	**53**	**-4**
		Total Core PhD	**17**	**22**	**22**	
	Affiliated Researchers		1	2	1	-1
	Admin.& Tech	Employees	1	1	1	
		Grant Holders and Trainees	1	1	1	
		Total Admin and Tech	2	2	2	
	Total Integrated HR		**49**	**61**	**56**	**-1**
	Total Integrated PhD		**18**	**23**	**24**	**1**
Curricular Trainees			2	1	1	
External Research Collaborators			6	11	13	2
External Administrative and Technical Staff						
External Students			2	1	8	7
Total			**59**	**74**	**78**	**4**

5.12.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3-CRACS - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT	160	141	126	-16
PN-PICT	National R&D Programmes - S&T Integrated Projects		172	317	145
PN-COOP	National Cooperation Programmes with Industry				
PUE-FP	EU Framework Programmes	11	67	65	-2
PUE-DIV	EU Cooperation Programmes - Other				
SERV-NAC	R&D Services and Consulting - National	277	114	78	-37
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes				
Closed Projects			2		-2
Total Funding		**448**	**497**	**585**	**88**

Table 5.4 - CRACS - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	9	9	14
International conference proceedings indexed by ISI, Scopus or DBLP	36	29	45
Books (author)	1		0
Chapter/paper in books	4	3	1
PhD theses concluded by members of the Centre	3	1	1
Concluded PhD theses supervised by members of the Centre	2	1	1

Table 5.5 - CRACS - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	0
Patent applications	0
Licence agreements	0

Table 5.6 - CRACS - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	3
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	5
International events in which INESC TEC members participate in the program committees	16
Participation in events such as fairs, exhibitions or similar	2
Advanced training courses	1

5.12.8 List of Projects

Table 5.7 - CRACS - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	ELVEN	Vítor Santos Costa	2016-07-01	2019-06-30
PN-FCT	FOTOCATGRAF	Luís Lopes	2015-06-01	2018-05-31
PN-FCT	Hyrax	Fernando Silva	2014-04-21	2018-04-20
PN-FCT	REMINDS	Álvaro Figueira	2015-04-27	
PN-PICT	FOUREYES-4	José Paulo Leal	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL3	Luís Filipe Antunes	2015-07-01	2018-12-31

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-PICT	NanoStima-RL4	Luís Filipe Antunes	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL5-3	Luís Filipe Antunes	2015-07-01	2018-12-31
PN-PICT	SMILES-3	Fernando Silva	2015-07-01	2018-12-31
PUE-FP	Digi-NewB	Luís Filipe Antunes	2016-03-01	2020-02-29
SERV-NAC	Consultoria	Fernando Silva	2010-01-01	
SERV-NAC	vCardID-2	Fernando Silva	2014-01-01	
SERV-NAC	vCardID2-1	Fernando Silva	2016-12-01	2018-04-30

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.12.9 List of Publications

International Journals with Scientific Referees

1. Alves, Sandra, Fernández, Maribel, “A graph-based framework for the analysis of access control policies", Theor. Comput. Sci., vol.685, pp.3-22, 2017
2. Antunes, L, Bauwens, B, Souto, A, Teixeira, A, “Sophistication vs Logical Depth", Theory Of Computing Systems, vol.60, pp.280-298, FEB, 2017
3. Antunes, LF, Souto, A, Vitanyi, PMB, “On the rate of decrease in logical depth", Theor. Comput. Sci., vol.702, pp.60-64, 2017
4. Aparicio, D, Ribeiro, P, Silva, F, “Extending the Applicability of Graphlets to Directed Networks", IEEE-Acm Transactions On Computational Biology And Bioinformatics, vol.14, pp.1302-1315, 2017
5. Areias, M, Rocha, R, “On scaling dynamic programming problems with a multithreaded tabling, Prolog system", Journal Of Systems And Software, vol.125, pp.417-426, MAR, 2017
6. Costa, J, Silva, C, Antunes, M, Ribeiro, B, “Adaptive learning for dynamic environments: A comparative approach", Engineering Applications Of Artificial Intelligence, vol.65, pp.336-345, OCT, 2017
7. Goncalves, R, Areias, M, Rocha, R, “On the implementation of a cloud-based computing test bench environment for prolog systems", Information (Switzerland), vol.8, pp.129, 2017
8. Loewe, L, Scheuer, KS, Keel, SA, Vyas, V, Liblit, B, Hanlon, B, Ferris, MC, Yin, J, Dutra, I, Pietsch, A, Javid, CG, Moog, CL, Meyer, J, Dresel, J, McLoone, B, Loberger, S, Movaghar, A, Gilchrist Scott, M, Sabri, Y, Sescleifer, D, Pereda Zorrilla, I, Zietlow, A, Smith, R, Pietenpol, S, Goldfinger, J, Atzen, SL, Freiberg, E, Waters, NP, Nusbaum, C, Nolan, E, Hotz, A, Kliman, RM, Mentewab, A, Fregien, N, Loewe, M, “ Evolvix BEST Names for semantic reproducibility across code2brain interfaces", Annals Of The New York Academy Of Sciences, vol.1387, pp.124-144, JAN, 2017

9. Monteiro Santos, J, Goncalves, H, Bernardes, J, Antunes, L, Nozari, M, Costa Santos, C, “Entropy and Compression Capture Different Complexity Features: The Case of Fetal Heart Rate", Entropy, vol.19, pp.688, 2017

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Books

Blank

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PhD Theses

1. Araújo, M., “Communities and Anomaly Detection in Large Edged-Labeled Graphs”

5.13 HASLAB - HIGH-ASSURANCE SOFTWARE LABORATORY

Coordinators: Alcino Cunha and Manuel Barbosa

5.13.1 Presentation of the Centre

HASLab is focused on the design and implementation of high-assurance software systems: software that is correct by design and resilient to environment faults and malicious attacks. HASLab accomplishes its mission within the Computer Science Cluster, anchoring its research on a rigorous approach to three areas of Computer Science: Software Engineering, Distributed Systems, and Cryptography and Information Security. The contributions of HASLab to these areas range from fundamental research on formal methods and algorithms, to applied research on developing tools and middleware that address real-world demands stemming from long-term collaborations with industry.

5.13.2 Research and Technology Development

Software Engineering

Our research on Software Engineering focuses mainly on developing formal methods for system design and program verification, in order to achieve high-quality software. In particular, we develop formal languages and tools for specification, verification (model checking), and design of complex systems, including stochastic, continuous, and systems where human-computer interaction plays a central role. This work is supported by a strong research line on the structural and foundational aspects of computer science. We also develop static and dynamic (automatic) analysis techniques for checking several software quality aspects, for example execution safety or energy consumption, and for automatic testing and debugging, namely fault localization.

Distributed Systems

Our work on Distributed Systems focuses on dependable data management for cloud computing and data science environments. In particular, we are interested in combining the scalability of NoSQL systems with the functionality of relational and transactional database management systems. Our contributions encompass the development of new techniques and mechanisms for data replication and distribution, including conflict-free approaches to eventual consistency with conflict-free replicated data types, query processing focused on analytic workloads, secure data processing in untrusted infrastructures, and operational management of performance and reliability. The main challenge is thus to make novel data management technologies as safe and usable as practice as the well-known and trusted SQL technologies.

The support of scalability is grounded on efficient dissemination protocols and data collection. This is based on topologies that are both resilient and effective in dissemination speed and load, and when appropriate, in stochastic data aggregation techniques that reduce the communication load while providing a global view of the system with controlled accuracy.

Cryptography and Information Security

Our work in Cryptography and Information security covers both fundamental and applied topics, and also the challenge of bridging theory and practice. At the theoretical level we conduct research in provable security and machine-assisted cryptography, where the goal is both to develop the theoretical foundations of rigorous security analysis of cryptographic protocols, and to design formal verification techniques that permit verifying security proofs. At the applied level we focus on high-efficiency and high-security implementations of cryptography, with an emphasis on providing high-assurance as to the functional and nonfunctional properties of cryptographic implementations. A major challenge that we address at this level is to provide domain-specific languages and tool support that guarantee the preservation of theoretically proven properties from high-level specifications to low-level implementations. Privacy enhancing technologies for securely storing data and computing in the Cloud are the most prominent application scenarios we have recently addressed.

5.13.3 Technology transfer

Requirement specification and validation

Early validation of requirements is key to ensure the success of a software project. We have members with a vast experience on using formal methods to specify and validate requirements (and on reliable system design methodologies in general) that can provide early feedback to all stakeholders about potential inconsistencies and critical scenarios. We can also provide consultancy in the process of developing domain specific languages and tools for requirement elicitation and validation. Finally, one important technology transfer area is the analysis of security requirements in software applications, namely those involving complex trust models, such as those arising in the Cloud, and the use of cryptography for more than securing communications and data at rest.

Algorithm design and implementation

We can provide consultancy in the design of algorithms for several complex and critical domains, for example, distributed data synchronization and aggregation, secure implementations of high-speed cryptographic modules for embedded devices, and complex implementations of advanced privacy enhancing protocols for the Cloud. We can also provide implementations of such algorithms with high correctness and efficiency guarantees, and, when applicable, implementations that are correct-by-construction obtained by refinement of formal specifications.

Evaluation of critical software components

We have expertise on evaluating the implementation of critical software components in order to check their conformance to functional and nonfunctional requirements, for example, security, execution safety, energy consumption, scalability or usability. We can also provide consultancy in the process of software certification required in several critical domains, for example, medical devices or aerospace. In the area of cryptographic software development we can provide independent validation of correctness and nonfunctional properties such as the deployment of side-channel countermeasures.

Polyglot data management

The use of multiple data management technologies side-by-side is increasingly common in practice. Besides the traditional SQL database management systems, applications rely on novel systems such as MongoDB or HBase for storage, and on Hadoop or Spark for query processing. In particular, the technologies based on the Hadoop stack have been proven useful in a variety of application domains. We have experience in deploying and operating these systems and can provide support in their implementation in new scenarios and the optimization of existing applications. Moreover, we have experience in integrating and combining multiple technologies in the scope of the same application.

Cloudification services

The deployment of applications on today's technological landscape is moving towards the cloud. The industry largest companies have started to migrate their infrastructure to a cloud environment, seeking to reduce the operational costs and reaping the benefits of resource allocation on demand. Whether the transitions is made to a public service provider, a private cloud or a hybrid-model there is always the problem of integrating an application on the cloud environment. It is not simply a matter of deploying an application on a virtualized environment, there are always concerns regarding the application's configuration, components interaction, resource monitoring and automatic resource allocation. From years of research and by collaborating with the industry, we gathered the experience required to accelerate the transition of applications to the cloud.

5.13.4 Knowledge valorisation chain

The following table presents the contribution of the "Research and Technology" areas to the "Technology Transfer" areas, giving some insight into the operation of the knowledge valorisation chain relevant to the Centre.

Table 5.1-HASLab - Table of relationships between the areas of Research and Technology Development and the areas of Technology Transfer

Areas of Research and Technology Development	Status (2)	Areas of Technology Transfer --> relationships (3)				
		Requirement specification and validation	Algorithm design & implementation	Evaluation of critical software components	Polyglot data management	Cloudification services
Software Engineering	I	H	M	H	L	L
Distributed Systems	I	L	H	M	H	H
Cryptography and Information security	I	M	H	M	L	M

(1) Existing areas in other Centres of INESC TEC (name in brackets) new areas to be created internally or external partnerships relevant for the development of one or more areas of Technology Transfer
(2) I - Internal; O - Other Centre of INESC TEC; C - To be created internally; E - External partnership
(3) "blank" - no direct relationship / contribution
L - Low or weak relationship / contribution; M - Medium relationship / contribution;
H - High or strong relationship / contribution; F - Future predicted relationship / contribution

5.13.5 Main Achievements in 2017

In 2017, HASLab has continued to produce fundamental and applied research that satisfies the quality standards of the top rated journal and conferences. In particular, we had 3 papers published at A* venues, as rated by the popular computer science CORE ranking, namely 1 article at the IEEE Transactions on Software Engineering presenting a "A Feature-Based Classification of Model Repair Approaches" and 2 papers at the ACM SIGSAC Conference on Computer and Communications Security, entitled "A Fast and Verified Software Stack for Secure Function Evaluation" and "Jasmin: High-Assurance and High-Speed Cryptography".

The quality of the research developed by HASLab' postgrad students was recognized in 2017 by several prizes at relevant events. In the context of the Green Software Laboratory project, Rui Pereira received the Silver Medal in the ACM Student Research Competition at the International Conference on Software Engineering with the paper "Locating energy hotspots in source code", and the paper "Towards a Green Ranking for Programming Languages", co-authored by several PhD and MSc students involved in this project, received the Best Paper award at the Brazilian Symposium on Programming Languages. The paper "SafeFS: A modular architecture for secure user-space file systems (one FUSE to rule them all)", reporting work developed in the European SafeCloud project and whose first author is Rogério Pontes, received the Best Student Paper Award in the ACM International Systems and Storage Conference. The work developed by Fábio Coelho also led to a publication entitled "Similarity aware shuffling for the distributed execution of SQL window functions," that was selected for the Best Paper award at the FIP International Conference on Distributed Applications and Interoperable Systems.

In terms of projects, 2017 was marked by a strong effort to establish new service and consultancy projects with key national and international companies. This effort led to two new contracts, one with Efacec Energia, Máquinas e Equipamentos Eléctricos, S.A. (Portugal), entitled "DSGrid - Digital Systems Technology for Next Generation Grid Automation" and another one with MedicalTech s.r.l. (Italy), entitled "Cartella Clinica INF" to design the user interface of an electronic record system for patient data. These projects target two key application areas of INESC TEC, respectively TEC4Energy and TEC4Health, and together with other ongoing research projects, namely 4 H2020 European projects, contributed to the clearly positive financial results of HASLab at the end of the fiscal year.

Finally, 2017 was also maked by the creation of SafeCloud Technologies Sàrl, a start-up company that will commercially exploit key results of the H2020 SafeCloud European project. It is a spinoff of both INESC TEC, including 4 researchers from HASLab, and the University of Neuchâtel, and leverages more than 10 years of experience in database technology, cloud computing and privacy preserving technologies. SafeCloud Technologies aims at providing the next generation of secure and highly

configurable data platform systems, and, following a privacy-by-design approach, its product line-up ranges from workspace management applications to enterprise-grade privacy-preserving database systems.

5.13.6 Centre Organisational Structure and Research Team

The HASLab is coordinated by Alcino Cunha and Manuel Barbosa and is organised in the following areas:

- Software Engineering - Responsible: Alcino Cunha
- Distributed Systems - Responsible: José Orlando Pereira
- Cryptography and Information Systems - Responsible: Manuel Barbosa

The Centre research team present composition and evolution is presented in Table 5.2.

Table 5.2 - HASLab - Research team composition

Type of Human Resources			2015	2016	2017	Δ 2016-2017
Integrated HR	Core Research Team	Employees			1	1
		Academic Staff	21	21	21	
		Grant Holders and Trainees	34	46	41	-5
		Total Core Researchers	**55**	**67**	**63**	**-4**
		Total Core PhD	**32**	**31**	**34**	**3**
	Affiliated Researchers			1	1	
	Admin.& Tech	Employees				
		Grant Holders and Trainees	1	1	2	1
		Total Admin and Tech	**1**	**1**	**2**	**1**
	Total Integrated HR		**56**	**69**	**66**	**4**
	Total Integrated PhD		**32**	**32**	**35**	**3**
Curricular Trainees			3	2		-2
External Research Collaborators			6	10	10	
External Administrative and Technical Staff			4	4	4	
External Students			7	17	19	2
Total			**76**	**102**	**99**	**-3**

5.13.7 Activity indicators in 2017

The following tables present the main indicators of the activity developed in 2017 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2017 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform, and also from CORE (Computing Research and Education Association of Australasia).

Table 5.3 - HASLab - Project funding

Funding Source		Total Income (k€)			
		2015	2016	2017	Δ 2016-2017
PN-FCT	National R&D Programmes - FCT			11	11
PN-PICT	National R&D Programmes - S&T Integrated Projects		132	189	57
PN-COOP	National Cooperation Programmes with Industry			16	16
PUE-FP	EU Framework Programmes	436	340	554	215
PUE-DIV	EU Cooperation Programmes - Other				
SERV-NAC	R&D Services and Consulting - National	130	99	60	-39
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes	9		19	19
Closed Projects				19	19
	Total Funding	**576**	**571**	**869**	**298**

Table 5.4 - HASLab - Summary of publications by members of the Centre

Type of Publication	2015	2016	2017
Papers in international journals indexed by ISI, Scopus or DBLP	27	43	15
International conference proceedings indexed by ISI, Scopus or DBLP	48	55	56
Books (author)			0
Chapter/paper in books		2	1
PhD theses concluded by members of the Centre	4	3	3
Concluded PhD theses supervised by members of the Centre	5	3	3

Table 5.5 - HASLab - Summary of IP protection, exploitation and technology transfer

Type of Result	No.
Invention disclosures	1
Patent applications	1
Licence agreements	0

Table 5.6 - HASLab - Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	2
Conferences organised by INESC TEC members (in the organizing committee or chairing technical committees)	7
International events in which INESC TEC members participate in the program committees	26
Participation in events such as fairs, exhibitions or similar	3
Advanced training courses	16

5.13.8 List of Projects

Table 5.7 - HASLab - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	GSL	Rui Maranhão	2016-07-01	2019-06-30
PN-PICT	CORAL-TOOLS-7	Alcino cunha	2016-01-01	2018-12-31
PN-PICT	NanoStima-RL1-4	José Creissac Campos	2015-07-01	2018-12-31
PN-PICT	NanoStima-RL3-4	Manuel Barbosa	2015-07-01	2018-12-31
PN-PICT	SMILES	Carlos Baquero	2015-07-01	2018-12-31
PN-COOP	Cloud-Setup-1	Manuel Barbosa	2016-07-01	2018-12-31
PUE-FP	CloudDBAppliance	Rui Carlos Oliveira	2016-12-01	2019-11-30
PUE-FP	InteGrid-1	Manuel Barbosa	2017-01-01	2020-06-30
PUE-FP	LeanBigData	Rui Carlos Oliveira	2014-02-01	
PUE-FP	Lightkone	Carlos Baquero	2017-01-01	2019-12-31
PUE-FP	SafeCloud	Rui Carlos Oliveira	2015-09-01	2018-08-31
PUE-FP	UPGRID-2	Rui Carlos Oliveira	2015-01-01	2018-03-31
SERV-NAC	Consultoria	Rui Carlos Oliveira	2014-01-01	
SERV-NAC	DSGrid	Vitor Fonte	2016-06-01	2018-12-31
SERV-NAC	vCardID2	Rui Carlos Oliveira	2016-12-01	
SERV-NAC	vCardID-3	Rui Carlos Oliveira	2014-01-01	
OP	EUROSYS'2018	Rui Carlos Oliveira	2017-10-01	2018-12-31
OP	FACS	José Paiva Proença	2017-05-01	
OP	PTCRIS	Alcino cunha	2016-07-01	2019-06-30

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

5.13.9 List of Publications

International Journals with Scientific Referees

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2. Baquero, C, Almeida, PS, Cunha, A, Ferreira, C, “Composition In State-Based Replicated Data Types", Bulletin Of The European Association For Theoretical Computer Science, vol.123, OCT, 2017
3. Campos, JC, Abade, T, Silva, JL, Harrison, MD, “Don't go in there! using the APEX framework in the design of ambient assisted living systems", J. Ambient Intelligence and Humanized Computing, vol.8, pp.551-566, 2017
4. Campos, JC, Fayollas, C, Gonçalves, M, Martinie, C, Navarre, D, Palanque, PA, Pinto, M, “A More Intelligent Test Case Generation Approach through Task Models Manipulation", PACMHCI, vol.1, pp.9:1-9:20, 2017
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6 TEC4 INITIATIVES

6.1 Overview

A TEC4 ("TEChnologies FOR …") is an initiative aiming at structuring the market-pull innovation process, as opposed to the science-push that occurs naturally in the Research Centres. This supports the establishment of the adequate balance between the two opposing motivations and supports the full knowledge-to-value chain.

Each TEC4 targets a specific market and induces cross-cluster multidisciplinary projects, promoting collaboration with industry and producing solutions to be transferred to companies. Each TEC4 is pushed by an Agent (contracted, linked to SAPE), working in close contact with a Champion (Senior Researcher linked to a Cluster). SAPE is the support service that provides active interaction with markets and innovation managers in companies.

The performance of each TEC4 is measured by the volume of direct contracts with the industry and the number of inter-Centre and Inter-Cluster projects motivated. The TEC4 are not execution structures: once a project opportunity is detected, negotiations occur with the relevant Research Centres (in consortia) and it is under these that the project is then managed and completed.

The TEC4 initiatives address regional and national challenges by mapping the short- and medium-term domain needs with the INESC TEC scientific roadmaps. Typically, three distinct parts compose each TEC4:

- A concrete market domain, represented by businesses and associations;
- A multidisciplinary scientific community dedicated to the challenges of that market domain;
- A technological R&D infrastructure that supports the scientific and innovation activities and is able to offer high added value services to businesses that cannot be found in the market.

Each TEC4 must have its own strategic agenda, according to their market domain, addressing three pillars: the stakeholders and partnerships perspective, the scientific roadmap and the technological R&D infrastructure evolution - to keep up with the state-of-the-art and support the roadmap.

The short-term objectives of the TEC4 initiatives are the creation of innovative products and services with high export potential, based on internationally competitive research and innovation capabilities, contributing to the resilience and growth of the Portuguese economy. The long-term objectives of the TEC4 comprise the identification of scientific and technical challenges, embracing multiple disciplines, involving and exploiting the full potential of INESC TEC in application domains that are easily understood and incorporated by businesses. Creating and maintaining these virtuous innovation cycles within each TEC4 is the main medium to long-term challenge.

Sections 1.2 to 1.7 present a short description of the scope and objectives of the current TEC4 initiatives.

6.1.1 Current Initiatives

Currently, INESC TEC is leading six TEC4 initiatives devoted to the following domains:

- TEC4Sea - solutions for the Blue Economy
- TEC4Media - solutions for the Creative Industries Economy
- TEC4Agro-Food - solutions for the Agro-Industrial, Forest and Green Economy
- TEC4Industry - solutions for the Retail and Manufacturing Economy
- TEC4Energy - solutions for the Energy Economy
- TEC4Health - solutions for the Health Economy

The application domains addressed by the TEC4 have the advantage of mapping directly in regional and national priority domains, aligning and consolidating internal R&D competencies around economic pillars, well understood by businesses. Furthermore, attracting international partners to the TEC4 initiatives, supports the INESC TEC internationalization strategy, facilitates the national companies an

easy access to international partners and enables the attraction of foreign direct investment into the Region and the country.

6.1.2 Methodology

Each TEC4 follows an implementation plan covering the following maturity states:

- Identification of market segments where INESC TEC competencies can create value;
- Identification of internal research lines with highest potential impact in businesses - based on the assessment of market needs;
- Identification of the R&D infrastructure (i.e., laboratories, equipment, demonstration facilities and other technical means) supporting the offer of high added value services to businesses;
- Identification of new potential partners and stakeholders that can bring added value to the TEC and support its innovation cycle;
- Definition/alignment of the strategic agenda of each TEC and the creation of its advisory board;
- Establishment of collaboration plans with other institutions and running of the projects.

Given their current maturity levels and the results obtained, the TEC4Sea and TEC4Media are described below.

6.2 TEC4SEA

Coordinator: Carlos Pinho

6.2.1 Scope and objectives

TEC4SEA is the INESC TEC initiative to induce a market pull drive into R&D and generate a convergence of knowledge and competences into producing solutions for the Blue Economy.

The articulation with stakeholders operating at Sea has been established through strong networking activities, in main national events (Business2Sea) and in strategic international fora - e.g. EIT Raw Materials (Teaming) or IEEE/MTS OCEANS.

TEC4SEA monitors research results in the range TRL 1-9 and focuses on applied research leading to products, processes and services (TRL 5-9) that can be transferred, combining several INESC TEC cross-Cluster competences, in a process where TEC4SEA structures opportunities and the Research Centres undertake the necessary R&D.

The TEC4SEA effort joins shorter term objectives, addressing traditional industries, with longer term visions addressing emerging activities. For traditional industries, projects will be pushed to improve efficiency, resource and cost optimization. Areas such as robotics and autonomous systems, sensors, information systems and communications have been contributing to coastal tourism, intensive aquaculture, port management, shipbuilding and repair industries.

Emerging activities are associated to safety and border surveillance, offshore wind energy, deep sea exploration, mining and deep-sea mining, deep- and ultra-deep-water O&G industries. Partnerships with companies and public sector have already been established and a number of projects developed, supporting the growth of new competencies to address foreseen business challenges.

A TEC4SEA Research Infrastructure (RI) is under implementation, with national support. It brings together a set of partners and laboratories, testbeds, equipment and support facilities, for testing and validating solutions in controlled and real environments. Its support to multidisciplinary research enables a full validation and evaluation of solutions, from simulation/lab experiment to field trials.

For the coming years (2022), TEC4SEA aims to:

- promote the use of the TEC4SEA RI by national and international stakeholders;
- increase the knowledge/technology transfer to industrial ecosystems and the impact in the sea economy and employment in the region;
- contribute for a long term presence on the surface and in the deep and ultra-deep waters;
- consolidate knowledge about resources, biodiversity and human pressures on the sea, empowering decision support.
- align action with the new AIR - Atlantic International Research Centre, where INESC TEC plays a supporting role.
- The activity of TEC4SEA will address also visibility, dissemination and interaction. Leveraged by the presence in national and international forums and the STRONGMAR initiative, meetings with decision makers will be conducted as well as thematic seminars and open daysMain Achievements in 2017

During 2017, the following achievements were possible regarding the TEC4SEA context:

Promotion and dissemination activities:

- Business2Sea: within this fair and exposition a set of results of the TEC4SEA initiative were presented to national and international entities. The signature of the protocol for the constitution of the consultation counsel of TEC4SEA infrastructure, took place in the opening of the Business2Sea event, and was signed by 10 entities.

- OceansMeetings: results of the TEC4SEA initiative were exposed to national and international entities.
- REX2017: the participation for the 6th year in the Robotics Exercises in collaboration with the Portuguese Navy reinforced the links and the visibility of the TEC4SEA team and competencies within this military branch.

Relevant new initiatives:

- TEC4SEA infrastructure: the 5.3M€ of funding for this research infrastructure lead by INESC TEC was approved in 2017 and the 3 years investments roadmap started. This is the main structural and strategic initiative that shall support the main R&D activities of TEC4SEA.
- ProtoAtlantic: this Interreg project aims at strengthening the transfer of innovation results to facilitate the emergence of new products, services and processes for SMEs working in the Sea Economy.
- EMSO-PT: INESC TEC started its participation, as member, in the Portuguese Research Infrastructure (RI) part of EMSO formed as a network of fixed point, deep sea multidisciplinary observatories, with the scientific objective of real-time, long-term monitoring of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere.
- MELOA: this H2020 project aims at developing effective low cost solutions to monitor surface ocean currents and their dynamic characteristics in any place of the world.

Structural initiatives:

- XPrize: INESC TEC participated and became one of the finalists in the Shell Ocean Discovery XPRIZE, a global competition challenging teams to advance deep-sea technologies for autonomous, fast and high-resolution ocean exploration. This initiative is structural to disseminate the INESC TEC competencies and capacities towards Deep-Sea, in a global scale.
- Eurathlon: winners at the ERL Emergency Robots 2017 major tournament. The ERL Emergency Robots 2017 competition consisted of four scenarios, inspired by the nuclear accident of Fukushima (Japan, 2011) and designed specifically for multi-domain human-robot teams. The first scenario is The Grand Challenge made up of three domains - sea, air, land, and the other three scenarios are made of only two domains. INESC TEC wan the 1st place for the “The Grand Challenge (Scenario 1: land, sea and air)”; the 3rd place for “Survey the building and search for missing workers (Scenario 2: land and sea)”and again the 1st place for “Pipe inspection and search for missing workers (Scenario 3: sea and air)”.
- Oceans 2017: organiser of the Thematic Workshop on Sensing the Deep Sea that took place within the OCEANS'17 MTS/IEEE Aberdeen conference. This organisation, inside the world biggest conference about Oceans, gave us important networking and visibility.

6.3 TEC4MEDIA

Coordinator: Cristina Guimarães

6.3.1 Scope and objectives

TEC4MEDIA is the INESC TEC initiative to induce a market pull drive into R&D and generate a convergence of knowledge and competences into producing solutions for the Content and Creative Industries Economy, increasing digital content market offer and improving end-user experiences. Being INESC TEC a high producer of research targeting this sector, technology transfer to companies and public sector must be ramped up.

TEC4MEDIA monitors results in the range TRL 1-9, focuses on applied research leading to products, processes and services (TRL 5-9) that can be transferred to: technological companies (multimedia, software, video games, streaming, content storage, digital marketing, digitalization); content producers (educational content producers, editors, audiovisual, film, digital arts, advertising); distributers (on-line media, traditional media, social media, broadcasters, libraries, cultural archives, entertainment, telecoms, museums and cultural organisations).

TEC4MEDIA is being targeted to: production and reuse of content for multiple platforms, second screen, virtual and augmented reality; digitization, restoration and preservation of contents (video, photography); access and navigation in large repositories, customizing and adapting content, gamification strategies; digital economy and digital marketing.

Future work in TEC4MEDIA will cover topics combining several INESC TEC cross-Cluster competences, such as:

- content management, distribution and interaction
- multimodal media user interaction
- multimodal content analysis
- user modeling and personalization
- cross-media information extraction and retrieval
- augmented reality
- multisensory immersive interaction with virtual reality
- digital games and serious games
- context aware multimedia services and applications
- personalised multimedia environments
- sound and music computing: generation, perception, description, interaction
- machine learning for multimedia environments
- data analysis and digital marketing
- long term consumer preferences
- digital tools integration and management
- automatic content generation
- digital content business models

INESC TEC had a major role in the creation and is a major actor in NEM Portugal, a mirror platform of the European platform NEM (New European Media). It gathers hundreds of European key players in media industries (content producers, technology providers). NEM Portugal working together with the supporting clusters (TICE.PT; ADDICT) fosters the interaction of creative and technological companies with the academia in the preparation of new services and products. TEC4MEDIA will allow INESC TEC to fully profit from this platform.

Leveraged by the presence in national and international forums, meetings with decision makers will continue as well as thematic seminars and open days.

6.3.2 Main Achievements in 2017

The main actions, that brought together research and industry of this particular sector and sub-sectors, in 2017, were:

a) Promotion and dissemination activities:

- NEM Portugal trimestral events gathering all members (49 SMEs and 3 Broadcasters) on the following subjects: Film Industry & Audio-visual; Virtual Reality & Augmented Reality; Cultural Heritage;
- Interface actions with industry: meetings to understand sector technological and innovation challenges and to present INESC TEC competences promoting collaboration with external partners and associated partners;
- Participation in CTM Open Day;
- Participation in Aveiro TECDAYS and other TICE.PT initiatives;
- Participation in "V Congresso Internacional Cidadaes Criativas";
- Participation in "Mobile World Congress" and "CEBIT" fair.
- Speaker in the Conference "Media e Produção de Conteúdo";
- Speaker in the Summit "Oportunidades para o Sector TICE" organised by ANETIE and Magellan;
- B2b meetings with participants on above initiatives;

b) Relevant new initiatives:

- Kick-off of CLOUD SETUP project with MOG to develop of a set of integrated ingest tools that, automatically and compatible with file-based (file-based) acquisition systems, make it possible for offline and live media productions;
- Kick-off of WHERE IS project with Wavecom to develop technology communications and adequate location to indoor environments, based on IoT (Internet of Things) that includes a pilot in "Casa da Música";
- Participation in NEM Initiative meetings and promoting participation in position papers;
- Co-organisation (along with VIDA ECONÓMICA) of the Conference "Media e Produção de Conteúdos"
- Co-organisation (along with University of Porto Media Innovation Labs) of information session on funding opportunities for the Media sector;

c) Structural initiatives:

- Meeting with the research groups in order to promote and enhance the infrastructures serving TEC4Media, namely:

    (i) Multimodal Acknowledgeable multiSenSory Immersive Virtual Environments Lab - MASSIVE is a laboratory devoted to the multidisciplinary study of the relationship between virtual reality technologies and the different dimensions of human performance. Our mission is to make use of virtual reality technology to enhance human abilities in order to address global challenges and improve the quality of life. Our vision is to become a world-reference laboratory within the field of multisensory virtual reality, perceptual equivalence, human performance, and technology that creates innovative solutions in a wide set of areas of applications such as training and certification, health, education, or entertainment;

    (ii) The Sound and Music Computing Lab - The lab hosts research in Applied Computing, Arts and Humanities, and Sound and Music Computing. This lab supports research not only in

audio synthesis and computational processing of sound, but also in automatic and procedural music generation e.g., for use in interactive computational systems, 3D audio spatialisation for integration in virtual environments, among other application contexts. It is well-equipped with sound and audio specific equipment, include a multi-loudspeaker setup, and is acoustically prepared for the associated activities and for audio content production and post-production;

(iii) Graphics, Interaction and Gaming Lab - The Computer Graphics and Virtual Environments Laboratory (CG&VE) is equipped to face the new challenges on areas such as Immersive Environments, Digital Games and User Experience, but also to deepen the knowledge in Computer Graphics on areas such as Image Rendering and Visualization;

(iv) U.Porto Media Innovation Labs - MIL is a Centre of Excellence created in the University of Porto to address the challenges that exist in developing a strongly interdisciplinary domain such as Digital Media. MIL is designed as a network within the university, leveraging the already existing capacity in different fields of knowledge such as Communication, Technology and Design. MIL manages several audiovisual resources, namely a digital TV studio with control room and a pre-screening auditorium, and audio recording booths.

- Organisation and moderation of NEM Portugal board monthly meetings;
- Kick-off of the “mobilizador” project CHIC-Cooperative Holistic View on Internet and Content adressing: Cloud platforms for content production and distrubution management; Management of the national cultural heritage contents based on preservation and interaction open systems; and Creation, production and consumption of content, focusing on Quality of Service and Experience, using immersive and high definition environments;
- Follow up of the “Four eyes” project deliverables and demonstrations and participation in seminars to discuss results and feel the media, creative and content industries ecosystem and its challenges;
- Attending webinairs on European calls such as: "European funding opportunities for the audiovisual sector”.

6.4 TEC4INDUSTRY

Coordinator: José Nina de Andrade

6.4.1 Scope and objectives

TEC4INDUSTRY is the INESC TEC initiative to induce a market pull drive into R&D and generate a convergence of knowledge and competences into producing solutions for the Retail and Manufacturing Industry, covering all supply chain actors, anchored in a history of successes and impact in technology transfer to companies.

TEC4INDUSTRY monitors results in the range TRL 1-9 and focuses on applied research leading to products, processes and services (TRL 5-9) that can be transferred to companies.

It aims at providing high impact services and foster partnerships, supported by applied research, resulting in systems, tools, techniques, models, and methods for decision making, design of operations and services, intelligent automation, robotics, strategy development, networks and chains governance and performance management. The purpose is to address the complex challenges of today's industry, in terms of digitalisation, sustainability and circular economy, human-Centredness, innovation, and changeability and flexibility.

This process works by gathering several scientific competences from all INESC TEC Clusters, benefiting from their multidisciplinary scope, in a process where TEC4INDUSTRY structures opportunities and the Research Centres perform the R&D. The innovation sought includes areas such as: operations, logistics and processes, business intelligence and analytics, networks and supply chains, robotics and intelligent systems, innovation and technology management, business information systems and customer interaction and co-creation.

INESC TEC has a unique experience of decades in working together with the manufacturing industry and TEC4INDUSTRY gives structure and strategy to this know-how. In the European context, INESC TEC participates in many HORIZON2020 projects (BEinCPPS , ScalABLE4.0, FASTEN, MANU-SQUARE, NEXT-NET, ColRobot), addressing subjects in the industry 4.0 context such as: business experiments in cyber physical production systems, flexible and autonomous manufacturing systems, collaborative robotics for smart manufacturing, and technology roadmapping for the future supply chains.

Aligned with the TEC4INDUSTRY roadmap, INESC TEC is member of the European Technology Platform Manufuture, the European Factories of the Future Research Association and euRobotics AISBL. In Portugal, INESC TEC is associate of PRODUTECH, TICE.PT and several sectorial industrial associations. Also, INESC TEC is currently actively involved in the creation of the Digital Innovation Hub - iMan Norte Hub, to foster the digital transformation of manufacturing companies of the Northern Region of Portugal and to nurture the respective innovation ecosystem.

The activity of TEC4INDUSTRY will address also visibility, dissemination and interaction. Leveraged by the presence in national and international forums, meetings with decision makers and prescribers will be conducted as well as thematic seminars and open days.

6.4.2 Main Achievements in 2017

In 2017 was created the TEC4INDUSTRY group with representatives of SAPE and the core R&D centers, which begun to structure INESC TEC approach to manufacturing, logistics and retail sector, defining its intervention areas.

During 2017 INESC TEC has continued the work in manufacturing, logistics and retail sector, resulting in 48 active projects, which were 28 direct contract with enterprises, 5 projects funding by H2020 program and 11 co-promotion projects with enterprises. Those projects addresses the main challenges in industry, logistics and retail sectors, thanks to the research results achieved in INESC TEC.

In 2017 continued collaboration with IKEA in the areas of factory design and operations planning, which led to the redesigning a set of factories in several countries. The work addressed simulation and optimization of the production lines through mathematical and simulation models to design facilities,

dealing with complex routings and bill of materials, and deciding the mix between push and pull production strategies.

In logistics was pursued projects where retailers have to deal with a complex distribution network with multiple distribution centers, and a vast range of store formats. An optimization-simulation approach to help retailer make the best decisions regarding product-warehouse-outlet assignment, product delivery modes planning and fleet sizing was developed.

Also projects on predictive maintenance were developed, predicting anomalous events in electric transformers.

Projects related with recommendation systems, micro characterization of the consumer in the retail stores, where georeferenced recommendation based on items and customer's location were accomplished.

Pursuing work in robotics and intelligent systems was developed solutions for trajectory planning for multiple robots based on AGV or mobile manipulators. Its objective was to assure efficient free routes and avoid system deadlocks. A novel approach, denoted Time Enhanced A* (TEA*), that is able to dynamically control a fleet of autonomous vehicles was implemented.

Besides traffic control, in order to improve mobile robot localization and tracking system was developed a localization system that avoids a dedicated laser scanner reducing the implementations cost and robot size.

As an applications of technologies developed was made a contract with GERTAL to implement an autonomous robotic system for hospital logistics operations of high flexibility, capable of operating in different hospital logistics flows, such as meals and laundry.

Participation in the mobilizing program, PRODECH SIF - Solutions for the Industry of the Future, which aims to be an integrated response for the development and construction of new production systems, based on advanced production technologies, to equip the manufacturing industry with the challenges of the 4th industrial revolution. In this project, INESC TEC was responsible for producing the final report on new business, products and services models in the context of i4.0, addressing the technological trends and recommendations in the scope of manufacturing technologies.

In 2017, INESC TEC participated in Hannover Mess in the stand promoted by PRODUTECH, where robotics and operational optimization solutions were demonstrated.

INESC TEC also participates in the iMan Norte Hub Coordination body, which aims to foster the digital transformation of manufacturing companies of the Northern Region of Portugal, by improving the collaboration between research institutions, industrial companies, and others main actors, focus on the main industrial sectors of the region.

In other to accomplish its objectives, iMan Norte Hub will support companies in suppliers and partners search, as well as formation of consortia and promote dissemination actions, participate in international events related with Digital Innovation Hubs and will promote de development of studies and roadmaps.

6.5 TEC4AGRO-FOOD

Coordinator: André Sá

6.5.1 Scope and objectives

TEC4AGRO-FOOD is the INESC TEC initiative to induce a market pull drive into RTD and generate a convergence of knowledge and competences into producing solutions for the Agricultural, Agrofood and Forestry Economy. INESC TEC is a relevant producer of research targeting these sectors. It has competencies in the main technologies involved in the digital (r)evolution of agriculture and forestry and digitization of agrofood industry, i.e. IoT, artificial intelligence, robotics and big data. In the last years INESC TEC image as a technological partner was promoted.

TEC4AGRO-FOOD strategy is driven by societal challenges, like food security, sustainable agriculture, forestry and bio-economy, and a will to contribute to the European goal of achieving leadership in enabling technologies, such as in biotechnology and ICT.

The INESC TEC Clusters participate in this effort by forming internal consortia of Research and Development Centres, establishing ad-hoc coordination for each action. The TEC4AGRO-FOOD Agent acts often as an opportunity detector or as a broker. Internal and external events (such as thematic market-focused workshops) are organised under the TEC4AGRO-FOOD umbrella to foster cooperation between Research and Development Centres and external visibility and cooperation.

The effort will build up on two pillars: experience and resources. As for experience, INESC TEC already has a history of R&D and contracts, such as the development of machinery equipped with Variable Rate Technology (VRT), or projects such as eFoodChain, RoMoVi, Smart Farming, FOCUS, DIVA, BIOTECFOR, Water4Ever and AGRINuPeS. INESC TEC may and will act in all phases of the smart precision agriculture/forestry cycle, from variability measurement to action with VRT, encompassing data analysis and decision and prescription.

Regarding the agrofood industry, the activity is already related with all Industry 4.0/digitization issues, i.e. digitalization, robotisation, automation and artificial intelligence. TEC4AGRO-FOOD follows-up results in the range TRL 1-9 and focuses on applied research leading to products and services (TRL 5-9).

INESC TEC is associate of TICE.PT (ICT companies) and AIFF (forestry companies), a member of the Technical Council of ADVID (wine producers) and a member of AEF (Agricultural Industry Electronics Foundation) and euRobotics. INESC TEC is currently involved in the Digital Innovation Hub "iMan Norte Hub".

As for resources, INESC TEC has available several laboratories, such as Robotics for Agriculture and Forestry, Optical and Electronic Technologies, Computer Graphics and Virtual Environments, Optoelectronics for Sensing Technologies and Smart Grids and Electric Vehicles.

The activity of TEC4AGRO-FOOD will address also visibility, dissemination and interaction. Leveraged by the presence in national (e.g. Agroglobal) and international forums (e.g. Agri Innovation Summit), meetings with decision makers and prescribers will be conducted as well as thematic seminars and open days.

In short, INESC TEC, through TEC4AGRO-FOOD, taking advantage of its competencies, experience and resources in the main digital technologies involved, i.e. Internet of Things (IoT), Artificial Intelligence, Robotics and Big Data, aims to co-shape the digital (r)evolution ongoing in Agriculture and Forestry, including Food Security and Bioeconomy.

6.5.2 Main Achievements in 2017

After the first years of activity, where the strategy was to create critical mass internally and notoriety in the market, which could be considered successfully accomplished:

Internally:

1. creation and development of INESC TEC TEC4AGRO-FOOD Community;
2. selection of the Preferential Contacts in INESC TEC TEC4AGRO-FOOD Community;
3. realization of the INESC TEC TEC4AGRO-FOOD Community Preferential Contacts Meetings;
4. creation of TEC4AGRO-FOOD area and Laboratory of Robotics for Agriculture and Forestry at CRIIS;
5. inclusion of TEC4AGRO-FOOD in INESC TEC communication supports.

externally:

1. projects EasyFlow: A Collaborative Platform for coordinating the logistics in the forest-based supply chain towards sustainability (FCT) and Smart Farming - Advanced tool for the operationalization of precision agriculture (PT2020 Co-promotion);
2. several applications for Direct Contracts, H2020, ERA-NET, POCTEP, PT2020 and PDR 2020;
3. and:
    - members of Rede INOVAR Strategic Council, Working Group UP - AGAVI, AEF and ADVID, Vine and Wine Cluster Technical Council;
    - invitation to participate in Agroglobal, the largest Agriculture professional fair in Portugal;
    - INESC TEC - INIAV Collaboration Protocol;
    - participation in Agrofood, Forestry and Biodiversity FCT R&I Thematic Agenda;
    - Speakers at Vida Económica Conference.

2017 was definitely a fruitful and affirmation year for TEC4AGRO-FOOD.

Regarding projects, the start up of RoMoVi - Modular and Cooperative Robot for Slope Vineyards (PT2020 Co-promotion), AGRINuPeS - Integrated monitoring and control of water, nutrients and plant protection products towards a sustainable agricultural sector (ERA-NET Cofund WaterWorks2015), BIOTECFOR - Biobusinesses and Technology for efficient valorisation of endogenous forestry resources in the North of Portugal and Galiza (POCTEP), GOTECFOR - Technology for the mobilisation and use of Forestry Biomass in agroindustry (PDR2020 Operational Group), Water4ever - Optimizing water use in agriculture to preserve soil and water resources (ERA-NET Cofund WaterWorks2015) and MobFood - Mobilizing scientific and technological knowledge in response to the agrifood market challenges (PT2020 Mobilizer Programme), may be highlighted. It was also in 2017 that the start up of a Direct Contract and partnership with HERCULANO ("Made by HERCULANO powered by INESC TEC") and the start up of Direct Contracts with Symington and The Morton Arboretum (USA), occurred. Furthermore, concerning H2020, Slopebot - Autonomous precision spraying for high-value crops in rough outdoor terrain (INESC TEC as Coordinator) was put on the reserve list and DIVA: Boosting innovative DIgitech Value chains for Agrofood, forestry and environment was approved.

It was also in 2017 that the iMan Norte Hub Digital Innovation Hub, where Agro-Food is included, started.

In what concerns CoLABS INESC TEC participated in the applications for CoLAB Vines&Wines - Portuguese vines and wines, competitiveness and sustainability and CoLAB ForestWise - Collaborative Laboratory for Integrated Forest & Fire Wise Management (INESC TEC as Leader).

INESC TEC co-organised Agri Innovation Summit, which was a joint initiative between a Portuguese Consortium, the Portuguese Government, the EIP-AGRI network and the European Network for Rural Development, SBIAgro 2017, CLBHort 2017 and the 1st Researchers Meeting CITAB (UTAD) - INESC TEC.

INESC TEC participated as Speakers at SBIAgro 2017, CLBHort 2017, XI Maize National Congress and Crédito Agrícola Conference;

Agro-Food and Forestry Business Area was created at INESC P&D Brasil;

INESC TEC continued to participate in the Agrofood, Forestry and Biodiversity FCT R&I Thematic Agenda.

6.6 TEC4ENERGY

Coordinator: Luís Seca

6.6.1 Scope and Objectives

TEC4ENERGY is INESC TEC initiative to induce a market pull drive into R&D and generate a convergence of knowledge and competences into producing solutions in the Energy Sector. INESC TEC is a high producer of research and technology transfer targeting this sector, allowing companies to be internationally competitive with innovative products.

The main drivers are the Societal Challenges and Innovation Strategies for Smart Specialisation defined by EU policies: the energy sector will be heavily digitalized, under user centric and market based approach, requiring the conceptualization and development of disruptive solutions.

The TEC4ENERGY benefits from a strong, recognized INESC TEC expertise in Power Systems, with more than 20 years transferring research results to manufacturers, utilities and large energy users in Portugal, in Europe and Brazil (e.g. EFACEC, ENERCON, EDP, TBE Brazil, etc). This adds credibility to a broader effort, extended to the fossil fuel sector, and encompassing from industry to transportation, buildings and energy efficiency.

The INESC TEC competence in IoT, artificial intelligence, power systems, robotics, sensors, communications and big data will leverage a multidisciplinary capacity to generate innovative advancements. The focus will be on the implementation of optimized, intelligent and sustainable solutions, in software and hardware, for all agents (utilities, industry, transportation, retail) that operate in a broadly defined energy-concerned social structure, including water or waste management when intimate connection with energy, keeping in mind climate change and global warming challenges.

TEC4ENERGY will support the establishment of pluri-annual contract-research programmes with companies - one already up with EDP since 2016 and others under way. It will also support the activity extension to other countries, such as Brazil (using INESC P&D Brasil) and Morocco (Government Agencies IRESEN and MASEN). The structuring of TEC4ENERGY obeys to a planetary vision: energy concerns extend beyond borders and INESC TEC already has international penetration in this area. Building up on on-going activities, TEC4ENERGY will also help to consolidate an international advanced consultancy capacity, already translated into international contracts in underwater HVDC interconnections.

TEC4ENERGY monitors results in the range TRL 1-9 and focuses on applied research leading to products, processes and services (TRL 6-9) that can be transferred from all INESC TEC clusters. A Smart Grid and Electric Vehicle Research Infrastructure (RI) provides interaction and services to industry.

The activity of TEC4ENERGY will also include a strong communication activity, combining classical presence in international fora (industry associations, standards bodies) with open day events, research think-tank and viral communication using worldwide-adopted social media.

6.6.2 Main Achievements in 2017

During 2017, the TEC4Energy initiative was redesigned considering the major challenges that de digitalization that is taking place in the energy sector entails. This task involved working closely to the different clusters of INESC TEC and start aligning the multidisciplinary capacity of INESC TEC towards those challenges identified in the beginning of the year, associated with 7 different domains of application:

- Energy Conversion
- Electrical Network Operation and Optimization
- Efficient Energy Use
- Electric Mobility
- Asset Management and Predictive Maintenance
- Software and ICT for Critical Systems
- Laboratory Services for technology testing

The internal capacity of INESC TEC was promoted through a different set of activities that will be described in detail in the next paragraphs.

Meetings and Workshops for companies

- Workshop with EDP: Several departments of the different companies within the EDP group we invited to participate in a workshop dedicated to the upcoming future of the electrical sector, including digitalization and data analytics as the main drivers for its operation; all the competences within INESC TEC were presented and some prospective projects with concrete software and hardware solutions were discussed;
- Workshop with EFACEC: The innovation director and the different business units (Power Products, Systems and Mobility) were invited to an open workshop on INESC TEC solutions for the sector, with all the clusters presenting their solutions and how they could enrich the manufacturer solutions
- Workshop with APIGCEE (Portuguese Association of large energy consumers): INESC TEC solutions were presented to the representatives of the different companies that are part of the association, highlighting the multidisciplinary capacity of INESC TEC, leading to several direct contacts and technical proposals bearing in mind energy efficiency, decision support and cybersecurity

These initiatives, together with other bilateral contacts with energy sector companies led to a relevant number of projects that resulted in a set of solutions for the sector, that will be descried in the following paragraphs.

Asset Management and preventive maintenance

- implementation of a risk-based maintenance strategy software for the gas distribution network by analysing failure modes, consequences and decision maker's risk attitudes
- estimation of power transformers condition and remaining useful life (RUL) by combining expert knowledge, engineering models and data analytics. The result of the project was an analytical tool to be applied in power transformers that will have a significant impact in this asset management
- fibre optic sensors are being designed and tested to measure vibration and magnetic field for HV lines, and corrosion monitoring in off shore wind parks
- drone with rotary wings o monitor electrical assets, such as, for example, medium and high voltage support, substations and wind turbines. This solution is innovative because it operates autonomously, making it possible to reduce risks and to optimise the inspection process

Electrical Network Operation and Optimization

- simulation user models of PV Plant Controller for solar power plants promotors
- automatic testing routine for SCADA-DMS modules included in Power Systems Applications from EFACEC
- model for Operational Reserve Adequacy, as support tool for adequate planning of generation systems not only to meet long-term capacity requirements but also to cope with sudden capacity shortages that can occur during system operation; the solution is being developed for the Portuguese TSO - REN
- software to calculate the compensations for wind curtailment in the island of Terceira, Azores; the solution was developed for EDA, the network operator of the Azores

Energy Conversion

- development of the business model for a potential start up company that is working on Dye-Sensitized Solar Cells(DSSC) by the Innovation, Technology and Entrepreneurship Centre, a relevant part of the Industry and Innovation cluster
- design of renewable-based energy supply systems for maritime activities, including a multi-temporal energy management tool
- probabilistic wind power forecasting tool installed and operational at EDP Renováveis for their assets in Poland and Romania. This tool is also being used as the internal benchmark model (forecasting accuracy) for contracting new forecasting services.
- development of a 10kW there phase inverter for stationary storage, with capability to operate in islanded mode by including frequency and voltage droop control capacity

Software and ICT for critical systems

- software components needed to manage the Windscanner Portugal infrastructure, namely to support the design and execution of open air field tests, and to support Open Access policies to deal with the collected datasets and related information
- procedures definition for automatic software testing in the division of Information Systems of EDP
- automation of the electronic costumer service support of EDP

Efficient Energy Use

- an integrated energy management system for buildings and households, that resulted from the H2020 AnyPlace project; the solution is currently being tested in the field in 30 households in Germany
- software application that aims to achieve grid responsive consumer-side resources through gamified competition between the building owners using common automation technologies; this work is still being developed in the scope of the Gresbas project

Electric Mobility

- development of controllable EVSE by using the PCS available in the IEC 61851, with interface for mode 2 and 3 EV

Laboratory Services for technology testing

- testing and module integration of Bosch Termotecnologia heat pumps
- testing and integration of GPTECH inverter modules
- testing of different microgrid operation strategies considering the integration of different inverter technologies
- testing of BMS of University of Seville

6.7 TEC4HEALTH

Coordinator: Cristina Guimarães

6.7.1 Scope and objectives

TEC4HEALTH is INESC TEC initiative to induce a market pull drive into R&D and generate a convergence of knowledge and competences into producing solutions for the Health Economy. INESC TEC is already a high producer of research targeting the Health Sector.

TEC4HEALTH monitors results in the range TRL 1-9 and focuses on applied research leading to products, processes and services (TRL 5-9) that can be transferred, in 3 broad areas of application: healthcare providers (primary, secondary and long-term care); patient monitoring (medical devices, e-health, m-health); pharmaceutical industry.

The focus is in human-centered technology, combining INESC TEC cross- Cluster competences: signal and imaging processing, pattern recognition; data mining (image, voice, text); intelligent systems (prediction and decision support), deep learning; robotics and man-machine interfacing. It runs across several areas, such as physics; microelectronics; computing; neurology, neuro-surgery, -physiology, -radiology and biology; systems architecture and interoperability; serious games and optimization. To produce solutions, scientific competences from all INESC TEC Clusters are made to converge, in a process where TEC4HEALTH structures opportunities and the Research Centres perform the R&D.

TEC4HEALTH is being targeted to: chronic diseases (cardiovascular; diabetes); neurological diseases; cancer (breast, lung); disease management; ambient assisted living; sports and wellness; active and healthy ageing and quantified self (personalized medicine & healthy life style).

This strategy is aligned with the EU research agendas. INESC TEC has been involved in H2020 projects, mainly in Societal Challenge 1 Health, Demographic Change and Wellbeing. Also, relevant is the involved in EIP on AHA with submitted commitments in C.2 group as member of the consortium of the reference site PORTO4AGEING, for the Silver Economy.

TEC4HEALTH is already supporting the interaction of INESC TEC with the Health Cluster Portugal (association of companies) to further promote the interaction with technological companies.

INESC TEC work in 2018-22 will cover: Medical Cyber-Physical Systems, Quantified self, Digital transformation, Photonic solutions for point of care diagnostics, Photonic solutions for genomics and proteomics and Photonic solutions for single cell diagnostics. This research will be supported by several research lines such as:

- Quantified self, following the trends of personalized medicine and self-monitoring activities for health sports and well-being;
- Snap-to and under skin advanced human sensing;
- Neuroengineering and human-machine symbiosis
- Biomedical imaging processing
- Health big data safety and security;
- Big health data mining;
- Business Analytics for clinical and operational management;
- Electromagnetic technology for health;
- Optogenetics and optonics micro and nano tools;
- Interoperability in Ambient Assisted Living.

Impact will be maximized through active engagement with world-leading regulatory authorities. On-going collaboration with US FDA aims at a new international standard (AAMI/UL-2800) for interoperable medical systems (to be extended to European and Portuguese safety bodies).

TEC4HEALTH will address also visibility, dissemination and interaction. Leveraged by the presence in national and international fora, meetings with decision makers and prescribers will be conducted as well as thematic seminars and open days.

6.7.2 Main Achievements in 2017

The main actions, that brought together research and industry of this particular sector and sub-sectors, in 2017, were:

a) Promotion and dissemination activities:

- Interface actions with industry: meetings to understand sector technological and innovation challenges and to present INESC TEC competences promoting collaboration with external partners and associated partners;
- Participation in two annual Conferences of Health Cluster Portugal with B2b meetings with participants;
- Close follow-up meetings of challenges posed by I3S, Hospital São João (nephrology, gynecology services, among others), IPO, Centro Hospitalar Vila Nova de Gaia e Espinho; Centro Hospitalar do Porto (H St António); Hospital de Braga and Clínica Saúde Viável;
- Promote and dissemination of H2020 projects as RECAP, and other on-going projects;
- Co-organisation of the participation of TEC4HEALTH in TEC Days, in Aveiro;
- B2B mettings and INESC TEC presentation in “Horizon 2020 Health Partnering Event” in Brussels;
- Participation in Horizon 2020 'Health, demographic change and wellbeing Open Info Day;
- World Café conduction in AAL Forum at Coimbra and B2B meetings;
- Participation in VIDA ECONÓMICA cicle of conferences: “O Setor da Saúde: entre um direito e a oportunidade de competitividade”, in Escola Nacional de Saúde pública;
- Participation and B2B meetings in E-Health Conference promoted by SPMS;

b) Relevant new initiatives:

- Kick-off of KNOWLOGIS project with Glintt Healthcare Solutions S.A. for clinical supplies logistics synchronization with supply chain strategy of a healthcare unit;
- Kick-off of WHERE IS project with Wavecom to develop technology communications and adequate location to indoor environments, based on IoT (Internet of Things) that includes a pilot in “Hospital de Braga” for smart monitoring of equipment;
- Lessons learned meeting on the submission of the two “mobilizadores”: “Medtech2Market” and “Health Gain”;
- Participation in RESOLVE program as associated partner and consultant;
- Kick-off of RECAP preterm Cohort Platform (H2020) - a 20 member consortium to improve health, development and quality of- life of children and adults born very preterm;
- Submission of MIND YOU Effective and personalised intervention for preventing loneliness and depression;
- Submission of WalkingPAD- development of a device / application to help patients in a home-based independent unsupervised exercise program in order to promote patient empowerment in a compromise solution for patient accountability in Peripheral arterial disease treatment.

c) Structural initiatives:

- Meeting with the research groups in order to promote and enhance the infrastructures serving TEC4HEALTH, namely Biomedical Imaging, Bioinstrumentation & Neuroengineering Lab; LABIOMEP - Porto Biomechanics Laboratory and Multimodal Acknowledgeable multiSenSory

Immersive Virtual Environments Lab -MASSIVE, in order to promote internal consortia of research centers to answer to challenges that require a multidisciplinary approach.

- Follow up of the “Nanostima” project deliverables and demonstrations and participation in seminars to discuss results and feel the health and medical devices ecosystem and its challenges;
- Attending webinars on European calls such as: "European funding opportunities for healthcare sector”.
- Participation in EIP_AHA initiatives as member of consortium Porto4ageing, namely in C2 working groups;
- Participation and voting in General Assembly of Health Cluster Portugal;

7 SPECIAL PROJECTS

7.1 CARNEGIE MELLON PORTUGAL PROGRAM

Coordinator: João Claro

The Carnegie Mellon Portugal Program (CMU Portugal) is a platform for education, research and innovation that brings together Portuguese universities, research institutions and companies, and Carnegie Mellon University (CMU). Its mission is to place Portugal at the forefront of innovation in key focused areas of Information and Communication Technologies (ICT), by promoting cutting-edge research, world-class graduate education and a close collaboration with the Portuguese industry.
Launched in 2006, the partnership was renewed in 2012, for five more years, until 2017, and recently for another decade. The activities of the CMU Portugal Program are financed by the Fundação para a Ciência e a Tecnologia (FCT), supported by the Conselho de Reitores das Universidades Portuguesas (CRUP), and co-financed by industry partners and by CMU.
The Program has become a close and productive partnership, shaping minds, advancing knowledge in ICT and in the contexts where it is used, with the potential to improve the lives of people and organisations, fostering cultural change in universities and companies, placing people and organisations in international networks, and serving as a catalyst for innovation, entrepreneurship and economic growth. In its more than ten years of existence, it has established in Portugal a successful international innovation engine in ICT.

The Program's collaborative network involves 15 Portuguese universities, represented by CRUP, four Associate Laboratories in the area of ICT and many other research institutions in Portugal, 19 CMU Departments, over 130 companies, and over 900 graduate students, faculty and senior researchers in Portugal and at CMU.
This collaborative network has focused its activities on:

- talent development - through 8 ongoing dual degree Ph. D. Programs, one ongoing dual degree Professional Master's Program, a Faculty Exchange Program, and an Undergraduate Internship Program;
- collaborative research - through 25 completed R&D projects, 12 ongoing Entrepreneurial Research Initiatives, and 10 recently completed Early Bird Projects, selected in competitive calls, involving multiple Portuguese universities and research institutions, CMU, and companies;
- industry partnerships - through multiple forms of engagement, including the advanced education and collaborative research activities;
- entrepreneurship support - through inRes, an entrepreneurship-in-residence initiative.

The Program has evolved to become a highly dynamic collaborative network of people and organisations, that together act in a sustainable manner as an international innovation engine: integrating a spectrum of R&D activities, from more upstream research, expanding the body of knowledge and looking at enabling the real-world solutions of the future, to more downstream R&D, in very close connection with industry and markets, enabling the immediate next generation of real-world solutions; encouraging and supporting the commercialization of R&D results; and developing the talent with the leadership and the advanced knowledge and skills required to be able to do all this in a sustainable manner, now and in the future.

In 2017 the coordination of the Program in Portugal remained hosted at INESC TEC. Based out of INESC TEC, the Program's National Director, Prof. João Claro, and the executive team carried out the planning, management and coordination of the activities of the partnership in Portugal, including the promotion of the cooperation between CMU and the Portuguese institutions. The executive team also worked in

close integration with INESC TEC's support services and staff on the Program's administrative, legal, and financial management.

At his request, Prof. João Claro stepped down in September 2017, after a five-year tenure as National Director, to refocus his efforts at INESC TEC and FEUP. With the decision by the Portuguese Government to rotate the International Partnerships' coordinating teams, 2017 was the last full year of hosting of the CMU Portugal Program at INESC TEC. Its coordination moved to Instituto Superior Técnico in 2018, and INESC TEC received the coordination of the UT Austin Portugal Program, with the executive team of the CMU Portugal Program becoming the new executive team for the UT Austin Portugal Program.

7.1.1 Main Achievements in 2017

The main activities developed during 2017 included:

- Organization of the annual symposium of the Program under the theme "Building the Fabric of our Digital World", where the key technological advancements that are shaping the contemporary and future digital worlds were showcased and discussed with the Program's community. The event included a Posters and Demo session of the ongoing research projects and exhibition of PhD students research posters;
- Preparation and coordination of the External Review Meetings led by the External Review Committee (ERC) that serves the Program in an advisory role. The ERC reviews annually the activities of the Program and makes recommendations from an independent point of view;
- Preparation and coordination of the Project Review Meetings for the Entrepreneurial Research Initiatives. Each year a panel of international renowned experts assesses and evaluates the progress of the research projects funded in the scope of the Carnegie Mellon Portugal Program;
- Organization of leadership meetings with the Board of Directors and the Scientific Directors;
- Visits to CMU, on several occasions, to meet with different stakeholders and the leadership of CMU, on matters related to the daily management of the Program, and in particular aiming at preparing the Program's third phase;
- Promotion of the Ph. D. Students "Orientation Day", creating an opportunity for dual degree Ph. D. students to get to know the Program better, network with other students, and share their experiences about life in Portugal and at CMU;
- Several public presentation sessions of the three mobility programs: Undergraduate Internship Program, Faculty Exchange Program, and inRes;
- Support and management of the admission of new dual degree doctoral students, and graduate student transfers throughout the year;
- Data collection and analysis of the main outputs of the Program to prepare the annual report of the Program;
- Preparation of a framework and identification of instruments for an impact assessment of the Program - two specific studies were conducted with dual degree Ph. D. students and with inRes participants; a full analysis report was prepared for the latter;
- A new line of funding for Exploratory Research Projects was opened to identify and assess emerging key strategic areas for a potential third phase;
- Several strategic meetings with the main stakeholders, academic institutions and company representatives, to discuss the third phase of the Program, including hosting a visit from the CMU president to Portugal;
- Participation in multiple events, such as "Relações Portugal e Estados Unidos, Passado, Presente e Futuro" hosted by the Ambassador of the United States of America, Robert Sherman; "Caixa Empreender Award" with Caixa Capital, in Lisbon; "Women Summit'17", in Porto; "Atlantic Interactions Research Center - Air Center", hosted by the Minister of Science, Technology and

Higher Education, in Azores; and "European Computer Science Summit", in Universidade Nova de Lisboa.

Throughout the year, the CMU Portugal Program managed its three mobility programs, supporting 11 research internships at CMU for young Portuguese researchers, under the ***Undergraduate Internship Program*** initiative, three faculty exchanges, promoting a positive exchange of culture and experiences at CMU, under the ***Faculty Exchange Program*** initiative, and four entrepreneurial teams, providing them a preparation period in Portugal, followed by a seven-week immersion in the U.S.A., closing with a final public presentation of the results back in Portugal, under the ***inRes*** **initiative**.

The team also carried out all the **strategic and operational management of the Program**, throughout the year, in the following key areas: management of the ongoing education, research, and innovation & entrepreneurship activities; design and implementation of new instruments; institutional and operational mobilization and coordination of the Program stakeholders, in close contact with FCT, CRUP, and multiple higher education institutions, research institutions, companies, and innovation & entrepreneurship support organizations; communication to the Program's community and the public in general of the Program's initiatives, results, and impact; development of the resources and configuration of the processes for the management and coordination of the Program.

7.2 DIGITAL COMPETENCE INITIATIVE

Coordinator: Pedro Guedes de Oliveira

In 2016, the Ministry of Science Technology and Higher Education (MSTHE) created a taskforce the goal of which was to conceive and promote a national programme to increase the number of graduates in ICT at the higher education level. The taskforce was led by Pedro Guedes de Oliveira and its work was concluded in October 2017. Earlier that year, the MSTHE decided to expand the purpose of this program, through an integrated public policy initiative with a much broader scope, organised in five different axes:

Axis 1, INCLUSION: making sure that the whole population has equal access to digital technologies to obtain information, communicate, and interact with others;

Axis 2, EDUCATION: stimulating digital thinking among young population, reinforcing digital literacy and competences at all levels of schooling and as part of lifelong learning;

Axis 3, QUALIFICATION: qualifying the working population by providing them with the knowledge they need to become a part of a labour market that relies heavily on digital skills;

Axis 4, SPECIALISATION: promoting specialisation in digital technologies and applications to improve employability and create a higher added value in the economy;

Axis 5, RESEARCH: enhancing the conditions for the production of new knowledge and active participation in international R&D networks and programmes.

Pedro Guedes de Oliveira was appointed to be the global coordinator of the initiative, where Francisco Vaz and José Maria Azevedo will still be involved, and Sofia Marques da Silva will be appointed as the Coordinator of Axis 1. Additionally, Sofia together with Nuno Feixa Rodrigues, professor at IPCA, will be Assisting Coordinators for the initiative and Lucília Fernandes will continue to assure the secretarial and administrative support. Finally, João Neves will also be involved in a special group dedicated to planning an Integrated Network for Public Communication Services.

In order to support the coordinating activities, a contract will be signed between FCT and INESC TEC.

7.2.1 Main Achievements in 2017

- In cooperation with a group of the University of Aveiro, headed by José Manuel Oliveira and coordinated by Francisco Vaz, 7 TeSP (Cursos Técnicos Superiores Profissionais) were adapted to the Project Based Learning (PBL) methodology, submitted and approved by the Ministry of Education;
- The “new” degrees started in September and by the end of the year a first questionnaire was administrated to monitor the impact on the students (97 respondents), the results of which support the methodology and suggest new actions, namely concerning girls in ICT;
- To extend the initial pilot phase (with only 5 Polytechnic Institutes) working visits to the remaining institutes were completed in the first semester: Castelo Branco in February, Coimbra and Portalegre in April, Santarém in June;
- We helped motivating and accompanied the cooperation between Porto Tech Hub (a tech companies association in the region of Porto) and ISEP to launch SWitCH, a graduate course to retrain STEM degree holders into ICT professionals. The course, taught in a kind of PBL approach, started in September;
- To keep a close link with ICT learning at secondary school level, we cooperated in various ANPRI (Associação Nacional de Professores de Informática) initiatives (meetings, conferences, etc.);
- A web platform for the 5 involved polytechnic institutes was prepared and is ready for use to improve communication and knowledge sharing.
- A final workshop for the global evaluation of the results of this phase the project took place at INESC TEC in October, with the presence of representatives of 14 Polytechnic Institutes. In this

full day workshop, beyond an appraisal of the work done, a joint definition of the transition to INCoDe.2030 was promoted;

- A lengthy report of the whole project was produced and delivered to FCT.

8 SUPPORT SERVICES

8.1 LEGAL SUPPORT SERVICE

Manager: Maria da Graça Barbosa

Table 8.1-AJ - Service team composition

	Type of Human Resources	2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	1	1	2	1
	Academic Staff				
	Grant Holders and Trainees	1	2		-2
	Affiliated Researchers				
	Total Integrated HR	**2**	**3**	**2**	-1
	Total Integrated PhD				
External Collaborators					
	Total	**2**	**3**	**2**	-1

8.1.1 Presentation of the Service

The Legal Support service provides legal advice and appropriate action on most of the legal matters emerging within the INESC TEC universe, namely in the areas of human resources, institutional relations, project contracts and public procurement of goods, services and works. The service is committed to always defend the institution's best interests, not only preventively, ensuring that the institution is compliant with national, European or other applicable legal frameworks, but also in order to repair any damage or minimize costs.

8.1.2 Highlights in 2017

- Intensive contractual activity, either under national, european or international financed projects or direct contracts with several national and foreign companies and institutions;
- Preparation, information and implementation of procedures following the Public Contracts Code's revision, as well as an intensive public procurement activity, both as contracting entity and as tenderer, including the launching of 5 open procedures for acquisition of goods and services;
- Information and implementation procedures for the new legal framework of scientific employment, following the alteration by the Parliament in 2017, and application of the transitory provision to INESC TEC;
- Active participation in the conclusion of drafting process and discussions on the Intellectual Property Regulation;
- Training and promotion of awareness and internal information on legal subjects with relevant or high impact to INESC TEC, namely the European Regulation on Personal Data Protection, which entered in force on the 24th may 2016, to be applied from 25th May 2018 onwards.

1.2 FINANCE AND ACCOUNTING SERVICE

Manager: Paula Faria

Table 8.1-CF - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	4	4	6	2
	Academic Staff				
	Grant Holders and Trainees	2	3	3	
	Affiliated Researchers				
	Total Integrated HR	**6**	**7**	**9**	2
	Total Integrated PhD	1	1	1	
External Collaborators					
Total		**6**	**7**	**9**	2

8.2.1 Presentation of the Service

The Accounting and Finance service is responsible for coordinating and executing the accounting activities, for fulfilling all fiscal obligations and for managing INESC TEC´s cash flow and ensure the availability of enough funds to meet the payments due. In this context, the service acts as a mediator between the institute and external parties, according to the guidelines provided by the Board. From an administrative perspective, it is also responsible for the purchasing and travel processes and for managing the institute insurances and fixed assets.

8.2.2 Highlights in 2017

According with the main actions planned for 2017 and the effective increase in INESC TEC´s activity, the main focus was on improving the quality of the services provided to the Research Centres, with a special attention to the travel and purchasing processes. To cope with the expressive growth of the activity in these processes, nearly 25% more than in 2016, two additional people reinforced the team.

Moreover, the Accounting and Finance service updated its internal processes to ensure an efficient compliance with the organisation and general financing rules.

8.3 MANAGEMENT CONTROL SERVICE

Manager: Marta Barbas
Assistant Manager: Vanda Ferreira

Table 8.1-CG - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	7	8	8	
	Academic Staff				
	Grant Holders and Trainees		1	2	1
	Affiliated Researchers				
	Total Integrated HR	**7**	**9**	**10**	1
	Total Integrated PhD				
External Collaborators					
Total		**7**	**9**	**10**	1

8.3.1 Presentation of the Service

The Management Control service is responsible for coordinating and executing the activities inherent to budgetary planning and control, and also to produce, coordinate and disseminate management information in order to ensure that all resources are obtained and used effectively and efficiently so as to fulfil the purposes of the institution. The service is also responsible for continuous reporting to funding agencies of financial reports and the reimbursement of expenses, monitoring funded projects for compliance with funding agencies terms and conditions by working closely with researchers and providing training whenever necessary.

8.3.2 Highlights in 2017

In 2017, the number of funded projects, i.e., those requiring reporting to funding agencies, was 115, an increase of 21 over the previous year.

The service hosted a European Commission audit to three H2020 European Projects, two FCT audits, as well as audits to three EEA Grants and one P2020 project. The result of these audits was very positive, having established that the service's reporting procedures were in accordance with the rules of eligibility.

Still in December, the service met with DGPM in order to try to reach an agreement on the eligibility of expenses in EEA Grants, which had been rejected due to unnecessary bureaucracy. The meeting was very successful and the eligibility of most related expenses was in fact recovered.

8.4 HUMAN RESOURCES SERVICE

Manager: Maria da Graça Barbosa
Assistant Manager: Margarida Gonçalves

Table 8.1-RH - Service team composition

Type of Human Resources		2015	2016	2076	Δ 2016-2017
Integrated HR	Employees	3	3	4	1
	Academic Staff				
	Grant Holders and Trainees				
	Affiliated Researchers				
	Total Integrated HR	**3**	**3**	**4**	1
	Total Integrated PhD				
External Collaborators					
Total		**3**	**3**	**4**	1

8.4.1 Presentation of the Service

The Human Resources service coordinates and executes all activities pertaining to human resources administrative management and to the implementation of HR related policies, according to the applicable law, internal regulations and guidelines provided by the Board.

Specific duties include follow-up and management of INESC TEC's insurances related to human resources, namely Health Insurance, Personal Accidents and Work Accidents, as well as the follow-up and control of the services rendered by the hired company in the area of Safety and Health at Work.

8.4.2 Highlights in 2017

- Conclusion of the implementation of HR processes in the institution's intranet, in particular the "New Collaborator" workflow, the "historical record" in PHC (HR database software application) and "IRIS";
- Collaboration in the design of the "recruitment process" (INESC TEC's ads) on INESC TEC's new website, and publication of jury minutes in the "Work with us" platform;
- Internal service reorganization, as a consequence of the hiring of a new element;
- Internal production of INESC TEC collaborator cards;
- Participation in the Welcome Sessions for new employees / grant holders, including the delivery of the individual contracts and INESC TEC cards;
- Implementation of the HR ticket service.

8.5 MANAGEMENT SUPPORT

Manager: Maria da Graça Barbosa
Assistant Manager: Isabel Macedo

Table 8.1-AG - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	1	1	2	1
	Academic Staff				
	Grant Holders and Trainees				
	Affiliated Researchers				
	Total Integrated HR	**1**	**1**	**2**	1
	Total Integrated PhD				
External Collaborators		1		1	1
Total		**2**	**1**	**3**	2

8.5.1 Presentation of the Service

The Management Support service promotes the coordination between the Board, R&D Centres and support services, guaranteeing process integration so that the institution provides a coordinated, coherent response. The service also prepares and assures the operationalization of the decision-making process at several levels, from the Board of INESC TEC to other empowered bodies at the institution.

8.5.2 Highlights in 2017

The following aspects can be highlighted in the service activity during 2017:

- Collaboration in the development and launch of INESC TEC's new website;
- Definition and implementation of the documental repository of INESC TEC which will contain diverse types of institutional documents (release planned for 2018);
- Collaboration with SIG in the implementation and release of the Personal Information Page in the institution's intranet.
- Support to INESC TEC's participation in other entities and companies, including the new participation in the Smart Waste Portugal association, the withdrawal from ADDICT and INESC-MN, the sale of the share in Prewind, and the winding up of Kinematix.

8.6 SECRETARIAL COORDINATION

Manager: Grasiela Almeida

8.6.1 Presentation of the Service

The Secretarial Coordination is responsible for managing the group of Secretaries of Centres and Services at INESC TEC in order to guarantee that all typical procedures are coherent and to make sure that all internal rules and procedures are followed in close collaboration with the different organisation and management services. The Coordinator provides feedback to the Board on performance and also supervises the group, anticipating the institutions needs and scheduling secretaries to accommodate absence periods. This service also verifies the constant update of the existing protocols necessary for the current activity of the secretariat group (hotels, renting and travel agencies, among others) and the creation of new protocols, if necessary.

8.6.2 Highlights in 2017

The team of secretaries has evolved to the state presented in the following table, by December 2017:

Secretary	Organizational Structures / Associate Organs	Intervention Areas/ Special Projects	Personal Assistance
Ana Isabel Oliveira	General Council (CG) Fiscal Council (CF) Infrastructures Maintenance Service (SGI)	Board of Directors Budget Infrastructure Management Communications Continuous Improvement	José Manuel Mendonça Mário Jorge Leitão Luís Carneiro
Lídia Vilas Boas	Organization and Management Services (SOG) Funding Opportunities Office (SAAF)	GC Plan and Report FCT Report Scientific Activity – Quarterly control Activity Indicators	Gabriel David João Peças Lopes Rui Oliveira
Sandra Nunes	Conflict of Interest Management Commission (CGCI) Scientific Advisory Board (SAB) Business Advisory Board (BAB) International Relations Office – India (GRI)	Conflict of Interest Process Management Document Repository	Bernardo Almada Lobo João Claro Vladimiro Miranda
Lucília Fernandes		National ICT Training Project	Pedro Guedes de Oliveira José Carlos Príncipe José Fortes
Grasiela Almeida	Enterprise Systems Engineering (CESE) Innovation, Technology and Entrepreneurship (CITE) International Relations Office – Brazil (GRI) Communications and Informatics Service (SCI)	Secretarial Coordination	
Catarina Fernandes	High-Assurance Software (HASLAB)		
Marta Oliveira	Enterprise Systems Engineering (CESE) Innovation, Technology and Entrepreneurship (CITE) Systems Administration Service (SAS) Management Information Systems Service (SIG)		
Vera Pinto		CMU Portugal	
Helena Silva	Industrial Engineering and Management (CEGI) Communication Service (SCOM)		
Joana Dumas	Artificial Intelligence and Decision Support (LIAAD) Advanced Computing Systems (CRACS)		
Renata Rodrigues	Telecommunications and Multimedia (CTM)		
Paula Castro	Power and Energy Systems (CPES)		
Rute Ferreira	Biomedical Engineering Research (C-BER) Power and Energy Systems (CPES) Industry Partnership Service (SAPE) Technology Licensing Office (SAL)		
Luísa Mendonça	Applied Photonics (CAP)		
Ana Paula Silva	Information Systems and Computer Graphics (CSIG)		
Flávia Ferreira	Robotics in Industry and Intelligent Systems (CRIIS) Robotics and Autonomous Systems (CRAS) Library and Documentation Service (BD)		
Sílvia Pina	Robotics and Autonomous Systems (CRAS)		

The coordination engaged in continuous improvement activities with the team of secretary colleagues as well as the remaining INESC TEC services, from which the following can be highligted:

1. Integration in the institution's intranet of scholarship related forms (reports and workplan);
2. Creation of a directory of useful information, available in a shared folder;
3. Training /coaching sessions
    a. Promotion of a "Protocol" Professional Training, lectured by TecMinho;
    b. "Desenrasca-te em Itália", an informal Italian Crash Course, for secretaries and SOG colleagues, lectured by a native;
    c. Information sessions with some departments regarding new processes or tools, namely the Human Resources and Systems Administration Services;
4. Support to the development of new contracts and purchases in the scope of the public procurement process (travel agencies, rental companies and supplier budget control).

Overall, 2017 was a year of consolidation both for the coordination and the team.

8.7 FUNDING OPPORTUNITIES OFFICE

Manager: Marta Barbas

Table 8.1-SAAF - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees				
	Academic Staff				
	Grant Holders and Trainees		1	1	
	Affiliated Researchers				
	Total Integrated HR		**1**	**1**	
	Total Integrated PhD				
External Collaborators					
Total			**1**	**1**	

8.7.1 Presentation of the Service

The Funding Opportunities Office aims at identifying the relevant funding opportunities to support INESC TEC Research, Development and Innovation activities, always aligned with the mission and objectives of the Institute. This service will also support and supervise the development and submission of proposals to different funding programmes, always in collaboration with the R&D Centres and with the other Business Development Services.

8.7.2 Highlights in 2017

From all the activities developed, the service highlights the support and supervision of the submission of proposals to FCT's call for "Projetos em Todos os Domínios Científicos" (Aviso 02/SAICT/2017), from February to May, involving:

- almost 80 coordinated proposals submitted;
- almost 2.000 emails exchanged;
- apart from individual support, the organization of an information session for more than 60 researchers.

8.8 INDUSTRY PARTNERSHIP SERVICE

Manager: Augustin Olivier

Table 8.1-SAPE - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	4	4	4	
	Academic Staff				
	Grant Holders and Trainees		1	1	
	Affiliated Researchers				
	Total Integrated HR	**4**	**5**	**5**	
	Total Integrated PhD	2	2	2	
External Collaborators		2	2	2	
	Total	**6**	**7**	**7**	

8.8.1 Presentation of the Service

The Industry Partnership Service aims at strengthening INESC TEC's approach to the market and achieve higher revenues from industry contracts.

The service is responsible for building strong relationships with partners, identifying business opportunities, negotiate and close industry contracts for innovative projects based on INESC TEC R&D competencies and maintain an extensive knowledge of market trends and conditions. Furthermore, SAPE plans different strategies and prepares marketing contents highlighting INESC TEC added value and differentiation, prospect for new industry partners, organize and set up business meetings and increase INESC TEC business network.

8.8.2 Highlights in 2017

The Industry Partnership Service's highlights for 2017 are related with four main activities.

Activity 1: Organisation based on a multidisciplinary approach

As planned, the TEC4MEDIA, TEC4INDUSTRY and TEC4SEA initiatives started to review and implement their roadmap agendas: for TEC4MEDIA, through the CHIC project, which will execute a roadmap agenda for the creative industries with the implementation of 10 demonstrators; for TEC4SEA, through the TEC4SEA infrastructure, which will implement new tools and structure the connection with businesses; and for TEC4INDUSTRY, through the development of a common vision for the portfolio and the market approach. For all TEC4 initiatives, key fundamental information was collected and organised for inclusion in the institutional website.

Activity 2: Networking and promotion activities for knowledge transfer

During 2017, a multidisciplinary team started to define the requests and functionalities for a Customer Relationship Management solution, based on the institution's characteristics and internal goals for the tool. The service also carried out an evaluation of the potential impact of an "industry affiliates" program on INESC TEC and developed the main guidelines for such a program considering the institution's regional and national contexts. The study, consolidated in an internal report, benchmarked equivalent programs implemented by top ranked R&D institutions and universities all over the world, emphasising

their main drivers of attraction, indicators, and impacts. A first draft of a potential portfolio to be included in this program was created.

In line with TEC4 initiatives, the service participated in the following events, several of which at an international level: Business2Sea, a national event related with the sea economy organized by Forum Oceano (the national Sea Cluster); Oceans Meeting, a national event organized by the Ministry of the Sea; Porto Water Innovation, an event related to sustainability (water and energy); TechDays, a national event dedicated to ICT professionals; Agri Innovation Summit 2017 (AIS 2017); Hannover Messe; CEBIT; Mobile World Congress; and SIMA 2017. The service was highly involved with the National Business Clusters aligned with the TEC4 initiatives, namely: Forum Oceano, Produtech, NEM Portugal, HEALTH CLUSTER Portugal and TICE.PT.

The service organised or co-organised seminars aligned with the smart specialization thematic areas and the societal challenges identified in Horizon 2020, to attract specialized entities and actors working on related sectors: Forum Outuno, dedicated to the Blue Economy; and the Vida Económica cycles of conferences, under the themes “A Economia Portuguesa e a Indústria 4.0 - Agroalimentar”, “O Setor da Saúde: entre um direito e a oportunidade de competitividade”, “Media e Produção de Conteúdos”, “Economia do Mar”, “A Economia Portuguesa e a Indústria 4.0”. The members of the service were also speakers in eight workshops/seminars.

Activity 3: Demonstration of R&D results and technological developments

INESC TEC received regular visits of national and international missions and government entities, as well as from business entities and associations, for which regular demonstrations of R&D results and technological developments were prepared.

Activity 4: New technologies and knowledge dissemination for businesses

For the communication and dissemination of the new thematic organisation, supported by the TEC4 initiatives, several videos were created and new flyers were developed and made available online.

8.9 TECHNOLOGY LICENSING OFFICE

Manager: Catarina Maia

Table 8.1 - SAL - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	1	1	1	
	Academic Staff				
	Grant Holders and Trainees	2	1	2	1
	Affiliated Researchers				
	Total Integrated HR	**3**	**2**	**3**	1
	Total Integrated PhD			1	1
External Collaborators					
	Total	**3**	**2**	**3**	**1**

8.9.1 Presentation of the Service

The mission of the Technology Licensing Office is to protect and license technology developed at INESC TEC. To carry out its mission, the office works in close collaboration with the Legal Support Service and the Industrial Partnerships Service. The office's responsibilities consist of establishing and managing INESC TEC's processes related to: internal scouting and dissemination of research results that can be protected by Intellectual Property (IP) rights; market and state of the art assessment; definition of IP strategy; technology licensing; negotiation and monitoring of licensing contracts.

8.9.2 Highlights in 2017

Following its mission and goals, the service developed numerous activities during 2017. There was a strong focus on scouting in order to fulfil the integrated programs' KPIs, supporting six new patent applications and six European Patent applications, and a direct USPTO application.

There was also a strong focus on securing competitive funding for patent internationalization (ten applications, 100% approval, securing over 400,000 Euros). The business development activities increased both nationally and internationally.

The service highlights the following activities:

- Internal technology scouting – meetings with researchers, provision of information and understanding of which and how technologies are patentable, and roadmap definition towards a successful patent application;
- Meetings with patent lawyers and researchers to develop the terms for patent application;
- Application and execution of national funding for patent applications (Aviso 17 - Sistema de Apoio à Investigação Científica e Tecnológica - Propriedade Intelectual (SAICT - PI) e Sistema de Incentivos à Investigação e Desenvolvimento Tecnológico - Propriedade Intelectual (SI I&DT - PI)), with 11 projects under execution in 2017;
- Collection of INESC TEC's IPR information and contribution to official surveys and requests (e.g. ASTP Proton, ANI);
- Development of exploitation plan proposals and follow-up of INESC TEC's projects;
- Technology vigilance, market research, and business development for licensing opportunities;
- Freedom-to-operate search and analysis for INESC TEC projects and results;

- Business development for INESC TEC technologies in the 2nd edition of the Business Ignition Programme organized by the University of Porto;
- Visit to international fairs, namely Medica 2017 (Dusseldorf), and the IOT World Congress 2017 (Barcelona);
- Participation in national matchmaking events (Forum Oceano 2017 and Health Innovation Market Portugal 2017);
- Participation in advanced courses in Technology Transfer organized by ASTP-Proton;
- Content development for INESC TEC's new website and corresponding service's webpage;
- Appointment of Catarina Maia as European IPR Helpdesk Ambassador for Portugal, integrating INESC TEC's European Enterprise Network team;
- Participation in ANI's working group on collaborative research contracts;
- Contribution for and development of internal policies, namely in the areas of Intellectual Property and Spin-off Companies;
- Training and raising of awareness of IPR matters, both internally at INESC TEC and externally in events, workshops, and courses, such as ASTP's training course "Organising your KTO for Growth and Success", The Hague (NL), 20-22 September 2017.

8.10 INTERNATIONAL RELATIONS OFFICE

Manager: Vladimiro Miranda

Table 8.1 - GRI - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees				
	Academic Staff				
	Grant Holders and Trainees	1	1	1	
	Affiliated Researchers				
	Total Integrated HR	**1**	**1**	**1**	
	Total Integrated PhD				
External Collaborators		3	3	3	
	Total	**4**	**4**	**4**	

8.10.1 Presentation of the Service

The International Relations Office (IRO) is established under the dependency of the Board to organise internationalisation activities in selected countries. The Office focuses specifically on identifying opportunities, concentrating knowledge on research and industrial foreign markets, promoting the attraction of foreign researchers to INESC TEC and acting in general as a facilitator of contacts and relations between research groups in INESC TEC and foreign organizations.
The IRO is a structure constituted presently by two Offices: the Brazil Office and the India Office. These Offices should act as mediators, facilitators or cooperation brokers. The human resources acting in this framework are recruited among the diverse structures of INESC TEC to give specific contributions and do not constitute a full-time dedicated force.

8.10.2 Brazil Office: Highlights in 2017

The Brazil Office handled contacts with INESC P&D Brasil (IB), including the promotion of regular meetings, through video-conferencing, between Directors of IB and members of the office or Brazilian researchers in INESC TEC.

Activities encompassed handling contracts between Portugal and Brazil, as well as being the front office for contacts and hosting Brazilian researchers, at post-graduation and post.doc levels.

The Office also organized regularly (monthly) the cultural event “Café com Pão de queijo”, aimed at promoting contacts between the diversity of the Brazilian society, uses, traditions and landscape, with other communities at INESC TEC. This counts as an effort to promote a seamless integration of the Brazilian community in the INESC TEC environment.

8.10.3 India Office: Highlights in 2017

The India Office designed a strategy to gain knowledge about the reality in India, in science and technology. It developed a plan to develop a set of actions that ultimately will lead to an increase in cooperation between INESC TEC and high level India Universities and R&D organizations and in the interest of Indian nationals to come to INESC TEC.

Contacts were initiated with a number of institutions with the support of the Embassy of India in Lisbon, and a set of visits to such institutions in India was agreed upon, to be carried out during 2018.

8.11 COMMUNICATION SERVICE

Manager: Sandra Pinto

Table 8.1 - SCOM - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	2	3	4	1
	Academic Staff				
	Grant Holders and Trainees	2	3	3	
	Affiliated Researchers				
	Total Integrated HR	**4**	**6**	**7**	1
	Total Integrated PhD				
External Collaborators					
Total		**4**	**4**	**6**	**7**

8.11.1 Presentation of the Service

The Communication Service collaborates with the Board in order to define the institution's communication strategies and image. Its main activities are planning, implementing, organising and coordinating both internal and external communication in accordance with the regulations and procedures established, promoting the image and prestige of the institution.

8.11.2 Highlights in 2017

External Communication

- The most relevant communication milestone of INESC TEC in 2017 was **the launch of a new institutional website** in December. For about a year and a half, a team of nine people, including two SCOM elements, worked on specifying the requirements of the website, benchmarking, sitemap definition, features and functionality, content production and images, website implementation, and revisions, culminating in the new website marketing campaign.
- In addition, a **new corporate identity** of INESC TEC was defined. The previous identity was in a deficit state in recent years, with only the logo and some applications. Of particular note in this process is the creation of a specific image for the clusters and the TEC4 initiatives, which will certainly contribute to a clearer structuring of the R&D activity and market-orientation.
- The efforts made to achieve greater visibility in the media have led to a **more sustained presence of INESC TEC in the main Portuguese media outlets**. A clipping service hired for this purpose accounted for 1,031 news pieces in 2017, 78 more than in the previous year. The Automatic Advertising Value (AAV) return was approximately EUR 6 million (€5.861.876,48).
- With regard to **Social Networks**, the INESC TEC pages on Facebook, LinkedIn, Twitter and Instagram registered a good performance in 2017, contributing to dissemination and brand recognition, and to the creation of an involved community. On Facebook there was an increase in the frequency of publications, with the annual total reaching 693,424. On LinkedIn, page engagement increased from 1.4% in 2016 to 12% in 2017. Twitter had the highest growth in the network of followers (+ 183% followers compared to 2016). Instagram was the most active network, with a growing community (+ 95% followers compared to 2016).

- It is important to highlight an annual event that is exclusively organised by INESC TEC and open to the public: the **"Fórum INESC TEC do Outono".** The 2017 edition focused on the theme "Ocean Engineering: Challenges and Opportunities". This event, which featured SCOM in the organising committee, had a tremendous impact and made INESC TEC known for the quality of the presentations and debates, the number of executives and managers present and the opportunity to promote new projects regarding the sea area and new business partnerships.
- In 2017, INESC TEC also participated in **various events that promoted the image of INESC TEC abroad**, such as Hannover Messe, Business2Sea 2017, Ocean Business in Lisbon, Porto Water Innovation Week 2017, Agri Innovation Summit 2017 or IPL 4.0.
- In its mission to **support the R&D centres**, it is important to stress the work in the European projects UPGRID, FEEdBACk, GReSBAS and InteGrid, whose dissemination activities are carried out by a SCOM collaborator. Additionally, it is worthy of note the support of the Communication Service in activities related to the European Enterprise Network, the integrated projects Nanostima and TEC4Growth and also the StrongMar project.
- It is worth mentioning the **production of promotional videos** for events and exhibitions, with 30 videos produced in 2017. The **photographic coverage of events** reached 100 albums in 2017.
- In terms of **materials**, exhibition stands, flyers and roll-ups were produced for various Centres, as well as stickers, templates, facts sheets, brochures, booklets, t-shirts and vinyl banners.
- Equally important is the collaboration with Ciência Viva to **disseminate science among younger generations**, namely as part of the initiative "Ocupação Científica nas Férias - Jovens Ciência Viva nos Laboratórios". Other activities include the institutional participation in events such as the European Researchers' Night, FEUP's SPE (Engineering Week), reception of the FEUP New Students and the Mostra of the U.Porto.
- **INESC TEC's monthly newsletter** (BIP) is available in Portuguese and English on INESC TEC's website. With the English version being disseminated quarterly to Universities in 25 countries, it is one of the institution's most effective communication instruments. In fact, the AWStats statistics system shows that people from 102 countries have visited the newsletter's website, with Portugal, USA, Brazil and United Kingdom being the most frequent, in a total of 421,306 page hits, and 137,826 visitors.
- A note should also be made for **the INESC TEC sponsorship of events** such as the 8th Symposium on Bioengineering or the Engineering Doctoral Congress (DCE17). In these events, in addition to receiving and assessing the support requests (15 requests in 2017), SCOM deals with the operationalization of all opportunities offered to INESC TEC by the organisers.

Internal Communication

- A Team Building action, "**INESC TEC on the move**", was first organised in 2017, providing moments of cooperation and teamwork, by putting participants to test with competition activities.
- A new format was also inaugurated for an annual **Strategic Meeting**, which brought together about 120 people to reflect and discuss basic themes for the future of the institution.
- In order to strengthen internal cohesion, in 2017 SCOM continued to **promote group activities**, such as the photo contest, the "magusto" and the multicultural party.
- In 2017, eleven **monthly sessions were organised to welcome new employees**. These sessions were designed by SCOM, always in articulation with the Human Resources service.
- Considering that the Media are increasingly involving researchers in interviews and news reports, SCOM organised two **Media Training sessions** to improve communication skills.

8.12 NETWORKS AND INFORMATICS SERVICE

Manager: Gil Coutinho

Table 8.1 - SCI - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	3	2	2	
	Academic Staff				
	Grant Holders and Trainees	1			
	Affiliated Researchers				
	Total Integrated HR	**4**	**2**	**2**	
	Total Integrated PhD				
External Collaborators		1		1	1
	Total	**5**	**2**	**3**	1

8.12.1 Presentation of the Service

The mission of the Networks and Informatics Service is to provide for the communication needs of INESC TEC's community. This service manages INESC TEC's voice and data communication infrastructures and is responsible for the implementation and maintenance of network-based services, as well as for providing the corresponding support.

8.12.2 Highlights in 2017

During 2017, a comprehensive revision of INESC TEC's network services and the underlying infrastructure was conducted. This revision resulted in transformations and reorganisations of some services during 2017 and triggered follow-up studies for action in 2018.

Restructuring of the Wi-Fi infrastructure resulted in better access conditions to the academic wireless network "eduroam", which led to a very significant increase of simultaneously associated stations. Similarly, the implementation of an opensource based VPN concentrator has provided all INESC TEC users with the ability to remotely and securely connect to the internal network, while choosing among a wide range of modern VPN technologies compatible with native clients of most common operating systems.

Core network routing topology and configuration was also optimised, leading to an increased performance and better utilisation of the available Internet bandwidth. Consequently, access to Internet based services was broadened, allowing internal users to access a larger set of services such as external VPNs, messaging services, etc.

In order to increase overall network resiliency and flexibility, a reinforcement of the optical fibre cabling between the two main datacenters was conducted, paving the way for full network and system redundancy between the two buildings. Cabling subsystems of each datacenter have also been slightly reorganised.

Recurring failures in the cooling system of one of the datacenters, as well as its low energy efficiency and high noise levels, motivated its complete decommissioning and replacement by a solution that is now redundant, more efficient, less noisy and with lower maintenance costs.

During 2017, conversations with the national research and education network's (RCTS) operator (FCT-FCCN) were conducted, in order to evaluate the feasibility of INESC TEC's integration, particularly without associated fees. These negotiations were fruitful and, by the end of the year, initial tests of a 10 gigabit/s

connection were conducted, following the deployment of an optical fibre cable between INESC TEC and RCTS's point of presence (FEUP). This ultimately led to designating FCCN as INESC TEC's Internet access provider at 10 gigabit/s speed, and to the discontinuation of the two commercially operated 100 megabit/s links (early 2018).

A close cooperation with the Systems Administration Service has permitted a more efficient use of computational, storage and networking resources, avoiding not only the waste of available capacity but also the duplication of tasks across teams. This work method effectively resulted in a number of optimisations, for example making 10 gigabit/s connections available to all servers or reutilising storage elements in order to provide for datacenter redundancy. Furthermore, network service's physical servers, some of which were out of date, began to be virtualised in this joint infrastructure, which resulted in simplified management processes, more efficient backup solutions and ultimately fewer costs. Also, the authentication servers of the updated network services were integrated with INESC TEC's directory, paving the way for a single set of credentials for all services.

Finally, during 2017 the email service has undergone a significant number of interruptions and performance degradations, mainly due to hardware failures and capacity shortages. Consequently, a large number of tuning or repairing operations were conducted, in strict cooperation with the Systems Administration Service. Simultaneously, both teams began the study of a clean slate email system, to be deployed during 2018.

8.13 MANAGEMENT INFORMATION SYSTEMS SERVICE

Manager: José Carlos Sousa

Table 8.1 - SIG - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	3	3	4	1
	Academic Staff				
	Grant Holders and Trainees		2		-2
	Affiliated Researchers				
	Total Integrated HR	**3**	**5**	**4**	-1
	Total Integrated PhD				
External Collaborators					
Total		**3**	**5**	**4**	-1

8.13.1 Presentation of the Service

The Management Information Systems Service is in charge of the development and maintenance of INESC TEC's management information system.

8.13.2 Highlights in 2017

- Implementation of new development, testing and production infrastructures;
- Implementation of INESC TEC's Institutional Repository for scientific publications and administrative archival documents, and implementation of the Research Data Management Repository;
- Increased SAP integration with the institution's intranet, providing online access to available budgets in projects and in the global accounts;
- Follow-up on the implementation of the new INESC TEC website, providing information collection services from the various existing systems;
- Finalization of the new collaborator process, that facilitates a faster onboarding of the collaborator into the institution's systems;
- Automation of publication data retrieval from Authenticus, and support to ad hoc changes indicated by the monitoring committee;
- Institutional indicators management;
- Partial implementation of the new IRIS - INESC TEC Research Information System (human resources, publications and theses);
- Integration of the individual activity plans and reports for grantees in the HR processes.

8.14 SYSTEMS ADMINISTRATION SERVICE

Manager: Jaime Dias

Table 8.1 - SAS - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees		3	3	
	Academic Staff				
	Grant Holders and Trainees				
	Affiliated Researchers				
	Total Integrated HR		**3**	**3**	
	Total Integrated PhD				
External Collaborators					
Total			**3**	**3**	

8.14.1 Presentation of the Service

The Systems Administration Service is responsible for managing servers, computer systems and collaborative applications, for providing support to end-users and for Research and Development. This Service is also responsible for managing the INESC TEC Living Lab, in collaboration with Centres and other Services, to enable INESC TEC's building and infrastructures as real life testbeds while promoting R&D results.

8.14.2 Highlights in 2017

The SAS team concluded the installation and configuration of the computing cluster and related infrastructure services that begun in 2016. During 2017, the cluster hosted around 160 virtual machines, 95% of which, servers for hosting new application services and Research & Development applications. In order to satisfy the growing demand, at the end of 2017, a set of five new servers were about to be acquired.

The main INESC TEC services, which include the INESC TEC website and Intranet have been migrated (virtualized) to the computing cluster. The infrastructure services include the Directory (LDAP service), which synchronizes with the Human Resource's database, enabling users to access INESC TEC services with a single password and to easily but securely reset the password in a single place. By synchronizing with the HR database, user accounts are created and disabled automatically without user intervention. This enables a better user experience while increasing the control over the INESC TEC resources. New services are connected with the Directory from the start, creating a seamless experience to users and paving the way for a faster adoption of the new services.

Due to the growing demand for GPU based High-performance computing, SAS created a think tank team with researches from several centres to evaluate and assess the requirements and needs of new GPU based HPC computing platforms. This work will continue throughout 2018.

SAS deployed new collaborative application services in 2017. The main ones are highlighted:

- The "Drive" (drive.inesctec.pt) is an on-premises file access and sharing service for Services and Centres. This file sharing service gives to centre coordinators and service managers greater control over the data and guarantees that the data is not lost due to, for instance, accidental deletion or due to unavailability of the data when users, with personal accounts in external services like Dropbox, cease to work at INESC TEC. The Drive is actively used by more 120 INESC TEC users.

- The “Chat” (chat.inesctec.pt) is an on-premises chat-op service, which enables users to organize their communications by teams and channels, and communicate securely. The chat service also enables automation tasks and integration with Gitlab and other development platforms. While still in its beginning (it was made available in the last month of 2017), the Chat service already accounts for 30 teams with 178 users.
- The Gitlab (gitlab.inesctec.pt), an on-premise Git repository service, was connected with the Directory. Moreover, in 2017, the integration of new services with Gitlab, including the new Chat service, was started, to enable the full DevOps production chain - from Development to Production. The full DevOps platform aims at increasing the productivity and quality of the software developed but also correcting bugs and updating software in production with minimal downtime. The Gitlab services already counts with 379 active accounts, including 57 accounts from external users (INESC TEC partners) that rely on INESC TEC services to actively develop and store the code. Within a single year, INESC TEC collaborators created 945 Gitlab projects, demonstrating the good adoption of Gitlab and related tools.
- The Knowledge Base (help.inesctec.pt), an on-premise wiki service, was deployed, integrated with the Directory, and made available to the INESC TEC community. Its main objective is to present frequently asked questions (FAQ), HOWTOs for everyday configurations, and help with common issues.
- The SAS team deployed the INESC TEC scientific dataset repository - RDM (rdm.inesctec.pt) - in close collaboration with INESC TEC researchers that developed and configured some of the main parts of this service. Ever since, the RDM has been receiving datasets from INESC TEC researchers.
- Web hosting service demand increased considerably, growing from around 20 web sites in 2016 to around 80 web sites in 2017. The SAS is responsible for the hosting and security monitoring of web framework instances such as Wordpress.
- During 2017, the SCI (Networks and Informatics Service) management changed, resulting in a close working relationship between both services that enabled better usage of resources such as network, servers and storage equipments. For instance, the planned acquisition and configuration of new networking equipment to interconnect the cluster servers with redundant 10 Gbit/s Ethernet links was handed to the SCI team while the management and exploitation of the SCI underused servers and storage was handed to SAS. Several SCI physical servers were virtualized to run on the computing cluster in order to increase the computing resources and availability of these virtualized servers.
- Due to hardware failures of the e-mail server and storage equipments, and due to the growing demand of the mailbox size and number of users (unlike in previous years, users were not requested to have mailboxes under a 1 Gbyte quota anymore), the SAS and SCI teams worked closely to overcome interruptions and performance degradations. For instance, besides extensive tuning of the configurations, the mailboxes storage had to be fully changed in a two-step process, to minimize the downtime of the email service, and the mailbox server was virtualized to increase the resources.
- After the SCI management change and email equipments hardware faillures, it was decided that INESC TEC needed a new e-mail service, where the email clients’ management, mailbox server, groupware and interconnection of these with other collaborative services will be managed by SAS while SCI will focus and optimize the email communication with the Internet, for instance, on the Mail Transfer Agent, anti-SPAM, and anti-malware. During 2017, a thorough study for a new email system was carried out. The new email system will be deployed throughout 2018.
- While there were many advances and work in the system administration tasks, the tasks related with support to end-users and for Research and Development were those that took the most part of the time. Two thirds of the SAS team spend around 80% of their time on support requests. The

SAS team handled and closed around 1300 support tickets. However, these support tickets only account for around 60% of the support requests, which means that the total number of support requests during 2017 exceeded the 2,000 support requests mark.

- The SAS Team manages around 200 PCs, 70 in the services and 130 in the centres. The management includes software and hardware maintenance.
- During 2017, SAS renegociated the MathWorks License Agreement (Matlab) and the Microsoft Site License Agreement for Schools (OVS-ES), including Office 365 licenses for all the INESC TEC users with no addicional costs. Whenever required, SAS helps secretaries and users assessing technical requirements of computer and software aquisitions and, when these are more complex, SAS also requests the quotes.

8.15 INFRASTRUCTURE MANAGEMENT SERVICE

Manager: Jorge Couto

Table 8.1 - SGI - Service team composition

Type of Human Resources		2015	2016	2017	Δ 2016-2017
Integrated HR	Employees	4	5	4	-1
	Academic Staff				
	Grant Holders and Trainees				
	Affiliated Researchers				
	Total Integrated HR	**4**	**5**	**4**	-1
	Total Integrated PhD				
External Collaborators					
Total		**4**	**5**	**4**	-1

8.15.1 Presentation of the Service

The Infrastructure Management Service assures the support services necessary for the adequate management and maintenance of INESC TEC buildings infrastructures.

8.15.2 Highlights in 2017

During 2017 the following activities and results can be highlighted:

- The active and passive security of the INESC TEC building was improved with the implementation of safety regulations, and improved access control;
- Maintenance actions in the buildings' electrical infrastructure were implemented on the main and partial LV switchboards;
- Rationalization and optimization of the air conditioning infrastructure in order to improve comfort levels and reduce costs;
- Actions to prevent and fight building fires were also implemented, namely improvement and technical verifications of equipment installed at INESC TEC buildings to detect and fight building fires;
- Improvement of internal processes allowing better maintenance and support services with the existing resources;
- A hybrid car was acquired to respond to the increased car usage and reduce the costs with car rentals and fuel;
- Recycling processes and awareness were improved.

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