INESCTEC

INESC TEC
ACTIVITY PLAN
2017

INESCTEC

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1 INTRODUCTION

The purpose of this document is to present INESC TEC Plan of Scientific and Technological Activities for the year 2017.

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

The research at INESC TEC is developed in 13 Research Centres, under four stable 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 and their objectives for the short and medium term.

Section 5 refers to INESC TEC 13 Research Centres, their objectives, activity plan and activity indicators for 2017, following the same order of the Clusters in Section 4.

Section 6 introduces two “special” projects that run at INESC TEC: Carnegie Mellon Portugal program and the Digital Competence Initiative.

Section 7 refers to the TEC4 initiatives which articulate INESC TEC’s activity towards the market and details the examples of the TEC4Sea and the TEC4Media.

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

2 INESC TEC PRESENTATION

2.1 Scope and Mission

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

INESC TEC's associates are the University of Porto, INESC and the Polytechnic Institute of Porto, and the institute also has as privileged partners the University of Minho and the University of Trás-os-Montes e Alto Douro. Presently, its 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 thematic domains - Computer Science, Industry and Innovation, Networked Intelligent Systems, and Power and Energy – and at the end of 2016 hosted 726 integrated researchers (343 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 of the academic and business worlds, bringing closer together academia, companies, public administration, and society, INESC TEC typically applies 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 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 strategic motto for 2015-2020 was defined as THE CHALLENGE OF PERVASIVE INTELLIGENCE. It reflects the view of INESC TEC researchers on the broad lines of development of Science and Technology (S&T) in the four above mentioned domains, and their application to real life.

The continuous pursuit of excellence by INESC TEC is driven by a bold response to S&T daring challenges and the originality and strength of the management model in S&T.

The S&T driver is decomposed in four perspectives, coherent with the definition of the four INESC TEC Clusters:

POWER AND ENERGY SYSTEMS

The cities in the future will become places of intense energy exchanges with strong distributed generation and storage (home and electric cars) and not only consumption. The generalization of the concept of Smart Grid demands original solutions with massive integration of renewable energy with telecommunications, control and new devices. INESC TEC will work for the power system of the future, with highly decentralized control loops and distributed intelligence taking care of local decisions, with a huge challenge in massive data flows in an environment of augmented uncertainty.

INDUSTRY AND INNOVATION

Modern supply chains and collaborative networks are based on increasingly complex and dynamic flows of materials and information, integrating the delivery of customized products and services. INESC TEC will develop innovative tools, based on massive data mining, simulation and optimization, to provide the pervasive intelligence required for their design and management. Collaborative robots and advanced automation will support further improvements in efficiency and flexibility and will enable a higher level of integration and data capture supporting the concepts of Industry 4.0. These results will be guided by research in innovation processes, thus building strong bridges to economics and management.

NETWORKED INTELLIGENT SYSTEMS

The pervasive ambient intelligence will constitute the fabric of the daily life in the future cities and rural areas. INESC TEC envisions a lively and sustainable world where networked intelligence enables ubiquitous interaction with sensory-rich content, with interoperability of a diversity of technologies. New sensors and devices based on optical technology will be developed to build interfaces of the communication fabric with the real world. INESC TEC will also be at the forefront of the exploration of a new frontier - the deep sea. Distributed intelligence will combine fleets of autonomous robots with an augmented environment perception, bringing challenging requirements for underwater sensors, equipment and broad band wireless communications. Biologic optic-based sensors, coupling physics with chemistry, will be another challenge met by INESC TEC and will serve also the biomedical engineering domain, where strong advancement in signal and image processing will be coupled with pervasive knowledge extraction.

COMPUTER SCIENCE

INESC TEC aims at excelling in the control of the chain data>information>knowledge for pervasive and massive data repositories and data flows. This includes the components of new high-level languages, distributed computing, critical software, privacy protection, pervasive cyber security and generalized knowledge extraction, namely from massive spatio-temporal distributed and geo-referenced databases possibly lodged in moving media.

2.3 Strategy

INESC TEC's strategy is driven by a conceptual vision that encompasses the following 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

Without excellence, all aspiration to world recognition and relevant impact in leading companies is void of hope. Therefore, the resolve in making robust a culture of demanding responsibility, quality, accountability, productivity of advanced science must be sustained at all cost. Most of all, incentives and recognition to high level science and researchers must be present. At INESC TEC, the classical indicator of quality (papers in international journals) has witnessed a steady growth that has moved the ratio papers/researcher to a reference value at international level for the areas of activity covered. A continued effort in pursuing excellence and valuing excellence as the trade mark of INESC TEC is the basic requirement for this step to be taken.

2.3.2 Excellence in talent development

The deep involvement in Doctoral Programmes is a necessary condition to have available human resources to conduct research and then to publish results. INESC TEC must be able to add value to Doctoral Programmes in the several institutions that are in one way or another associates. In particular, the MAP (Minho-Aveiro-Porto) programmes in computer science and in telecommunications, as they join the strongest schools in the north of Portugal, should be examined as possible models to be extended to other areas. The requirement to take this step is the strengthening of the alliance between INESC TEC and the Faculties/Universities to reinforce these programmes.

2.3.3 Excellence in technology transfer and collaboration with industry

The other face of the coin representing INESC TEC, as an interface organization in Engineering, must be the capacity to produce socially relevant results and transferring them to relevant companies. The relations with industry are crucial, and INESC TEC must be perceived as a partner of excellence able to provide unique

knowledge and technology relevant for product and process innovation in companies. The requirement here is that all Research Centres of INESC TEC may contribute to this objective – either directly or by integrating a process of knowledge transfer with other Centres.

2.3.4 Managed Science Model

INESC TEC's management and operational model implements the concept of the knowledge-to-value production chain, leading the research activity from knowledge generation to its valorisation through a mix of processes of technology transfer, from pure transfer of technology to collaborative development, advanced consulting and training, until the possible creation of spin-offs.

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

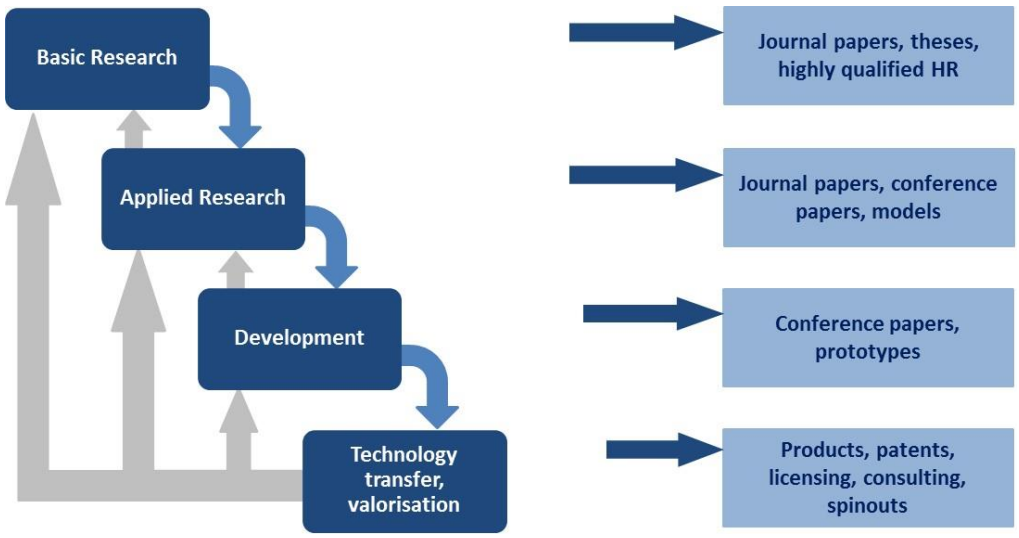

Figure 1 - Knowledge production and valorisation chain concept

The figure also shows some 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, 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.

INESC TEC Centres present distinct coverage of this chain. Some are more research oriented and are therefore positioned in the early stages, while others are more market oriented and thus their activity has a higher share in the later stages. The idea is not that all Centres will cover the whole chain; but their organisation must allow for knowledge flow, not only within each Centre but also between Centres, so that INESC TEC as a whole and its four Clusters can perform research and produce what is socially relevant. This means that INESC TEC will focus on both science and technology transfer.

The success of this model relies on the capacity or ability to allow or guarantee an easy flow from top to bottom and a feedback in the reverse direction. In order to achieve this, one does not require that each researcher should act on every stage of the chain – however, there is a definite incentive for the Centres to have a large enough dimension so that they can accommodate a broad spectrum of activities.

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 dynamics among the several Centres. While the Clusters and the TEC4 initiatives, described below in the Managed Science Model section, play a key infrastructural role towards this purpose, other measures have been implemented, which include, among others: encouragement of research projects joining together more than one Centre; encouragement of cooperation in co-authorship of papers with authors from different Centres; special actions called LAI (Inter-Centre Action Lines), put in place to allow cross-centre fertilization; frequent conduction of direct contracts with industry by a team constituted by members from several Centres; adequate management and accounting procedures to allow a Centre to use resources (including researchers) from other Centres.

2.3.6 Scale, density, critical mass

The recent years have been devoted to growth and densification of the coverage of important areas of knowledge and capacity.

A few examples: (1) the area of computer science, for years identified as a weakness of INESC TEC, witnessed the aggregation of several groups (LIAAD, CRACS and HASLab), none connected with the School of Engineering and one of them not related to the University of Porto; (2) the area of control and robotics has been reinforced with the integration of an external group from the School of Engineering and another from the Polytechnic Institute of Porto (IPP); (3) the area of Industrial Management has been reinforced with the association of a new Centre (CEGI) formerly external to INESC TEC; (4) the programs run by FCT (Foundation for Science and technology, Government of Portugal) supporting the contracting of scientists have been used to reinforce fragile areas where excellence should be maintained – such is the case of optoelectronics (CAP), very much depending on the faculty of the School of Sciences in scarce number.

So far, the basic requirement to take this step has been met, the challenge for the future will be the consistent effort to focus the activity and attract leading researchers to further reinforce INESC TEC's critical mass.

2.3.7 Integration

INESC TEC cannot become a loose federation of almost independent Centres or its potential will be put in jeopardy. Some Centres at present have more than 100 researchers and therefore the risk of self-containment in each private universe is real.

The Clusters and the TEC4 initiatives, described below in the Managed Science Model section, are key instruments in INESC TEC's active policy for achieving cohesion in the institution. 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 involving multi-disciplinary teams.

2.3.8 International visibility and presence

One only exists when one is seen. Moreover, one is only valued when one is measured. The importance of international projects and activities is crucial to achieve the status of world player. The long-term objective is to guarantee that the international activity of INESC TEC may be accounted for a significant part of the total activity, measured in indices of scientific output as well as financial results. To reach excellence in science and technology, it is essential to collaborate and develop strong partnerships with leading international research institutions.

To achieve this, a first requirement must be taken in account: the massive presence in the European research effort consubstantiated in the so called European projects.

A second requirement is the constitution of a base of operations outside Portugal, to gain access to projects, funding, human resources and ultimately to conquer the status of multi-national organization. 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 light.

2.4 Managed Science Model

2.4.1 Management

In terms of coordination, 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 Supporting Services, meeting every other week. This ensures cross-centre coherency in vision and policy and co-responsibility both in strategic and current management decisions.

The International Scientific Advisory Board is another important structure, whose composition reflects the diversity of areas and interests within INESC TEC. It has always had a relevant role in permanently auditing the activity and counselling the Board. Its recommendations have been valued 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 trimester, considering economic and scientific perspectives. The implementation of the annual Plan of Activities is equally monitored. Each researcher is subject to an evaluation process every year and grant holders every three months. In order to provide the right behaviour signals, INESC TEC has in place a set of incentives that go from performance supplements to publication prizes, depending on the quality and productivity.

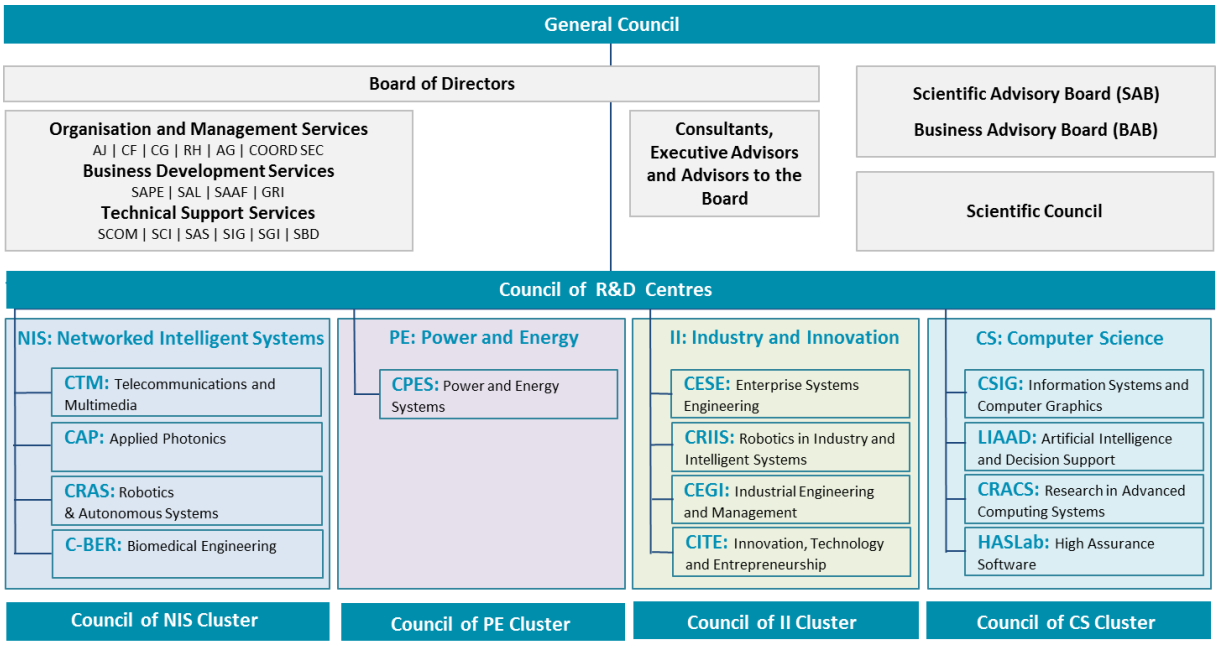

Figure 2 - INESC TEC Organisational Structure

2.4.2 Clusters

The research at INESC TEC is developed under 13 Research Centres, organised in four stable structures denoted 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 gather together their “core” Centres in their specific domain and articulate and interface with other relevant Centres, denoted “associated” Centres. The strategy in a Cluster is designed 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 responsible for its own planning and strategy and answers 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 the market strategy and planning INESC TEC's interaction with its main markets or application areas. A TEC4 must not be confused with a Cluster: it is a process implementing a market pull vision and does not have a rigid core of Research Centres. Instead, a TEC4 initiative provides coherency to the cross-Cluster intervention of all Centres in specific markets, or economy target areas.

A TEC4 is not driven by science but by a market of application domain perspective, where multidisciplinary interventions are usually important. A TEC4 initiative establishes a network of contacts and dialogue with industrial partners and brings back into the several INESC TEC Centres major challenges and the identification of opportunities.

The TEC4s are not rigid or permanent structures like the Clusters are. They are flexible, evolving and adaptive to external conditions and internal response. Examples of TEC4 initiatives being developed are: TEC4Sea, TEC4Health, TEC4Agro-food, TEC4Media, or TEC4Energy.

2.4.4 Supporting services

A streamlined and dynamic team of highly qualified technical and administrative personnel provide support to the activities in INESC TEC. Much of the capacity and excellence of these supporting services derive from the continued internal policy of permanently qualifying human resources. For instance, several of the administrative staff hold MSc degrees and three have a PhD degree.

The supporting services are organized and managed under the principle that they must alleviate the researchers from all administrative and bureaucratic burden. Additionally, one member of the staff has also been a National Contact Point of an EU R&D programme, being a highly valuable experience. A set of services are organized to serve the researchers: juridical, project management, accounting, information management, human resources, computing and communications, media. Furthermore, each research Centre has its autonomous administrative support, with staff also qualified at the same high level.

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

3 MAIN INDICATORS FOR 2017

This section presents the main global indicators for INESC TEC, regarding human resources, activity in projects and scientific publications planned for 2017. The presentation of each Cluster and R&D Centre and detailed discussion of its objectives, activities and results is carried out in Sections 4 and 5, respectively for Clusters and Centres, and in Section 9 for the Supporting Services.

3.1 Human Resources

3.1.1 Global Indicators

Table 3.1 and Figure 3.1 show the breakdown of INESC TEC Human Resources by type of contractual link with INESC TEC and the expected evolution for 2017. The number of PhDs is also shown (353 expected in 2017).

Table 3.1 – Evolution of INESC TEC Human Resources

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016-2017	
Integrated HR	Core Research Team	Employees	56	56	75	19	34%
		Academic Staff	196	200	192	-8	-4%
		Grant Holders and Trainees	307	400	452	52	13%
		Total Core Researchers	**559**	**656**	**719**	**63**	**10%**
	Affiliated Researchers		62	59	38	-21	-36%
	Management, Administrative and Technical	Employees	53	59	64	5	8%
		Academic Staff	8	8	8	0	0%
		Grant Holders and Trainees	17	25	19	-6	-24%
		Total Manag, Admin and Tech	**78**	**92**	**91**	**-1**	**-1%**
	Total Integrated HR		**699**	**807**	**848**	**41**	**5%**
	Total Integrated PhD		**329**	**347**	**353**	6	2%
Curricular Trainees			70	36			
External Research Collaborators			75	102			
External Administrative and Technical Staff			9	8			
External Students			60	71			
Total			**1 242**	**1 371**			

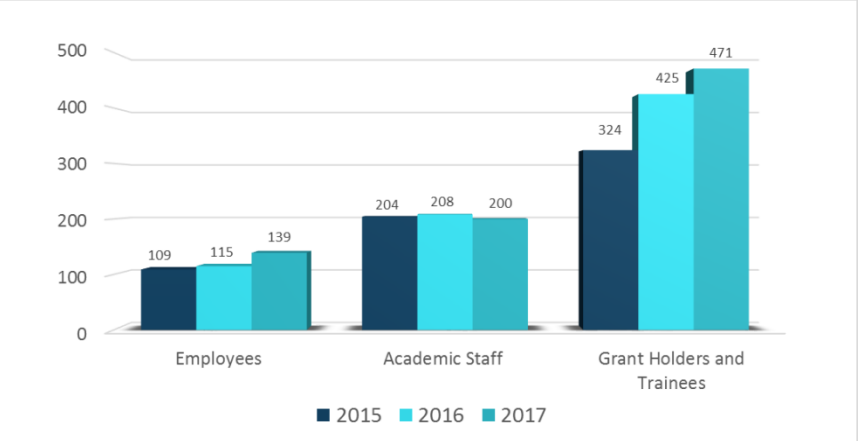

Figure 3.1 – Evolution of INESC TEC Human Resources

It can be seen in Figure 3.2 that grant holders and trainees is the largest group of human resources (58%).

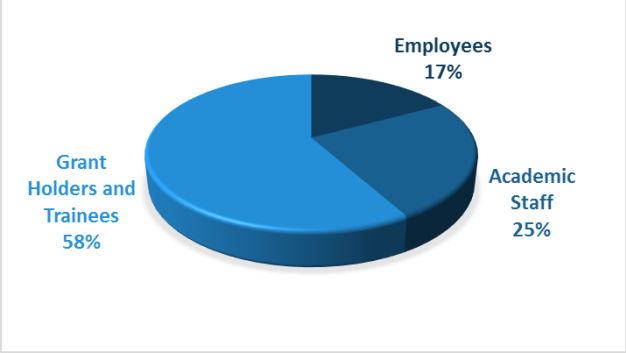

Figure 3.2 – Distribution of Human Resources (Plan 2017)

The core research team increases 10% to support the larger activity level, reflecting public policies, including the funding that has been provided for the support of new employment for researchers. There is also an increase on the number of human resources of the supporting services, with some grant holders and trainees being transferred to a contracted position.

Curricular trainees and external collaborators are allocated to INESC TEC activities in a small percentage of time, having a negligible financial impact and being difficult to forecast. For this reason, the evolution of these types of human resources is not considered in the planning for 2017, but the figures for 2015 and 2016 are given in Table 3.1.

3.1.2 R&D Centres Indicators

The detailed figures expected for the end of 2017 are given in Table 3.2 for each R&D Centre.

Table 3.2 – Human Resources by type and R&D Centre (Plan 2017)

Type of Human Resources			R&D Centres														
			CTM	CAP	CRAS	CBER	CPES	CESE	CRIIS	CEGI	CITE	CSIG	LIAAD	CRACS	HASLAB	Special Projects	Total
Integrated HR	Core Research Team	Employees	7	5	10	3	16	11	6	0	2	10	0	2	3	0	75
		Academic Staff	22	8	10	6	12	11	20	19	2	26	23	12	21	0	192
		Grant Holders and Trainees	54	14	39	21	44	49	21	37	7	52	42	31	35	6	452
		Total Core Researchers	**83**	**27**	**59**	**30**	**72**	**71**	**47**	**56**	**11**	**88**	**65**	**45**	**59**	**6**	**719**
	Affiliated Researchers		6	1	0	3	3	2	0	3	3	13	2	0	0	0	36
	Administrative and Technical	Employees	1	2	3	0	2	2	1	0	0	1	0	1	0	3	16
		Grant Holders and Trainees	0	0	3	0	0	0	0	0	0	0	0	0	1	4	8
	Total Integrated HR		**90**	**30**	**65**	**33**	**77**	**75**	**48**	**59**	**14**	**102**	**67**	**46**	**60**	**13**	**779**
	Total Integrated PhD		**44**	**16**	**12**	**15**	**28**	**19**	**27**	**34**	**7**	**47**	**37**	**19**	**34**	**0**	**339**

R&D Centres:

CTM	Centre for Telecommunications and Multimedia
CAP	Centre for Applied Photonics
CRAS	Centre for Robotics and Autonomous Systems
CBER	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

3.1.3 Supporting Services Indicators

The figures expected for the end of 2017 for the Management Board and each Supporting Service is given in Table 3.3 (decimal values apply for shared resources between Services).

Table 3.3 –Human Resources by type and Service (Plan 2017)

Type of Human Resources		Supporting Services															Total
		Board and Advisors	Operations and Management Services					Business Development				Techical Supporting Services					
			AG	AJ	CF	CG	RH	SAAF	SAPE	SAL	GRI	SCOM	SCI	SIG	SAS	SGI	
Integrated HR	Employees	5	1.2	2.7	3.8	6.8	4.3	0.2	4	2		5	2	3	3	5.1	48
	Academic Staff	8															8
	Grant Holders and Trainees				4	1		1	1			2		2			11
	Affiliated Researchers	2															2
	Total Integrated HR	**15**	**1.2**	**2.7**	**7.8**	**7.8**	**4.3**	**1.2**	**5**	**2**		**7**	**2**	**5**	**3**	**5.1**	**69**
	Total Integrated PhD	**10**			**1**				**2**	**1**							**14**

Supporting Services:

AJ	Legal Support
CF	Accounting and Finance
CG	Management Control
RH	Human Resources
AG	Management Support [1]
SAAF	Funding Opportunities
SAPE	Industrial Partnerships
SAL	Technology Licensing
GRI	International Affairs
SCOM	Communication
SCI	Networks and Informatics
SIG	Business Informatics
SAS	System Administration
SGI	Infrastructures Management

[1] Includes Secretarial Coordination

3.2 Activity in Projects

3.2.1 Global Indicators

Table 3.4 shows the breakdown of INESC TEC funding sources and the expected evolution for 2017.

Table 3.4 - Funding Sources and planned evolution

Sources			Value (k€) 2016	Value (k€) 2017	Δ (k€ / %) 2016-2017	
Firm Projects	PN-FCT	National R&D Programmes - FCT	713	1 365	653	92%
	PN-PICT	National R&D Programmes - S&T Integrated Projects	1 950	2 748	799	41%
	PN-COOP	National Cooperation Programmes with Industry	255	1 168	913	358%
	PUE-FP	EU Framework Programmes	4 563	4 319	-243	-5%
	PUE-DIV	EU Cooperation Programmes - Other	736	454	-281	-38%
	SERV-NAC	R&D Services and Consulting - National	1 923	2 160	237	12%
	SERV-INT	R&D Services and Consulting - International	187	252	65	35%
	OP	Other Funding Programmes	814	1 113	299	37%
		Total Firm Projects	**11 140**	**13 580**	**2 440**	**22%**
Uncertain Projects			911	1 877	966	106%
National Strategic Programme - Pluriannual			2 814	3 062	248	9%
National Strategic Programmes - Other			103	126	22	22%
Other Revenues			323	199	-124	-38%
		Total Revenues	**15 291**	**18 844**	**3 553**	**23%**

Figure 3.3 illustrates the funding distribution from firm projects planned for 2017 and the comparison with the Plan for 2016.

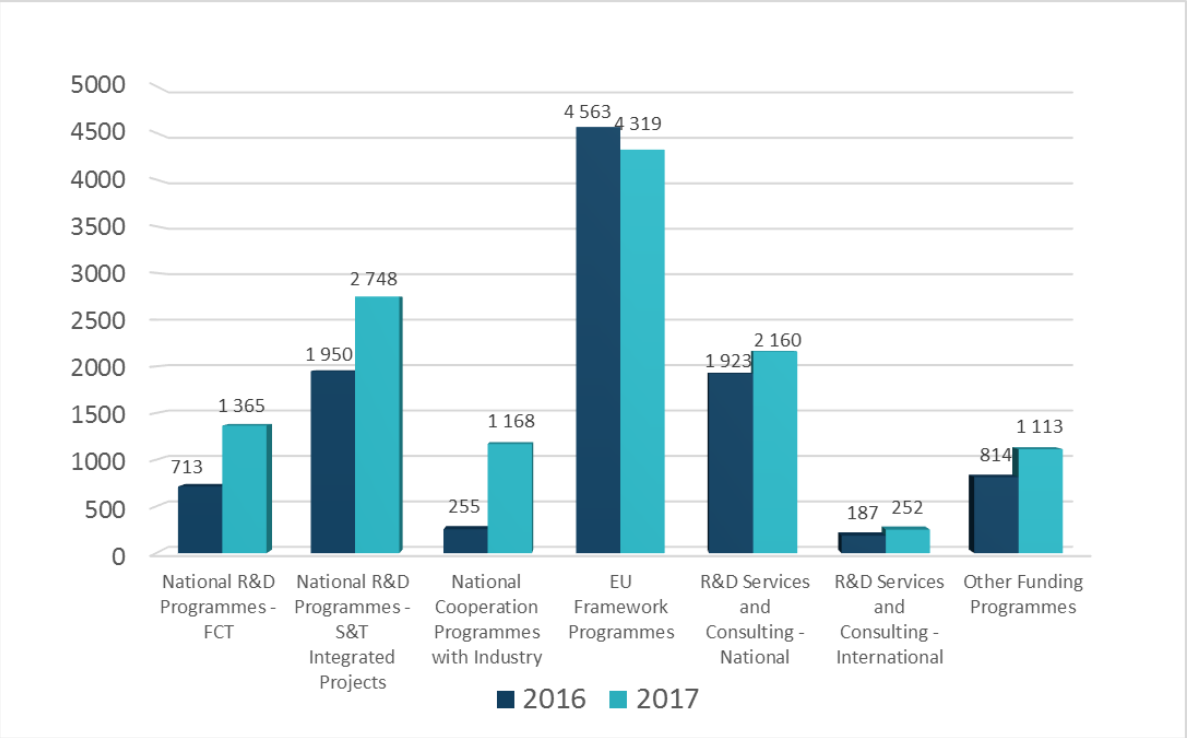

Figure 3.3 – Evolution of Funding Sources from Projects (k Euros)

Figure 3.4 shows the correspondent distribution from funding sources expected from firm projects, and the comparison with the previous plan.

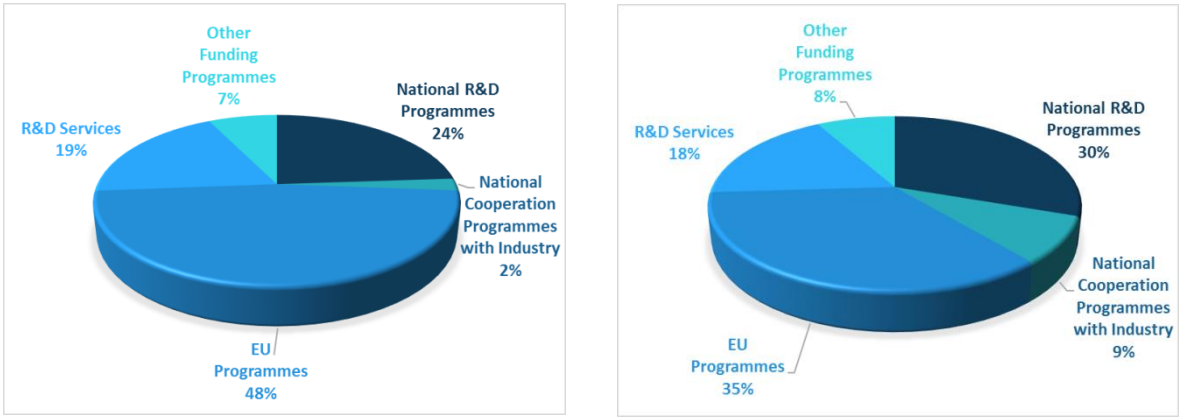

Figure 3.4 – Distribution of Funding Sources from Projects - Plan 2016 (left) and Plan 2017 (right)

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 Firm Projects by Type and Average Funding (Plan 2017)

Type of Project		Total (No.)	Average Funding (k€)
PN-FCT	National R&D Programmes - FCT	22	62
PN-PICT	National R&D Programmes - S&T Integrated Projects	10	275
PN-COOP	National Cooperation Programmes with Industry	20	58
PUE-FP	EU Framework Programmes	25	173
PUE-DIV	EU Cooperation Programmes - Other	14	32
SERV-NAC	R&D Services and Consulting - National	41	53
SERV-INT	R&D Services and Consulting - International	6	42
OP	Other Funding Programmes	16	70
	Total	**154**	**88**

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

- Funding from National Programmes show a large increase, especially from cooperation projects with industry (358%) due to the new calls launched in 2016 under P2020, but also FCT projects (92%).
- Funding from EU Programmes continues to be the largest source (35% planned for 2017) but shows a decrease mainly to the ending of FP7 which has not been compensated yet by an equivalent increase of H2020 funding - these changes in the funding volume per programme type are associated with the normal evolution along the lifecycle of those programmes and the launch of specific calls for proposals.
- R&D Services increase in value but reduces in proportion to other sources, because of the overall increase activity level.
- Support from the National Strategic Programme – "Plurianual" is an important source of funding due to its flexibility and funding rates, but represents a small proportion of the total funding sources (16%).
- The largest projects in terms of funding are indeed Integrated Projects and EU Framework Projects; on the opposite extreme, other EU Cooperation Programmes fund in generally small projects (with complicated and often specific rules); R&D Services and Consulting are expected to be under the global average of funding per project.
- Funding from uncertain projects represent 10% of the total funding.

3.2.2 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 (K Euros) and Uncertainty Analysis (Plan 2017)

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	1 366	42	0	55	260	345	127	75	146	5	107	62	123	19	0
	PN-PICT	2 747	563	144	108	280	24	167	50	197	47	341	347	280	199	0
	PN-COOP	1 168	182	0	248	0	63	380	158	20	0	0	88	0	20	9
	PUE-FP	4 321	287	132	1 424	0	842	290	154	20	56	285	94	100	637	0
	PUE-DIV	454	23	22	74	0	183	63	28	0	38	23	0	0	0	0
	SERV-NAC	2 160	31	0	102	30	812	187	411	59	0	215	34	190	80	9
	SERV-INT	252	25	0	120	0	103	4	0	0	0	0	0	0	0	0
	OP	1 112	74	3	0	0	160	0	0	27	92	134	5	0	14	603
	Firm Projects	13 580	1 227	301	2 131	570	2 532	1 218	876	469	238	1 105	630	693	969	621
Uncertain Projects		1 878	224	259	349	0	99	316	28	119	43	339	14	0	88	0
Total		15 458	1 451	560	2 480	570	2 631	1 534	904	588	281	1 444	644	693	1 057	621
Uncertainty (%)		12%	15%	46%	14%	0%	4%	21%	3%	20%	15%	23%	2%	0%	8%	0%

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

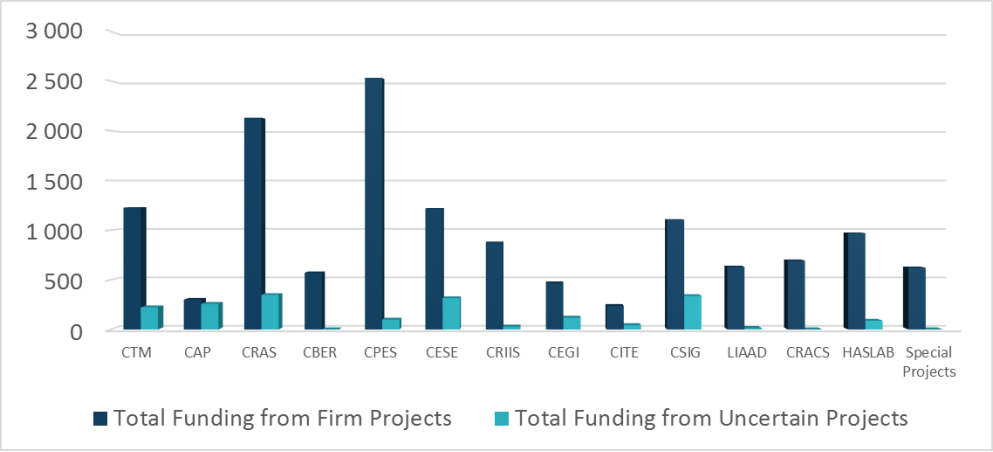

Figure 3.5 –Project Funding (K Euros) by R&D Centre (Plan 2017)

Table 3.6 also shows that uncertain projects represent 12% of the total funding from projects, although the relative weight per R&D Centre between uncertain/firm projects is quite variable, as shown in Figure 3.6.

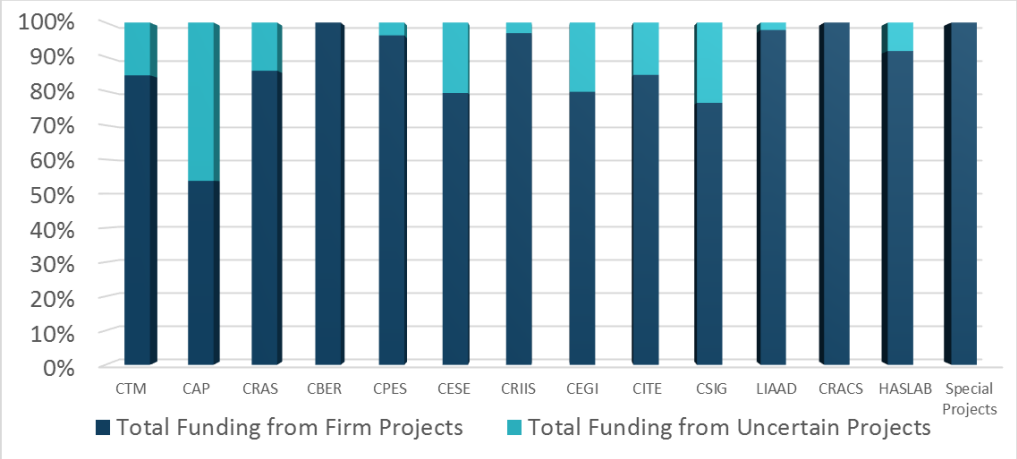

Figure 3.6 – Uncertainty Analysis by R&D Centre (Plan 2017)

3.3 Publications

3.3.1 Global Indicators

Table 3.7 and Figure 3.6 show the number of INESC TEC publications and the expected evolution for 2017.

The number of publications for 2015 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform. 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.

Values for 2016 and 2017 have been estimated using a bottom-up approach and need to be used with care. Since it was not possible to remove possible duplications, the totals obtained summing values from each Centre were reduced by the same factor derived from 2015 publications (about 10% of the articles are authored by researchers from more than one Centre).

Table 3.7 – Number of INESC TEC Publications

Publication Type	2015	2016 (Forecast)	2017 (Plan)
Indexed Journals	247	294	363
Indexed Conferences	440	407	447
Books	5	12	11
Book Chapters	40	30	44
PhD Thesis - Members	26	34	48
PhD Thesis - Supervised	66	43	62

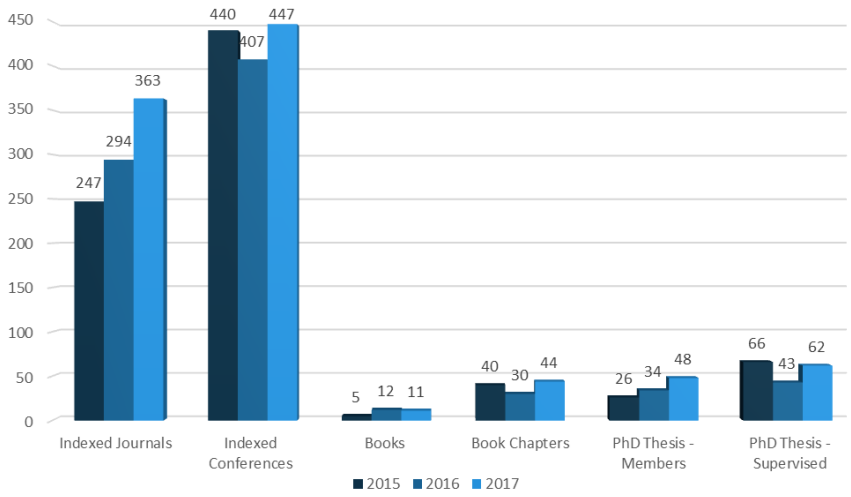

Figure 3.6 – Evolution of INESC TEC Publications

3.3.2 R&D Centres Indicators

Figure 3.7 exhibits the number of indexed publications in journals and conferences per R&D Centre. These figures planned for 2017 are compared with previous figures in the presentation of each R&D Centre.

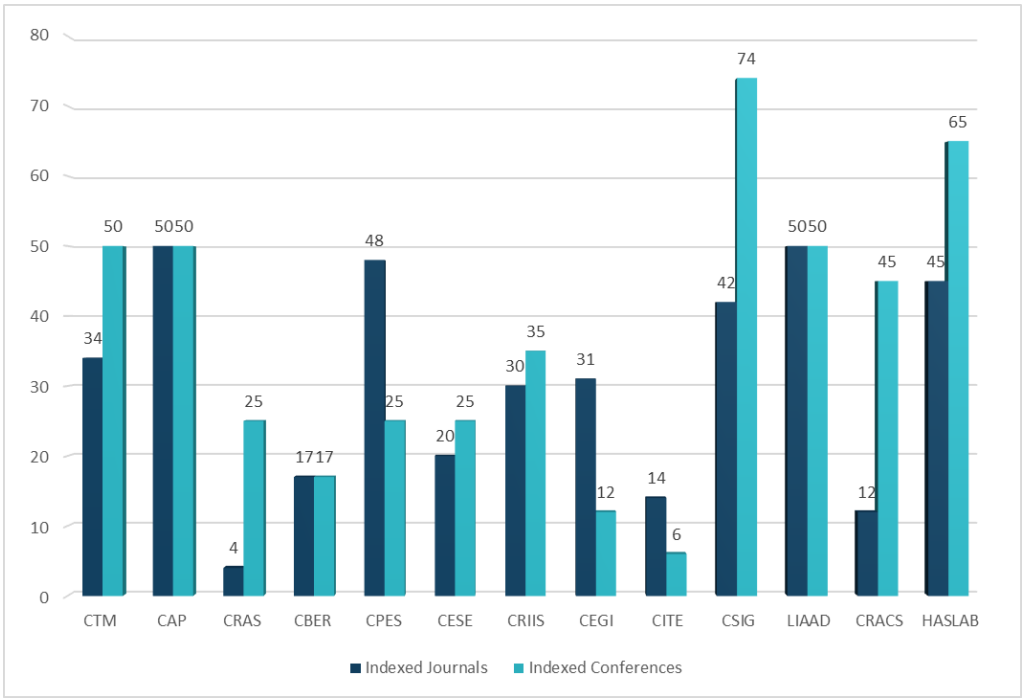

Figure 3.7 - Indexed Publications in Journals and Conferences (Plan 2017)

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), which are presented in the following sections.

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, an 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 we aim to create 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 probably lead to new results in the NIS centres, including chemical and bio-sensors, bio instrumentation, high bitrate underwater communications systems, or positioning and navigation systems at deep sea.

4.1.2 Objectives for the short and medium term

The NIS cluster aims to develop key enabling technologies for localized and distributed sensing and their deployment in critical and complex environment conditions. The main research lines of this cluster include the following:

- **Sensing technologies**, including physical sensors, chemical sensors, biosensors, optical sensors, RF antennas including planar and arrays of antennas, and acoustic sensors. The adaptation or improvement of multimedia sensors, including video cameras or microphones is also considered.
- **Signal processing techniques**, which are required to collect and process the information provided by these sensors, including digital signal processing, software defined radio, or analogue signal handling techniques.
- **Electronics**, both analogue and digital, which will be required to help implementing the sensors, harvesting or transferring energy, process data, and provide adequate integration means.
- **Machine learning and pattern recognition techniques**, used to obtain relevant information from heterogeneous sensors by taking advantage of pattern recognition and information obtained is past experiences performed in similar contexts.

- **Robots and autonomous systems**, which carry out the sensors, the processing units, the communications modules and are able to operate in complex environments, including underwater or in human bodies, individually or in groups.
- **Communications**, mainly focused on wireless communications technologies and networks, which will enable the transference of large volumes of information, possibly in real-time, between autonomous vehicles and the Internet operating in complex environments.

The General Objectives of NIS for 2017 are the following:

- To increase the number of project proposals aligned with the NIS vision by 10%, when compared to 2016.
- To increase the number of accepted papers aligned with NIS vision by 10%, when compared to 2016.
- To use 20% the Plurianual FCT funding for buying equipment which is used in NIS activities.

The Actions of NIS for 2017 are the following:

- To promote an internal workshop involving actively the researchers of all the centres of the cluster.
- Define at least one project proposal involving all the NIS centres and that is fully aligned with the NIS vision and research objectives.

4.2 POWER AND ENERGY CLUSTER

Coordinator: Manuel Matos
Core Centres: CPES
Associated Centres (potential): Centre for Industrial Engineering and Management (CEGI), Centre for Telecommunications and Multimedia (CTM), Artificial Intelligence and Decision Support Laboratory (LIAAD), Centre for Robotics 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, 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) and cybersecurity (HASLab). However, rather than just sharing projects, the goal is to deep and extend this kind of partnership to create new knowledge at low TRL and favour new developments and tools at higher TRL.

The cluster council is presently composed by: Carlos Moreira, Jorge Pereira, Luís Seca, Manuel Matos, Ricardo Bessa (all from CPES) and followed by Luís Carneiro and João Peças Lopes (both from the Board). Representatives of the associated clusters will be invited to participate in the future meetings of the cluster.

4.2.2 Objectives for the short and medium term

Structural objectives

The consolidation of the cluster structure is a short term objective, namely regarding the discussion with the foreseen associated centres, as mentioned in other part of this plan.

Following a suggestion from the Board, the cluster will develop efforts in the middle term to promote two new centres, one resulting of the autonomisation and extension of the power electronics area, another in the area of Oil and Gas.

Strategic areas

The cluster identified already a preliminary list of strategic areas for present and future activity. This list is now in the process of being discussed with the foreseen associated centres:

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.

Multi-energy networks

Joint modelling of electricity, gas and heat networks 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; 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, 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 management tasks, electricity markets and demand response actions.

Stochastic Optimization of Energy Systems

Integration of uncertainty forecasting information in grid operational tools that 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 management structures, 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 to perform RTDS. Enhancing RTDS through connection with similar simulators.
- Specific developments for enhancing system behavior (inverters, protections).

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 market hubs. Development and test of new tariff options, namely associated to dynamic tariffs.

Cybersecurity of the grid

Start from the December 2015 attack against Ukraine's power grid to analyze the internet threats for the power systems and means to avoid, early detect and combat such attacks

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.

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 Industrial Engineering and Management (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 c_I+I@INESCTEC wants to make INESC TEC internationally recognised as a leading research centre in the industry and innovation area 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 Prescriptive 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, Multimodal Sensor Fusion, Design Science and Explanatory Research, Creative Thinking and Problem Structuring.

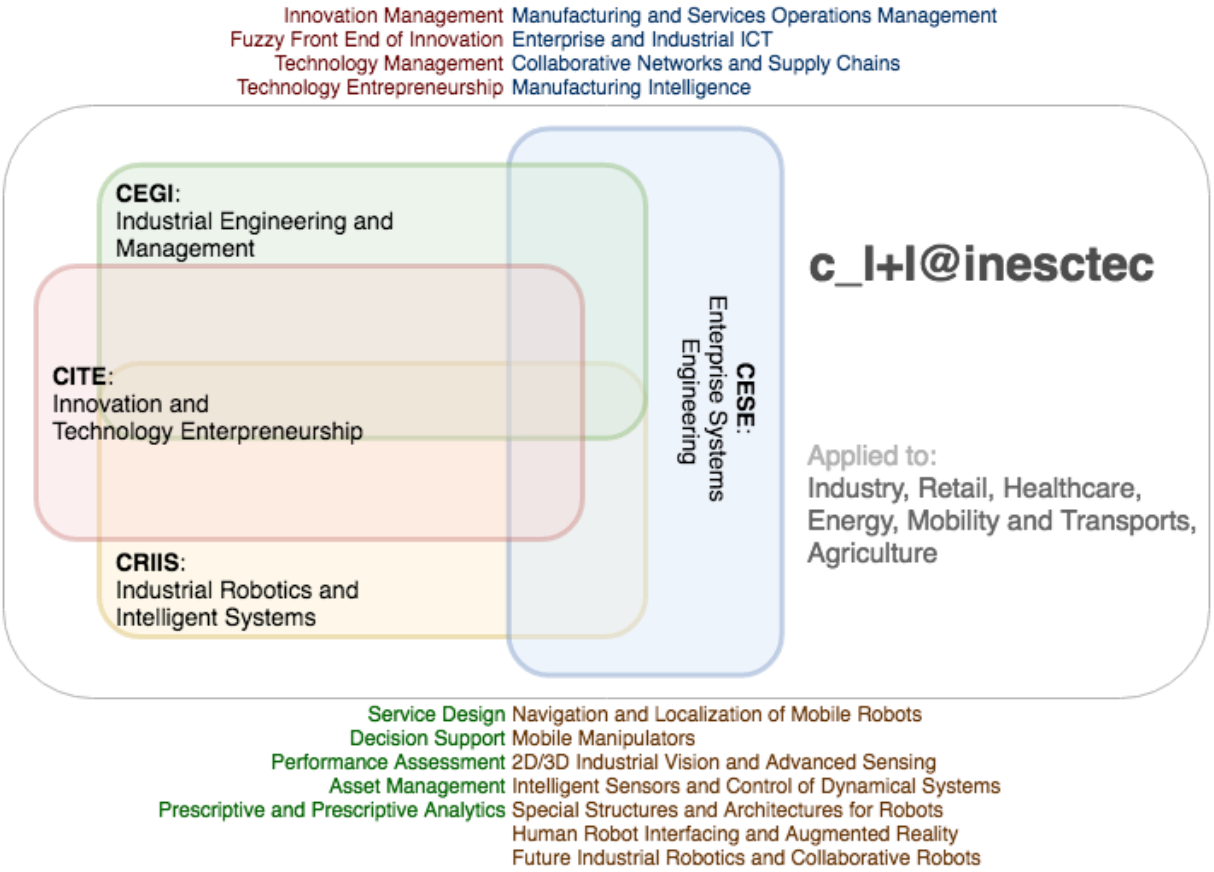

Figure 4.1: c_ I+I@INESCTEC research domains

4.3.2 Objectives for the short and medium term

The c_I+I@INESCTEC core centres have a good track record of joint projects, publications and consultancy services, as well as established collaboration practices. Still, there is room for improvement. In the second semester of 2006 the cluster undertook an internal project — "Shape the future" — involving five inter-centre teams that analysed the as-is situation regarding the axis of collaboration and proposed a set actions to substantially improve the cluster performance. The bellow described objectives already reflect the results of this project.

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;
- To implement joint strategies to attract high quality PhD students and scholarship holders;
- To define a strategy for the technology transfer and consultancy projects portfolio;
- Evaluate the potential of new technology transfer and consultancy areas;
- Develop a roadmap for existing and new high-value services to offer;
- Consolidation of 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.

Related actions to start in the first trimester of 2017 are:

- To develop and implement a plan to make more effective the collaboration between centres;
- To develop and implement a plan for scientific performance improvement and balancing;

- To have a cluster's "Research with us" (digital) flyer as an entry point for attracting prospective, highly qualified researchers.

Short term goals involving all the centres are:

- To develop a roadmap for pushing the additional cluster competencies into Industry 4.0 applications;
- To develop a framework for the selection of Industry 4.0 technologies;
- To develop a methodology for Industry 4.0 implementation road-mapping as a service offered to industrial associations and companies;
- To propose a project for studying the impact of Industry 4.0 technologies;
- In the collaboration axis of information management and knowledge discovery the cluster will coordinate the active search for an opportunity and preparation of a proposal for a large scale European project aimed at strengthen this.

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

INESC TEC aims at excelling in the control of the chain data>information>knowledge for pervasive and massive data repositories and data flows. This includes the components of new high-level languages, distributed computing, critical software, privacy protection, pervasive cyber security and generalized knowledge extraction, namely from massive spatio-temporal distributed and geo-referenced databases possibly lodged in moving media.

The Computer Science Cluster mission is to achieve excellence in both fundamental and applied research, with international impact, with a strong emphasis on technology innovation and transfer that benefits society at large. Our strong commitment encompasses many core areas from programming languages and rigorous software development, data processing and large scale computing to security and usability, to newer challenges of bringing better intelligence into everything.

The Computer Science (CS) Cluster is composed by four Centres, namely:

- CRACS - Centre for Research in Advanced Computing Systems
- CSIG - Centre for Information and Computer Graphics Systems
- HASLab - High-Assurance Software Laboratory
- LIAAD - Artificial Intelligence and Decision Support Laboratory

The CS Cluster Centres address diversified, heterogeneous and yet complementary research areas. The main research areas are:

- Accessibility and Assistive Technologies
- Big Data Applications
- Computer Graphics and Virtual Environments
- Cryptography, Information Security and Privacy
- Distributed Systems
- Information Management and Information Systems
- Intelligent and Adaptive Systems
- Languages and Distributed Computing
- Machine Learning and Data Mining
- Mathematical Modeling in Decision Support
- Software Engineering
- Special Purpose Computing Systems

The Cluster is also 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. Major examples of these activities are:

- vCardID - Development and implementation on smartcard of a fingerprint match-on-card algorithm for the next version of the Portuguese citizen card. This project involved three CS Cluster Centres (and CTM): CRACS, CSIG and HASLab.

- WiderMoS - Implementation of a prototype of a Logistics Single Window, for multimodal cargo transport.
- DRIW2020 - Consultancy for the design of new e-infrastructures supporting navigation in river Douro.
- SIGAMP - Implementation of a Spatial Data Infrastructure (SDI) for the Porto Metropolitan Area.
- Esporão - Design and implementation of data mining solutions for increased efficiency in different stages of agricultural processes

Additionally, several spin-off and start-up companies have been launched in the period 2015-2016, namely:

- ADYTA - a start-up company of the University of Porto with its core business in mobile security, created with 2 collaborators.
- LEANXCALE – a start-up in the area of real time analytics, producing an ultra-scalable transactional database, created in the sequence of the CumuloNimbo (EU FP7), CoherentPaaS (EU FP7) e LeanBigData projects (EU FP7). It has 10 collaborators (7 PhDs).
- MITMYNID – a spin-off in the area of e-logistics for multimodal cargo transport, resulting from MIELE (EU TEN-T) and WIDERMOS (EU TEN-T) projects, launched with 8 collaborators (1 PhD).

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.

The computing infrastructure at Porto comprises a reliable OpenStack cloud setup implemented in the model of infrastructure-as-a-service. It is a cluster comprising 280 Intel Xeon cores with 1.5TB of memory distributed among 12 compute nodes. The architecture includes a 16TB of usable storage, a 40-Gb- Infiniband to interconnect the compute nodes and 10-Gbs copper Ethernet to connect the nodes and storage, all built to be fully redundant and fault tolerant from the network to service layers. The computing infrastructure at Braga is broken into 3 distinct components: one cluster composed of server grade machines, providing a total of 192 cores and sharing a 16TB DAS connected via 8Gb fiber; one cluster with 104 commodity machines, providing 4 cores each; one private OpenStack cloud currently providing 50 cores.

The multisensorial immersive virtual reality laboratory (MASSIVE Laboratory) has 150m2 and is organized in 7 spaces: waiting area, experimental room, multisensory experimental room, control room, survey room, researcher's workspace and maintenance area. Its main equipment is composed by omnidirectional treadmills and a VirtuSphere, sound proofed facilities, optical tracking systems, smell capture and delivery, wind blower, temperature control, eye trackers and bio sensors (EEG and ECG).

4.4.2 Objectives for the short and medium term

- Increase the level of consultancy and R&D services.
- Increase the number of publications.
- Increase the participation in European projects and networks.
- Reinforce the partnership with other INESC TEC centres that require the use of our competences in their target domains.
- Create a joint OpenDay.
- Organise small events among Cluster Centre's researchers to promote collaboration.
- Create a web streaming infrastructure to support remote access and archive of Cluster events.

4.5 Main Indicators by Cluster

In this section, we include the Cluster main indicators which allow obtaining an overview of their relative size and expected results planned for 2017.

4.5.1 Human Resources

Type of Human Resources			Total	Clusters			
				NIS	PE	II	CS
Integrated HR	Core Research Team	Employees	75	25	16	19	15
		Academic Staff	192	46	12	52	82
		Grant Holders and Trainees	452	128	44	114	160
		Total Core Researchers	**719**	**199**	**72**	**185**	**257**
	Affiliated Researchers		36	10	3	8	15
	Administrative and Technical	Employees	16	6	2	3	2
		Grant Holders and Trainees	8	3	0	0	1
	Total Integrated HR		**779**	**218**	**77**	**196**	**275**
	Total Integrated PhD		**339**	**87**	**28**	**87**	**137**

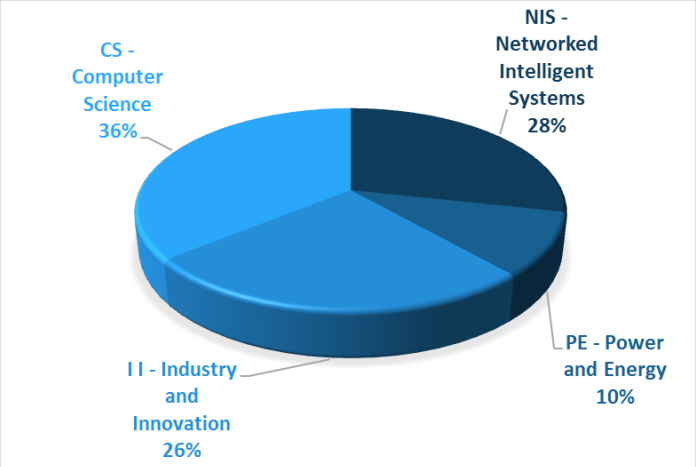

Figure 4.2 – Human Resources by Cluster (Plan 2017)

4.5.2 Activity in Projects

Funding Source			Total (k€)	Clusters			
				NIS	PE	II	CS
Firm Projects	PN-FCT	National R&D Programmes - FCT	1 366	357	345	353	311
	PN-PICT	National R&D Programmes - S&T Integrated Projects	2 747	1 095	24	461	1 167
	PN-COOP	National Cooperation Programmes with Industry	1 168	430	63	558	108
	PUE-FP	EU Framework Programmes	4 321	1 843	842	520	1 116
	PUE-DIV	EU Cooperation Programmes - Other	454	119	183	129	23
	SERV-NAC	R&D Services and Consulting - National	2 160	163	812	657	519
	SERV-INT	R&D Services and Consulting - International	252	145	103	4	0
	OP	Other Funding Programmes	1 112	77	160	119	153
		Firm Projects	13 580	4 229	2 532	2 801	3 397
		Uncertain Projects	1 878	832	99	506	441
		Total	**15 458**	**5 061**	**2 631**	**3 307**	**3 838**

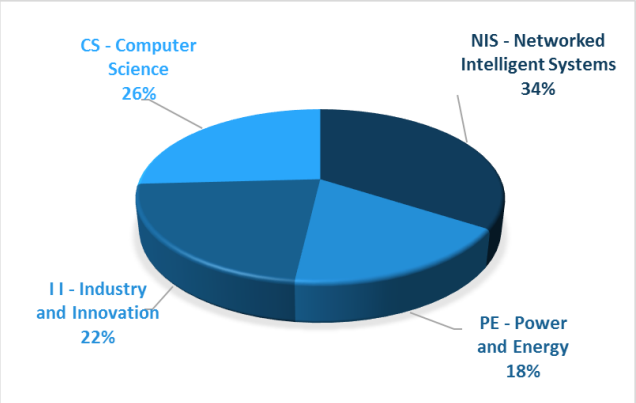

Figure 4.3 – Project Funding by Cluster (Plan 2017)

4.5.3 Publications

Type of Publication	Clusters			
	NIS	PE	II	CS
Indexed Journals	105	48	95	149
Indexed Conferences	142	25	78	234
Books	3	0	2	6
Book Chapters	7	2	12	23
PhD Thesis - Members	10	2	14	22
PhD Thesis - Supervised	14	3	15	30

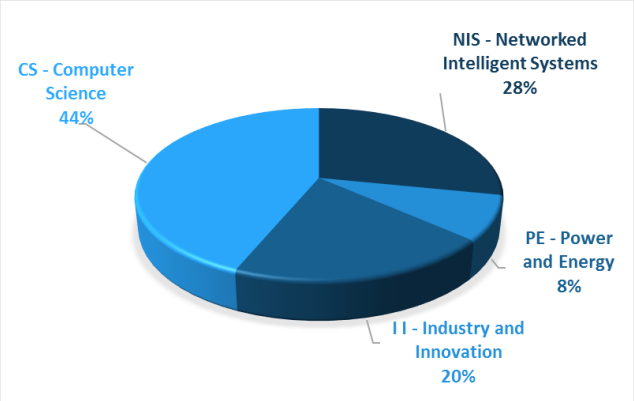

Figure 4.4 – Planned Indexed Articles by Cluster (Plan 2017)

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 addresses 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 suitable for next generation networks. 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 and Communications 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 audiovisual information learning system, to empower the next generation of intelligent systems with the capability of reasoning from audiovisual data. On the shorter-term IPPR aims to develop computer based algorithms and systems by proposing computer vision and machine learning architectures that attempt to explain the input data from the world by exploiting prior experience with similar data. The new advances are being validated in key applications on the areas of biometry, medical image analysis, human sensing, and network information processing, 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/RF communications and wireless power transfer in underwater environments. CTM holds an advanced laboratory 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 mesh networks for network infrastructure extension.
- Planning and design of communications networks for autonomous vehicles (aerial, surface, and underwater).

MCT - Multimedia and Communications 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 the sound and vision area, CTM is able to transfer technology and provide consulting services on:

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

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						
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 objectives and actions planned for 2017

5.1.5.1 General Objectives and Actions

The **General Objectives of CTM** for 2017 are the following:

- **High quality publications**. CTM is aimed at (1) maintaining the number of articles published in journals and (2) increasing the number of articles published in the journals classified by SCOPUS as first quartile.
- **Provide research services to community**. In 2017, CTM will have a relevant number of researchers involved in basic research (low TRLs). Besides publishing our scientific results and protecting our intellectual property, CTM will also prepare new partnerships with companies with the purpose of enabling the transference of the new results to relevant partners.
- **Increase international visibility**. The increase of CTM international visibility will also be pursued, either by participating in international fora or by organizing international conferences, with the purpose of facilitating the formation of new and strong European consortia or helping the publication of new scientific results in top ranked journals.
- **Increase research within NIS cluster**. CTM will contribute actively to the consolidation of the cluster NIS by proposing new joint research projects involving also other NIS' centres or by helping organizing internal events.

The **General Actions of CTM** for 2017 are the following:

- **Open Day 2017**. CTM will launch during 2017 some activities with the purpose of attracting high quality students to the fields of Telecommunications and Multimedia. We aim at increasing the number of prospective PhD candidates.
- **Organize international events**. At least 3 international conferences will be organized, what implies the coming of international researchers and relevant invited speakers to Porto.
- **Help organizing a NIS internal event**. CTM will actively contribute to the organization of an event involving all the researchers of the cluster NIS.

5.1.5.2 OET Objectives and Actions

The main Objectives of the OET area are the following:

- Demonstrate the concept of cognitive radio in space: analyse, simulate and experimentally evaluate cognitive radio algorithms for spectrum sensing, dynamic spectrum management and learning in the context of satellite applications.
- Design and develop compact on-chip integrated antennas for current and future wireless applications.
- Demonstrate the feasibility of resonant tunnelling diodes (RTDs) to operate as electro-optical transceivers for high speed wireless communications in the sub-THz range addressing beyond 5G scenarios.
- Explore communication technologies and architectures for enabling RTD-based ultra-broadband communications.
- Investigate new technologies and solutions for enabling THz communication systems in beyond 5G scenarios.
- Demonstrate wireless power transfer for battery recharging in underwater environment (both freshwater and saltwater scenarios).
- Demonstrate short range RF and optical wireless high-speed communications in underwater maritime application scenarios, namely data transfer between a docking station and an UAV.
- Devise new RF/microwave based technology solutions for biomedical sensing.
- Demonstrate efficient short-range communication for stand-alone wireless sensors.
- Study the effectiveness of new hardware methods for chip security.
- Explore the use of dynamic reconfiguration for baseband processing of 5G wireless telecommunications.
- Investigate the use of adaptive hardware acceleration in high performance computing platforms.

The main Actions of OET area are the following:

- Advise of MSc and PhD students towards the proposed objectives.
- Design and optimisation of antennas for sub-THz and THz frequency range; on-chip antenna design.
- Design of antennas for operation RF underwater wireless communications.
- Design and optimisation of a wireless power transfer system, including both inductor and electronics, in underwater maritime scenarios.
- Reconfigurable hardware design in ASIC for local efficient computation in biological applications.
- Design and test of a short-range transmitter for biological applications.
- Design of a computational method for chip security.
- Coordinate the final demonstrations in H2020 projects SCREEN and iBROW.

- Coordinate the final demonstration of EEA grants funded project ENDURE.
- Submission and collaboration on the submission of new project proposals along the targeted research lines, specifically, ultra-broadband wireless communications beyond 5.
- Participate in European COST actions within the framework of the targeted research lines.
- Participate in the technical committees of international conferences.

5.1.5.3 WiN Objectives and Actions

The main Objectives of the WiN area are the following:

- Development of flying ad-hoc networks, including the design and adaption of: 1) Medium Access Control (MAC) protocols, namely IEEE 802.11 MAC, for enabling long distance communications; 2) routing protocols for enabling multi-hop communications within the flying network; 3) topology control algorithms for augmenting network performance and range.
- Development of long-range, broadband maritime networks, including the use of short-range radio communications and Autonomous Underwater Vehicles (AUV) as data mules for underwater communications and novel MAC and routing protocols enabling ship-to-shore communications.
- Design of green Wi-Fi networks, addressing the reduction of the energy consumption of Wi-Fi access points by dynamically configuring their operation parameters (e.g., transmission power, bandwidth, operation mode) according to the user traffic demand.
- Strengthen partnerships and competences by reinforcing existing partnerships, seeking new partnerships at national and international levels, and deepening collaboration with other Centres at INESC TEC.

The main Actions of WiN area are the following:

- Flying network prototype and demonstration, including the integration of all hardware and software networking components to create a flying communications node, its integration in four UAV platforms, and demonstration of the 4-node flying sensor network in sea environment as part of the final demonstration of the FP7 SUNNY project in Crete, Greece.
- Design and simulation of topology control algorithm for augmenting network performance and range, using Network Simulator 3 (ns-3) and considering different flying networking scenarios, namely the ones considered in the FP7 SUNNY and FCT WISE projects.
- Implementation of a point-to-point underwater communications prototype for proof-of-concept and supporting future related developments and experiments.
- Design and simulation of novel maritime MAC protocol using as a basis the data collected in maritime environment.
- Design and simulation of new maritime routing protocol targeting multi-hop ship-to-shore broadband communications.
- Design of Wi-Fi traffic prediction models based on existing models for cellular networks, which will be as input to the smart configuration manager for Wi-Fi access points (see Action 3.2).
- Design and simulation of smart configuration manager for Wi-Fi access points enabling the optimization of the energy consumption according to the user traffic demand.
- Visit to relevant EU partners within the context of the STRONGMAR project, including: 1) one-week visit to Norwegian partners aiming at exploring future collaboration opportunities within H2020 and EEA Grants projects.
- Organization of international scientific events, namely the IEEE/IFIP Wireless Days 2017 conference and the 2017 Workshop on ns-3.

- 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.

5.1.5.4 MCT Objectives and Actions

The main Objectives of the MCT area are the following:

- Develop personalised media services. Develop tools that enable context-aware personalised access to media content. This includes the integration of different video formats, such as 3D and multi-view content, the development of metadata approaches for content, user and environment description, algorithms for content recommendation and new immersive and participatory services.
- Exploit new application domains namely in sports, retail, surveillance and farming environments. Background on image and video processing and cross-media knowledge extraction provides the grounds for devising enhanced tools in areas other than the media sector. Within this objective, we intend to develop work on video segmentation, object identification and tracking applied in areas such as sports, retail, surveillance and farming.
- Develop tools to help user-centric content creation. Develop tools for content analysis and manipulation, namely sound and music, to help creativity. This includes new techniques for audio and music processing, and approaches for automatic content creation.
- Promote R&D activities and partnerships that require multidisciplinary competencies. The scope of the scientific and application areas of MCT are highly multidisciplinary and research towards the definition of novel techniques for content production, distribution and consumption requires the participation of a research team with a diverse technical background. MCT aims to decisively contribute tangible advances in the digital media sector, in the relevant scientific communities and in a number of additional application areas or markets by promoting the sharing of advanced facilities to spread knowledge among communities with different backgrounds and enable creative experimentation of new ideas.

The main Actions of MCT area are the following:

- Promote the cooperation with external partners through the organization of scientific events, namely CMMR 2017, submission of new project proposals and the participation on international scientific committees.
- Develop prototypes that enable a better communication of MCT scientific knowledge and provide an integrated and multidisciplinary view of the team.
- Develop action towards the captation of new students and researchers, namely by proposing MSc and PhD thesis and organising actions within the CTM OpenDay.

5.1.5.5 IPPR Objectives and Actions

The main Objectives of the IPPR area are the following:

- Improve the performance of learning algorithms in weakly supervised settings.
- Propose better than state of the art algorithms for fingerprint recognition in uncontrolled acquisition.
- Improve decision support systems for breast cancer screening and diagnosis.
- Improve decision support systems for cervical cancer screening and diagnosis.
- Strengthen partnerships and competences by reinforcing existing partnerships, seeking new partnerships at national and international levels, and deepening collaboration with other Centres at INESC TEC.

The main Actions of IPPR area are the following:

- Advise Ph.D. Students researching towards the aforementioned objectives.

- Participate in National and European projects tackling the aforementioned objectives.
- Organize and participate in events fostering the discussion in the fields related with the objectives. In particular, a special session in IWANN 2017 in learning with imbalance data, a special session in breast image analysis in ISBI 2017, a biometric competition in face recognition, and the visum summer school. Additionally, we will also participate in the DREAM breast challenge.
- Lead and participate in proposals of national and international projects.

5.1.6 Centre Organizational Structure and Research Team

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

- OET - Optical and Electronics Technologies - Responsible: Henrique Salgado
- WiN - Wireless Networks - Responsible: Rui Campos
- MCT - Multimedia Communications Technologies - Responsible: Paula Viana
- IPPR - Information Processing and Pattern Recognition – Responsible: Jaime Cardoso

The centre has two councils: the **CTM Coordination Council** and the **CTM Scientific Council**. The CTM Coordination Council meets every 2 week 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 2 months and it is composed by 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 planned evolution is presented in Table 5.2.

Table 5.2-CTM – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	5	7	7	0
		Academic Staff	22	21	22	1
		Grant Holders and Trainees	44	46	54	8
		Total Core Researchers	**71**	**74**	**83**	**9**
	Affiliated Researchers		11	8	6	-2
	Admin. & Tech.	Employees	1	1	1	0
		Grant Holders and Trainees	0	0	0	0
	Total Integrated HR		**83**	**83**	**90**	**7**
	Total Integrated PhD		**43**	**43**	**44**	**1**

5.1.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CTM – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	73	35	42	7
National R&D Programmes - S&T Integrated Projects	162	417	563	146
National Cooperation Programmes with Industry	14	44	182	138
EU Framework Programmes	662	533	287	-246
EU Cooperation Programmes - Other	27	121	23	-98
National R&D Services and Consulting	294	132	31	-101
International R&D Services and Consulting	25	75	25	-50
Other Funding Programmes	22	18	74	56
Total Funding from Uncertain (future) or Closed (past) Projects	17	49	224	175
Total Funding	**1 296**	**1 424**	**1 451**	**27**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	32	31	34
International conference proceedings indexed by ISI, Scopus or DBLP	51	42	50
Books (author)			
Chapter/paper in books	5	5	3
PhD theses concluded by members of the Centre	7	6	5
Concluded PhD theses supervised by members of the Centre	10	6	7

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

Type of Result	No.
Invention disclosures	0
Software copyright registrations	0
Patent applications	3
Licence agreements	0
Spin-offs	0

Table 5.6-CTM – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	4
Conferences organized by INESC TEC members (in the organizing committee or chairing technical committees)	8
International events in which INESC TEC members participate in the program committees	20
Participation in events such as fairs, exhibitions or similar	8
Advanced training courses	3

Table 5.7-CTM – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	EVOXANT	André Marçal	15-06-2016	14-06-2019
PN-PICT	CORAL-TOOLS	Rui Lopes Campos	01-01-2016	31-12-2018
PN-PICT	FOUREYES	Paula Viana	01-07-2015	30-06-2018
PN-PICT	NanoStima-RL1-3	Henrique Salgado	01-07-2015	30-06-2018
PN-PICT	NanoStima-RL5	Jaime Cardoso	01-07-2015	30-06-2018
PN-PICT	SMILES-6	Manuel Ricardo	01-07-2015	30-06-2018
PN-COOP	BCCT.Plan	Hélder Filipe Oliveira	01-11-2016	31-10-2019
PN-COOP	Cloud-Setup	Maria Teresa Andrade	01-07-2016	31-12-2018
PN-COOP	MareCom	Rui Lopes Campos	01-03-2016	31-08-2018
PN-COOP	ROMOVI-1	Manuel Cândido Santos	07-01-2017	31-08-2019
PN-COOP	WI-GRIEN	Rui Lopes Campos	01-10-2016	30-09-2018
PUE-FP	AnyPLACE-1	Rui Lopes Campos	01-02-2015	31-01-2018
PUE-FP	iBROW	Luís Pessoa	01-01-2015	31-12-2017
PUE-FP	SmarterEMC2-1	José Ruela	01-02-2015	31-01-2018
PUE-FP	STRONGMAR-1	Rui Lopes Campos	01-01-2016	31-12-2018
PUE-FP	SUNNY-1	Manuel Ricardo	01-01-2014	30-06-2017
PUE-DIV	BLUECOM+	Rui Lopes Campos	17-07-2015	30-04-2017
PUE-DIV	ENDURE	Luís Pessoa	17-07-2015	30-04-2017
SERV-NAC	ASSIST	Pedro Miguel Carvalho	01-11-2012	31-07-2017
SERV-NAC	Consultoria	Manuel Ricardo	01-01-2010	
SERV-NAC	vCardID-1	Jaime Cardoso	01-01-2014	30-06-2017
SERV-INT	RAWFIE-1	Rui Lopes Campos	01-09-2016	28-02-2019
OP	CMMR2017	Matthew Davies	01-04-2017	31-12-2017
OP	WD'17	Manuel Ricardo	01-01-2017	30-06-2017

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 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 areas of research: optical sensors; integrated optics and microfabrication; advanced optical imaging. In this arrangement, optical sensors comprise Chemical/Biosensors and Physical sensors.

This organization of the activities understands sustained inter-activities and support within the different fields of expertise, sharing researchers whose activities touch the different areas of research.

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 organization 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 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 also 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

- Implementation of a 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 objectives and actions planned for 2017

Following a SWOT analysis, the recruitment of new researchers, the low participation in Horizon2020 and projects with industry partners were identified as weaknesses.

In order to interest potential new researchers, the Centre intends to keep a policy of awarding scholarships for last year students so they can get acquainted with the research activity. This policy has proven to be fruitful in the past and it will be continued. A dedicated laboratory already in place with advanced photonics projects will attract also younger students.

An Open Day will be organized to disseminate the activities and projects of the Centre focused both in new researchers as well as potential partners, mainly from industry.

Profiting from the network of contacts in running and previous COST Actions a strong effort will be put in the submission of H2020 proposals.

5.2.6 Centre Organizational 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 organization 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 planned evolution is presented in Table 5.2.

Table 5.2-CAP – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	5	5	5	0
		Academic Staff	9	9	8	-1
		Grant Holders and Trainees	12	15	14	-1
		Total Core Researchers	**26**	**29**	**27**	**-2**
	Affiliated Researchers		8	7	1	-6
	Admin. & Tech.	Employees	2	2	2	0
		Grant Holders and Trainees	0	0	0	0
	Total Integrated HR		**36**	**38**	**30**	**-8**
	Total Integrated PhD		**22**	**22**	**16**	**-6**

5.2.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CAP – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	52			
National R&D Programmes - S&T Integrated Projects	62	206	144	-62
National Cooperation Programmes with Industry				
EU Framework Programmes	27	122	132	10
EU Cooperation Programmes - Other	25	13	22	9
National R&D Services and Consulting	30			
International R&D Services and Consulting		90		-90
Other Funding Programmes	33	10	3	-7
Total Funding from Uncertain (future) or Closed (past) Projects (k€)	28	9	259	250
Total Funding	**257**	**450**	**560**	**110**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	30	45	50
International conference proceedings indexed by ISI, Scopus or DBLP	29	45	50
Books (author)			1
Chapter/paper in books		2	2
PhD theses concluded by members of the Centre	1	2	3
Concluded PhD theses supervised by members of the Centre	2	3	3

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

Type of Result	No.
Invention disclosures	1
Software copyright registrations	0
Patent applications	1
Licence agreements	0
Spin-offs	0

Table 5.6-CAP – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	0
Conferences organized 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	2
Participation in events such as fairs, exhibitions or similar	0
Advanced training courses	0

Table 5.7-CAP – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-PICT	CORAL-SENSORS	Pedro Jorge	01-01-2016	31-12-2018
PN-PICT	CORAL-TOOLS-2	Pedro Jorge	01-01-2016	31-12-2018
PN-PICT	NanoStima-RL1-1	Carla Carmelo Rosa	01-07-2015	30-06-2018
PUE-FP	STRONGMAR-2	Ireneu Dias	01-01-2016	31-12-2018
PUE-FP	VAMOS-1	Pedro Jorge	01-02-2015	31-07-2018
PUE-DIV	AGRISENSUS-1	Paulo Vicente Marques	01-01-2017	31-12-2019
PUE-DIV	CostActions	José Luís Santos	01-01-2008	
PUE-DIV	MarineEye-2	Pedro Jorge	30-07-2015	29-07-2017
SERV-NAC	TunLas	José Luís Santos	01-01-2009	
SERV-INT	TECCON2	Pedro Jorge	01-01-2016	31-12-2018
OP	Coop-Transnacional	José Luís Santos	01-01-2010	
OP	Femto3D	Paulo Vicente Marques	01-01-2016	30-06-2017

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 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 organized 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:

- Implement 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								
Long term deployments	I				H	H						
Sensing, mapping, and intervention	I						H	H	H	H		
Multiple platform operations	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

5.3.5 Main objectives and actions planned for 2017

5.3.5.1 General Objectives

The **General Objectives of CRAS** for 2017 are the following:

- High quality publications. CRAS aims to increase the number of articles published in the journals classified by SCOPUS as first quartile.
- Provide research services to community. Besides publishing scientific results in relevant fora and protecting intellectual property, CRAS will also pursue new partnerships with companies with the purpose of enabling the transference of the new results to relevant partners.
- Increase international visibility. The increase of CRAS international visibility will also be pursued, by participating in relevant international fora, by organizing international events, and by promoting the short term exchanges of researchers with partner institutions to foster the publication of new scientific results in top ranked journals.

5.3.5.2 Specific Objectives and Actions

Autonomous navigation

- Development of vision based control algorithms for underwater docking;
- Development of acoustic network operation modes for one way simultaneous navigation and external tracking of multiple underwater vehicles;
- Development of obstacle avoidance algorithms for autonomous surface, underwater and aerial vehicles;
- Development, implementation and testing of mission planning algorithms for autonomous underwater vehicles;
- Aerial robot network control formation.

Long term deployments

- Development and field testing of docking systems for AUVs;
- Development and field testing of an underwater vertical profiler.

Sensing, mapping, and intervention

- Design, development, and testing of underwater visual mapping system;
- Design and development of sensing and control system for autonomous underwater manipulation;
- Design and development of automatic water sampler device;
- Design and development of underwater mining mapping;
- Design and Development underwater pseudo-Lidar system.

Multiple platform operations

- Development of small size unmanned surface vehicles for the establishment of reconfigurable communication networks over extended areas;
- Development and field testing of coordination algorithms between underwater and surface platforms;
- Implement a robotic lander network.

5.3.6 Centre Organizational 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 planned evolution is presented in Table 5.2.

Table 5.2-CRAS – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	3	5	10	5
		Academic Staff	10	10	10	0
		Grant Holders and Trainees	17	25	39	14
		Total Core Researchers	**30**	**40**	**59**	**19**
	Affiliated Researchers		**0**	**0**	**0**	**0**
	Admin. & Tech.	Employees	1	2	3	1
		Grant Holders and Trainees	0	1	3	2
	Total Integrated HR		**31**	**43**	**65**	**22**
	Total Integrated PhD		**8**	**7**	**12**	**5**

5.3.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CRAS – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	19	44	55	11
National R&D Programmes - S&T Integrated Projects	94	45	108	63
National Cooperation Programmes with Industry	113		248	248
EU Framework Programmes	876	1 175	1 424	249
EU Cooperation Programmes - Other		163	74	-89
National R&D Services and Consulting	139	47	102	55
International R&D Services and Consulting		20	120	100
Other Funding Programmes	4	23		-23
Total Funding from Uncertain (future) or Closed (past) Projects (k€)	17	40	349	309
Total Funding	**1 262**	**1 557**	**2 480**	**923**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	9	2	4
International conference proceedings indexed by ISI, Scopus or DBLP	30	19	25
Books (author)	1	1	1
Chapter/paper in books	1		1
PhD theses concluded by members of the Centre	1	2	1
Concluded PhD theses supervised by members of the Centre	1	2	2

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

Type of Result	No.
Invention disclosures	0
Software copyright registrations	0
Patent applications	1
Licence agreements	0
Spin-offs	0

Table 5.6-CRAS – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	0
Conferences organized 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	4
Participation in events such as fairs, exhibitions or similar	3
Advanced training courses	4

Table 5.7-CRAS – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	MyTag	Eduardo Silva	01-06-2016	31-05-2019
PROG - NAC	DeepFloat	Eduardo Silva	09-03-2016	30-03-2018
PROG - NAC	SIDENAV	Eduardo Silva	01-12-2016	30-05-2018
PROG - NAC	CORAL-SENSORS-1	Eduardo Silva	01-01-2016	31-12-2018
PROG - NAC	CORAL-TOOLS-1	Eduardo Silva	01-01-2016	31-12-2018
PROG - UE	ENDURE-1	Eduardo Silva	17-07-2015	30-04-2017
PROG - UE	BLUECOM+-1	Eduardo Silva	17-07-2015	30-04-2017
PROG - UE	MarineEye	Eduardo Silva	30-07-2015	29-07-2017
PROG - UE	SpilLess	Eduardo Silva	01-01-2017	31-12-2018
PROG - UE	SUNNY	Eduardo Silva	01-01-2014	30-06-2017
PROG - UE	VAMOS	Eduardo Silva	01-02-2015	31-07-2018
PROG - UE	STRONGMAR	Eduardo Silva	01-01-2016	31-12-2018

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - UE	UNEXMIN	Eduardo Silva	01-02-2016	31-10-2019
PROG - UE	EMSODEV	Aníbal Matos	01-09-2015	31-08-2018
SERV - UE	EDA-SAVEWATE	Nuno Cruz	25-01-2012	24-01-2017
SERV - UE	Evologics	Nuno Cruz	01-05-2013	30-04-2018
SERV - NAC	Demo_Drone	José Miguel Almeida	01-05-2015	30-04-2017
SERV - NAC	Fmanagement	Aníbal Matos	10-05-2016	09-05-2017
SERV-UE	RAWFIE	Aníbal Matos	01-09-2016	28-02-2019
SERV - NAC	Consultoria	Eduardo Silva	01-01-2016	
SERV - INT	HAIFA	Nuno Cruz	01-09-2016	01-03-2017
OID	CINMarS	Eduardo Silva	12-03-2015	11-03-2017
INT	SIEPIP-3	Eduardo Silva	01-06-2016	31-05-2018

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 CBER - 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 mission and 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 and neurology;
- 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 organized 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 main 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 organized 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.
- Characterization 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 and Neurobiology.

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)
- Movement disorders in neurological diseases
- Neurosurgery Aiding Systems

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, Psychology, Psychophysics, 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 organized 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 characterization of lung pathologies in chest CT scans.

NeuroEngineering Lab

- We do not foresee any technology transfer from this lab. We will continue to provide several advanced neuroimaging services to clinical partners from Porto and Munich.

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”, Pedido Provisório de Patente 20161000064607, 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
- Mixed-signal test and measurement framework for monitoring systems, pedido provisório de patente 20131000012338, 2013/02/15, INPI
- Imager with compressive sensing capability, pedido provisório de patente 20131000012300, 2013/02/15, INPI
- Control module for multiple mixed-signal resources management, pedido de patente PT107537; PCT/IB2015/052141; WO/2015/145347A1, Pub date 2015/10/01

During 2017, we intend to start the spin-off process of the achieved patents looking for different possible paths (licensing, selling, etc.).

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-CBER – 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 objectives and actions planned for 2017

C-BER objectives for 2017

- Develop the undergoing R&D projects as planned;
- Develop new approaches for CAD, in particular in "Gynecology and Obstetrics" and lesion detection of gastrointestinal tract in endoscopy videos;
- Increase the number of journal publications particularly in 1st quartile journals;
- Install R&D successful software applications in clinical departments;
- Continue and increase the fruitful interactions and joint R&D with other INESC TEC R&D centres, namely at the cluster leve;
- Attract the best PhD and MSc students in the Biomedical Engineering area (not only from FEUP…);
- Evolve the joint R&D actions with CTM and look for new opportunities with these and other INESC TEC centres, particularly within the NIS cluster;
- Develop applications for the Ultrasound Equipment particularly for "Gynecology and Obstetrics" and "Neurology";
- Maintain or increase the production of patents,
- Continue and increase the fruitful interactions and joint R&D with other INESC TEC R&D centres, namely at the cluster level;
- Achieve the first spin-off of C-BER technology;
- Submit/be involved in one or more large H2020 or NIH project.

C-BER Actions for 2017

- Actively look for new H2020 and/or NIH projects;
- Attract the best PhD and MSc students in the Biomedical Engineering area (not only from FEUP…);
- Start the first C-BER spin-off process to a start-up company;

- Further deepened the “R&D program” contract with Biodevices SA and look for new “R&D program” contracts;
- Evolve the joint R&D actions with CAP and CTM and look for new opportunities with these and other INESC TEC centres, for example by more involvement in the NIS cluster;
- Install and start operation of the MRI simulator heavy equipment;
- Increase journal papers publications;
- Continue and increase the fruitful interactions and joint R&D with other INESC TEC R&D centres, namely at the cluster level;
- Increase the interaction with sports and high performance training groups under the initiative “Health, Sports and Well-Being hub” supported by the European Platform for Sports Innovation (EPSI);
- Submit/be involved in one or more large national clusters in the health sector and the textile and shoe industries;
- Submit/be involved in one or more large H2020 consortium and project;
- Look for new “R&D program” contracts with industry;
- Investigate new technologies and solutions for enabling THz communication systems in beyond 5G scenarios;
- Demonstrate wireless power transfer for battery recharging in underwater environment (both freshwater and saltwater scenarios).

5.4.6 Centre Organizational Structure and Research Team

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

Table 5.2-CBER – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	1	1	3	2
		Academic Staff	6	6	6	0
		Grant Holders and Trainees	5	15	21	6
		Total Core Researchers	**12**	**22**	**30**	**8**
	Affiliated Researchers		**4**	**3**	3	**0**
	Admin. & Tech.	Employees	0	0	0	0
		Grant Holders and Trainees	0	0	0	0
		Total Integrated HR	**16**	**25**	**33**	**8**
		Total Integrated PhD	**11**	**11**	**15**	**4**

5.4.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CBER – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	126	121	260	139
National R&D Programmes - S&T Integrated Projects		168	280	112
National Cooperation Programmes with Industry	44			
EU Framework Programmes				
EU Cooperation Programmes - Other				
National R&D Services and Consulting	43	30	30	
International R&D Services and Consulting				
Other Funding Programmes	17			
Total Funding from Uncertain (future) or Closed (past) Projects (k€)				
Total Funding	**230**	**319**	**570**	**251**

Table 5.4-CBER – Summary of publications by members of the Centre

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	7	18	17
International conference proceedings indexed by ISI, Scopus or DBLP	17	11	17
Books (author)	1	1	1
Chapter/paper in books			1
PhD theses concluded by members of the Centre		1	1
Concluded PhD theses supervised by members of the Centre	3	1	2

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

Type of Result	No.
Invention disclosures	2
Software copyright registrations	1
Patent applications	1
Licence agreements	2
Spin-offs	1

Table 5.6-CBER – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	1
Conferences organized by INESC TEC members (in the organizing committee or chairing technical committees)	3
International events in which INESC TEC members participate in the program committees	4
Participation in events such as fairs, exhibitions or similar	0
Advanced training courses	0

Table 5.7-CBER – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	VR2Market	João Paulo Cunha	15-07-2014	14-07-2018
PROG - NAC	LNDetector	Aurélio Campilho	01-06-2016	31-05-2019
PROG - NAC	SCREEN-DR	Aurélio Campilho	01-04-2016	31-03-2020
PROG - NAC	NanoStima-RL1	João Paulo Cunha	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL5-1	Aurélio Campilho	01-07-2015	30-06-2018
PROG - NAC	SMILES-1	João Paulo Cunha	01-07-2015	30-06-2018
SERV - NAC	Bio-Early	João Paulo Cunha	01-10-2015	30-06-2017
SERV - NAC	Consultoria	João Paulo Cunha	01-01-2016	

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 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 INESC TEC's main actor in the areas of electrical energy. The Centre is internationally recognised for its expertise in integration of renewable energy in power systems, distributed generation, storage, smart-grids and areas traditionally associated with planning and operation of power systems. The high level of expertise developed has allowed specialists at CPES to take on key roles in important EU projects as part of the successive framework programmes that led to notable scientific and technical advances with considerable impact on industry. This has led to contracts for development and consultancy with companies manufacturing equipment and with generation, transmission and distribution companies, regulators, government agencies and investors in Europe, South America, the United States of America and Africa.

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.

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, such as: topology processors, load allocation, fuzzy state estimation, voltage and reactive power control, fault location with fuzzy inference, isolation and restauration (FDIR), optimal

network reconfiguration, 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 organization, 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 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 meter data and other sensors. The final goal is to embed extracted knowledge in decision-aid methods under risk and create new paradigms for power system control 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.

Advanced Training

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

5.5.4 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-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 objectives and actions planned for 2017

Main Objectives

The advent of internet of things (IoT) technologies will create the technical conditions for data-driven decision-making and control algorithms in different areas of the power system, such as flexibility management, electricity market, asset management and grid optimization. Therefore, one objective is to develop new algorithms in the scientific area of forecasting, to support the technology transfer of Energy Analytics and Forecasting and of Electricity Markets and Regulation results to industrial partners and generate new basic knowledge to foster distributed learning and optimization paradigms.

The impact in planning and operation activities of the foreseeable large deployment of smart grids will be assessed and conduct to new tools, following the recent developments in the framework of European and national projects and also contracts with the industry.

On the other hand, it is an objective of the centre to develop new electricity market model that substitutes the traditional day ahead market by a larger number of sessions as a way to bridge the gap between gate closure and the moment of electricity delivery. It will be studied the integration of secondary and tertiary markets in these sessions and simulations will be conducted using realistic data from the Iberian Electricity Market in order to get meaningful conclusions about the performance of this design.

Specification of RES system support functions for the future energy system: address the power system stability and security challenges integrating both the transmission and distribution layers in the context of up to 100% shares of renewables, including the identification of new system services to be requested from these sources and its dimensioning.

New developments in DMS/EMS & System Operation

Some of the new developments are related with the developments directly done on other areas namely in Energy Analytics and Forecasting, it is important to refer the improvements that will be done in the DMS for LV distribution networks in the scope of the P2020 project ADMS4LV, especially in the improvement of the network monitoring and in the DER management and control.

New developments in System Planning and Reliability

Development of new algorithms for the detection of anomalous consumption behaviour, aiming at identifying uncharacteristic system exploration conditions and energy. The techniques to be applied involve clustering, Fourier decomposition and data streams. These activities will be developed under the scope of contract with EDP Distribuição.

Development of loss profiles for the Portuguese part of the MIBEL (Iberian electricity market). This task has been successfully performed by CPES since 2007 to 2016, and it is expected to be continued in the next year.

Specification of the implementation plan of the Project Pump-storage Santiago Island / Cape Verde. Its overall objective is to mobilize investment in Cape Verde's electricity supply sector and to provide sufficient energy at a fair price benefitting from the country's attractive RE sources and to introduce innovative electricity storage technologies and schemes to manage high RE shares in the electricity supply mix and managing their intermittencies. In the centre of the analysis will be three identified pump-storage sites on Cape Verde's Santiago Island and the potential impact upon higher RE penetration in the island's electricity supply mix. A preliminary work was developed in 2016, including visits to the candidate hydro reservoir sites and analysis of the Cape Verde distribution system. In, 2017, after the agreement of the govern agencies, the specification of the new infrastructures and systems to be implemented will proceed. Storage ability to stabilize generation will provide a wider usage of the endogenous energy sources, namely solar and wind.

Development of models (in the finalization phase) to emulate the Brazilian electrical system to estimate the impacts of climate changes on the electricity generation, security of supply, costs and emissions. Another objective of this research is to anticipate the benefits of smart grids under a climate changing environment.

New developments in Network Studies and RES & DER integration

The anticipation of system services needs in the future power supply scenario (up 100% renewables integration) combined with the identification of units' capabilities to meet these needs represents the basis for the research activities to be exploited in the near future. Power system stability studies including scenarios with up to 100% shares of renewables will be concentrated on the further development (description and dimensioning) of existing controls of renewable-based generators with specific attention to the distribution and transmission levels and the potential interaction that may occur between these levels. Complementarily, the new and/or adapted controls of renewable generation sources will be tested and proven under controlled environment by means of laboratory and Power Hardware in the Loop (PHIL) testing.

In parallel with the research and development activities in this area, it will be reinforced the core group of researchers that have been involved in the consultancy activities in this area. This core group will be strengthened with researches with a strong background on dynamic and transient stability analysis of electric power systems.

New developments in Electricity Markets and Regulation

Along 2017 new developments will be available regarding a new design of electricity markets substituting the traditional day ahead markets by a larger number of sessions as a way to reduce the gap between gate closure and the delivery moment. This will enable including better quality forecasts thus reducing the need for the activation of reserves. Additionally, it will be continued the work that started to be developed in 2016 regarding the design of dynamic tariffs namely putting in place a number of pilot projects involving EHV, HV and MV consumers in order to get insight on the possible demand changes induced by the activation of critical periods and possible impacts on network operation and investment planning. Finally, new developments are

expected on the area of long term transmission expansion planning in a market environment as well as on the use of Dynamic Systems in the generation expansion planning considering the impact of different levels of renewable wind and PV generation.

New developments in Energy Analytics and Forecasting
Knowledge discovery/extraction algorithms applied to state estimation algorithms, including information about state estimation uncertainty distribution, applied to incomplete (spatial-temporal) measures of distribution systems and identification of inter-relations between system variables. Moreover, data mining algorithms, based on smart meter data, will be developed to fraud detection and result from the combination of clustering and change/novelty detection algorithms. This work is inserted in a direct R&D contract with EDP Distribuição (Distribution System Operator of Portugal).
Development of new data-driven concepts for virtual power plants (VPP) operation that cover two important research gaps: (a) real-time control with heterogeneous resources, i.e. different response times and operating costs; (b) lack of knowledge about network constraints and the need to include local information in the optimization framework to mitigate potential curtailment due to "weak" network areas.

Inclusion of renewable energy forecast uncertainty in the classical optimal power flow (OPF) problem be exploring robust optimization approaches and sample average approximation techniques for chance constrained optimization. This work is being done in collaboration with the Technical University of Denmark – DTU.

A load monitoring system will be installed in INESC TEC main building with ca. 165 sub-metering points and measurements data will be stored in a local server. This data will be used as input for a gamification platform which main objective will be to leverage behavioural demand response and energy efficiency increase. A gamification engine will be created to enable competition between the building users and send tailored hints to change their behaviour.

Development of a modular, flexible and cost-effective hardware solution for Home Energy Management Systems (HEMS) with a local computational module that has embedded data analytics functions, such as consumption disaggregation, and energy optimization functions based on mixed integer linear programming. This research is being conducted in the framework of the European Project AnyPlace (coordinated by INESC TEC) and will continue in 2017 aiming at integrating the developed solution in the field.

Development of price forecasting algorithms tailored to large consumers participating in the electricity market and risk hedging strategies considered forecast uncertainty and futures market. A "virtual battery" model will be formulated to model the industrial process flexibility and to enable the participation of large consumers in the ancillary services market and balancing tasks. A potential partnership with an industrial consumer is being explored in order to have access to field data and understand end-user needs/requirements.

New developments in Decision Making, Optimisation and Computational Intelligence RTD
New concepts and tools for global cost minimization applied to power system planning, under the framework of smart grids and increasing share of intermittent production.

Consolidation of the existent INESC TEC approaches for optimization and multicriteria decision-aid using metaheuristics through the application to new problems in the power systems sector.

Research on multi-temporal optimization applied to the optimal power flow problem variants, in the framework of DER management. Research on the stochastic versions of these problems.

New developments in Forecasting RTD
Multivariate probabilistic forecasting with distributed learning techniques (e.g., alternating direction method of multipliers, proximal algorithms) applied to (a) different energy sources within a single market, (b) to neighbour energy markets, (c) to multi-energy systems. In addition to development in the probabilistic forecasting methodology, it is also foreseen the development of online and distributed learning techniques, inclusion of exogenous variables and use of deep learning techniques to explore spatially distributed numerical weather predictions. A partnership with Vestas (Denmark) was established to have access to very large datasets of wind power plants/turbines and for potential licencing of the results. A collaboration with Strathclyde University is also ongoing for joint publications.

Development of algorithms mainly based on local measures and low level (local) actuation to solve high level system issues, by decomposing the main problem into a set of a large number of small sub-problems, exploring the parallelism of distributed processing abilities. Moreover, new simulation and machine learning algorithms will be developed to forecast the multi-temporal flexibility at the residential level, which results from the combination of storage/controllable appliances/local PV. This information will be included in distributed optimization algorithms for two types of end-users: (a) LV system operators; (b) retailers/aggregators.

Explore copula vines to model spatial and spatial-temporal renewable energy uncertainty through a set of trajectories or random vectors.

Development of statistical algorithms based on conditional extreme value theory and time series analysis in order to find reliable models for predicting quantile of electricity prices and renewable energy. This work still in development and will be applied to dynamic line rating in collaboration with MINES ParisTech.

New developments in Reliability RTD

Development of tools for the adequacy assessment of MV/LV 3-phase unbalanced grids with renewables and storage systems. These tools will allow to quantify the benefits in terms of continuity of supply and/or renewable energy not used by installing distributed storage in these grids with different capacities and strategies of operation. In addition, tools for the adequacy assessment of the static and operational reserve in a multiarea environment will also be implemented aiming to quantify the overall benefits from the having the possibility of energy and reserve exchanges between different areas of control.

New developments in Static and Dynamic Analysis of Energy Grids RTD

Development of simulation tools for analysing the dynamic behaviour of inverter dominated grids and characterize the resulting challenges that will drive the identification of new operational methodologies and specification of new system services for assuring system stability.

In a scenario with a very large scale integration of renewables, it is expected that Hydropower will play a more flexible within the overall system operation. Therefore, it will be development new models for variable speed hydropower plants to provide advanced grid supporting services in new types of variable speed generators, namely fast Frequency Containment Reserve (FCR), Frequency Restoration Reserve (FRR) and Black Start in emergency situations.

These topics are currently being exploited in the “REstable” project and an application to the H2020 LCE-07 call was recently submitted.

New developments in Power Electronics RTD

The research focus is on the development of advanced control techniques of electronic power processors applied to electrical distributed generation systems and energy storage devices. Specific short and long term goals:

- Prototype an innovative interface for energy storage based on a Single-stage Bidirectional and isolated AC/DC Matrix converter;
- Implementation and test of Fault Ride Through and Inertia emulation control capabilities on Three-Phase power converter;
- Methods and tools to build power electronics interface units with fault tolerance and diagnosis in order to improve the reliability of power converters.

New interarea projects

Start (1st January) of the new H2020 project INTEGRID (Demonstration of INTElligent grid technologies for renewables INTEgration and INTEractive consumer participation enabling INTEroperable market solutions and INTErconnected stakeholders), duration 42 months, budget INESC TEC 1 297 050 € (total project 11 320 811 €).

Start (1st January) of the National project ESGRID on the smart grids domain and that covers three main topics: (a) demand response; (b) new algorithms for monitoring, forecasting and control of distribution grids; (c) new market models and regulatory frameworks. The duration is 36 months.

Proposals
The Centre is engaged in a number of consortia to answer different calls from the European Union, in the framework of H2020. NB: Since the proposals are still in negotiation and there are pending NDA, no further information can be disclosed in this document.

A proposal for data-driven energy efficiency and demand response actions in the agriculture sector was submitted to National funds.

A proposal for an R&D contract with an industrial partner was submitted for local data validation, estimation and edition in smart meters.

Organization of scientific events
CPES will organize the 10th Bulk Power Systems Dynamics and Control Symposium - IREP'2017, a prestigious international conference that will take place in Espinho, August 27th – September 1st.

CPES will organize the closure dissemination event for the ongoing project HYPERBOLE – an international conference to be held in Porto (2nd-3rd February 2017).

Advanced Training
The Centre will organize a course for REN technical staff on emergent topics of modern power systems.
The Centre also participates in the organization with EFACEC of a course about management functions for transmission and distribution networks for operators from Angola.

In the framework of the EES-UETP consortium a new course on "Data mining techniques applied to energy systems" is envisaged to 2017.

5.5.6 Centre Organizational Structure and Research Team

The Centre for Power and Energy Systems is coordinated by Manuel Matos and Luís Seca and is organized 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 and planned evolution is presented in Table 5.2.

Table 5.2-CPES – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	13	12	16	4
		Academic Staff	11	12	12	0
		Grant Holders and Trainees	36	51	44	-7
		Total Core Researchers	**60**	**75**	**72**	**-3**
	Affiliated Researchers		3	3	3	0
	Admin. & Tech.	Employees	2	2	2	0
		Grant Holders and Trainees	0	0	0	0
	Total Integrated HR		**65**	**80**	**77**	**-3**
	Total Integrated PhD		**24**	**25**	**28**	**3**

5.5.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CPES – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	79	71	345	274
National R&D Programmes - S&T Integrated Projects	93	14	24	10
National Cooperation Programmes with Industry			63	63
EU Framework Programmes	1 253	1 144	842	-302
EU Cooperation Programmes - Other		182	183	1
National R&D Services and Consulting	627	566	812	246
International R&D Services and Consulting	68	77	103	26
Other Funding Programmes	23	135	160	25
Total Funding from Uncertain (future) or Closed (past) Projects (k€)	52	25	99	74
Total Funding	**2 195**	**2 214**	**2 631**	**417**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	13	18	48
International conference proceedings indexed by ISI, Scopus or DBLP	33	31	25
Books (author)			
Chapter/paper in books	5	2	2
PhD theses concluded by members of the Centre		2	2
Concluded PhD theses supervised by members of the Centre	4	3	3

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

Type of Result	No.
Invention disclosures	0
Software copyright registrations	0
Patent applications	0
Licence agreements	0
Spin-offs	0

Table 5.6-CPES – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	1
Conferences organized 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	3
Participation in events such as fairs, exhibitions or similar	0
Advanced training courses	3

Table 5.7-CPES – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	SusCity	Manuel Matos	01-01-2015	31-12-2017
PROG - NAC	INFUSE	Vladimiro Miranda	01-04-2016	31-03-2019
PROG - NAC	ESGRIDS	João Peças Lopes	01-01-2017	31-12-2019
PROG - NAC	NEXTSTEP	Clara Gouveia	01-12-2016	30-11-2019
PROG - NAC	iMAN-5	Luís Seca	01-07-2015	30-06-2018
PROG - NAC	CORAL-TOOLS-4	Carlos Moreira	01-01-2016	31-12-2018
PROG - UE	REStable	Carlos Moreira	01-04-2016	31-03-2019
PROG - UE	GReSBAS	Filipe Joel Soares	01-04-2016	31-03-2019
PROG - UE	SmartGuide	Filipe Joel Soares	01-04-2016	31-03-2019
PROG - UE	Smares	Carlos Moreira	01-04-2016	30-09-2018
PROG - UE	INDuGRID	Carlos Moreira	01-07-2016	30-06-2019
PROG - UE	Hyperbole	Carlos Moreira	01-09-2013	28-02-2017
PROG - UE	EleCtra	José Nuno Fidalgo	01-12-2013	30-11-2017
PROG - UE	SENSIBLE	Ricardo Bessa	01-02-2015	31-07-2018
PROG - UE	UPGRID	Luís Seca	01-02-2015	31-01-2018
PROG - UE	AnyPLACE	David Rua	01-02-2015	31-01-2018
PROG - UE	SmarterEMC2	David Rua	01-02-2015	31-01-2018
PROG - UE	InteGrid	Ricardo Bessa	01-01-2017	30-06-2020
SERV - NAC	EFACEC-DMS	Jorge Correia Pereira	15-04-2001	
SERV - NAC	CP_T_Dinamicas	João Tomé Saraiva	01-02-2015	30-06-2017
SERV - NAC	Automacao_Faial	Clara Gouveia Moura	01-01-2016	30-06-2017
SERV - NAC	Tarif_Dinam_Acores	João Saraiva	01-12-2015	31-01-2018
SERV - NAC	Estim_Invest_Dist	José Nuno Fidalgo	01-09-2015	31-03-2017
SERV - NAC	Cidade_sustentavel	Filipe Joel Soares	01-01-2016	31-12-2017
SERV - NAC	Tarif_Dinam_Madeira	João Tomé Saraiva	01-02-2016	31-12-2017
SERV - NAC	MORA	Leonel Magalhães Carvalho	05-04-2016	04-04-2018
SERV - NAC	ADMS4LV	Luís Seca	01-04-2016	31-03-2018
SERV - NAC	SACC	Filipe Joel Soares	01-01-2016	31-12-2017
SERV - UE	StatProbWind	Ricardo Bessa	01-05-2016	30-04-2017
SERV - NAC	Hidrica_reversivel	João Peças Lopes	01-03-2016	31-08-2017
SERV - NAC	Automacao_PST	André Madureira	30-04-2016	29-06-2017
SERV - NAC	Wind_curteil_soft	Leonel Magalhães Carvalho	12-05-2016	11-01-2017
SERV - NAC	PANACea	José Nuno Fidalgo	08-08-2016	07-03-2017
SERV - NAC	FARad	João Peças Lopes	01-01-2017	30-06-2017
SERV - NAC	Perfis_Perdas_2017	José Nuno Fidalgo	01-11-2016	28-02-2017
SERV - NAC	Graciosa	João Peças Lopes	25-11-2016	24-05-2017
SERV - NAC	Generation_RAM	João Peças Lopes	30-11-2016	29-05-2017
SERV - NAC	Consultoria	Manuel Matos	01-01-2008	
SERV - INT	SECRETS	Luís Seca	01-12-2013	31-05-2017
SERV - INT	STABLING	Carlos Moreira	01-09-2016	31-03-2017

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
O	CoordEES-UETP	João Peças Lopes	01-04-2007	
O	IREP'2017	João Peças Lopes	01-01-2017	31-12-2017
INT	SGEVL	Carlos Moreira	01-01-2014	

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 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 organized 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 organizations and networks need are characterised by being partly documented and executed with the partial support of a wide range of

information systems. Furthermore, organizations 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 in:

- 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.

In 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 organizations to find the strategic decisions that best fit the underlying organization 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 organization and of the decisions the organization 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 organization 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 organizations. 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		Status (2)	Areas of Technology Transfer --> relationships (3)					
			Manufacturing Systems Management	Logistics Systems	Digital Platforms for Networks and Supply Chains	Business Intelligence	Urban Mobility	Construction Information and Knowledge Management
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 objectives and actions planned for 2017

During 2016, CESE started a process to refocus its strategic research domains and to reinvent the consulting services. Part of this process is articulated with the formation and development of the Industry&Innovation cluster of INESC TEC which aggregates, besides CESE, the CEGI, CITE and CRIIS.

In 2017, and in general terms, the centre main objectives are:

- To consolidate the strategic research domains (see above);
- To improve the scientific performance (publications quality and quantity);
- To implement strategies to attract high quality PhD students and scholarship holders;
- To define a strategy for the projects portfolio;
- To develop a roadmap for existing and new high-value services to offer;
- To increase the contribution of CESE for the visibility of INESC TEC in society.

To achieve these objectives, the following activities are planned.

In what concerns to the consolidation of the strategic research domains, there is the intention of creating (in "test mode") a new research domain on Natural Resources Management. This aims at applying several techniques and tools developed under the CESE strategic research domains in the specific context of natural-resources based supply chains. The goal for 2017 is to design and develop the tasks and resources needed to structure this domain, grounded in past CESE past research processes. Collaboration can be promoted with other INESCTEC research Units under the framework of the Cluster Industry&Innovation.

For the existing research domains, consolidation means to advance in the complexity and scope of the tackled problems through the following new research topics:

Manufacturing and Services Operations Management

- Research new planning and scheduling heuristics and optimization and simulation tools to dealt with tailored production processes, for small series, high-customization;
- Research and develop novel optimization-simulation approaches to address uncertainty in production scheduling and planning;
- Research the combination and integration of both hard and soft approaches to deal with complex production planning problems.

Enterprise and Industrial ICT

- Development of Plug&Produce software for advanced robotics in logistic and production areas (DM4Manufacturing project);
- Analysis and selection of methodologies and software tools aiming to model cyber-physical systems and of new software-based tools to increase the level of intelligence on automation devices (PLC, intelligent sensors);
- Development of a conceptual framework addressing the design, management and monitoring of unstructured or semi-structured processes (active case management) and simulation for BPM.

Collaborative Networks and Supply Chains

- Consolidation of a research line aimed at covering from studies to design of methods and tools for the transformation of existing networks into collaborative networks;
- Identification and characterization of enablers for the increasing participation of regions in global supply chains: the Portuguese role in the aircraft interior industry;
- Development of methodologies for the selection of practices for supply chain management towards increasing resource-efficiency and resilience;
- Development of consultancy services in the area of supply chain strategy.

Business Analytics and Decision Support Systems

- Research to extend the range of RS applications to other parts of the production process, such as feeding the product design process with patterns in user preferences;
- Strengthen the contributions in terms of model management and infrastructure integration;
- Integration of knowledge discovering with information management models and techniques;
- Research to deal with growing uncertainty levels and risks, in strongly dynamic environments which are not obvious for traditional, commercially available optimization software solutions through powerful and ergonomic Decision Support Systems.

Transport, Logistics and Mobility

- Research in advanced optimization and simulation models, along with data and knowledge management procedures. As an example, the research will focus on the development of novel optimization-simulation approaches for the distribution of biomass and wood along forest-based supply chains;
- Research handling big quantities of data, the extraction and management of knowledge, the optimization of transport networks and services (involving important resources) and the planning and management of those services;
- Interesting project topics are being discussed with municipalities, public agencies, authorities, and transport operators. Promising applied research is therefore envisaged for 2017, in national locally funded projects, and in broader European initiatives.

5.6.6 Centre Organizational Structure and Research Team

The Centre for Enterprise Systems Engineering is coordinated by Américo Azevedo and António Lucas Soares and is organized 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 and planned evolution is presented in Table 5.2.

Table 5.2-CESE – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	12	12	11	-1
		Academic Staff	11	11	11	0
		Grant Holders and Trainees	33	33	49	16
		Total Core Researchers	**56**	**56**	**71**	**15**
	Affiliated Researchers		4	4	2	-2
	Admin. & Tech.	Employees	2	2	2	0
		Grant Holders and Trainees	0	0	0	0
		Total Integrated HR	**62**	**62**	**75**	**13**
		Total Integrated PhD	**22**	**19**	**19**	**0**

5.6.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CESE – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	63	66	127	61
National R&D Programmes - S&T Integrated Projects	126	129	167	38
National Cooperation Programmes with Industry	129	103	380	277
EU Framework Programmes	449	389	290	-99
EU Cooperation Programmes - Other	77	103	63	-40
National R&D Services and Consulting	440	133	187	54
International R&D Services and Consulting	44	15	4	-11
Other Funding Programmes		53		-53
Total Funding from Uncertain (future) or Closed (past) Projects (k€)	48	265	316	51
Total Funding	**1 376**	**1 256**	**1 534**	**278**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	12	13	20
International conference proceedings indexed by ISI, Scopus or DBLP	21	26	25
Books (author)		2	
Chapter/paper in books	4	1	5
PhD theses concluded by members of the Centre	2	2	5
Concluded PhD theses supervised by members of the Centre	3	3	5

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

Type of Result	No.
Invention disclosures	0
Software copyright registrations	0
Patent applications	0
Licence agreements	0
Spin-offs	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 organized 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	13
Participation in events such as fairs, exhibitions or similar	5
Advanced training courses	8

Table 5.7-CESE – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	E2Web	Ana Barros	01-06-2014	31-05-2018
PROG - NAC	VR2Market-1	Ana Barros	15-07-2014	14-07-2018
PROG - NAC	EasyFlow	Alexandra Sofia Marques	01-06-2016	31-05-2019
PROG - NAC	DM4Manufacturing-1	César Toscano	01-11-2016	31-10-2019
PROG - NAC	FASCOM	Rui Diogo Rebelo	01-10-2015	30-09-2017
PROG - NAC	PrecisionCork	Américo Azevedo	15-05-2016	14-10-2018
PROG - NAC	3GEnergy	António Lucas Soares	01-09-2016	31-08-2018
PROG - NAC	ADIRA_I4.0	António Correia Alves	01-09-2016	31-08-2019
PROG - NAC	AdaptPack	Américo Azevedo	01-09-2016	31-08-2019
PROG - NAC	ATM	António Correia Alves	01-09-2016	28-02-2018
PROG - NAC	MAPPLE	António Correia Alves	01-09-2016	28-02-2018
PROG - NAC	PERSONA-1	Rui Diogo Rebelo	01-03-2017	31-05-2019
PROG - NAC	iMAN	Américo Azevedo	01-07-2015	30-06-2018

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	SMILES-4	Américo Azevedo	01-07-2015	30-06-2018
PROG - UE	MANTIS	Hugo Ferreira	01-05-2015	30-04-2018
PROG - UE	STAMINA-1	César Toscano	01-10-2013	31-03-2017
PROG - UE	BEinCPPS	César Toscano	01-10-2015	30-09-2018
PROG - UE	Futuring	Luís Carneiro	01-09-2016	28-02-2018
PROG - UE	ScalABLE4.0-1	César Toscano	01-01-2017	30-06-2020
SERV - UE	IzaroGrey	António Correia Alves	01-01-2007	
SERV - NAC	ParqueEscolar	Luís Guardão	01-11-2009	31-12-2017
SERV - NAC	COOL	Jorge Pinho de Sousa	01-12-2013	
SERV - NAC	PRODUTECH_Plan	António Correia Alves	01-06-2015	
SERV - NAC	PlantSetup	Samuel Moniz	01-05-2016	30-04-2017
SERV - NAC	CMLDM	Carlos Soares	16-05-2016	15-05-2017
SERV - NAC	BI4UP2	António Lucas Soares	01-08-2016	31-03-2017
SERV - NAC	PROGROW2	Pedro Ribeiro	17-11-2016	16-11-2017
SERV - NAC	MESAI	Rui Diogo Rebelo	12-11-2016	31-01-2017
SERV - NAC	SmartRetail	Rui Diogo Rebelo	13-12-2016	12-12-2017
SERV - UE	ROGER	Samuel Moniz	05-12-2016	04-02-2017
SERV - NAC	SilosL	Samuel Moniz	01-02-2017	31-03-2017
SERV - NAC	BoF	Rui Diogo Rebelo	01-02-2017	31-03-2017
SERV - NAC	SimIntra	Rui Diogo Rebelo	01-02-2017	31-03-2017
SERV - NAC	Consultoria	Luís Carneiro	01-01-2009	

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 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 indoor robotics, industrial robotic manipulators, Automated Guided Vehicles (AGVs), navigation solutions for indoor and outdoor environments.

The Centre for Robotics in Industry 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 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 in 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 p.e., 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 have 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 of 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 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 of the 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 unit will further develop the use development of 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 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 integrates 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 in 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 occurs 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 transfer 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 Embebed 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) and other are in progress (GISLOTICA, Rail-Inspect).

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 applications.

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	Areas of Technology Transfer --> relationships (3)					
	Status (2)	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

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
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 objectives and actions planned for 2017

Strategic Objectives, Main initiatives / actions planned

- Improve the alignment between basic research, applied research and consultancy;
- Maximise the impact of the Centre's activity in the companies, and promote the valorisation of results;
- Establish strategic partnerships with international research key players, industries and stakeholders, allowing the alignment of the research activities with future industrial projects;
- Improve internal competences by developing the motivation of human resources and creating conditions for attracting high level national and international researchers;
- Improve the Centre's external visibility, through the organisation and participation in key national and international scientific and industrial events;
- 2017 is the consolidation year for the new application area Agriculture Robotics. With some seed projects already running, this year will be focused on the growth of the team dedicated to the area, with special emphasis on the increase of the available equipment infrastructure, and finally the diversification of funding, namely European Projects and direct contracts;
- Consolidation of the strategic communication plan established in 2016, that includes the establishment of Centre's dedicated website, youtube channel in articulation with the communication strategy of INESC TEC;
- Analysis and establishment of a team to evaluate the potential of new technology transfer areas. Two main candidate are identified based on previous projects: (1) Robotics for health applications (2) Robotics for architecture and construction;
- Consolidation of a tight national network of partners in the scientific areas Vertical Integration, IoT, Industry 4.0 (CEG-IST, UC, IPB), Human Robot Interfacing and Future Industrial Robotics (UC, UA), Navigation and Localization of Mobile Robots (LarSys and DEMEC both from IST);

- In terms of sources of funding the Centre will try to keep the 2016 balance between fundamental (FCT), applied research (P2020 – Co-promotion), European funded projects (H2020) and direct contracts. The goal is to have 40-50% of the latest two (H2020 and direct contracts);
- Team- The objective is the maintenance of the permanent staff (4-5 contracts) the increasing of the number of scholarships to 10-12, and restructuring the non-research contracts. In detail the focus will be sharing of resources with other units and the answer to specific needs in technical support;
- Increase the number of financed PhD students by external programmes, FCT, N2020, MIT, CMU and others;
- Significant development of the activities under the FABTEC umbrella, including new research project proposals, advanced formation and technology transfer;
- Develop new partnerships with national and international research organizations, leaders in fields near or complementary to the Centre's activity;
- Maintain/Increase the Centre participation and the visibility in European projects;
- Consolidate partnerships with international research key players, industries and stakeholders and continue direct contact with large number of companies, in Portugal and abroad;
- Promote an internal regular discussion on research opportunities and project organization. In particular, 2017 is the consolidation year for the robotics LabMeetings, held together with the CRAS Centre;
- Define plans for the valorisation of the intellectual property of the Centre.

Future research

- Control of mobile manipulators for non-logistic processes. The focus will be on the integrated kinematics development, safety and process control;
- Multi robot coordination methodologies for automatic generation of mission plans; supervision of autonomous platform operations; cooperative operation of multiple platforms;
- Concerning vision based real time sensors: perception systems as a sensor for on board sensing; real time stereo, and 3D point-cloud sensing for mapping, self-localization and objects detection; low latency and robust feature extraction in semi controlled environments;
- In the field robotics area: modelling and control of mobile robots; navigation and localization in out-door semi structured environments (using natural and artificial landmarks);
- Industrial robotic manipulators: vision and manipulator coordination; advanced sensing: measurements and testing of features; rapid teaching and programming interfaces;
- Intelligent control and smart sensors: control algorithms for complex dynamic systems. New sensing strategies.

5.7.6 Centre Organizational Structure and Research Team

The Centre for Robotics in Industry and Intelligent Systems is coordinated by António Paulo Moreira and is organized 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 planned evolution is presented in Table 5.2.

Table 5.2-CRIIS – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	3	3	6	3
		Academic Staff	20	21	20	-1
		Grant Holders and Trainees	10	15	21	6
		Total Core Researchers	**33**	**39**	**47**	**8**
	Affiliated Researchers		0	0	0	0
	Admin. & Tech.	Employees	2	2	1	-1
		Grant Holders and Trainees	1	1	0	-1
	Total Integrated HR		**36**	**42**	**48**	**6**
	Total Integrated PhD		**24**	**26**	**27**	**1**

5.7.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CRIIS – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	18		75	75
National R&D Programmes - S&T Integrated Projects	25	52	50	-2
National Cooperation Programmes with Industry		72	158	86
EU Framework Programmes	19	284	154	-130
EU Cooperation Programmes - Other			28	28
National R&D Services and Consulting	330	70	411	341
International R&D Services and Consulting	36			
Other Funding Programmes				
Total Funding from Uncertain (future) or Closed (past) Projects (k€)		117	28	-89
Total Funding	**428**	**595**	**904**	**309**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	22	29	30
International conference proceedings indexed by ISI, Scopus or DBLP	79	34	35
Books (author)	1	2	
Chapter/paper in books	3	2	
PhD theses concluded by members of the Centre			1
Concluded PhD theses supervised by members of the Centre	4		2

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

Type of Result	No.
Invention disclosures	1
Software copyright registrations	0
Patent applications	1
Licence agreements	0
Spin-offs	0

Table 5.6-CRIIS – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	2
Conferences organized 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	8
Participation in events such as fairs, exhibitions or similar	1
Advanced training courses	2

Table 5.7-CRIIS – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	DM4Manufacturing	Germano Veiga	01-11-2016	31-10-2019
PROG - NAC	CoopWeld	Germano Veiga	28-12-2015	27-06-2017
PROG - NAC	PrecisionCork-1	Hélio Mendonça	15-05-2016	14-10-2018
PROG - NAC	AdaptPack-1	Manuel Santos Silva	01-09-2016	31-08-2019
PROG - NAC	ROMOVI	Filipe Neves Santos	07-01-2017	31-08-2019
PROG - NAC	SmartFarming	Filipe Neves Santos	01-10-2016	30-09-2018
PROG - NAC	ATM-1	António Paulo Moreira	01-09-2016	28-02-2018
PROG - NAC	iMAN-3	António Paulo Moreira	01-07-2015	30-06-2018
PROG - UE	Water4Ever	Filipe Neves Santos	01-03-2016	28-02-2019
PROG - UE	AGRISENSUS	José Boaventura	01-01-2017	31-12-2019
PROG - UE	STAMINA	Germano Veiga	01-10-2013	31-03-2017
PROG - UE	ColRobot	Germano Veiga	01-02-2016	31-01-2019
PROG - UE	ScalABLE4.0	Germano Veiga	01-01-2017	30-06-2020

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
SERV - NAC	AutoClassII	António Paulo Moreira	01-01-2015	31-10-2017
SERV - NAC	RAIL_INSPECT	António Paulo Moreira	01-01-2016	30-04-2017
SERV - NAC	TEXTILPRINT	Hélio Mendonça	04-01-2016	29-11-2017
SERV - NAC	TRiHo	Germano Veiga	01-07-2016	31-03-2018
SERV - NAC	BITMAKER	Filipe Neves Santos	01-01-2017	31-08-2017
SERV - NAC	Inspectum	Manuel Santos Silva	01-09-2016	31-08-2017
SERV - NAC	Consultoria	António Paulo Moreira	01-01-2014	

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 CEGI – CENTRE FOR INDUSTRIAL ENGINEERING AND MANAGEMENT

Coordinator: Ana Viana and Pedro Amorim

5.8.1 Presentation of the Centre

CEGI accomplishes its mission, within the Cluster I+I - Industry and Innovation, by following an organizational structure based on six knowledge fields (Service Design, Decision Support, Performance Assessment, Asset Management, Business Intelligence, and Prescriptive Analytics) and on five areas of application (Mobility and Transports, Energy, Retail, Industry, and Health). Each of the knowledge fields is headed by one/two senior researchers that are responsible to foster collaboration, among CEGI researchers, in the respective topic, and to look for funding opportunities and external collaboration. A similar coordination structure is used in each of the application areas. Activity in each of the identified fields ranges from fundamental research to consultancy and services providing.

CEGI aims to pursue research areas that are just at the interface of these fields. Namely, CEGI wants to investigate the methodologies that should be used to hybridize optimization and data-mining techniques. Moreover, the relevance of using service design and engineering approaches to better frame decision problems is another goal to be attained.

Currently, CEGI has 30+ integrated PhD members. This number is expected to rise in the years to come as several structural projects were recently approved.

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 organizations, particularly in the areas of mobile services, smart services, and social networks.

DECISION SUPPORT

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).

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 organizational 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 explored in the following 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.

BUSINESS INTELLIGENCE

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

The solution approaches used to tackle these problems make a trade-off between effectiveness and efficiency, and include:

- 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.

5.8.3 Technology transfer

ENERGY

The energy application area 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 application area is the area where CEGI has historically been more active, and covers both the industrial and the service sectors. CEGI provides services for this application 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		Areas of Technology Transfer --> relationships (3)					
		Status (2)	Energy	Mobility and Transports	Retail	Industry	Health
Service Design		I	M	M	L	H	M
Decision Support		I	M	M	H	H	M
Performance Management		I				M	M
Asset Management		I	H			M	
Business Intelligence		I		M		M	
Prescriptive Analytics		I	H	M	H	H	H
Other areas (1)	Energy (CPES)	O	M				
	Operations (CESE)	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

5.8.5 Main objectives and actions planned for 2017

It is foreseen that in 2017 significant breakthroughs will be obtained at the interconnection between the research areas in CEGI. Two examples are given below.

- Enhancement of the focus of intelligent systems to also include a strategic level, taking into account performance measurement information. The optimization of systems involving massive data will demand for performance assessment information within the decision support system. This will enable decision agents to benchmark the components of the system, or to explore the evolution of performance over time. The analysis and comparison of the solutions proposed by optimization techniques and the decisions that were taken under real conditions will help to better understand complex decision processes and to enhance decision making.
- The Servitization of manufacturing – extending the scope of manufacturers offerings into services – poses significant research challenges at the borders of service innovation and intelligent systems to support the reshape of service support supply chains, optimizing Service Networks and Value Chain. Servitization is being enabled by new information and communication technologies. The optimum extent (level) of servitization for different types of industries is an open research question that CEGI intends to address.

Through CIPS - Centre for Innovation and Development of Products and Services, recently launched that was promoted and is co-coordinated by CEGI members – a Service Design Lab will foster the development of new service design methodologies, and support the development of new service concepts at its different stages. The identification of medium and long term trends involving ICT and Service Engineering and Design in the 2020 horizon will be sought.

In prescriptive analytics and decision support, the incorporation of Network design issues in Production and Distribution Planning Models and Algorithms, as well as Risk Management in Sustainable (Green) Supply Chains (in light of the strong uncertainties that the current supply chains face), will enable the development of the new generation of advanced supply chain decision support systems (containing novel mathematical programming-based algorithms). After many breakthroughs obtained for deterministic problems, CEGI makes a step forward to cope with uncertainty by means of developing simulation-optimization stochastic programming approaches that will enhance robust planning, allocation and scheduling. New flexible solutions, capable of adapting to environment changes (under the paradigm of IoT/Physical Internet) will also be a focus of research. To pursue this goal, besides one ongoing project, CEGI is collaboration with some H2020 projects in this topic.

For the healthcare sector, a target will be on the joint use of predictive and prescriptive analytics. In particular, advance optimised solutions for different possible scenarios, provided by predictive analytics, both in healthcare logistics, planning and policies.

The strategic objectives for the Business Intelligence area include the use of data mining techniques in direct marketing initiatives, and the development of enhanced models to evaluate the effect of promotions in customer lifetime value and prevention of churn. Web mining will be explored, given the increased importance of e-business. In the area of Performance Management, the use of frontier techniques to evaluate performance will be explored focusing on contexts requiring the analysis of big data in companies (namely in mobility and retail). Another research area concerns performance measurement in contexts where corporate/social sustainability and quality issues are key concerns.

5.8.6 Centre Organizational Structure and Research Team

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

- Service Design - Responsible: Lia Patrício and Jorge Teixeira
- Decision Support - Responsible: João Pedro Pedroso and Gonçalo Figueira
- Performance Assessment - Responsible: Ana Camanho
- Business Intelligence - Responsible: José Luís Borges and Vera Miguéis
- Prescriptive Analytics - Responsible: José Fernando Oliveira
- Moreover, there is an advisory board to assist the coordination.

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

Table 5.2-CEGI – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	0	0	0	0
		Academic Staff	19	19	19	0
		Grant Holders and Trainees	25	34	37	3
		Total Core Researchers	**44**	**53**	**56**	**3**
	Affiliated Researchers		4	3	3	0
	Admin. & Tech.	Employees	0	0	0	0
		Grant Holders and Trainees	0	0	0	0
	Total Integrated HR		**48**	**56**	**59**	**3**
	Total Integrated PhD		**28**	**32**	**34**	**2**

5.8.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 6 and new projects to be signed during the year.

Table 5.3-CEGI – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	2	50	146	96
National R&D Programmes - S&T Integrated Projects		115	197	82
National Cooperation Programmes with Industry			20	20
EU Framework Programmes	31	57	20	-37
EU Cooperation Programmes - Other	53			
National R&D Services and Consulting	63	155	59	-96
International R&D Services and Consulting				
Other Funding Programmes			27	27
Total Funding from Uncertain (future) or Closed (past) Projects (k€)	-5	65	119	54
Total Funding	**144**	**442**	**588**	**146**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	32	31	31
International conference proceedings indexed by ISI, Scopus or DBLP	16	12	12
Books (author)			
Chapter/paper in books	8	4	4
PhD theses concluded by members of the Centre	6	3	3
Concluded PhD theses supervised by members of the Centre	9	3	3

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

Type of Result	No.
Invention disclosures	0
Software copyright registrations	0
Patent applications	0
Licence agreements	0
Spin-offs	0

Table 5.6-CEGI – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	2
Conferences organized by INESC TEC members (in the organizing committee or chairing technical committees)	3
International events in which INESC TEC members participate in the program committees	8
Participation in events such as fairs, exhibitions or similar	0
Advanced training courses	1

Table 5.7-CEGI – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	HHRPLAN	Bernardo Almada Lobo	01-04-2016	31-03-2018
PROG - NAC	mKEP	Ana Viana	01-04-2016	31-03-2019
PROG - NAC	EasyFlow-1	Pedro Amorim	01-06-2016	31-05-2019
PROG - NAC	DM4Manufacturing-2	Pedro Amorim	01-11-2016	31-10-2019
PROG - NAC	KnowLOGIS	Pedro Amorim	01-07-2017	30-06-2019
PROG - NAC	iMAN-2	Luís Guimarães	01-07-2015	30-06-2018
PROG - NAC	SMILES-8	Teresa Galvão	01-07-2015	30-06-2018
PROG - NAC	CORAL-TOOLS-6	João Pedro Pedroso	01-01-2016	31-12-2018
PROG - UE	UPGRID-1	Lia Patrício	01-02-2015	31-01-2018
SERV - NAC	BestWare	Pedro Amorim	01-03-2015	28-02-2017
SERV - NAC	RosaEvolution	Bernardo Almada Lobo	06-04-2015	05-01-2017
SERV - NAC	Path	Luís Guimarães	01-01-2017	30-05-2017
SERV - NAC	Consultoria	Bernardo Almada Lobo	01-01-2014	
OID	Atena	Maria Antónia Carravilla	14-10-2016	13-10-2019
O	Euro2017	Pedro Amorim	01-11-2016	30-06-2017

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 CITE – CENTRE FOR INNOVATION, TECHNOLOGY AND ENTREPRENEURSHIP

Coordinator: Alexandra Lobo Xavier

5.9.1 Presentation of the Centre

CITE accomplishes its mission, within the Cluster I+I - Industry and Innovation, by carrying out R&D, advanced consulting and executive education in Technology Management, Innovation Management, Technology Entrepreneurship and Fuzzy Front End of Innovation. The Group seeks to promote the valorisation of the knowledge it creates, by developing conceptual frameworks, methodologies, tools, and executive programs, to be provided to 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.

5.9.2 Research and Technology Development

Innovation Management

Investigating how innovation is organised, developed and commercialised within the scope of technology-based companies; an emphasis is placed on innovation management practices and tools and innovation metrics, building on a history of contributions to the Portuguese Standard for R&DI Management and for the European Technical Guide for Innovation Management. Participation in ISO-TC279 for Innovation Management Assessment.

Develop user cantered innovation methodologies and tools to support new business model approaches, new product and services concepts and facilitate the implementation of lean start up approaches to engage potential clients and end users in order to mitigate risks and increase the product-market fit.

Fuzzy Front End of Innovation

Creating multidisciplinary approaches to enabling the Front End of Innovation, combining methods and tools that build on state-of-the-art concepts and trends in enterprise information systems, enterprise integration, information and communication technology and business narrative modelling and analysis.

Technology Management

Looking 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. A particular attention is dedicated to the topics of diffusion, adoption, and implementation of technological innovations, since for an innovation to change the way people live or the way organizations work, it has to be adopted and implemented by them.

This focus on adoption and implementation is complemented by the study of 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

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.

- Create entrepreneurial awareness through the organization by implementing training actions, seminars and workshops and giving direct support to entrepreneurs in the process of turning ideas and technologies into business;
- Develop and use case studies to disseminate creative entrepreneurship projects that will be examples for emerging new entrepreneurial projects;
- Implement accelerator programmes to facilitate the development of new technological early stage projects.

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.

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.

User Canter Innovation

Develop a set of co creation workshops supported by creative tools to generate new business model, product and services concepts.

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	User Centre Innovation	Consulting
Innovation Management	I	M	H	H	M	H
Fuzzy Front End of Innovation	I	M		M	M	F
Technology Management	I		M	M		F
Technology Entrepreneurship	I/E	H	M	M	M	F

(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 objectives and actions planned for 2017

Develop new training programmes focused on: adoption and implementation of technology and on Innovation Management;

Launch three different accelerator programmes that include mentorship and educational components:

- IN&OUT – an early stage start-ups accelerator for everyone who wants to development a technological based entrepreneurial project;
- BIP – Business Ignition Programme: a programme design to researchers in order to improve their capacities to be part of the process of the technology exploitation;
- LET IN Catalyst – implement an internal entrepreneurship programme to support INESC TEC researchers in their entrepreneurship initiatives.

Implement Innovation Management services into at least fifteen SMES, under the EEN Innovation Project;

Provide support to company's benefits from SME Instrument, under the EEN Innovation Project.

Implement the advisory support services to SME´s under the EEN Portugal consortium.

Concerning the activity of Technology Management and Technology Entrepreneurship during 2017, CITE aims to:

- Reinforce the team working in these fields and the number of published papers and participation in conferences;
- Submit a proposal for a scientific project focused on the concerns mentioned above;
- Complete the tasks that were agreed for 2017 within the following projects: Safecloud, Nanostima, iMan, FourEyes, SMILES, CORAL, and Screen-DR;
- Start the Spin-off project together with ANI (Agência Nacional de Inovação).

5.9.6 Centre Organizational Structure and Research Team

The Centre CITE is coordinated by Alexandra Xavier and is organized 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 planned evolution is presented in Table 5.2.

Table 5.2-CITE– Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	2	2	2	0
		Academic Staff	1	1	2	1
		Grant Holders and Trainees	5	4	7	3
		Total Core Researchers	**8**	**7**	**11**	**4**
	Affiliated Researchers		6	6	3	-3
	Admin. & Tech.	Employees	0	0	0	0
		Grant Holders and Trainees	0	0	0	0
	Total Integrated HR		**14**	**13**	**14**	**1**
	Total Integrated PhD		**6**	**6**	**7**	**1**

5.9.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CITE – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	181	2	5	3
National R&D Programmes - S&T Integrated Projects	5	9	47	38
National Cooperation Programmes with Industry	16	36		-36
EU Framework Programmes	202	57	56	-1
EU Cooperation Programmes - Other	109	35	38	3
National R&D Services and Consulting	620			
International R&D Services and Consulting				
Other Funding Programmes	39		92	92
Total Funding from Uncertain (future) or Closed (past) Projects (k€)	70	1	43	42
Total Funding	**1 242**	**140**	**281**	**141**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	7	8	14
International conference proceedings indexed by ISI, Scopus or DBLP	1	3	6
Books (author)	1	3	2

Type of Publication	2015	2016 (Forecast)	2017
Chapter/paper in books	3	2	3
PhD theses concluded by members of the Centre		3	5
Concluded PhD theses supervised by members of the Centre	3	4	5

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

Type of Result	No.
Invention disclosures	0
Software copyright registrations	0
Patent applications	0
Licence agreements	0
Spin-offs	0

Table 5.6-CITE – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	2
Conferences organized 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	0
Participation in events such as fairs, exhibitions or similar	1
Advanced training courses	3

Table 5.7-CITE – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	VR2Market-2	Catarina Maia	15-07-2014	14-07-2018
PROG - NAC	SCREEN-DR-1	Catarina Maia	01-04-2016	31-03-2020
PROG - NAC	FOUREYES-1	João Claro	01-07-2015	30-06-2018
PROG - NAC	iMAN-1	João Claro	01-07-2015	30-06-2018
PROG - NAC	SMILES-2	João Claro	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL1-2	João Claro	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL2-1	João Claro	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL3-1	João Claro	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL4-1	João Claro	01-07-2015	30-06-2018
PROG - NAC	CORAL-SENSORS-2	João Claro	01-01-2016	31-12-2018
PROG - UE	EEN2017/2018	Alexandra Xavier	01-01-2017	31-12-2018
PROG - UE	SafeCloud-1	João Claro	01-09-2015	31-08-2018
SERV - NAC	Consultoria	Alexandra Xavier	01-01-2008	
OID	BIP	Alexandra Xavier	01-02-2016	31-01-2018
OID	IN&OUT	Alexandra Xavier	01-12-2015	30-11-2017

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 CSIG – CENTRE FOR INNOVATION, TECHNOLOGY AND ENTREPRENEURSHIP

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.

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 investigates in Image Synthesis and Visual Perception, 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, and Virtual Environments for Learning and Procedural Modelling of Urban Environments.

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 Systems and Information Management research area investigates in the areas of Information Management, Information Retrieval, Information Processing, Digital Preservation and Research Data Management. This area includes work in frameworks for information management, retrieval and processing in contexts such as Web Mining, Recommender Systems, Social Web, Semantic Web, Information Retrieval and Text Mining. 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 investigates 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 pattern-based GUI testing, automated pattern-based testing of mobile applications, model-based testing and certification in digital ecosystems, automated scenario-based testing of distributed and heterogeneous systems, modular testing for aspect-oriented programs, automated software process performance analysis and improvement recommendation, recommender systems for requirements maintenance, platforms for collaborative framework understanding, software documentation with adaptive software artifacts, 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

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 area 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 competences in information systems and software engineering, but a larger involvement is expected 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	M	H
Software Engineering		I	H	H
Information Management and Systems		I	H	H
Accessibility		I	M	M
Special Purpose Computing Systems		I	L	L
Other areas (1)	Communication Networks (CTM)	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 objectives and actions planned for 2017

CSIG global main objectives are:

- Maintain a balanced economic operation;
- Increase scientific production;
- Obtain at least one new H2020 project;
- Enlarge collaboration with main partners, contracting at least one new Technology Transfer contract per partner;
- Diversify collaborations with new partners, obtaining at least two new Technology Transfer contracts, with new partners;
- Public opening of MASSIVE Laboratory.

Main objectives per scientific area are:

Computer Graphics and Virtual Environments

In the area of Serious Games, the H2020 BEACONNG project is entering the second year providing a system to design, develop and manage pervasive games for learning. The major SW components and small pilots will take place in 2017. Another project in this area is GRISBAS, a gamified platform to reduce the energy costs in buildings, which is going to be tested at the INESC TEC Porto facilities. The link of Serious Games and e-Learning platforms for Health will be continued in projects like RECAP and E-COMPARED, but also will be pushed forward as the results of recent applications.
In the area of Virtual Environments, the MASSIVE project is undergoing its second phase, starting in 2017 with the inauguration of the Vila Real Research Lab. Research in Usability and User Experience will be taken to a new level of quality and impact. Google DNI will also explore how immersive environments can improve the impact of the media in the audience and will develop new tools for journalists. The TeleMediaArte project will also enhance how technology can improve accessibility of the citizens to art.

The project FOUREYES will also be pushed to a new level to provide integration of these research lines with other INESC TEC centres. This integration will provide opportunities to new applications at both national and international scopes.

The Geospatial Systems area will continue its support to the national industry in distinct national projects.

Information Management and Information Systems

In the area of Information Management and Information Systems, several objectives are set for 2017. In Research Data Management, the work in the context of project TAIL is expected to progress with the publication of datasets, described according to domain-dependent models. The Dendro platform, used experimentally in INESCTEC and the University of Porto, will be promoted as the support for data organisation and description within projects in research organisations. Work on the windscanner European e-infrastructure will also progress, namely with the collaboration in the European Wind Atlas where a platform for supporting field experiments is under development. The SeaBioData project will be completed, resulting in a data repository for marine research, based on the European INSPIRE directive and a Sensor Observation Service with specific extensions.
Within the Information Retrieval area we will continue our work on the development of tools that help laypeople search the web for health information. Part of the work will be associated with the NanoSTIMA project. We plan to proceed with the development of a Portuguese version of a consumer health vocabulary through HealthTranslations; to work towards a method to assess the readability of Portuguese health contents; to develop HealthTalks, a mobile app that will help patients manage and understand the information provided in doctor's appointments; to advance previous work on the influence of health literacy on health search behaviours, namely eye-movements; to compare automatic methods to classify messages shared in online health communities and to progress with the development of HealthSuggestions.

In the area of Digital Media, work will continue in FourEyes, a large interdisciplinary project with a focus in the field of media. This project has the participation of several groups within CSIG and, in 2017, emphasis will be on

fostering collaboration between the different areas. Also in the media area, a new project will start in 2017 focused on information extraction and natural language generation for news innovation. This is a project supported by the Digital News Initiative Fund from Google.

Software Engineering

In the area of Software Engineering, several objectives are set for 2017.
In the scope of the NanoSTIMA project, we will continue the work on automated scenario-based testing of distributed and heterogeneous systems, initiated in 2016. Decentralized algorithms will be developed to fully automate the scenario-based integration testing of distributed systems, following an adaptive model-based testing strategy, with a minimum communication overhead between test components, and with application examples in the e-health domain.

We expect to start the work on the Software560 project of the TICE.PT cluster on the "Productization and Internationalization of Portuguese Software". Besides being responsible for the scientific coordination of PPS5 on "Tools and Frameworks for Software Development", we will be involved in the research and development of the following tools and frameworks: automated pattern-based testing of mobile applications (iMPAcT tool); automated fault localization in mobile applications (Zoltar2); model-driven development of cyber-physical systems (Plug-Things framework).

We will also consolidate and extend the work on automated software process performance analysis and improvement recommendation (ProcessPAIR), in order to support the automated assessment of adherence to agile practices and take further advantage of data mining, crowdsourcing and gamification techniques.

We are also involved in the FOUREYES project and our goal is to develop and apply techniques for ensuring the quality of the multimedia software applications developed inside this project.

Accessibility and Assistive Technologies

In the area of Accessibility and Assistive Technologies we will continue the work developing and integrating technologies to help blind people in their daily life and for enhancing their autonomy, namely implementing a demonstrator prototype of the ISEABlind in a municipality within the scope of the 2015 Digital Inclusion and Literacy Prize - Integrated System for Enhancing the Autonomy of the Blind, promoted by the Portuguese ICT and Society Network, granted by the Portuguese Foundation for Science and Technology (FCT).
We will also develop assistive technologies to assist people with intellectual disabilities by enhancing their abilities and autonomy in the access of web content. This objective was defined in the project "Metáfora de interação acessível para navegação web sem recurso a texto" supported in the 2015 Digital Inclusion and Literacy Prize promoted by the Portuguese ICT and Society Network granted by the Portuguese Foundation for Science and technology (FCT).

The AAT area will continue developing the Research Line 2 (RL2) of the project NanoStima with others partners and in particular, in RL2, with CIDESD, developing smart interfaces for data acquisition of the elderly physics activity.

We plan to contribute to the BEACONING H2020 project in the areas of Accessibility and Usability and to submit 3 proposals for the Horizon 2020 in this area.

We will disseminate and promote the AAT area organizing special sessions and publishing in scientific conferences of this area, namely in the HCII2017, and publishing as well as in scientific journals.

The work of the Web Accessibility Barometer of the web sites of private companies will be continued.

Special Purpose Computing Systems

In 2017, the Special Purpose Computing Systems (SPeCS) area will mainly address compiler transformations and the efficient mapping of computations to hardware accelerators using GPGPUs and FPGAs. The mapping methods and approaches will take into account performance, energy and power consumption figures. The area also intends to provide custom solutions for data-intensive algorithms, mainly considering classification and recommendation systems, such as the ones to be developed in the context of the projects CONTEXTWA and SMILES.
The SPeCS area will continue to research new techniques to map efficiently (in terms of performance and energy consumption) matrix-oriented computations. This mapping process will continue to be focused on the translation of MATLAB/Octave models to C/OpenCL both targeting multicore architectures and hardware

accelerators (GPGPUs and FPGAs). The new techniques will be used in the MATISSE compiler to provide a prototype of a recommendation system (in the context of an interdisciplinary work between members of SMILES and FOUREYES).

In the context of the CONTEXTWA project, the SPeCS area will address runtime adaptivity and autotuning schemes for algorithms to classify user's activities based on sensing from, e.g., accelerometers and gyroscopes. The intention is to provide the required accuracy levels with respect to activities of the user while saving energy and satisfying real-time requirements.

In 2017, the SPeCS area intends to participate in at least two H2020 proposals.

5.10.6 Centre Organizational Structure and Research Team

The Centre for Information Systems and Computer Graphics is coordinated by António Gaspar and Ângelo Martins and is organized 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 planned evolution is presented in Table 5.2.

Table 5.2-CSIG – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	10	7	10	3
		Academic Staff	24	26	26	0
		Grant Holders and Trainees	38	35	52	17
		Total Core Researchers	**72**	**68**	**88**	**20**
	Affiliated Researchers		14	15	13	-2
	Admin. & Tech.	Employees	1	1	1	0
		Grant Holders and Trainees	0	0	0	0
	Total Integrated HR		**87**	**84**	**102**	**18**
	Total Integrated PhD		**40**	**45**	**47**	**2**

5.10.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CSIG – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	1	123	107	-16
National R&D Programmes - S&T Integrated Projects	49	242	341	99
National Cooperation Programmes with Industry				

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
EU Framework Programmes	73	261	285	24
EU Cooperation Programmes - Other		110	23	-87
National R&D Services and Consulting	72	474	215	-259
International R&D Services and Consulting				
Other Funding Programmes	64		134	134
Total Funding from Uncertain (future) or Closed (past) Projects (k€)	2	255	339	84
Total Funding	**261**	**1 465**	**1 444**	**-21**

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

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	26	35	42
International conference proceedings indexed by ISI, Scopus or DBLP	72	78	74
Books (author)		3	4
Chapter/paper in books	4	7	14
PhD theses concluded by members of the Centre		7	12
Concluded PhD theses supervised by members of the Centre	13	11	20

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

Type of Result	No.
Invention disclosures	1
Software copyright registrations	0
Patent applications	1
Licence agreements	1
Spin-offs	0

Table 5.6-CSIG – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	14
Conferences organized by INESC TEC members (in the organizing committee or chairing technical committees)	13
International events in which INESC TEC members participate in the program committees	42
Participation in events such as fairs, exhibitions or similar	19
Advanced training courses	6

Table 5.7-CSIG – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	TAIL	Cristina Ribeiro	30-05-2016	29-05-2019
PROG - NAC	CONTEXTWA	João Paiva Cardoso	01-06-2016	31-05-2019
PROG - NAC	Icarefordepression	Artur Rocha	01-06-2016	31-05-2019
PROG - NAC	FOUREYES-2	Sérgio Nunes	01-07-2015	30-06-2018
PROG - NAC	SMILES-5	João Paiva Cardoso	01-07-2015	30-06-2018
PROG - NAC	CORAL-SENSORS-3	Susana Alexandra Barbosa	01-01-2016	31-12-2018
PROG - NAC	CORAL-TOOLS-3	Artur Rocha	01-01-2016	31-12-2018
PROG - NAC	NanoStima-RL2	João Barroso	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL3-2	Ângelo Martins	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL4-3	Carla Lopes	01-07-2015	30-06-2018
PROG - UE	SeaBioData	Artur Rocha	01-07-2015	30-04-2017
PROG - UE	E-Compared	Artur Rocha	01-01-2014	30-06-2017
PROG - UE	LeanBigData-1	Alexandre Carvalho	01-02-2014	31-01-2017
PROG - UE	BEACONING	António Coelho	01-01-2016	31-12-2018
PROG - UE	RECAP	Artur Rocha	01-01-2017	31-03-2021
SERV - NAC	CCDRN-EA	António Gaspar	21-10-2010	
SERV - NAC	PWA	José Correia	17-06-2013	31-12-2017
SERV - NAC	vCardID	José Correia	01-01-2014	30-06-2017
SERV - NAC	SIGAMP	Lino Oliveira	01-01-2016	31-12-2017
SERV - NAC	IMOPORTAL	José Correia	01-07-2016	31-07-2017
SERV - NAC	ARQNET	José Correia	26-10-2016	30-06-2018
SERV - NAC	Consultoria	António Gaspar	01-01-2008	
OID	Atena-1	Carla Lopes	14-10-2016	13-10-2019
OID	Tele-Media-Arte	Leonel Morgado	01-10-2016	30-09-2017
OID	HDR4RTT	Maximino Bessa	30-09-2016	29-09-2018
INT	AV360-DNI	Rui Pedro Rodrigues	01-03-2017	31-08-2018
O	ACESSWEB	Ramiro Gonçalves	01-01-2015	30-06-2017
O	ISEABlind	João Barroso	01-10-2016	28-02-2017

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 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 organization.

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 behavior 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 valorization 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 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 objectives and actions planned for 2017

- Promote the contracting of consultancy services by start-ups and other companies (3 contracts);
- Reinforce the partnerships with centres in INESC TEC that are closer to domain areas to boost participation more actively in technology transfer (2 new joint projects);
- Promote the participation in European projects and networks (participation in 4 new proposals);
- Continue the exploration of the application of data science to new application domains: Oil and Gas, Internet-of-Things, Farming (10 papers in new areas, 2 events).

5.11.6 Centre Organizational Structure and Research Team

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

- Machine Learning and Data Mining - João Gama / Luís Torgo
- 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 planned evolution is presented in Table 5.2.

Table 5.2-LIAAD – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	0	0	0	0
		Academic Staff	29	29	23	-6
		Grant Holders and Trainees	17	38	42	4
		Total Core Researchers	**46**	**67**	**65**	**-2**
	Affiliated Researchers		5	5	2	-3
	Admin. & Tech.	Employees	0	0	0	0
		Grant Holders and Trainees	0	0	0	0
	Total Integrated HR		**51**	**72**	**67**	**-5**
	Total Integrated PhD		**37**	**41**	**37**	**-4**

5.11.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-LIAAD – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT	160	30	62	32
National R&D Programmes - S&T Integrated Projects		188	347	159
National Cooperation Programmes with Industry			88	88
EU Framework Programmes	11	108	94	-14
EU Cooperation Programmes - Other		9		-9
National R&D Services and Consulting	277		34	34
International R&D Services and Consulting				
Other Funding Programmes		102	5	-97
Total Funding from Uncertain (future) or Closed (past) Projects (k€)		55	14	-41
Total Funding	**448**	**492**	**644**	**152**

Table 5.4-LIAAD – Summary of publications by members of the Centre

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	44	45	50
International conference proceedings indexed by ISI, Scopus or DBLP	39	45	50
Books (author)			1
Chapter/paper in books	3	2	2
PhD theses by members of the Centre	2	2	3

Type of Publication	2015	2016 (Forecast)	2017
Concluded PhD theses supervised by members of the Centre	7	3	3

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

Type of Result	No.
Invention disclosures	0
Software copyright registrations	0
Patent applications	0
Licence agreements	0
Spin-offs	0

Table 5.6-LIAAD – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	15
Conferences organized 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	35
Participation in events such as fairs, exhibitions or similar	4
Advanced training courses	10

Table 5.7-LIAAD – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	Dynamics2	Alberto Pinto	01-06-2016	31-05-2019
PROG - NAC	FOTOCATGRAF-1	Luís Torgo	01-06-2015	31-05-2018
PROG - NAC	SmartFarming-1	Carlos Ferreira	01-10-2016	30-09-2018
PROG - NAC	PERSONA	Alípio Jorge	01-03-2017	31-05-2019
PROG - NAC	FOUREYES-3	Alípio Jorge	01-07-2015	30-06-2018
PROG - NAC	iMAN-4	Dalila Fontes	01-07-2015	30-06-2018
PROG - NAC	SMILES-7	João Pedro Moreira	01-07-2015	30-06-2018
PROG - NAC	CORAL-TOOLS-5	Luís Torgo	01-01-2016	31-12-2018
PROG - NAC	NanoStima-RL3-3	Rui Camacho	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL4-2	Rui Camacho	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL5-2	Nuno Escudeiro	01-07-2015	30-06-2018
PROG - UE	MarineEye-1	Luís Torgo	30-07-2015	29-07-2017
PROG - UE	MAESTRA	João Gama	01-02-2014	31-07-2017
PROG - UE	RECAP-1	Rui Camacho	01-01-2017	31-03-2021
SERV - NAC	BI4UP2-1	Carlos Soares	01-08-2016	31-03-2017
SERV - NAC	PANACea-1	João Gama	08-08-2016	07-03-2017
O	ECML/ PKDD	João Gama	31-07-2014	30-06-2017
O	MDM_2016	João Gama	01-01-2016	31-12-2017
INT	SIEPIP-2	Alípio Jorge	01-06-2016	31-05-2018

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 CRACS – CENTRE FOR RESEARCH IN ADVANCED COMPUTING SYSTEMS

Coordinato: Fernando Silva

5.12.1 Presentation of the Centre

The mission of CRACS, accomplished within the Computer Science Cluster, is to pursue scientific excellence in the areas of programming languages, parallel and distributed computing, security and privacy, information mining, and Web based systems with a focus on developing scalable software systems for challenging, multidisciplinary applications. The research team is currently composed by around 55 members, of which 15 are senior researchers, mostly faculty at the CS department at FCUP, and 8 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

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 activities in large WSN deployments, with a focus on scalability, energy efficiency and seamless management; innovative peer-to-peer middleware and cloud-computing platforms, specifically for ad-hoc networks of mobile devices; scheduling for edge-computing. A synopsis of our main intervention in this area is:

- Programming Languages Theory and Implementation
- Parallel and Distributed Computing
- Middleware for Mobile-Computing

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 in this area 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 in this area 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 by 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.

Mooshak

We developed a contest management tool system that has been widely used for competitive programming in many regions, but also as a teaching tool as an automatic exercises evaluator in CS courses such as introduction to programming, data structures and algorithms, graphical interfaces, databases. It has also been used with a for an IEEE Xtream contest involving over 3000 students with a setup of 19 servers on the cloud.

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.

Distributed Mobile Computing

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.

Regarding eID, we emphasize our work developing and implementing a fingerprint match-on-card algorithm on smartcards for the next version of the Portuguese citizen card in the context of a contract from INCM.

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	Areas of Technology Transfer --> relationships (3)								
	Status (2)	Yap Prolog	Mooshak	vCardID	Authenticus	FotoCatGraf	HLTSYS	ADYTA	INTERRELATE
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 objectives and actions planned for 2017

The main objectives of CRACS for 2017 are to consolidate or even strengthen the research core areas with an emphasis on accomplishing goals and deliverables of the on-going projects, increasing our publications output, and continuing developing the research lines that we proposed as strategic for INESC TEC, particularly for the Computer Science cluster, namely cloud computing, big data and security. These are areas that connect well with other areas of competence within INESC TEC to tackle application areas with high societal impact, namely in health, climate change, oceans, and energy. In order to achieve these objectives we set the following actions:

- Setup a monthly CRACS workshop in which at least two researchers will give a presentation on their current work. This should foster internal awareness of on-going work, which also simplifies sharing with other sister centres of INESC TEC. These presentations will be complemented with invited seminars from external collaborators or visitors.

- Increase the number of publications by 10/15%. This should be accomplished by coaching the recently hired post-docs so that they quickly become productive.
- Be successful in at least 2 new projects, preferentially 1 European. We are preparing ourselves to the expected project calls from FCT and also from H2020, but we will also look into Norte2020 and technology transfer projects with companies, specially in the area of security. We expect to at least maintain our average funding level from projects.

5.12.6 Centre Organizational Structure and Research Team

The Centre is coordinated by Fernando Silva, who ensures scientific coordination jointly with Luís Antunes. The Centre is organized 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: Inês Dutra and Vítor Santos Costa

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

Table 5.2-CRACS – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	2	2	2	0
		Academic Staff	13	14	12	-2
		Grant Holders and Trainees	31	41	31	-10
		Total Core Researchers	**46**	**57**	**45**	**-12**
	Affiliated Researchers		1	2	0	-2
	Admin. & Tech.	Employees	1	1	1	0
		Grant Holders and Trainees	1	1	0	-1
	Total Integrated HR		**49**	**61**	**46**	**-15**
	Total Integrated PhD		**18**	**23**	**19**	**-4**

5.12.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-CRACS – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT		171	123	-48
National R&D Programmes - S&T Integrated Projects		208	280	72
National Cooperation Programmes with Industry				
EU Framework Programmes	436	65	100	35
EU Cooperation Programmes - Other				
National R&D Services and Consulting	135	157	190	33
International R&D Services and Consulting				

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
Other Funding Programmes	17			
Total Funding from Uncertain (future) or Closed (past) Projects (k€)		10		-10
Total Funding	**588**	**611**	**693**	**82**

Table 5.4-CRACS – Summary of publications by members of the Centre

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	9	8	12
International conference proceedings indexed by ISI, Scopus or DBLP	36	32	45
Books (author)	1		
Chapter/paper in books	4	1	2
PhD theses concluded by members of the Centre	3	1	2
Concluded PhD theses supervised by members of the Centre	2	1	2

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

Type of Result	No.
Invention disclosures	0
Software copyright registrations	0
Patent applications	0
Licence agreements	0
Spin-offs	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 organized by INESC TEC members (in the organizing committee or chairing technical committees)	6
International events in which INESC TEC members participate in the program committees	20
Participation in events such as fairs, exhibitions or similar	0
Advanced training courses	0

Table 5.7-CRACS – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	Hyrax	Fernando Silva	01-04-2014	31-03-2018
PROG - NAC	REMINDS	Álvaro Figueira	27-04-2015	26-04-2017
PROG - NAC	FOTOCATGRAF	Luís Lopes	01-06-2015	31-05-2018
PROG - NAC	ELVEN	Vítor Santos Costa	01-07-2016	30-06-2019
PROG - NAC	FOUREYES-4	José Paulo Leal	01-07-2015	30-06-2018
PROG - NAC	SMILES-3	Fernando Silva	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL3	Luís Antunes	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL4	Luís Antunes	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL5-3	Luís Antunes	01-07-2015	30-06-2018
PROG - UE	Digi-NewB	Luís Antunes	01-03-2016	29-02-2020
SERV - NAC	vCardID-2	Fernando Silva	01-01-2014	30-04-2017
SERV - NAC	vCardID2-1	Fernando Silva	01-12-2016	31-03-2017
SERV - NAC	Consultoria	Fernando Silva	01-01-2010	

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 HASLAB – HIGH-ASSURANCE SOFTWARE

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	Areas of Technology Transfer --> relationships (3)					
	Status (2)	Requirement specification and validation	Algorithm design and 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 objectives and actions planned for 2017

- Reinforce the partnership within INESC TEC's Computer Science cluster and centres that target domains where software plays a critical role, namely CPES and CRIIS, by writing joint project proposals and scientific publications;
- Increase the income from consultancy and R&D services, by actively searching for new contracts and partnerships. The goal is to increase the income from this category to 20% of the global budget of the centre;
- Clarify the relationship of INESC TEC with Universidade do Minho, namely make a clearer distinction (both formally and in terms of branding) between the HASLab, R&D centre of INESC TEC, and the INESC TEC pole at Universidade do Minho, currently also named HASLab;
- Reinforce the stability of the research team by hiring 30% of the current postdocs with regular medium term contracts instead of yearly grants;
- Target higher Technology Readiness Levels, namely by releasing more polished tools and end-user applications, akin to SafeCloud photos.

5.13.6 Centre Organizational Structure and Research Team

The HASLab is coordinated by Alcino Cunha and Manuel Barbosa and is organized 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 planned evolution is presented in Table 5.2.

Table 5.2-HASLab – Research team composition

Type of Human Resources			2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Core Research Team	Employees	0	0	3	3
		Academic Staff	21	21	21	0
		Grant Holders and Trainees	34	46	35	-11
		Total Core Researchers	**55**	**67**	**59**	**-8**
	Affiliated Researchers		0	1	0	-1
	Admin. & Tech.	Employees	0	0	0	0
		Grant Holders and Trainees	1	1	1	0
	Total Integrated HR		**56**	**69**	**60**	**-9**
	Total Integrated PhD		**32**	**32**	**34**	**2**

5.13.7 Activity indicators for 2017

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

The income from projects presented in Table 5.3 includes signed contracts listed in Table 5.7 and new projects to be signed during the year.

Table 5.3-HASLab – Project funding

Funding Source	Total Funding (K€)			
	2015	2016 (Forecast)	2017 (Plan)	Δ 2016 - 2017
National R&D Programmes - FCT			19	19
National R&D Programmes - S&T Integrated Projects	168	157	199	42
National Cooperation Programmes with Industry			20	20
EU Framework Programmes		369	637	268
EU Cooperation Programmes - Other				
National R&D Services and Consulting		69	80	11
International R&D Services and Consulting				
Other Funding Programmes	595		14	14
Total Funding from Uncertain (future) or Closed (past) Projects (k€)		20	88	68
Total Funding	**763**	**615**	**1 057**	**442**

Table 5.4-HASLab – Summary of publications by members of the Centre

Type of Publication	2015	2016 (Forecast)	2017
Papers in international journals indexed by ISI, Scopus or DBLP	27	38	45
International conference proceedings indexed by ISI, Scopus or DBLP	48	59	65
Books (author)			1
Chapter/paper in books		2	5
PhD theses concluded by members of the Centre	4	3	5
Concluded PhD theses supervised by members of the Centre	5	3	5

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

Type of Result	No.
Invention disclosures	1
Software copyright registrations	0
Patent applications	1
Licence agreements	1
Spin-offs	1

Table 5.6-HASLab – Summary of dissemination activities

Type of Activity	No.
Participation as principal editor, editor or associated editor in journals	1
Conferences organized by INESC TEC members (in the organizing committee or chairing technical committees)	8
International events in which INESC TEC members participate in the program committees	50
Participation in events such as fairs, exhibitions or similar	2
Advanced training courses	0

Table 5.7-HASLab – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PROG - NAC	GSL	Rui Maranhão	01-07-2016	30-06-2019
PROG - NAC	Cloud-Setup-1	Manuel Barbosa	01-07-2016	31-12-2018
PROG - NAC	SMILES	Carlos Baquero	01-07-2015	30-06-2018
PROG - NAC	CORAL-TOOLS-7	Alcino Cunha	01-01-2016	31-12-2018
PROG - NAC	NanoStima-RL1-4	José Creissac Campos	01-07-2015	30-06-2018
PROG - NAC	NanoStima-RL3-4	Manuel Barbosa	01-07-2015	30-06-2018
PROG - UE	LeanBigData	Rui Carlos Oliveira	01-02-2014	31-01-2017
PROG - UE	SafeCloud	Rui Carlos Oliveira	01-09-2015	31-08-2018
PROG - UE	UPGRID-2	Rui Carlos Oliveira	01-02-2015	31-01-2018
PROG - UE	Lightkone	Carlos Baquero	01-01-2017	31-12-2019
PROG - UE	CloudDBAppliance	Rui Carlos Oliveira	01-12-2016	30-11-2019
PROG - UE	InteGrid-1	Manuel Barbosa	01-01-2017	30-06-2020
SERV - NAC	vCardID-3	Rui Carlos Oliveira	01-01-2014	30-06-2017
SERV - NAC	DSGrid	Vitor Fonte	01-10-2016	30-09-2017
SERV - NAC	vCardID2	Rui Carlos Oliveira	01-12-2016	31-03-2017
SERV - NAC	Consultoria	Rui Carlos Oliveira	01-01-2014	
OID	PTCRIS	Alcino Cunha	01-07-2016	30-06-2017
INT	SIEPIP-1	Rui Carlos Oliveira	01-06-2016	31-05-2018

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

6 SPECIAL PROJECTS

6.1 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. 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 organizations, fostering cultural change in universities and companies, placing people and organizations in international networks, and serving as a catalyst for innovation, entrepreneurship and economic growth. In its ten years of existence, it has established in Portugal a successful international innovation engine in ICT, and is building on the achievements of its first years to carry out an ambitious Roadmap, crafted by the Program community, for its Phase II.

Currently the Program is hosted at INESC TEC. Based out of INESC TEC, the Program's National Director, Prof. João Claro, and executive team carry 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 works in close integration with INESC TEC's support services and staff on the Program's administrative, legal, and financial management.

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 120 companies, and over 400 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 organizations, 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.

6.2 DIGITAL COMPETENCE INITIATIVE

Coordinator: Pedro Guedes de Oliveira

In May 2016, the Ministry of Science Technology and Higher Education (MSTHE) created a taskforce the goal of which is to conceive and promote a national programme to increase the number of graduates in ICT at the higher education level (Desp. Nº 6931/2016). To lead the taskforce, the MSTHE nominated Pedro Guedes de Oliveira and the group includes Francisco Vaz, former vice-rector of the University of Aveiro, José Maria Azevedo, former Inspector General of the Ministry of Education and presently with the Northern Regional Coordination and Development Commission, Pedro Veiga who coordinates the National Centre for Cybersecurity and Sofia Marques da Silva, from the CIIE – Centre for Research and Intervention in Education, Faculty of Psychology and Education Sciences, of U.Porto. The secretarial and administrative support was assigned to Lucília Fernandes and the group includes Ana Reis, a young researcher recently awarded a degree in Information Sciences.

In order to support the activities of the group, a contract that will last until the 31 of October, 2017, was signed between FCT and INESC TEC.

In 2016 the work started with a pilot group, in which the Polytechnic Institutes (PIs) of Bragança, Cávado e Ave, Leiria, Setúbal and Beja were included and, beyond local visits and meetings to start the program, the following actions took place: design of TeSP Courses (TeSP stands for High Level Professional Technicians) based on a Project Based Learning (PBL) model; development of the concept of "networked communities" joining, around the PIs, the local municipalities, companies, secondary schools, different types of NGO with interests in the area of digital literacy, etc. and discussion with the pilot group; exploratory research on young people and educational choices, with particular interest on girls; design of different types of dissemination on the benefits of ICT, namely through videos, facebook, etc; competences meetings with a variety of companies in the area of ICT, both national and international, to understand their needs and forms of cooperation towards common goals; meetings with several government bodies from the ministries of Education, Work Solidarity and Social Security, Economy and Administrative Reform to understand both their needs as well as policy and cooperation strategies, namely on regional development. Finally, we developed an online questionnaire that was sent to a large number of companies, both directly and through Enterprise Associations (ANETIE, APDC, AEP), to understand their present situation and future HR needs, both in quantity and quality, in the area of ICT.

In 2017 and until the end of the project, we foresee the following actions:

- To develop a one year course to be carried out by ISEP in cooperation with Porto Tech Hub and with the support of IEFP, for the technical conversion of STEM graduates, to ICT;
- In the area of PBL, to support the registration of the reformulated TeSP degrees and to organise training sessions for the teachers that will have to perform according to the PBL methodology.
- To deploy an online platform that will allow an intra and intercommunication among PIs as well as students and companies involved in this initiative;
- To produce a short movie publicising the area and the challenges and opportunities it represents to young people, to disseminate through Youtube, Social Networks, Schools and other environments where young people can be reached;
- To focus on the gender gap that we still observe in ICT which seem to be taken as a "men's profession";
- To analyse the results of the questionnaire to be able to quantify the needs in terms both of TeSP and "licenciatura" graduates, in the various areas and various regions of Portugal, and to have an overview on the most valued profiles;
- To extend the program to a second tier of Polytechnic Institutes (Tomar, Viseu, Guarda and Castelo Branco and Viana do Castelo) in the various type of actions;
- To extend the contacts to other companies in the field, to promote their cooperation and support to the courses, both at the level of TeSP and technical conversion;
- To promote a 1 day meeting, by the end of the 1st semester, with all the Polytechnic Institutes involved in this initiative, to analyse the results so far and design a follow-up strategy in order to ensure a continuous growth in the number of graduates, in the years to come.

7 TEC4 INITIATIVES

7.1 Overview

INESC TEC intends to present its competencies on the market based on a new structured model that facilitates the targeting of potential clients and the communication with companies and stakeholders. This strategic initiative is being leveraged by the Industrial Partnerships Service and it is supported by a new multidisciplinary approach organized in thematic areas, called TEC4 ("TEChnologies FOR …") that have a strong link with the regional and national smart specialization strategy.

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 TEC4 initiatives bring together the R&D Institutions, businesses and associations, increasing synergies and critical mass to address real world challenges. 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.

7.1.1 Current Initiatives

Currently, INESC TEC is leading six TEC4 initiatives, in different stages of maturity and devoted to the following domains:

- TEC4Sea – sea activities and economy
- TEC4Media – creative industries and tourism
- TEC4Agro – agro-food and forestry
- TEC4SupplyChain – production technologies, manufacturing, retail, distribution, logistics and transport
- TEC4Energy – energy related activities and economy
- TEC4Health – health and well-being

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 potentiates the attraction of foreign direct investment into the Region and the country.

7.1.2 Methodology

The TEC4 initiatives are operationalized through collaborative and multidisciplinary platforms, coordinated by INESC TEC, but open to other scientific institutions. These collaborative and multidisciplinary platforms, putting

together R&D entities, businesses and associations, supported by R&D infrastructures, create a unique environment to develop scientific activities that serve the businesses' innovations needs.

Each TEC4 follows an implementation plan covering different 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.

7.2 TEC4SEA

Coordinator: Eduardo Silva

7.2.1 Motivation

The oceans have been seen as an opportunity to support the future challenges driven by global economic growth and increasing demand. This will change the landscape of maritime industries in the coming decades, in terms of established and emerging industries (See the Table 7.1).

Established	Emerging
Capture fisheries	Marine aquaculture
Seafood processing	Deep- and ultra-deep water oil and gas
Shipping	Offshore wind energy
Ports	Ocean renewable energy
Shipbuilding and repair	Marine and seabed mining
Offshore oil and gas (shallow water)	Maritime safety and surveillance
Marine manufacturing and construction	Marine biotechnology
Maritime and coastal tourism	High-tech marine products and services
Marine business services	Others
Marine R&D and education	
Dredging	

Table 7.1 - Established and Emerging Ocean Industries (copied from OCDE Report, see footnote[2])

Driven primarily by developments in global population, economic growth, trade and rising income levels, climate and environment, and technology, the rapid expansion of economic activity in the oceans has the potential to outperform the growth of the global economy as a whole until 2030, both in terms of added value and employment. Particularly strong growth is expected in marine aquaculture, offshore wind, fish processing, and shipbuilding and repair. Ocean industries also have the potential to make an important contribution to employment growth. Deep-sea mining is also gaining momentum. Increasing political interest on this matter has been driven by the increasing demand for natural resources supported by economic growth and growing population. Extraction rates are expected to accelerate further over the next two to three decades.

Portugal has the 3rd largest Exclusive Economic Zone (EEZ) of the EU and the 10th largest EEZ in the world. With the new reality brought by the Continental Shelf Extension proposal, currently under appreciation by the United Nations Commission on the Limits of the Continental Shelf (CLCS), the Portuguese territory becomes approximately 4 million km2 wide (roughly equivalent to 91% of the European Union's land area), with the vast majority of this North Atlantic area being constituted by deep and ultra-deep sea. Thus, the two main contextual challenges to the national capability for both exploration and exploitation of the Portuguese Sea are the referred dimension and depth difficulties.

TEC4Sea is fully aligned with international and National trends, and lies on the assumption that sustained innovation in the maritime sector can only be achieved by joining researchers, end users, SMEs and public agencies in a single organization with enhanced links to closest stakeholders.

[2] "OECD (2016)", The Ocean Economy in 2030, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264251724-en"

7.2.2 TEC4Sea Presentation

Vision: Breaking the deep-sea technological challenges and empowering the sea Economy through a sustainable approach for exploration and exploitation of living and non-living ocean resources.

TEC4Sea has ambitious goals that imply:

- To establish an entity able to address all steps of the market value chain, ranging from research to innovation with focus on the creation of value by R&D+I;
- To gather a fairly diversified set of multidisciplinary competences and resources, in complementary engineering and scientific fields related with addressed ocean engineering market segments, solidly put in place through a well-designed and coherent plan;
- To put together a “big picture” (stating the Blue Economy importance and driving top-down policy) mapping the opportunities along the value chain and the “small picture” to engage the researchers, SMEs and cluster organisations which can integrate these perspectives;
- To establish and strengthen a network of stakeholders, from different types such as SMEs, Large Industry, Governmental organizations, research Centres, University and NGO's, streamlining and developing the Sea Research Business activity in all steps of the value chain.

TEC4Sea addresses these goals through three dimensions:

- Infrastructure: recognized by FCT roadmap of strategic infrastructure in consortium with CINTAL from University of Algarve;
- Research: TEC4Sea’s research lines (Networked autonomous systems for ocean environments), including, marine wireless communications, power, acoustics, marine robotics and autonomous systems and hyperbaric sensors;
- Innovation: While research and technology development is the main focus, the TEC4Sea vision is also driven by its usefulness to the local community, where the stronger impacts are expected, as they shall effectively support the regional/national Sea economy. TEC4Sea promotes and spreads the best practices for industry-embedded research and technology transfer, actively involving the industrial partners in the research activities, in order to insure the appropriate uptake and full benefit from the developed maritime technology, including advanced training, accelerating the integrated scientific and economic development of the region.

7.2.3 Objectives for the short and medium term

Taking into consideration existing estimations/forecasts, the short-term objectives are:

- Align INESC TEC’s research lines with common objectives related with TEC4Sea goals;
- Reinforce INESC TEC network with SMEs, public agencies and others R&D institutes;
- Increase INESC TEC participation in projects with SMEs, contributing to the strengthening of the Portuguese industry related with sea business;

The challenge of boosting long-term development prospects of emerging ocean industries and their contribution to growth and employment, while managing the ocean in a responsible and sustainable way can only be achieved by managing different orthogonal fronts (referring OCDE Report), namely:

- Foster greater international co-operation in maritime science and technology as a means to stimulate innovation and strengthen the sustainable development of the ocean economy;
- Strengthen integrated ocean management.

It is becoming clear that scientific and technological advances are expected to play an important role in the future of oceans, addressing simultaneously the environmental challenges and the development of ocean-based economic activities. In fact, many technological innovations have the potential to influence the ocean economy in areas such as, advanced materials, subsea engineering and technology, sensors and imaging,

satellite technologies, computerization and big data analytics, autonomous systems, biotechnology and nanotechnology (for example, seabed mining companies are all looking to robotics for their subsea operations, renewable ocean energies are making increasing use of advances in new materials and sensors; fisheries, maritime safety, ocean observation and environmental assessment will continue to benefit from several technological innovations (satellite, communications, remote sensing, navigation, etc.).

The following impacts can be expected from its middle- to long-term running activity:

- Reinforced current Portuguese Ocean R&D+I sector and integration of new technology research areas lead by the Portuguese scientific community, with distinguished tradition and achievements in Ocean Engineering but still lacking the capacity to compete globally in some key areas, by taking benefit from the particularly attractive maritime area of Portugal for technology testing, based on the characteristics of the North Atlantic Ocean and the energy it encloses;
- Better governance of the North Atlantic marine ecosystem, namely by reinforcing the knowledge base of North Atlantic fragile ecosystems, especially of deep-sea habitats, through the development of cross-cutting technologies with Sea application;
- Reinforced positioning of Portuguese research and industrial stakeholders in Ocean Engineering to compete globally in the Sea Economy, as the SME engagement within the Sea Economy value chains will be facilitated, and it will become easier to attract important funding and investments in this area;
- Reinforced institutional academic and research cooperation in the different fields of Ocean Engineering;
- Increase of the global expertise on Ocean Engineering, either throughout the attraction of new researchers or researchers from core complementary research areas, but also by creating advanced training mechanisms;
- Reduced gap between the research and innovation capabilities of Portugal against other European countries leading in Ocean Engineering research, such as UK, Norway or Spain.

7.3 TEC4MEDIA

Coordinator: Cristina Guimarães

7.3.1 Motivation

The Media, Cultural and Content industries have demonstrated resilience to the economic and financial crisis by increasing the number of enterprises that, through innovation processes, adjusted their value proposition according to the new big trends (emergence of platforms, automation of jobs, semantics and language technology, big data and user-driven creation) and new consumer settings where the "on-line" is paramount.

Books, press, software and games, advertising and broadcasting were the leading innovative and technological improved sub-sectors that most contribute to a new ecosystem, now called as "New European Media" that has been guiding this sector in core activities and spill over effects and cross-sectorial fertilisation that can be observed in the increasing "digital world" in several settings (manufacturing, e-commerce, healthcare, tourism, just to name a few).

Finding alignment with the European research agenda by membership in New European Media (NEM Initiative) Platform, INESC TEC research groups participate in projects gathered by the mirror platform- NEM Portugal. The NEM platform, gathering hundreds of European key players in media industries, both content producers and technology providers, has been a key player in the European innovation ecosystem to help turn Europe into a leading Innovation Union. NEM Portugal, at national level, is taking a holistic view, identifying the pathway to commercial deployment of research, providing strategic insights into market opportunities and needs, and mobilising and connecting innovation actors within Portugal in order to enable Portuguese companies (not only SMEs, but also economic groups) and stakeholders to gain competitive advantage in European and global markets. Workgroups were formed to gather contributions and to produce a national view on issues being discussed, as well as inputs to the European position papers and white documents. Additionally NEM Portugal has been working together with the supporting clusters, TICE.PT and ADDICT, to foster the interaction of creative and technological companies with the academia in the preparation of new services and products.

7.3.2 TEC4Media Presentation

The TEC4Media faces the real economy challenges throughout state-of-the art research and knowledge value chain focused on results transferable to the digital media and the creative industries, including content and fashion industries, within a range of economic activities which are concerned with the generation or exploitation of knowledge and information, namely:

- Advertising, architecture, visual arts, design (including product and fashion design), film, music, performing arts, editing and publishing, archives, libraries, culture heritage and tourism, books and press, toys and games, newspapers, TV and radio, software and video games, education industry, including public and private services.

Vision: TEC4Media aims to place INESC TEC as the key research institute in addressing the above application areas specific challenges.

7.3.3 Objectives for the short and medium term

TEC4Media overall goals are:

- To foster the development and introduction of novel audio-visual and multimedia broadband services and applications to the benefit of citizen and enterprises. It aims at having a significant impact on the European economy in the context of the Lisbon objectives, bearing in mind the renewed goals as set up by the Commission Communication "i2010";
- To build a technical innovation focused ecosystem fostering networking with large Industry, SMEs (with and beyond sectorial clusters' members), research centres, universities and NGO's, governmental organizations feeding the knowledge creation value chain;

In a short term:

- To pursue the goals of the strategic research agenda that serves specific technological needs of this sector transforming the means by which multimedia content is created, distributed and consumed in a world where users are becoming “prosumers” (content creators and consumers concomitantly).

Expected Impact:

By connecting innovation actors within Portugal in order to enable Portuguese companies, of above sectors list, and stakeholders to gain competitive advantage in European and global markets, TEC4Media will contribute to economic strengthens of growing sector.

We will work on scientific advancements that are crucial for economical and application areas of this domain, namely in the challenges related to personalization and the digital age. We will make use of multidisciplinary resources and assets to addressed relevant topics, including digital games, immersive media, natural interfaces, digital arts, media creation and transformation. Such topics will potentially give rise to new media products relevant for cultural creation, dissemination and consumption. Based on our strong collaborations between academia and industry, we will contribute to a stronger articulation between creative and cultural initiatives and the industries of the region. This research line recognizes the region’s strong knowledge and will contribute to augmented training in ICT as well in activities associated with creativity. Moreover, it will foster a greater intersection between ICT and cultural and creative industries. Outcomes of TEC4Media will provide important contributions towards the transformation of value chains, enabling a better understanding of consumer behaviours and consequently meeting their expectations by providing richer digital experiences.

8 SUPPORTING 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 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	0.9	0.7	2.7	2
	Academic Staff				
	Grant Holders and Trainees	1	2		2
	Affiliated Researchers				
	Total Integrated HR	**1.9**	**2.7**	**2.7**	
	Total Integrated PhD				

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 for 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 Main actions planned for 2017

- Proposal of a Personal Data Protection Policy, paving the way to adapt to recent legal developments in the field of Data Protection, namely the application (May 2018) of the new European General Data Protection Regulation (Regulation EU 2016/679);
- Monitor and adapt to foreseen legal developments in the field of Public Procurement (Public Procurement Code);
- Proposal of a Confidentiality Guarantee Policy ("Chinese walls");
- Promotion of awareness and information internal sessions, addressed to different attendees, on legal subjects with relevant or high impact to INESC TEC, namely:
  - Scientific Employment;
  - State Aid and related rules for participation in R&D consortia, especially in the ambit of the Programme Portugal 2020;
  - Revision of the Public Procurement Code;
  - European Regulation on Personal Data Protection.
- Conception and availability in the intranet of templates for the most frequent types of contracts;
- Revision of rules and templates for R&D Services and Consulting contract proposals, in line with the Proposals submission business process;
- Participation in the conclusion and implementation of the IP Regulation, ensuring the appropriate provisions in contracts with collaborators and with entities;
- Revision of templates of decisions and other documents related to public procurement procedures;
- Conception and launch of the Framework-Agreement for acquisitions of travel and accommodation services.

8.2 FINANCE AND ACCOUNTING SERVICE

Manager: Paula Faria

Table 8.1-CF – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	4.3	3.8	3.8	
	Academic Staff				
	Grant Holders and Trainees	2	3	4	1
	Affiliated Researchers				
	Total Integrated HR	**6.3**	**6.8**	**7.8**	**1**
	Total Integrated PhD	**1**	**1**	**1**	

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 Main actions planned for 2017

The main actions planned for 2017 is the improvement of the quality of the services provided to the Research Centres, to the Administration and to the other Centres with special attention to the travel and purchasing processes, with the support and collaboration of the Management Information Systems Service. Define and implement other improvements and new support services resulting from the dialogue and identification of to the needs and requirements of the INESC TEC Research Centres coordinators and researchers, ensuring an efficient compliance with internal 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 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	6.7	7.8	6.8	1
	Academic Staff				
	Grant Holders and Trainees		1	1	
	Affiliated Researchers				
	Total Integrated HR	**6.7**	**8.8**	**7.8**	**1**
	Total Integrated PhD				

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 producing, coordinating and disseminating management information in order to make sure 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 funded projects continuous reporting to funding agencies and the respective 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 Main actions planned for 2017

- Implementation of new tools for monitoring Human Resources projects' allocation.
- Organisation of meetings with projects' Principal Investigators.
- Organisation of periodical meetings with the Centres secretaries and organization and management services.
- Workshops' organisation for Centres' managers about projects financial control.
- Enrich intranet by sharing contents for common usage.
- Simplification of quarterly Financial Reports (slide-based presentation format).
- Design and implement support tools to improve the process of preparing projects payment reports.

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	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	3.1	3.3	4.3	1
	Academic Staff				
	Grant Holders and Trainees				
	Affiliated Researchers				
	Total Integrated HR	**3.1**	**3.3**	**4.3**	**1**
	Total Integrated PhD				

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 people, 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 Main actions planned for 2017

- Conclusion and implementation of intranet HR processes, in order to reduce workload, time of processing and error occurrences; in particular, completion of the "New Collaborator" workflow and implementation of the "historical record" in PHC (HR database software application);
- Based on the historical record implementation, generation of the most frequently needed reports and lists, as versatile as possible, in order to help HR management at global and centre levels;
- Generate strategic HR indicators, organised by function besides legal status of the collaborators;
- Promote the clear definition of rights and duties of each kind of liaison of INESC TEC collaborators, as well as clarification and updating of the set of agreements or individual terms and commitments applied to each one;
- Job descriptions updating, so as to reflect the organization evolution;
- Improvement of Recruitment Process: enabling the publication of the Jury minutes in the platform, participate in job fairs, improve the consultation and presentation of INESC TEC's ads on the internet and review its content/presentation (making them more appealing), namely including an appropriate introduction for each kind of applicant (the Post-doc is different from the Bachelor or the Student);
- Creation of a spontaneous applications database to be directly accessed by centre coordinators;
- Promotion of information internal sessions, addressed to the Secretariat or other attendees, on changes in HR processes and new requirements;
- Service internal reorganization, in consequence of the hiring of a new element.

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 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	1.2	1.2	1.2	
	Academic Staff				
	Grant Holders and Trainees				
	Affiliated Researchers				
	Total Integrated HR	**1.2**	**1.2**	**1.2**	
	Total Integrated PhD				

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 Main actions planned for 2017

- Support the final implementation of INESC TEC's management model in the intranet (implementation of electronic approval workflows at all management levels, including the Board and sub-delegations);
- Start periodical business processes management analysis routines for continuous improvement;
- Make available in the intranet contracts/protocols signed by INESC TEC to designated groups and the lists of Non-Disclosure Agreements;
- Collaboration in the reorganization of internal business processes, namely Proposals Submission and HR processes, and in the automation of other projects, such as the gathering of INESC TEC Strategic Indicators.
- Collaboration in the launch of the new website of INESC TEC;

  Collaboration in the preparation of the information sessions to R&D Centres Coordinators.

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 organization 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 Main actions planned for 2017

Continuous improvement of support tools/ applications such as PLONE and others used by the secretaries, suggesting changes and improvements, such as:

- Integration in PLONE of forms used in paper support. This would be important because it would allow us to gradually evolve towards a paper free environment, to have more fluent workflows and also providing us with indicators. Here are some examples:
  - HR (“Prestação de serviços” form and Scholarship based Workplan and Reports),
  - CF (“Pedido de Emissão de Fatura” and “Pedido de Adiantamento” forms),
  - CG (form “Abertura OI”).
- Creation of new fields that isolate the supplier for travel, hotel and rent-a-car agent. This will allow us to gather new useful data for activity reports such as “suppliers per user/centre”, “hotel occupancy rate per year”, etc;
- Creation of a new step in the workflow of travel and purchases processes in PLONE, to include a final step of registering a feedback from CG regarding the approval or rejection within the rules of eligibility and also according to the feedback from the Financing Agencies. This could generate periodic reports allowing us to learn from our work pattern and evolve our Service Quality Indicators;
- Implementation of a new area in PLONE to register indicators related to the secretariat work (conference organization, agenda management as well as other defined indicators).

Creation of a Directory of useful Information (residences or renting agencies for scholars or visiting fellows, bus or other transports, venues for events, catering companies, IT suppliers, and many others);

Training/Coaching actions: evaluate possible training opportunities for the Secretaries; provide information meetings whenever necessary.

Formulation of a chart that compares the tasks performed by the several secretaries as a way to evidence the different types of use of these human resources in the different Units and make the coordinators aware of a more efficient use of them.

8.7 FUNDING OPPORTUNITIES OFFICE

Manager: Marta Barbas

Table 8.1-SAAF – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	0.3	0.2	0.2	
	Academic Staff				
	Grant Holders and Trainees		1	1	
	Affiliated Researchers				
	Total Integrated HR	**0.3**	**1.2**	**1.2**	
	Total Integrated PhD				

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 Main actions planned for 2017

Organization of workshops to explain the procedures for preparing and submitting proposals to particular calls for proposals.

Monthly presentation (@ CCI and Intranet) of open calls and submission.

Clear definition of “proposals workflow” in order to better coordinate tasks between the different services involved in the process.

8.8 INDUSTRIAL PARTNERSHIPS SERVICE

Manager: Augustin Olivier

Table 8.1-SAPE – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	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**	

8.8.1 Presentation of the Service

The Industrial Partnerships Service aims at strengthening INESC TEC's market position and achieves higher industry contract revenues.

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. Plan different strategies and 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.

The main actions will be divided in four activities described below.

8.8.2 Main actions planned for 2017

8.8.2.1 Activity 1: Organization based on a multidisciplinary approach

INESC TEC intends to present its competencies on the market based on a new multidisciplinary approach organized in thematic areas, called TEC4 ("TEChnologies FOR …").

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.

Currently, INESC TEC is leading six TEC4 initiatives, in different stages of maturity and devoted to the following domains:

- TEC4Sea – sea activities and economy
- TEC4Media – creative industries and tourism
- TEC4Agro – agro-food and forestry
- TEC4SupplyChain – production technologies, manufacturing, retail, distribution, logistics and transport
- TEC4Energy – energy related activities and economy
- TEC4Health – health and well-being

Some TECs are still in the initial phase of identification of both market segments where INESC TEC competencies can create value and internal research lines with highest potential impact in business, whereas other are already running projects and pursuing ambitious collaboration plans with other institutions.

The plan to 2017 is to leverage the growth of TEC4Sea and TEC4Media, and start the implementation of the other TEC4 that shall be completed in 2018 (i.e., TEC4Agro, TEC4SupplyChain, TEC4Energy and TEC4Health).

8.8.2.2 Activity 2: Networking and promotion activities for knowledge transfer

The main objectives of this activity are:

- to increase the networking activities with national and international partners as well as the efficiency of these networking activities;
- to extract more knowledge and value from the regular interactions with partners, supporting better targeting and, if possible, anticipating needs;
- to perform benchmarking good practices with worldwide top-ranked R&D institutions, namely concerning programs to maintain close articulation with industry and retain business partners;
- to strengthen the INESC TEC positioning as an R&D partner of businesses, by increasing the number of national and international projects;

Those global objectives are supported by the following tasks:

- Deployment of CRM support tool, to increase the effectiveness of the networking activities, enforce suitable processes and methodologies and support the extraction of knowledge;
- Study of the potential impact and the suitable design of an "industry affiliate" program, as the bases of an ecosystem of innovation and knowledge transfer. Such program should contribute to create a “centre of gravity” around INESC TEC; promoting continuous cycles of innovation with businesses and creating the conditions to develop differentiated and added value solutions with high economic and social impact;
- Networking and promotion activities - participation in exhibition fairs/events. Aligned with the TEC4, INESC TEC considers the participation in Business2Sea (Ocean Forum), EMAF (manufacturing and logistics sector), Agroglobal (agriculture and agri-food), TechDays (ICT);
- National networking and promotion activities – 10 Seminars organization, aligned with the smart specialization thematic areas and/or societal challenges identified in Horizon 2020;
- International networking and promotion activities, in 14 events such as infodays, international fairs, participation in interest groups, ...), to enable the identification of high level challenges that remain to be solved and facilitate the entrance in international consortiums;
- Networking and promotion activities by through Business Clusters. The establishment of strong links with the Business Clusters, strategic aligned with the TEC4, is a means to access people with power to decide, influence and/or provide valuable feedbacks. The National Business Clusters aligned with the previously presented TEC4, are: Forum Oceano, Produtech, NEM Portugal, HEALTH CLUSTER Portugal and TICE.PT.

8.8.2.3 Activity 3: Demonstration of R&D results and technological developments

In order to maintain partners’ confidence about INESC TEC competencies and attract the interest of new partners, INESC TEC organizes regular "OPENDAYS" in thematic areas. These open events are a means to disseminate the internal competences, raise awareness and potentiate the breeding of new ideas. Several businesses are invited and are attended by a member of the Business Development department.

This activity also contributes to the dissemination and visibility of the technological innovation projects developed by INESC TEC, as these events have a significant media impact.

The objective is to organize 2 demonstration sessions; during 2017 the SupplyChain OPENDAY shall take place, while in 2018 the Agro-Food OPENDAY will be prepared.

8.8.2.4 Activity 4: New technologies and knowledge dissemination for business

Communicating and disseminating the new thematic organization, supported by the TEC4, must also take place in the Internet. This activity aims at creating a web site for each TEC4, publicizing the corresponding Research Lines addressed by the institution concerning that domain, the main businesses and academic partners, the

R&D infrastructure capabilities and corresponding available services. Dedicated web sites also serve as a space for rapid dissemination of technological results and achievements.

Websites will also be created to all identified TEC4, in 2017 will plan to implement TEC4Sea and TEC4Media.

8.10 TECHNOLOGY LICENSING OFFICE

Manager: Catarina Maia

Table 8.1-SAL – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	1	1	2	1
	Academic Staff				
	Grant Holders and Trainees	2	1		1
	Affiliated Researchers				
	Total Integrated HR	**3**	**2**	**2**	
	Total Integrated PhD			**1**	**1**

8.10.1 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.

8.10.2 Main actions planned for 2017

The office's main activities planned for 2017 include:

- technology scouting;
- market research and business development for licensing opportunities;
- the development of a standard for one of INESC TEC's patented technologies – a new market-facing activity, required to increase the market exposure and value of the technology;
- technology roadmapping for one of the TECs – also a new activity, which includes technology/industry surveillance roadmapping with relevant patents;
- the adoption and implementation of a software for IP management, in case an application submitted for funding is approved.

The service will continue to provide support on IP matters to INESC TEC researchers through:

- meetings and workshops for IP knowledge dissemination;
- support to patent drafting;
- the preparation of applications for public funding of patent processes.

8.11 INTERNATIONAL RELATIONS OFFICE

Manager: Vladimiro Miranda

Table 8.1-GRI – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	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				

8.11.1 Presentation of the Service

The International Relations Office (IRO) is established under the dependency of the Board to systematically and regularly organise the internationalisation of activities in selected countries. The Office focus 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 researchers.

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 resource.

8.11.2 Brazil Office: main actions planned for 2017

The Brazil Office, acting as a broker or facilitator and as an aid to the Board in Latin America matters, will not have the responsibility over projects or contracts. The main activities of the Brazil Office will be the following:

- follow up the activity in INESC P&D Brazil (IB) and keep regular meetings with the IB secretariat and administration;
- track the direct relation of INESC TEC with Brazilian partners and assist the Board in these contacts;
- assist the INESC TEC Centres in the contact with IB and in proposing/implementing R&D contracts;
- assist Brazilian visitors to INESC TEC;
- provide assistance to the relations of INESC TEC with other Latin American countries;
- provide a sense of community and attachment to INESC TEC of the Brazilian researchers in the institution.

These activities will be distributed among a diversity of actions. One example of actions, related to the community of Brazilian researchers at INESC TEC, will be the continuation of the initiatives “Café e Pão de Queijo”, as cultural events that promote the understanding of roots and cultural backgrounds among Brazilian and Portuguese researchers.

8.11.3 India Office: main actions planned for 2017

The India Office, acting as a broker or facilitator and as an aid to the Board in India matters, will not have the responsibility over projects or contracts. Its main activities in 2017 will be the following:

- Continue the study of the India system of research and education and reinforce the knowledge on key partners and actors, legislation and opportunities;
- Launch initiatives to attract Indian students and post-docs to INESC TEC;
- Build bridges with important actors in India and the India industry and act as a facilitator between such partners and INESC TEC Centres, to the point of achieving the signature of MoUs and other agreement instruments formalising a cooperation framework.

8.12 COMMUNICATION SERVICE

Manager: Sandra Pinto

Table 8.1-SCOM – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	2	3	5	2
	Academic Staff				
	Grant Holders and Trainees	2	3	2	1
	Affiliated Researchers				
	Total Integrated HR	**4**	**6**	**7**	**1**
	Total Integrated PhD				

8.12.1 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: the planning, the implementation, the organisation and the coordination of both internal and external communication in accordance with the regulations and procedures established, promoting the image and prestige of the institution.

8.12.2 Main actions planned for 2017

The Communication Service has been defining its strategies in accordance with the principles of integrated marketing communication, which involve a number of instruments, such as Public Relations (events, media advisory), digital marketing (social media management), sponsorships, exhibitions and fairs. The goal is for these instruments to complement each other in a coordinated fashion in order to bring more notoriety to the INESC TEC brand.

The flagship project in 2017 will be the new website. Created in 2006, the current website is clearly outdated and static. More importantly, it does not respond to the Institute's current needs when it comes to disseminating competences, activities and results. Presently, the website does not reflect INESC TEC's exponential growth and increasing multi-disciplinarily.

Other external communication goals include reinforcing INESC TEC's presence in international media, particular in Europe and Latin America, and consolidating our presence in social networks. Moreover, the goal is to improve the multimedia component by producing videos and infographics, as that is the trend in digital marketing. In fact, one of the key aspects mentioned in the Evaluation of the Communication Service was the need to communicate more dynamically and visually using new technologies, and to improve graphic design and multimedia competences.

In terms of the institutional image, the goal is to create a new corporate identity that best represents INESC TEC in the present and the future because, similarly to the website, the current image is now over 10 years old. New communication material will also be produced in order to project INESC TEC's image with partners and stakeholders. Efforts will also be made to reinforce the identity of INESC TEC's building at FEUP campus.

In the field of internal communication, in 2017 the Communication Service will launch an internal TV to disseminate news in the main building, and also organise a Strategic Meeting for senior researchers which will take place annually, as well as a Team Building event open to all employees.

It is also important to stress the support that the Service provides to INESC TEC's R&D Centres with dissemination work packages, as is the case of European projects UPGRID and StrongMar, of the integrated projects Nanostima, TEC4Growth and Coral, and the EEN network. The Service will also prepare the visit of the FCT evaluation committee, which will be preceded by the visit of the members of the Advisory Board (SAB), which will entail a significant effort in terms of the image we want to project.

The usual communication activities are also worth mentioning, namely: national media advisory, promotional project videos, events organised by INESC TEC, such as the Fórum INESC TEC do Outono, supporting INESC TEC's participation in renowned events, organising Science Communication initiatives, producing the institution's monthly newsletter (Bulletin INESC TEC), overseeing visits to INESC TEC, photo and video coverage of events, organising monthly welcome sessions for new employees, organising media training and academic writing training sessions, and organising internal events, such as photo competitions, the "magusto" and the multicultural party.

8.13 NETWORKS AND INFORMATICS SERVICE

Manager: João Neves

Table 8.1-SCI – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	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				

8.13.1 Presentation of the Service

The Networks and Informatics Service manages INESC TEC's communication network infrastructure (data and VoIP) and network services, including e-mail and printing services.

8.13.2 Main actions planned for 2017

- Automate and simplify the process of connecting a new system to the network, WiFi and cable;
- Upgrade switching infrastructure to allow redundancy, reliability, and the delivery of Gigabit access to any Ethernet access point;
- Improve the performance (speed and services) of the WiFI network for INESC TEC users, eduroam and visitors;
- Upgrade videoconferencing infrastructure with integration of the new solution and the existing terminals and services, eg. Cisco WebEx;
- Management and maintenance of the new versions of the VoIP systems, terminals and services;
- Improvement of the e-mail servers' software versions and clustering, management tools and procedures for SPAM filtering;
- Accounting and billing of network services usage;
- Management, upgrade and maintenance (software and hardware) of network multifunction printing equipment;
- Acquisition and tuning of new redundant firewall appliances for INESC TEC network and services.

8.14 MANAGEMENT INFORMATION SYSTEMS SERVICE

Manager: José Carlos Sousa

Table 8.1-SIG – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	3	3	3	
	Academic Staff				
	Grant Holders and Trainees		2	2	
	Affiliated Researchers				
	Total Integrated HR	**3**	**5**	**5**	
	Total Integrated PhD				

8.14.1 Presentation of the Service

The Management Information Systems Service is in charge of the development and maintenance of INESC TEC's management information system.

8.14.2 Main actions planned for 2017

- Reorganize the development, testing and production infrastructures in collaboration with SAS;
- Significant improvement of Intranet performance;
- Repositories of full text and data documents;
- Increase SAP integration with the Intranet;
- Continuous improvement of processes;
- Follow-up on the implementation of the new INESC TEC Website, providing information collection services from the various existing systems;
- Finalize the new collaborator process, in order to facilitate a faster entry of the collaborator into the institution's systems;
- Implementation of the Projects Database;
- Inventory validation for CF with online listings for SCI;
- Automate the publications data retrieval from Authenticus; Allow ad hoc changes indicated by the monitoring committee; Verify that the information in the researchers' ORCID is up to date;
- In evaluation process, continue to take steps to make it fully automated;
- Systematic collection and subsequent availability of all institutional indicators;
- System for reporting research results to the Associates and FCT.

8.15 SYSTEMS ADMINISTRATION SERVICE

Manager: Jaime Dias

	Type of Human Resources	2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Employees		3	3	
	Academic Staff				
	Grant Holders and Trainees				
	Affiliated Researchers				
	Total Integrated HR		**3**	**3**	
	Total Integrated PhD				

8.15.1 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.

8.15.2 Main actions planned for 2017

The installation and configuration of the computing cluster and related infrastructure services will be concluded. The main INESC TEC services, which include the INESC TEC website, Intranet, and file sharing service, will be migrated. The infrastructure services include the LDAP service, which will synchronize with the Human Resource's database, and enable users to access all the INESC TEC services with a single password. The computing cluster will also enable the creation of Virtual Machines on demand. New networking equipment will be acquired and configured to interconnect the cluster servers with redundant 10 Gbit/s Ethernet links.

A repository to store the INESC TEC datasets, with the possibility to share them with the scientific community, will be made available. The storage capacity will be increased accordingly.

New collaborative application services will be made available to Services and Centres, to increase productivity but also to increase the communication between different Centres and Services. The following main collaborative application services are planned:

- A team collaboration application service like Slack, Mattermost, Rocket.Chat or Teams. This application is intended to complement the email and mailing lists services;
- A file access and sharing application like Nextcloud for Services and Centres;
- Gitlab. Gitlab provides Git repository management, code reviews, issue tracking, and activity feeds. This application service is already available at gitlab.inesctec.pt but with accounts created on demand. The Gitlab service will be presented to INESC TEC users after the LDAP service becomes available; existing accounts will be migrated to LDAP;
- A wiki application service like MediaWiki or DokuWiki.

The INESC TEC Living Lab initiative will be started. The INESC TEC Living Lab aims at promoting and enabling the exploitation of INESC TEC R&D results, and use the INESC TEC building and infrastructures as a laboratory testbed for experiments with real people and real scenarios. The promotion shall exploit the "WOW Effect", increase researcher's inspiration and creativity, and help attracting new customers and researchers. Centres will have a central role in the definition of the testbeds and on the selection of the R&D results to be promoted. The initiative will start with the Living Lab plan that was previously devised for the CTM. Some of the planned equipment are Smart Displays, which include a Smart Glass and an Interactive Wall that will allow the presentation of news, promotion of INESC TEC R&D results, access to remote testbeds and equipment in real-time, and possibly to building telemetry.

8.16 INFRASTRUCTURE MANAGEMENT SERVICE

Manager: Jorge Couto

Table 8.1-SGI – Service team composition

	Type of Human Resources	2015	2016	2017 (Plan)	Δ 2016 - 2017
Integrated HR	Employees	3.6	5.1	5.1	
	Academic Staff				
	Grant Holders and Trainees				
	Affiliated Researchers				
	Total Integrated HR	**3.6**	**5.1**	**5.1**	
	Total Integrated PhD				

8.16.1 Presentation of the Service

The Infrastructure Management Service guarantees the support services necessary for adequate management and maintenance of INESC TEC's buildings and infrastructures.

8.16.2 Main actions planned for 2017

The main actions of the service planned for 2017 are the following:

- Improve the active and passive security of the INESC TEC building. Implement safety regulations and install video surveillance systems;
- Submit an application to the P2020 programme to support the installation of LED lighting in the building, and thus reduce electricity costs;
- Schedule and develop a set of maintenance actions in the buildings' electrical infrastructure (transformer substation, main and partial switchboards, water pumps, etc.);
- Rationalize and optimize the air conditioning infrastructure in order to improve comfort and reduce costs;
- Continue actions to prevent and fight building fires;
- Schedule and register technical verifications of equipment installed at INESC TEC to detect and fight building fires;
- Continue the painting works which started on the 1st floor (offices and common areas) using internal resources;
- Use as frequently as possible internal resources in the different maintenance and support tasks;
- Increase the number of corporate cars by purchasing a new one, preferably an hybrid car;
- Improve the image and environment inside the buildings with natural plants;
- Improve the documentation of the service processes and equipment;
- Increase the level of usage of tickets for services to be provided;
- Promote recycling in the buildings.