ANNUAL REPORT'19

INESCTEC

MESSAGE FROM THE **BOARD**

In 2019 INESC TEC concluded a decade of continuous expansion. The year's 3% growth in activity to a record 18 M€ is a sign of our solid standing in the ecosystem, accomplishing our mission in a true collaboration with associates, public agencies, partner companies, and science and technology peers. Behind the steady stream of projects, initiatives and structural developments that have contributed to this continued positive evolution, stand the creativity, know-how and passion of our community, and the merit of our research and innovation model.

INESC TEC will celebrate its 35th anniversary in 2020, at the dawn of a new decade. Our motto "science-based innovation" remains now more relevant than ever, as we look back to a successful history of science, technology and impact in industry and society, and ahead to major challenges in our future, most prominently the COVID-19 pandemic and all its consequences, and to the significant advances in knowledge and innovation that they are requesting from us. A greater responsibility and commitment come hand in hand with a sustainable growth capability, developed through our experience and achievements. The challenge now is to continuously reinvent INESC TEC as a dynamic and resourceful research and innovation organization actively contributing to creating the foundations that will shape the future.

To be able to support these dynamics, we are carrying out transformations in multiple areas of our activity. These include the deployment of organizational structures aiming at exploiting synergies between R&D Centres – Clusters for strategic scientific planning and management, and TEC4s for articulation of activity in key markets. They include also the strengthening of our Human Resources management – implementation of a new management model, prioritisation of gender balance and social responsibility, and preparation of a Code of Ethics. Internationalization – with an increased participation in several international strategic initiatives and partnerships, and the creation of INESC Brussels Hub, the joint representation of the five INESC institutes near the European Commission – has also been given a heightened focus.

Digital technologies, which are at the core of INESC TEC's work, are increasingly foundational for the economy and society and challenged with endless opportunities. With a unique presence in both the regional and national innovation ecosystems, INESC TEC bears a particular responsibility for further strengthening their research and innovation capabilities in this field, increasing their scientific and economic competitiveness, and enabling their dynamics of digital transformation.

Achieving these ambitious goals is only possible with the outstanding dedication of our community and the strong, highly committed collaborations with our partners. The year of 2019 has shown us this. Our history of 35 years has shown us this. Let us go into a future of great accomplishments with that same shared conviction and boldness that enabled our founders to break through in the very harsh ecosystem that they started to turn around back in the eighties.

José Manuel Mendonça, *Chairman*
João Claro, *CEO*

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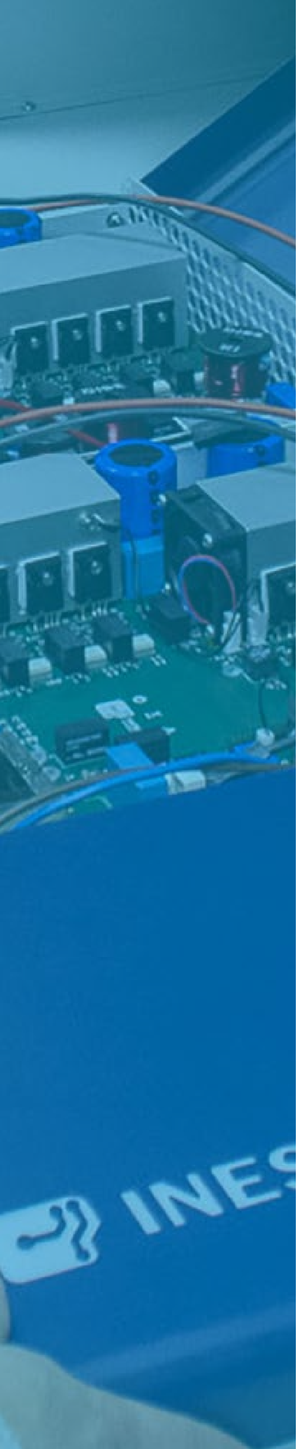
1.

INESC TEC DNA

WE ARE **INESC TEC** WE ARE **KNOWLEDGE GENERATION** WE ARE **SCIENCE-BASED INNOVATION** WE ARE **NETWORKED INTELLIGENT SYSTEMS** WE ARE **POWER AND ENERGY** WE ARE **INDUSTRIAL AND SYSTEMS ENGINEERING** WE ARE **COMPUTER SCIENCE**



WE ARE **NETWORKED INTELLIGENT SYSTEMS.**

WE ARE **POWER AND ENERGY.**

WE ARE **INDUSTRIAL AND SYSTEMS ENGINEERING.**

WE ARE **COMPUTER SCIENCE.**

WE ARE **INESC TEC .**

1.1 FROM **KNOWLEDGE GENERATION** TO **SCIENCE-BASED INNOVATION**

As a **leading R&D institution in Engineering in Portugal**, INESC TEC implements the concept of **the knowledge-to-value production chain**, leading the research activity from knowledge generation to its valorisation through **a mix of technology transfer processes**, from the pure transfer of technology to collaborative development, advanced consulting and training, until the possible creation of spin-offs.

FOSTER PERVASIVE INTELLIGENCE
OUR MISSION

Contribute to the **competitiveness and internationalisation of Portuguese companies and institutions**.

EXCEL IN RESEARCH
OUR MISSION

To be **socially relevant** and **internationally influential.**

RELEVANT PLAYER
OUR VISION

To be a relevant international player in science and technology in the domains of **Networked Intelligent Systems**, **Power & Energy**, **Industrial and Systems Engineering** and **Computer Science**.

OUR VALUES

SOCIAL RESPONSABILITY

COOPERATION

RESEARCH FREEDOM

INNOVATION EXCELLENCE

PEOPLE CENTERED

STRENGTHENING THE TIES BETWEEN **ACADEMIA** AND **SOCIETY**

Universidade do Porto
ASSOCIATE

Instituto Politécnico do Porto
ASSOCIATE

INESC
ASSOCIATE

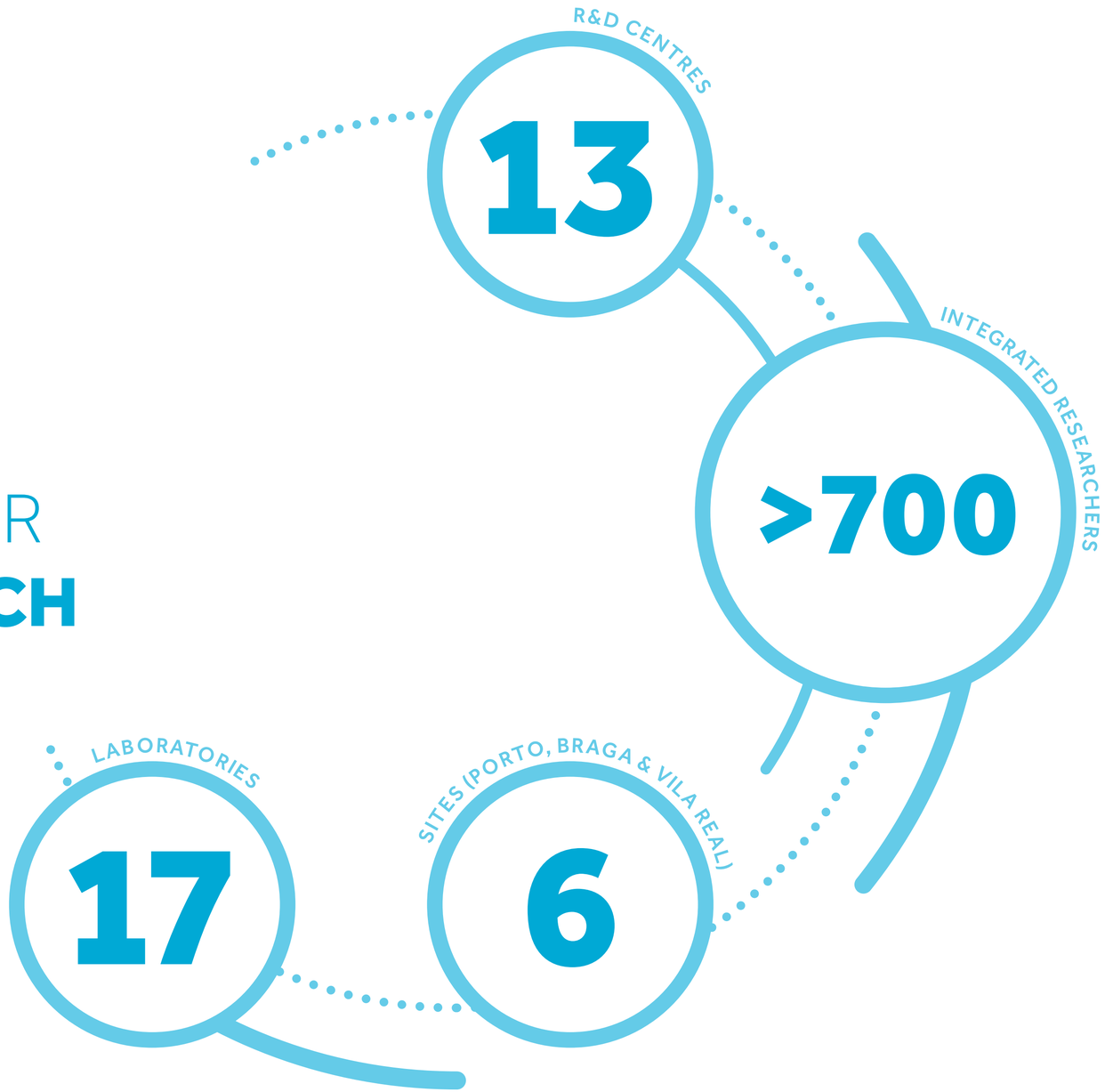
Universidade de Trás-os-Montes e Alto Douro
ASSOCIATE

Universidade do Minho
ASSOCIATE

Universidade Aberta
NUCLEUS

Instituto Politécnico de Bragança
NUCLEUS

1.2
AN **ECOSYSTEM** MADE FOR **EXCELLENCE IN RESEARCH**



PUTTING PERVASIVE INTELLIGENCE TO WORK

RESEARCH
CLUSTERS BEHIND SCIENCE PUSH

Clusters of research centres build a multidisciplinary environment to optimise resources and maximise synergies.

INNOVATION
TEC4 BEHIND MARKET PULL

Strategy driven platforms addressing and impacting great societal challenges and market needs.

4 CORE R&D DOMAINS

- **NETWORKED INTELLIGENT SYSTEMS**
- **POWER AND ENERGY**
- **INDUSTRIAL AND SYSTEMS ENGINEERING**
- **COMPUTER SCIENCE**

5 PLATFORMS SOCIETAL CHALLENGES AND MARKET NEEDS

- TEC4 **AGRO-FOOD**
- TEC4 **ENERGY**
- TEC4 **HEALTH**
- TEC4 **INDUSTRY**
- TEC4 **SEA**

1.3
A **SCIENTIFIC ADVISOR** FOR **PUBLIC POLICY**

As an Associate Laboratory, INESC TEC has been playing an active role in advising public authorities dedicated to science and innovation.
This scientific support in the development of public policies is provided in multiple ways. INESC TEC focuses on specific issues, but also acts as an advisor in the establishment of important science, technology and innovation guidelines at national level.

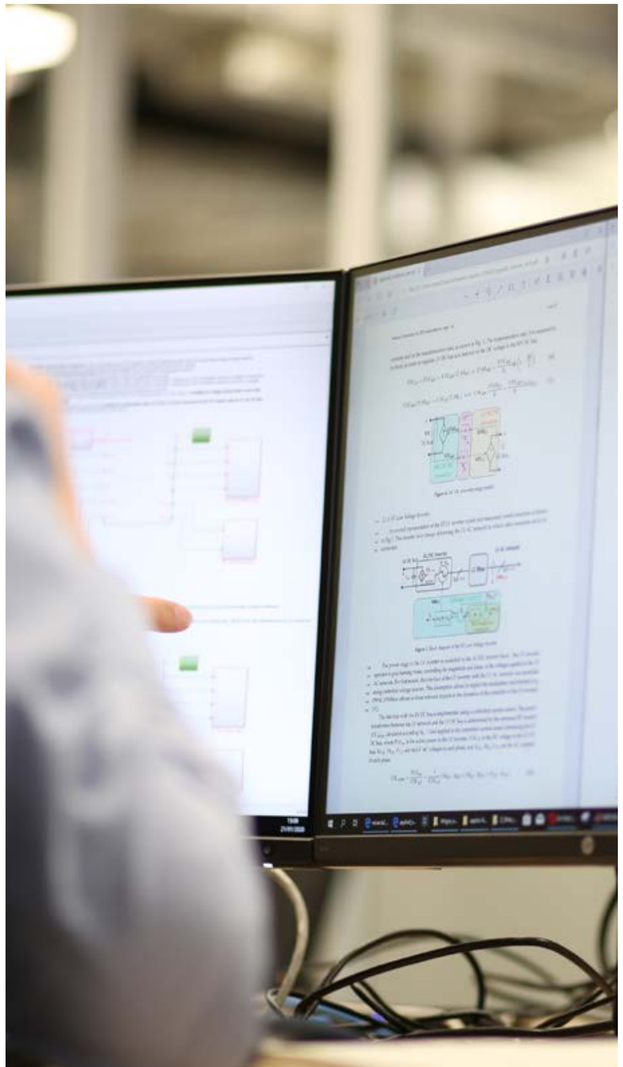
INESC TEC carries out applied and fundamental research, with a strong connection to the business fabric, thus ensuring a strategic position and direct participation in important fields such as Energy, Industry, Telecommunications, Sea, Health, Information Systems and Science Management.

RECENT CONTRIBUTIONS FOR PUBLIC POLICIES:

- **Active involvement and contributions to administrative simplification** in the field of Science and Technology at a national level (OE, P2020 e P2030);
- **Permanent involvement in the update of the regional and national smart specialisation strategies** in the institute's areas of expertise;
- **Technical coordination, in partnership with UM, of the acquisition process of the EuroHPC** supercomputer for the Minho Advanced Computer Center (MACC): Deucalion, the second largest computer in the world supported by ARM processors, with hybrid architecture i.e. combining several avant-garde architectures, expected to be installed by the end of 2020;
- **Major developments in collaboration with the CoLABs** INESC TEC is associated with.

1.4 PRIORITIES AND OBJECTIVES

Continuous efforts in promoting excellence through all the knowledge value chain and strengthening its position as international player.

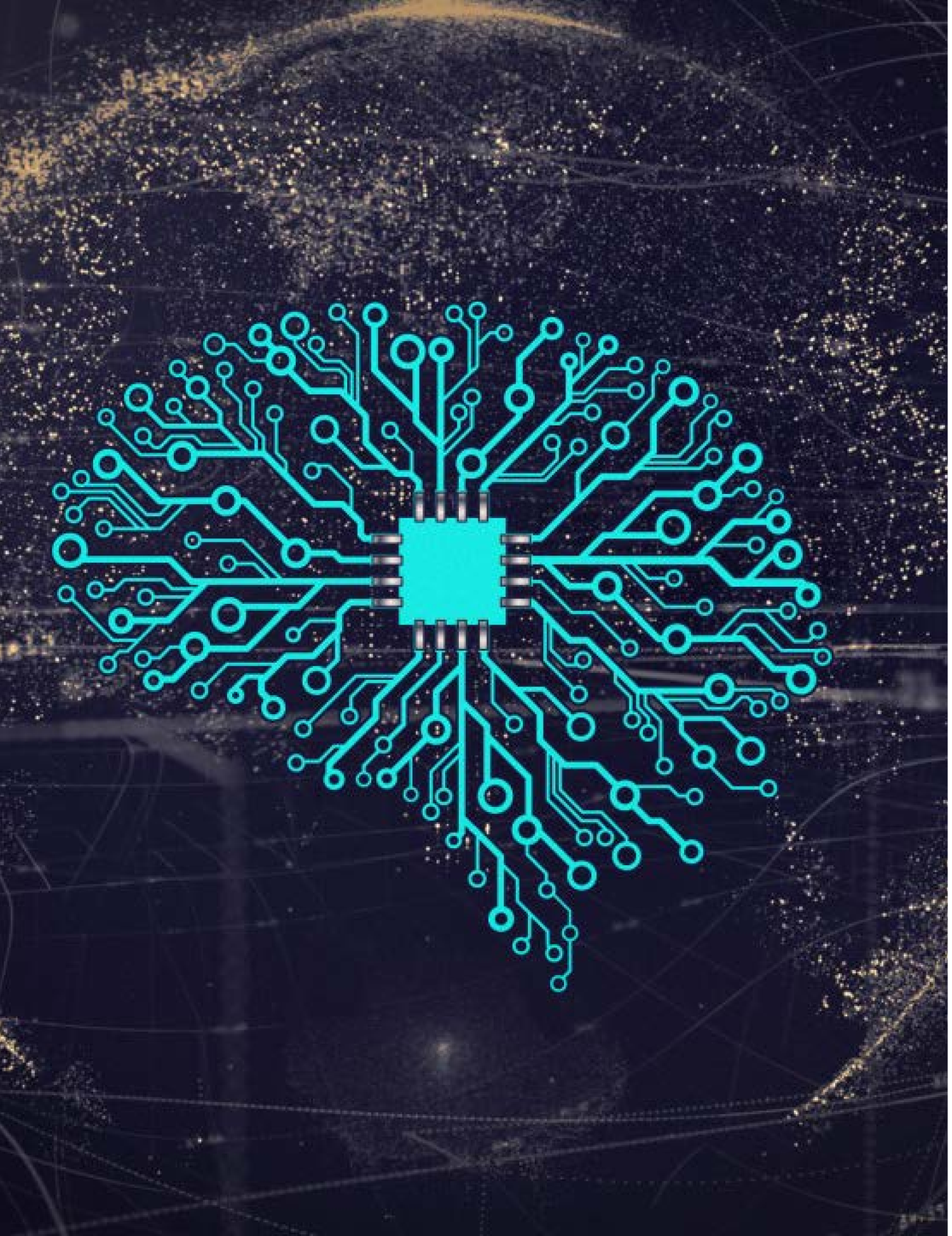


EXCELLENCE IN RESEARCH, TALENT DEVELOPMENT AND INNOVATION

INESC TEC generates new knowledge and technology to improve products, processes, services and business models. This knowledge is based on **rigorous scientific research and a dynamic research environment** that enables the Institute to engage and foster the development of excellent researchers. Initiatives such as the creation of a research data repository and the active participation in the Portuguese cluster of the Research Data Alliance (led by INESC TEC) contribute to strengthening the Institute's position regarding open science policies.
Internationally speaking, **the build-up of its positioning as an interface organisation** of excellence is key to expand the ability to collaborate with other players, generating and transferring socially relevant results. The reinforcement of its global dynamics is a permanent priority for the institution, whose expansion required a renewed attention to some of its fundamentals, namely human resources management, science management and advanced training models, as well as research ethics and gender equality policies.

FULL COVERAGE OF THE KNOWLEDGE VALUE CHAIN

The success of INESC TEC's managed science model relies on **the ability to promote the "upstream to downstream flows" along the knowledge value chain, leading to positive feedbacks in the opposite direction**. In fact, the interaction and collaboration with industry is also essential for the identification of new research lines and the valorisation of research outcomes, through processes such as technology licensing, collaborative development, advanced consulting, training and spin-off launching, all of them key to the economic sustainability of the Institute.



INTEGRATION AND MULTIDISCIPLINARITY

In order to promote adequate integration dynamics, INESC TEC focuses on the renewal, improvement and combination of resources, in order to keep up with the institutional evolution and that of the current context. The **Clusters and the TEC4 initiatives are key instruments to support INESC TEC's policy** for achieving institutional cohesion and maximising synergies, diversity and impact. Overall, this policy aims to strengthen the connections among Centres by promoting cross-fertilisation, thus leading to new science via the relation between knowledge and skills, and the promotion of multidisciplinary research and innovation by truly multidisciplinary teams.

SCALE, DENSITY AND CRITICAL MASS

INESC TEC's ambitious vision and mission require a level of scale and density that is only possible through its **multi-institutional base model.** The resource endowment collaboratively brought to INESC TEC by its associates is continuously leveraged by the Institute, in order to sustain a level of growth and densification in the areas of knowledge that are critical for its activity, which is not only unique in the country, but also increasingly relevant in the international arena. One of the Institute's key priorities for the future is a consistent effort to focus its activities and attract **leading researchers to improve its critical mass.**

INTERNATIONAL STATUS AND RELEVANCE

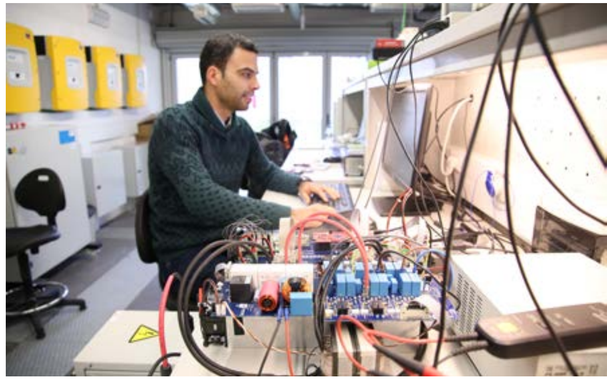
INESC TEC's international projects and activities are crucial to securing the status of **international player**. In this sense, INESC TEC's active participation in the European Knowledge and Innovation Communities (KICs) plays a significantly important role in this area. A second step is **strengthening the operations outside Portugal**, in order to improve the ability to promote projects, secure funding and attract human resources at an international level.
The creation of **INESC P&D Brasil** and its recognition by the Brazilian Science and Technology agencies, the creation of **INESC Brussels Hub** and a of the **International Relations Service** are good examples of said goals. The India Office also aims to establish bridges with companies and public actors and encourage the involvement of students and post-docs. The participation in the **Portuguese Government's International Partnerships** with MIT, CMU and UT Austin, and the hosting at INESC TEC of the national leadership of the UT Austin Portugal Program, play a key role in the development of partnerships with the United States.

1.5 A PROFESSIONAL JOURNEY **OF EXCELLENCE**

THE **CHALLENGE**

INESC TEC is a challenging place to work, ideal for self-improvement. Moreover, the Institute provides a multicultural, international and collaborative environment that makes it easier to exchange ideas, network and create synergies.
At INESC TEC, the collaborators have the opportunity to participate in international projects with some of the most important companies on a daily basis, with the mentoring support from the best researchers in the fields of electrical and industrial engineering, bioengineering, information technology and physics.

When young researchers join INESC TEC, they can choose different paths:
- Join top R&D projects while pursuing PhD or MSc studies, or even before that;
- Become an INESC TEC researcher and work on the most exciting fields, before moving to the industry sector;
- Have a career as INESC TEC researcher;
- Create his/her own science-based start-up with INESC TEC's support.



TALENT INCUBATOR

More than **200 professionals** transfered to market in 2019 (26 PhDs).

A **PROUD** INSTITUTION

In a community that holds more than 800 people, there are many who had a performance in 2019 suitable for "Limelight".

Henrique Teixeira

João Vieira Silva

Artur Capela

João Teixeira

Sílvia Bessa

Tiago Soares

José Pedro Pinto

Inês Teixeira

Luís Vilaça

Ana Rebelo

Claúdia Rocha

Hugo Santos

Tiago Oliveira

Filipe Teixeira

Paulo Rebelo

Erick Lima

João Pedro Aguiar

Romão Santos

Narciso Caldas

João Basto

André Coelho

José Pedro Pinto

Pedro Ferreira

Vasco Correia

Inês Carvalho

José Nuno Oliveira

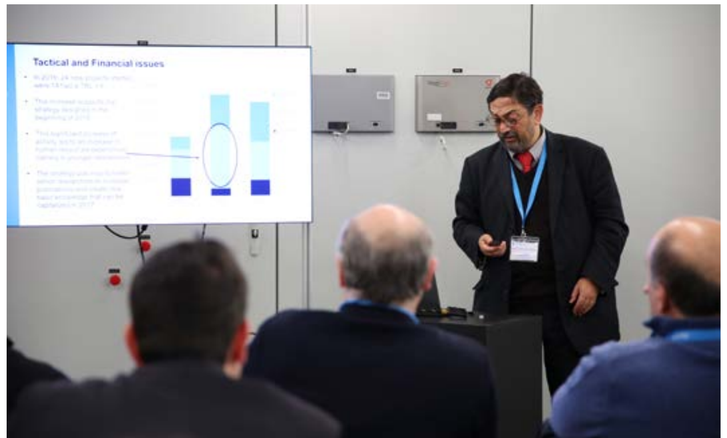
Patrícia Vale

Rafael Arrais

Daniel Loureiro

Rui Campos

1.6 MANAGEMENT MODEL



BOARD OF **DIRECTORS**

The high-level management of INESC TEC is undertaken by a **Board of Directors**, and an **Executive Board**, composed of four members from the Board of Directors.

The Boards act in coordination with the **Council of R&D Centres**, meeting regularly with the Centre Coordinators and Service Managers. This ensures institution-wide coherence in vision and policy, and joint responsibility and commitment in both strategic and operational management decisions.

SCIENTIFIC ADVISORY BOARD

The **Scientific Advisory Board** is a statutory body of assessment and strategic follow-up. This external board is composed of recognised international scientists from prestigious institutions, international experts in INESC TEC's fields of competence that support the institution in its search for continuous improvement and excellence, building a vision for future research through a valuable benchmark at an international level.

BUSINESS ADVISORY BOARD

The **Business Advisory Board** performs a similar role in the areas of business development and industry relations, assessing the institute's performance and providing recommendations to the Board in those areas.

SCIENTIFIC COUNCIL

The **Scientific Council** is an internal body responsible for monitoring and guiding scientific activity, and it includes one representative from each Centre and three additional members appointed by the Board

CONFLICT OF INTEREST MANAGEMENT COMMISSION

The **Conflict of Interest Management Commission** is appointed by the Board to implement the institute's Policy of Interest.

DATA PROTECTION OFFICE

The **Data Protection Office** leads the implementation across INESC TEC of the General Data Protection Regulation.

SUPPORT SERVICES

A streamlined and dynamic team of highly qualified technical and administrative personnel provides support to INESC TEC's activities. A comprehensive set of **support services** is organized to support the R&D Centres across the domains of Business Development, Organisation and Management, and Technical Support. Furthermore, each research Centre has its autonomous administrative support, also with highly qualified staff.

BOARD OF DIRECTORS

CHAIRMAN
José Manuel Mendonça

CEO EXECUTIVE BOARD

João Claro

EXECUTIVE BOARD

Gabriel David

EXECUTIVE BOARD

Luís Seca

EXECUTIVE BOARD

Luís Carneiro

Bernardo Almada Lobo

José Carlos Caldeira

Manuel Ricardo

Rui Oliveira

BUSINESS ADVISORY BOARD

Jorge Vasconcelos
Chairman

António Murta
Managing Partner

Luís Filipe Reis
CEO

Alberto Barbosa
Chairman of the Board

João Paulo Oliveira
Member of the Administrative Board

SCIENTIFIC ADVISORY BOARD

José Fortes
University of Florida (USA)

Anne-Marie Kermarrec
INRIA – Rennes (France)

Bruno Siciliano
Università degli Studi di Napoli
Federico II, Prism Lab (Italy)

Edward Knightly
Rice University (USA)

J Elsa Angelini
Imperial College London (UK)

M. Grazia Speranza
Università degli Studi di Brescia (Italy)

Mario Paolone, EPFL
L'Ecole Polytechnique Fédérale de
Lausanne (Switzerland)

Masaru Kitsuregawa
Institute of Industrial Science, The
University of Tokyo (Japan)

Pere Ridao
Institut de Recerca en Visió Per
Computador i Robòtica (Spain)

Robert Lieberman
Former Presidente of SPIE
The International Society for Optics and
Photonics, President of Lumoptix LLC (USA)

Tomás Gómez San Román
Universidad Pontificia Comillas (Spain)

Volker Stich
Aachen University of Technology (Germany)

2.

OUR 2019 HIGHLIGHTS

2.1 MAJOR **ACHIEVEMENTS**

DECISIVE REINFORCEMENT OF THE MULTI-INSTITUTIONAL BASE MODEL

The University of Trás-os-Montes e Alto Douro and the University of Minho became associates of INESC TEC in 2019, reinforcing the institute's ability to provide a cohesive and collaborative ecosystem to researchers from multiple Higher Education Institutions, while strengthening the ties between academia and society.

A DECADE OF CONTINUOUS GROWTH

In 2019 INESC TEC consolidated a decade of continuous expansion, contributing to the competitiveness of the economy and benefiting society. The balance between different funding sources at the institute was successfully maintained in the portfolio of 338 R&D projects, underlying a turnover of about 18 M€, with an annual growth of 3%.

LEADING PARTICIPATION IN EUROPEAN R&D

INESC TEC consolidated in 2019 as one of the top five Portuguese organisations in net contribution and participation in Horizon 2020. With 34% of project funding coming from European projects, during the year the institute further strengthened its involvement in the European Knowledge and Innovation Communities, coordinated and saw approved several large European project proposals, it was actively involved in the creation of INESC Brussels Hub, the joint representation of the five INESC institutes near the European Institutions.

A 17% INCREASE IN THE NUMBER OF ARTICLES IN INDEXED JOURNALS

In 2019 the numbers of indexed journal and conference papers reached 369 and 410, respectively. The total number of papers increased 17% and the number of papers published in first quartile (Q1) journals (according to SCOPUS) increased 3%, in line with a higher focus on indexed journal publications.

SOLID KNOWLEDGE TRANSFER POSITION

INESC TEC was among the top five Portuguese applicants to European patents in 2019. The institute also filed 16 national applications in geographies such as the U.S., Canada, Japan, China, South Korea, and Australia, strengthening the internationalization of its patent portfolio. Four patents were also granted, in the U.S., Japan, China, and Europe. Two spin-offs, Keyruptive Technologies (Software security/Fintech) and Insignals Neurotech (Medtech), were launched, and three others gave major steps in their initial developments: iLoF (Medtech, digital health), UNEXMIN Georobotics (Geological consulting), and WeSENSS (Medtech).
A successful exit in LTP Labs was also accomplished in 2019. Throughout the year, more than 200 highly qualified human resources (26 PhDs) were transferred to the labour market. Revenues from R&D services and consulting remained strong, at approximately 3 M€.

KEY ACTOR IN PUBLIC POLICY

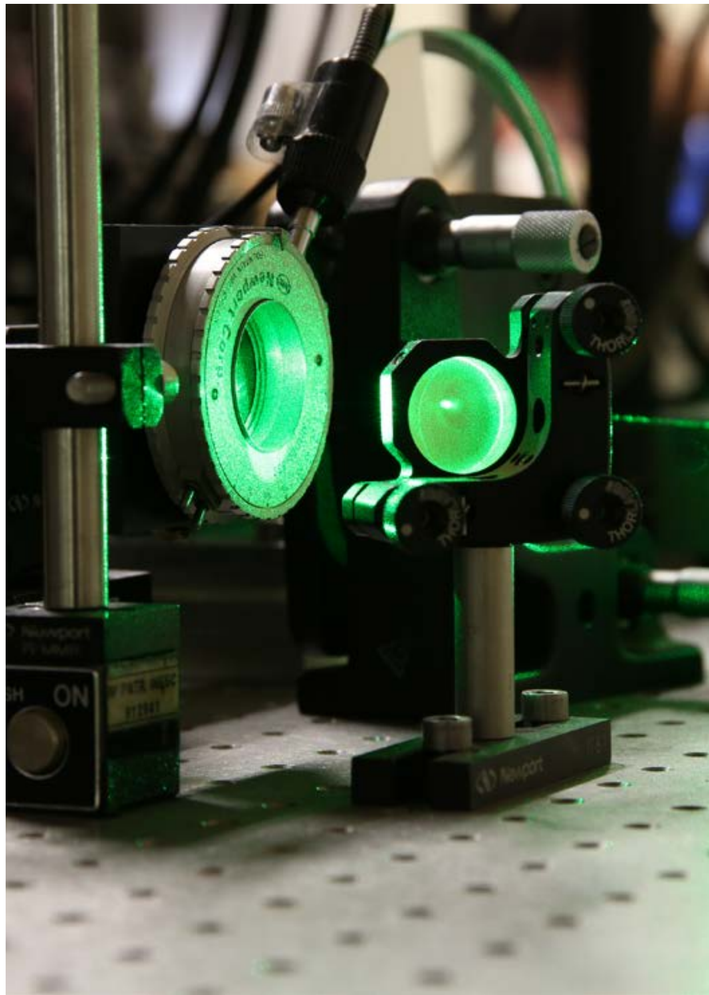
The institute was actively involved during 2019 in providing contributions to administrative simplification in the area of Science and Technology at a national level and was actively involved in the update of the regional and national smart specialisation strategies in the institute's areas of expertise. INESC TEC also formally joined or helped establish five national Collaborative Laboratories (CoLABs): B2E (Blue Economy), BUILT (Future Built Environment), CSESI Hub (Smart Energy Services Innovation), VG CoLAB (Vasco da Gama - Energy Storage) and Vortex (Cyber-Physical Systems and Cyber Security), in addition to the initial leadership of ForesWise (Forest and Fire Integrated Management), and active participation in Vines&Wines.

ONE OF THE LEADING PORTUGUESE ORGANISATIONS IN SCIENTIFIC EMPLOYMENT

Hosting over 700 integrated researchers, 341 with a Ph.D. degree, at the end of 2019, INESC TEC's core research team continued to change significantly along the year. In particular, in line with the national policies for scientific employment, the number of R&D employees increased 19% to 121 researchers holding work contracts.

A STEP OF STRATEGIC IMPORTANCE IN BRIDGING ACADEMIA AND INDUSTRY

In 2019 INESC TEC opened "iiLab - Industry and Innovation Lab", an infrastructure aimed at facilitating the diffusion of state-of-the-art advanced production technologies through research demonstration, experimentation and advanced training.



2.2
2019 ACTIVITY OVERVIEW

DELIVERING
SCIENCE AND INNOVATION

18M€ ACTIVITY
3% INCREASE

k€

9 437 National Programmes
4 743 EU Programmes
3 300 R&D Services
486 Other Revenues

338 PROJECTS

ACTIVE PROJECTS BY FUNDING SOURCE

105 National R&D Programmes
68 EU Programmes
134 R&D Services & Consulting
31 Other Funding Programs

> 700 INDEXED PUBLICATIONS

369 Indexed Journals Papers
410 Indexed Conference Articles
33 Concluded PhD Theses - Supervised

PATENTS

28 Patent Applications
4 Patents Granted
1st Patent in China
1st Software Patent

SHARING R&D RESULTS

54 Conferences, workshops and scientific sessions
organised by the R&D Centres
19 Advanced Training Courses Organised
75 Editorial Roles in Journals
75 Organisation of conferences
in organizing committee or chairing technical committees
330 International Events
with members of INESC TEC partaking
in programme committees
66 Participation in Fairs and Events

2019
ACTIVE SPIN-OFFS

Keyruptive Technologies

Mobile app solution for secure cloud storage and management of digital assets such as crypto currency, using patent pending technology that enables the distribution of trust among multiple entities.
Sectors: Software security / Fintech
<10 jobs created

Ubirider

Develop solutions to make urban mobility smarter and to improve travellers' overall experience. Pick is a universal app which integrates any mobility service for multimodal trip planning and mobile payment of fares.
Sectors: Digital mobility
<20 jobs created

WeSENSS

in development
Corporate solutions for security and quantified occupational health approaches to promote worker wellbeing and improve performance, based on a wearable & IoT platform for hazardous professionals' vitals and work environment monitoring.
Sectors: Medtech

iLoF

in development
Leverage machine learning to drastically reduce the cost and time of drug discovery, using a patented photonics and Artificial Intelligence system to identify unique features of various gold-standard biomarkers, capturing their signature on a cloud-based library.
Sectors: Medtech, Digital health
<10 jobs created

Insignals Neurotech

Wearable wireless devices to precisely measure wrist rigidity, helping surgeons place brain implants more accurately during surgery on patients with Parkinson's, epilepsy, and other neural conditions.
Sectors: Medtech
<10 jobs created

MitMyNid

Marketplace to search and compare transport and logistics services with simple or multimodal door-to-door solutions. Intelligent Routing System to search and combine logistics services (air, rail, road, sea) to provide optimized solutions.
Sectors: IT for transport and logistics
<10 jobs created

LTP Labs*

Advanced analytics and business consultancy in Marketing, Sales, Operations and Supply Chain, based on digital platforms.
Sectors: Business consultancy
<50 jobs created

*Successful exit in 2019.

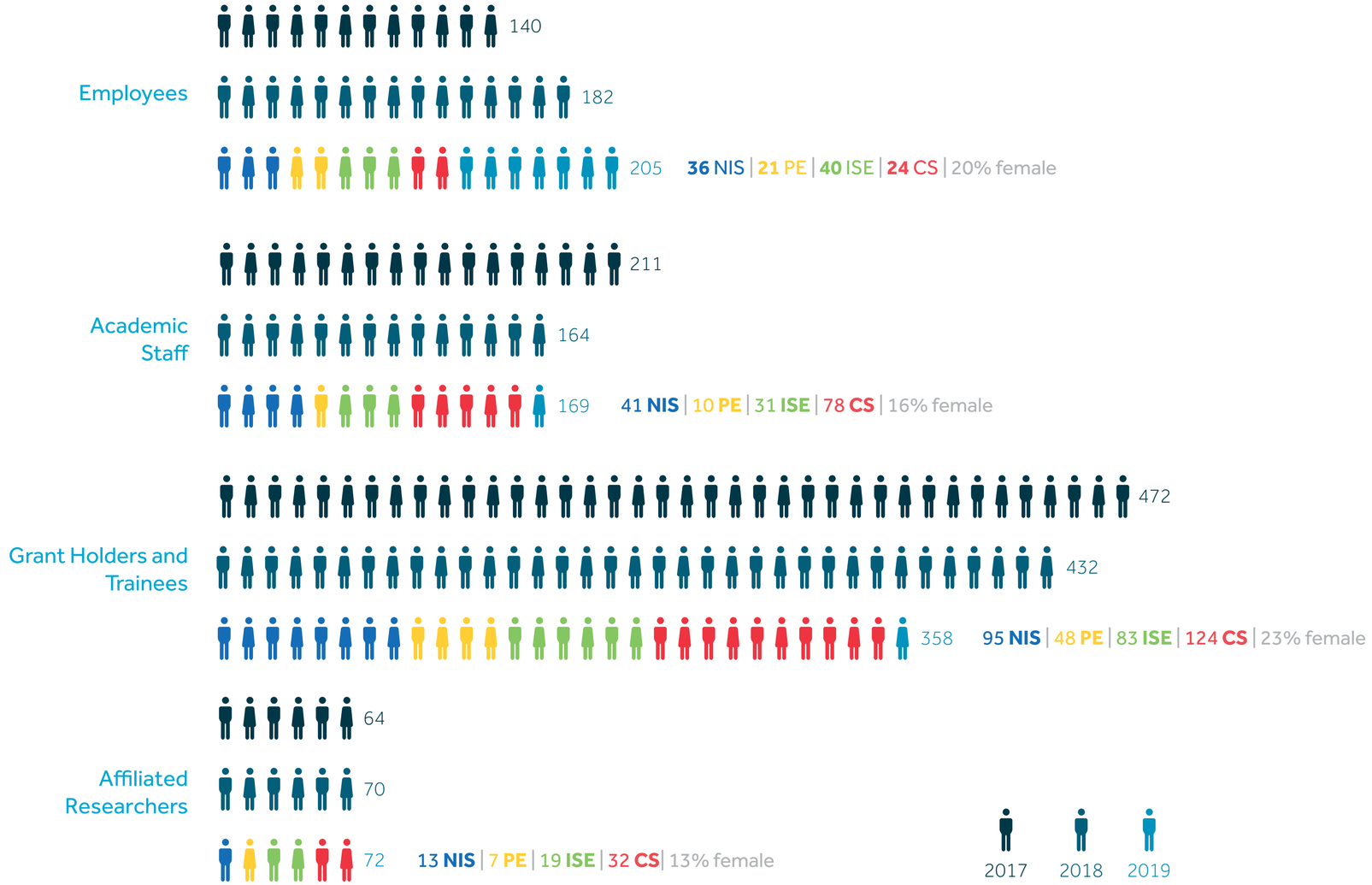
UNEXMIN Georobotics Ltd.

in development
Underwater mine exploration robotic system for commercial mine surveying, exploration and geoscientific purposes.
Sectors: Geological consulting
<10 jobs created

2.3
HUMAN RESOURCES
SCOPE

EXPANDING
WORKFORCE

341
RESEARCHERS WITH PHD



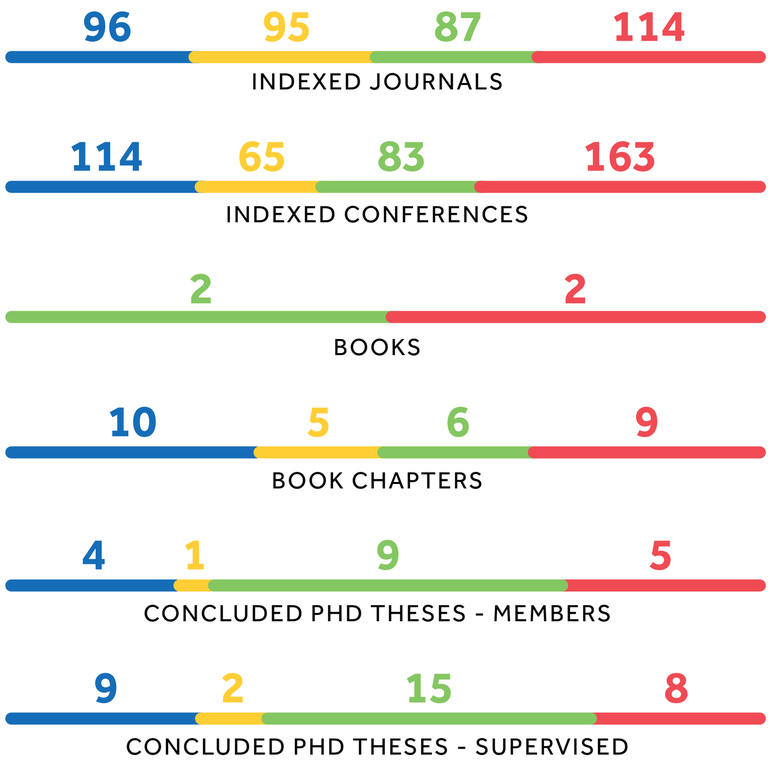
2019 Gender Balance Actions:

- Women in Engineering International Leadership Summit Portugal | INESC TEC official sponsor
- Creation of a Work Group for Gender Balance
- Internal Awareness Talk on Gender Balance

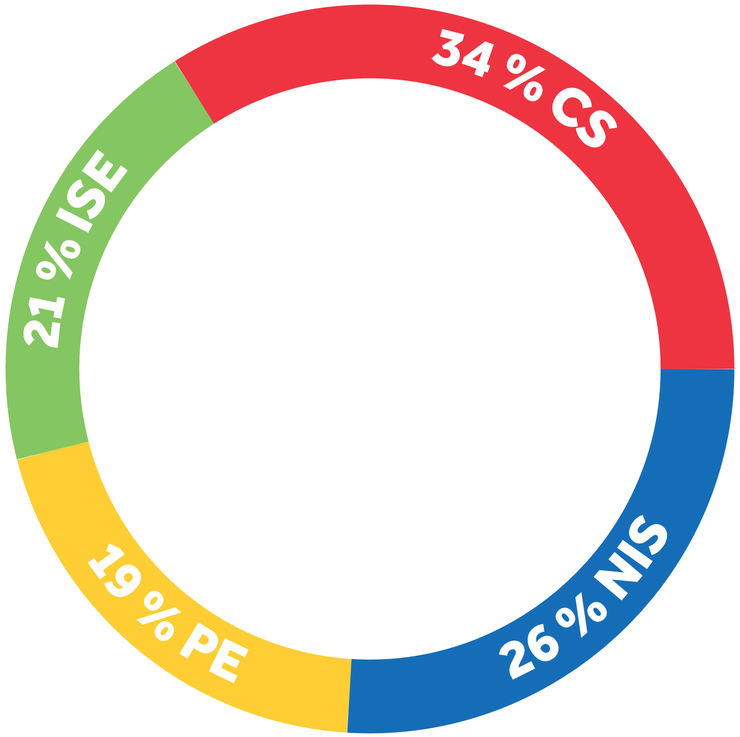
2.4 PUBLICATIONS AND PROJECTS BY R&D CLUSTER

CLUSTERS PERFORMING:
369 ARTICLES IN **INDEXED JOURNALS** AND **62% IN Q1**

PUBLICATIONS



INDEXED ARTICLES



PUBLICATIONS IMPACT

IN THE 10% MOST CITED PAPERS IN PLOS ONE

"Classification of breast cancer histology images using Convolutional Neural Networks", which was carried out by Teresa Araújo, Guilherme Aresta, Eduardo Meca Castro, José Rouco, Aurélio Campilho and three authors from i3S (INEB/Ipatimup), António Polónia, Carolina Eloy and Paulo Aguiar, aims at **developing a system capable of supporting the diagnosis, thus reducing the costs and increasing the efficiency of breast cancer diagnosis**.

MOST INFLUENTIAL PAPER

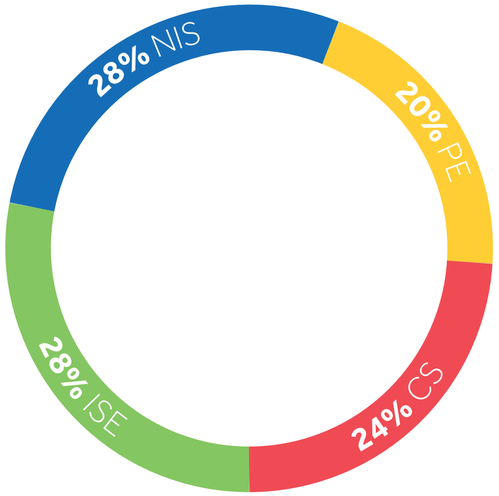
"Automatically Inferring ClassSheet Models from Spreadsheets", co-written by João Saraiva, was awarded the **Most Influential Paper** from the VL/HCC 2019 international conference.

BEST CONFERENCE PAPER AWARD

"Model Predictive Power Allocation for Hybrid Battery Balancing Systems" is the name of the scientific paper awarded at the **"IEEE Vehicular Power and Propulsion 2019" (IEEEVPPC'2019) conference**, which was developed by Rui Araújo (INESC TEC) and Ricardo Castro, researcher at the DLR Institute of System Dynamics and Control.

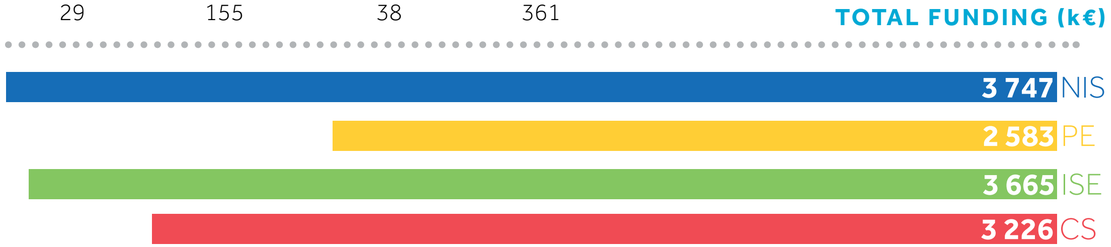
FUNDING SOURCES
DIVERSITY AND RANGE

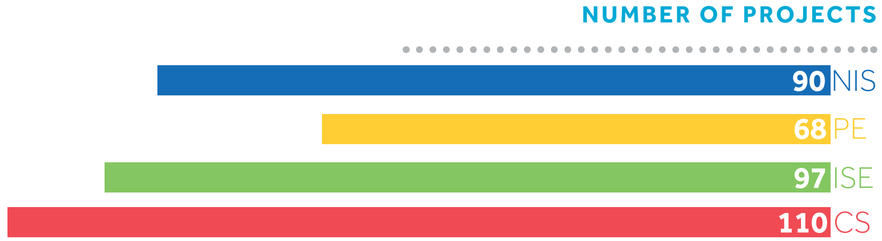
PROJECT FUNDING 2019



FUNDING SOURCES (k€)

FUNDING SOURCES	NIS	PE	ISE	CS
National R&D Programmes - FCT	1 541	488	759	888
National R&D Programmes - S&T Integrated Projects	241	4	64	159
National Cooperation Programmes with Industry	395	21	442	70
EU Framework Programmes	543	977	1 234	988
EU Cooperation Programmes - Other	272	88	289	65
R&D Services and Consulting - National	412	796	773	535
R&D Services and Consulting - International	222	12	48	129
Other Funding Programmes	29	155	38	361





2.5 EVENTS AND VISITS

INESC TEC AUTUMN FORUM

"Digital (R)evolution in Agri-Food and Forestry"

Regular and thematic event organised by INESC TEC | 200 participants
The 2019 edition was co-organized by INIAV – National Institute for Agrarian and Veterinarian Research

The 5th edition of the Autumn Forum was dedicated to the "Digital (R)evolution in Agri-Food and Forestry". The event gathered nearly 200 participants and several experts and policy makers, in order to promote a debate and come up with ideas capable of addressing the challenges faced by the agri-food and forestry sectors. Maria do Céu Albuquerque, the Minister for Agriculture, and Manuel Heitor, the Minister for Science, Technology and Higher Education, attended the 2019 edition of the event.

SHOWCASING OUR ECOSYSTEM

Deputy Director-General of DG CONNECT
Khalil Rouhana, Deputy Director-General of the European Commission Department DG CONNECT (Communications Networks, Content and Technology), visited INESC TEC and got to know several projects on Energy and Smart Grids and Artificial Intelligence.

Chief of Staff of the Navy
Admiral Mendes Calado, Chief of Staff of the Navy (CEMA), and other members of his delegation visited INESC TEC, in order to establish a relationship between said institution and some of the most recent projects developed in the oceans field.

Ministry of Science of Angola
Domingos da Silva Neto, Secretary of State for Higher Education, Science and Innovation of Angola, visited INESC TEC during the presentation of the roadmap of the Science Week between Portugal and Angola.

Ambassador of the Republic of China
The Ambassador of the People's Republic of China in Portugal visited INESC TEC's MASSIVE Laboratory, an infrastructure that focuses on studying the stimulation of the five senses in Virtual Reality applications. Credits: UTAD

Secretary of State for Energy
The main purpose of this visit was to understand the technical capacity of INESC TEC, namely concerning the support to the implementation of the National Energy-Climate Plan (PNEC2030) and the Roadmap for Carbon Neutrality.

Government of the State of Espírito Santo
The key-objective was to formalise a cooperation agreement for scientific development, technological innovation, entrepreneurship and collaborative work.

SHARING KNOWLEDGE: TRAINING AND PARTNERSHIP

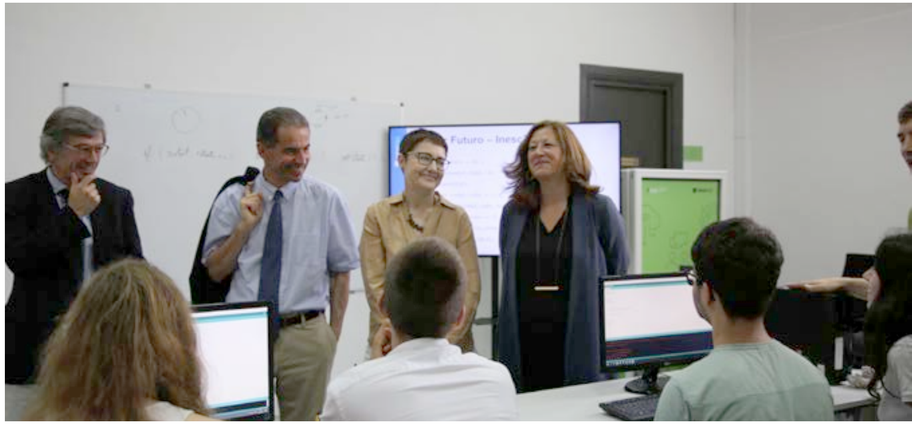
Programa Verão no Campus 2019
The Computation Without Borders, an activity integrated in the Summer on the Campus 2019 programme and organised in collaboration with INESC TEC's High-Assurance Software Laboratory, had the participation of 28 secondary school students and took place in University of Minho.

Encontro Ciência 2019
Encontro Ciência is the annual meeting of Portuguese researchers that aims at promoting a broad debate on the main topics and challenges of the scientific agenda beyond the world of research.

Semana Profissão Engenheiro da FEUP
INESC TEC participated in another edition of SPE (Engineering Week), an annual exhibition organised by Faculty of Engineering of the University of Porto (FEUP).

European Researcher's Night
During this annual European Commission initiative, INESC TEC presented an European project UNEXMIN – Exploration and mapping of flooded mines with robots.

Mostra UP
In this event, targeting younger students, INESC TEC presented three demonstrators: "Conta-me Histórias", BEACONING and a wireless power transfer project.



Ciência Viva
In the context of the initiative "Ciência Viva nos Laboratórios - Ocupação Científica de Jovens nas Férias", a new studentship in AI was created. INESC TEC was selected to host the kick-off event of this nationwide initiative – with the presence of the Minister of Science, Technology and Higher Education.

TOGETHER FOR TEAM BUILDING AND NETWORKING

INESC TEC On the Move - Team Building Activities
12 June | City Park | 90 Participants
INESC TEC brought its collaborators to the Porto City Park in order to participate in another team building activity.

INESC TEC on Foot – Hiking activities
11 May 11 | Serra da Lousã | 50 Participants
Lousã was the destination of the third edition of "INESC TEC on foot", an internal initiative that promotes the organisation of hikes across the country.

Strategic Meeting
13 September | Fundação António Cupertino de Miranda | 230 Participants
The success stories of INESC TEC were highlighted in the Strategic Meeting 2019, an event organised to reflect and discuss the institution future.

«Holidays 2019» - Photo Competition
September | 18 Candidates

Welcome Session for new collaborators
13 sessions/year | 140 participants

Roasted Chestnuts Party
13 November | INESC TEC | 150 participants

Multicultural Party and awards-giving ceremony
17 December | INESC TEC | 200 participants

2.6 SPECIAL INITIATIVES

UT AUSTIN PORTUGAL

National Coordinators: José Manuel Mendonça and Rui Oliveira

The UT Austin Portugal Program is a partnership between the Portuguese Science and Technology Foundation (FCT) and the University of Texas at Austin (UT Austin), in conjunction with several national universities and laboratories.

It was launched in 2006, as part of a strategy to promote Portuguese scientific institutions at an international level, through a series of main structured areas of research and education organized in the form of a Co-Laboratory for Emerging Technologies (CoLab).

The transatlantic partnership moved into a new phase in 2018 towards 2030, determined to ensure its actions would go on shaping research agendas and delivering transformative results across five knowledge areas:

- **Advanced Computing;**
- **Nanotechnologies;**
- **Medical Physics;**
- **Space-Earth Interactions;**
- **Technology Innovation and Entrepreneurship.**

UT Austin Portugal offers an integrated and consistent approach to the knowledge-to-value chain thanks to its three types of instruments - Research, Education and Innovation.

MAIN ACHIEVEMENTS IN 2019

At the end of 2019, the following achievements must be highlighted:

- **Setting up of the Minho Advanced Computing Center (MACC)**, the most advanced research-based computational infrastructure in Portugal thanks to the supercomputer BOB, brought all the way from TACC (the Texas Advanced Computing Center) under the international partnership;

- **Implementation of an advanced training scheme** in partnership with TACC;

- **Launch of two competitive calls**, managed by Portuguese funding agencies, for collaborative projects oriented towards pre-defined research and innovation agendas.
For the first time ever, the Program supported the engagement of researchers both from Portugal and UT Austin with Portuguese companies, through a dedicated call for three-year industry-driven R&D projects (sponsors: Compete2020 & FCT). Additionally, the Program supported a call to fund high-risk and high-impact collaborative one-year research projects. Performance in both calls largely exceeded the Program and sponsors' best expectations.

- **Increased visibility of the Program**, through enhanced communication outreach - as the partnership gathered pace, its community of stakeholders grew significantly and the Program reached beyond its conventional geographic scope (e.g.: Japan; Germany; Norway).

- **Organization of several training and networking activities** in practically all areas of the Program in partnership or with the support and involvement of relevant stakeholders (e.g.: Portugal Space; AIR Centre; Faculty of Medicine of the University of Coimbra; NASA; AICIB; QuantaLab), fostering discussion and knowledge sharing and opening up new partnering opportunities for attendees and speakers.

DIGITAL COMPETENCE INITIATIVE

Coordinator: Pedro Guedes de Oliveira

The Digital Competence Initiative constituted INESC TEC role in the coordination of the National Initiative for Digital Competences, e.2030 (INCoDe.2030) for which Pedro Guedes de Oliveira (PGO) was nominated General Coordinator in 2017 and until the 20 of august 2019.

INCoDe.2030 is structured in **5 Action Lines (AL)**:
- **AL 1, INCLUSION;**
- **AL 2, EDUCATION;**
- **AL 3, QUALIFICATION;**
- **AL 4, SPECIALISATION;**
- **AL 5, RESEARCH.**

MAIN ACHIEVEMENTS IN 2019

GLOBAL ACTIONS

- **Organisation of set of meetings, one for each Action Line** (with the exception of AL4), to assess the results obtained so far and to programme the actions for the future. The meetings took place in May and the objectives were fully accomplished having mobilised most of the relevant actors in each domain;

- **Contract with INOVA RIA to develop a programme** to bring together tech companies and basic and secondary school students to promote ICT studies. More than 1200 students from Aveiro region were involved but, although the report shows a considerable impact on the students approach to the subject, difficulties with the school schedules didn't allow a full development of the programme;

- **Discussion of the 2018 report** concerning the Integrated Network for Public Communication Services (RISPC), with the Directory General of Education and the Directory General of Statistics of Education and Science as well as with the Secretary of State of Local Constituencies, which has led to a budgetary plan for RISPC;

- **Implementation of the platform to manage the INCoDe Sea**l, as well as participation in a vast number of public events to promote the programme;

- **Organisation of the visit of the members of the International High Level Group**, both prior and during the visit, creating the conditions to the submission of a preliminary assessment report of INCoDe.

ACHIEVEMENTS IN EACH ACTION LINE

AL 1 | In cooperation with CIENCIA VIVA, the coordination supported the **submission of applications to the POISE** that involved 6 different consortia to carry out 110 CCID to reach 47 thousand people, with a global value of more than 10M€. Although it was considered a particularly relevant programme, the application was not successful, due to bureaucratic difficulties;
An intense cooperation was developed with DNS.pt and MUDA, as well as with the Directory General of Reinsertion and Prisons, in order to integrate the Digital Campus EducOnline@Pris within the concept of CCID;

AL 2 | Creation of the e-Computation Association to promote Computational Thinking in basic and secondary studies, with the first steps towards the development of the curricula for each year;

AL3 | Continuation of the programme SWitCH with PortoTechHub and ISEP

AL4 | Contract with the University of Aveiro (ESTG of Águeda) to carry out a quantitave assessment of the 7 CTeSP developed under a Project Based Approach, which led to important conclusions to new implementations of this methodology;

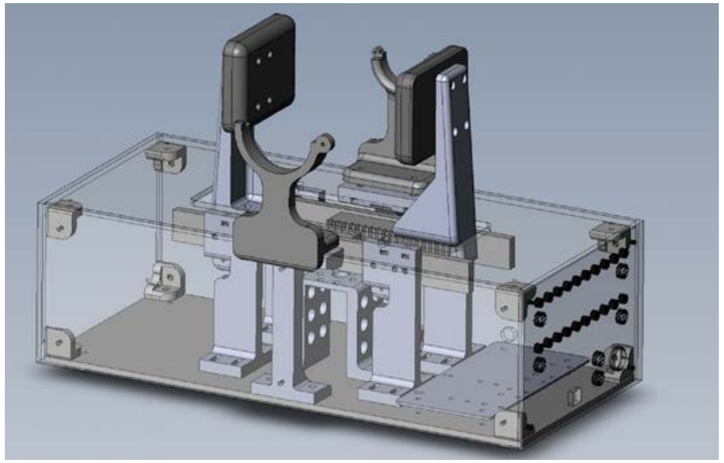
AL5 | Development of strategic plans for Advanced Computing and Artificial Intelligence (this one, led by Alípio Jorge, Portuguese Sherpa for the European AI Initiative) which involved an intense mobilization of the interested communities, both from companies and academia.

INESC P&D BRASIL

Coordinator: Vladimiro Miranda

INESC P&D is a private non-profit R&D association, recognized by the Brazilian Government. **It coordinates the joint work of research group within its associates, belonging to 14 top Brazilian universities.** As an independent institution, the partners agreed to trust INESC TEC with the leadership of the shared management, **to explore synergies in projects in South America and the European Union.**

INESC TEC is the single Portuguese institution to create and operate a research institute overseas, in a unique internationalization process. The benefits are clear: scientific cooperation, access to valuable human resources, import/export of technologies and creation of a dense network of alliances in South America.



MAIN ACHIEVEMENTS IN 2019

EVOLUTION IN 2019:

- **Eight universities joined as members of the juridic association**, while others, while remining in the cooperation network denoted Rede INESC Brasil, are in the process of becoming formal associates.
- **Balanced budget and execution**, at the level of R$9 million.
- **7th consecutive year with positive accounting** balance.
- **Joint projects with INESC TEC and under the Horizon 2020 EU-Brazil framework**.
- **First laboratory of the CITI concept (Centres for the Integration of Technologies for Innovation)**, installed by INESC P&D Brasil, inaugurated in São Paulo - the CITI LabPro PD, for rapid prototyping of devices emerging from R&D activities, with funding from EDP Brasil, ENERGISA and ITC companies.

KEY PROJECTS

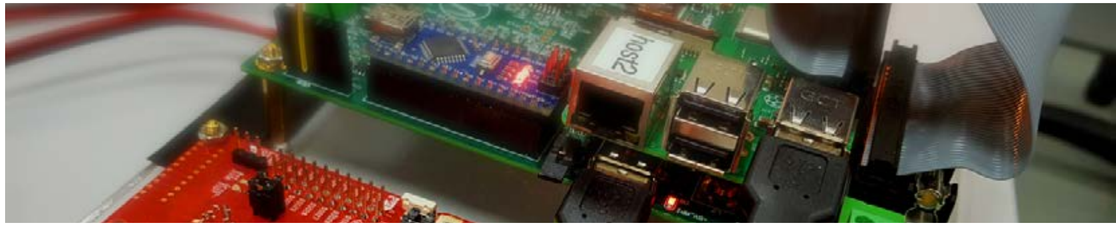
TECCON II | The project Sensor technology in optical fibres for supervision, control and protection of electric power systems aims to increase the efficiency, reliability and safety of transmission lines, using sensor systems based on optical fibre.

FASTEN | The FASTEN project - Flexible and Autonomous Manufacturing Systems for Custom-Designed Products, aims to develop and validate an additive manufacturing system connected to units dedicated to the manufacturing of customised low-cost products.

AUTOMON | The project focuses on automated surveying and intelligent data analysis, for the measurement of liquid and solid discharges. It aims to automate the process of sample collecting for the assessment of the water conditions at hydroelectric power reservoirs.

RADAR | The RADAR project - Recloser with advanced distributed smart functions for network automation, aims at the development of equipment with adequate means to host protection and control functions, within the scope of intelligent networks. The project also focuses on the creation of a prototyping laboratory.

QEE | The QEE project - Development of a system for the monitoring of energy quality and decision-making concerning transmission lines, focuses on the development and implementation of a prototype for an online system dedicated to monitoring electric power quality, at two 230 kV substations.



INESC BRUSSELS HUB

Head of the Brussels Office: Ricardo Miguéis
Coordinator of INESC Brussels Hub at INESC TEC: José Carlos Caldeira

INESC's strategy is driven by a conceptual vision that includes international visibility and presence. The creation of a representation in Brussels, the INESC Brussels Hub (HUB), is a cornerstone of this vision and strategy implementation, being the first research and technology organisation from Portugal with a formal and independent representation in the heart of European S&T policy making.

The HUB is an initiative of the five INESC institutes (INESC Coimbra, INESC ID, INESC INOV Inovação, INESC MN and INESC TEC).

The aim of the INESC representation in Brussels is:

- to promote the visibility and reputation of all the INESC research and technology development capacity in Europe and beyond;
- to facilitate and increase the representation in key thematic areas, platforms and networks with a view on guaranteeing insertion in projects and programs of strategic interest from an early stage;
- to contribute to capacity building of its technical, research and administrative staff in existing and new areas central to its activity;
- to contribute to the development of informed science and technology related policies;
- to position the organisation as a relevant stakeholder in thematic domains strategically and jointly pre-defined by the Management Committee.

The activity of the HUB is based in three main pillars:

a) Representation and visibility;
b) Capacity building;
c) S&T and Innovation policy analysis and positioning.

MAIN ACHIEVEMENTS IN 2019

Concluded the establishment of physical space and basic services

- Finalise the establishment of a fully functional physical office in Brussels.
- Implemented the graphic ID of the HUB in all documentation (word, excel and PPT templates), as well as visit cards.
- Developed and established the rules for management and operation of governing bodies, work groups and task forces.
- Established a list of contacts for renting of in-building auditoriums, catering solutions and other logistical necessities to be identified.
- Opened possibility of temporary secondments from INESC organisations with the aim of contributing to training and capacitation of already existing team members.

Initiated operation

- Initiated regular meetings for the Management Committee and fully functioning permanent groups (Policy and Operations Board and Task Force Funding).
- Met with the INESC research community and managers to develop an initial mapping of capacity and potential.
- Developed a 3-year Strategic Plan and the first yearly Activities Plan.
- Started the process for establishing 2 thematic work-groups and initiate their operation.
- Started to hold regular meetings with the European Commission and key European stakeholders to boost the INESC visibility and representativeness.
- Supported the adhesion process (INESC TEC) to EARTO – European Association of Technology and Technology and Research Organisations.

2.7 PARTICIPATION IN **COLLABORATIVE LABORATORIES**

In order to encourage the hiring of qualified HR to add economic and social value in Portugal, the Government decided to promote "labs" mainly dedicated to Technology Transfer and Innovation. These projects, known as Collaborative Laboratories (CoLAB), bring together enterprises, universities and scientific centres.

INESC TEC plays an active role in several Collaborative Laboratories in strategic domains for the country development and INESC TEC activity and is the leading entity of the FORESTWISE - Collaborative Laboratory for Integrated Forest and Fire Management.

FORESTWISE

Led by INESC TEC, FORESWISE aims at developing applied research, innovation and transfer of technology activities, in order to enhance the competitiveness of the Portuguese forestry sector, and minimise the negative effects of wildland fire.

BUILT

The BUILT CoLAB aims to develop innovative solutions for adaptable, smart, resilient and sustainable infrastructure and buildings. BUILT brings together academia, research organisations, industry agents and end users in a collaborative environment, leading to a common value creation model that will contribute to the transformation of the Architecture, Engineering and Construction sector (AEC).

B2E

Under the motto "Ocean-Inspired - Market Driven - Knowledge Fuelled", CoLAB B2E aims to promote the creation of highly skilled jobs that will actively contribute to increase the economic and social value of products and services – according to new and existing biological processes, including the internationalisation of national scientific and technological expertise. In this sense, B2E focuses on supporting two of the blue growth sectors with the most potential: biotechnology and aquaculture.

VINES&WINES

The mission of the VINES & WINES CoLAB is developing and communicating knowledge and technology, in order to support the wine sector's estimated growth of 25% in export value (to reach €1 billion over the next five years). This CoLAB also aims to prepare and adapt the national wine system for the major challenges it faces – like climate change, for instance.

VORTEX

Combining the potential of academic and industry research models, Vortex aims to become the largest international hub for accelerating innovation and knowledge and technology transfer in the areas of cybersecurity and cyber-physical systems. In this sense, Vortex will actively contribute to accelerating innovation and the development of cutting-edge technologies, closing the current gap between research institutions.

VASCO DA GAMA

VG-CoLAB - Energy Storage is focused on providing high technology services and added-value products, as well as innovative solutions for its partners and the market, particularly in the field of electrochemical energy storage. This CoLAB contributes to the implementation of the European energy transition agendas, by supporting the development of world leading energy transition technologies and solutions.

SMART ENERGY LAB

SeLAB aims to fill a gap in the academic/industrial energy ecosystem by finding solutions that help the energy transition process of energy users. The CoLAB's research and innovation agenda stems from the development and convergence of knowledge about key verticals in the industry, along with key multidisciplinary: a) Industry Verticals: the distributed Management of Energy Resources; Power management; Flexibility; Storage; Mobility; b) Horizontals: Engineering; IoT; Computer hardware and software; Big Data and Artificial Intelligence; Cyber security; Service Design and Design Thinking; UX/UI.

3.

OUR ACTIVITY

3.1

TEC4: VISION AND ADDED VALUE FOR INESC TEC MAIN MARKETS

TEC4
AGRO-FOOD

TEC4
ENERGY

TEC4
HEALTH

TEC4
INDUSTRY

TEC4
SEA

TEC4 AGRO-FOOD

Co-shaping the digital evolution in agro-food and forestry.

The TEC4AGRO-FOOS aims at tackling productivity and sustainability societal challenges, towards an effective bioeconomy.

TEC4AGRO-FOOD acts through Research and Technological Development (RTD) in all phases of the Smart Precision Agriculture and Forestry, from Variability Measurement to Action with Variable Rate Technologies (VRT), encompassing Data Analysis and Decision and Prescription Map, as well as in what concerns Food Security and Bioeconomy.

In the scope of TEC4AGRO-FOOD, INESC TEC provides innovation services of Consultancy and Research and Technological Development, in the following application areas:

Smart Precision Agriculture and Forestry | This innovation service comprises all phases of the Smart (IoT, Big Data, Robotics and Artificial Intelligence) Precision (right time, right amount, right place) Agriculture and Forestry: Variability Measurement, Data Analysis and Decision, Prescription Map and Action with Variable Rate Technologies (VRT)

Food Security | This innovation service deals with Food Security issues along the Agriculture and Forestry supply chains

Bioeconomy | This innovation service deals with Bioeconomy issues along the Agriculture and Forestry supply chains

In 2019 TEC4AGRO-FOOD has continued its consolidation as the main RTD national partner in the scope of ICT&E and Robotics for Agro-Food and Forestry. At the same time, at an European level TEC4AGRO-FOOD is entering in a sustainable manner the "champions league" of H2020.

Relevant Initiatives

AGROBOFOOD
INESC TEC is part of a network of Digital Innovation Hubs in Robotics. The project **agROBOfood: Business-Oriented Support to the European Robotics and Agri-food Sector** has started in 2019.

DEMETER
The kick-off meeting of the H2020 large-scale project DEMETER - Building an Interoperable, Data-Driven, Innovative and Sustainable European Agri-Food Sector took place in 2019. The project involves 60 partners and adopts a **multi-actor approach across the value chain (demand and supply)**.

ROBOCARE
The project focuses on the research and development of smart modular robotic platforms with reasonable costs, which will later be used in agriculture 4.0 contexts, in order to **improve the efficiency and competitiveness of agricultural operations/businesses in protected crops, nurseries and greenhouses**. In 2019, it was approved this PT2020 Individual R&D Project.

PIVOTBOT and SIFOREST
INESC TEC concluded contracts for the projects PIVOTBOT - Robotized Pivot for Agricultural Operations and SIFOREST - Shared Information Systems in the Scope of Organizational and Forestry Management.

Smart Region Platform
INESC TEC has a participation in "Agroenvironmental Systems and Food" Smart Specialization Regional Platform (CCDR-N), which **links the regional agricultural potential in high added value products with the scientific and technological knowledge and the existent industrial knowledge** for the development of associated products.

Collaboration with National Centre for Climate Change
INESC TEC joined the Climate Change National Competence Centre in the Agroforestry Sector, thus **supporting the effort to promote Research and Innovation, identify the climatic scenarios in the country and address the climate changes threats**.

Promotion and Dissemination

EPIA 2019
Organization of EPIA - 19th EPIA Conference on Artificial Intelligence (AI), with the aim to promote research in all areas of AI and the scientific exchange among researchers, engineers and practitioners in related disciplines.

AgroIN 2019
INESC TEC participated in the sixth edition of AgroIN, a meeting for the agribusiness sector, with a presentation dedicated to the theme «Forest 4.0: Smart Precision Forest».

BIOTECFOR
INESC TEC organised the BIOTECFOR - Machines and Forestry Workshop, to discuss the needs and desires of innovation in machines and tools dedicated to forest cleaning and biomass collection.

WORKSHOP ABOUT TECHNOLOGY and SUSTAINABILITY
The workshop "Research and Technology at the Service of Forestry Value Chains Sustainability", organised by INESC TEC, gathered national and foreign experts to discuss the contribution of digital technologies to increase the sustainability of operations from the forest to the factories.

TEC4 ENERGY

Decarbonization and digitalization of the energy sector.

TEC4ENERGY benefits from a strong recognized INESC TEC expertise in Power Systems, with more than 20 years transferring research results to manufacturers, software vendors, electric utilities and large energy users in Portugal, Europe and Brazil. This adds credibility to a broader effort, extended also to the fossil fuel sector, and encompassing from industry to transportation, buildings and energy efficiency.

TEC4ENERGY initiative responds to the Societal Challenges and Innovation Strategies for Smart Specialization defined by EU policies: the energy sector will be heavily digitalized, decentralized, under a user centric and market-based approach, involving a large-scale integration of renewable power sources, requiring the conceptualization and development of disruptive solutions.

TEC4ENERGY offers several innovation services to the energy ecosystem as:

DMS/EMS and network automation | Specification, development and integration of advanced computational tools for network management systems for all voltage levels (transmission, distribution and island systems) and of new solutions for network automation, protection and control of distribution networks.

System planning and reliability | Tools and models within this area aim at supporting not only the operational planning but also the expansion of power systems. Naturally, this activity appeals to advanced optimization techniques and new stochastic models for the representation of the overall system behaviour.

RES & DER integration | 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. Part of these activities are supported by the laboratorial infrastructure of CPES (SGEVL).

Asset Management and preventive maintenance | Implementation of a risk-based maintenance strategy software for the distribution grids by analysing failure modes, consequences and decision maker's risk attitudes; estimation of power transformers condition and remaining useful life (RUL) by combining expert knowledge, engineering models and data analytics; fibre optic sensors to measure vibration and magnetic field for HV lines, and corrosion monitoring in off shore wind parks; drone with rotary wings or monitor electrical assets, such as medium and high voltage support, substations and wind turbines.

In 2019 TEC4ENERGY aimed to identify new potential projects with the industry and the society, through a multidisciplinary scientific-based approach to overcome the limitations that stakeholders found in the existing market solutions.

Relevant Initiatives

Interconnect
The biggest project ever led by a Portuguese entity, has started in 2019. INESC TEC is responsible for the leadership of this project, which has 51 partner institutions from 11 European countries and that **aims at digitalising the power system**. InterConnect will develop solutions based on architectures for the Internet of Things which, with the help of several digital platforms and by using a universal ontology called SAREF. That way will ensure the interoperability between equipment and systems while preserving the privacy and cybersecurity of data of different users.

InteGrid
INESC TEC is the technical coordinator of this project that brings together 14 European partners and is funded by the H2020 – Framework Programme for Research and Innovation. In the scope of InteGrid, a total of 175 residential and business participants started the **testing of new solutions aimed to improve the functioning of the electricity network**.

POCITYF
It started in 2019 an initiative, funded by the European Union, that aims at implementing the concept of Positive Energy Blocks (PEBs) – geographically defined areas with a renewable local production greater than the consumption. With the implementation of these PEBs, POCITYF will **transform the urban fabric of these cities into more sustainable and citizen-oriented places**.

XFLEX
The development of new technology solutions to **improve the performance of hydroelectric power plants.** This is the goal of the €18M European project XFLEX Hydro, involving INESC TEC.

EU-SysFlex
EU-SysFlex (Pan-European system with an efficient coordinated use of **flexibilities for the integration of a large share of RES**) is the name of the project that, until October 2021, will work in the identification and evaluation of technical challenges and in the development of technical, market and regulatory strategies to identify, quantify and take advantage of flexibilities in the European electricity system.

Smart4RES
INESC TEC is part of a European project that gathers 12 institutions from six countries, aiming at developing technologies capable of **improving the performance of forecasting systems** for the production of renewable energy by at least 15%, and thus contributing to an increase of the integration of production of these energy sources.

FEEdBACk
Eight organizations from seven European countries are working together to promote, stimulate and deliver energy efficiency through behavioural change. The project encourages a more **efficient energy utilization and a more responsible consumer behaviour** through a gamification platform that will be used to motivate sustainable behavioural change.

Promotion and Dissemination

Paris - European Utility week
INESC TEC was once again present at the largest European event dedicated to the power sector, which was held in Paris (France), with four technologies in the energy area, developed within the scope of the InteGrid project, in which the institution is the technical coordinator, and the other one is a result of the UNEXMIN project.

Interconnect kickoff meeting
Around 130 people gathered, in October, at the Estádio do Dragão for the official kick-off meeting of the InterConnect project. Throughout the two-day meeting, the institutions responsible for each of the project's working groups had the opportunity to present the goals, the targets to be achieved and what is expected from each of the participating institutions.

IoT Week
Within the framework of the European project InterConnect, INESC TEC participated in the 9th edition of IoT Week, which was held in Aarhus, Denmark. A researcher of INESC TEC's High-Assurance Software Laboratory (HASLab) represented the institution and the European project in the "Nuances of IoT Marketplaces. Energy, Mobility, Smart Cities and Beyond" workshop.

TEC4 HEALTH

User-centred ICTs to improve health care and personal wellbeing

The mission of TEC4HEALTH is to target healthcare and wellbeing challenges towards personalized medicine, healthier life styles and better systems management.

TEC4HEALTH is the INESC TEC initiative to generate a convergence of knowledge and competences into producing solutions for the Health Economy.

INESC TEC is already a relevant producer of research targeting the Health sector, leading to products, processes and services that can be transferred in 3 broad areas of application: **healthcare providers (primary, secondary and long-term care); patient monitoring (medical devices, e-health, m-health), and pharmaceutical industry**.

From a technology transfer perspective, health technologies have already been quite successful within INESC TEC (3 recent spin-offs, 50% of INESC TEC's patent portfolio). Mapping the past experience of INESC TEC with current worldwide health challenges led to the identification of three key TEC4HEALTH challenges to address in the next 5 years: cancer, neurological diseases and disease screening.

Innovation services provided by INESC TEC in the scope of TEC4HEALTH:

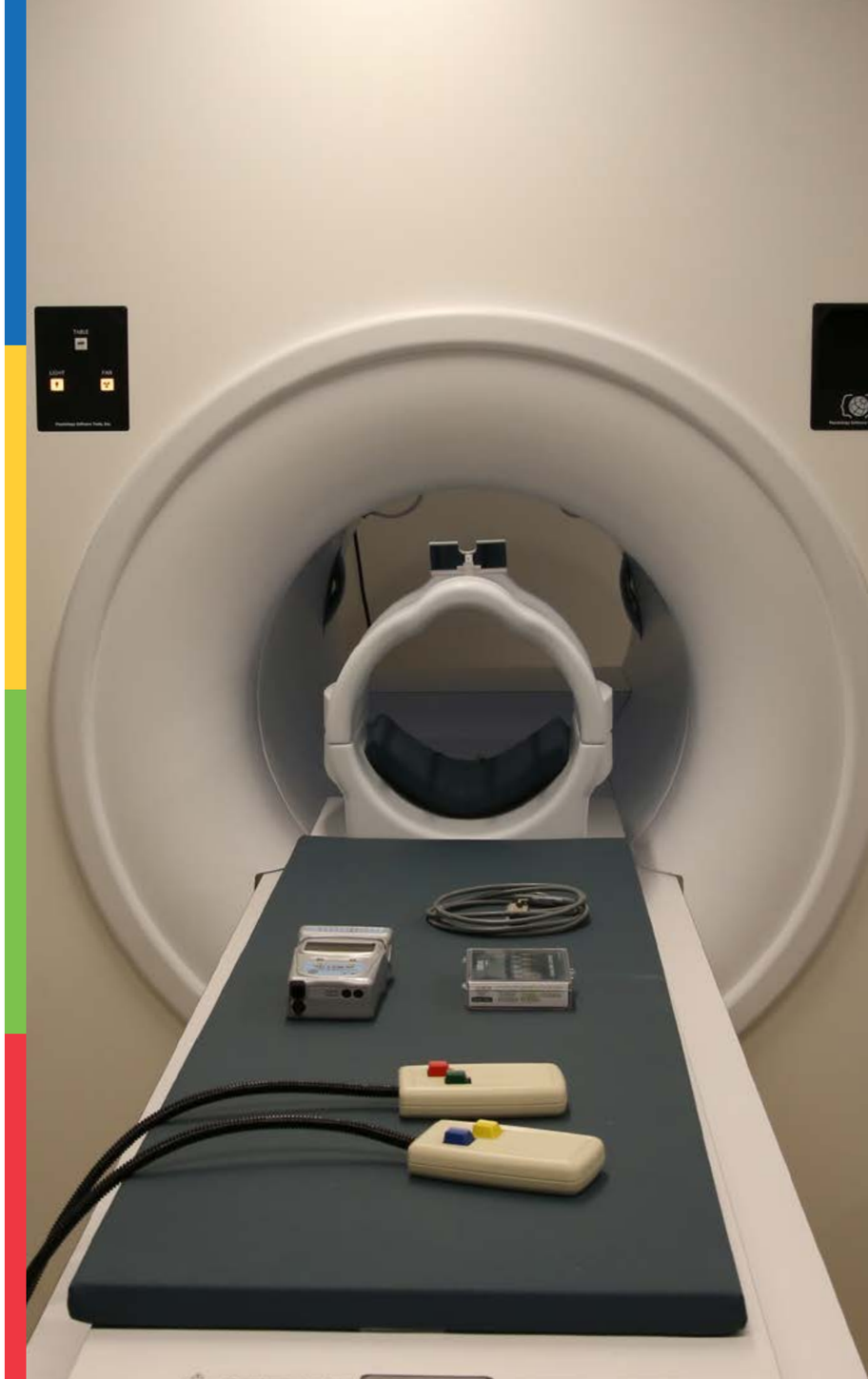
Artificial Intelligence Enhanced Healthcare

Predictive Analytics

TeleHealth and Information Systems

Healthcare Sensing and Monitoring

In 2019 TEC4HEALTH consolidated its presence in thematic international and national networks.



Relevant Initiatives

Coordination of EIP_AHA Working Group

INESC TEC is responsible for the coordination of the C.2 Working Group of the EUROPEAN INNOVATION PARTNERSHIP on Active and Healthy Ageing (EIP_AHA). The objective of the C2 Action Group is to **develop interoperable independent living solutions, including guidelines for business models**. These solutions ought to encourage the deployment of open and personalised solutions supported by global standards, thus helping to promote active and independent living.

PORTO4AGEING

INESC TEC has been participating in EIT Health initiatives through PORTO4AGEING, a consortium that brings together over 90 organisations, the large majority of them established within the Porto Metropolitan Area. By involving an extensive number of institutions, the Porto4Ageing alliance is **committed to promoting local convergence and improving the health innovation ecosystem, while reducing and overcoming existing bottlenecks.**

Consortium with Glintt

INESC TEC established a consortium with Glintt – Global Intelligent Technologies for the development of **Consulting Services in Artificial Intelligence to SPMS (Shared Services of Portuguese Health Minister)**.

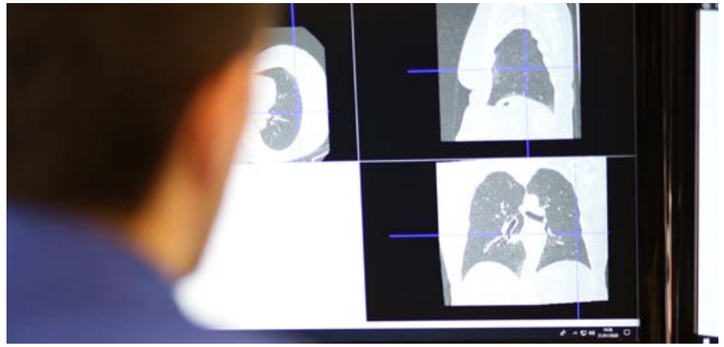
EARTO Working Group

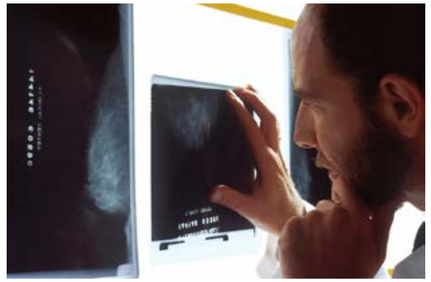
INESC TEC is now part of WG Emerging Technologies for Healthcare, a work group within EARTO (European Association of Research and Technology Organisation), which comprises 20 active experts and aims at **promoting & advocating the interests of RTOs in the upcoming healthcare-related funding programmes in Europe.**

Promotion and Dissemination

Market of Open Innovation in Health

Within the framework of the TEC4Heath, INESC TEC participated in the fourth edition of the Market of Open Innovation in Health, in order to present some of the projects developed in the healthcare field.





TEC4 INDUSTRY

Foster transformation for an innovative, collaborative, human-centred and sustainable industry.

TEC4INDUSTRY is the INESC TEC initiative to drive into R&D and generate a convergence of knowledge and competences into producing solutions for the Retail and Manufacturing Industry, covering end-to-end supply chain actors anchored in a history of successes and impact in technology transfer to companies.

TEC4INDUSTRY is committed to bringing unique knowledge and solutions to logistics, manufacturing industry, distribution, and retail.

Innovation services provided by INESC TEC in the scope of TEC4INDUSTRY:

Factory Design and Operational Planning | The work addresses simulation and optimization of the production lines through mathematical and simulation models to design facilities and to plan and operate operations.

Future Industrial Robotics and Collaborative Robotics | 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, close collaboration with humans and continuous process learning.

Logistics and Retail | Development of intra and inter-organisational logistics systems. Services to enable companies to integrate IoT components and orchestrate manufacturing modules, such as planning and scheduling. New models and algorithms for optimising the delivery of products purchased by online customers.

Predictive Maintenance and Consumer Forecasting | Prediction of anomalous events and machine learning techniques to increase maintenance optimization and consumer forecast.

In 2019 TEC4INDUSTRY continued participating in national and international projects addressing solutions covering all value chain areas of TEC4INDUSTRY. Most of the new projects addressed the challenges related with digitalization activity of the enterprises in the context of INDUSTRY 4.0 framework.

Relevant Initiatives

IILab
The inauguration of the Industry and Innovation Laboratory – iiLab took place in May, as part of ANI's (Innovation National Agency) technological demonstrator. The laboratory presented **production technologies and cyber-physical systems, and besides the demonstration of different technologies, the laboratory offers training programmes**.

iMAN Norte
INESC TEC is one of the entities responsible for the coordination of this programme. In 2019, the institute maintained active **participation in iMAN Norte HUB, a Digital Innovation Network for Digital Transformation and Innovation of manufacturing companies** in northern Portugal.

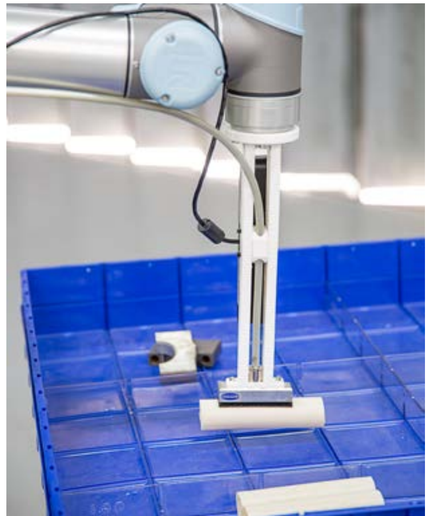
EIT Manufacturing
INESC TEC is part of the EIT Manufacturing consortium. Leading Manufacturing innovation is Made By Europe is the name of the winning project of the competition launched by the European Institute of Innovation and Technology (EIT), which aimed to award a Knowledge Innovation Community (KIC) in the manufacturing industry field. **INESC TEC and SONAE are the two Portuguese institutions involved in this project as core partners.**

EIT DIGITAL
INESC TEC is one of the 200 European entities involved in EIT Digital, which **promotes innovation and the consequent digital transformation in Europe, particularly through research, training and entrepreneurship**.

Promotion and Dissemination

360TECHINDUSTRY
At the 360TECHINDUSTRY fair, INESC TEC presented technologies that support the companies' digital transformation, namely through the digital twin technique, which enables the design and optimisation of plants and production systems. INESC TEC also presented a mobile manipulator that acts in scalable production systems, and an intelligent autonomous vehicle for internal logistics applications.

Industria 4.0.
INESC TEC participated in the official launch of the second phase of the Industria 4.0 programme, promoted by the Portuguese Ministry of Economy. The event took place at the University of Minho, and INESC TEC, in partnership with the company TALUS, demonstrated a prototype developed for the transport and reorientation of boxes, combining different technologies for said purpose.



TEC4 SEA

Bringing the digital world to a sustainable sea economy.

The mission of TEC4SEA is to articulate INESC TEC activity to the sea and deep-sea domains towards a sustainable Sea Economy.

TEC4SEA is able to offer value-added innovation services related with 3D mapping and data fusion in unstructured environments, optical and bio-sensors, broadband communications solutions for marine environments, software solutions for data collection, processing and management, among others.

The multidisciplinary competencies within the TEC4SEA facilitate the development of solutions for a wide range of industries, such as: aquaculture, marine and seabed mining, management of marine protected areas, deep-sea observation, ocean renewable energy (including offshore wind energy), maritime safety and surveillance.

In the scope of TEC4SEA, INESC TEC provides innovation services in the following areas:

High-tech marine products and services
Marine business services
Marine manufacturing and construction
Marine R&D and education
Maritime and coastal tourism
Maritime safety and surveillance
Ports
Shipbuilding and repair
Shipping

In 2019 the main focus was the infrastructure and to make INESC TEC competencies in the Sea domain known in international forums.

Relevant Initiatives

NESSIE
A 3-year project involving national stakeholders aims at developing innovative technologies and solutions **to address several issues related with offshore infrastructures inspection and maintenance**.

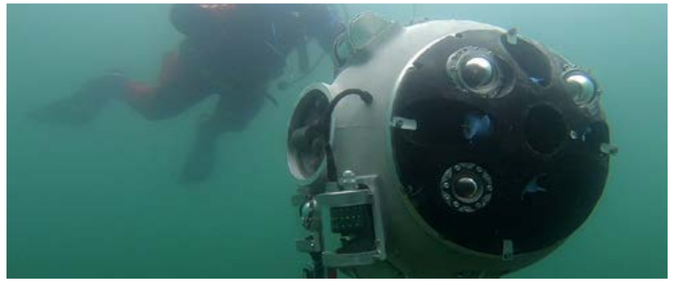
DeepField
A 3-year project that started aims at consolidating the knowledge on **Deep Learning within the robotics domain**, as well as promote and strengthen the networking with other European Institutions experienced in this domain.

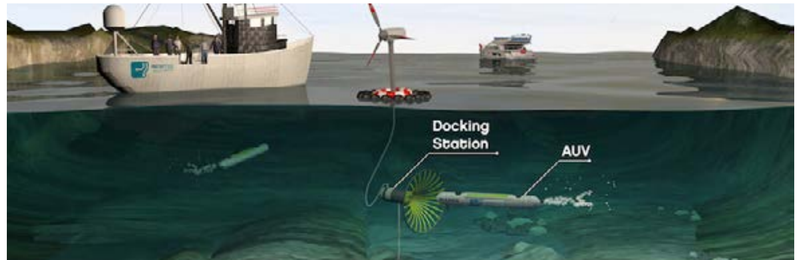
SIMBED+
A 2-years project that started in mid-2019, funded under the H2020 Fed4FIRE+ Open Call 5, focus on the **replication of wireless networking experiments** using ns-3 with real data assimilation, including above and underwater environments.

INTHEBLACK 2019
«In the Black – Exploration, Extraction and Construction Opportunities for Underwater Technology» was the name of the workshop **organized by INESC TEC for the third consecutive year in coordination with the EIT Raw Materials**. The workshop had several relevant worldwide representatives interested in this theme.

REP (MUS)10
Large-scale demonstration, experimentation and cooperation exercises involving academia, industry and the naval operational community across the NATO alliance.

TEC4SEA Infrastructure
INESC TEC pursued its ambition to install an infrastructure dedicated to **support research, development, and test of marine robotics, telecommunications, and sensing technologies for monitoring and operating in the ocean environment**. The investments in this infrastructure continued during 2019.





Promotion and Dissemination

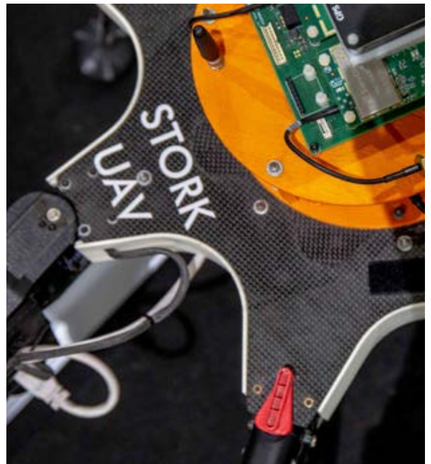
European Maritime Day
The TEC4SEA Research Infrastructure ambition, prototypes and solutions developed were exposed to national and international entities present in this international event, where entrepreneurship, innovation and investment were its main focus.

Oceans
The TEC4SEA initiative was showcased at the OCEANS´19 Marseille exhibition to international entities present in this event. The theme of the conference "Let's sea our future together" reflects our concern to understand the future of our oceans in terms of the preservation of marine, animal or plant life, as well as the exploitation of new energies.

Business2Sea
Several R&D results, prototypes and solutions developed were showed to national and international entities. The TEC4SEA Research Infrastructure and its services were the main focus of the stand.

Sea OpenDay
The event under the name "Waving the Future" focused in the R&D competencies and technological capabilities of Robotic and Autonomous Systems. The event counted with the presence of representatives of multiple companies as well as R&D partners. The TEC4SEA Research Infrastructure and its services was also presented.

Shell Ocean Discovery Xprize Screening Panel
The event aimed at aligning and disseminate the competencies of the finalist teams within Shell Group, who might be interested in developing technology and pursuing future commercial agreements.



3.2 SCIENTIFIC RESEARCH ACTIVITY

NETWORKED INTELLIGENT SYSTEMS

Towards autonomous networked intelligent hybrid systems enabled by ubiquitous sensing and processing of information.

COORDINATED BY MANUEL RICARDO
ASSISTANT TO THE CLUSTER COORDINATOR: ANDRY PINTO

CAP Centre for Applied Photonics
C-BER Centre for Biomedical Engineering Research
CRAS Centre for Robotics and Autonomous Systems
CTM Centre for Telecommunications and Multimedia

The Cluster on Networked Intelligent Systems (NIS) envisions to work "towards autonomous networked intelligent hybrid systems enabled by ubiquitous sensing and processing of information". This cluster is formed by research centres working in complementary scientific domains: CAP addresses optical sensing, optical imaging, and microfabrication of devices; C-BER addresses bio-instrumentation, biomedical imaging, and neuro-engineering; CRAS addresses robotics and autonomous systems operating in complex environments for data gathering, mapping, inspection, surveillance, and intervention; CTM addresses electronics, radio and optical communications, communications networks, multimedia technologies, computer vision, and intelligent information processing.

Sensing aims to design multi-parameter sensing systems for capturing relevant information. Communications aims to create self-learning communications systems that can support different types of services and data in Immersive and extreme environments, taking advantage of state of the art heuristics including artificial intelligence (AI) and machine learning. Computer Vision aims to empower the next generation of intelligent systems with the capability of reasoning from visual data, approaching or even surpassing the human vision. Autonomous systems addresses the development of innovative robotics solutions for operation in complex environments; relevant examples are underwater environments, and particularly deep-sea water.

RESEARCH LINES SENSING | COMMUNICATIONS | COMPUTER VISION | AUTONOMOUS SYSTEMS

CENTRES OF THE NIS CLUSTER

CAP

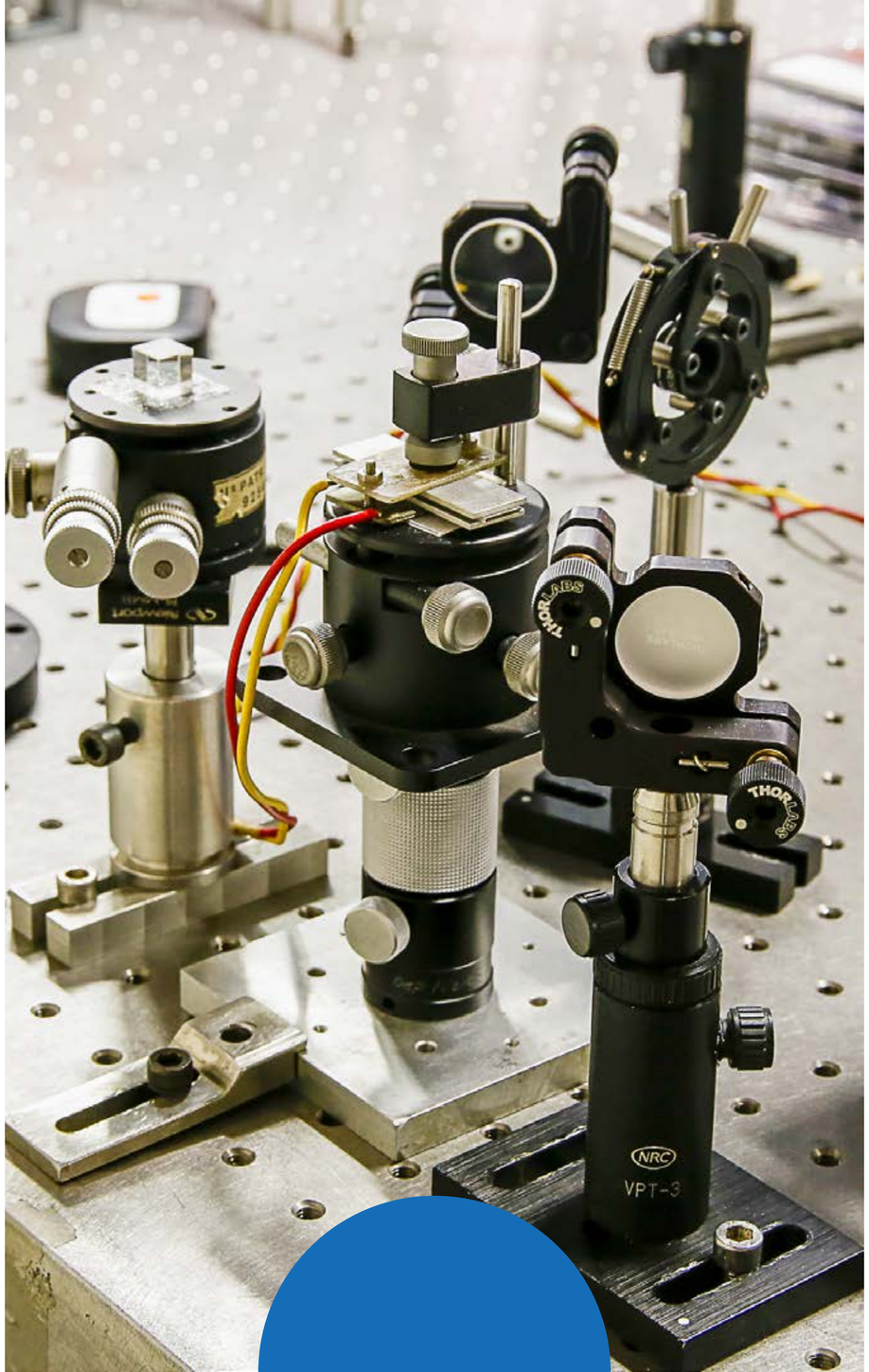
Centre for Applied Photonics
Coordinator: Paulo Marques
Assistant Centre Coordinator: Ireneu Dias

CAP accomplishes its mission within the Cluster NIS by directing its activities towards 4 main areas of research: integrated optics and microfabrication, advanced optical imaging, optical sensors, comprising chemical/biosensors and physical sensors, and high-performance simulations for nanophotonics. This organization is non-hermetic and the development of solutions implies multidisciplinarity and cooperative work from the different fields of the available expertise.

C-BER

Centre for Biomedical Engineering Research
Coordinators: Aurélio Campilho and João Paulo Cunha

The mission of C-BER – Centre for Biomedical Engineering Research is "to promote scientific knowledge excellence through fundamental and applied research, advanced training and innovation in Biomedical Engineering". C-BER activities are aligned with the vision of the Cluster on Networked Intelligent Systems (NIS). To accomplish its mission, C-BER is organized in three Labs (Biomedical Imaging Lab, BioInstrumentation Lab and NeuroEngineering Lab).



CRAS

Centre for Robotics and Autonomous Systems
Coordinators: Eduardo Silva and Aníbal Matos
Assistant Centre Coordinators: Carlos Pinho

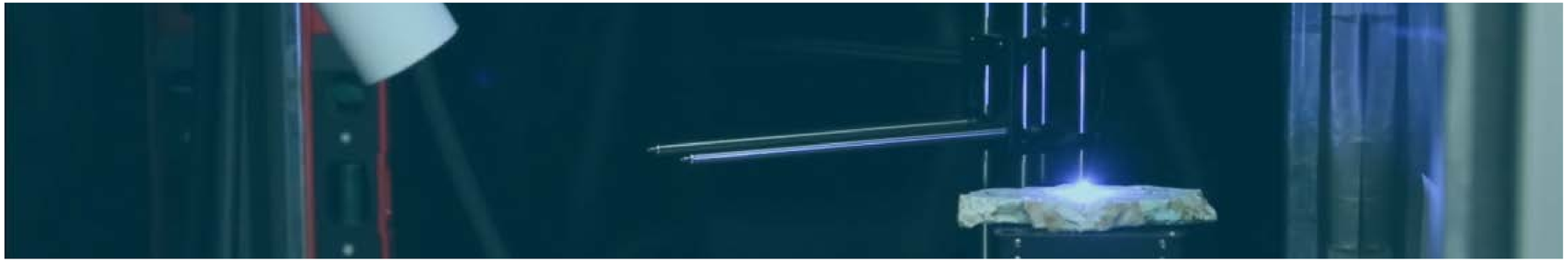
The Centre for Robotics and Autonomous Systems (CRAS) aggregates more than 40 researchers addressing scientific and technological topics associated to field robotics and autonomous systems. CRAS aims at becoming a worldwide reference in field robotics and autonomous systems and is already internationally recognised for its innovative robotics solutions for operation in complex environments – relevant examples are underwater environments, and particularly deep-sea water.

CTM

Centre for Telecommunications and Multimedia
Coordinator: Jaime Cardoso
Assistant Centre Coordinator: Filipe Ribeiro

CTM accomplishes its mission, within the Cluster NIS, by directing its activities towards 4 main areas of research: Optical and Electronic Technologies (OET); Wireless Networks (WiN); Multimedia and Communications Technologies (MCT); Information Processing and Pattern Recognition (IPPR).

Scientific Outcomes in 2019



Label free method for medical analysis

New method and corresponding sensing system, for direct analysis of biological entities in complex solutions. It deals with AI analysis of backscattered signals from optically trapped cells or biomolecules and has a very strong potential for medical and environment applications.

Broadband optical waveguides by laser direct writing

High quality broadband (from the visible to infrared) waveguides in fused silica substrates by femtosecond laser direct writing. These results are of outmost importance for the demonstration of integrated sensors, based in plasmonics for instance.

Raman endoscopy

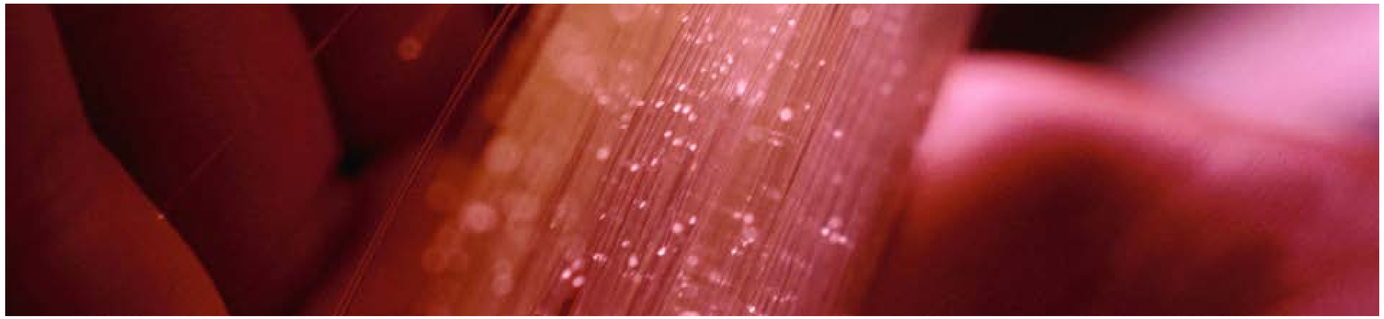
Development and application of Raman fiber endoscopy based on new fibers such as hollow core PCFs and plastic fibers. The fiber endoscope is intended to detect cancer tumors by Raman spectroscopy, complementing existing characterization methods.

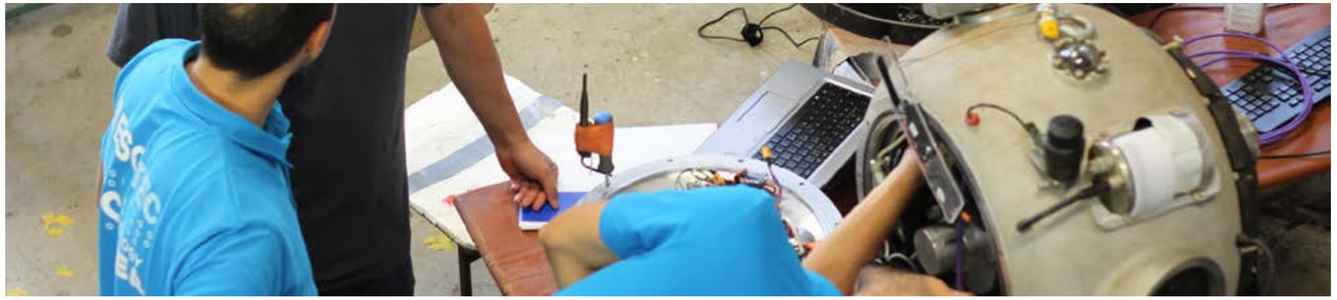
Sparse Multi-Bending Snakes

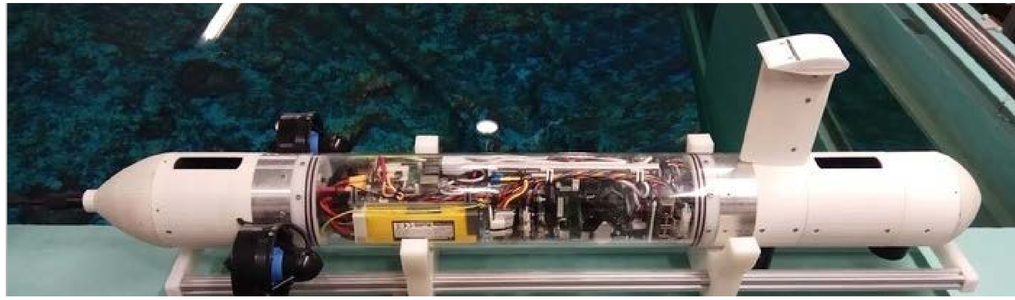
Novel parametric active contour model which can divide the contour into a set of contiguous regions with different bending properties. We derived a new energy function that induces such behaviour and present a group optimization strategy to find the optimal bending resistance parameter for each point of the contour.

Region identification in images and video frames

Flexible strategies combining computer vision techniques and deep machine learning models for processing images and videos, while seeking to minimise required training data and favouring online training.







Uncertainty-aware deep learning-based approach for computer-aided diagnosis and grading.
A CAD grading system that supports the clinical decision and the assigned pathology grades by providing a medically interpretable explanation. This methodology was successively tested in grading Diabetic Retinopathy.

Underwater Mine Explorer Robot
Validation in real experiments of an autonomous robot for exploration of flooded mines. This robot is endowed with multiple sensors for extendend perception of the enviorment allowing for its autonomous operation inside flooded galleries.

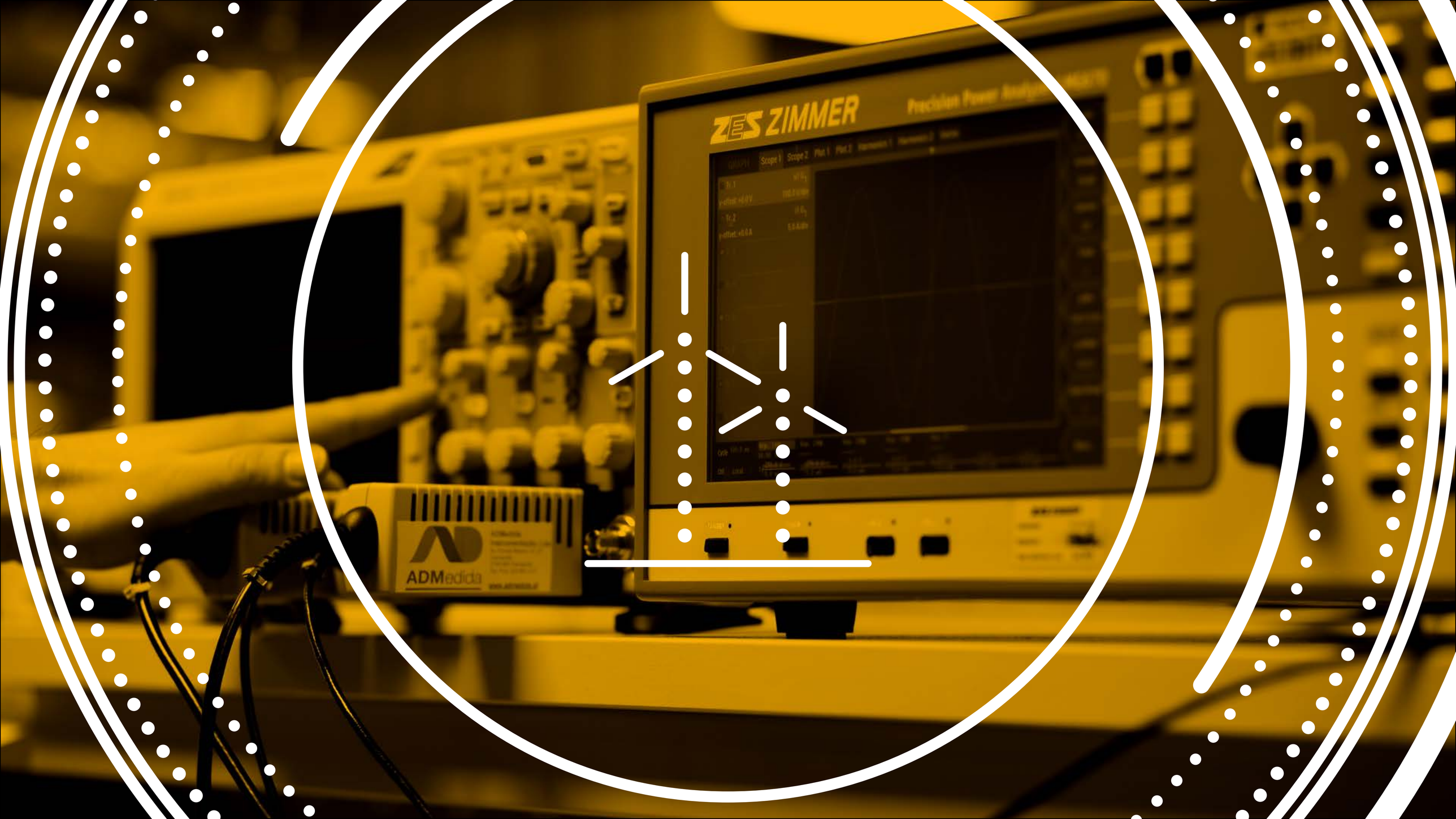
IS-ABS - In situ autonomous biosampler
The IS-ABS automates the process of collecting environmental DNA, and is suitable for integration in water observation systems, what will contribute to substantially increase biological surveillances.

Multiple AUV tracker
The proposed approach is based on a Probability Hypothesis Density Filter, thus overcoming the data association problem which is crucial in multiple AUV tracker. Our tracker is able not only to successfully estimate the positions of the vehicles, but also their velocities.

Positioning and routing algorithms for aerial networks
Position control and routing algorithms for aerial networks that enable significant performance gains (higher throughput, lower delay) when compared to state of the art counterparts.

Content buffering approaches for interactive streaming
Predictive stream buffering mechanisms based on Machine Learning techniques to optimize network resources and reduce view switching latency on multi-view content when transitioning from distinct views.

Impulse-radio integration-and-fire transceiver
Ultra-low power, transceiver architecture based on impulse-radio ultra-wide band communications that avoids the need for conventional A/D conversion and outperforms competing state-of-the-art solutions.


ZES ZIMMER
ADMedida

POWER AND ENERGY

A digital and decarbonized energy system.

COORDINATED BY LUÍS SECA.
ASSISTANT TO THE CLUSTER COORDINATOR: DAVID RUA

CPES Centre for Power and Energy Systems

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 (EV) 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, soft computing and data science.

CPES is the core Centre of the Cluster, as it is clearly where the sector critical mass is concentrated, but the evolution of the energy system, particularly the electrical power system, has supported the involvement of other competences, held by associated Centres, due to the multidisciplinary nature of the problems and opportunities to address. There are already examples of this collaboration and joint projects, in the areas of information and communication technologies (CTM), data science (LIAAD), data platforms and hubs (HASLab), asset management (CEGI) and combined energy and process optimization in industry (CESE).

More than sharing projects, the goal is to foster a multidisciplinary approach to support current applied research and technology transfer, but most of all, to design the scientific strategy for this particular domain, distributed among the different Centres of the cluster, that will guarantee the creation of new knowledge to support the future challenges of a digital and decarbonized energy system.

RESEARCH LINES TOWARDS 100% RENEWABLE ENERGY SOURCES (RES)INTEGRATION AND MASSIVE INTEGRATION OF POWER ELECTRONIC-BASED INTERFACES | LARGE-SCALE MODELLING AND OPTIMIZATION OF ENERGY SYSTEMS | DATA-DRIVEN METHODOLOGIES FOR ENERGY SYSTEMS | ASSET MANAGEMENT AND PREDICTIVE MAINTENANCE | CYBERSECURITY AND IOT FOR ELECTRICAL INFRASTRUCTURES

CENTRES OF THE PE CLUSTER

CPES

Centre for Power and Energy Systems

Coordinator: Manuel Matos
Assistant Centre Coordinator: Ricardo Bessa
Advisor Centre Coordinator: Jorge Pereira

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

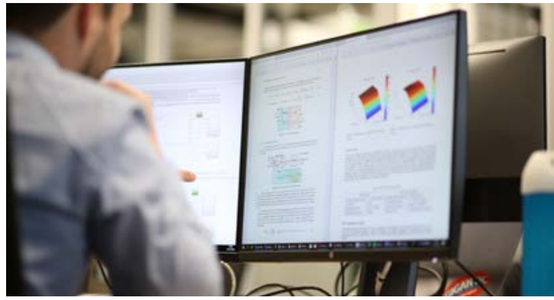
Scientific Outcomes in 2019

Control Parameters Solution
Novel grid-forming self-adaptive control parameters solution that improves the isolated power system transient stability, considering large shares of RES.

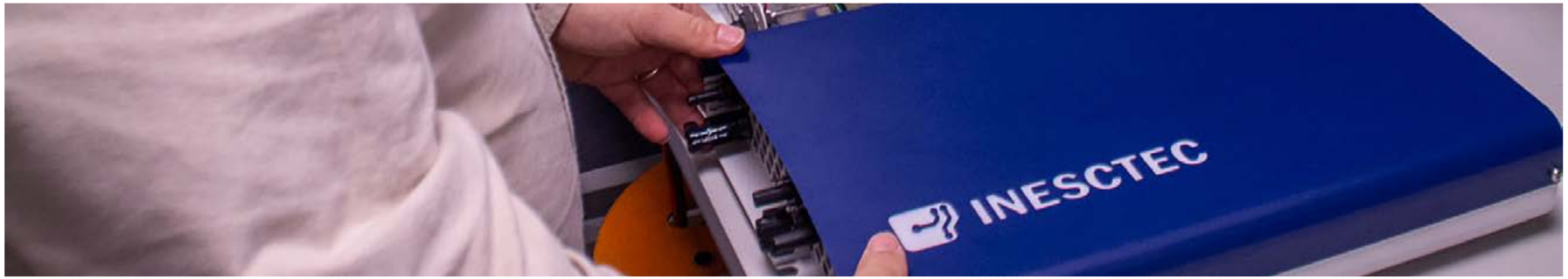
Innovative Control Strategies
Innovative control strategies for hybrid AC/DC microgrids supplied by Smart Transformers involving advanced functionalities (e.g., frequency-support to the AC grid, islanded mode).

Grey-box Approach
For identifying an aggregated dynamic model for active distribution grids.

Hierarchical optimisation
Hierarchical optimisation for the energy dispatch and volt/var control of a photovoltaic-battery microgrid cluster.



Prototypes
Development of a methodology and an experimental prototype that enables the balancing of battery cells and hybridization with supercapacitors (best paper award in 2019 IEEE Vehicle Power and Propulsion Conference), and a prototype of a smart inverter with full integration of PV modules and batteries and remote monitoring functions.



Optimization
Large-scale modelling and optimization of energy systems; a two-stage stochastic optimization model to support an aggregator in the definition of bids for the day-ahead energy and secondary reserve markets, and a Cluster-based optimization approach to support an aggregator in the definition of demand and supply bids for the day-ahead energy market. A genetic and cross-entropy algorithms for energy optimization in a home energy management system with low computation platform

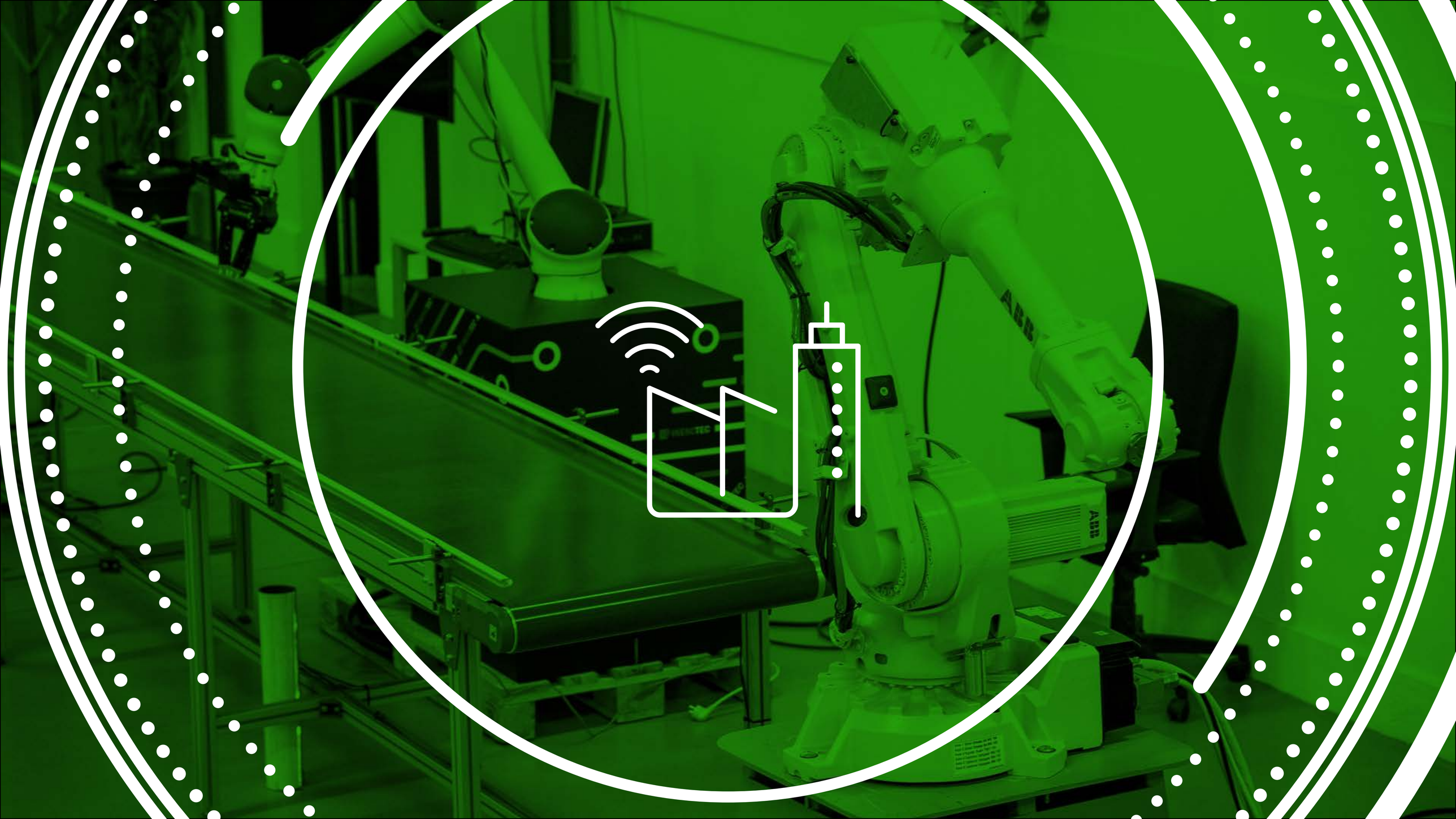
Analysis and estimation
Cost-benefit analysis regarding the changes proposed by ERSE to be introduced the Portuguese tariff code. Estimation of the Levelized Cost of Electricity for wind and PV units, taking into account the need to limit the ramping values; c) Estimation of domestic consumers' elasticity in response to dynamic tariffs.

RES forecasting
New contributions to RES forecasting, such as privacy-preserving collaborative forecasting and data markets. Conceptualization, development and integration of an end-to-end forecasting platform for load and solar resources for Elergone Energias.

GPU-based implementation
GPU-based implementation for the adequacy assessment of generating systems via sequential Monte Carlo simulation.

New models to assess effects of investments
New models to assess the integrated effects of investments and maintenance in the quality of service, as well as to estimate the impact of RES on distribution network losses.

Data-driven optimization method
Data-driven energy optimization method for wastewater pumping stations (patent submitted).



ABB

INDUSTRIAL AND SYSTEMS ENGINEERING

Leading complex decision-making in end-to-end, customer-centric, agile supply chains.

COORDINATED BY BERNARDO ALMADA LOBO
ASSISTANT TO THE CLUSTER COORDINATOR: ALEXANDRA MARQUES

CEGI Centre for Industrial Engineering Management
CESE Centre for Enterprise Systems Engineering
CITE Centre for Innovation, Technology and Entrepreneurship
CRIIS Centre for Robotics in Industry and Intelligent Systems

The Cluster on Industrial and Systems Engineering (C_ISE) aims to research and innovate in systems and services applied to the management of value streams. C_ISE envisions to lead complex decision-making in end-to-end, customer-centric, agile supply chains across different industries (e.g., manufacturing, process industries, retail, health and mobility).
In order to improve business performance and foster productivity, as well as to contribute to environmental and social sustainability, C_ISE intervention ranges from local optimization of individual organizations to complex system optimization of networks and chains. Its activities cover the design, implementation and improvement of systems for decision support, operations automation, management and intelligence, as well as the provision of innovation management & technology transfer consultancy services.
Clearly, the cluster helps companies to fully embrace the fourth industrial revolution by leveraging digital transformation, advanced analytics and the integration of advanced manufacturing technologies and new business models. Customer-centric and real-time supply chain optimisation, as well the decentralized decision-making, will only be possible with highly flexible, realocable, adaptable and intelligent automation, control and robotics.

RESEARCH LINES **OPERATIONS MANAGEMENT** | **OPERATIONS RESEARCH AND MANAGEMENT SCIENCE** | **ICT FOR DIGITIZATION** | **HUMAN-ROBOT COLLABORATIVE WORKSTATIONS** | **TECHNOLOGY ENABLED-INNOVATION**

CENTRES OF THE ISE CLUSTER

CEGI

Centre for Industrial Engineering and Management

Coordinators: Ana Viana and Pedro Amorim

This Research Group (RG) is an international reference in business analytics through decision support systems for service and operations management, contributing also in data science, service science, and other emerging topics (e.g., blockchain and asset management). The goal is to extract knowledge from data that can be leveraged to increase, for example, revenues of a business. The focus of the RG is on prescriptive analytics, particularly in addressing challenges related to dynamic optimization under uncertainty.

CESE

Centre for Entreprise Systems Engineering

Coordinators: Américo Azevedo and António Lucas Soares

CESE mission is to advance the scientific knowledge in enterprise systems engineering, providing unique expertise targeting complex industrial organisation challenges that foster high impact management and ICT systems and generate innovative services for industrial organisations. CESE wants to be positioned as a leading research Centre focused on connected, sustainable and customizable production systems through the engineering of innovative enterprise systems and as a first choice in helping industrial organisations to improve competitiveness and sustainability of their supply chains and achieve high-performance levels of their inner business processes.

CITE

Centre for Innovation, Technology and Entrepreneursip

Coordinator: Alexandra Lobo Xavier

CITE accomplishes its mission, by carrying out R&D, advanced consulting and executive education bringing together expertise in Innovation & Technology Management and Technology Entrepreneurship fostering a cross-cutting approach to all INESC TEC's Clusters, and for Private and Public organizations. CITE aims at contributing for a better innovation and technology management with a sustainable and circular perspective of the entire knowledge value chain.

CRIIS

Centre for Robotics in Industry and Intelligent Systems

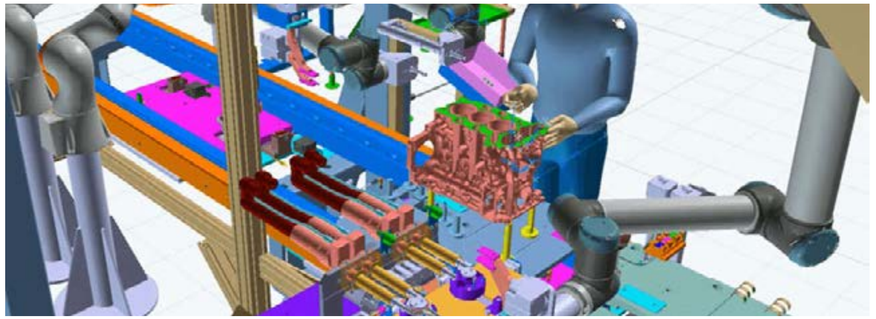
Coordinator: António Paulo Moreira
Assistant Centre Coordinator: Germano Veiga

The Robotics and Intelligent Systems Centre designs and implements 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.

Scientific Outcomes in 2019

Asset Management
Predictive and Presctiptive models for asset management and reliability engineering to control the health status across the whole life cycle of the asset (e.g. a health index for the hydropower system to monitor the effects of the newly designed flexible power services).

Logistics and Supply Chain Management
Multiple vehicle synchronisation in a full truck-load pickup within the biomass supply chain; and new ways of exploring the marketing-operations interface on the delivery service model in grocery retail; we pushed mobile robots systems closer to industrial production lines.



Mathematical Programming-based heuristics
New insights were obtained on how to deal with uncertainty and hybridize heuristics and mathematical programming (matheuristics). These approaches have been applied on emerging topics related to car-sharing.

Data Visualization
Within this emerging topic in data science, C_ISE brought to light new ways of exposing and exploring data by means of contextual family trees.

Machine Learning meets Optimization
New results were to improve well established research of the cluster in Optimization by coupling it with Machine Learning techniques.

Internet of Things and Planning and Control Systems
New linkages between the Internet of Things and Planning and Control Systems in Industrial Applications, as well as a novel method to test the vertical and cyber-physical integration of cognitive robots in manufacturing (including the architectural development of the Task Manager for Skill based robotic system orchestration).

Human-Robot interfacing and Augmented Reality

New brekthroughs on (i) the advanced use of spatial augmented reality for assembly tasks through Building information modelling; (ii) the collaborative assembly workbench with visual guidance and increased operator comfort by making robot movements explicit.

Collaborative Robots

Integration of augmented reality in collaborative robotics systems in the structural steel sector, and an overview of the use of collaborative robots in industry 4.0 regarding the human role and safety.

2D/3D Industrial Vision and advanced Sensing

The extension of a modular and highly reconfigurable 3D Robot Perception framework for estimating both the 6 DoF (degrees of freedom) and for grasping poses of rigid and semi-rigid objects. The visual perception systems were also improved in 2019 to work under all-weather (illuminations) conditions, to feed localization and mapping procedures with high-level visual features positioning.

Technology management and adoption

Research outputs on: (i) the drivers impacting Cobots Adoption in Manufacturing Context; (ii) the environmental factors influencing the adoption of digitalization technologies in automotive supply chains; (iii) Scaling-up innovation capacities through the design and engineering of cognitive systems.

Advancing the theory of service design

Service design research has been advanced with the design science research, and we have demonstrated how service design can be leveraged as a multidisciplinary approach to service innovation.

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COMPUTER SCIENCE

POWERING DEPENDABLE DIGITALIZATION.

COORDINATED BY RUI OLIVEIRA
ASSISTANT TO THE CLUSTER COORDINATOR: ANA ALONSO

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

The mission of the Computer Science Cluster is to achieve international excellence in both fundamental and applied research, with strong emphasis on technological innovation and transfer that benefits society at large.
Computing became fully decentralized, mobile, increasingly autonomous, and ubiquitous reaching all appliances, devices and living beings. As a result, current information and communications systems present many hard and intricate challenges associated to scalability, security and criticality. The ever-increasing amounts of generated data embody a wealth of information that needs to be properly and timely mined and analysed.
This challenges our capacity to filter, curate, store, process, query and visualise unprecedented volumes of data from diverse sources and formats. In addition, the economic value of the data, trade and state secrets, and individual rights require data manipulation to comply with demanding levels of privacy. Smarter and autonomous systems in critical realms such as utilities, health care, transportation and finance require dealing with new, and often unanticipated, sorts of risks that challenge the best practices of software engineering, network and information security and human-computer interaction.

RESEARCH LINES ARTIFICIAL INTELLIGENCE | CYBER SECURITY | COMPUTER GRAPHICS AND VIRTUAL ENVIRONMENTS | INFORMATION MANAGEMENT SYSTEMS | DECISION SUPPORT METHODS | PARALLEL AND DISTRIBUTED SYSTEMS | SOFTWARE ENGINEERING

CENTRES OF THE CS CLUSTER

CRACS

Centre for Research in Advanced Computing Systems

Coordinator: Luís Antunes
Assistant Centre Coordinator: Ricardo Rocha

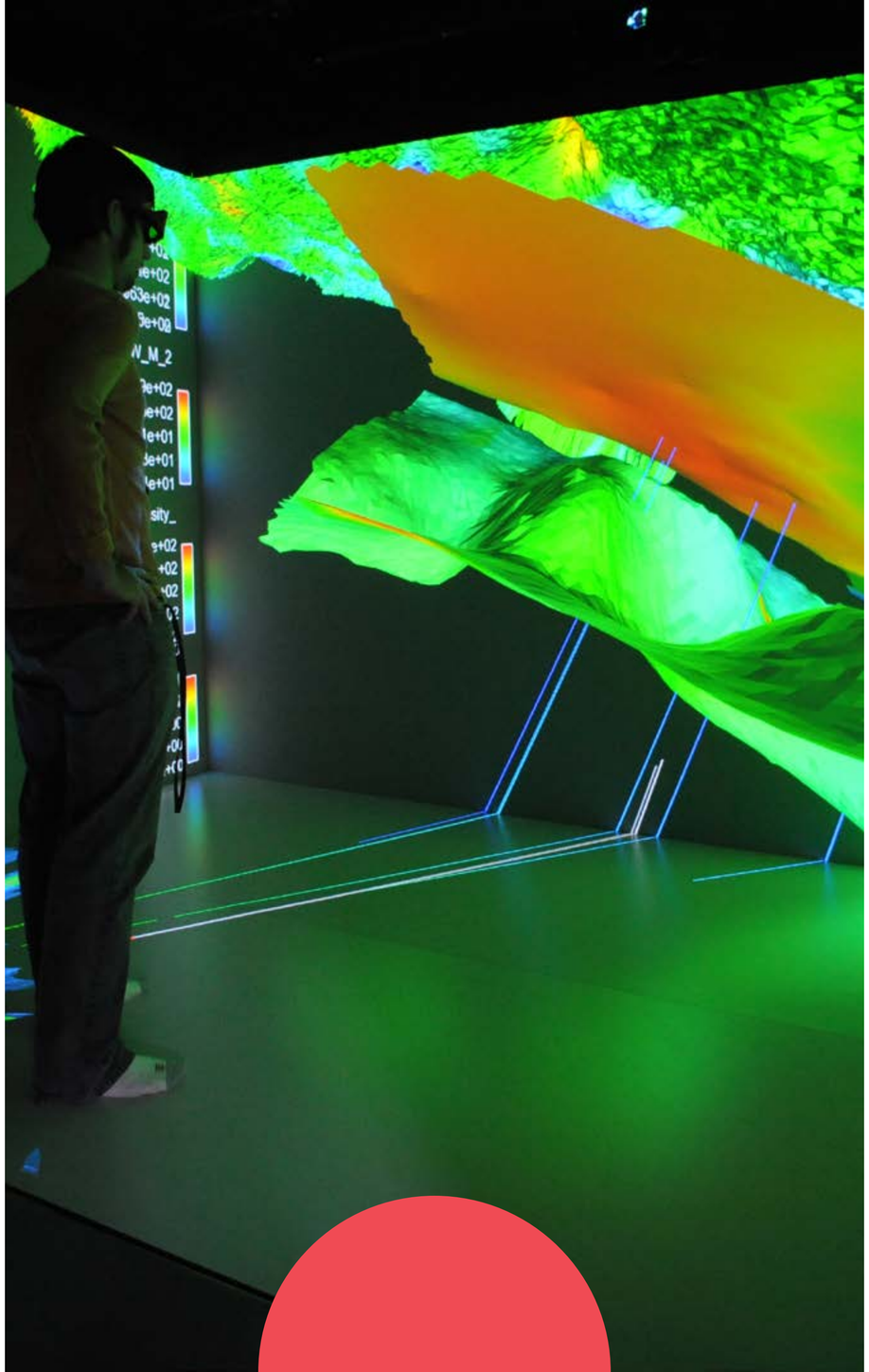
CRACS integrates the Computer Science Cluster with the mission of pursuing scientific excellence in the areas of programming languages, parallel and distributed computing, information mining, security and privacy, with a focus on scalable software systems for challenging multidisciplinary applications in Engineering, Life Sciences, Social Networks and the Internet of Things.

CSIG

Centre for Information Systems and Computer Graphics

Coordinators: António Gaspar and Ângelo Martins

The Centre for Information Systems and Computer Graphics (CSIG) is integrated in the Computer Science Cluster. Its mission 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 Embedded/Special Purpose Computing Systems.



HASLAB

High-Assurance Software Laboratory

Coordinators: Alcino Cunha and António Luís Sousa

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.

LIAAD

Artificial Intelligence and Decision Support Laboratory

Coordinator: Alípio Jorge

LIAAD aims to produce high quality cutting-edge research in the international forefront of our research areas and promoting transfer of knowledge and technology. This Centre has been working in the area of Machine Learning and Data Science since 1991. 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 and e-government, motivating our investment in different approaches to modeling.

Scientific Outcomes in 2019

Big Data and Machine Learning

Two contributions were made for the replication of large databases; one on the efficient synchronization of state-based Conflict-free Replicated Data Types (IEEE International Conference on Data Engineering) and the other a full-featured prototype of high-available large scale convergent databases (transactional and analytical) in the context of the H2020 CloudDBAppliance project.
Three important outcomes on Natural Language Processing (NLP) were published in the Association for Computational Linguistics conference, the number one forum for NLP, as well as in the Information Processing and Management journal and the European Conference on Information Retrieval - the top European forum in the subject.

Privacy-Preserving Computing

The cluster had two ACM CCS publications on machine-checked proofs co-authored by researchers from the Max Planck Institute for Security and Privacy and the Stanford Research Institute, and two publications on IEEE Symposium on Reliable Distributed Systems contributing to the state-of-the-art of multi-party computation practical systems (d'Artagnan) and of computation over encrypted data (BISEN).

Tools for Reliable Software Development

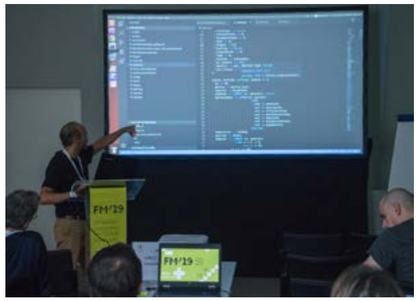
The recently consolidated research line encompassing topics such as software engineering, programming languages, logic and computation, and computer-human interaction was granted the Most Influential Paper award at the IEEE Symposium on Visual Language and Human-Centric Computing conference and the research on automatic generation of FPGA-based hardware accelerators was published on ACM Computing Surveys, the computer science journal with the highest impact factor, and on IEEE Transactions on Very Large Scale Integration Systems.

Virtual Environments

The CG&VE area achieved scientific outcomes in the use of gamification and games-based learning, at H2020 projects Feedback and BEACONING awarded with the Gamification award of 2019. Three IEEE Access and IEEE Transaction on Visualization and Computer Graphics publication are noteworthy results of the cluster work on Virtual Enviroments.

Articles published in top conferences
Three scientific articles in the field of high-assurance privacy-enhancing technologies were published in the ACM Conference on Computer and Communications Security 2019, one of the top conferences in the area of cryptography and information security.

"Most Influential Paper" award
The work "Automatically Inferring Class Sheet Models from Spreadsheets", published in 2010, received the "Most Influential Paper" award at the IEEE Symposium on Visual Language and Human-Centric Computing 2019.



III World Congress on Formal Methods
INESC TEC organised the III World Congress on Formal Methods (CORE A). The event gathered 600 computer experts from more than 40 countries, and it is considered the largest international congress in the Formal Methods field.

Eurovis 2019
The Eurovis is the annual Visualization Conference organised by the Eurographics Working Group on Data Vizualisation, supported by the IEE Visualization and Graphics Technical Committee (IEEE VGTC). The 2019 edition was organised by the GPCG (Eurographics Portuguese Chapter), in partnership with INESC ID Lisbon and INESC TEC.

European Networks of Artificial Intelligence Excellence
In 2019, INESC TEC became a member of one of the European Networks of Artificial Intelligence Excellence.

Research Data Alliance Portugal (RDA-pt)
INESC TEC created and promoted the Research Data Alliance Portugal (RDA-pt) node, a member of the RDA Europe 4.0, which aims to lead a EU Open Science Strategy through a consolidated European network of National Nodes.

4.

WHAT MOVES US

OUR PEOPLE

«Working at INESC TEC means learning and facing new challenges every day. I started as a press advisor at the Communication Service, but, after some time, I began getting involved in European projects in the energy field. I keep supporting the Communication Service, namely within the scope of social responsibility, but I am increasingly involved in the Centre for Power and Energy Systems (CPES). At CPES, I manage the Dissemination, Communication, and Exploitation work package of one of the biggest European projects in the energy area. Working at INESC TEC has been quite an experience! It allows me to face challenges I would never imagine!»

Joana Desport Coelho
Communication Manager
Centre for Power and Energy Systems (CPES) and the Communication Service

« Ever since I first started working at INESC TEC, on May 15, 2019, I felt a good and spirited atmosphere between colleagues. Besides improving my programming skills with MATLAB and Python, I worked with some simulation software (Simulink and PSS/E) and improved my knowledge of Reinforcement Learning, by studying some genetic algorithms.»

Hodjat Mariji
Postdoctoral Researcher, Centre for Power and Energy Systems (CPES)

«At INESC TEC, I have the privilege to work on the fundamental science that I love, while benefiting from the synergy between engineering and technology. There's a lot of support from the different INESC TEC services and that really makes a difference, particularly concerning my scientific work. I feel that we're all (scientists, engineers, staff, etc.) on the same boat - and what an excellent boat this is!»

Susana Alexandra Barbosa
Senior Researcher
Centre for Information Systems and Computer Graphics (CSIG) and Centre for Robotics and Autonomous Systems (CRAS)

«INESC TEC represents a multicultural workplace, open to innovation and improvement. It provides vast opportunities of networking and knowledge sharing, while encouraging the development of skills through teamwork activities and constant feedback policies.»

Pedro Pinho Senna
Research Assistant, Centre for Enterprise Systems Engineering (CESE)

OUR PEOPLE

«Working at INESC TEC has been quite beneficial for me, and in so many ways. It made me realise that everything is possible as long as you have an incredible team by your side. This includes not only CRIIS, but also the collaborators from the other centres, which provide the skills required to develop multidisciplinary and innovative projects. It also gave me the opportunity to be part of a team that focuses on the application of robotic systems to many areas, from industry to healthcare, and to participate in different projects, while contacting clients and organising some international events.This journey has helped me improve, not only in terms of technical and communication skills, but also as a person.»

Cláudia Rocha
Researcher
Centre for Robotics in Industry and Intelligent Systems (CRIIS)

«I am proud of being part of INESC TEC for the past 15 years. Ever since I joined, as a recent graduate, I had several opportunities to advance my research career, thanks to all the support and encouragement. Nowadays, as a PhD researcher, I'm grateful for still being part of INESC TEC, and having the opportunity to work with talented people and good friends. Here, I've found a positive workplace environment, and I firmly believe that team spirit is the essence of this great institution.»

Susana Silva
PhD Research Assistant
Centre for Applied Photonics (CAP)

«I really enjoyed being a part of the INESC TEC family. The work I carried out was quite interesting and challenging, but I'd highlight the opportunity to get to know some of the wonderful people who work here.»

Matthew Brian Gough
Ph.D. Grant Holder, Centre for Power and Energy Systems (CPES)

« I started working at INESC TEC almost four years ago and I soon found out that I was part of a great team. In fact, they are one of the reasons why I enrolled on a doctoral programme. They inspire me to work harder and better on a daily basis, in the pursuit of knowledge and innovation in science.»

Sara Pires Oliveira
PhD Student/ Junior Researcher
Visual Computing & Machine Intelligence Research Group - IPPR Research Area at the Centre for Telecommunications and Multimedia (CTM)

OUR PARTNERS

«I'd like to point out the establishment of a common language between two teams with such different backgrounds, and the creation of the Breast Research Group. Our collaborative solutions will hopefully improve the lives of women with breast cancer.»

Maria João Cardoso
Coordinator of the Surgical Team
Champalimaud Clinical Centre - Breast Unit

«We recognise INESC TEC's professionalism and commitment to the partnership that we've established, and our relationship has been quite positive and beneficial. In fact, I can think of many reasons to keep working with INESC TEC. In this sense, we believe in a long-lasting relationship with the institute.»

Carlos Sampaio
Chief Operating Officer
Elergone Energia, Lda.

«INESC TEC's researchers have a very close connection to the business world, thus being able to combine state-of-the-art research with the short-term needs of companies. There clearly is a practical sense in what they do. I believe this is one of the key aspects of INESC TEC.»

Paulo Sousa
CEO
Maxdata Software, S.A.

«INESC TEC plays an absolutely vital role in the partnerships established with private entities, thus favouring a level of technical research that would be difficult to achieve among the Portuguese Small and Medium-Sized enterprises.»

Armindo Oliveira
General Manager
Egitron

«JASIL didn't have an operations scheduler, which made it almost impossible to predict the estimated delivery time with a high level of certainty – mainly due to the complexity and the amount of operations that needed to be scheduled. The advanced planner developed by INESC TEC has proven to be the ideal tool for this task, thus becoming a vital instrument to determine the availability of tools, production and human resources, as well as subcontractors.»

Luís Oliveira
Manager
JASIL - J. ANTÓNIO DA SILVA LDA.

TECHNICAL SHEET

DESIGN
COMMUNICATION SERVICE
[SCOM]

PHOTOGRAPHY
COMMUNICATION SERVICE
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INESCTEC

Campus da FEUP
Rua Dr. Roberto Frias
4200-465 Porto, Portugal

+351 222 094 000
info@inesctec.pt
www.inesctec.pt