

DEFINING TECHNOLOGY

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# FOREWORD

INESC-ID – Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento em Lisboa, a research institute associated with Instituto Superior Técnico and INESC, was created in 1999, and is devoted to advanced research and development in the domains of Information Technologies, Electronics, Communications, and Energy.

INESC-ID was evaluated as a top quality Excellent Research Unit by the Portuguese Foundation for Science and Technology and awarded by the Portuguese government with the status of Associate Laboratory. INESC-ID has established worldwide collaborations with some of the top universities, research centres, and companies.

Leveraging on the enthusiasm, energy, and hard work of an increasingly larger team, comprised of young and talented people working together with experienced senior researchers, INESC-ID is internationally recognized by the quality and innovative character of its scientific work.

Researchers from INESC-ID have been engaged in many research projects in the area of information and communication technologies and at the seed of several start-up companies, thus contributing to the development of a Portuguese economy increasingly based on new technologies.

We are very proud to lead such a young and dynamic research institute. On behalf of all INESC-ID researchers, we invite you to make a brief journey along the last twenty years of INESC-ID through the pages of this booklet. We hope that you will enjoy reading this short publication and, maybe, that some of you may join us in the journey that we are ready to pursue in the coming years.



**Leonel Sousa and Isabel Trancoso**

Head of the Board of Directors  
and President of the Scientific Council



## WHO WE ARE

INESC-ID is a research institute dedicated to advanced research and development in the areas of Information Technologies, Electronics, Communications, and Energy.

INESC-ID was created in 1999, as a result of the reorganization of the R&D activities of its parent institution, INESC, in Lisbon.

INESC-ID is a not for profit, privately owned institution, declared officially of public interest. It is owned 51% by IST - Instituto Superior Técnico – and 49% by INESC - Instituto de Engenharia de Sistemas e Computadores.

When celebrating the 20 years anniversary, INESC-ID is organized into five research lines:

Embedded Electronic Systems

Information and Decision Support Systems

Interactive Intelligent Systems

Computing Systems and Communication Networks

Sustainable Energy Systems

## ASSOCIATE LABORATORY

INESC-ID was awarded the status of “Laboratório Associado” in December 2004. This has increased the funding and enabled the recruitment of some post-doctoral researchers and support staff.

INESC-ID was also recently awarded with the grade “Excellent” in the last national evaluation of the research and development units. In this evaluation, INESC-ID got the maximum mark in all the evaluation criteria, namely: the quality, merit, relevance and internationalization; the merit of the team; and the appropriateness of objectives, strategy and organization.

## HUMAN RESOURCES AND FUNDING

The majority of the researchers of INESC-ID are members of the academic staff and post-graduate students of Instituto Superior Técnico. There are also researchers from other Universities and Polytechnic Institutes, with whom we have previously established formal protocols, and a small number of contracted post-doctoral researchers.

On 31 December 2018 INESC-ID had 343 researchers, of which 186 with a Ph.D. degree and 105 with a M.Sc. degree.

The main source of national funding of INESC-ID is through FCT – Fundação para a Ciência e Tecnologia, either through basic funding or project funding awarded in a nationwide competitive basis. National funding is also provided by ANI – Agência Nacional de Inovação.

Another main source of funding are European projects. In 2018 the European projects accounted for 38 % of the annual budget.

Significant funding is also obtained from contracts with companies and other institutions, corresponding to about 15 % of the total budget in 2018.

## PARTNERSHIPS

INESC-ID actively participates in the MIT-Portugal and CMU-Portugal international partnerships. Since 2018, INESC-ID hosts the CMU-Portugal program management and one of the directors of the program is Rodrigo Rodrigues, a researcher at INESC-ID. Other formal partnerships include Instituto Superior Técnico, ISCTE-Instituto Universitário de Lisboa, Instituto Superior de Engenharia de Lisboa, Universidade de Évora, Universidade do Algarve, Universidade da Beira Interior, Universidade da Madeira, Escola Superior de Tecnologia e Gestão de Beja, Instituto Politécnico de Setúbal and Escola Superior de Tecnologia de Setúbal. In addition to the above formal partnerships, there is a large number of cooperation agreements with other institutions within the framework of the research projects, both at the national and international levels.

Finally, our researchers are actively engaged in research collaborations with faculty and researchers from leading institutions worldwide, as demonstrated by the large number of publications in coauthorship with such researchers.

## OUTCOME

INESC-ID has been very active in research, development, and technology transfer throughout the last twenty years of existence.

### PUBLICATIONS

Books **43** \ Edited Books **51** \ Book chapters **295**

PhD Thesis **278** \ MSc Thesis **1616**

International Journal Papers **1431**

National Journal Papers **49**

International Conference Papers **3995**

Technical Reports **542**

### RESEARCH PROJECTS

Over the past twenty years INESC-ID has participated in a large number of projects. In 2018 there were active:

European Union projects **17**

National projects **64**

Projects with companies **26**

### TECHNOLOGY TRANSFER

Seven start-ups have been launched as a direct result of the technology transfer:

Coreworks | SiliconGate | PETSys | VoiceInteraction  
NWC | HeartGenetics | Magnomics



BLOCK 01

NODE 01

NODE 04

NODE 05

NODE 03

NODE

BLO

BLOCK 01

NODE 01

NODE 02



# TECHNOLOGY TRANSFER

Our research and development activities cover a broad range of research areas and application markets, such as wireless communications, electronic equipment, biotechnology, health-care, medical imaging, industrial automation, e-learning, and enterprise information systems. INESC-ID also acts as a service provider, stimulating cooperation with industry and focusing research on day life issues, providing a high level of technology transfer.

Several start-up companies have been created by researchers and former graduate students associated with INESC-ID. This is an interesting indicator of the industrial technology impact of INESC-ID.

INESC-ID has equity in the following start-up companies:

**Coreworks** – digital integrated circuit design

**SiliconGate** – mixed-signal circuit design

**PETsys** – medical imaging

**Voiceinteraction** – speech processing

**NetworkConcept** – communication networks

**HeartGenetics** – biotechnology

**Magnomics** – biotechnology

*Besides owning equity in each company, there is close connection of these start-ups with INESC-ID due to partnerships for R&D projects.*

# GLIMPSE OF THREE START-UPS



**VoiceInteraction** is a technologic SME developing base and advance technology on the speech processing area. Was founded in 2008 by researchers from the Spoken Language Systems Lab of INESC-ID. With more than 20 high skilled people (MSc and PhD) and offices in Lisbon, São Paulo and New York covering the European, South America, Latin America and North America markets.

This company believes that speech will be the main interface to information technology systems and over a solid and strong R&D background we offer innovative solutions centered on speech processing technologies, as Audio Processing and Classification, Speaker Clustering and Identification, Automatic Speech Recognition (speech-to-text), Speech Synthesis (text-to-speech), Natural Language Processing and Understanding – automatic punctuation, keyword extraction, sentiment analysis, text segmentation and classification according to contents. All technologies using Machine Learning algorithms mostly based on Deep Neural Networks.

VoiceInteraction uses these technologies in areas as Closed Captioning / Subtitling systems for TV broadcasters, Media Monitoring Solutions for clipping services, Meetings Transcriptions for Senates/Assemblies/Courts and Speech Analytics for Call Centers. With over 300 clients mostly in Europe, South America and USA, reaching an estimate of 160 million viewers daily and always looking for innovation on Speech Processing Technologies.





**HEARTGENETICS**  
GENETICS & BIOTECHNOLOGY

**Heartgenetics** \ is a data-driven company that is bringing intelligence to genetic testing, to prevent diseases and promote wellness (nutrition and fitness). Their machine learning tools are the heart and mind of our own CE-IVD certified HeartDecode® system for intelligent reporting.

HeartGenetics is an ISO 9001:2008 and ISO 13485:2003 certified company using an award-winning methodology to provide high accurate and cost-effective genetic tests. Founded in 2013, the company's main goal is to play a leading role in genetic testing, developing new genetic tests and software, with a keen focus on the fields of pharmacogenetics and wellness. Based on more than 15 years of its own cutting-edge research in the cardiovascular field, the new wellness genetic tests are instrumental in the definition of highly personalized lifestyle plans. The company has itself as a reference in Europe and Latin America, having grown >100% since 2016.

HeartGenetics' team comprises highly qualified PhDs, engineers, entrepreneurs and MBAs, covering all aspects of its business, from informatics, analytics, genetics and biotechnology, to management and marketing. A core strength of HeartGenetics is its ability to successfully combine, in a lean and well-oiled structure, both bio and IT elements, working in tandem for the same purpose.



**SILICONGATE**

**SiliconGate** \ a specialized supplier of Power Management IP for ASIC/SoC, provides the global electronics market with intellectual property (IP) and services used in semiconductor design.

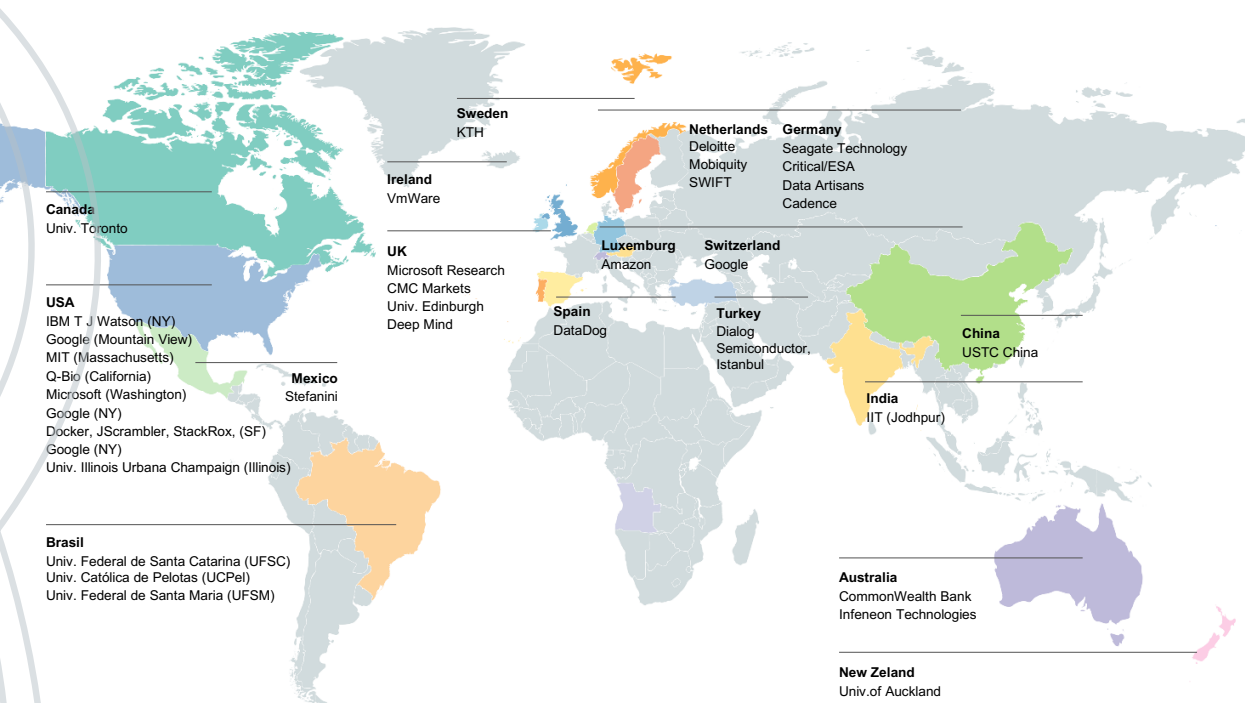
SiliconGate's IP solutions address the key Power Management challenges faced by designers today, such as efficiency, power consumption, total solution area, system verification and time-to-results. Its characterization services are oriented for Power Management in-system characterization and support towards production. This mix of technology-leading IP solutions and services give SiliconGate's customers a competitive edge in bringing the best products to market quickly while reducing costs and schedule risk.

In 2019 SiliconGate is celebrating its 10th anniversary with a portfolio of over 40 clients and 9 consecutive years of strong growth fueled by reinvested revenues.

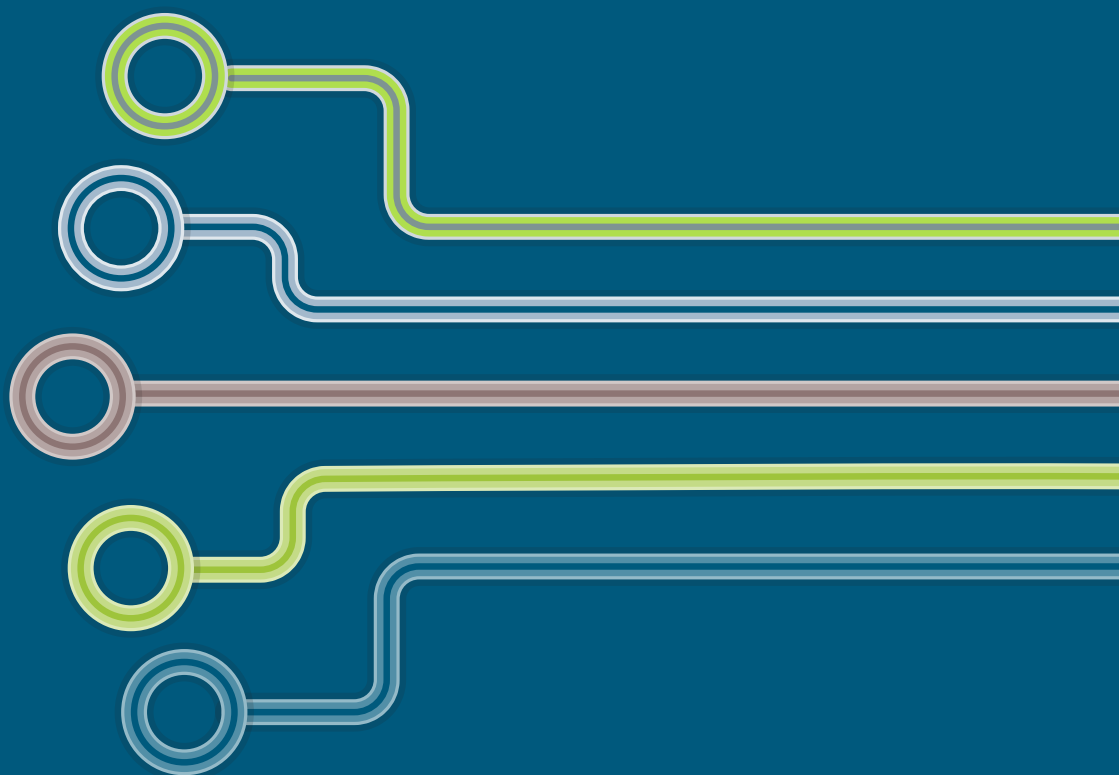


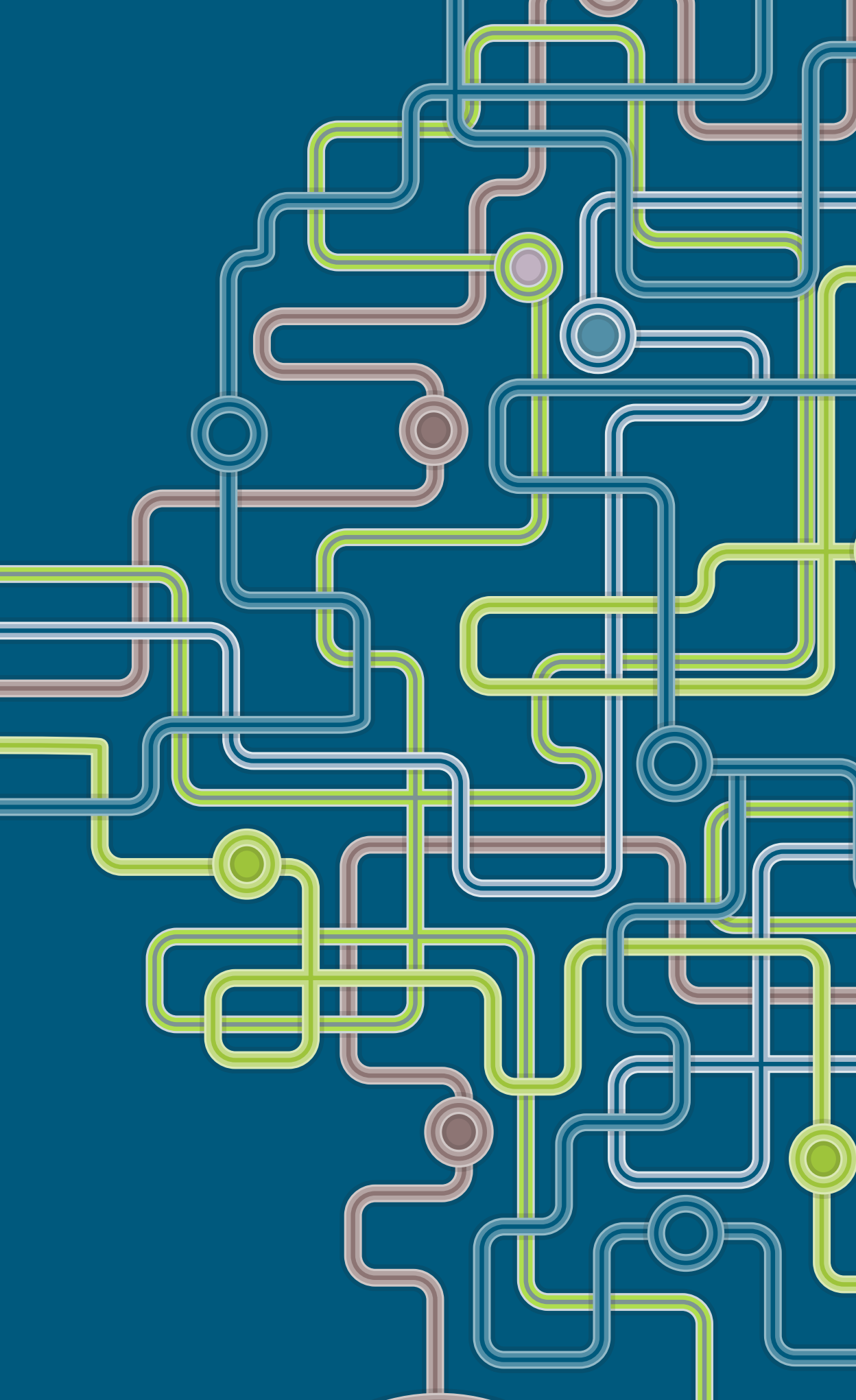
# INESC-ID ALUMNI

INESC-ID's former researchers and students are worldwide, from academy to research institutions and national and international companies.



# INESC-ID OUTLOOK







**JOSÉ TRIBOLET**

President of INESC, Professor at IST

INESC ID Lisboa was born 20 years ago, at the beginning of the XXI century. Its creation as an independent legal entity, simultaneously affiliated with the IST and with INESC ecosystems, happened in the context of the dynamics of the transformation of the original organizational model of its mother institution, INESC, founded 20 years earlier in 1980, within which all present R&D institutes of the INESC network, namely, INESC TEC in the north, INESC Coimbra, and INESC MN, INESC INOV and INESC ID in Lisbon, coexisted.

The profound transformation of the organizational topology of the original institution, which had by the end of the century a considerable dimension at the Portuguese scale, was the consequence of the need to provide within the system INESC with more degrees of freedom, by converting it into a network of R&D institutions each with their own juridical personality and self-management, capable of agile adaptation to the characteristics of their environments and to intensify the creation and nurturing of sound social and institutional relations, more easily materialized in terms of objectives to be achieved and challenges to be addressed, with impacts perceived as relevant by the key players of their operational context.

After 20 years of existence, it is evident that INESC ID has achieved the essential goals that justified its foundation, and has done so with high marks. INESC ID is a key research platform of the IST ecosystem, an engine of continuous creation of scientific knowledge via high quality research, relevant for the pedagogic, scientific and technologic activity of the School, as is patent by its recognition of one of the first Associated Laboratories of Portugal, its intense involvement in european, national and international RD project, and the essential support it provides to the masters and doctoral thesis work and post-doc programs at IST and at national and international levels, involving many other academic institutions of Portugal and abroad.



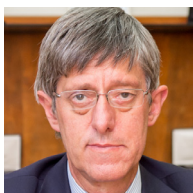
Also very significant is INESC ID's contribution in terms of continuous provision of leaders to the academic and scientific world. Through INESC ID new leaders have emerged at all levels, from the basic PI R&D projects level to the higher institutional, scientific, pedagogic, departmental, and school levels and to the national and international programs management levels.

Above all INESC ID has kept alive, at its human core the pioneering foundational genetic code of the original INESC of 1980, i.e., by considering its primary responsibility to act as a tool of the IST ecosystem, aimed at the development of the national, international and world communities, through excellence in science, technology and higher education.

As a Private Contract-Based Not-For-Profit R&D Institution (IPFSL) INESC ID maintains its economic and financial viability through its continuous capability to create value for Society, via contractual R&D with public and private national and international entities.

All members of INESC ID are acutely aware that they are the institution, and it is through their work and the added value it brings to our clients that its operational continuity and social relevance is maintained. INESC ID does not exist or will keep existing just because it has any sort of God given right to exist. It will project itself in the future if and only if its members keep working hard in the daily fight for its right to exist! As founder of INESC ID am deeply indebted to all that were and are the reality of the institution during these two decades.

I hope your example will have continuity and we all celebrate the 30 years of INESC ID, 10 years from now with an INESC ID even better than what it is today.



**ARLINDO OLIVEIRA**

President of IST, INESC-ID Researcher

To me, the creation of INESC-ID, 20 years ago, represented more than the creation of a new institution. It was the beginning of a long journey, that of learning (on the job) how to manage scientific and academic institutions. In 1999, my relatively simple life as a university professor became suddenly a more complex reality, as director of an independent institution, with its unique challenges and responsibilities. This change turned out to be deeper and more significant than I assumed at first, and I became inextricably linked with INESC-ID, the first institution I helped to create and develop.

INESC-ID was created mostly with researchers who integrated, at the time, two large units of INESC. José Tribolet, Luís Vidigal, and José Alves Marques, who were directors of INESC in 1999, played a critically important role in the creation of the philosophy and the culture that are now characteristic of INESC-ID and, in different roles, have been very important in the creation of the INESC group. Due to the particular rearrangement of the INESC group that took place at the time, INESC-ID integrated mostly the more academically oriented groups of researchers.

However, in the two decades that have since passed, INESC-ID grew and developed its own culture and perspective, which evolved from a somewhat simplistic and uniquely academic viewpoint to a more complex and multifaceted vision. Today, INESC-ID activity includes significant components of research, development, innovation and entrepreneurship, which were mostly absent in 1999.

Part of this transformation took place while I was in the management board, for the first ten years, first with Luís Borges de Almeida (chair of the board) and Helena Sarmiento, and later with Leonel Sousa, Luís Caldas de Oliveira and José Monteiro. In the last ten years, under the leadership of Luís Rodrigues and Leonel Sousa, INESC-ID kept improving and changing for the better, leading to an institution more active, more dynamic and more relevant than the one created in 1999.

During these two decades, researchers from INESC-ID authored thousands of scientific articles, advised many generations of students, developed hundreds of projects, wrote dozens of books, and created a handful of companies.



The scientific results, the people that were educated at INESC-ID and the companies that were created contributed strongly to the development of science and technology in Portugal, mostly in the fields of Electrical Engineering and Computer Science.

INESC-ID became an associate laboratory, in 2004 and, with time, became well-known, nationally and internationally, having participated in many networks built over the years.

Although Técnico has more than 20 research centers, only a few have shown to possess the vision, the ability, and the resources to pursue an independent and autonomous strategy, and INESC-ID is certainly among these few. This very positive evolution of the institution culminated with the recognition of its research as excellent, by the Foundation for Science and Technology, in the last assessment process, which finished in 2019.

Interestingly, even though the institution is very different today from what it was in 1999, several things remained mostly the same. The bylaws, redacted by Manuel de Medeiros Silva, have shown exceptional resilience and adaptable to an ever-changing institution.

Another characteristic that remained unchanged was the spirit of cooperation that always existed between the management board, in charge of executive tasks, and the scientific council, more connected with scientific evaluation and assessment.

Manuel de Medeiros Silva was also the first chair of the scientific council, significantly contributing to create a culture of internal cooperation, consistency and quality that lasts to this day. He was followed by Augusto Casaca, João Lemos, Luís Miguel Silveira, and Isabel Trancoso, who kept the tradition of fruitful and close cooperation between the scientific council and the management board.



**CARLOS SALEMA**

President of IT, INESC co-founder

I can still remember quite vividly the discussions that took place in the eighties, between José Tribolet, J. C Lourenço Fernandes, José Moura and myself about setting up a new type of organisation that would foster a much closer collaboration between university and telecom operators.

From the discussions (and a lot of work) INESC was born, headed at the time by Tribolet and Lourenço Fernandes. And the whole field of R&D in Portugal started to change. The model was good, so good that copycats (like IT) started appearing here and there, particularly with the push provided by CIENCIA in the early nineties.

Meanwhile INESC evolved and twenty years ago INESC-ID was born with a focus on research, development and innovation.

INESC-ID and Instituto de Telecomunicações (IT) share the same goals: to create and disseminate new knowledge and to foster advanced training. Only the fields of work are different, in many ways complementary, even if borderlines touch here and there.

INESC-ID excels in computer engineering, informatics and energy. Very successful in the European scene INESC-ID stands out as a R&D&I institution that plays a role model for many of us.

The close proximity not only between telecommunications and computer engineering but also between working quarters has already bear fruit in quite a number of successful projects. Both institutions collaborate rather than compete.

Speaking on behalf of IT researchers and staff, I congratulate our INESC-ID friends and colleagues on the remarkable achievements of the last 20 years and wish you all another  $n \times 20$  years.



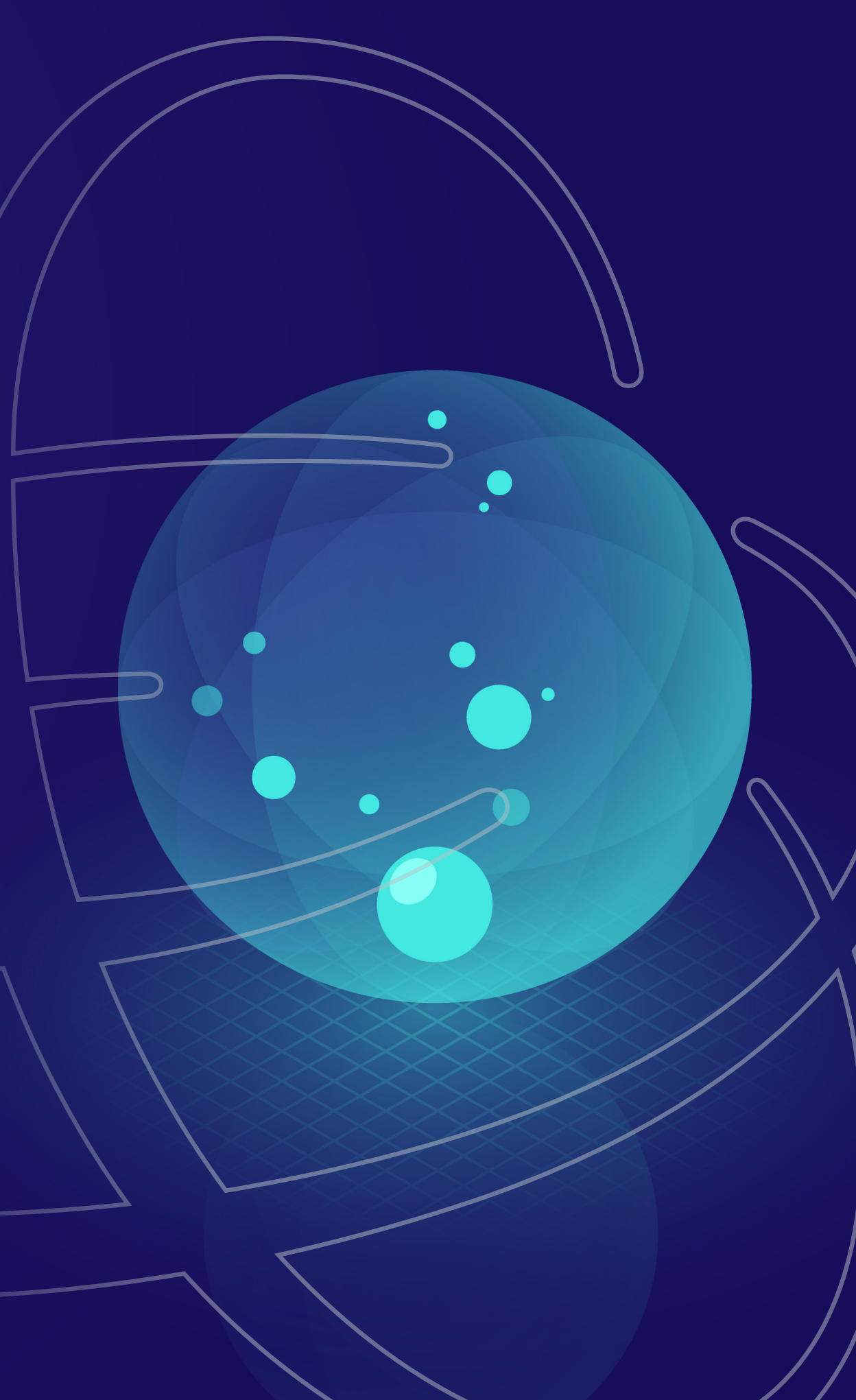
**SRINIVAS DEVADAS**

Professor of EECS, MIT

I congratulate INESC-ID on twenty years of excellence. I feel privileged to have interacted with INESC-ID researchers since the founding of INESC-ID in 1999, and am honored to have served on the Technical Advisory Board of INESC-ID since 2006.

Over the years, I have observed a monotonic increase in research volume and quality, two metrics that sometimes conflict, but not in the case of INESC-ID's two-decade trajectory! Groundbreaking research in many research fields, including CAD, distributed systems, computational biology and algorithms by world-renowned researchers along with motivated and productive Masters and PhD students have together been a hallmark of the past twenty years.

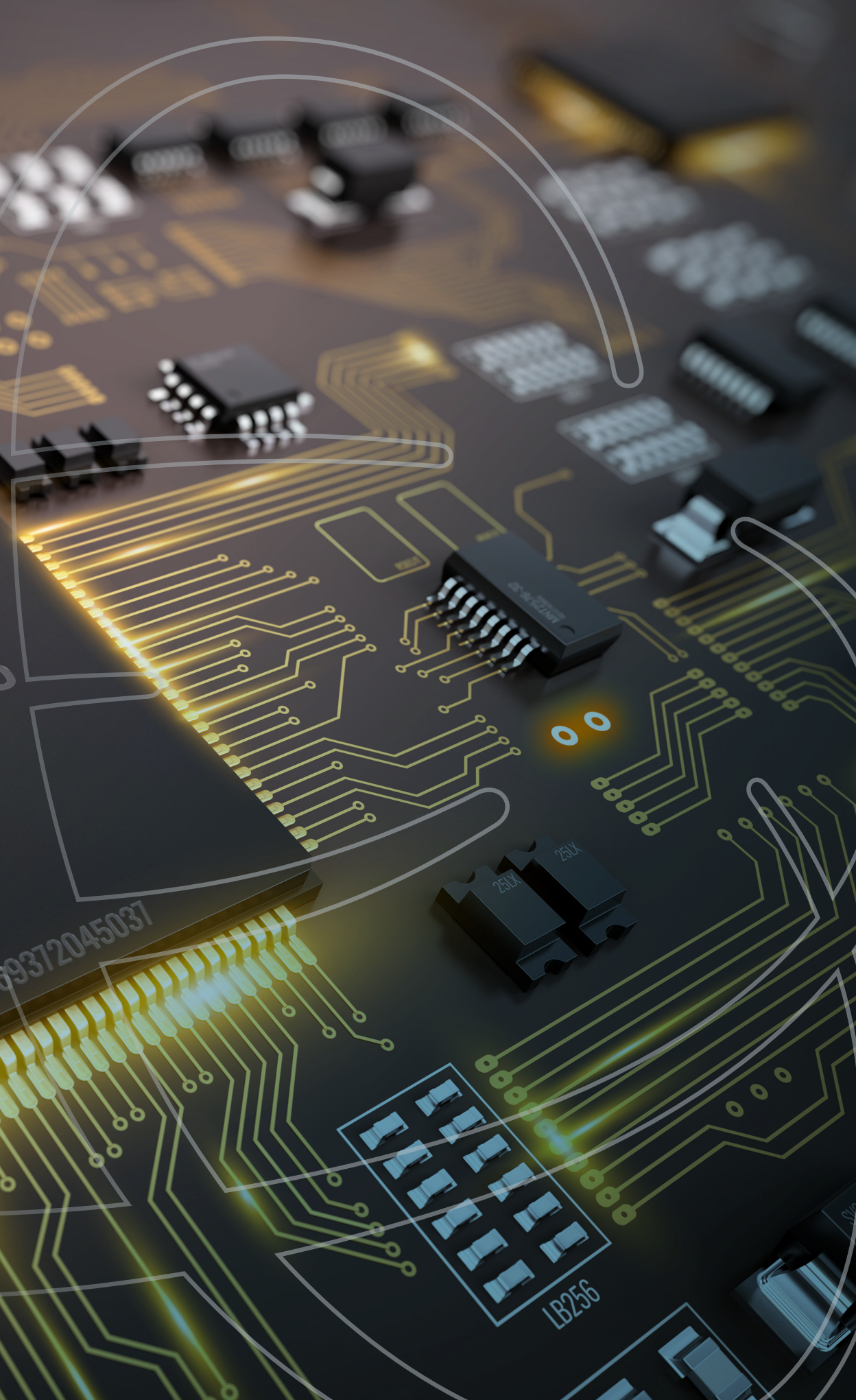
Furthermore, developed theory has been applied to practice and practical systems have been deployed in the public domain as well through startup companies to achieve world-wide impact. Indeed, INESC-ID is well on its way in achieving its mission of integrating expertise from electrical engineering and computer science to solve difficult problems in computer and telecommunication system design.



# HIGHLIGHTS

INESC-ID is certainly an institution with a high degree of internationalization. Within Portuguese institutions, INESC-ID is one of the most successful in attracting international funding, integrated in various international research networks and collaborating with master's and doctoral European programs. INESC-ID researchers are integrated into the international scientific community and take an active role in the scientific and management leading of research projects.

Within such a high number of research projects covering different work areas, we present a very small sample that we believe is representative of some challenging projects with different funding schemes.



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# DEPENDABLE CLOUD

## Towards the dependable cloud: Building the foundations for tomorrow's dependable cloud computing infrastructures

The general topic of the Dependable Cloud project is cloud computing, a new computing paradigm where companies and organizations transfer part of their IT and computing infrastructure to an external provider.

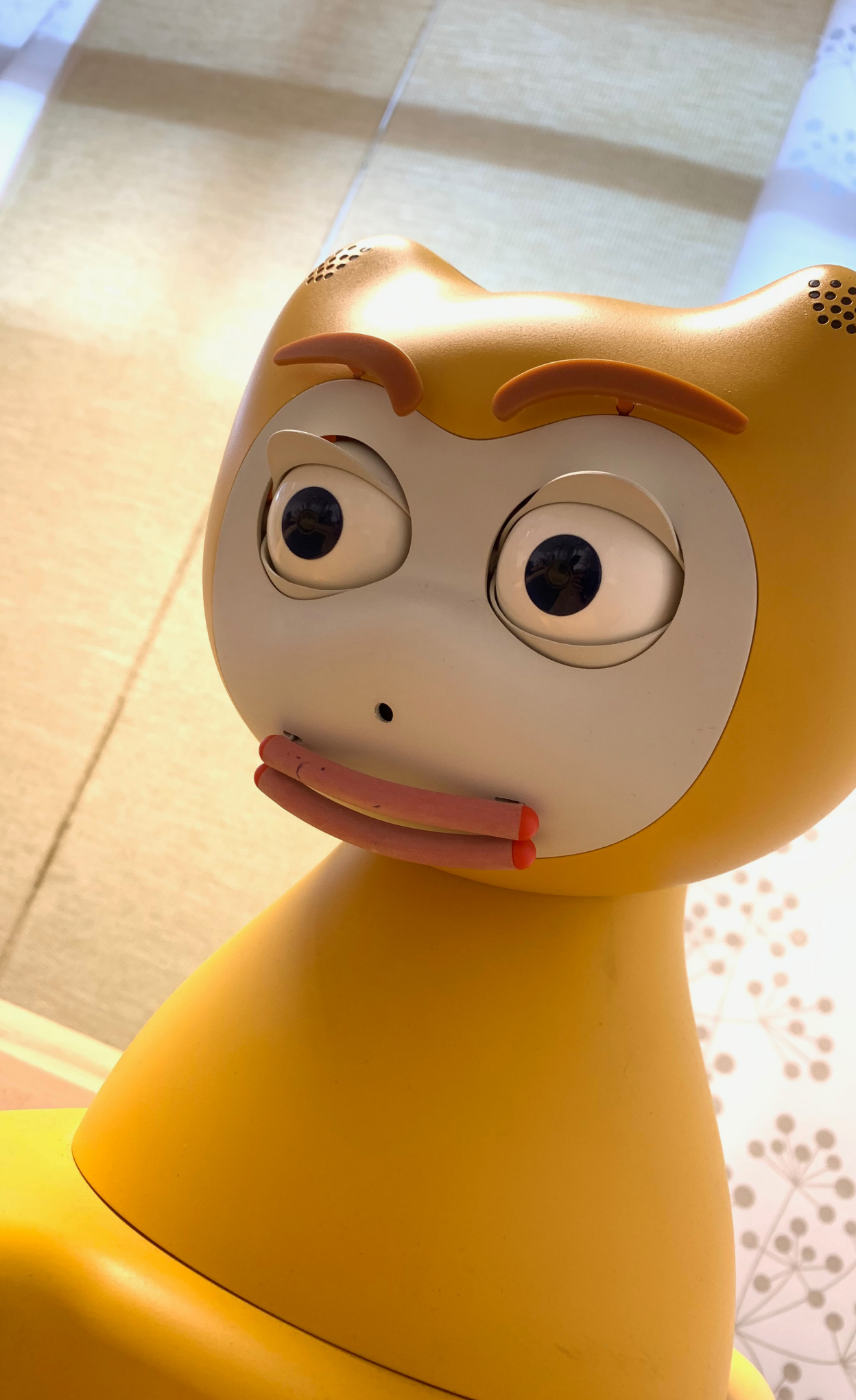


This enables important gains, both in terms of lowering IT costs and providing access to a much larger computing infrastructure than the one that is owned and operated by those companies and organizations.

The infrastructure underlying cloud computing services has several novel characteristics, namely in terms of the scale of the data centres where such services run, and the geographic distribution of the servers where cloud data is replicated.



In this context, the project aims to research new methods for developing the services that form the cloud infrastructure, in order to improve the reliability and performance of cloud services and meet the expectations of its users.





# LIREC

## Living with Robots and Interactive Companions

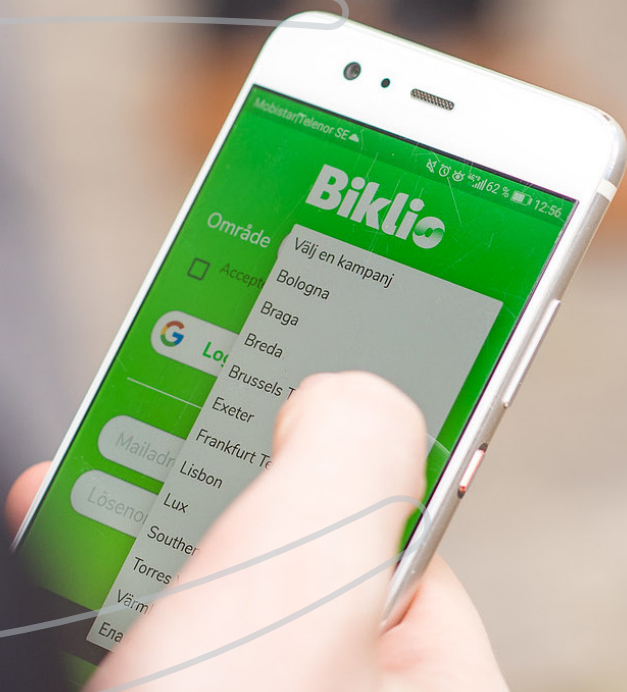
LIREC was an European funded (FP7) research project exploring how we live with digital and interactive companions. The LIREC network aims to create a new generation of interactive, emotionally intelligent companions that is capable of long-term relationships with humans.



The research team focuses on both virtual companions and physical embodiments such as robots. They also examine how people react to a familiar companion when it migrates from a robot body into a virtual form, for example on a mobile PDA screen.

LIREC is a collaboration of 10 European partners specialised in psychology, ethology, human-computer interaction, human-robot interaction, robotics and graphical characters.

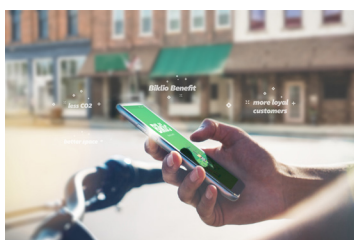
The project has received funding from the European Community's Seventh Framework Programme.



# TRACE

## Opening the cycling and walking tracking potential

The mission of the TRACE project was to assess the potential of movement tracking services to better plan and promote walking and cycling in cities, and develop tracking tools that will fuel the take up of walking and cycling measures.



The project targeted established measures to promote cycling and walking to the workplace, to school, for shopping purposes or simply for leisure. More particularly, TRACE assessed the potential of ICT based tracking services to optimize the planning and implementation of such measures and enhance their attractiveness and potential impact. Issues such as data privacy, cost, interoperability, financial/tax incentives, infrastructure planning and service concepts were addressed.



Dedicated TRACE tracking based tools to promote behaviour change and support mobility planning were tested in eight pilot sites: Breda (NL), Águeda (PT), Southend on Sea Borough (UK), Bologna (IT), Esch (LU), Belgrade (RS), Plovdiv (BG) and Leuven (Belgium), and evaluated in terms of impacts, success factors and

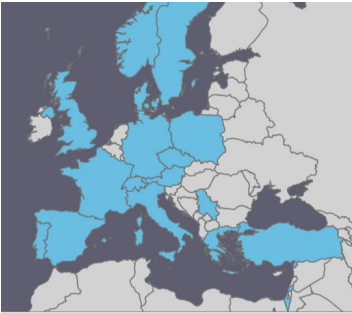
benefits, while preparing for their full commercial exploitation. Users, policy makers, and walking and cycling practitioners were closely involved in all stages of the project.

To that end, common, flexible and open access tools were developed, which addressed related ICT challenges and enable the development of products based on tracking services tailored to the requirements of specific measures by market-oriented application developers. A particular outcome was the Biklio mobile application, developed by INESC-ID and which is currently exploited by a startup company.

# EURO-TM

## Transactional Memories: Foundations, Algorithms, Tools, and Applications

The COST Action Euro-TM is a pan-European research network, which brought together more than 200 researchers from 50 institutions in 17 European countries working in the area of Transactional Memory.



Started in 2011 and ended in 2015, Euro-TM fostered and coordinated European research efforts on Transactional Memory, encompassing a broad range of interdisciplinary aspects such as theoretical foundations, algorithms, hardware and operating system support, language integration, development tools, and applications.



Euro-TM implemented a number of diverse activities aimed at raising awareness on scientific results and fostering international collaborations, including: funding dozens of short-terms scientific collaborations between different European research units; 69 joint publications, including a tutorial book on Transactional Memory coauthored by 60 researchers of the network;

10 scientific meetings, bridging academic and industrial research; 20 joint national and European project proposals on a broad range of interdisciplinary topics; 2 doctoral schools designed to foster cross-fertilization with other hot research areas in the parallel and distributed computing domain; and showcasing TM platforms and applications in premier EU industrial conferences.

INTEL

## Cache-aware Roofline Model in Intel® Advisor

Researchers from INESC-ID proposed a set of fundamental Cache-aware Roofline models (CARMs), which provide a simple and intuitive way to visually represent the limits of parallel processing on contemporary computer architectures. In 2017, a team of Intel software developers integrated the performance CARM as an official feature of Intel® Advisor (part of Intel's main application development framework).



In the scope of CARM integration in the Intel Advisor, INESC-ID and Intel Corporation signed several official agreements in 2017. This collaboration has received the HiPEAC Tech Transfer Award 2017, being recognized as one of the most successful technology transfers in Europe.

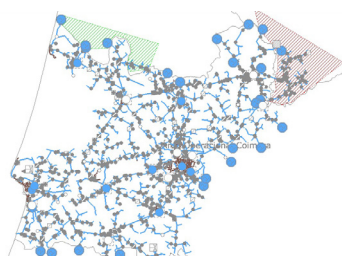
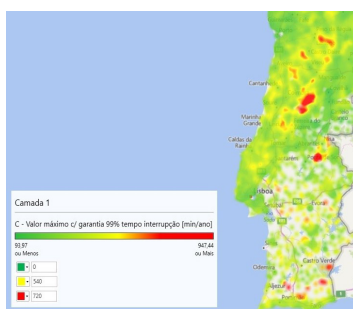
The collaborative research efforts between INESC-ID and Intel have resulted in a set of scientific activities, such as publication of joint papers and organization of tutorials at top international conferences, such as SC, ISC, PACT, etc. Since 2018, this collaborative research is also performed in the scope of a joint project, funded by Intel Corporation.





# ERSE Collaboration

## Determining expected values in the continuity of energy service by structural limitations of the distribution grid



INESC-ID has contributed to the National Energy Services Regulatory Authority with a probabilistic methodology to determine the expected values of the continuity of service that are explainable by structural limitations of the distribution grid.

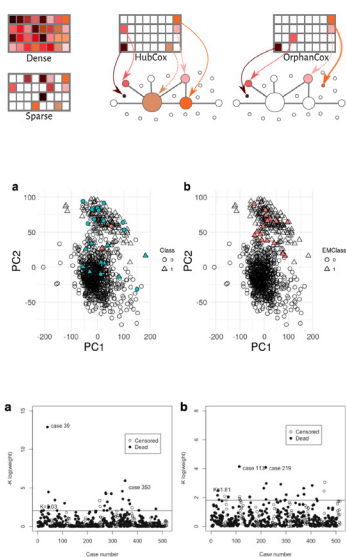
Results were obtained for each and every medium voltage power delivery point in Portugal - more than a 100,000 values for the expected time and the expected frequency of interruption.

The development of the methodology and its application was supported by projects from the main Portuguese utilities: EDP in the mainland, EDA and EEM in the autonomous regions.

Results obtained are being used to redefine the quality of service standards and to assess the future investment priorities for complying with such standards.

# PERSEIDS

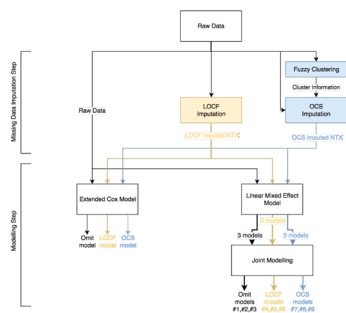
## Personalizing cancer therapy through integrated modeling and decision



In developed countries, cancer is one of the most severe diseases in terms of mortality and morbidity. In particular, breast and prostate cancer have the common feature of metastasizing majorly to the bone tissue, a late-stage event that severely worsens the prognosis and also causes the reduction of bone integrity and serious skeletal-related events (SRE).

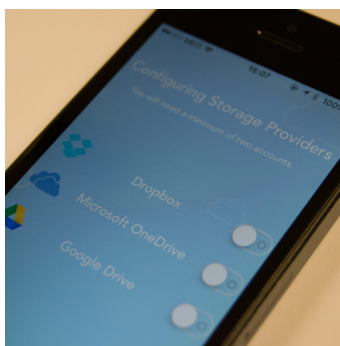
This project addresses the problem of optimizing cancer therapy by integrating multidimensional patient-specific data. The goal is to create accurate classifiers and identify factors associated with disease outcome, which in turn will support the design of adaptive controllers and decision systems.

The ultimate aim is to develop robust clinical decision support systems for personalized cancer therapy optimization by integrating patient multilevel data.





# SAFECLOUD



Cloud computing, despite all its benefits and importance to the competitiveness of modern economies, raises fundamental questions regarding the privacy, integrity, and security of offsite data storage and processing tasks. There are major cybersecurity concerns about data located in the cloud, especially when data is physically located, processed, or must transit outside the legal jurisdiction of its rightful owner. These questions are currently not answered satisfactorily by existing technologies.

SafeCloud developed cloud security mechanisms to ensure that data transmission, storage, and processing can be: partitioned in multiple administrative domains that are unlikely to collude, so that sensitive data can be protected by design; entangled with interdependencies that make it impossible for any of the domains to tamper with its integrity. These two principles – partitioning and entanglement – have been applied holistically across the entire data management stack, from communication to storage and processing.

At INESC-ID it is designed, implemented, evaluated and made publicly available a set of cloud security technologies. As leaders of the secure communication activities, set of innovative protocol solutions are designed to tolerate a set of attacks and 0-day vulnerabilities, including the private reactive multipath communication middleware (PREMIUM) and the vulnerability-tolerant channels for transport layer security (vtTLS). Moreover, we developed SafeCloudFS, a file system backed by a single cloud or a cloud-of-clouds that is resilient to client-side attacks.



# VITHEA

## Virtual Therapist for Aphasia

A relevant project in terms of applications to e-Health is VITHEA (Virtual Therapist for Aphasia, 2010-2012). This award winning platform integrates automatic speech recognition technology to provide word naming exercises to individuals with lost or reduced word naming ability.

The adopted solution is based on a keyword spotting approach that validates the correctness of what was said by the patient.

The program provides feedback both as a written solution and as a spoken message produced by an animated agent using text-to-speech synthesis. The application allows the easy addition of new therapy exercises and provides tools for the therapists to remotely track the recovery of the patients.

The VITHEA platform has been the starting point for an extensive collaboration with several clinical facilities: Faculdade de Medicina da Universidade de Lisboa, Hospital Garcia da Orta, Centro Psiquiátrico Hospitalar de Lisboa, Luz Saúde, and Centro de Electroencefalografia e Neurofisiologia Clínica.

It has also been the starting point for many other applications of speech and language technologies to the therapy, diagnosis or monitoring of several voice pathologies and diseases that affect speech, such as Alzheimer's, Parkinson's, ALS (Amyotrophic lateral sclerosis), ASD (Autism Spectrum Disorder), depression, bipolar disease, cold, and obstructive sleep apnea, among many others.

In fact, the results of this first project have motivated our participation in the follow-up projects H2020 ITN TAPAS, FCT-CMU Portugal INSIDE and BioVisualSpeech.

This experience has also been of fundamental importance to our current work in the area of Ambient Assisted Living, namely in terms of integrating methods that can seamlessly analyse the daily conversations of elderly users in order to detect potential cognitive decline. The most recent follow-up of the VITHEA project concerns the development of multi-party quiz games.

The game was recently tested in senior universities, showing how motivating the experience can be for the elderly. Engaging people with games is a promising way to keep them performing cognitive tasks and involved in social interactions.



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