DEMOKRITOS

INSTITUTE OF INFORMATICS
& TELECOMMUNICATIONS

AR/VR
ANTENNAS
NETWORKS
INSTITUTE
BIGDATA
SCIENCE
ARTIFICIAL
INTELLIGENCE
5G
INNOVATION
INFRASTRUCTURES OF EDUCATION
& TELECOMMUNICATIONS
IoT
CYBER
SECURITY
EXCELLENCE
COMMUNICATION
DEMOCRATISING AI
RESEARCH
INFORMATICS

2020
ANNUAL REPORT
INSTITUTE OF INFORMATICS & TELECOMMUNICATIONS

REFLECTING ON 2020

We are working towards making IIT, an international Research and Innovation hub on AI, 5G and IoT technologies.

2020 marked the mid-point for the realisation of our 2019-2022 strategic plan. The plan was built around three core pillars, Research Excellence, Innovation and Education and aimed to set the strategic goals for all three interconnected pillars, while ensuring that the supporting infrastructures, processes, and people are in place.

Our actions during 2020 drove the Institute of Informatics and Telecommunications (IIT) further towards the goals of focusing its research activities in specific areas of Intelligent Computing and Networking and strengthening its extrovert nature with synergies across its Labs, with other NCSR Demokritos' Institutes and with established third parties. The influx of new, ambitious, inter-disciplinary projects and initiatives such as the national Artificial Intelligence strategy, along with the growth of the Document Intelligence Centre of Excellence (DICE), are success stories and strong indicators that the established direction is fruitful and sustainable.

Regarding Innovation, IIT continued its strong involvement in NCSR Demokritos' ahedd Digital Innovation Hub and played a central role in the two first-ranked national proposals for the establishment of the European Digital Innovation Hubs (coordinated 'Smart Attica' and participated in 'Smart Health'). Furthermore, it continued its strong collaboration with innovative SMEs in the Lefkippos Technology Park and beyond. Connections with Big Industry are also strengthening, via the involvement of large corporations in the establishment of the Centre's Smart Campus and the organisation of executive-oriented training programmes.

Education, the third pillar of IIT's strategic plan, was always a priority and a competitive advantage for the Institute and the Centre. During the last year, along with the continuation of successful initiatives like the joint PhD programme with US universities and the Industrial Scholarship programme co-funded by the Stavros Niarchos Foundation, the Institute proceeded to the expansion of its MSc programme portfolio. The programmes cover trending and rapidly evolving domains, like Artificial Intelligence, Data Science, Quantum Computing and the Application of IT technology in Education, with a high number of students rollout and highly relevant topics covered. Of particular note was also the online organisation of NCSR Demokritos' Summer School, highlighted by compelling talks and round tables on AI and ethics.

The realisation and proper dissemination of all those actions would not be possible without strong support from the administration, operation and communication personnel of the Institute and NCSR Demokritos' eGov Office. Along with their efforts and commitment, the provision of modern, functional, and pleasant workspaces was a priority for the year and will continue to be with the upcoming construction of the new IIT building.

Although 2020 changed the way we work, collaborate and communicate, IIT continued to operate effectively and grow. I would like to thank all my colleagues for giving their best under these difficult circumstances and helping to bring our ambitious, long-term vision into reality.

Dr Vangelis Karkaletsis
Director of the Institute of Informatics & Telecommunications, NCSR Demokritos

FINANCIALS

6.844.299,37 €

EU research grants
2.862.287,05 €

National research grants
1.215.576,75 €

Regular public budget
961.631,42 €

Other funding
1.804.804,15 €

2020
YEAR AT A GLANCE

233 PEOPLE

129 PUBLICATIONS

16 NEW RESEARCH PROJECTS

46 PhD STUDENTS

15 POST DOC & PhD SCHOLARSHIP

€6.8M COMPETITIVE FUNDING

35 POST DOCS

NEW PROJECTS IN 2020

16 new
research projects

DebateLab

From Linked Data
to Linked Arguments

National project, SKEL | The AI Lab
1/1/2020 - 31/12/2022
NCSR budget: 51.065€
https://debatelab.ics.forth.gr

P4-LUCAT

Personalized medicine for lung cancer
treatment: using Big Data-driven
approaches for decision support

National project, SKEL | The AI Lab
1/4/2020 - 31/3/2023
NCSR budget: 199.750€
https://p4-lucat.eu/

NAVMAT

Knowledge based System
for naval materials failures

National project, SKEL | The AI Lab
1/3/2020 - 28/2/2023
NCSR budget: 7.200€
https://navmat.gr/

iRTA

intelligent Robotic high-precision
Treatment Application in rough terrain
vineyards

EU H2020, SKEL | The AI Lab
1/5/2020 - 31/12/2021
NCSR budget: 20.000€
https://irta.agenso.gr/

SARS-CoV-2

Flagship Action for SARS-CoV-2
Epidemiological study in Greece

National project, SKEL | The AI Lab
1/5/2020 - 30/4/2022
NCSR budget: 160.000€
https://greecevscorona.gr/

MGM
MYgrant
METAMORPHOSIS

Professionalization Of Youth Workers.
Integration Of Migrants Through
Multi-Medial & Art-Based Learning

Erasmus+, NML & Mind
1/5/2020 - 31/8/2021
NCSR budget: 28.695€
https://www.mygrant.world/

RESPOND-A

Next-generation equipment
tools and mission-critical
strategies for First Responders

EU H2020, MNL
1/6/2020 - 31/5/2023
NCSR budget: 387.500€
https://respond-a-project.eu/

ESA DELHILA

Deployable high gain antenna structure
for small spacecraft science mission

European Space Agency, WiCom
1/6/2020 - 30/6/2021
NCSR budget: 90.000€

EuroCC

National Competence Centres
in the framework of EuroHPC

EU H2020, SKEL | The AI Lab
1/9/2020 - 31/8/2022
NCSR budget: 350.000€
https://www.eurocc-project.eu/

EU–Pri

An approach how to teach
citizenship education in the prison

Other european project, SKEL | The AI Lab
22/6/2020 - 31/5/2021
NCSR budget: 29.999€
https://eu-pri.demokritos-dev.eu/

SANCUS

Analysis Software Scheme
of Uniform Statistical Sampling,
Audit and Defence Processes

EU H2020, MNL
1/9/2020 - 31/8/2023
NCSR budget: 346.250€
https://www.sancus-project.eu/

PALANTIR

Practical Autonomous
Cyberhealth for resilient
SMEs & Microenterprises

EU H2020, MNL
1/9/2020 - 31/8/2023
NCSR budget: 251.250€
https://www.palantir-project.eu/

SAFETY4RAILS

Data-based analysis for SAFETY
and security protection FOR detection,
prevention, mitigation and response
in trans-modal metro and RAILway networks

EU H2020, ISL
1/10/2020 - 30/9/2022
NCSR budget: 447.950€
https://safety4rails.eu/

3D2ACT

Fostering Industry 4.0 and
3D Technologies through Social
Entrepreneurship: An Innovative
Programme for a Sustainable Future

Erasmus+, NML & Mind
1/12/2020 - 31/5/ 2023
NCSR budget: 61.700€
http://3d2act.eu/

META WIRELESS

Future Wireless Communications
Empowered by Reconfigurable
Intelligent Meta-Materials

Marie Skłodowska-Curie, ITNs, WiCom
1/12/2020 - 30/11/2024
NCSR budget: 243.018€
https://h2020-msca-itn-metawireless.cnit.it/

VAST

Values Across Space and Time

EU H2020, SKEL | The AI Lab
1/12/2020 - 30/11/2023
NCSR budget: 610.625€
https://vast-project.eu/

KICK OFF IN 2021

Projects approved to start in 2021

01

AI4Copernicus
Reinforcing the AI4EU Platform by Advancing Earth Observation Intelligence, Innovation and Adoption
EU H2020, SKEL | The AI Lab | 1/1/2021 - 31/12/2023
NCSR budget: 2.703.125€
https://ai4copernicus-project.eu/

02

EVOLVED-5G
Experimentation and Validation Openness for Long-term evolution of VErtical inDustries in 5G era and beyond
EU H2020, MNL | 1/1/2021 - 30/6/2023
NCSR budget: 503.000€
https://evolved-5g.eu/

03

STEAM4ALL
Supporting the Digital Inclusion of all Students through an Inter-Disciplinary Programme for a Sustainable Future
Erasmus+, NML & Mind | 1/1/2021 - 29/6/2023
NCSR budget: 25.855€
http://steam4all.4learning.eu/

04

Health CASCADE
Evidence-based co-creation methodology for closing the implementation gap between knowledge and action in health promotion
EU H2020, CIL | 1/1/2021 - 31/12/2024
NCSR budget: 243.018€
https://healthcascade.eu/

05

Colibri Women
Second Chance For Colibri Birds: Empowering and Increasing Capabilities Of Women
Erasmus+, CIL | 1/1/2021 - 29/6/2023
NCSR budget: 18.285€

06

M-REWEAR
Innovative Textile Structures for Mechanical Electromagnetic Reconfigurability of Wearable Antennas
National Project, WiCom | 1/1/2021 - 31/12/2024
NCSR budget: 195.000 €

07

pop AI
A European Positive Sum Approach towards AI tools in support of Law Enforcement and safeguarding privacy and fundamental rights
EU H2020, ISL - SKEL | The AI Lab | 1/10/2021 - 30/9/2023
NCSR budget: 245.000€

08

ML - MULTIMEM
Machine Learning-aided Multiscale Modelling Framework for Polymer Membranes
EU H2020, IIT - INN | 1/10/2021 - 30/9/2023
NCSR budget: 153.085,44€
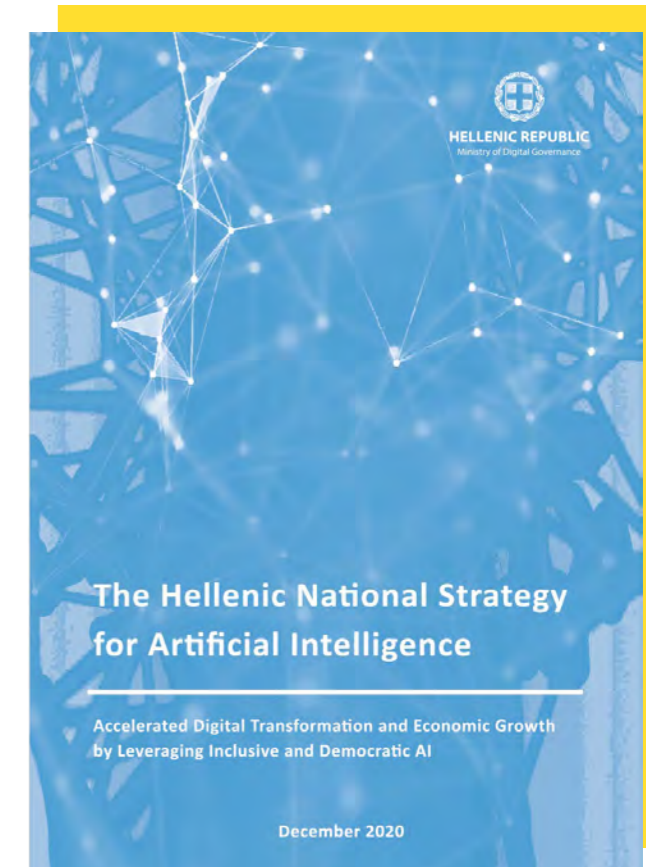

NATIONAL AI STRATEGY

Democratising AI

As one of the leading and most active research entities on the Artificial Intelligence (AI) domain, IIT has produced a White Paper publication aiming to set out the National AI Strategic Vision for Greece and to provide an initial plan of action on its achievement.

Taking into consideration the rapid evolution of the AI sector, this White Paper aims to put the adoption of AI, by both public and private sectors in Greece, on the fast-track, and to help increase the relevant skillset required in the research and development domain.

Through the provision of the necessary AI infrastructure and enablers, Greece aims to foster a technology-enabled future that will facilitate the Democratisation of AI. By infusing AI with the principles and moral ideals of Democracy for the common good, values that constitute the core values of Europe; ideals and fundamental rights that have become more relevant in this AI era.

The White Paper Democratising AI is available:
http://democratisingai.gr/

In December 2020, NCSR Demokritos along with a multi-disciplinary team of Greek scientists and AI experts, under the auspices and supervision of the Ministry of Digital Governance released the first ever Hellenic National Strategy for Artificial Intelligence (AI).

The Strategy is aligned with EU policies and recommendations for AI, as well as with relevant initiatives. Its development has considered international best practices from the strategies of other EU-27 countries and the UK, and from other prominent AI strategies outside the EU.

The Strategy aspires to provide a sound basis for creating a vibrant AI ecosystem that will benefit the Greek Society and Economy, while providing a unique contribution to EU's Strategic Targets for AI, notably in terms of the EU-wide 'Democratisation' of AI.

DICE - AI Centre of Excellence in Document Intelligence

Dr George Paliouras
Scientific Director

Dr Eirini Spyropoulou
Associate Scientific Director

The global organisation EY has expanded its expertise on Document Intelligence by investing in a dedicated Artificial Intelligence Centre of Excellence at NCSR Demokritos, namely DICE, which is led by Dr George Paliouras, Head of SKEL | The AI Lab and Dr Eirini Spyropoulou.

In its first year of operation, the DICE team has managed to establish itself both internally within EY and to external audiences by gaining positive feedback for both academic excellence and the ability to set clear and meaningful goals.

The team conducts research using Machine Learning and Natural Language Processing, related to the automatic understanding of financial and legal documents in the context of auditing and accounting applications. Work focuses on a variety of topics including: text classification in real-world settings, document-to-document information retrieval and explainability with applications on regulatory documents, legal documents and financial statements.

In terms of scientific achievements, the team has published five papers in top tier NLP conferences. It has also provided thought leadership within EY by giving three technical talks to a broad audience and providing an internal technical report. Finally, DICE has had the chance to present its work to the Science and Technology adviser of the US State Department.

For the coming year, DICE aims to embark on patent submissions and to integrate more tightly with EY's AI strategy.

More info: **https://dice.iit.demokritos.gr/**

5G Research at NCSR Demokritos

The development of the 5th generation mobile networks (5G) is not only a promising technology in terms of performance and services, but also, a radical development of the Telecommunication infrastructures with great benefits for our daily lives which are set to transform businesses in the years to come.

The Institute participates and coordinates research projects, which are developing plenty of innovative 5G use cases by utilising the competitive technological benefits of 5G networks. Through its research activities, the Media Networks Laboratory (MNL) is becoming a research pioneer in 5G technologies, both in Greece and Europe. With the developed know-how and the necessary material and technical infrastructure, MNL acts as a catalyst for technological innovation and development in digital transformation and support of new services and 5G applications.

MNL has actively contributed to the National Strategy for AI of the Ministry of Digital Governance, identifying the need for wider spectrum below 1 GHz to be released in order the state to spread the benefits of 5G to rural areas and accelerate Internet of Things (IoT) growth.

In the roadmap towards 6G for achieving ultra-low latency and meeting the requirements of AI-based use cases, the mobile operators should be able to provide computing resources across the whole telco domain – all the way to the edge of the mobile network. MNL has identified the above in the National Strategy for AI. As 5G is known for revolutionising flexibility, 6G would likely be known for using AI to capitalise on flexibility. AI-based services exposure and APIs will play a key role in creating solutions that are both effective and cost efficient.

Active European research projects in 2020 included: 5G!DRONES, 5GENESIS, SANCUS, INSPIRE-5Gplus and a new one starting in 2021 namely EVOLVED-5G. This way, NCSR Demokritos will drastically contribute to the formation of new business models, which will soon emerge from the 5G providers in collaboration with businesses providing new opportunities in the Industry 4.0.

Ahedd, the Attica Hub for the Economy of Data and Devices strives to bring together Research and Industry in order to develop, orchestrate and sustain an open data-driven innovation ecosystem which will facilitate technology transfer, support digital transformation and increase the innovation capacity of SMEs, industrial stakeholders and the public sector.

> In the past year, ahedd grew its cycle of activities and progressed with new business ventures and collaborations.

Experimentation – Among ahedd's immediate goals is the transformation of the NCSR Demokritos Campus into a 5G-enabled smart city ecosystem that will act as a test-bed for experimentation of IoT sensors and platforms and data analytics provision. Under this light, ahedd formed an alliance with Vodafone, to provide the Campus with capabilities, such as smart facility and building management features and security solutions at the Lefkippos Technology Park. In this regard, another collaboration with Fuelics allows to monitor real-time water consumption in the Campus.

Innovation Services – Closely connected to the domain of Artificial Intelligence (AI), ahedd helps transfer to the Industry cutting-edge expertise of IIT Labs and other technology partners (SciFY, LinkedBusiness, SciO, Fint, Fuelics etc.), therefore creating innovation clusters that will pave the way to digital transformation. To this end, ahedd launched a series of workshops on AI, providing top-notch theoretical and hands-on training to company executives, ranging from large tech providers to start-ups.

Additional collaborations were formed for the provision of specialised R&D services such as the development of an AI-enabled dialogue system for the Pepper robots of Athens International Airport, a classification system for legal documents for Nomiki Bibliothiki with SciFY, software for the routing control of a disinfection robotic platform, as well as for the provision of expert consulting services for companies that need to develop AI solutions in-house.

Excellence – ahedd has been selected as one of the three finalists –amongst 185 nominees– at the EEPA 2020 Awards (European Commission Enterprise Promotion Awards) in the category 'Promoting the Entrepreneurial Spirit' through its participation titled 'NCSR Demokritos: Innovation Ecosystem for Sustainable Entrepreneurship'. Finally, research results of the recently completed European H2020 project iASiS (SKEL | The AI Lab) have been

Periklis Terlixidis

exploited with the submission of two patent applications for software by the Institute's researchers and a new start-up, LangAware, opening its wings. A third patent was filed in the frame of the INFORE project.

ahedd also participated in two consortia for the European Digital Innovation Hubs (EDIHs), as a coordinator of Smart Attica and a partner of Smart Health, both ranked 1st among 15 ranked candidates in the Greek pre-selection.

Moreover, ahedd participates in EuroCC, a European project aiming to establish national Competence Centres in the area of High-Performance Computing (HPC) that will inform, train and facilitate the adoption of HPC applications by the Greek industrial ecosystem.

ahedd is a Big-Data Value Association (BDVA) silver-labelled i-space and helped to shape the BDVA's Strategic, Research, Innovation and Deployment Agenda (SRIDA).

Patent Applications in Artificial Intelligence

Aiming to strengthen the Greek innovation ecosystem, IIT performed three patent fillings at the European Patent Office and the US Patent Office during 2020. These patents involve high-potential technological innovations in Artificial Intelligence (AI) that have emerged from EU-funded research and innovation projects. All three innovations have been included in the European Commission's Innovation Radar along with other NCSR Demokritos' innovations. Two of these patents focus on AI in Health whilst one focuses on AI in Maritime.
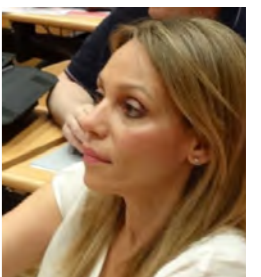
More info: **https://ahedd.demokritos.gr/**

Dr George Giannakopoulos

Dr Denia Kanellopoulou

Dr Xenia Ziouvelou

EDUCATION

Education and the continuous support to national capacity building is a key mission of the Institute and NCSR Demokritos. This mission includes the unification of higher education with research and the building and nourishment of capabilities, ideas and knowledge in Greek society through education. In this direction, the Institute implements a wide set of activities spanning across different levels of education, transferring innovation and excellence in ICT and relevant disruptive technologies into educational assets for PostDoc and PhD students, MSc and BSc students as well as interns. The Covid-19 pandemic imposed challenging conditions during 2020, however IIT ensured that education, excellence and inspiration were seamlessly provided to hundreds of students.

PhDs and Scholarships

In 2020, the excellent collaboration of the Institute with accredited Greek and foreign Universities in Europe and the US continued through many Joint PhD programmes and scholarships, including the highly successful Stavros Niarchos Foundation Industrial Research Fellowship programme. The scholarships provide a fruitful framework, creating prospects that boost researchers' careers.

In 2020, Mr George Retsinas received his PhD degree from the Department of Electrical and Computer Engineering of National Technical University of Athens realised in collaboration with IIT. The main research direction during this collaboration was document analysis and recognition, with emphasis on machine learning approaches.

Internships

In 2020, IIT received numerous applications for internships whilst offering a wide selection of topics, support, tools, and flexibility to students during this challenging year. We were happy to welcome and guide students from Greek Universities into completing 26 internships throughout the year in various topics of Informatics and Telecommunications.

55th Summer School

The NCSR Demokritos Summer School is a historic educational activity which offers, for more than 50 years, open and free classes including talks, presentations and workshops to undergraduate and graduate students of the formal, natural and applied sciences. The 55th Summer School of NCSR Demokritos took place from 13 to 17 July 2020 and due to safety restrictions was conducted virtually for the first time in its long history. IIT supported the highly successful digital realisation of the Summer School, which attracted a record high number of 867 registrations.

The dedicated day of the conference to Informatics and Telecommunications included among others a SingularityU career orientation event and nine presentations across current scientific topics by IIT researchers.

The highlight of the 55th Summer School and IIT day was the invited keynote speech by world renowned Prof Constantinos Daskalakis of MIT, Boston, USA. The captivating keynote speech, titled 'Learning from Biased Data', was delivered live from Boston, followed by a round table where Prof Daskalakis joined IIT researchers into a lively discussion on the multiple aspects and challenges of the Ethics of Artificial Intelligence. During a very memorable session for the audience, IIT researchers were particularly touched by Prof Daskalakis reference to his first visit at IIT, NCSR Demokritos 25 years ago, during a school visit, where he had his first encounter with a deep neural network demo.

More info: **https://shorturl.at/luDK8**

Master's Programmes

In 2020 IIT, co-managed four cross-Institutional Master's Programmes in collaboration with Greek Universities. All Master's Programmes receive increased interest from high quality applicants which currently run in full capacity. The pandemic conditions imposed a new modus operandi during the academic year 2019-2020, adapting quickly and converting to a fully digital programme with remote participation. In October 2021, a **new Master's Degree is starting**, the **MSc Quantum Computing & Quantum Technologies** in collaboration with the Institute of Nanoscience and Nanotechnology (INN) and the Democritus University of Thrace.

MSc in Data Science
University of the Peloponnese

http://msc-data-science.iit.demokritos.gr/

MSc in Artificial Intelligence
University of Piraeus

http://msc-ai.iit.demokritos.gr/

MSc in ICTs & Special Education Psychopedagogy of Integration
Democritus University of Thrace

http://specialedu.iit.demokritos.gr/

MSc in Clinical Practice & Applications Technology in Health
Democritus University of Thrace

https://clinextech.phyed.duth.gr/

ELECTRONIC GOVERNANCE OFFICE OF NCSR DEMOKRITOS

The eGovernance Office of NCSR Demokritos supports the whole Centre as well as the Lefkippos Technology Park and is assisted by the Institute of Informatics & Telecommunications. The Office consists of two dedicated teams: the Application Design & Development Team and the Infrastructures Team.

> This year challenged the eGov Office to respond to increased user needs for online service provision and support.

eGov Application Design & Development Team

The year 2020 saw the foundation of the Application Design & Development Team which is responsible for the design and development of applications and services for NCSR Demokritos and for external entities. The team of six expert developers and designers undertakes work which focuses on the redesign and digitalisation of procedures and services, the implementation of interoperability mechanisms between different digital systems at organisational level, and the creation of a unified context for the development of electronic services always keeping in mind user needs and friendliness of the product to be delivered.

A lot has been accomplished in the first year of the Team's operations including: the design and development of the online presence (visual identity and websites) for the Institute of Nuclear & Particle Physics and the Institute of Nuclear & Radiological Sciences and Technology, Energy & Safety, for ahedd Digital Innovation Hub, and Praxi Network. Additionally, the team worked on the design and development of the Centre's electronic phone catalogue, the deployment of minutes keeping and online voting systems, installation of a cloud repository for IIT and its supportive groups.

Lefteris Koukianakis | Head of Team

Vassilis Diakoumakos
Dimitris Giannakis
Spyros Karagiannis
Vassiliki Kyriakidou
Kostas Stamatakis

eGov Infrastructures Team

The eGov Infrastructures Team is aligned with the strategic planning and programming of the organisation providing services of informatics that cover the administrative services and the research Institutes of NCSR Demokritos. Services such as the seamless distribution of email, eDocuments and eSignatures. Additionally, the team operates and supports the main network infrastructure and the computing resources, as well as the applications of the administration and the Department of Research Special Accounts (ELKE).

As 2020 was marked by the Covid-19 pandemic, the main activities of the eGov Infrastructures Team focused on the transformation of the procedures and the infrastructures, so as to cope with the daily work challenges caused by this new reality.

Usage expansion of the central identity management system, remote access, teleworking and user support system, file sharing, new email system for administrative services, integration of infrastructure for the users of the Institute of Nuclear & Radiological Sciences and Technology, Energy & Safety, are among the tasks implemented.

Charis Koutsouris | Head of Team

Athanasios Fontaras
Christos Liakaris
Charis Margaritis
Kyriakos Papadomanolakis
Dimitris Samartzis

COMMUNICATION

Let's make Science for everyone

The Communications Team of the Institute of Informatics and Telecommunications was set up in 2019 with the aim to assist researchers and Labs to raise awareness of their scientific achievements. The Team consists of three members who support the Labs by planning, creating, and managing all communication and dissemination activities as required.

A wide spectrum of external and internal communications tasks is undertaken; from communicating research project results externally to wider audiences and managing media relations to engaging and building communities by using all the available online and offline tools. Taking into consideration the distinctiveness that this year brought in our daily routines, the Team facilitated the online migration of most activities for Labs to seamlessly continue operations.

The Team also focuses on internal communications working closely with the Labs in the Institute and throughout NCSR Demokritos with the aim to bring colleagues closer and raise awareness amongst Labs on the work conducted.

In our daily work routine, we go by our motto: Science for everyone not just for Scientists!

skel
THE AI LAB

Communication strategies - Rebranding

Social Media Management
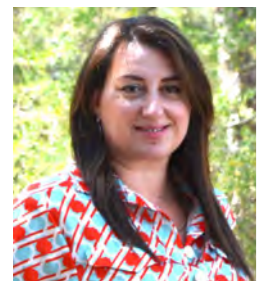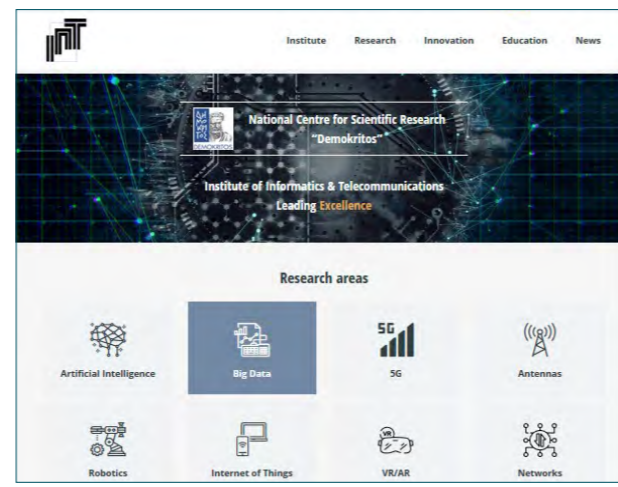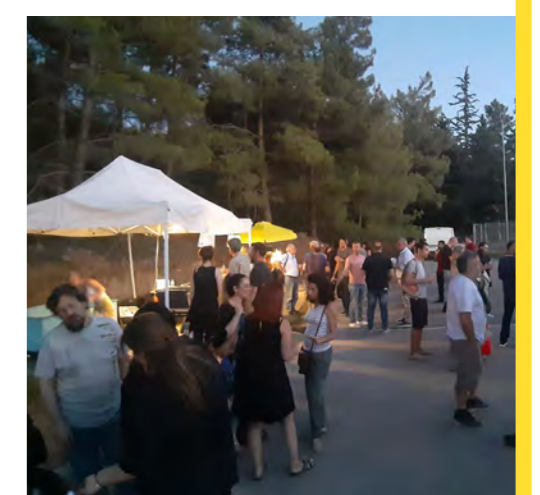
Elena Galifianaki

Elsa Kaltsi

Fay Pitsilidou

Media kits - Cards - Annual Reports

Websites - Videos - eNewsletters: content creation & maintenance

Organising Events

> In 2020, CIL continued its pioneering research activities in historical document image processing aiming to significantly improve access to historical texts and remove the barriers that stand in the way of digitising the European cultural heritage.

> ISL reached another important milestone in 2020 by winning a highly competitive and strategic H2020 grant in AI Security & Ethics.

The Computational Intelligence Laboratory (CIL) undertakes research and development activities in the area of intelligent and adaptive learning systems.

Computational Intelligence Laboratory

Dr Stavros Perantonis
Head of CIL

Dr Basilis Gatos
Research Director, CIL

2020 started with good news for the TRANSKRIBUS project which won a prestigious Horizon Impact Award 2020 in a special session held during the European Research and Innovation Days in September. The award, a European Commission initiative, recognises and celebrates outstanding projects that have used their results to provide value and long-term impact for society. TRANSKRIBUS is a platform that resulted from the completed European research projects READ and tranScriptorium for which CIL's researcher Dr Basilis Gatos was the scientific responsible. The platform uses Artificial Intelligence to access and analyse hand-written historical documents and archives, aiming to preserve European heritage and history. This technology is free and available to everyone, already counting 38.000 registered users, while currently being implemented at the National Archives of Finland and the Netherlands. The Lab continued the implementation of the national research project CULDILE that aims to use advanced imaging and machine learning techniques in order to develop an integrated expert system for capturing and identifying historical documents, enhancing images and understanding historical books and manuscripts automatically.

CIL continued its research activities in human activity and emotion recognition and in multimodal multimedia analysis. Significant progress has been made within the national project ENORASI that aims to provide a novel wearable system that offers accessibility and guidance to open environments of high cultural and touristic value. Progress has also been made on the national project VISOR, which envisions to provide a novel virtual coaching environment for the elderly. In this context, novel algorithms for the recognition of activities of daily living and of medical conditions using non-invasive sensors have been implemented.

Additionally, CIL incorporates the eHealth Unit, led by Dr Homer Papadopoulos, which during 2020 was involved in Interreg projects Remote CARE and Health NET that aim to provide country residents with direct access to medical services through innovative electronic health systems. Moreover, the Unit coordinates the Reference Site: Active and Healthy Ageing for Attica (AHA4Attica). In 2021, two new projects will kick off: Health CASCADE and Colibri WOMEN. The former will work on enabling big data, AI and knowledge management techniques to facilitate evidence-based co-creation services in Health Cascade use cases. The latter aims to contribute in the creation of a Distance Learning Platform to inspire female entrepreneurs in Greece and Turkey to overcome barriers and take their businesses to the next level.

More info: **https://www.iit.demokritos.gr/labs/cil/**

The Integrated Systems Laboratory (ISL), founded in 1999 by the then Director of the Institute, Dr Stelios C. A. Thomopoulos, focuses on large scale integrated pilot projects relevant to contemporary and disruptive technologies in research fields with high impact, including physical and cyber security, digital culture, AR/VR immersive environments, and digital simulation.

In 2020, ISL continued its research, coordination, and management activities uninterruptedly leveraging distance working technology and using Covid-19 crisis mitigation plans on all its ten ongoing R&D projects: the EU funded projects (TRESSPASS, D4FLY, SAFE-TY4RAILS, CIVILNEXT) in the domain of security and MARINE-EO in the domain of Earth Observation; and the nationally funded projects SYNTELESIS, COSMOS, AFIGISSI, ESTIA and TMI-Builder in the domain of digital culture and tourism. Furthermore, ISL continued its collaborative R&D activities with MNL in the 5GENESIS project. Key coordination challenges included the uninterrupted continuation and successful completion of MARINE-EO, the first EU funded Pre-Commercial Procurement (PCP) project on Earth Observation, and TRESSPASS.

TRESSPASS, a security Innovation Action on EU integrated risk-based border management coordinated by ISL, was successfully guided through a very challenging interim review with 40 deliverables, pilot field tests, and a Covid-19 mitigation plan.

SAFETY4RAILS, a security Innovation Action EU H2020 on EU infrastructure protection, began in 2020 with ISL's research focusing on hybrid threat modelling and the use of innovative agent-based simulation for analysing the cyber-physical resilience of metro and railway systems.

During the Frankfurt Book Fair 2020, and through multiple live-streaming sessions, Dr Stelios C. A. Thomopoulos introduced COSMOS to a worldwide audience and raised considerable interest for this innovative digital application for the nonlinear, immersive, and interactive presentation of the ancient Greek Mythology and Art.

In another milestone for ISL, Dr Dimitris Kyriazanos continued to serve as National Representative in the H2020 Programme Committee for Secure Societies. He also coordinated the submission of pop AI, a winning proposal for the creation of a trusted, sustainable, and inclusive European AI hub for Law Enforcement.

More info: **https://www.iit.demokritos.gr/labs/isl/**

Integrated Systems Laboratory

Dr Stelios C. A. Thomopoulos
Head of ISL

Dr Dimitris Kyriazanos
Associate Researcher, ISL

> MNL continued its increasingly active role in research activities of the 5G & cyber security domains through its participation in numerous European and national projects, and its connection with the Industry and the Academic World.

> In 2020, NeL continued its active presence and contribution on building technologies for Heterogeneous Networks, accommodating relevant emerging concepts linked to 5G and energy-efficient networks.

During 2020, Media Networks Laboratory (MNL) continued its research activities in 5G and cyber security through its successful participation in nine EU funded projects.

The Telecommunication Networks Laboratory (NeL) focuses on issues pertaining to the design, operation, management and optimisation of communications and computer networks, with an emphasis on performance and efficiency aspects.

Media Networks Laboratory

The year 2020 proved quite fruitful for MNL in the 5G domain, as it continued its successful participation in research activities in seven EU funded projects, namely 5G-TANGO, IORL, MATILDA, 5G-MEDIA, 5GENESIS, 5GDRONES and RESPOND-A.

In the cyber security domain, the Lab continued its activities by participating in two research EU-funded projects, namely INSPIRE5GPlus and PALANTIR.

Two new projects were brought in: EVOLVED-5G and SANCUS. EVOLVED-5G endorses the vision where the world of NetApps follows the paradigm of mobile applications hosted in a related marketplace. The project will contribute towards Industry 4.0, recognised as one of the major vertical industries by 5G-PPP. Industry 4.0 brings innovative use cases, yet technologically challenging, and creates a fertile environment for SME-driven entrepreneurship, where new use case-tailored functions (as NetApps) can be provided to compose a digitalised, secure, and automated generation of the industrial operations (mainly referring to functions for process and machine control as well as procedures for advanced product lifecycle management). The industry-oriented EVOLVED-5G NetApps will be tested, validated, and certified in a vendor-agnostic experimentation platform, and progressively define the first set of NetApps that the EVOLVED-5G marketplace will host.

SANCUS is related to cyber security which aims to formalise the logic of expressing, for the first time, the notions of cyber security and digital privacy by means of final formulas and fuse them into optimisation strategies to acquire the truly optimum defense recommendation in dynamic manner, i.e., with respect to the runtime changes of the telecommunications network environment. The project will feature new inclusive Key Performance Indicator metrics, such as the security vs privacy vs reliability efficiency trade-off, for measuring the system network cyber security and privacy performance explicitly, flexibly, automatically and agnostically. SANCUS is based on methods for automated firmware and software validation and verification, and innovative Artificial Intelligence driven game techniques for the automated optimisation of the control and trust of digital services.

During the past year, NeL continued its research on the topic of Seamless Mobility and Vertical Handovers in Heterogeneous Networks (HetNets), also considering emerging concepts of 5G software-defined architectures. A methodology was developed to design and assess alternative context acquisition strategies, focusing on the proactive collection of local resource availability information that can enable significant performance gains, by reducing the latency and the computational resources required for initiating a Vertical Handover. This translates into processing and energy consumption savings, towards the goal for greener architectures, and into lower OPEX and CAPEX costs.

NeL's activities continued to focus on research and experimentation in mobile IoT networks, aiming at the development and assessment of novel radio resource management and intermittent connectivity schemes that exploit the mobility characteristics of IoT nodes, considering different use case scenarios related to Smart Cities and Precision Agriculture.

Additionally, NeL participated in Think20, an international engagement group with the mission to provide research-based policy recommendations to the annual G20 Summit in 2020. NeL contributed to the development of policy recommendations that focused on the use of Smart City technologies and the Internet of Things for addressing the challenges of Water, Energy and Food sustainability challenges. Furthermore, NeL participated in two webinars organised by the EU-GCC Clean Energy Technology Network with invited presentations that focused on the use of IoT technologies for supporting the Water, Energy and Food Nexus in Smart Cities.

As always, in 2020 NeL was an active contributor of services to the scientific community. Lab members were invited to the Technical Programme Committees (TPC) of many leading international conferences on networking. Similarly, Lab members were invited to evaluate manuscripts submitted to leading technical journals. Finally, a member of NeL has been appointed as a Review Editor on the Editorial Board of Data Science for Communications, which is a special section of the Frontiers in Communications and Networks journal.

Dr Anastasios Kourtis
Head of MNL

Dr Harilaos Koumaras
Associate Researcher, MNL

Telecommunication Networks Laboratory

Dr Kimon Kontovasilis
Head of NeL

More info: **https://www.iit.demokritos.gr/labs/mnl/**

More info: **https://www.iit.demokritos.gr/labs/nel/**

SKEL | The AI Lab

> The AI Lab, SKEL, operates on a plan to balance scientific excellence, business innovation and social impact.

SKEL | The AI Lab is one of the largest Artificial Intelligence research labs, with more than 70 people, organised in several groups and teams: Content Analysis and Knowledge Technologies, Complex Event Recognition, Data Engineering, Robotics, Centre of Excellence on Document Intelligence, Intelligent Data-Intensive Systems, Biomedical and Health Informatics, and AI for Culture.

The research highlights of SKEL in 2020 include: (a) new methods for complex event forecasting in fast and heterogeneous data streams, (b) multi-relational graph analytics methods for large Knowledge Graphs, (c) a new line of research on the use of AI for representing and reasoning about societal and philosophical values, (d) deep learning methods for the analysis of large collections of legal and financial documents, (e) a method for teleoperating a robot arm through human wrist movements, (f) the first ever federated query processor that can join geospatial linked data, (g) a novel framework to promote biomedical research through the interaction of researchers with automated question answering systems (BioASQ Synergy).

Much of the work in the above areas has matured into various innovative applications, including the LangAware start-up, which emerged from the EU H2020 iASiS project to facilitate the digital diagnosis of Alzheimer's. The same project has produced a patent-pending technology for the prediction of unknown drug-drug interactions for specific diseases, such as lung cancer. Another patent application within 2020 concerned the complex event forecasting technology developed in the context of the EU H2020 INFORE project, with potential applications in maritime surveillance, financial fraud and cancer research. Of direct commercial value is also the work of the DICE Centre of Excellence on the analysis of business documents, which is a collaboration with EY. SKEL is actively pursuing various other collaborations with local and international companies that are interested in AI, through the ahedd Digital Innovation Hub.

The Lab is also actively seeking to address societal problems, through participation in flagship activities, such as the national efforts for precision medicine in cancer and for Covid-19. Similarly, the work on AI and philosophy will have a direct impact on culture, starting with the House of Classical Greek Ideas, an innovative exhibition on Greek ideas and ancient Greek philosophy. Last but not least, in 2020, SKEL has proposed a ground-breaking National Strategy to democratise AI, with a potential international impact.

Additionally, SKEL continued its education activities, co-organising an MSc in AI and an MSc in Data Science, and supervising PhD, MSc and undergraduate theses in collaboration with universities in Greece and abroad. Furthermore, the Lab organised scientific and wider-audience events and webinars in relevant domains. These range from a specialised Dagstuhl seminar and the national AI conference (SETN 2020) to the widely attended Summer School of NCSR Demokritos.

All in all, despite the new ways of working that the pandemic has imposed on us, 2020 was a productive year for SKEL. The quality of our teams provides a solid ground on which even more can be achieved.

More info: **https://www.iit.demokritos.gr/labs/skel/**

Dr George Paliouras
Head of SKEL | The AI Lab

WiCom LAB
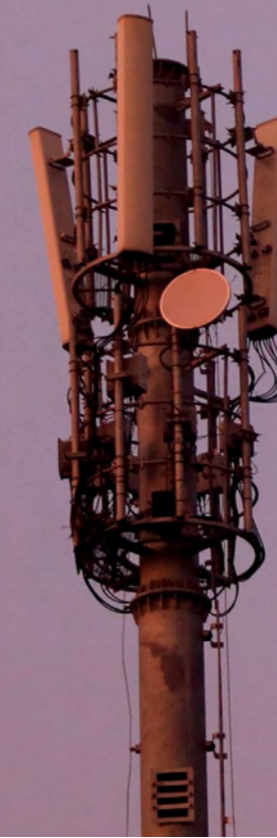
> In 2020, WiCom focused on issues related to mmWave networks and technologies, as well as innovative antenna design, while extending its reach to space applications.

The research activities of the Wireless Communications Laboratory (WiCom) fall under the domains of antenna design and implementation, MIMO telecommunication systems, characterisation measurements and wireless communication channel modelling, electromagnetic interaction between human body and antennas of wireless systems and body-centric communications and wearable antennas.

In 2020, work on channel modelling at the D-band focusing on small scale fading statistics was based on measurement data shared by Aalto University, Finland. Significant effort was devoted to the study of Reconfigurable Intelligent Surfaces (RIS), artificial structures acting as intelligent signal reflectors. RISs are a hot topic in wireless communications, especially for beyond 5G technologies. The research was also focused on High Gain Antennas (HGA) operating both in D- and X- frequency bands. Challenges and requirements associated with mmWave HGAs have been investigated and various designs of reflector antennas in X-band for satellite applications were analysed and evaluated.

During 2020, WiCom research was supported by two European projects, ARIADNE and ESA-DELHILA. ARIADNE is an ICT-Horizon 2020 project that brings together a novel high frequency advanced radio architecture and Artificial Intelligence (AI) processing and management approach into a system beyond 5G in D-band. This project is implemented by WiCom in close collaboration with SKEL | The AI Lab.

The ESA-DELHILA project, is funded by the European Space Agency (ESA) aiming at the development of a deployable reflector antenna in X-band for small spacecraft science missions. The project is a great challenge for the Lab, as it provides the chance to exploit its infrastructure and know-how of antenna technologies in the field of space applications.

At the end of 2020, a new project kicked off named META WIRELESS, which is a Marie Curie Innovative Training Networks (ITNs) project that will investigate RISs in future wireless networks. In the beginning of 2021, another project will start, the M-REWEAR PostDoc research project, which is funded by the Hellenic Foundation for Research and Innovation (ELIDEK) and will study innovative structures for the reconfiguration of wearable textile antennas.

In the area of Education, two Fellowships of the Stavros Niarchos Foundation (SNF) Industrial Research Fellowship Programme were successfully completed, one on the topic of wearable antennas and the other on the design of mmWave MIMO transceivers.

Noteworthy is the signing of an Open Innovation Collaboration Agreement between WiCom and Adamant Composites Ltd, a high-tech industrial Greek SME. The agreement sets the ground to jointly claim funds for R&D in the area of innovative antenna systems for space applications.

More info: **https://www.iit.demokritos.gr/labs/wicom/**

Wireless Communications Laboratory

Dr Antonis Alexandridis
Head of WiCom

ISLab

> ISLab collaborates with IIT's research laboratories MNL, SKEL | The AI Lab and ISL, on 5G networks, cyber security and precision medicine networks.

NML & Mind LAB

> Through its activities in research projects, as well as in Education via the postgraduate and PhD Programmes, NML & Mind aims to innovate across different disciplines.

The Internet Systematics Lab (ISLab) is dedicated to specialised services and products in Computer Networks. The Lab is one of the first Network Labs in Greece formed in the mid-80s, which pioneered the development of the Greek NREN. In addition, ISLab introduced the first ISP in Greece in 1992 and co-founded with OTE and NTUA the Commercial Internet Services in 1995. During 2002-2007, ISLab pioneered awareness about Internet attacks, being part of the International Honeynet Research Alliance.

Net Media Lab & Mind-Brain R&D activities span the areas of Research and Development in the domains of e-Services, emphasising on innovative interdisciplinarity between ICTs, STEM, Neuropsychology, General and Special Education, e-Entrepreneurship, e-Environment, e-Culture, and e-Government.

In the year 2020, ISLab created the eFiling Cloud Platform, an innovative electronic filing system, which allows users to pre-search and file patents and applications for copyright online. The project was successfully completed and handed over to the Greek Industrial Property Organisation (OBI) to be provided as a service to the Greek and the European public. In the first months of having been put to use, OBI received several thousand applications which indicates the heightened interest and the need of the market for such a system. eFiling was also mentioned in the Press as a contribution to the digital transformation of the Greek Industrial Property Organisation (OBI).

During the year, ISLab has also been mentioned in numerous publications, like the Aspects of the History of Computing in Modern Greece, a record of vital contributions in the history of Computing and the impact of Computing on society, published by the Institute of Electrical and Electronics Engineers (IEEE) amongst others.

Finally, the Lab participated in the scientific conference FOSSCOMM 2020, the 13th Conference of the Free and Open Source Software Communities Meeting, with a presentation under the title 'A case of Migration to an SDDC based on Open Source' where Lab's focus for the past three years is an innovative digital skills learn-by-doing platform. This is to cater for the massive number of mini Data Centres expected to appear in the coming years.
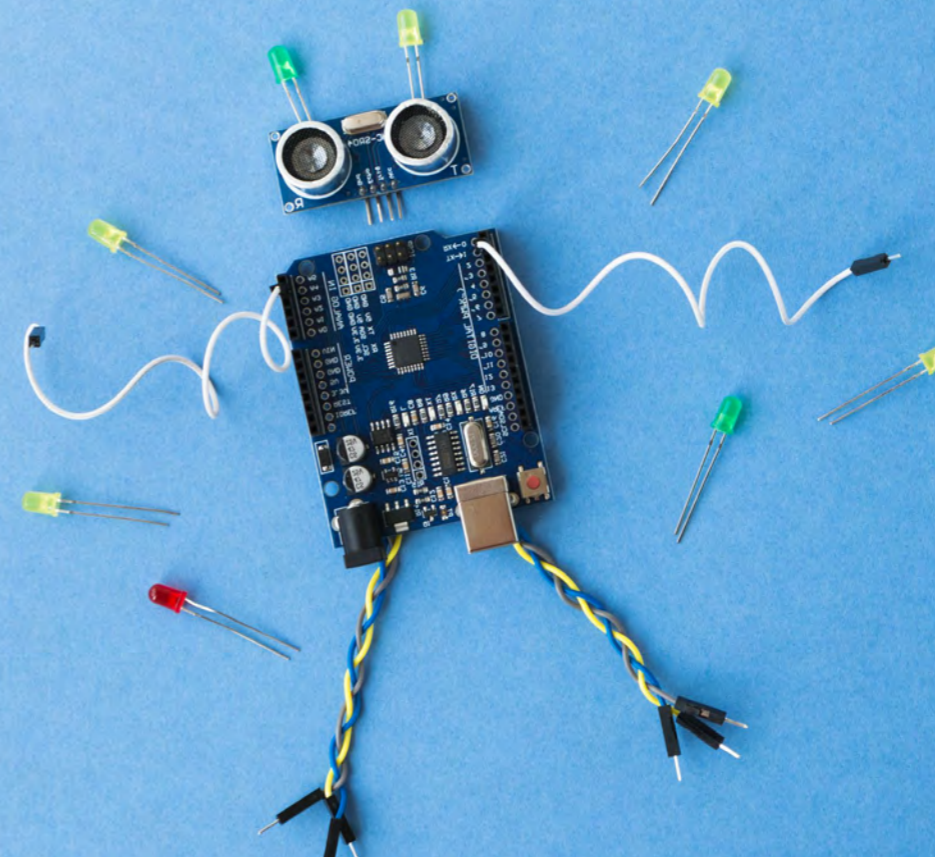
During 2020, the NML & Mind Lab continued with the coordination of the Erasmus+ project CODESKILLS4ROBOTICS and its participation in four Erasmus+ projects: Seniors Go Digital, ROBOTICS4DEAF, MeLDE and CLICHA. In 2020, NML & Mind Lab became a partner in the Erasmus+ project MGM: MYgrant METAMORPHOSIS. In December 2020, the new project 3D2ACT kicked off, which focuses on 3D Technologies through social entrepreneurship.

Towards the end of the Seniors Go Digital project, the Lab successfully organised a training activity and the International Conference entitled 'Seniors Go Digital: Active Aging and ICTs', with the participation of all partners (Sweden, Cyprus, Greece, Bulgaria, Italy). The Lab also participated in the training activity of the MeLDE project, during which secondary school teachers from the UK, Cyprus, Greece and Germany, were trained on media and digital literacy skills.

The Lab's activities also included its participation in several forums and events, such as the 5th Business Forum of the CLICHA project which took place at the Latvia University of Life Sciences and Technologies; the 1st International Interdisciplinary Online Conference entitled 'The Traffic Society - Considering Parameters for Tomorrow's Mobility' organised by the Hellenic Driving Instructors Association; and the 55th Summer School organised by NCSR Demokritos.

Finally, the 3rd cycle of the interinstitutional postgraduate degree programme 'Specialisation in ICTs and Special Education: Psychopedagogy of Inclusion' concluded with the graduation of students. The successful two-year programme kicked off for the 5th time running in collaboration with the Democritus University of Thrace.

The future looks promising, as an additional research project STEAM4ALL was approved to start in the beginning of 2021.

Internet Systematics Laboratory

Net Media Lab
Mind & Brain R&D

Dr Yannis Korovesis
Head of ISLab

Dr Athanasios Drigas
Head of NML & Mind

More info: **https://www.iit.demokritos.gr/labs/islab/**

More info: **https://www.iit.demokritos.gr/labs/nml/**

LIBRARY BUILDING

Renovated library basement hosts IIT groups

The basement of the Library building of NCSR Demokritos gained new tenants in 2020. The area was fully renovated to host IIT teams. Amongst them are included the DICE team, the eGovernance Application Design & Development Team and the Intelligent Data-Intensive Systems group of SKEL | The AI Lab. More building work will be underway in 2021 to cater for the increased relocation needs of more IIT personnel and Lefkippos Technology Park companies.
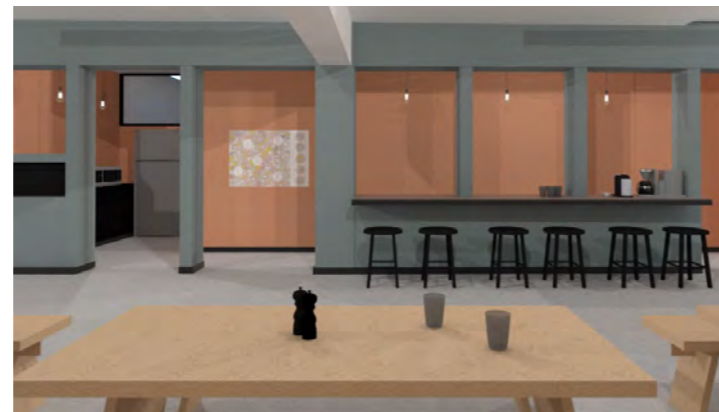
NEW IIT BUILDING

Design plans progressed in 2020

The design phase of the new IIT building, which is co-funded by the European Investment Bank (EIB), progressed well during 2020, despite the Covid-19 pandemic. A Task Force was created comprising the Institute's personnel, as well as architects, civil and electrical engineers. The Task Force objective was to draft a document that would collect all the requirements and assumptions related to the new building. The Task Force held weekly meetings drafting use cases that exploit the smart features of the new building, preparing the requirement elicitation phase. In addition, architectural issue, were discussed for the floor plans and the inclusion of additional older structures delegated to the new building. Finally, the first designs for the Data Centre and its placement were achieved. The plan for 2021 is to finalise the requirements elicitation that will lead to the first technical implementation proposal and proceed with the publication of the procurement call.
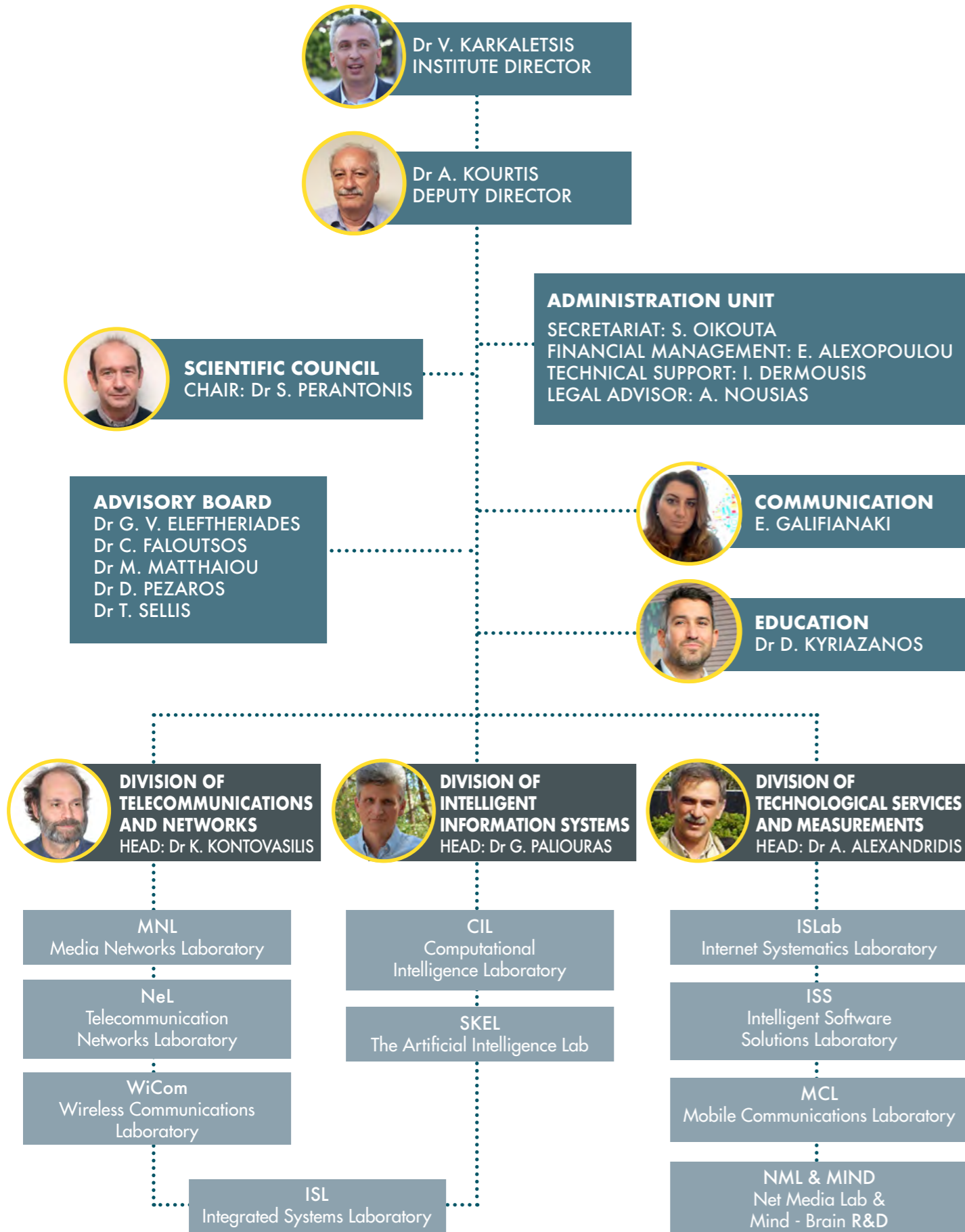
Pictured from left to right: Thanos Stubos, George Nounesis, Christos Dimas and Vangelis Karkaletsis during the inauguration ceremony of the EIB project

ORGANISATIONAL CHART

Dr V. KARKALETSIS
INSTITUTE DIRECTOR

Dr A. KOURTIS
DEPUTY DIRECTOR

ADMINISTRATION UNIT
SECRETARIAT: S. OIKOUTA
FINANCIAL MANAGEMENT: E. ALEXOPOULOU
TECHNICAL SUPPORT: I. DERMOUSIS
LEGAL ADVISOR: A. NOUSIAS

SCIENTIFIC COUNCIL
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DIVISION OF TELECOMMUNICATIONS AND NETWORKS
HEAD: Dr K. KONTOVASILIS

DIVISION OF INTELLIGENT INFORMATION SYSTEMS
HEAD: Dr G. PALIOURAS

DIVISION OF TECHNOLOGICAL SERVICES AND MEASUREMENTS
HEAD: Dr A. ALEXANDRIDIS

MNL
Media Networks Laboratory

NeL
Telecommunication Networks Laboratory

WiCom
Wireless Communications Laboratory

CIL
Computational Intelligence Laboratory

SKEL
The Artificial Intelligence Lab

ISLab
Internet Systematics Laboratory

ISS
Intelligent Software Solutions Laboratory

MCL
Mobile Communications Laboratory

ISL
Integrated Systems Laboratory

NML & MIND
Net Media Lab &
Mind - Brain R&D