

# Activity Report 2020



# Contents

Forewords	2
In Brief...	4
Research Achievements and Awards	5
Research Activities	6
Competitive R&I Funded Projects	11
KIOS Innovation Hub: Collaboration with Industry	17
KIOS CoE Research Infrastructure	20
Education & Training Activities	22
Communication & Dissemination Activities	23

Published by:  
KIOS Research and Innovation Center of Excellence

Copyright © 2021 KIOS CoE. All Rights Reserved.

## CONTACT US

KIOS Research and  
Innovation Center of  
Excellence

1 Panepistimiou Avenue  
P.O.BOX 20537  
2109 Aglantzia, Nicosia

Tel: +357 22 893450/893451  
Fax: +357 22 893455  
Email: [kios@ucy.ac.cy](mailto:kios@ucy.ac.cy)

Follow us:



[www.kios.ucy.ac.cy](http://www.kios.ucy.ac.cy)



# Forewords



## Message from the Rector

“ The University of Cyprus has continued to offer high-quality teaching and maintained an active presence in the fields of research and innovation locally and internationally

Dear reader,

In these challenging times for the world, and Cyprus in particular, knowledge and education have proven to be a significant factor for ensuring financial development and social growth. 2020 has been a pivotal year, as academics, scientists and students from various disciplines all over the world came together in a collective effort to fight the COVID-19 pandemic and contributed with their expertise and proficiency by providing their services, novel ideas and constructive insight.

The University of Cyprus has continued to offer high-quality teaching and maintained an active presence in the fields of research and innovation locally and internationally, while adhering to the standards that have established it as the best Higher Education Academic Institution in Cyprus, since its founding in 1989. For the third year in a row, it has been ranked amongst the #601-700 and #501-600 best universities in the world for 2020, according to the widely recognised Shanghai Ranking List and the Times Higher Education World University Rankings respectively.

The University of Cyprus, with almost 7,000 students, currently hosts 7 Faculties with 22 Departments which offer a number of diverse undergraduate and postgraduate programs. Numerous research projects currently being run by the University are funded by the European Commission, the Cyprus Research and Innovation Foundation, certain public and private research organisations, as well as industrial and governmental organisations.

The KIOS Research and Innovation Centre of Excellence has a fundamental role in the Institution's aspiration to develop into a dynamic pillar of education, research and innovation, globally renowned and with a distinct international stature.

Throughout the past year, the Centre made important contributions towards developing new knowledge and promoting research and innovation excellence at both the local and international levels.

I wish to congratulate the Faculty and researchers of the KIOS Research and Innovation Centre of Excellence on their exceptional devotion and tireless effort to preserve and improve the already eminent work of the Centre, as well as on excelling in research and innovation.

Sincerely,

Professor Tasos Christofides  
Rector, University of Cyprus



## Message from the Director

“ As we are looking further into the future, we will continue to strive towards providing an inspiring environment in Cyprus for carrying out top level research and innovation

By all accounts, 2020 has been a challenging year worldwide due to the global pandemic. Under these unprecedented conditions and continuing uncertainty, both in Cyprus and internationally, the KIOS Center of Excellence remained focused on its goals: to conduct cutting-edge research and innovation in the area of Information and Communication Technologies, and to produce new knowledge and tools for solving real-life societal and technological problems.

During the period covered in this Activity Report, the KIOS Center of Excellence has been highly successful in attracting competitive research funding at the European level, including a prestigious ERC Synergy Grant (the first such grant for Cyprus), and participating in several multidisciplinary research projects funded by international and national funding sources. Moreover, KIOS researchers have continued publishing their research work in high impact journals and international conference proceedings.

Significant progress was made in the Center's collaboration with governmental organizations and several companies in Cyprus and abroad through new research and innovation projects. Additionally, the KIOS Center of Excellence voluntarily supported the national efforts in Cyprus to effectively confront the COVID-19 pandemic by developing an emergency response management system for recording, analyzing and managing all suspect and confirmed COVID-19 cases in Cyprus, which is fully utilized by the Ministry of Health.

In conclusion, I would like to take this opportunity to express my gratitude and appreciation to all KIOS personnel for their hard work and remarkable dedication, which have added value to the Center and helped it to reach new heights. I would also like to thank the leadership of the University of Cyprus, for their ongoing strong support.

As we are looking further into the future, we will continue to strive towards providing an inspiring environment in Cyprus for carrying out top level research and innovation.

Prof. Marios M. Polycarpou,  
Director, KIOS Research and Innovation Center of Excellence  
Professor of Electrical and Computer Engineering, University of Cyprus  
Honorary Professor, Imperial College London, U.K.  
Founding Member of the Cyprus Academy of Sciences, Letters, and Arts



# In brief



The KIOS Research Center was established in 2008 at the University of Cyprus and was subsequently selected by the EU to advance into a Research and Innovation Center of Excellence in 2017.

The mission of the KIOS Research and Innovation Center of Excellence (KIOS CoE) is to conduct multidisciplinary research and innovation in the area of Information and Communication Technologies (ICT) with emphasis on the monitoring, control, management and security of critical infrastructures. These infrastructures include large-scale, complex systems such as power and energy systems, water systems, transportation systems, telecommunication networks, and emergency management and response systems.

The Center's vision is to provide an inspiring environment for conducting excellent, cutting-edge research at a global scale, producing new knowledge and advanced engineering and management tools that can be applied to solve timely and real-life problems in the considered Critical Infrastructure Systems.

## SCIENTIFIC FOUNDATIONS

● Research in high-tech areas important to Cyprus and the global economy

- Computational Intelligence & Machine Learning
- Control & Optimization
- Modeling & Simulation
- Intelligent Data Processing
- SW/HW System Design & Integration

## APPLICATION AREAS

- Power & Energy Systems
- Water Systems & Environmental Monitoring
- Intelligent Transportation Systems
- Telecommunication Systems & Networks
- Emergency Management & Response

## RESEARCH OUTCOMES

- Intelligent Monitoring & Control
- Resilience, Adaptation & Reconfiguration
- Security, Safety & Trustworthiness
- Big Data Analysis & Management
- Performance & Energy Optimization

# Research Achievements

## ERC Synergy Grant – The 1st for Cyprus

A major achievement for the KIOS Center of Excellence at the University of Cyprus was the securement of an ERC Synergy Grant, that was awarded to the Center's Director Prof. Marios Polycarpou for the research project "Water-Futures". Although Cyprus has had significant successes in securing competitive funding from the European Research Council, this ERC Synergy Grant is the first for an academic institution based in Cyprus. The Grant was awarded in 2020 and the research project will commence in 2021.



## 4 Researchers received EU MSCA Grants to undertake research at KIOS CoE

Four talented researchers have been awarded prestigious Research Fellowships in 2020 through the EU Marie Skłodowska Curie Action Grants (MSCA) to undertake research at the KIOS Research and Innovation Center of Excellence. The Research Fellowships were awarded to Dr. Kleanthis Malialis, Dr. Yiolanda Englezou, Dr. Christian Vitale and Dr. Andreas Kasis to work on the projects "FAULT-LEARNING", "Bayesian Intelligent Transportation Systems – BITS", "Connected Autonomous Vehicles Orchestrated with Intelligent Decisions – C-AVOID" and "SmarTher Grid", respectively.



## Emergency Management System for Handling COVID-19 Cases

In 2020, the KIOS research team in collaboration with the Cyprus Ministry of Health and the Deputy Ministry of Research, Innovation and Digital Policy voluntarily developed the "Emergency Management System for Handling COVID-19 Cases" to assist in the fight against the COVID-19 virus pandemic crisis in Cyprus. The system contributed significantly in reducing the time for tracking suspected or confirmed cases of coronavirus in Cyprus and assisting the Cyprus Government in making vital policy decisions related to the handling of the pandemic. As a recognition of this contribution, the KIOS CoE received an Honorary Award from the Scientific Technical Chamber of Cyprus (ETEK), as part of the "ETEK Engineering Award".



## Competitive Research Projects and High-Impact Publications

In 2020 the KIOS CoE coordinated or participated in 36 multidisciplinary research projects awarded after a competitive process and funded by international and national funding sources. In addition, the KIOS CoE researchers have continued to conduct excellent research and publish their research findings in high-impact international journals and conference proceedings, with a total of 100 publications by the KIOS researchers in 2020.

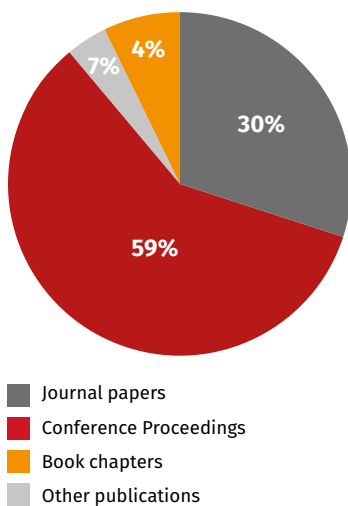




# Research Activities

## Scientific dissemination

KIOS CoE Publications 2020



Scientific dissemination is an important and integral part of the KIOS CoE since it fosters the transfer of knowledge and results in international scientific communities.

In 2020, the KIOS Faculty and the wider KIOS research team have published 89 journal and conference papers, 4 book chapters and 7 other publications.

### • Peer-reviewed journal publications

Academic journals serve as one of the principal forums for researchers, to disseminate their research work within the scientific community. The KIOS CoE researchers continue to target high-quality and high-impact journals, whose topics of interest cover the research activities of the Center. In 2020, the KIOS research team has published 30 peer-reviewed journal papers in academic journals within their areas of expertise.

### • Conference proceedings

Conference proceedings facilitate fast scientific dissemination, allowing researchers to present their research to conferences, workshops and symposia, aiming at the fast and wide adoption of their research ideas by their peers in the scientific community. In 2020, the KIOS research team has published 59 peer-reviewed papers in scientific conference proceedings.

## KIOS CoE Open Science Activities

The KIOS CoE has recognized the significance of openly disseminating scientific results. Towards that goal the KIOS Open Knowledge Portal<sup>1</sup> was launched in 2017. This is an online repository hosted on Zenodo that stores and manages all research-related papers, open research data and open source code produced at the KIOS CoE. The majority of the Center's journal and conference publications are available to the scientific community following the "green" open access model through this Portal.

In addition, the KIOS CoE Repository on Github<sup>2</sup> is another channel for making the software code and associated datasets available to the research community.

Finally, the KIOS CoE follows the best practices in Open Science and actively contributes to reproducible research initiatives. To this end, a number of scientific results produced at KIOS CoE can be easily reproduced online by other researchers using the relevant software code and accompanying data that are publicly available on the KIOS CoE Reproducible Research Platform on Code Ocean<sup>3</sup>.



<sup>1</sup> <https://zenodo.org/communities/kios-coe/>

<sup>2</sup> <https://github.com/KIOS-Research>

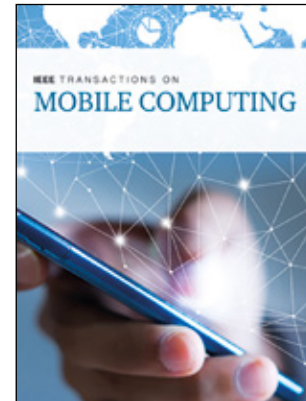
<sup>3</sup> <https://codeocean.com/explore/capsules?query=kios>

## Research News

### Jointly-Optimized Searching and Tracking with Random Finite Sets

The main objective of a search and rescue mission is to search for and provide aid to people who are in imminent danger as efficiently and safely as possible. Towards this goal, the KIOS research team proposes a unified probabilistic approach to jointly tackle the problem of searching and tracking of multiple moving targets (survivors) by a team of mobile agents inside a given surveillance area. A novel decision and control algorithm is developed, that takes into account the stochasticity of the system in order to tackle the joint objective of searching and tracking. Subsequently, the decision and control problem is formulated as a non-linear binary optimization program (NLBP) which is then solved using a genetic algorithm. To study the effectiveness and performance of the proposed approach extensive simulation experiments were conducted.

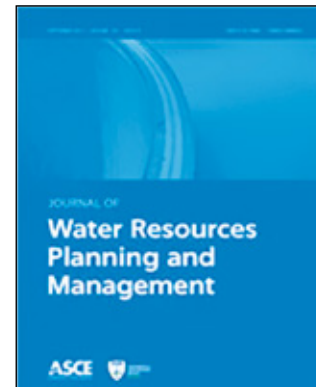
S. Papaioannou, P. Kolios, T. Theodorides, C.G. Panayiotou, and M.M. Polycarpou, "Jointly-Optimized Searching and Tracking with Random Finite Sets", *IEEE Transactions on Mobile Computing*, 19(10):2374-2391, 2020.



### Faster Water Contamination Alerts using Active Fault Detection

As contamination events in water distribution systems, mainly due to infrastructure failures or accidents, can have a significant impact on the health of the consumers, they must be detected quickly. The KIOS research team collaborated with Technion - Israel Institute of Technology to address this challenge by utilizing the concept of Active Fault Detection (AFD), an attractive alternative to manual water sampling. Through this approach, the operator manipulates the system inputs to maximize the ability of detecting a possible contamination event. Using remotely controlled valves, the proposed approach aims to drive water from a suspected contamination location to a specialized sensor, which can confirm a contamination event, while also maintaining the system operability. Moreover, the contamination impact (e.g., the number of people affected) is minimized through this approach. The main results of this work are the mathematical formulation of the active contamination detection problem and the development of a solution methodology using heuristic optimization approaches.

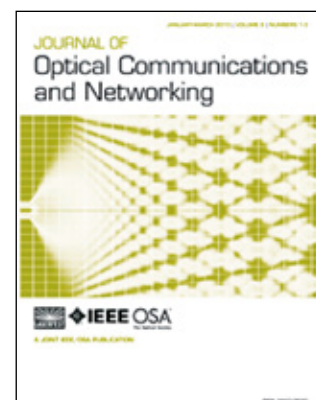
S. Vrachimis, R. Lifshitz, D.G. Eliades, M.M. Polycarpou, A. Ostfeld, "Active Contamination Detection in Water-distribution Systems", *ASCE Journal of Water Resources Planning and Management*, 146(4), 04020014, 2020.



### Decentralizing Machine-learning-based QoT Estimation for Sliceable Optical Networks

Network slicing is considered today as a promising and fundamental framework for supporting 5G mobile networks and their emerging services and applications that have very diverse service level requirements. The KIOS research team investigated the machine learning (ML)-based Quality-of-Transmission (QoT) estimation problem for sliceable optical networks, where each slice has to meet a different QoT requirement. Centralized and distributed frameworks are examined and compared according to their model accuracy, routing and spectrum allocation (RSA) accuracy, and CPU (training time) and RAM (memory) requirements. Further, it is demonstrated that the multi-slice QoT-aware RSA approach significantly improves network performance, a clear indicator that the commonly considered single-slice QoT-aware RSA approach may lead to connection overprovisioning.

T. Panayiotou, G. Savva, I. Tomkos, and G. Ellinas, "Decentralizing Machine-learning-based QoT Estimation for Sliceable Optical Networks," *IEEE/OSA Journal of Optical Communications and Networking*, 12(7):146-162, 2020.







## Robust Machine Learning Systems: Challenges, Current Trends, Perspectives, and the Road Ahead

Currently, machine learning (ML) techniques are at the heart of smart cyber-physical systems (CPSs) and Internet-of-Things (IoT). Despite their high inference accuracy in practical applications, ML systems are highly vulnerable to security and reliability threats at both the cloud and the edge. Poisoning the training data, inserting malicious components into the system hardware, polluting inputs with imperceptible noise during inference, process variation during hardware fabrication, and memory errors are some of the ways that can affect the security/reliability of an ML system. Approaches to defend ML systems against these concerns exist, but each approach has its own limitations. This article provides a comprehensive overview of vulnerabilities that affect modern ML systems, surveys state-of-the-art attacks and defense mechanisms, describes different solution, directions and challenges, and identifies potential promising avenues to research.

M. Shafique, M. Naseer, T. Theocharides, C. Kyrkou, O. Mutlu, L. Orosa, and J. Choi, "Robust Machine Learning Systems: Challenges, Current Trends, Perspectives, and the Road Ahead", *IEEE Design & Test*, 37(2): 30-57, 2020.



## State Estimation for Distribution Grids with a Single-Point Grounded Neutral Conductor

Distribution system state estimation (DSSE) has been enabled by the deployment of smart meters and is currently the subject of active research, focused mainly in medium-voltage distribution grids (MVDGs). This article proposes a modified weighted least-squares (WLS) DSSE for low-voltage distribution grids (LVDGs) where the neutral conductor is grounded only at the MV-LV substation. The effectiveness of the proposed DSSE is illustrated in a real LVDG and in the IEEE European low-voltage test feeder under different operating conditions, smart meter classes, and system layouts. In addition, a Monte Carlo analysis is performed for highlighting the importance of the proposed modifications to the WLS DSSE. Among others, the analysis indicates that the proposed method converged in all trials, despite including the neutral voltage in the state vector.

A. Kotsonias, M. Asprou, L. Hadjidemetriou, and E. Kyriakides, "State Estimation for Distribution Grids with a Single-Point Grounded Neutral Conductor", *IEEE Transactions on Instrumentation and Measurement*, 69(10): 8167-8177, 2020.



## Scalable Distributed Sensor Fault Diagnosis for Smart Buildings

The enormous energy use of the building sector and the requirements for indoor living quality that aim to improve occupants' productivity and health, prioritize Smart Buildings as an emerging technology. The Heating, Ventilation and Air-Conditioning (HVAC) system is considered one of the most critical and essential parts in buildings since it consumes the largest amount of energy and is responsible for the comfort of the buildings' inhabitants. This article presents a distributed intelligent fault diagnosis algorithm for detecting and isolating multiple sensor faults in large-scale HVAC systems. Modeling the HVAC system as a network of interconnected subsystems allows the design of a set of distributed sensor fault diagnosis agents capable of isolating multiple sensor faults by applying a combinatorial decision logic and diagnostic reasoning. The performance of the proposed method is investigated with respect to robustness, fault detectability and scalability.

P.M. Papadopoulos, V. Reppa, M.M. Polycarpou, and C.G. Panayiotou, "Scalable Distributed Sensor Fault Diagnosis for Smart Buildings", *IEEE/CAA Journal of Automatica Sinica*, 7(3):638-655, 2020.

## Scientific Conferences

During 2020, the KIOS CoE successfully organized four international conferences in Cyprus: the “23rd EURO Working Group on Transportation” (EWGT 2020), the “IEEE Computer Society Annual Symposium on VLSI” (ISVLSI 2020), the “Security Helix Event” (in collaboration with the Crowdhelix Network) and the “Evolution of Power Systems” - A Workshop in memory of Elias Kyriakides.

The aim of the conferences was to attract academic and industrial professionals, scientists and professional engineers from all over the world and give them the opportunity to present their work, to discuss with peers, to exchange ideas and transfer knowledge, as well as to expand their networks and explore future collaborations.

The organization of scientific conferences helps to increase the reputation of both KIOS CoE as a center that promotes excellence in research, and Cyprus as a country that is an ideal destination for hosting high-quality scientific events.



*The 23rd EURO Working Group on Transportation*



*Security Helix Event*

## KIOS CoE participation in EU level networks

In 2020, the KIOS CoE research team participated in a number of brokerage events organized by the EU, aiming to increase the visibility of the Center and to exploit future collaborations. This enables the KIOS CoE team to reach potential partners and increase access to proposal consortiums.



### **A sample of events in 2020 with KIOS researchers participation:**

- Workshop on Security Issues for Horizon Europe (17 January 2020)
- H2020 Secure Societies Info Day & Brokerage Event (12/13 March 2020)
- Water Knowledge Europe 2020 - EU Green Deal Call Brokerage event (12 October 2020)
- Water Workshop on the Security Appraisal for Horizon Europe (18 November 2020)
- Knowledge Europe 2020 - Horizon Europe Brokerage event (9 December 2020)





# 154

## RESEARCHERS EMPLOYED by KIOS CoE at the end of 2020

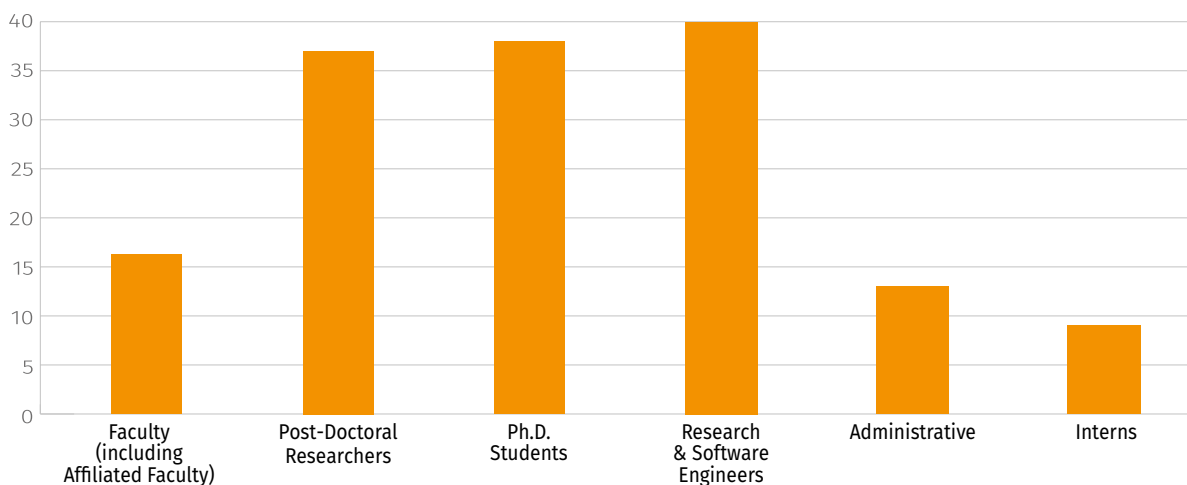
### KIOS CoE Personnel

The human capital is the most important asset of an organization. Thus, the KIOS CoE places particular emphasis on recruiting high-caliber researchers who will contribute significantly to the development of the Center.

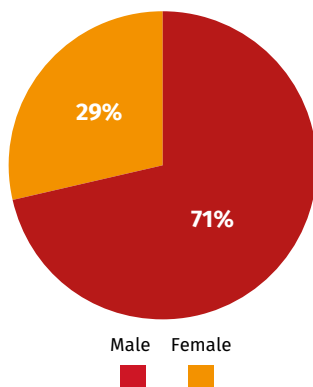
The KIOS CoE places also particular emphasis on promoting diversity, equal opportunities and gender balance at all levels of its research and innovation teams. Towards this end, the Center aims to increase gender balance among its research personnel by offering female researchers an attractive working environment. In addition, the KIOS CoE has developed recruitment initiatives to attract highly-qualified personnel from Europe and the Middle East - North Africa (MENA) region.

At the end of 2020, 154 researchers were employed by the KIOS CoE including full-time and part-time employees. This number includes Faculty, Affiliated Faculty, Research Faculty, Postdocs and Research Associates, PhD Students, Research and Software Engineers, Interns and Administrative Personnel. In addition, the KIOS CoE spoke at Imperial College London employs 13 Researchers.

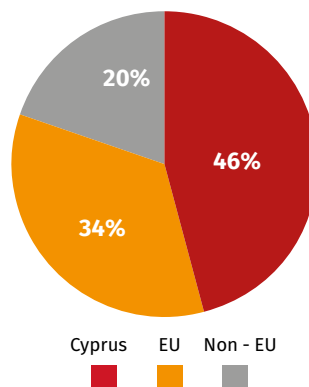
KIOS CoE Personnel 2020



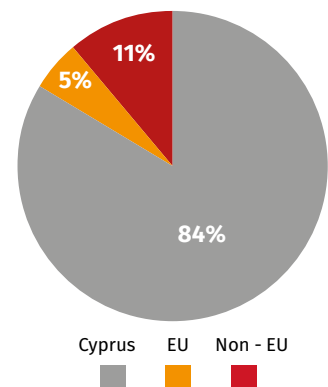
Gender



Country of Highest Academic Degree



Country of Origin



# Competitive R&I Funded Projects

In 2020, the KIOS CoE participated in a number of collaborative research and innovation projects funded by various competitive funding programs including Horizon H2020, the Cyprus Research and Innovation Foundation, other EU funding programs, including INTERREG and SolarEranet Co-fund, as well as EU funding programs tackling specific EU policy and objectives such as emergency response. These projects which involve multidisciplinary international consortiums address important global challenges for critical infrastructure systems such as power and energy systems, water networks, transportation networks, telecommunication networks, and emergency management and response systems.

**36**  
**FUNDED**  
**RESEARCH**  
**PROJECTS**  
in 2020

ACRONYM	SHORT DESCRIPTION	FUNDING SOURCE	KIOS ROLE
1 KIOS CoE	The KIOS CoE project focuses on the advancement of KIOS into a world-class research and innovation Center of Excellence. The project which is part of the EU's strategic program "Spreading Excellence and Widening Participation", is being implemented in collaboration with Imperial College London	EU - H2020 TEAMING*	Coordinator
2 PathoCert	Development of technologies for detecting and managing pathogen contamination events during emergency response situations	EU - H2020	Coordinator
3 EMPOWER	Empowering the Cyprus power system with sustainable and intelligent technologies to enhance its stability and reliability, under high penetration of renewable energy sources	Cyprus RIF <sup>1</sup>	Coordinator
4 SmartWater2020	Development of smart technologies capable of helping water authorities to improve their water distribution system's monitoring and control capabilities	EU - INTERREG Greece - Cyprus	Coordinator
5 SWIFTERS	Effective use of Unmanned Aerial Vehicles (UAV) swarms for the prevention and response to emergency situations	EU CIVIL PROTECTION	Coordinator
6 FAULT LEARNING	Design and development of an online learning-based fault diagnosis engine with adaptation capabilities - MSCA Research Fellowship	EU - H2020 MSCA	Coordinator
7 BITS	Development of Bayesian statistical methodologies and tools in the area of Intelligent Transportation Systems - MSCA Research Fellowship	EU - H2020 - MSCA	Coordinator
8 C-AVOID	Development of a realistic fully-fledged transportation architecture based on the new generation of cellular networks (5G) - MSCA Research Fellowship	EU - H2020 - MSCA	Coordinator



9	SmarTher Grid	Design of control schemes for thermostatic loads to provide effective, efficient, and reliable ancillary support to the power network - MSCA Research Fellowship	EU - H2020 - MSCA	Coordinator
10	GLADIATOR	Next-generation theranostics of brain pathologies with autonomous externally controllable nanonetworks: a trans-disciplinary approach with bio - nanodevice interfaces	EU - H2020 FET OPEN	Coordinator
11	REALFLON	Design and development of innovative optimization algorithms for resource allocation, scalability, and security in flexible optical networks	Cyprus RIF	Coordinator
12	ITS-CONNECT	Development of novel monitoring and control solutions to improve the efficiency of road transport	Cyprus RIF	Coordinator
13	GLADIATOR Complementary	Complementary infrastructure to support the development of a working prototype of a complete, autonomous and clinically applicable, nanonetwork-based, Molecular Communications platform	Cyprus RIF	Coordinator
14	CAPACIDI	Building the capacity of researchers to coordinate and participate in EU funded project	Cyprus RIF	Coordinator
15	OneNet	Development of new generation of grid services able to fully exploit demand response, storage and distributed generation	EU - H2020	Partner
16	AIDERS	Deployment of artificial intelligence techniques for the improvement of emergency response	EU CIVIL PROTECTION	Partner
17	MariSense	Development of a maritime cognitive decision support system	Cyprus RIF	Partner
18	Control4COVID	Development of an intelligent emergency information management platform for controlling COVID-19	Cyprus RIF - Seed-COVID	Partner
19	CovTracer-EN	Development of the CovTracer - Exposure Notification tracing application in collaboration with the CYENS CoE	EU - ESI	Partner
20	AURA	Development of an innovative software for the improvement of the indoor air-quality monitoring in large, energy efficient buildings	Cyprus RIF - Pre-Seed	Partner

21	SWIFTERS	Enable local and international security organizations to build, manage, and scale their drone programs, and leverage the full capabilities of drones in their own missions	Cyprus RIF - Pre-Seed	Partner
22	KIOS CoE - HUAWEI	Development of an information fusion radio location algorithm with Tango-aided floor plan and signal mapping	HUAWEI Technologies Ltd	Partner
23	DiMPAH	Aggregate, connect, and make widely available, novel open education resources on selected digital methods	EU - ERASMUS	Partner
24	AIRMOS	Implementation of intelligent real-time drone monitoring tactics to safeguard sensitive facilities	Cyprus Seeds	Partner
25	CUREX	Address the protection of the confidentiality and integrity of health data by producing a novel, flexible, and scalable situational awareness-oriented platform	EU - H2020	Partner
26	DOMOGNOSTICS +	Conduct industrial research, develop and evaluate an innovative low-cost intelligent software/hardware solution designed for building operators to better monitor and control their building systems	Cyprus RIF	Partner
27	CARMEL	Address the cybersecurity challenge of the next generation mobility, contributing to the long-term vision of safer roads with zero fatalities	Cyprus RIF	Partner
28	EnergyXchange	Conduct industrial research to develop and evaluate a novel product to facilitate the introduction of stakeholders to the new liberalized energy market	Cyprus RIF	Partner
29	Pvgnosis	Development and demonstration of technical novel solutions to advance the operation, maintenance, and lifetime of photovoltaic plants	Cyprus RIF and EU - SOLAR ERANET <sup>2</sup>	Partner
30	CERETAB	Utilization of new, state-of-the-art border surveillance technologies for border monitoring and security	EU Internal Security Fund Borders and Visa	Partner
31	LEAPFROG	Introduction of remotely piloted aircraft systems (RPAS) modules to the voluntary pool of emergency response units through the development of standard operating procedures, addressing regulatory, technical and organizational aspects, establishing training structures, and conducting relevant exercises	EU CIVIL PROTECTION	Partner
32	WaterAnalytics	Development of an innovative low-cost intelligent software/hardware solution to reduce the water system's operational expenses, leakages, and energy usage	Cyprus RIF	Partner





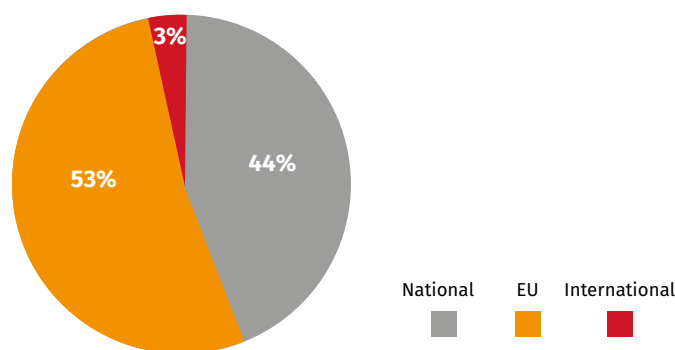
33	CybPhys	Upgrade bachelor/master-level curricula and study programs in Belarusian and Ukrainian universities in the area of cyber-physical systems modelling and simulation	EU - ERASMUS+	Partner
34	FLEXITRANSTORE	An integrated platform for increased flexibility in smart transmission grids with storage entities and large penetration of renewable energy sources	EU - H2020	Partner
35	FLOBIT	Smart water usage and savings enablement metering system, supported by artificial intelligence and machine learning methods, for building environments	Cyprus RIF	Partner
36	RONDA	Help transport stakeholders better assess the condition of the roadway network and its vulnerabilities, mitigate associated risks, and manage transport networks	Cyprus RIF	Partner

\* Complementary funding for the KIOS CoE is provided by the Government of the Republic of Cyprus through the Directorate General for European Programmes, Coordination and Development, by the University of Cyprus and Imperial College London.

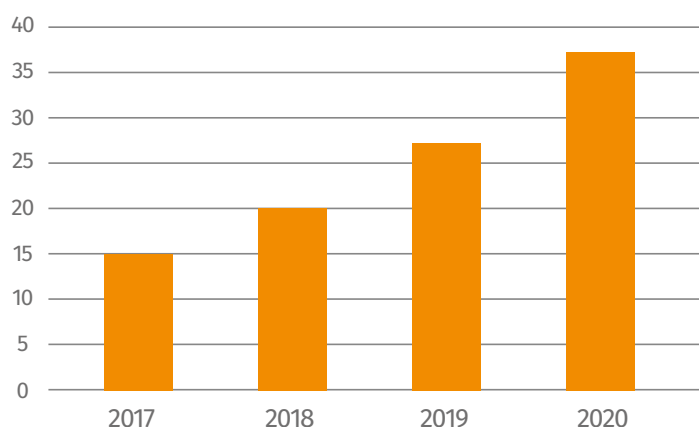
(1) Cyprus RIF - Cyprus Research & Innovation Foundation

(2) Horizon 2020/FP 7 SOLARERA.NET Cofund and the Cyprus Research and Innovation Foundation

Number of project by Funding Source



Competitive funding projects per year



---

## Competitive R&I funded projects

### Selected projects

A sampling of research at KIOS CoE is presented below.

---

#### Pathogen Contamination Emergency Response Technologies

The PathoCERT project aims to develop novel technologies for detecting and managing pathogen contamination events during emergency response situations.

PathoCERT's outcomes will strengthen the capabilities of first responders and agencies, in terms of real-time accurate pathogen detection, increased situational awareness, improved ability in contamination event control and risk mitigation, and joint coordination between agencies to effectively manage these events

This project is funded by the EU Horizon 2020 research and innovation programme and includes 23 partners from the European Union and South Korea.

---



#### One Electrical Network Infrastructure for Europe

The OneNet project aims at creating the conditions for a new generation of grid services able to fully exploit demand response, storage, and distributed generation, while creating fair, transparent, and open conditions for the consumer.

The OneNet project aspires to create a unified vision for the European electricity market, involving system operators, aggregators, prosumers, and other stakeholders across Europe.

This project is funded by the EU Horizon 2020 research and innovation programme and includes 70 key partners from several countries of the European Union.

---



#### Deployment of Artificial Intelligence Techniques for the Improvement of Emergency Response

The AIDERS project aims at developing machine learning algorithms and a novel mapping platform to help authorities process and analyze the large volume of data received in real-time.

This will improve the capability of first responders to obtain accurate visualizations that can help build knowledge maps, which can assist command stations to make more informed and reliable decisions in crisis situations.

The project is funded by the European Union Civil Protection.

---



#### Artificially Intelligent Real-Time Drone Monitoring Tactics to Safeguard Sensitive Facilities

The AIRMOS project focuses on the implementation of intelligent real-time drone monitoring tactics to safeguard sensitive facilities.

It acts complementary to existing approaches employed in the Security Services sector and addresses the growing scale and sophistication of threats by enhancing monitoring and response capabilities, enabling economies of scale and introducing higher security levels.

This project is funded by the Non-Profit Organization Cyprus Seeds.





### Bayesian Intelligent Transportation Systems - (BITS) – MSCA Research Fellowship

The BITS project aims to transfer Bayesian statistical methodologies in the area of Intelligent Transportation Systems (ITS) and contribute towards the efficient decision-making and fault diagnosis capabilities of intelligent vehicles (IVs), as well as improve their collective behavior when interacting with other vehicles and the road infrastructure.

The project is funded by the EU Horizon 2020 research and innovation programme.



### Connected Autonomous Vehicles Orchestrated with Intelligent Decisions (C-AVOID) – MSCA Research Fellowship

The C-AVOID project focuses on connected autonomous vehicles orchestrated with intelligent decisions and aims at unveiling the safety potentials provided by the next-generation of cellular networks (5G) in the automotive sector.

The focus of the project is on collision avoidance by exploiting the modeling of human driver maneuvers and on the autonomous vehicle coordination at dangerous road areas

The project is funded by the EU Horizon 2020 research and innovation programme.



### Ancillary Services from Smart Thermostatic Loads in Power Grids (SmarTherGrid) – MSCA Research Fellowship

The SmarTherGrid project aims to address the problem of designing control schemes for thermostatic loads to provide effective, secure and efficient ancillary support to existing frequency mechanisms in the power network.

The project is funded by the EU Horizon 2020 research and innovation programme.



### Air Quality Monitoring for Indoor Environments

The AURA project aims at improving indoor air-quality monitoring in large, energy efficient buildings and reducing the overall cost of the monitoring system by developing an innovative software for the monitoring purposes.

The developed software will be able to detect and localize the source of contaminant sources in the interior of the buildings and minimize at the same time the required sensing devices.

The project is funded by the European Regional Development Fund and by the Republic of Cyprus through the Research and Innovation Foundation.

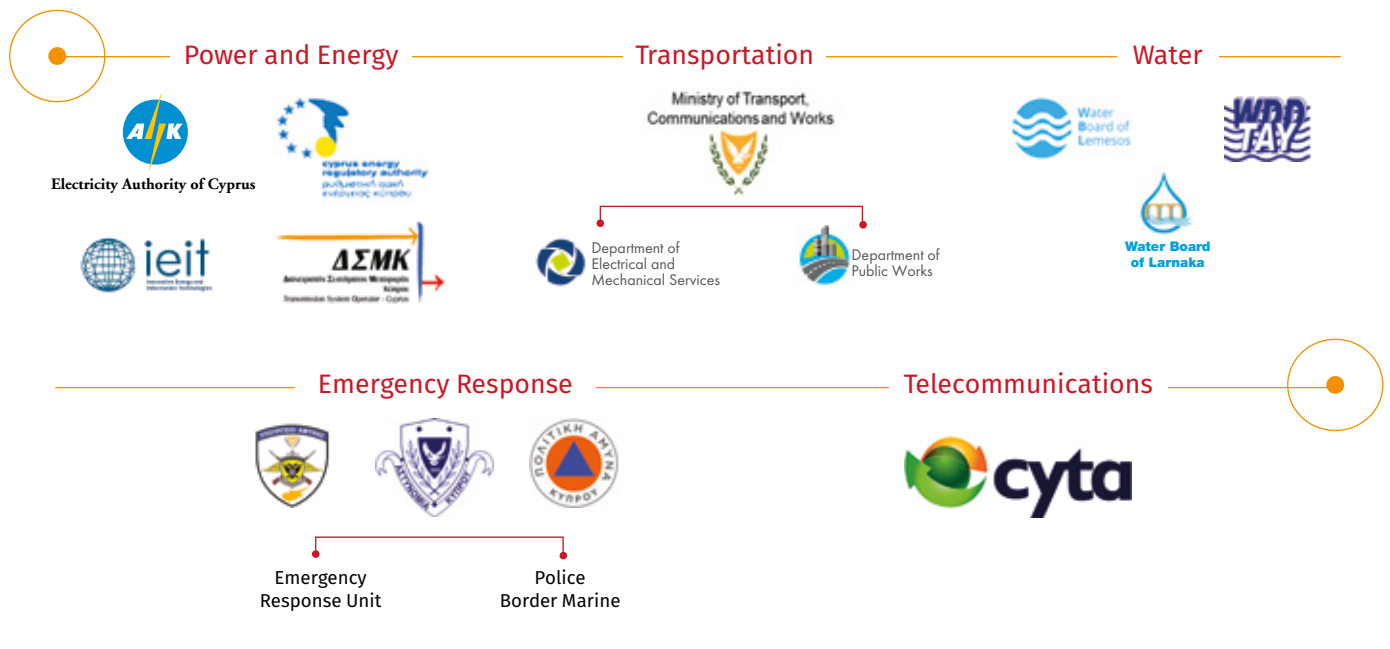
# KIOS Innovation Hub: Collaboration with Industry

The KIOS Innovation Hub was created in 2017 with the aim to enable the technology transfer of the core research competencies of KIOS CoE in the area of ICT to organizations involved in the monitoring, control, security and management of critical infrastructures.

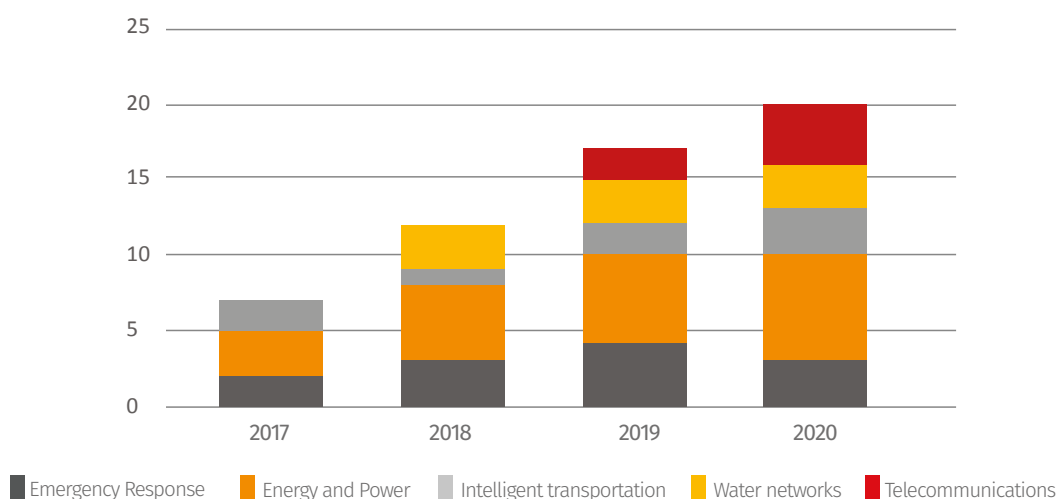
Its vision is to promote collaboration between academia, industry, operators of critical infrastructure systems, regulators, as well as governmental organizations with the ultimate goal to create an ecosystem that spans the entire innovation cycle from conception of an idea to its commercialization.

**20**  
**ACTIVE**  
**PROJECTS**  
with the  
**INDUSTRY**  
in 2020

## Innovation Hub Partners



## Active Projects per Application Area





## Power Systems

In 2020, the KIOS CoE undertook several research projects in collaboration with the Electricity Authority of Cyprus (EAC) and the Transmission System Operator (TSO). These included the optimization of the Cyprus transmission and distribution power systems, the redesign of the Cyprus Electricity System ahead of 2021-2030, the development of EAC's risk management system, as well as the planning of the EAC's communications network infrastructure. Furthermore, the Center collaborated with the company Innovative Energy and Information Technologies LTD to investigate the impact of cyber-attacks on smart grids operation using the advanced power systems testbed infrastructure.



## Transportation Systems

During this period, the research team was involved in research and innovation activities in collaboration with the Public Works Department of the Ministry of Communication and Works of the Republic of Cyprus. These activities included the development of the software platform "GNOSIS" which collects, stores, analyzes and manages data regarding the Cypriot transport network as well as the platform "TN-ITS" which provides open data related to changes of regulations within the road network of Cyprus.



## Water Distribution Systems

In collaboration with the Water Board of Limassol (WBL), our team of researchers and engineers further developed the "OCEANOS" software platform, an integrated system for efficiently managing water distribution systems. Oceanos will bring WBL closer to its vision to establish a "Smart Water Network". In addition, KIOS CoE studied the impact of COVID-19 to water consumption at different representative areas within the utility.



## Emergency Management and Response Systems

During 2020, the research team upgraded the innovative "Mission Control" platform with real-time data fusion algorithms to facilitate the informed operations for the Cyprus Police Emergency Response Unit. Moreover, the team worked on the development of the decision support system "RESPonse" for the Port and Marine Police to improve the situational awareness at an operational level. Finally, the KIOS CoE in collaboration with the Cyprus Ministry of Health and the Deputy Ministry of Research, Innovation and Digital Policy, worked on the development of the "Emergency Management System for Handling COVID-19 Cases", on the "SNOW" contact tracing system for all positive cases, and on the new contact tracing app "CovTracer-EN" which enables anonymous alerting of citizens of potential exposure to COVID-19.



## Telecommunication Systems

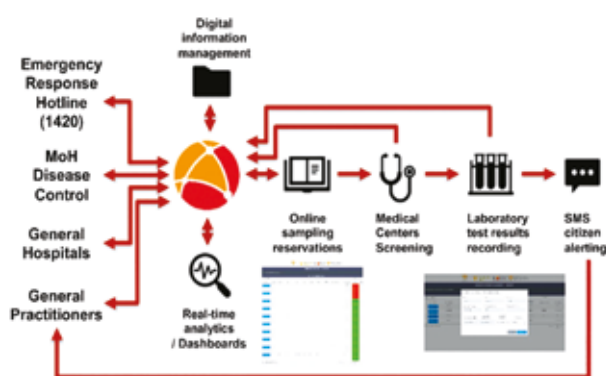
In this period, the Center was involved in three research projects in collaboration with the Cyprus Telecommunications Authority which focused on the use of machine learning and optimization algorithms to enhance CYTA's operational capabilities. These included the development of a chatbot software for customer experience purposes, the creation of job scheduling methodology and the improvement of customer experience and satisfaction at the CYTA Call Centre by analyzing customer behavior.

During the March-April 2020 lockdown period, the KIOS CoE research team volunteered to utilize its expertise in Information and Communication Technologies (ICT), data analysis and emergency response management to assist in the fight against the COVID-19 virus pandemic crisis in Cyprus. In collaboration with the Cyprus Ministry of Health and the Deputy Ministry of Research, Innovation and Digital Policy, the KIOS research team developed the **“Emergency Management System for Handling COVID-19 Cases”**.

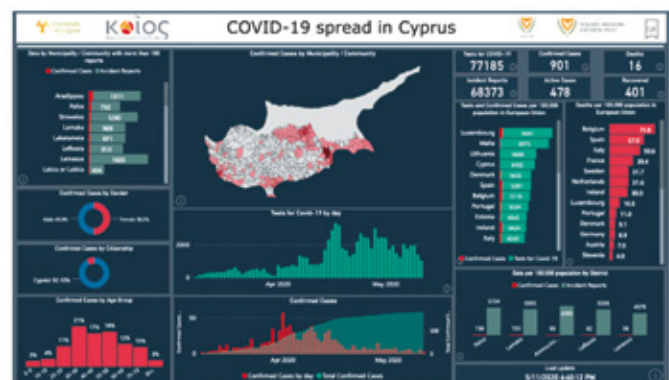
The system developed by KIOS CoE provides a distributed data management service with multiple interfaces for the different user roles. It automates the processes for scheduling of test-sampling of patients at health centers, the reporting of test results, and patient notification of their test results. The system algorithms enable the analysis of the data in real-time and the visualization of the information through dashboards, thus providing a valuable resource for the health experts and decision makers, to obtain up-to-date information on the spread of the virus in Cyprus.



*The Ambulance Service team of the hotline 1420 enters data on the computer*



### End-to-end system architecture



*Web Portal for Information on the Spread of COVID-19 in Cyprus*





# KIOS CoE Research Infrastructure

## KIOS Testbeds

The KIOS CoE, together with Imperial College London, develop physical and virtual platforms, the KIOS CoE Testbeds, for conducting rigorous and transparent testing on methodologies, tools and new technologies related to the monitoring, control, management and security of large scale and complex critical infrastructure systems (CIS). These environments allow researchers to examine the reliability, safety, security and resilience of a wide range of cyber-physical systems and add value to their research and innovation activities. Furthermore, these infrastructures can be utilized by the Center's collaborators and partners to advance the technological readiness levels of new concepts and tools as well as promote the efforts towards the co-creation of new products and services.

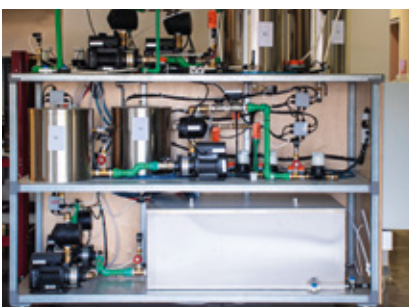
## Power Systems

The Power Systems Testbed targets high penetration of Renewable Energy Sources (RES) to reduce greenhouse gas emissions. The testbed aims towards modeling, simulation, emulation, and experimental validation of energy systems, with capabilities in the development of smart technology for the efficient and reliable integration of renewable energy sources both at the building and grid level. A real-time simulator is used to develop digital twins of actual power systems and investigate the interaction with smart grid controllers and actual power devices in hardware in the loop framework. Three different energy storage setups are integrated to study the intelligent capabilities of batteries and flywheel systems. Further capabilities of the testbed include the development of real-time control algorithms for power electronic converters to advance the grid integration of renewable energy sources as well as testing of cyber security solutions in active distribution grids and in digital substations.



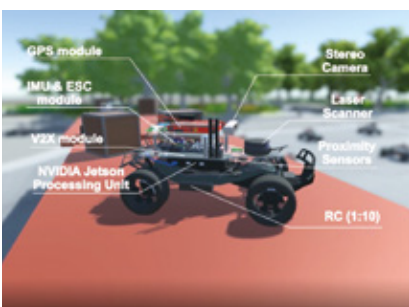
## Water Systems

The Water Security Testbed is a small-scale representation of an urban water transport system, and is composed of a network of tanks, pumps, valves as well as hydraulic and quality sensors. A key feature is the ability to reconfigure the topology and to emulate realistic water demands through its controller. The Testbed can be used as a benchmark to generate datasets that can be used by researchers to demonstrate results in the area of real-time monitoring, control, management, and cyber-physical security. The research infrastructure is complemented with a virtual city water distribution system, corresponding to 10,000 consumers, to be able to demonstrate, in a realistic environment, the impact of these technologies, for instance, in reducing water losses, improving security, and reducing greenhouse gas emissions.



## Transportation Systems

The Transportation Systems Testbed consists of robotic cars representing real-life Connected and Autonomous Vehicles (CAVs) in the scale of 1:10. The CAVs will play a significant role in future transportation systems and will provide enormous societal and environmental benefits in terms of reducing traffic accidents, enhancing quality-of-life, improving the efficiency and costs of transportation systems, and reducing greenhouse gas emissions. The testbed is a real-time experimental platform with various sensors installed



to collect real-time measurements that allows the development and evaluation of novel monitoring, management and control schemes related to the recently introduced CAVs within a low-cost, controlled and safe environment.

## Emergency Response, Sensors and Robotics

The KIOS CoE develops state-of-the-art tools and methodologies for emergency response management, as well as monitoring and inspection of critical infrastructures through the utilization of Unmanned Aerial Vehicle (UAVs), sensors and robotics technologies.

These technologies are used for the development of intelligent functionalities including automated path-planning, real-time image analysis, and object detection and coordination architectures for multi-drone systems that ensure scalable and robust operations. The key benefits of such systems include, the enhancement of public safety, improvement of CIS efficiency, safety of operations and hazards avoidance, reduction of person-hours and costs.

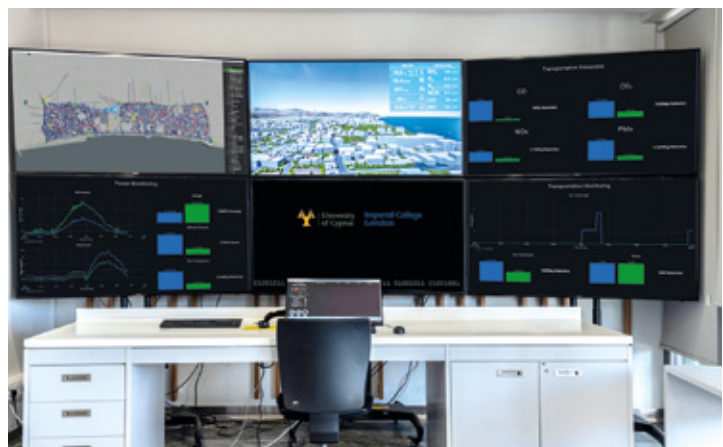


## KIOS Virtual City

The KIOS Virtual City is a specially designed virtual platform to assist with the management and operation of interdependent critical infrastructures systems (e.g., water, power, telecommunications, transportation, and health systems) and can be used to assess the cascading effects of natural or manmade disasters (e.g., flooding, power blackouts) which can seriously impact people's everyday lives, affecting their safety and well-being.

The Virtual City emulates the actual operation of critical infrastructure systems (CIS) within the urban and sub-urban environment and offers a virtual decision support facility for assessing the security and efficiency of a city as well as its environmental footprint and operational costs.

This platform is ideal for use by policy makers, CIS operators, and other stakeholders to assist them towards their decision making with respect to the management of a smart city environment. It is accessible through the KIOS Control Room with custom interfaces and it is also available as a research tool to be downloaded by researchers.





# Education & Training Activities

Education and training activities are essential for building and maintaining scientific excellence at the Center. During 2020, the MSc Program in Intelligent Critical Infrastructures run successfully for the second consecutive year. In addition, the KIOS personnel participated in a number of training activities such as workshops, seminars, webinars and talks that helped their development and enhanced their competences.



Master of Science in  
INTELLIGENT CRITICAL  
INFRASTRUCTURE SYSTEMS

## MSc Program in Intelligent Critical Infrastructure Systems

The innovative MSc Program in Intelligent Critical Infrastructure Systems is offered by the Department of Electrical and Computer Engineering at the University of Cyprus in collaboration with the KIOS Research and Innovation Center of Excellence and Imperial College London.

It is designed to train high-qualified engineers on the newest ICT approaches, in order to be able to deal with the challenges in monitoring, control, management and security of critical infrastructure systems, namely power systems, water distribution networks, telecommunication networks and transportation systems. The coursework provides a blend of the necessary theory, tools, applications, transferable skills and practical/research experience, in a holistic approach which provides students with knowledge, skills, competencies and experiences relevant to the topic of the program. Furthermore, the program takes advantage of the state-of-the-art buildings and laboratory/testbed infrastructure facilities at the University of Cyprus campus.

The duration of the program is 3 semesters (1.5 years) and is also available for part-time students (6 semesters / 3 years). Courses are delivered by academics from the University of Cyprus and Imperial College London.

In 2020, five students successfully completed their MSc Thesis on diverse application areas such as "Cyber security in power networks", "Cyber-Physical attack graphs", "Route reservation architecture", "Routing, Spectrum, and Core allocation in Spatially Spectrally - Flexible Optical Networks" and "Integrating renewables and other emerging technologies into the smart grid".

For more information about the program please visit the website: [www.msccis.ucy.ac.cy](http://www.msccis.ucy.ac.cy)

## Personnel Learning, Training and Development

In 2020 the KIOS personnel had the opportunity to attend workshops, seminars, webinars, and talks covering a variety of topics such as Innovation & Entrepreneurship, Project Management and Intellectual Property Management, QGIS Python Programming, Introduction to Web programming for GIS applications, Writing Django apps, JavaScript algorithms and Data Structures, etc.

# Communication and Dissemination Activities

The KIOS Research and Innovation Center of Excellence places special emphasis on communication and dissemination activities in order to make its research activities and results accessible to its stakeholders, partners, and the general public.

For the year 2020, the Center's dissemination and communication activities included:

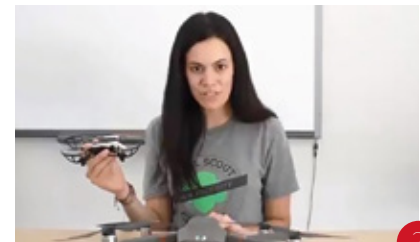
- High profile visits
- Short videos
- International competitions
- Networking events with the industry
- Outreach activities
- Online presence
- Media publicity

## High – profile visits

The KIOS CoE has gained significant national and international visibility through high-profile visits from international experts, national policy and decision makers, and enterprise and innovation experts. An example is the visit by a delegation of the Cyprus Deputy Ministry of Research, Innovation and Digital Policy, the Director General of the Research and Innovation Foundation, and the National Chief Scientist for Research and Innovation (photo 1).

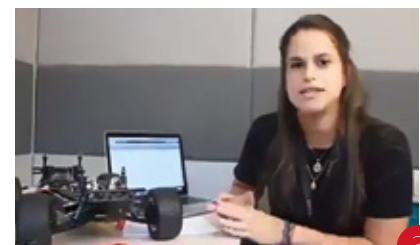


1



2

*Dr. Maria Terzi, post-doc researcher talked about how data collected from multiple drones can address emergency situations*



3

*Dr. Yiolanda Englezou, a Marie Curie Fellow, talked about intelligent transportation systems*

## “MyJobinResearch” video challenge

The KIOS CoE researchers participated in the EU Research Executive Agency (REA) video challenge “MyJobinResearch”, by preparing short videos, in which researchers very briefly and concisely presented their research. Two videos were selected by REA for publication in its Twitter Account. You can find the related videos on the KIOS YouTube channel (photos 2, 3).

## International Competitions

The KIOS CoE organized two international research and Innovation competitions related to intelligent water and transportation systems. The first, named “BattLeDIM2020: Battle of the Leakage Detection and Isolation Methods” addressed the detection of leakage events within water distribution systems. Over 100 researchers and engineers participated in this event from 13 countries.



The second, named “Electric Vehicle Routing Problem”, focused on optimization methods to find the best possible routes within the battery charge level limits of electric vehicles. Several international research groups participated in this competition, which was organized at the 2020 IEEE World Congress on Computational Intelligence.

In addition, the KIOS CoE research team participated in another international research and Innovation competition named MyGalileoDrone 2020, organized by the European Global Navigation Satellite Systems Agency.







KIOS – Electricity Authority of Cyprus workshop



KIOS – Public Works Department workshop



GIS workshop

## Networking Events with the Industry

During 2020, the KIOS CoE organized three networking events to promote its research activities and the successful collaboration with its industrial partners through the KIOS Innovation Hub.

The first event involved the Electricity Authority of Cyprus, the second the Public Works Department of the Ministry of Transport Communication and Works, and the third the stakeholders of critical infrastructures that use Geographic Information Systems (GIS) as a tool to enhance and improve their operations. All events attracted stakeholders, decision makers, and government officials, and highlighted the benefits of research and innovation for the society at large.

## Outreach Activities

### • Undergraduate Research Opportunities Program

The KIOS CoE organized the prestigious Undergraduate Research Opportunities Program (UROP) for young students for the 12th consecutive year. In 2020, KIOS accepted nine students into the program. The selected students had the opportunity to work with KIOS faculty and researchers on innovative research projects for two months.

### • European Researcher's Night 2020

The KIOS CoE participated in the European Researcher's Night 2020, held as a virtual event due to the pandemic. Visitors to the KIOS virtual booth had the opportunity to learn about renewable energy technologies, and intelligent water, transportation and telecommunication systems. Furthermore, they were informed on how Artificial Intelligence can improve drone-based in emergency response missions and how coronavirus transmission becomes manageable with mobile tracking.

All videos with the KIOS CoE research activities presented at the European Researcher's Night 2020 are available on the KIOS YouTube Channel.



## Online Presence

The KIOS CoE uses a number of online communication mediums to disseminate the Center's research results, news and events, achievements etc. Examples include the KIOS website, the KIOS e-newsletter, as well as our social media pages (Facebook, Twitter, LinkedIn, and the YouTube).

## Media Publicity

The research activity undertaken at the KIOS CoE has been widely published in the printed and electronic media. This includes a number of articles in newspapers and websites with large readership numbers.





The KIOS Center of Excellence has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement No. 739551 (KIOS CoE).



The KIOS Center of Excellence has received funding from the Government of the Republic of Cyprus through the Deputy Ministry of Research, Innovation and Digital Policy.

Complementary funding for the KIOS CoE is also provided by the University of Cyprus and Imperial College London.