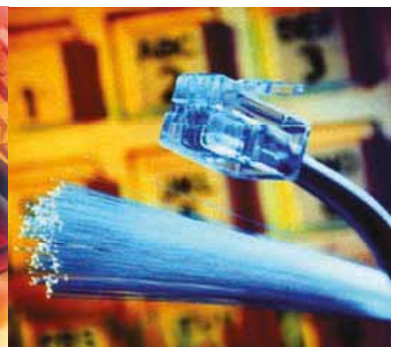




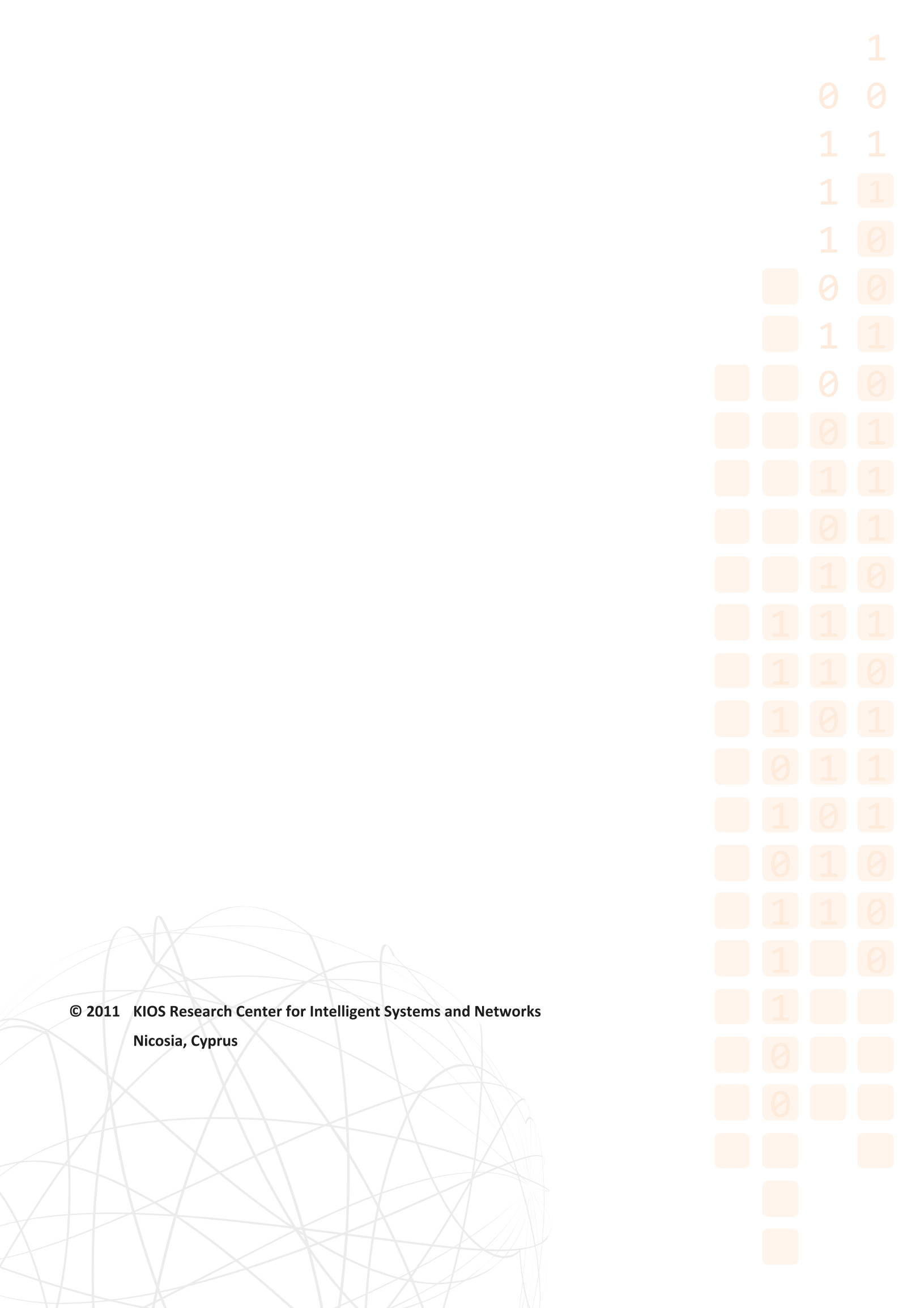
KIOS Research Center for Intelligent Systems and Networks

Biennial Report September 2009 – August 2011

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University
of Cyprus



The KIOS Research Center for Intelligent Systems and Networks is committed to cutting-edge, interdisciplinary research in intelligent monitoring, optimization, and management of complex, safety-critical systems.

KIOS Biennial Report

September 2009 – August 2011

State of the Center 2

Message from the Rector 3

Message from the Director 4

Highlights and Achievements 5

Research 6

Research Output 8

Research Programs 9

Collaborations 14

International Collaborations 15

Industrial and Local Partnerships 16

Honors and Awards 18

Outreach 22

Undergraduate Research Opportunities Program 23

Informing on Research - Reporting on Results 24

International Conference Coordination 25

Future Prospects 26

Outlook 27

The KIOS Research Center

The KIOS Research Center for Intelligent Systems and Networks was established in 2008 within the University of Cyprus and is in its third year of operation. The Center is now a leading research center in Cyprus with strong international standing.

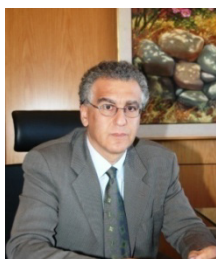
KIOS delivers cutting-edge, interdisciplinary research in intelligent monitoring, optimization, and management of complex, safety-critical systems.

The Center currently employs more than 60 researchers funded by 38 external research projects.

State of the Center



Message from the Rector



Dear reader,

Research constitutes a powerful engine for sustainable economic and labor market growth, and is a driver for improved quality of life. Research can also contribute significantly towards tackling major societal challenges, such as environmental sustainability, energy and resource scarcity, health and ageing.

The University of Cyprus (UCY), since its establishment in 1989, is considered a pioneer research institution in Cyprus and a center of scientific excellence in the wider Euro - Mediterranean region. As a modern university, with international standing, it invests in a wide range of expert research personnel, and high-quality units, centers, and laboratories.

With its promotion of the knowledge triangle (research, education, and innovation) its aims are to make significant contributions towards efforts to boost the country's economy and welfare, whilst at the same time actively participating in research efforts at EU and international levels. Now, more than ever, with the prevalent economic crises, public budget constraints, major demographic changes, and increasing global competition, the University of Cyprus can make significant contributions in efforts to tackle some of these challenges.

Today, there are 10 research units and centers and 85 research laboratories operating at the University of Cyprus. Currently, there are over 340 research programs financed by national, European, and international funding sources, being delivered by the University to the total value of 16.7 million Euros. This success equates to a significant increase in research funding being invested in Cyprus from external resources, quadrupling the investment made from national public sources. UCY has managed to increase the ratio of internal versus external funding to 1:4, meaning that, for every euro that the government invests in the UCY budget, there is a return of four euro.

This publication introduces the research profile of one of the University's main research centers: the KIOS Research Center for Intelligent Systems and Networks. It reveals the breadth and depth of research conducted at KIOS and embodies the valuable know-how and immense dedication invested by its faculty and its research team.

The KIOS Research Center is considered to be a leading research center in Cyprus in the area of Information and Communication Technologies (ICT). It is a vibrant research center, which has made notable contributions to the wider global research agenda in the area of intelligent systems and networks. Not only is this reflected in both the quantity and the quality of its research, but also in the research profile and standing of KIOS amongst its international peers.

Finally, I would like to congratulate the Director of the Center, Professor Marios Polycarpou, and its faculty for their remarkable dedication and outstanding research portfolio. I am confident they will continue to receive more distinctions and attract valuable research funding in the years to come.

Friendly regards,

Professor Constantinos Christofides

Rector



Message from the Director



The KIOS Research Center for Intelligent Systems and Networks was established in February 2008 on the basis of an ambitious long-term vision of becoming a leading Center of Excellence in the field of information and communication technologies. A key objective of the KIOS Research Center is to create an inspiring environment where a critical mass of researchers can work synergistically. It aims to contribute to the advancement of knowledge in the areas of computational intelligence and intelligent networked embedded system design, and to apply these methodologies in monitoring, controlling, and optimizing the operation of large-scale complex systems. Furthermore, the KIOS Research Center aims to contribute towards the technology transfer and the promotion of a knowledge-based economy in Cyprus via the creation of new jobs in high-tech areas and the design of new products and services.

Computational intelligence is at the heart of many new technological developments. As technology advances, we are able to generate massive amounts of data. This data can be generated not only locally, but with communication networks it can be transmitted almost instantaneously to just about anywhere we wish. The processing and interpretation of such data in real-time is a key ingredient of “smart” computational devices that are being developed. In the future there will be more emphasis on distributed intelligent and networked systems, where the intelligence of complex systems will be distributed throughout the network. The computational intelligence approaches that are developed at the KIOS Research Center provide key tools for future development of new technologies related to intelligent systems and networks.

Currently, the KIOS Research Center brings together over 60 researchers, who are working on externally funded research projects. The Center provides a stimulating environment for pursuing high-quality interdisciplinary research. It currently participates in 38 research projects and boasts over 150 international and national research collaborations. Despite being in operation for less than four years, the KIOS Research Center can celebrate many successes, including:

- Achieving international recognition as a leading research center in its field. This is evident from its research output and being the recipient of several awards, honors, and distinctions.
- Attaining significant research funding in key technological areas of importance to Cyprus and the global economy. In the last year, KIOS has been awarded several new research projects, primarily from EU funding sources, such as FP7, Eurostars, Joint Undertakings, and EU Cross Border Collaboration projects.

I would like to take this opportunity to sincerely acknowledge the support of the University of Cyprus, who believed in the strong potential of the KIOS Research Center and empowered its growth. I would also like to thank the select team of colleagues who dedicated their time to help initiate the KIOS Research Center from the ground up, and everybody involved in the Center for helping it achieve international stature. I believe this is just the beginning!

We hope that you will find this report informative. For further information about the Center please take a look at our webpage, www.kios.ac.cy, or come and visit us.

Sincerely,



Marios Polycarpou, IEEE Fellow
Director, KIOS Research Center
Professor, Electrical and Computer Engineering

Highlights and Achievements

One of the key successes of the KIOS Research Center has been an *Infrastructure Grant*, awarded through a competitive open call by the Cyprus Research Promotion Foundation. This infrastructure grant of €1.1 million over 4 years was initiated on 1st September 2010, and it is co-sponsored by the European Regional Development Fund and the Republic of Cyprus. The KIOS Infrastructure Grant is coordinated by the University of Cyprus, in partnership with ETH Zurich, Politecnico di Milano, Arizona State University, and Boston University.

In 2010 KIOS was selected to coordinate a large EU FP7 research project, *iSense*. The *iSense* project consists of a multidisciplinary team of researchers from five organizations (research organizations, universities, and industry). With an overall budget of over €4 million it is the first FP7 collaborative project of this size to be coordinated by the University of Cyprus. This is a strong indication of the positive impact the KIOS Research Center has already had in promoting research at the European level and providing the opportunity for Cyprus to coordinate EU-level research.

The KIOS Research Center has also initiated and is leading the IntelliCIS ESF-COST Action, which is in its third year of activities. The IntelliCIS COST Action has participation of 33 countries and 160 researchers, making it one of the largest COST Actions funded by the European Science Foundation (ESF). IntelliCIS forms a European-wide scientific and technology knowledge platform to promote interdisciplinary interaction in the development of innovative intelligent monitoring, control, and security methodologies for safety-critical infrastructure systems, such as electric power systems, telecommunication networks, and water systems. It is the first ESF COST program to be initiated and coordinated by Cyprus.

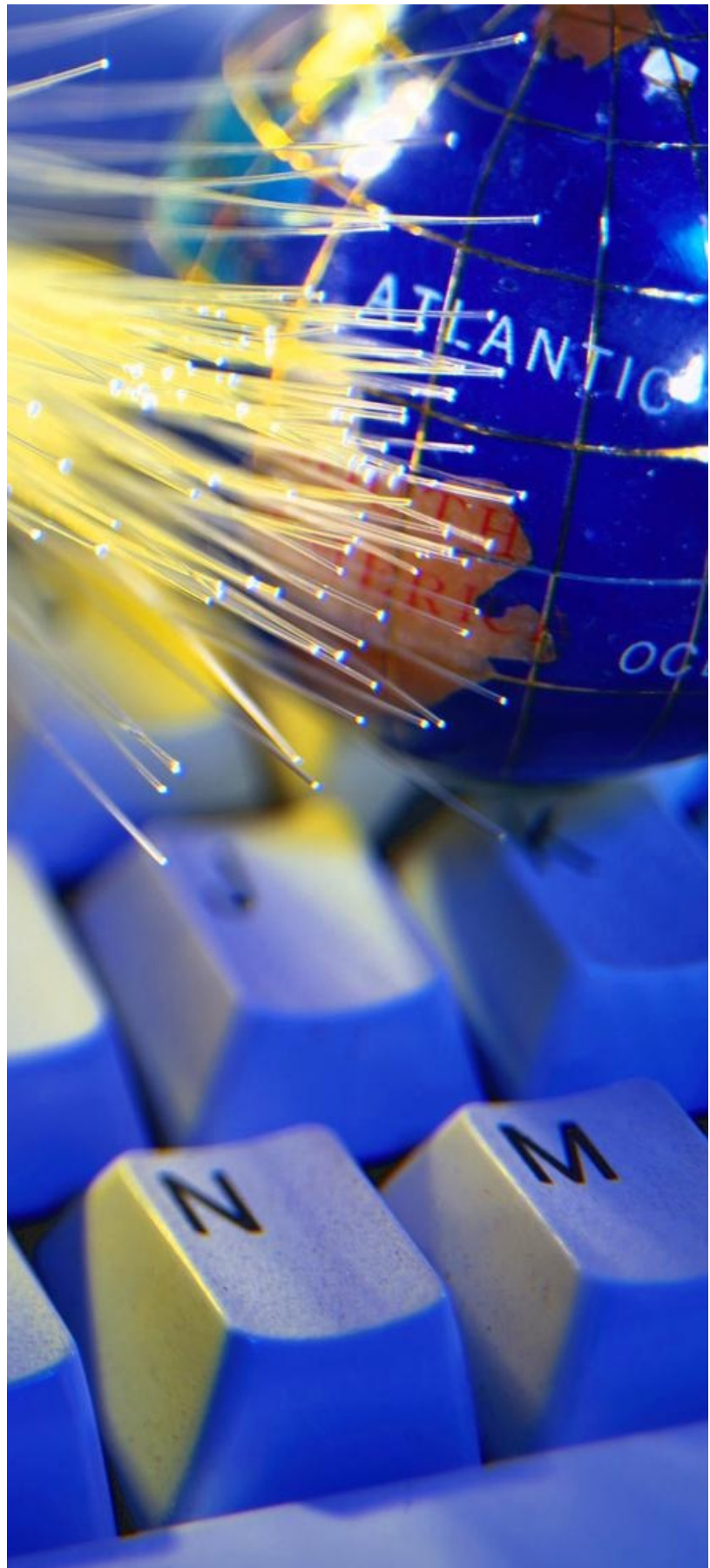
A key priority of the KIOS Research Center is to promote technology transfer from academia to industry and other governmental organizations. The KIOS Research Center has fruitful collaborations with a large number of organizations (private, public, national, and international). It is important to strongly emphasize the support for the activities of the Research Center provided by the KIOS Industrial Members: the Electricity Authority of Cyprus (EAC) and PrimeTel PLC. These collaborations are crucial for the future success of the research center.

The KIOS Research Center for Intelligent Systems and Networks has recently moved to a new research space. These premises bring together, under one building, a significant part of the KIOS research activities. The new premises (450 m²) are specifically designed to create an inspiring environment for conducting high-quality research, to provide the conditions from which to stimulate interdisciplinary interaction between researchers, and to promote further collaboration with industry. They also signify an important step towards the further development and growth of the KIOS Research Center and represent the strong level of commitment from all concerned (The University of Cyprus, faculty, staff, and researchers) to develop a research center which can stimulate cutting-edge research in promising scientific and technological fields.



KIOS research aims to:

- *Conduct high-quality research in modern cutting-edge scientific and technological fields*
- *Provide an inspiring environment for conducting high-quality research and stimulate interdisciplinary interaction between researchers*
- *Develop a critical mass of researchers working synergistically in the area of intelligent systems and networks*



OVERVIEW OF KIOS RESEARCH ACTIVITIES

During the period of this biennial report, the research activities of the KIOS Research Center for Intelligent Systems and Networks have grown significantly. The KIOS Faculty and the wider KIOS research team has published 44 archived journal papers, 98 peer-reviewed conference papers, as well as 2 books and 7 book chapters. These publications included a number of multidisciplinary works. Members of the KIOS research team were also awarded international paper and presentation awards, demonstrating international recognition for the Center's research quality output. In addition to its publication output, in the last two years, three patents associated with the KIOS faculty have been granted, signifying the Center's potential towards the advancement of technology.

A substantial amount of multidisciplinary research was undertaken at KIOS through research projects, secured from grants from the EU, the Cyprus Research Promotion Foundation, and the University of Cyprus. This funding, obtained entirely from the submission of proposals through a competitive process, has enabled KIOS researchers to tackle research problems of significance to both Cyprus and the global economy. In the period covered by this report, the KIOS research team has participated in 42 research projects.

KIOS has developed an excellent reputation for offering exciting research opportunities for outstanding researchers from Cyprus and other countries worldwide (e.g., France, India, Spain, Romania, Greece, and the USA). During this two-year period, there has been a steady increase in the number of researchers participating in research activities at KIOS, with a 39% increase in the number of researchers from one academic year to the next (including an impressive threefold increase in the number of postdoctoral researchers).

SCIENTIFIC EXPERTISE AND EXCELLENCE

The KIOS team includes faculty staff from the University of Cyprus, who are accomplished academics with excellent research records. In addition to teaching a number of courses in the University of Cyprus, the members of the Center serve as special advisors to a variety of organizations, including industrial and government organizations. They are frequently invited to participate in expert panels at the EU and international levels. They also serve on the technical program committees of leading international conferences and serve on editorial boards of major journals. The Director of KIOS has recently been elected as the President of the IEEE Computational Intelligence Society for 2012-2013; this is a major distinction for the Center, as well as for Cyprus.

Recognizing that research in intelligent systems and networks requires multidisciplinary expertise, the KIOS Research Center has developed a critical mass of researchers to work alongside the core KIOS Faculty and Affiliate Faculty. The research team specializes in a wide range of areas, such as systems and control, distributed systems and algorithms, graph theory and optimization, computational intelligence, fault diagnosis and fault tolerance, and embedded systems, in an attempt to provide holistic and viable solutions for a variety of critical systems and applications.

RESEARCH FACILITIES

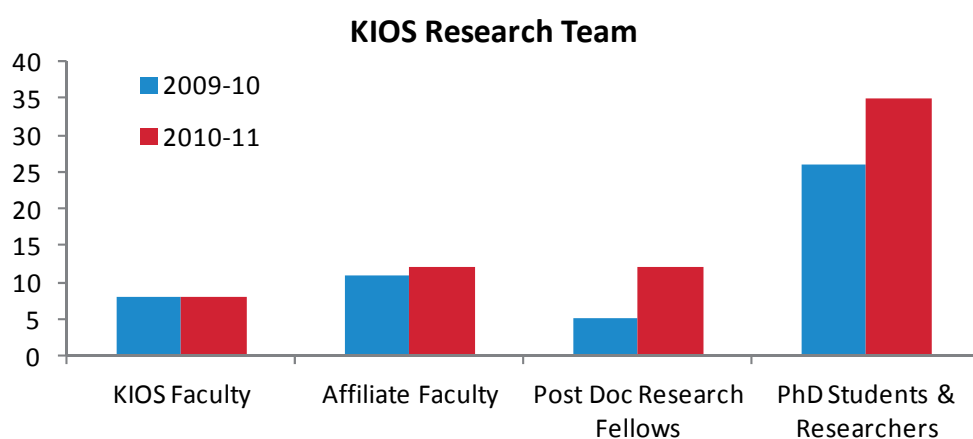
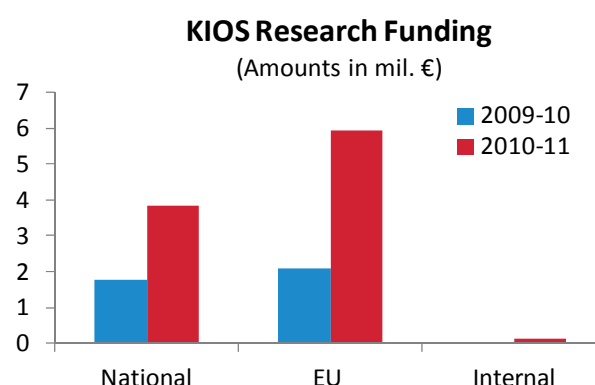
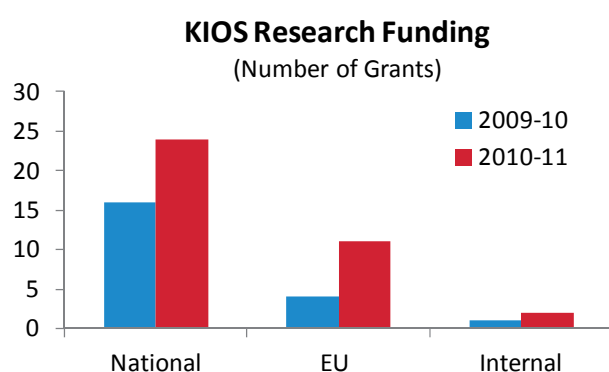
In 2010 KIOS moved into its new premises comprising of specially designed office and laboratory space. Dedicated laboratories were customized to provide the physical and technical infrastructure required for both KIOS researchers and partners to conduct high-quality research in modern cutting-edge scientific and technological fields. These laboratories include:

- Embedded Systems Laboratory
- Wireless Sensors Laboratory
- Bio-sensing Laboratory

Moreover, KIOS faculty and researchers have access to additional specialized facilities and equipment, available at the University of Cyprus and at the various KIOS collaborators and partners.

Publications, Editorial, Conference, and Evaluation Activities

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|------------------------------|----|---------------------------------------|----|
| Books and Edited Proceedings | 2 | Editorial Activities | 8 |
| Book Chapters | 7 | Program Organization and Committees | 59 |
| Patents | 3 | Proposal Evaluation Activities | 6 |
| Journal Publications | 44 | Honors and Awards | 10 |
| Conference Proceedings | 98 | Invited Keynote Plenary Presentations | 15 |
| Presentations | 32 | | |



Research Programs

During the academic years 2009-10 and 2010-2011, the KIOS Research Center coordinated and/or participated in 42 research projects funded by international and national sources including the European Union 7th Framework Program for Research, the European Structural Funds, and the Cyprus Research Promotion Foundation.

These projects, often multidisciplinary, have focused on various fundamental research areas, to provide comprehensive and viable solutions to global research challenges. A sampling of research at KIOS is presented below.

The KIOS Infrastructure Project

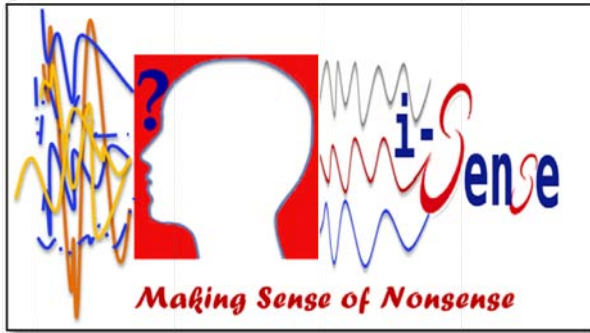
The KIOS Research Center was selected to receive funding from the Cyprus Research Promotion Foundation's Framework Program for Research, Technological Development and Innovation 2008 (DESMI 2008). This program is co-funded by the Republic of Cyprus and the European Regional Development Fund, and specifically under the funding pillar "Development of Research Infrastructures."

The project aim is to build the capacity of KIOS to contribute to the advancement of knowledge in the area of intelligent networked embedded systems and its applications to the design and management of large-scale complex systems with emphasis on safety-critical and trustworthy systems and infrastructures. These include telecommunication, power, water distribution, and transportation networks, as well as healthcare delivery systems.

Funding for the Center's development will help towards the creation of an inspiring environment for conducting high-quality interdisciplinary research for the promotion of a knowledge-based economy in Cyprus, which will ultimately benefit the Cyprus educational system, high-tech industry, and society at large.



iSense: Making Sense of Nonsense



The emergence of networked embedded systems and sensor/actuator networks has made possible the collection of large amount of real-time data about a monitored environment. Depending on the application, such data may have different characteristics: multidimensional, multi-scale, spatially distributed, time series, etc. Moreover, the data values may be influenced by controlled variables, as well as by external environmental factors. However, in many cases the collected data may be incomplete, or it may not make sense for various reasons, thus compromis-

ing the sensor-environment interaction and possibly affecting the ability to manage and control key variables of the environment.

The main objective of this project is to develop intelligent data processing methods for analyzing and interpreting the data such that faults are detected (and where possible anticipated), isolated, and identified as soon as possible, and accommodated for, in future decisions or actuator actions. The problem becomes more challenging when these sensing/actuation systems are used in a wide range of environments which are not known a priori and, as a result, it is unrealistic to assume the existence of an accurate model for the behavior of various components in the monitored environment. Therefore, this project focuses on cognitive system approaches that can learn characteristics or system dynamics of the monitored environment and adapt their behavior and predict missing or inconsistent data to achieve fault tolerant monitoring and control. This European level research project is coordinated by KIOS in collaboration with leading academic institutions and industrial partners in Italy, the UK, and Spain.

SCANDLE : acoustic SCene ANALysis for Detecting Living Entities

The SCANDLE Project is an EU FP7 funded research project within the Cognitive Systems, Interaction, Robotics challenge. It is an exciting collaboration between five leading European institutions (located in the UK, Hungary, Germany, Cyprus, and Switzerland), for developing a system that will be able to identify and distinguish living beings from inanimate objects on the basis of sound alone: a cognitive acoustic scene analysis system.

There are many real-world applications that can benefit from the technological innovations of this project. Examples include:

- systems that can transparently and non-invasively provide situation awareness (warning signals) that might be useful at busy road crossings
- detecting movement in a smoke-filled room where cameras cannot be used
- detection of intentional human movements aimed at harming individuals or a group
- recognition of normal/abnormal behavior in a crowd



WATERBEE: Low Cost, Easy to Use Intelligent Irrigation Scheduling System

According to the World Wildlife Foundation, agriculture wastes 60% or 1,500 trillion liters, of the 2,500 trillion liters of water it uses each year. One of the main culprits is inefficient water irrigation systems.

WATERBEE, an EU funded FP7 project, combined the knowledge of internationally recognized academic institutions and industrial companies (Italy, Ireland, Cyprus, Spain, Malta, Estonia, and Sweden) to develop a prototype for an intelligent, flexible, easy-to-use irrigation scheduling system at an affordable cost. This system takes advantage of recent technological advances in wireless networking (ZigBee), environmental sensors, and improvements in crop modeling. The system is easy to install and maintain, and can be used by farmers, growers, hotels, golf clubs, and even homeowners.



ZeroCO₂: Electricity Generation System with Zero CO₂ Emissions

Over the next 12 years, 332 GW of new electricity capacity – 42% of current EU capacity - needs to be built to replace ageing power plants and meet the expected increase in demand.

The objective of this project is to develop an electricity generation system that has zero CO₂ emissions (as well as zero emissions of any other type of gases). The proposed prototype system will generate electricity from renewable sources (mainly wind energy) and at the same time it will avoid all the problems associated with electricity generation from wind energy such as the variability of the wind, harmonics in the power system, and system stability problems. Due to the configuration proposed in this project, the electric energy out of this system will be clean, green, and regulated.



The proposed prototype holds the key to developing a regulated emissions-free renewable power station and makes it a viable solution for the future, for Cyprus, the European Union, and the rest of the world. The proposed system will be able to alleviate the operating problems of conventional renewable sources and offer a reliable method of harvesting renewable energy and feeding it into the electricity network. It is believed that the proposed system can compete economically with conventional methods and provide a stable, reliable, and financially sound environmental alternative for electricity generation. The project is funded by the Norwegian Financial Mechanism and co-funded by the Republic of Cyprus and the University of Cyprus.

SAFEMETAL: Increasing EU Citizen Security by Utilizing Innovative Intelligent Signal Processing Systems for Euro-coin Validation and Metal Quality Testing

Over 80 types of counterfeit coins and corresponding tooling and working methods can be identified for Euro coinage. Also, conductivity measurements are widely used for characterization of heat treatment of aluminum alloys and other non-destructive testing, especially for safety-critical applications in aerospace industry, nuclear reactors, etc.

The KIOS Research Center is participating in this EU FP7 project alongside several European universities and companies to develop metal validation technology required to distinguish between increasingly sophisticated counterfeit and genuine coins and to characterize the metal quality. This involves the development of advanced signal processing and data fusion techniques, and planar electro-magnetic sensors and pulse eddy-current measurement techniques with increased field sensitivity. The market being addressed includes coin validators, aerospace, and nuclear industries.



RUNNER: Reconfigurable Ultra-Autonomous Novel Robots



In the future there will be millions of robots in various application areas that will all be navigated in an autonomous manner based on 3D video capture.

KIOS researchers are taking part in a research project funded by the EU funding program Eurostars. Eurostars is an industry focused international research collaboration for the development of new products for transnational and international markets.

Within this context, the project RUNNER will provide an innovative infrastructure for the creation of highly autonomous robots. The robots will have much better perception than existing solutions. Research

is utilizing high-end reconfigurable devices, to allow for extremely high-performance and power-efficient processing, when implementing 3D sensing/matching schemes.

FireALERT: Obstacle Detection System under Power Transmission Lines

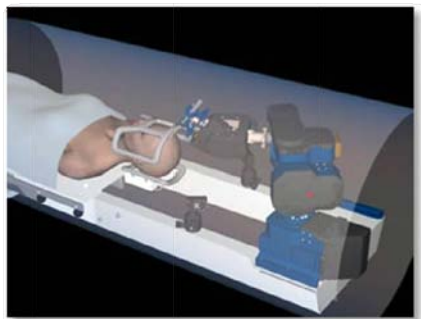


Vegetation interference with transmission lines is a significant issue world-wide, especially in dense forest areas. Forest fires and black-outs caused due to arching between a high-voltage wire and a tree branch are a frequent phenomenon. An example of such an event is the August 14, 2003 blackout in the US and Canada.

Detection of objects under transmission lines is a challenging problem since transmission lines typically span hundreds of kilometers of rough terrain or dense forests, rendering direct visual inspection difficult. The discontinuities of the wires at the towers make robotic monitoring devices difficult to implement. The main goal of the

project, funded by the Cyprus Research Promotion Foundation, is to offer an innovative solution to the problem of the detection of vegetation below transmission lines using wireless sensor network technology. It involves the installation of wireless transceiver equipment with specialized antenna on electricity towers, capable of initiating warnings to electric utility maintenance personnel if objects (mainly vegetation) approach electric power transmission lines. The application will also include sensory information (e.g., weather conditions) in order to avoid possible false alarms and allow the receiver to reliably detect obstacles. Once an obstacle is detected, multi-hop communication will be used to send the information to the operations center of the utility company.

MRI Robot: Development and Testing of a Robotic System for Minimally-invasive Interventions with Real-time MRI Guidance.



Despite its many advantages, Magnetic Resonance Imaging (MRI) is not frequently used for micro-surgeries due to the doctor's limited access to the patient inside the scanner.

A newly-developed robotic system has been designed, with funding from the Cyprus Research Promotion Foundation, to offer access to the patient inside closed-type magnetic scanners and therefore provide pictures of higher quality. The uniqueness of the robotic system lies in the fact that it can be directly controlled by the doctor, who can proceed with these operations, based on the pictures that are

obtained at that exact moment. The system is completely made out of plastic for safety purposes and it is compatible with MRI scanners. It also has several diagnostic and therapeutic applications, such as biopsies, cauterisation of tumours, and placing radioactive implants for the irradiation of tumours. The development of this specialized application of robotics will allow the realization of different minimally-invasive microsurgeries, under the guidance of MRI.

FiWi: Converged Fixed-Mobile Networking Transport Infrastructure for Next-Generation Broadband Access

There is a growing perception that copper-based access networks will soon no longer be able to meet the ever-growing consumer demand for bandwidth. This, along with a combination of regulatory and competitive forces, as well as recent rapid advances and standardization of Passive Optical Network (PON) technology, have prompted carriers around the world to consider PON-based fiber-to-the-curb/home systems as a possible successor to current copper-based access solutions. Concurrent with the upsurge of PON-based wireline broadband access solutions, the growing demand for advanced data-centric mobile multimedia services including multimedia messaging, mobile video, mobile music, mobile TV, and IPTV, has accelerated the development and deployment of new wireless broadband access technologies.

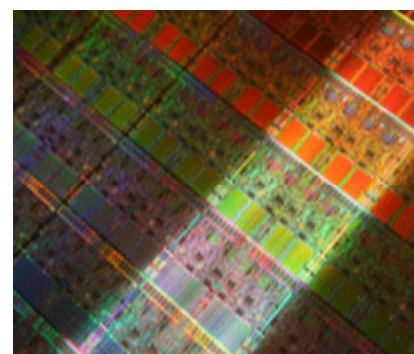


By leveraging the advantages of both of these access technologies combined on an integrated architecture platform, next generation Fiber-Wireless networks will enable the support of a wide range of emerging applications and services. Research is underway at KIOS, funded by the Cyprus Research Promotion Foundation, to propose and devise all of the critical elements necessary for the implementation of a high-capacity, high-performance, cost-effective, converged fixed-mobile access networking solution that holistically addresses many of the key outstanding issues with both of today's wired/wireless broadband access technologies. This novel architecture can then efficiently backhaul and support a mix of advanced wired and wireless multimedia traffic and services, along with the diverse quality of service (QoS), capacity/rate, and reliability requirements set by these services.

The results of this project can be utilized by telecommunications companies to better design their access networks for high data-rate, high-capacity, high-performance applications for fixed and mobile users. This will result in improved client services and reduced operation costs for the telecommunications networks, which in turn will result in cheaper services for the clients of these networks.

REMACORE: Reliable Manycore Chips

REMACORE is a research project, funded by the Cyprus Research Promotion Foundation, involving the design of reliable next-generation manycore chips. The project involves the development of a resilient system architecture and operation, where both design correctness (hardware verification) and fabrication correctness (manufacturing test) are performed dynamically, during the lifetime of the chip.



This research is particularly relevant globally. On-chip manycore systems, containing hundreds to thousands of small cores, are expected to surface in mainstream computing systems/devices, expanding on the current trend of Chip Multi-Processors (CMPs) which consider only a small number of processing cores. Research for on-chip parallel architectures has recently attracted increased worldwide attention from both academia and industry, and is expected to keep growing in the coming years. Computation and information processing hungry applications in scientific (e.g., bioinformatics), personal (e.g., multimedia and entertainment), and business (e.g., financial modeling) computing will all benefit from on-chip manycore parallel architectures, in terms of performance improvements. Besides performance, energy-efficiency, and parallel software, an emerging research key issue in these parallel chips is system reliability. As technology scales, we will face large increases in device variability, massive number of defects (including wear-outs), and device degradation. Scaling also increases the complexity of the chips, which in turn poses challenges in completing design verification and manufacturing tests. Such effects manifest as inherent unreliability of the components, redefining the design and test paradigm for reliable systems.

KIOS Collaborations

The KIOS Research Center actively encourages collaboration between industry, academia, and research organizations in high-tech areas of both global and local importance.

Our goal is to apply the results and methodologies developed through our research to partner industries and organizations, to enable a mutually beneficial collaboration.

The Center's collaborators range from world-renowned academic institutions, in Europe and the United States to large industrial partners and small and medium size enterprises who are seeking solutions to real-life problems.

Collaborations



International Collaborations

The KIOS Research Center collaborates with over 150 organizations worldwide. These collaborations have occurred at various levels (national and international) and with a variety of organizations and companies (private and public). They have developed in various ways, primarily through customized research collaborations, to tackle specific industrial problems and/or global research challenges related to intelligent monitoring, management, and security of safety-critical systems.

The benefits of such collaborations have been extremely significant. For example, they have provided opportunities from which knowledge transfer between industry and academia can occur and they have created a greater pool of expertise that can be drawn upon to solve specific research problems. These collaborations have resulted in several EU and nationally funded research projects often yielding results that have a positive impact on the economy, society, and individual citizens such as the improved operation of critical infrastructures (e.g., power or water distribution networks) as well as the safety and security of society at large.

The KIOS Research Center has a strong network of collaborators, including several internationally recognized research institutions, with which it is pooling expertise and working together on large research challenges. This collaboration primarily occurs through international cross-sectorial and multidisciplinary research projects focusing on several important areas of scientific and technological advancement. Collaborators include Arizona State University, Boston University, ETH Zurich, Georgia Institute of Technology, Imperial College London, John Hopkins University, and Politecnico di Milano amongst others.

COST Network Coordination

The KIOS Research Center is leading a European research cooperation program in the framework of the European Science Foundation COST Actions. The KIOS Research Center was selected to develop and coordinate a network in the scientific area of ICT, following a competitive selection process at the European level. This is the first-ever approved COST Action to be initiated from Cyprus. The network is in the area of Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems (IntelliCIS) and was established to instigate interdisciplinary interaction and promote collaboration between industry, academia, and research organizations on the subject of security, quality, reliability, and efficiency of critical infrastructure systems. With a focus on electric power systems, telecommunication networks, and water distribution networks, this COST Action now comprises up to 160 researchers and 81 organizations in 33 different countries.



 **IntelliCIS**
Cost Action IC0806

Experts at International and EU Levels

The KIOS Faculty members are extremely active at the international level. They are often called upon as evaluators for organizations such as the National Science Foundation (NSF), USA, the Science and Engineering Research Council (SERC), Singapore, the Qatar National Research Foundation (QNRF), the Spanish Ministry of Education and Science, the Directorate General for Research and Innovation of the EU, as well as FP7 program committees. They also serve on the technical program committees of leading international conferences (59) and serve on editorial boards of major journals. The Director of KIOS, Professor Marios Polycarpou, was elected President of the IEEE Computational Intelligence Society for a two-year term (2012 – 2013). In the last three years Professor Polycarpou has also been invited to give 15 invited key-note plenary talks at international conferences, highlighting the recognition he holds in the international scientific community.

Industrial and Local Partnerships

The KIOS Research Center has cultivated positive working relations with over 35 industrial companies and public service authorities responsible for the management of critical infrastructure and related provision of services to the public. These collaborations have concentrated on specific research needs of various critical infrastructure sectors as well as towards new and emerging research fields in these areas.

With a view to sharing of information and expertise, the KIOS Research Center collaborates closely with public sector departments such as the Electricity Authority of Cyprus (EAC), the Ministry of Communication and Works, the Transmission System Operator, and the Water Development Department of the Ministry of Agriculture, National Resources and Environment, Republic of Cyprus. These collaborations have been extremely successful, often resulting in funding for joint research projects. Research collaborations also exist with the Ministry of Health, as well as several hospitals, and clinics. Some of these collaborations are resulting in mutually beneficial Memorandums of Understanding (MoUs). Furthermore, efforts are underway to facilitate technology and knowledge transfer between academia and industry for exploitation of research results.

Power Industry

The KIOS Research Center collaborates closely with the Electricity Authority of Cyprus (EAC). This bilateral collaboration has focused on the research needs of the power industry in Cyprus, as well as towards new and emerging research ideas that are of interest to the Electricity Authority of Cyprus in the near- and long-term future. Researchers at KIOS have worked on a number of specific research problems related to power systems, including techniques which can improve the state estimation process in power systems (development of novel hybrid state estimators) and mechanisms to ensure the optimal economic dispatch of the EAC generating units within the new context of the deregulated electricity market.

Telecommunications Industry

Another specific example of KIOS-industry partnership is the activity undertaken at KIOS in collaboration with its industrial partner PrimeTel PLC. The research has focused on a number of topics related to the provisioning of fast, efficient, and reliable recovery techniques to enable carriers such as PrimeTel to provide uninterrupted service to end-users. Such quality-of-service (QoS) issues have become an important requirement for the operation of telecommunication networks. The KIOS-PrimeTel collaboration provides KIOS researchers with access to a large telecom service provider that owns and operates its own nationwide fiber-optic network, which can be leveraged for the successful testing of proof-of-concept architectures and algorithms.

The KIOS Research Center appreciates and values the collaboration and support provided by the Electricity Authority of Cyprus and PrimeTel PLC.



Water Systems

In the area of water systems, KIOS has a strong research collaboration with the Cyprus Water Development Department (Ministry of Agriculture, Natural Resources and Environment) and the Limassol Water Board. This collaboration aims at enhancing the efficiency and management of water systems in Cyprus using information and communication technologies.

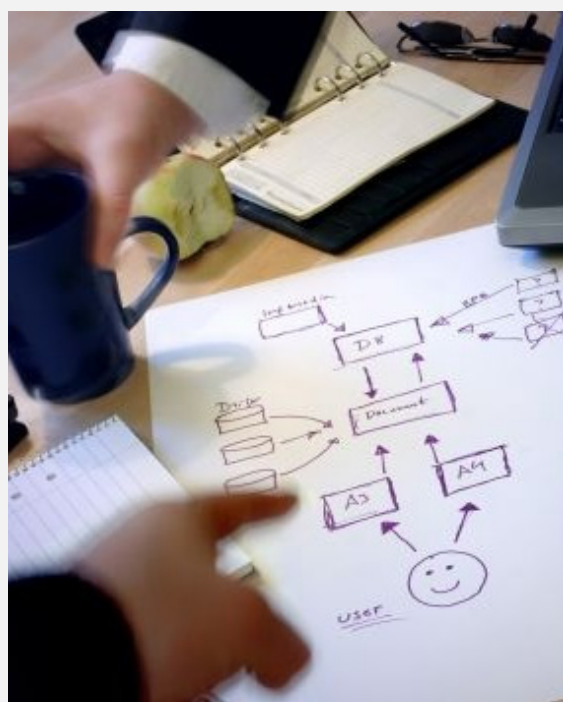
Memorandums of Understanding

In 2011, KIOS signed a Memorandum of Understanding with the Limassol Water Board to highlight a commitment for collaborative research. With a view to sharing of information and expertise, similar Memorandums of Understanding are planned with other public sector departments in Cyprus. This represents a long-term commitment from KIOS and its partners to work together to address research challenges and an appreciation of the benefits afforded for increased technology and knowledge transfer through such collaboration.

Knowledge Transfer and Exploitation of Research Results

The KIOS research team participates in EU research programs aiming to improve knowledge transfer between public research and industry. In addition to undertaking research for the benefit of the economy in Cyprus, it also has growing research collaborations with 18 international industrial partners situated in the EU and other countries.

Particular emphasis is given to research collaborations that involve the transfer of research findings, skills, and competence to industry so they are able to transform them into economic outcomes and/or improve public services. A number of research projects, in which the KIOS team participates, encourage better exploitation of research results and facilitate the practical application of scientific research. Examples of these types of research collaborations resulting in improved and marketable technology include the development of highly-efficient autonomous robots, improved irrigation systems for European farmers, and metal validation technology for use by coin validators, as well as by other industries. The recently developed MRI Robot technology also offers valuable technology for the health industry.



International Recognition

The quality of research is judged by many factors, including the extent of funding, the quantity and quality of publications, and the recognition it receives from the scientific community.

The KIOS research team has received international recognition for its high-quality research by several groups of peers. It has come in the form of prestigious awards and prizes which serve to underpin the Center's commitment to excellence, including:

- *IEEE recognition*
- *Best paper and presentation awards*
- *Best design awards*
- *EU panel organization*

Honors and Awards



KIOS Director Elected as the New President of the IEEE Computational Intelligence Society

The KIOS Research Center Director, Professor Marios Polycarpou, was elected the new President of the IEEE Computational Intelligence Society (CIS). Professor Marios Polycarpou is serving as the President-Elect in 2011, the President of the Society in 2012-2013, and the Past-President in 2014. This is a very prestigious position of international recognition. It is only the second time in the history of IEEE CIS that the president of the society is from outside North America. The Computational Intelligence Society is one of the key societies of IEEE, with more than 7000 members around the world. CIS plays a key role in the promotion of computational intelligence research and innovation. It has 11 technical committees and over 100 task forces aimed at promoting specific technical interests or application domains. Each year, the CIS sponsors a dozen international conferences and technically sponsors several others. The Society also sponsors some of the most prestigious journals in the field, such as the IEEE transactions on Neural Networks, the IEEE Transactions on Fuzzy Systems, and the IEEE Transaction on Evolutionary Computation.

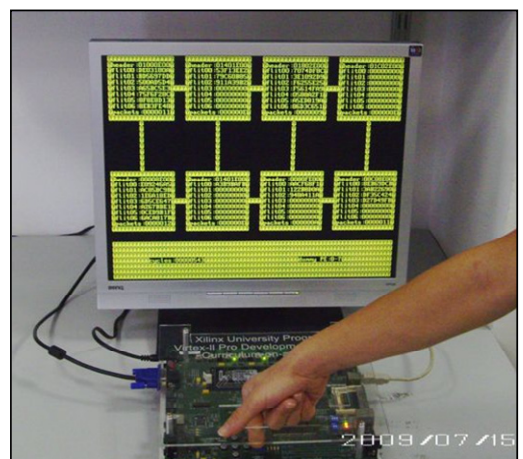
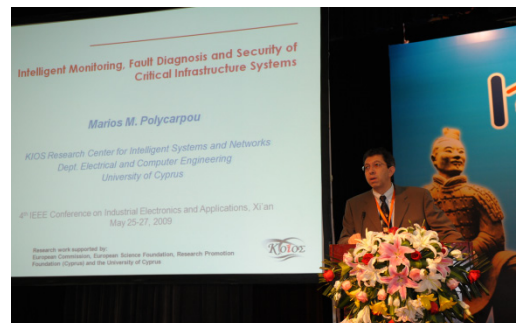
IEEE Distinguished Lecturer in Computational Intelligence

The Director of the KIOS Research Center, Professor Marios Polycarpou, has been selected as an IEEE Distinguished Lecturer in Computational Intelligence for the three year period January 2010-December 2012. This title is conferred to a very limited and select group of world-renowned experts by the IEEE, the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity and the leading technical organization representing electronics and electrical engineering. The IEEE Distinguished Lecturer Program facilitates lectures from internationally distinguished experts on the latest research and practical applications for the benefit of interested communities (research, academic, government, and industry).

Best Paper Awards

KIOS researchers Christos Ttofis and Christos Kyrkou, as well as Prof. Theodoros Theodorides and Prof. Maria Michael received the "Best Paper Award" at the IEEE International Conference on Microelectronic Systems Education (MSE2009), for their work entitled "FPGA-Based NoC-Driven Sequence of Lab Assignments for Manycore Systems". The conference took place on the 26th of July 2010, in San Francisco, California. Manycore systems are expected to emerge as the dominant trend in next-generation computer systems. These parallel systems are expected to be interconnected via packet-based Networks-on-Chip (NoCs). NoC-based manycore systems demand modifications in the existing computer-related teaching curricula. This work presented a practical FPGA-based teaching framework to emulate NoC-based manycore systems. Instructors can utilize this framework to teach students the fundamental design concepts of NoC-based manycore systems and their integration, through a series of VHDL laboratory assignments.

A collaborative effort between KIOS researchers Prof. Julius Georgiou and Charalambos Andreou, and the Sensory Communications Group of Prof. Andreas Andreou at Johns Hopkins University, has led to the design and fabrication of the world's lowest power image sensor. The resulting image sensor was presented at the 2011 IEEE International Symposium on Circuits and Systems (ISCAS 2011), and was awarded a Best Paper Award. The power drain of this image sensor is so small that it can take 20 photos per second continuously for 250 days when powered on a small hearing aid battery!



First Prize in eBook Reader Competition

The proposal submitted by KIOS researchers Christos Laoudias, Demetris Eliades and Demetris Stavrou was ranked first in the competition “Design of a digital eBook reader and content management platform”. The competition was launched by the University of Patras and the Greek Free/Open Source Software Society (GFOSS), under the auspices of the Special Secretariat for Digital Planning in Greece.

The objective of the competition was to describe new ideas for the introduction of eBook readers in education. The proposal was based on a lightweight portable device, such as the increasingly popular tablets (e.g., iPad), which could eventually replace printed schoolbooks and notepads in the near future, thus enhancing the learning experience for students. In addition, teachers will be able to better organize their courses and classes, and provide material to the students via the Internet.

Leading a Networking Session at EU ICT 2010 Conference

The KIOS Research Center was selected to lead a networking session at the EU ICT 2010 Conference, following a highly competitive application process. The networking session, coordinated by KIOS faculty and researchers, was entitled “Trustworthy Critical Infrastructure Systems” and was designed to facilitate an open discussion on intelligent control and security of critical infrastructure systems with key players from academia and industry. This emphasizes a positive recognition at the European level of research undertakings in Cyprus and reflects the significant contribution Cyprus can make towards research in the field of Trustworthy Critical Infrastructure Systems.

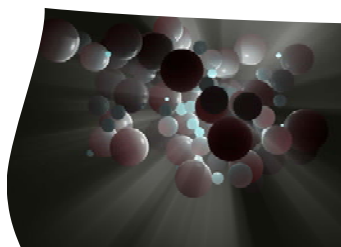
The EU ICT 2010 Conference which is organized every two years by the European Commission and was hosted by the Belgian Presidency of the European Union attracted over 6000 participants. This biennial event is a unique gathering point for researchers, business people, investors, and high-level policy makers in the field of digital innovation. Through a program of speeches, workshops, and networking sessions the Conference provides a valuable forum from which the latest research trends in information and communication technologies can be explored. In the EU ICT 2010 conference, there was a 10.000 m² exhibition of Europe's latest cutting-edge ICT research and a carefully selected program of networking session on topics of key relevance for ICT.

In addition, KIOS Researcher George Millis was one of three researchers chosen from a large number of submissions from across the EU, to present his paper “Build the Smart Critical Infrastructure Systems (CIS) Grid”, at the conference workshop entitled “My big idea for the Digital Agenda”. This paper was considered visionary and in line with the EU’s Digital Agenda, one of seven flagship initiatives under the Europe 2020 strategy for smart, sustainable, and inclusive growth. George Milis presented his “Big Idea” at the workshop chaired by Neelie Kroes, the Vice-President of the European Commission.



Other Prizes and Awards

- Prof. Elias Kyriakides, a member of the KIOS faculty, was awarded Second Prize in the Cyprus Entrepreneurship Competition for “Cynergy: Commercialization of a Patented Invention for Electricity Conversion from DC to AC”. Cynergy is a spin-off company from research carried out at the KIOS Research Center, aiming to commercialize a patented invention in the electric energy market. The invention proposes a new method for converting direct electric current to alternating current, which is the required energy form for connecting to the electric power grid. Cynergy has great potential as its technology may hold the key to unlock further the huge commercial potential of fuel cells in electricity generation. Fuel cell technology is an emerging market, anticipated to see accelerated adoption in the green energy sector over the next decade.
- Best Student Presentation (2nd Place), A. Kyriakides, K. Hadjigeorgiou, E. Kastanos, C. Pitris, “Classification of Raman Spectra using Support Vector Machines,” 9th International Conference on Information Technology and Applications in Biomedicine, November 5-7, 2009, Larnaca, Cyprus.
- Best Student Presentation (Finalist), E. Bousi, A. Kartakoullis, C. Pitris, “Spectral Analysis for Scatterer Estimation in Optical Coherence Tomography Images,” 9th International Conference on Information Technology and Applications in Biomedicine, November 5-7, 2009, Larnaca, Cyprus.



Outreach

Inspiring the next generation of researchers

To ensure continuous and successful research progress, the Center strives to create an inquisitive and growing research culture among young scientists and the community at large.

KIOS Researchers are also active in organizing scientific conferences as well as exposing the general public to the results of their research.

The Center's outreach efforts include:

- *A unique Undergraduate Research Opportunity Program (UROP)*
- *Newsletter*
- *Press articles*
- *Conference organization*



Undergraduate Research Opportunities Program

The KIOS Research Center runs a summer internship program for undergraduate young researchers called UROP, an acronym for Undergraduate Research Opportunities Program. The purpose of UROP is to involve undergraduate students in cutting-edge research within the KIOS Research Center. The emphasis is to encourage young people to participate in research and to nurture the skills, experience, and confidence required for such an endeavor. The UROP program took place in the summers of 2009, 2010, and 2011. A total of 14 students successfully completed the program, undertaking research in various areas such as renewable energy, ICT for health, and telecommunication networks.

"My experience at the KIOS Research Center was very fulfilling and enlightening. It was extremely rewarding to be involved in research and to have the opportunity to build a wind turbine from scratch. The sourcing of material and learning about their properties as well as the search for tradesmen able to build various components was at times frustrating but also rewarding when our efforts yielded successful results."

Christos Frangeskou

"My participation in UROP has been a remarkable developmental experience. Having the opportunity to research different types of source material and to evaluate the credibility of different scientific claims has definitely helped to improve my research skills and to develop my knowledge in my study area. Sharing ideas, opinions and knowledge, has helped me to absorb, learn, and improve my skills." **Christina Themistocleous**

"Working on the routing and wavelength assignment (RWA) problem for the UROP program gave me the opportunity to improve my knowledge in the field of Fiber Optics and to understand the way research is carried out. Furthermore, working with experienced academics, I was able to learn valuable research skills and how to apply research methodologies to specific issues. It was a great experience, which broadened my horizons and encouraged new ways of thinking." **Ioannis A.Yiannaki**



"This summer, I had the opportunity to gain valuable experience, skills, and knowledge. Observing how researchers work, cooperate, and overcome research challenges was an invaluable experience that changed the way I think. I developed new skills and was able to appreciate the value of research and how it can have a positive impact on society at large. Throughout the entire program I had the support of my advisor and the other KIOS researchers. I hope I will be lucky enough in the future to work with them again. For me, the KIOS Undergraduate Research Opportunity was indeed an excellent opportunity." **Eleni Proxenou**



"The UROP program gave me the opportunity to collaborate with other people from a variety of research disciplines. With guidance from my advisor I learned how to conduct research. I believe the experience was unique. I am able to add this experience to my CV, which will undoubtedly be beneficial for my future career." **Angelos Hadjian-tonis**



Informing on Research - Reporting on Results

The KIOS Research Center endeavors to keep its stakeholders, partners, and the wider public informed about its research activities and results. In line with EU policy "Research in Society", special emphasis is given to raising awareness and disseminating research results to the wider public in order to encourage widespread appreciation of the values and benefits of research within the society.

During this two-year period, KIOS provided regular updates on its activities through specific measures that have become essential to the organization's operations. KIOS has also received considerable attention from the national media wishing to report on the potential impact of the research conducted in the Center. This has resulted in several special feature articles and guest television appearances from the KIOS research team.

Intelligent Times – KIOS Newsletter

The KIOS newsletter, "Intelligent Times", is circulated to over 1000 scientists, public bodies, key decision makers, and the media in Cyprus and abroad. It serves as a vehicle to update its readers on the latest scientific activities of the Center and related scientific research updates.

The first issue, published in September of 2009, covered subjects such as the launch of the Research Center, descriptions of new European projects, the IntelliCIS COST action which the Center is coordinating, the launch of the Un-Undergraduate Research Opportunities Program (UROP), and other news from the Center and its industrial partners (the Electricity Authority of Cyprus and Primetel PLC).

Intelligent Times will serve as permanent dissemination tool for the Center. It is designed to complement the KIOS website (<http://www.kios.ucy.ac.cy/>) which also provides up-to-date information on KIOS research and other activities.



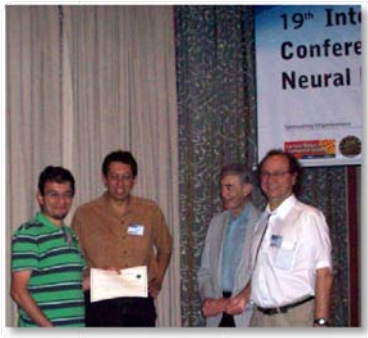
Media

From 2010 onward, details of the impact of research undertaken at KIOS and its partners, have been published in international, regional, and national newspapers and magazines. During this period there have been over 35 news articles and reports in the publishing press and in particular special feature articles in popular national press with substantial readership numbers. Research projects undertaken at KIOS have also attracted television coverage, with several references to the research undertaken at KIOS in national news broadcasts. There have also been several guest appearances by members of the KIOS research team on special interest programs on both radio and television.



International Conference Coordination

The KIOS Research Center, together with the Department of Electrical and Computer Engineering of the University of Cyprus, successfully organized two conferences in Cyprus in the period covered by this report. These initiatives helped to increase the visibility of the Center and the University at an international level. It also enabled access to world-renowned experts for Cyprus-based researchers and industry.



19th International Conference on Artificial Neural Networks (ICANN 2009), Limassol, September 14-17, 2009

This is an annual meeting sponsored by the European Neural Network Society (ENNS), in cooperation with the International Neural Network Society (INNS) and the Japanese Neural Network Society (JNNS). ICANN 2009 was also technically sponsored by the IEEE Computational Intelligence Society. This conference has been held annually since 1991 in various European countries and covers the field of neurocomputing, learning systems, and related areas. ICANN 2009 attracted more than 300 participants.



IEEE Biomedical Circuits and Systems Conference (BIOCAS 2010), Paphos, November 3-5, 2010

In recent years there has been an explosion of research activities in the areas of life sciences, physical sciences, and engineering with application to medical problems. Such activities require interdisciplinary collaborations among scientists, engineers, medical researchers, and practitioners to solve complex real-world problems. The BIOCAS conference is the premier forum where researchers can present results and innovative solutions for today's health problems at the frontiers of Biomedical Engineering.



KIOS Workshop

On Monday 18 April 2011, the KIOS Research Center organized the First KIOS Workshop aiming to facilitate better collaboration between the researchers within the Center as well as its research partners. The Workshop was co-organized with SignalGeneriX Ltd, and was funded through a number of research programs from the Cyprus Research Promotion Foundation and EUREKA.

Talks included an overview of the KIOS Research Center by its Director, Prof. Marios Polycarpou, as well as presentations from Center collaborators Prof. Andreas Spanias, Arizona State University (SenSIP Center and NSF Consortium Research), Prof. Cesare Alippi, Politecnico di Milano (Distributed Embedded Systems), and Kostas Margellos, ETH Zurich (Security in Power Systems: Impact Identification of a Cyber Attack in the Automatic Generation Control). Various talks from KIOS researchers spanned the entire range of research fields covered by the Center. They included subjects in the broad areas of "Infrastructure Monitoring and Applications," "Embedded Systems," and "Communication Systems and Classification." This workshop was an excellent opportunity to exchange ideas and foster further collaborations between KIOS researchers as well as with the KIOS international partners.

Center of Excellence

The KIOS Research Center strives to establish itself as a Center of Excellence in the scientific field. It builds on the strengths and multidisciplinary capabilities of its researchers and its expanding infrastructure to:

- *Address challenging scientific and technological problems*
- *Be a reputable protagonist in the niche area of intelligent networked embedded systems*
- *Provide a promising avenue for qualified and motivated researchers to pursue successful careers*



Outlook

In the first few years of operation, the KIOS Research Center has undergone a phase of noteworthy developmental growth and is recognized as a leading research center, nationally and internationally. The Center has strong foundation upon which it can continue generating new research knowledge of international stature in the area of information and communication technologies.

The research and application domains relevant to KIOS continue to be high priorities in research and technology agendas, providing opportunities for high-quality, global, research collaboration. Within this context, future plans for KIOS focus on ensuring that the Center has the capacity to develop, evolve, and grow in ways that enable its research team to respond to emerging research opportunities and challenges. More specifically in the short- and long-term future, KIOS will strive to:

- Participate actively in the international research arena and make significant contributions to global research challenges and priorities in the areas of ICT, Security, Energy, Health, and the Environment.
- Maintain high-quality standards and excellence in its research.
- Promote multidisciplinary research and collaboration, to achieve integration between theory and applications.
- Provide a promising avenue for qualified and motivated researchers to pursue successful careers by creating new job opportunities in the high-tech arena and attracting new researchers to Cyprus.
- Promote national and international collaboration between industry, academia, and research organizations in high-tech areas of global importance and relevance to Cyprus. Emphasis will be given to ensuring these collaborations steer the Center towards the research needs of industry in Cyprus, as well as towards new and emerging global research fields that will be of interest to KIOS partners in the near and long-term future.
- Continue efforts to strengthen existing collaborations and develop new ones amongst the KIOS research team and its external partners so it is better able to address challenging scientific and technological problems within the constantly evolving research field.
- Promote efforts for knowledge and technology transfer between academia and industry, and for the exploitation of research results.



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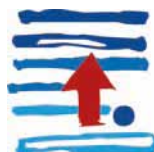
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