imdea networks institute

developing the **science of networks**

institute
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networks

annual report 2013

foreword

foreword

Arturo Azcorra
Director of IMDEA Networks Institute
May 2014

annual report
2013

Over the past years, IMDEA Networks Institute has succeeded in putting together a team of top scientists that is contributing to boost Madrid's competitiveness as a technology-oriented region. IMDEA Networks is bringing substantial external funds to the region with its research contracts and projects: since its creation, it has been awarded a total of 12 M€ from competitive funds, out of which 2.52 M€ were budgeted for 2013. Furthermore, IMDEA Networks is contributing to strengthen the technology profile of the region, and its collaboration with local companies is helping to enhance Madrid's high-tech output with cutting edge research findings. We believe that it is precisely by focusing on the development and manufacturing of high-tech products and services that Spain may efficiently combat the current economic crisis and make its mark on the 21st Century.

IMDEA Networks is focusing on an area that has a profound impact on people's lives. The widespread access to networks (Internet, social networks, cellular, Wi-Fi, etc.) has drastically changed the way manufacturers produce and supply their goods, how public administrations operate, how professionals work and, in general, how individuals and society at large communicate. The recent proliferation of mobile handheld devices with 3G and 4G data access has revolutionized information access, making the notion of network access everywhere and anytime a reality. Far from stabilizing, the networked socio-economic phenomenon continues to transform our everyday life at an amazing pace. One of the most attractive new research areas is that of fifth-generation cellular networks (5G), which intends to deliver solutions, architectures, technologies and standards to create ICT infrastructure and intelligent communication networks that are ubiquitous, robust, flexible, interoperable and cost effective. This technology thus promises a new revolution in the way data is accessed from mobile devices, providing much higher capacities and enabling a plethora of new services and applications.

Currently, Europe is making a large bet on 5G technology by targeting a new partnership initiative: the 5G Public-Private-Partnership – 5G PPP. The launch of the 5G initiative arises in the context of "Horizon 2020", the EU research framework program, which will operate from 2014 for a period of 7 years with an estimated budget of 80 billion euros. The 5G Infrastructure PPP has a budget of 7 billion euros, which is jointly funded by the private sector and the European Commission. In line with this European scale initiative, IMDEA Networks is also putting a strong research effort on this groundbreaking technology. Let me name just a few of our achievements in this area.

The iJOIN project - one of the current flagship European projects in the area of 5G - which is coordinated by IMDEA Networks' Deputy Director, Albert Banchs, has won the runner-up award for the Best European R&D Cooperative Project within the region of Madrid. Recently, one of our Research Professors, Joerg Widmer, was awarded a prestigious ERC Consolidator Grant to investigate mmWave communication, one of the key 5G technologies. Last but not least, I have been voted onto the Steering Board of the European Technology Platform responsible for the coordination of the 5G PPP initiative, aiming to deliver an ambitious research agenda and produce and influence international standards for next-generation cellular networks. Our work on 5G positions the Community of Madrid at the forefront of scientific leadership in a sector characterized by a high level of innovation.

In addition to the above achievements, 2013 has also been a great success on many other fronts, including the quality and international recognition of the publications authored by our researchers, the attraction of new research projects and grants, and the effective transfer of technology, amongst others. From all of our achievements, one that I would like to particularly highlight is the strengthening of strategic partnerships with ZED Worldwide and Telefonica and the reinforcement of the collaboration with other long-term collaborators such as NEC Europe, Alcatel-Lucent and Cisco Systems. All these achievements contribute to the consolidation of the Institute as one of the leading networking research laboratories in Europe.

My gratitude goes to the Regional Government of Madrid for its continuous support of this economy-transforming initiative, as well as to all those who are contributing to make this exciting project a great international success.

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executive summary

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IMDEA Networks Institute is a top international research centre in the area of networking. *2013 has been a great year for us in a number of ways. Our strategy to transfer scientific and technological developments to industry has led to various new collaborations in addition to strengthening the existing partnerships with some of our key industrial collaborators. We have also been very successful in several highly competitive public calls for funding to conduct new research projects. Through an extremely selective recruitment process we were able to attract outstanding scientists to strengthen our research team. Our research work - focused on innovative technological solutions to real-world problems - has been published in the most prestigious venues within our field. All these achievements have received the recognition of the international scientific community along with other stakeholders, as reflected by the awards received by the Institute this year.*

The **research team** of IMDEA Networks consists of preeminent technical leaders. All IMDEA Networks researchers hold a **meritorious research record** that includes publications in the most influential venues in our area of research, and they have graduated from, or worked for, top-level international universities, such as Columbia University, MIT, UT Austin, UC Berkeley, Politecnico di Torino, EPFL, Duke University or Rice University. Additionally, many of our researchers have received important **awards and prizes** for their research work and achievements; among the awards received this year, it is worth highlighting the 2013 Applied Networking Research Prize, granted to Pierre François, and the 2013 Prize to Best Young Researcher, awarded to Albert Banchs by University Carlos III of Madrid (UC3M). Our scientists do not only have an excellent research record, but they also possess an **extensive industry background.** Most of them have been employed in leading industry research laboratories, such as NEC, Telefónica, AT&T, Cisco, Alcatel, Philips, NTT Docomo or Disney Research Labs. What is more, they have been granted over 40 patents during their professional careers. This background is essential to carry out **research that can be transferred to companies** and in turn be transformed into profitable products that will **stimulate economic growth and job creation.**

In addition to experienced world-renowned researchers, an essential part of the Institute's research team is composed of **highly motivated pre-doctoral researchers,** keen to explore new ideas, who are pursuing their Ph.D. theses at IMDEA Networks. These researchers form the life-blood of any research team and are essential to conduct many project-related research tasks, such as the development of prototypes. We are proud that in 2013 the Institute graduated yet another Ph.D. Student, Dr. Michal Kryczka, who received the maximum distinction in his Ph.D. defense from a committee formed by recognized international experts. It is worth highlighting that many of our Ph.D. students have received important distinctions, such as the Outstanding Ph.D. Award of University Carlos III of Madrid or the Runner-up Award to the Best Final Project awarded by the Official Board of Telecommunications Engineers (COIT) and the Spanish Association of Telecommunications Engineers (AEIT). They have also been awarded very selective scholarships, such as FPU grants.

In 2013, **the Institute has continued to reinforce its research team.** We had 1 opening for a researcher position, which received 51 high quality applications from 20 different countries. The position was awarded to Domenico Giustiniano, an outstanding, widely recognized researcher who combines an excellent research and publication record with extensive industry experience, having received prizes such as the Disney Inventor Award and the Best Project Award at Telefónica. We also received a large number of applications (over 400) for our open Pre-doc Researcher positions, out of which 4 excellent candidates were selected. This highly demanding selection process guarantees that we are attracting first rate scientists. With the new incorporations, the IMDEA Networks team as of 31 of December 2013 is composed of **38 researchers from 26 different countries at different stages of their research careers.**

A key accomplishment of 2013 has been our participation in research projects. These projects bring external funding, highly productive collaborations with prominent research institutions and industrial partners, and the opportunity to transform our research ideas into practical deployments. IMDEA Networks is **currently working on 14 projects,** which is a notable quantity considering the size of the Institute. Out of these 14 projects, 8 are European, 1 is funded by the National Science Foundation of China, another is funded by the Swiss National Science Foundation (SNSF) - Sinergia project, 2 are national projects and 2 have a regional scope. During 2013, Joerg Widmer was awarded one of the very prestigious ERC Consolidator grants, and another European project, NetIDE, was also awarded to IMDEA Networks in an extremely competitive call. Furthermore, the iJOIN project was the recipient of the Runner-up Award to the Best Collaborative R&D Project in the region of Madrid. **iJOIN is the first Research and Technological Development (RTD) European project that is coordinated by an IMDEA institute.**

In addition to research projects funded by public institutions, a substantial part of the external funding attracted by IMDEA Networks originates from **direct contracts with industry.** While IMDEA Networks has strong ties with the international private sector, collaboration with local companies is at least as crucial (if not more) due to the value that it brings to the Madrid region. Two noteworthy examples of such local alliances are the **strategic partnerships** that the Institute has established with ZED Worldwide and Telefonica I+D, which provide a stable long-term framework to conduct joint research work. In addition to these, the Institute has also strong ties with many other national and international companies, such as Cisco Systems and NEC.

The efforts made by our team to produce outstanding scientific work led to a large number of scientific publications in 2013. However, rather than their quantity, we would like to emphasize their quality. According to Web of Science, IMDEA Networks is the Spanish organization with most publications at IEEE/ACM Transactions on Networking, the top journal in our area. This is a very remarkable achievement taking into account the youth of the Institute as compared to most Spanish organizations. Another indicator of the quality and impact of our publications is the data on the Institute provided by Google

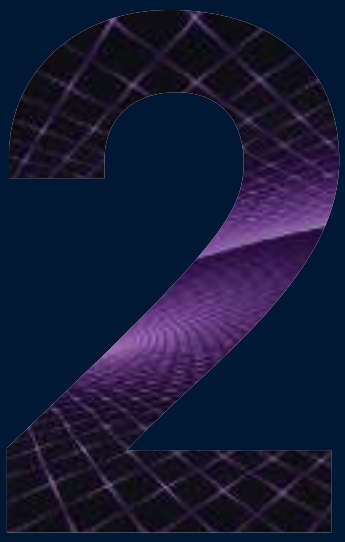
Scholar. According to these data, the Institute's researchers have received more than 30.000 citations in total, and the H index of the institute is 83 (meaning that 83 of the articles published by researchers of the institute have received 83 citations or more). **These figures place the Institute not only ahead of other Spanish organizations, but also at the forefront of European networking research.**

Beyond the publication of research articles, **a fundamental objective of our research is to have socio-economical impact.** Such impact can take various forms, such as **standardization, patent licensing or knowledge transfer of scientific and technological results** with the objective of further development and exploitation in commercial products. Research performed at IMDEA Networks during 2013 has attained impact to a sizable degree. Our researchers have been particularly active on this front, and some of their ideas have been standardized at the IETF (which is the body responsible for standardizing Internet technology) and patented (four patent applications were filed in 2013). These contributions have led to fruitful cooperation with companies interested in our **efforts to bridge the gap between theoretic results and practical implementation, deployment and commercialization.**

Last, but not least, another major activity over the past year concerns **the extension of our premises and infrastructure.** Networking science requires the rigorous validation of new algorithms and protocols, which makes the **infrastructure for experimentation** in the form of fully equipped laboratories an essential working tool. In 2013, IMDEA Networks signed an agreement to obtain a property transfer of our current building for the next 50 years. This provides the institute with a **permanent building** and guarantees enough space to satisfy its needs for many upcoming years. During this year, the Institute also made a substantial investment to acquire specialized equipment for its networked systems laboratory, indispensable to conduct research in this area. This investment was co-funded via a collaboration agreement with the Spanish Ministry of Economy and Competitiveness (previously known as the Spanish Ministry of Science and Innovation).

In **summary,** the Institute's **research output** in 2013 comprises publications in books (1), book chapters (2), peer-reviewed international journals and magazines (31), presentations in international conferences (57), funded research projects (9), industry contracts (6), and standardization contributions (7). In addition, 4 patents were filed in 2013. We believe that all the above data show the excellence of the Institute in research and technology transfer, and provide the basis to achieve ever growing success in the years to come.

about us



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2.1. Profile

IMDEA Networks Institute is a networking research organization whose multinational team is engaged in cutting-edge fundamental science. As a growing, English-speaking Institute located in Madrid, Spain, IMDEA Networks offers a unique opportunity for pioneering scientists to develop their ideas. IMDEA Networks is establishing itself internationally at the forefront in the **development of future Internet technologies** and has already incorporated highly-reputed scientists. Our researchers will contribute to shaping the future of networking science over the coming years.

2.2. Our Strategic Goals

- Conduct first class research on an international level in the area of computer networking
- Transfer technology to the industrial sector, in order to improve its capacity for innovation and competitiveness
- Transfer technology to spin-off-companies in order to promote the release of new products and services to the global market
- Attract and retain human capital of excellence with the aim to internationalize research in the Madrid region
- Collaborate with Madrid's industrial sector, research centers and educational institutions

2.3. Our Mission

Our mission is to create value by **leading research in protocol, algorithm and systems developments** that enable the **Future Internet**. We do this by conducting research and developing innovative and useful scientific and technical advances in the above areas, while actively **promoting their successful transfer to market**. The Institute strives to provide the best working conditions and the most attractive and best-equipped environment in which researchers can focus on this process of innovation and scientific advance.

2.4. Our Values

A culturally-diverse team, such as IMDEA Networks', needs goals, but it also has to share values that transcend our social, religious and other cultural differences. These values serve to unify us by defining how we conduct ourselves, both within the team and in our dealings with others. Our core values will remain constant and will be promoted actively within the Institute:

- To be open to the new
  To be constantly adapting to our changing environment

- To value diversity
  We seek out and cherish different perspectives and diversity. We understand the value of diversity

- To be positive
  We encourage positive critical thought with a view to addressing the issue of generating better solutions, not simply identifying problems

- To act with integrity
  We act with integrity and honesty, delivering on our commitments in all our interactions. The trust this engenders provides the foundations for productive partnerships

- To listen well and speak clearly
  We listen actively to other people and take responsibility for explaining ourselves as we wish to be understood

- To respect individual brilliance
  We respect, honor and reward exceptional individual contributions

- To work collaboratively
  Our individual contributions are more fruitful when performed in a team environment. We work in a spirit of partnership in all our activities with others. We achieve this by identifying and pursuing shared objectives in an open and honest way

- To innovate always
  We always look at problems from different points of view. We aim to do breakthrough research, not incremental research

- To compete sportingly across the globe
  We compete fairly but intensely, according to the letter and spirit of accepted standards. Competition drives us to be the best and most successful in our field

- To enjoy our work
  We enjoy what we do and share our enjoyment with each other

2.5. Our Credo

- We believe in group discussion and in bright individual ideas
- *We do not believe in voting and committees. We believe in running code and rough consensus*. (David D. Clark)
- Demo or die (in addition to publish or perish)
- *Genius is 1% inspiration and 99% perspiration.* (T.A. Edison)

research areas

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As illustrated by **our motto – Developing the Science of Networks –** IMDEA Networks identifies and addresses major scientific and engineering challenges in communications and computer networks, and also aims to develop these results by bringing them into practical deployments. The nature of these challenges varies with ever-greater rapidity. To ensure the relevance of our research activities, we continuously adjust our research agenda to stay at the forefront of technological innovation. We organize our scientific activities into research areas that reflect our current working priorities, ensuring sufficient flexibility to allow us to respond to emerging technological challenges. The research mission of our Institute also adapts to the strengths of our growing research team and our external collaborators. **Currently, our research is focusing on the general areas presented in the following sections:**

networked systems&algorithms

3.1. Networked Systems and Algorithms

Any network has a structure and needs protocols to achieve its objectives. IMDEA Networks' researchers have an **extensive expertise** in architectures and protocols for communication networks, e.g., for network topology design, routing, forwarding, in-network storage, congestion control, and media access control. Besides, we have research interests in other networking domains such as social networks, energy networks, and transportation networks.

Our research takes a **multi-disciplinary approach** to the design and understanding of network protocols and architectures. We go beyond technological constraints and account also for social and economic factors. For example, our research on Internet routing and forwarding accounts for the multitude of Internet service providers and their individual eco-

nomic interests. In working on either centralized or decentralized solutions to problems, we assume that perfect information is never available. To deal with such uncertainty as well as selfishness of individual entities, our analysis adopts game-theoretic techniques. Our protocol design assumes that behavior of counterparts is always unpredictable to some extent. Hence, the designed protocols rely on continuous learning and adaptation as the main modes of operation.

Practicality is another distinguishing aspect of our research. Real data serves as a departing point for our analytical efforts as well as a basis for validating our analytical conclusions. For instance, our large-scale simulation studies of Internet routing rely on real Internet topologies. Furthermore, we implement our theoretical ideas and make the prototypes available to the public, either directly or through our commercial partners.

An important focus of our work is on the systems side of networks. For example, we apply software verification techniques to develop tools that help network builders create more reliable networks. We also work on networking aspects that pertain to cloud computing.

This research area targets the following **objectives**:

- **Novel architectures and protocols for behavioral networking**
  - The Internet is modeled as an association of independent entities
  - Behavior of counterparts is not taken for granted
  - Continuous learning and adaptation are main modes of operation

- **Bridging the gap between network economics and networking**
  - Deployment of innovative designs becomes the primary concern
  - Economic and political landscapes of the Internet are analyzed with higher fidelity
  - Economic-political knowledge guides the technical design

- **Making it easy to develop and deploy reliable, high-performance networked systems**
  - Correct functioning of networks is becoming paramount
  - Software Defined Networking is revolutionizing networking, but carries a lot of risk
  - Leverage increases in computational power and bandwidth to predict future reliability
  - Resolve difficult choices at runtime to increase performance

3.2. Wireless Networking

wireless networking

Given the scarcity of wireless spectrum resources and the rising demand for mobile applications, optimizing wireless communication is currently one of the most important and challenging research topics in networking. The proliferation of inexpensive, high-rate mobile devices and ubiquitous connectivity opens up a vast spectrum of possible

new services but also poses unique challenges concerning wireless interference and the unpredictability of the wireless medium.

IMDEA Networks is involved in a number of different wireless research areas. Part of our efforts aim at improving existing wireless technologies such as **Wi-Fi** (IEEE 802.11) and **LTE**, for example, through the design of opportunistic scheduling mechanisms and interference management schemes. We further investigate emerging wireless technologies such as **extremely high frequency communication** (e.g. IEEE 802.11ad) and **Visible Light Communication.** Our work on wireless capacity improvements focuses on topics such as intelligent interference management, cooperative coding and network coding, improved medium access control mechanisms that make use of advanced physical layer technologies such as MIMO, successive interference cancellation, etc. We have an extensive track record in the areas of ad hoc and mesh networks, in particular on routing and MAC layer design, and apply them in several contexts, such as the Internet of Things (IoT) and Unmanned Aerial Vehicle Networks. To improve the flexibility and programmability of future wireless technologies, we explore novel programmable interfaces that expose low-level operations to foster network evolution and enable performance optimization and service customization. One of the goals of this work is to implement application specific optimizations, for example, to provide efficient wireless video streaming. We also study novel solutions to use wireless technologies for localization.

We recognize the importance of **bridging the gap between theoretic results and applied wireless research** and have deployed a range of wireless testbeds (IEEE 802.11, software defined radios) on which we implement and evaluate our ideas.

This research area targets the following **objectives**:

- **Optimization of wireless networking**
  - Opportunistic scheduling
  - Adaptive coding and modulation
  - Interference management in dense networks
  - Traffic offloading in heterogeneous networks
- **Heterogeneous wireless networks**
  - We are facing the proliferation of many different wireless technologies
  - Supporting them in the current Internet is highly complex
  - Existing solutions are based on technology specific interfaces
  - The wireless Internet architecture needs to be rethought for efficient support of heterogeneity
- **Self organizing wireless networks**
  - Scaling and increased heterogeneity require self-organization
  - Solutions needed to track and exploit changing spatial traffic loads
  - Complex dynamics of wireless system and user behavior are involved
  - Significant performance gain and energy savings can be achieved

3.3. Energy-efficient Networking

energy-efficient networking

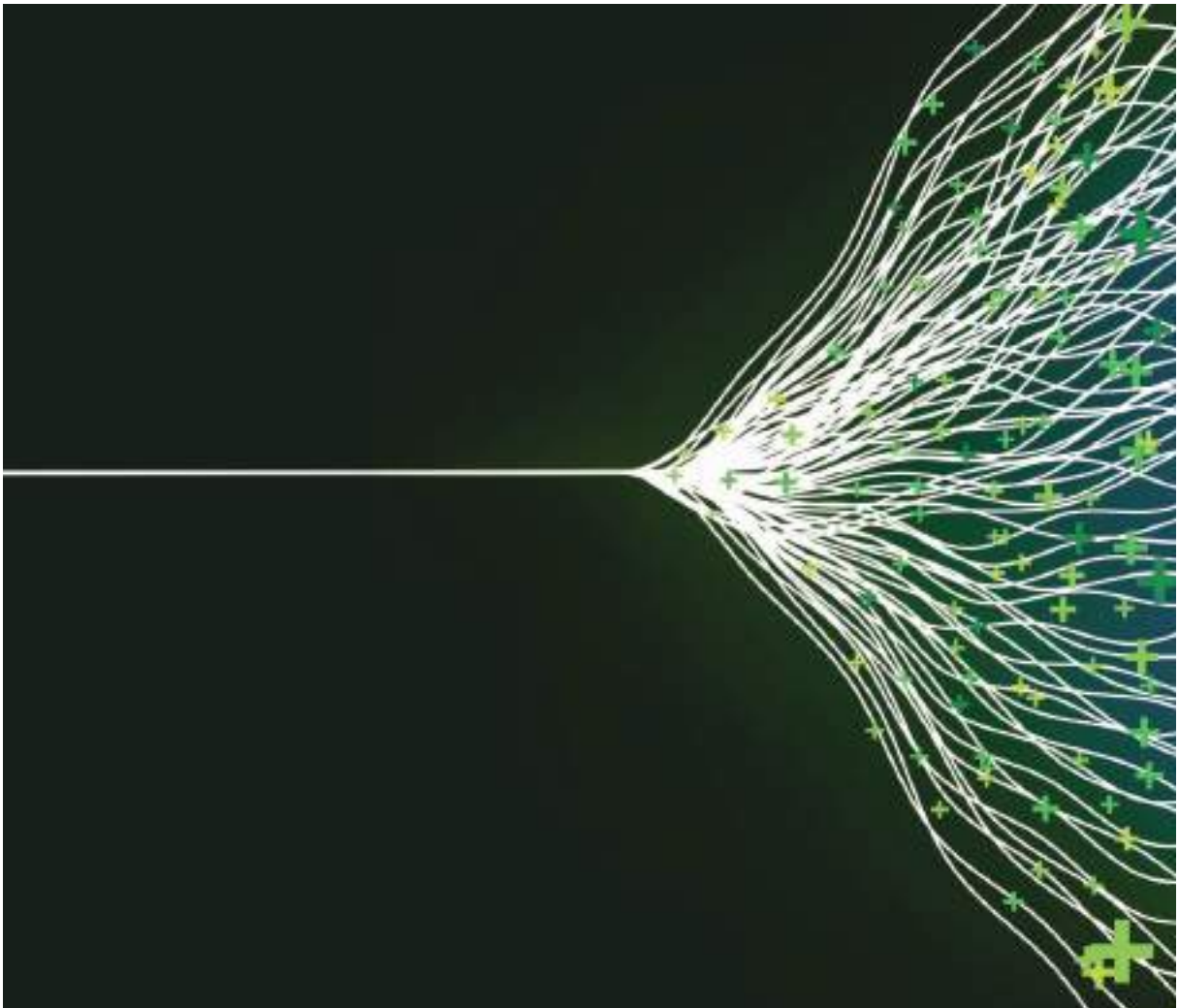
Energy production, distribution, and consumption are becoming topics of interest worldwide, due to issues like climate change and the greenhouse effect. IMDEA Networks is actively involved in **research conducted to increase energy performance with the use of computation and communication.** These research efforts can be grouped into two main lines. The first line involves research that attempts to save energy in computing and communication systems, like computers and networks, named energy efficient ICT. The second line involves research that attempts to design ICT systems that improve energy production and distribution, and optimize consumption, named ICT for energy efficiency.

In the area of **energy-efficient ICT**, researchers of the Institute have developed techniques for many different areas, ranging from wireless communication to cloud computing. For instance, they have proposed techniques to save energy in cellular networks. One of these techniques is switching off access points in periods of low traffic or in areas of high density of base stations. This may require cell phone operators to reach agreements so that some of their base stations are switched off and their customers reassigned to base stations of other operators. The savings achieved by such agreements has been studied as well. Another technique studied to save energy in cellular networks is to offload traffic from the cellular networks to other networks. Finally, the

use of renewable sources of energy to power cellular base stations has been evaluated. In other types of wireless networks, techniques for energy saving using opportunistic relaying have been proposed.

One interesting line is the study of the optimal deployment of Energy Efficient Ethernet (IEEE 802.3az) equipment, where the effect of packet coalescing in the energy consumption of links that follow this standard has been studied. Finally, techniques for energy saving in data centers have been proposed in the form of algorithms to schedule and manage the assignment of virtual machines to the physical machines of a data center.

In the area of **ICT for energy efficiency**, researchers from the institute have proposed techniques to provide good service for the users of electric-vehicle charging stations. These solutions use concepts taken from networking, like load balancing and fairness. Current lines of research in this area include scheduling appliances in order to reduce electricity costs in households, and the use of social networks and game theory to modify user energy consumption patterns.



research projects, grants and fellowships

4.1. Funding awards **[21]**

4.2. Externally-funded research projects, attracting European Union, National or Regional funds **[23]**

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4.1. Funding Awards

We dedicate extensive resources to obtaining external funding to support our research team and in particular those members who excel in their capacities, with the objective to promote the scientific and technical potential of our human capital and, as a direct result, the outreach of the Institute's activities.

The funding of our individual researchers takes the form of awarded grants, scholarships and fellowships from international, national and regional funds. These awards are similar to externally-funded research in their openness and the strict selection processes used, and they confer prestige on the awardee as well as on the organization he is affiliated to.

ERC Grants

Awardees

- Dr. Dejan KOSTIĆ, Research Associate Professor **(ERC Starting Grant).** Principal Investigator of the **PROPHET** research project. *This project has been executed in IMDEA Networks since November 2012*
- Dr. Joerg WIDMER, Research Professor **(ERC Consolidator Grant).** Principal Investigator of the **SEARCHLIGHT** research project

Funded by

European Union. European Research Council (ERC Grants)

"MARIE CURIE" AMAROUT Europe Programme

Awardees

- Dr. Pierre FRANCOIS, Research Assistant Professor
- Dr. Domenico GIUSTINIANO, Research Assistant Professor
- Dr. Sergey GORINSKY, Research Associate Professor
- Dr. Vincenzo MANCUSO, Research Assistant Professor
- Dr. Joerg WIDMER, Research Professor

Funded by

European Union. Marie Curie Action (PEOPLE-COFUND)

"MARIE CURIE" Intra-European Fellowships (IEF) for Career Development

Awardees

- **Scientist in charge:** Dr. Antonio FERNÁNDEZ ANTA, Research Associate Professor, IMDEA Networks Institute
- **Name of researcher:** Dr. Nicolas NICOLAOU, Special Scientist (Teaching Position), University of Cyprus

Research project

ATOMICDFS

Funded by

European Union. FP7-PEOPLE-IEF

Ramón y Cajal Grants

(Programa Ramón y Cajal)

Awardees

- Dr. Sergey GORINSKY, Research Associate Professor
- Dr. Joerg WIDMER, Research Professor

Funded by

Spanish Ministry of Economy and Competitiveness (*Ministerio de Economía y Competitividad - MINECO*), previously known as the Spanish Ministry of Science and Innovation (*Ministerio de Ciencia e Innovación – MICINN*)

FPU Scholarships

(Becas del Programa de Formación de Profesorado Universitario)

Awardees

- Michal KRYCZKA, Pre-doc Researcher
- Elli ZAVOU, Pre-doc Researcher

Funded by

Spanish Ministry of Education, Culture and Sports (*Ministerio de Educación, Cultura y Deporte - MECD*), previously known as the Spanish Ministry of Education (*Ministerio de Educación - MEC*)

I3 Subventions

(Programa I3)

Awardee

- Dr. José Félix KUKIELKA, Research Associate Professor

Funded by

Department of Education, Youth and Sports, Regional Government of Madrid (*Consejería de Educación, Juventud y Deporte, Comunidad de Madrid*)

4.2. Externally-funded research projects, attracting European Union, National or Regional funds

Externally-funded research projects enable us to collaborate with researchers from other organizations and backgrounds. Research funding is awarded following an open competitive selection process in which project proposals, and the private or public sector organizations presenting them, are subject to rigorous scrutiny. Such thoroughness helps to ensure that research undertaken with those funds is relevant, well-managed and with high probability of success in achieving its stated goals.

4.2.1. Ongoing projects

PROPHET

Simplifying Development and Deployment of High-Performance, Reliable Distributed Systems

Project website: prophet.networks.imdea.org
Funded by: European Union. European Research Council (Starting Grant)
Duration: February 2011 to January 2016. *This project has been executed in IMDEA Networks since November 2012*
Project partners: École Polytechnique Fédérale de Lausanne (EPFL), IMDEA Networks Institute

Problem statement: Distributed systems form the foundation of our society's infrastructure. Unfortunately, they suffer from a number of problems:

1. they are time-consuming to develop because it is difficult for the programmer to envision all possible deployment environments and design adaptation mechanisms that will achieve high performance in all scenarios;

2. their code is complex due to the numerous outcomes that have to be accounted for at development time and the need to re-implement state and network models;

3. they are unreliable because of the difficulties of programming a system that runs over an asynchronous network and handles all possible failure scenarios.

If left unchecked, these problems will keep plaguing existing systems and hinder development of a new generation of distributed services. A key set of new services arises in cloud computing.

Our approach: We propose a radically new approach to simplifying development and deployment of high-performance, reliable distributed systems. The key insight is in creating a new programming model and architecture that **leverages the increases in per-node computational power, bandwidth and storage** to achieve this goal. Instead of resolving difficult deployment choices at coding time, the programmer merely specifies the choices and the objectives that should be satisfied. The PROPHET runtime then resolves the choices during live execution so as to maximize the objectives. To accomplish this task, the runtime uses a combination of state-space exploration, simulation, behavior prediction, performance modeling, and program steering.

CROWD

Connectivity management for eneRgy Optimised Wireless Dense networks

Project website: www.ict-crowd.eu
Funded by: European Union. ICT Programme FP7
Duration: January 2013 to June 2015
Project partners: Intecs Informatica e Tecnologia del Software S.P.A., Alcatel Lucent Bell Labs France, France Telecom SA (FT), IMDEA Networks Institute , Signalion GmbH, Universidad Carlos III de Madrid, Universität Paderborn

Wireless traffic demand is currently growing exponentially. This growing demand can only be satisfied by increasing the density of points of access and combining different wireless technologies. Mobile network operators have already started to push for denser, hetero-

geneous deployments; however, current technology needs to steer towards efficiency, to avoid unsustainable energy consumption and network performance implosion due to interference. While some efforts have already been devoted to evolving the technology, these efforts mostly take a restricted PHY perspective and do not consider higher-layer mechanisms, which are required to fully optimize global performance. In this context, **CROWD promotes a paradigm shift in the future Internet architecture towards global network cooperation, dynamic network functionality configuration and fine, on demand, capacity tuning.**

The project targets very dense heterogeneous wireless access networks and integrated wireless-wired backhaul networks. In this framework, CROWD pursues four key goals: i) bringing density-proportional capacity where it is needed, ii) optimizing MAC mechanisms operating in very dense deployments by explicitly accounting for density as a resource rather than as an impediment, iii) enabling traffic-proportional energy consumption, and iv) guaranteeing mobile user's quality of experience by designing smarter connectivity management solutions. The technology developed by the project will be designed taking into account the requirements for commercial deployment. Exploitation plans comprise a thorough roadmap for standardization that includes the support letters from chairs of the relevant groups at IETF, IRTF, IEEE and Femto Forum. The consortium combines the integrated perspectives of a major mobile operator, a top leader manufacturer, a provider of test equipment, an innovative company engaged to develop new technologies, two leading academic partners and a world-renowned research institute.

EINS

Network of Excellence in Internet Science

Project website: www.internet-science.eu
Funded by**:** European Union. ICT Programme FP7
Duration: December 2011 to May 2015
Project partners: Alcatel-Lucent Bell Labs, Alma Mater Studiorum, Universita di Bologna, Centre for Research and Technology Hellas, Consiglio Nazionale delle Ricerche (CNR), École Polytechnique Fédérale de Lausanne (EPFL), Swiss Federal Institute of Technology in Zürich (ETHZ), IMDEA Networks Institute , Chinese Academy of Sciences, Korea Advanced Institute of Science and Technology, London School of Economics and Political Science (LSE), National and Kapodistrian University of Athens, National ICT Australia (NICTA), Oxford Internet Institute, University of Oxford, Politecnico di Torino (Nexa Center), Royal Netherland Academy for Arts and Science, Sigma Orionis, Stockholms Universitet, Technicolor R&D, Technische Universität München, Technische Universiteit Delft, Universidad Autónoma de Madrid (UAM), Universität Passau, Universite De Savoie, Universite Pierre et Marie Curie (UPMC), Universitetet i Oslo, University of Cambridge, University of Essex, University of Lancaster, University of Ljubljana, University of Southampton, University of Warwick, University of Waterloo

The goal of EINS is coordinating and integrating European research aimed at achieving a deeper multidisciplinary understanding of the development of the Internet as a societal and technological artifact, whose evolution is increasingly intertwined with that of human societies. Its main objective is to allow an open and productive dialogue between all the disciplines which study Internet systems under any technological or humanistic perspective and which in turn are being transformed by the continuous advances in Internet functionalities and applications. EINS will bring together research institutions focusing on network engineering, computation, complexity, security, trust, mathematics, physics, sociology, game theory, economics, political sciences, humanities, law, energy, transport, artistic expression, and any other relevant social and life sciences.

This multidisciplinary bridging of the different disciplines may also be seen as **the starting point for a new Internet Science**, the theoretical and empirical foundation for a holistic understanding of the complex techno-social interactions related to the Internet. It is supposed to inform the future technological, social, political choices concerning Internet technologies, infrastructures and policies made by the various public and private stakeholders, for example as for the far-ended possible consequences of architectural choices on social, economic, environmental or political aspects, and ultimately on quality of life at large.

The individual contributing disciplines will themselves benefit from a more holistic understanding of the Internet principles and in particular of **the "network effect".** The unprecedented connectivity offered by the Internet plays a role often underappreciated in most of them; whereas the Internet provides both an operational development platform and a concrete empirical and experimental model. These multi- and inter-disciplinary investigations will improve the design of elements of Future Internet, enhance the understanding of its evolving and emerging implications at societal level, and possibly **identify universal principles for understanding the Internet-based world** that will be fed back to the participating disciplines. EINS will:

- Coordinate the investigation, from a multi-disciplinary perspective, of specific topics at the intersection between humanistic and technological sciences, such as privacy & identity, reputation, virtual communities, security & resilience, network neutrality

- Lay the foundations for an Internet Science, based i.a. on Network Science and Web Science, aiming at understanding the impact of the "network effect" on human societies & organizations, as for technological, economic, social & environmental aspects

Provide concrete incentives for academic institutions and individual researchers to conduct studies across multiple disciplines, in the form of online journals, conferences, workshops, PhD courses, schools, contests, and open calls

eCOUSIN

enhanced COntent distribUtion with Social INformation

Project website: www.ict-ecousin.eu
Funded by**:** European Union. ICT Programme FP7
Duration: November 2012 to April 2015
Project partners: France Telecom SA (FT), Alcatel-Lucent Bell Labs, IMDEA Networks Institute , Institut Telecom, NEC Europe Ltd., Technische Universität Darmstadt, Telecom Italia S.p.a., University of Cambridge, Universidad Carlos III de Madrid

Content Distribution Services are booming and they will be responsible for the majority of future Internet traffic. In parallel, **Online Social Networks** (OSNs) have become **today's most popular Internet application**. The widespread adoption of OSNs has drastically changed the way content is consumed in the Internet, as content consumption is nowadays highly impacted by the information shared by users through OSNs and the popularity of a given content is most often dictated by its "social" success. With such a **"social-content revolution"**, operators need to evolve and optimize their network to avoid being overwhelmed by the ever growing traffic volumes resulting from this paradigm change. To this aim, **the goal of eCOUSIN is to design a novel social-aware network architecture with built-in content dissemination functionalities that exploits the social-content interdependencies to improve its efficiency**. This goal translates into the following specific objectives: (i) the implementation of high performance distributed tools for collecting necessary data to study and model the social-content interdependencies; (ii) the improvement of the scalability of network infrastructures when handling content by exploiting social information; (iii) the design of an on-net operational framework that tightly integrates network functionalities and content-related service functionalities; and (iv) the design of algorithms that exploit

social information for placing and delivering contents in an optimized manner with a special focus on mobile environments. We envision that all these will be fundamental components of the future Internet architecture.

The eCOUSIN consortium comprises two leading network operators, two major manufacturers of telecommunication equipment, one research institute and four universities. All of them are strong actors in the areas of this project, and their complementary nature ensures the impact of the eCOUSIN outcomes on both the industrial and scientific domains.

i-JOIN

Interworking and JOINt Design of an Open Access and Backhaul Network Architecture for Small Cells based on Cloud Networks

IMDEA Networks Institute is the Project Coordinator

Project website: www.ict-ijoin.eu
Funded by: European Union. ICT Programme FP7
Duration: November 2012 to April 2015
Project partners: IMDEA Networks Institute, NEC Europe Ltd., Telecom Italia S.p.a., Sagemcom Broadband SAS, Telefonica Research, Intel Mobile Communications France, Hewlett Packard Italiana SRL, Commissariat à l'Energie Atomique et aux Energies Alternatives, Universidad Carlos III de Madrid, Universität Bremen, University of Surrey, Technische Universität Dresden

The last decades brought an **exponential increase in mobile traffic volume**. This will continue and a 1000-fold increase by 2020 has been forecasted. **Small-cells promise to provide the required data rates through an increased spatial utilization of the spectrum**.

Due to strong inter-cell interference, small-cell deployments will require a high degree of coordination as offered by centralized processing. Furthermore, heterogeneous backhaul solutions will be used to connect small-cells and core network. So far, access and backhaul are individually designed and therefore not optimized. In order to support centralized processing and a heterogeneous backhaul, challenges on access and backhaul must be simultaneously tackled.

iJOIN introduces the novel concept RAN-as-a-Service (RANaaS), where RAN functionality is flexibly centralized through an open IT platform based on a cloud infrastructure. iJOIN aims for a joint design and optimization of access and backhaul, operation and management algorithms, and architectural elements, integrating small-cells, heterogeneous backhaul, and centralized processing. Additionally to the development of technology candidates across PHY, MAC, and the network layer, iJOIN will study the requirements, constraints, and implications for existing mobile networks, specifically 3GPP LTE-A.

iJOIN will design new network operation and management algorithms in the context of RANaaS, show their implications on 3GPP LTE, and evaluate the derived technologies with respect to four quantitative key objectives: 1) system throughput 2) energy-efficiency 3) cost-efficiency 4) utilization-efficiency. iJOIN will further impact 1) the research community by identifying new challenges, 2) business opportunities through new concepts for implementing mobile networks, and 3) standardization through strong industry participation of all major stakeholders.

E2NET

Energy Efficient Networks (Redes energéticamente eficientes)

Funded by: Spanish Ministry of Economy and Competitiveness (*MINECO*), previously known as the Spanish Ministry of Science and Innovation (*MICINN*)
Duration: January 2012 to December 2014
Project partners: IMDEA Networks Institute, Universidad Carlos III de Madrid

Recent studies reveal that **ICT (Information and Communications Technology) energy consumption is becoming a significant component of the worldwide consumption**. This situation has generated a keen interest in **mechanisms and methods for saving energy by telecommunication network operators, Internet Service Providers (ISPs) and content providers**. Depending on the specific scenario, energy costs are a substantial cost factor, and a reduction of network and data center energy consumption provides an important contribution to cost efficiency, besides corporate social responsibility and the obvious environmental benefits. **The main objective of this project is the design of algorithms and techniques to reduce the energy consumption of communication systems without significantly affecting the service quality.** We utilize a cross-layer approach that includes algorithms and techniques to be applied at different layers of the network architecture, with main focus on the link, network, transport, and application layers.

On the one hand, we address the energy efficiency at the link, network, and transport layers. We will define precise energy consumption and traffic models for network elements (e.g., routers and links) in different setups, namely LAN, WAN, and data centers. These setups differ in the granularity and the time scales at which resource and energy optimization are performed. At the same time, applications like content distribution span all of these different areas, and their joint optimization is likely to lead to even better performance results. Par-

ticular care will be taken to define models that convey as much as possible the technological aspects of current and future network elements. For instance, models for new energy saving techniques, like 802.3az (Energy Efficient Ethernet), will be developed. Based on these models we will design techniques (e.g., routing and scheduling algorithms) to minimize the overall energy consumption. The performance of the developed solutions will be formally analyzed, and evaluated via simulation and testbed experiments. In addition, **we will explore the potential of these and other proven techniques, originally developed for the area of networking, to also save energy in other application areas.** In particular, we will explore how to save energy and/or improve the service when operating appliances and charging electric vehicles. Many of the challenges in such non-networking contexts are similar to those encountered in the communications world. Thus, exploring the application of concepts and techniques already used in communications and networks to these problems seems promising.

On the other hand, we address the energy efficiency at the application layer with a mixture of theoretical, simulation and Internet measurement techniques. We consider content distribution applications since they are responsible for the major portion of the current Internet traffic. In more detail, we have three independent but related objectives. First, we will design content distribution scheduling algorithms that minimize the energy wastage of the system. We will provide proof of correctness for these algorithms. Second, we aim to design an energy-efficient peer-to-peer (P2P) client for minimizing the energy consumption of the content distribution process through P2P techniques. We will validate the proposed techniques using a realistic workload generated from data collected from real P2P applications such as BitTorrent. Furthermore, we will implement a prototype of our energy-efficient P2P client and will make it publicly available. Finally, we will study the energy consumption vs. performance trade-off of different content distribution infrastructures (i.e., centralized vs. Content Delivery Network (CDN) vs. P2P) for the distribution of User Generated Content (UGC). For this purpose, we will collect real data traces from well-known applications that owe their success to UGC such as YouTube or Online Social Networks (Facebook and Twitter) in order to generate a realistic workload to evaluate the energy wastage of the described infrastructures. **As result of this study we will design a novel content distribution architecture to reduce the energy wastage of the UGC distribution.**

GREEN NETWORK

Theory and Technique for Reducing Network Energy Consumption

IMDEA Networks Institute is an Associated Partner in this project

Funded by: National Natural Science Foundation of China. Grant number 61020106002
Duration: January 2011 to December 2014
Project partners: Institute of Computing Technology, Alcatel-Lucent Bell Labs, Universidad Rey Juan Carlos, Tsinghua University, Chinese Academy of Sciences

This research is on **theories and techniques for globally reducing energy consumption at the network level**. The following issues are investigated: (1) Techniques for network infrastructure design and deployment of network nodes that can reduce network energy consumption. (2) Scheduling and routing algorithms and protocols that can reduce network energy consumption. The goals of this research include: (1) System models will be formalized to realistically express the characteristics and restrictions of current network technologies. (2) Techniques for network nodes deployment that can reduce network energy consumption will be developed. (3) Energy efficient algorithms and protocols for network message routing and scheduling will be developed. (4) Correctness proof of our protocols and algorithms and theoretical analysis of them will be provided. (5) A platform will be built for the simulation of the algorithms, protocols and for testing the infrastructure design and node deployment schemes.

SWARMIX

Synergistic Interactions in Swarms of Heterogeneous Agents
Collaboration Agreement for Research & Development with ETH Zürich

Project website: www.swarmix.org
Funded by: Swiss National Science Foundation (SNSF): Sinergia project
Duration: November 2013 to July 2014
Project partners: Swiss Federal Institute of Technology in Zürich (ETHZ), IMDEA Networks Institute

IMDEA Networks Institute and **ETH Zürich** have signed a collaboration agreement for research and development. Dr. Domenico Giustiniano, Research Assistant Professor at IMDEA Networks, will contribute to the project objectives and to the scientific dissemination of the results.

The **SWARMIX** project is about laying the foundations for the design, implementation, and adaptive control of heterogeneous multi-agent systems that are composed of **humans**, **animals,** and **robots**, working in cooperation to solve distributed tasks that require a wide diversity of sensory-motor and cognitive skills. We refer to such systems as **mixed swarms**. The aim is to provide each component of the mixed swarm with a high level of autonomy in order to allow it to fully exploit its own unique skills and abilities, and at the same time to set up close bidirectional **interactions** and **information flows** between all system components in order to ensure overall **synergistic cooperation**. The main novelty of this project lies in the cooperative integration of a possibly large number of humans, animals, and robots in tight cooperation in one single networked system with distributed control.

CLOUDS

Cloud Computing for Scalable, Reliable and Ubiquitous Services (Cloud Computing para Servicios Escalables, Confiables y Ubicuos)

IMDEA Networks Institute is an Associated Group in this project

Project website: lsd.ls.fi.upm.es/clouds
Funded by: Department of Education, Youth and Sports, Regional Government of Madrid (*Consejería de Educación, Juventud y Deporte, Comunidad de Madrid*)
Duration: January 2010 to May 2014
Project partners: Universidad Politécnica de Madrid (UPM), Universidad Rey Juan Carlos

Cloud computing is a new emerging paradigm in distributed systems whose goal is to offer software as a service, enabling the deployment and management of services through data centers and/or clouds of devices accessible via the Internet, across administrative domains, technology platforms and geographical areas, and with a high degree of autonomy, with properties such as self-healing, self-provisioning, self-optimization and auto-configuration. **This project aims to make the necessary scientific progress to advance the state of the art in the various lines of research associated with cloud computing,** in order to make this paradigm possible. In this manner, the concept of computing is reformulated through a web of resources distributed globally (data centers, PCs, ubiquitous devices), automatically provisioning on-demand services, reducing software complexity and cost, and increasing reliability and the transparency of deployment and self-provisioning.

These systems also are managed autonomously with on demand self-provisioning at competitive cost and with high quality of service. **This new paradigm will increase the accessibility of users to the services of public administrations and companies.** On the one hand, it will propose new paradigms for cloud computing. It will design and develop cloud computing platforms that can be deployed in data centers and/or ubiquitous networks (Internet of things). On the other hand, it will develop protocols that allow the development of such systems, such as distributed algorithms, and it will provide the desired properties, such as autonomic behavior, security, scalability and availability. Furthermore, it will address the architectures and technologies to materialize it, such as service-oriented architectures, as well as the necessary computing, communication and storage infrastructure. Finally, it will also address the modeling of users and applications to be built on cloud computing platforms.

MEDIANET

Integration of Next Generation Multimedia Services in the Internet of the Future (Integración de Servicios Multimedia de Siguiente Generación en la Internet del Futuro)

Project website: www.medianet-cm.es
Funded by: Department of Education, Youth and Sports, Regional Government of Madrid (*Consejería de Educación, Juventud y Empleo, Comunidad de Madrid*)
Duration: January 2010 to May 2014
Project partners: IMDEA Networks Institute, NETCOM Research Group - Universidad Carlos III de Madrid, DSA Research group - Universidad Complutense de Madrid, GIST Research Group - Universidad de Alcalá

This program strives for a significant **scientific advance in the future media Internet** where important advances are necessary **to allow end-users to perceive a good quality of experience**. The network technologies objectives consist of the definition and validation of new proposals for the efficient transport of high bandwidth, real-time data flows in a decentralized way where the network provides mechanisms to seamlessly request and configure devices to increase the quality of experience perceived by end-users. Furthermore, new experiences with layer 2 networks and a cross-layer design will be tested with high bandwidth demanding media services. The global result will be **an integrated and independent advancement in future media Internet protocols, algorithms, switching architectures and standards**.

TREND

Towards Real Energy-efficient Network Design - The Network of Excellence on Energy-Efficient Networking

IMDEA Networks Institute is a Collaborating Institution in this project

Project website: www.fp7-trend.eu
Funded by: European Union. ICT Programme FP7
Duration: September 2010 to September 2013
Project partners: Politecnico di Torino (PoliTO), Alcatel-Lucent Bell Labs, Huawei Technologies Dusseldorf GmbH (HWDU), Telefonica Research, France Telecom SA (FT), Fastweb SPA (FW), Universidad Carlos III de Madrid, Interdisciplinary Institute for Broadband Technology (IBBT), Technische Universität Berlin (TUB), École Polytechnique Fédérale de Lausanne (EPFL), Consorzio Nazionale Interuniversitario per le Telecommunicazioni, Panepistimio Thessalias - University of Thessaly (UTH)

TREND is a **Network of Excellence**, coordinated by Politecnico di Torino, funded by the European Commission within the Seventh Framework Programme.

TREND aims at integrating the activities of major European players in networking, including manufacturers, operators, research centers, **to quantitatively assess the energy demand of current and future telecom infrastructures, and to design energy-efficient, scalable and sustainable future networks**.

The NoE will integrate and drive the many recent research efforts in energy-efficient networking towards commonly agreed technical goals, laying down the bases for **a new holistic approach to energy-efficient networking**, investigating effective strategies and mechanisms to reduce energy consumption in current and future networks in general, and the future Internet in particular. We aim at identifying the best answers to the following questions:

- What is the real power consumption of ICT?
- What are the means to best reduce the energy consumption of today's networks without compromising requirements in network and service performance?
- What are the best suited engineering criteria and principles to actively support energy efficiency along the sequence of network design, planning, and operation?
- What changes in the design of network equipment are necessary in the short and long term in order to obtain the largest possible energy saving?
- Which communication and management paradigms and protocols will be able to mediate and ensure the most effective distributed energy control?

- What are the most promising and sustainable long-term approaches to energy efficient networking, assuming that a clean slate network design is possible, and what are potential migration strategies to achieve this?
- What kind of mutually beneficial incentives can be proposed to network operators, service providers, and users, in order to maximize energy efficiency?

The aim of TREND is to establish the integration of the EU research community in green networking with a long term perspective to consolidate the European leadership in the field.

MEDIEVAL

MultimEDia transport for mobIIE Video AppLications

IMDEA Networks Institute participates as a third party of University Carlos III of Madrid

Project website: www.ict-medieval.eu
Funded by: European Union. ICT Programme FP7
Duration: July 2010 to June 2013
Project partners: Alcatel-Lucent Bell Labs, Telecom Italia S.p.a., Portugal Telecom Inovaçao, Docomo Communications Laboratories Europe, LiveU, Instituto de Telecomunicacoes, Universidad Carlos III de Madrid, Consorzio Ferrara Ricerche, EURECOM

Video is a major challenge for the future Internet. This traffic type is foreseen to account for close to 90 percent of consumer traffic already by 2012. However, the current Internet, and in particular the mobile Internet, was not designed with video requirements in mind and, as a consequence, its architecture is very inefficient when handling video traffic. It is the vision of this consortium that, as video is going to represent the majority of the traffic, the future Internet architecture should be tailored to efficiently support the requirements of this traffic type. Specific enhancements for video should be introduced at all layers of the protocol stack where needed, ideally supporting an incremental deployment.

Following the above vision, the main goal of the project is **to evolve the Internet architecture for efficient video traffic support**. The proposed architecture will follow a cross-layer design that, by exploiting the interaction between layers, can raise performance to values unattainable with individual developments. The following key issues will be addressed by the architecture: i) enhanced wireless access support to optimise video performance, ii) novel IP mobility architecture adapted to the requirements of video traffic, iii) transport optimisations for video distribution and iv) network-aware video services that interact with the underlying layers.

The technology developed by the project will be designed taking into account the require-

ments of network operators for commercial deployment, and will aim at improving the Quality of Experience by users as well as reducing the associated costs for operators. Standardization and early incremental testing are considered key success factors for MEDIEVAL.

The consortium is well balanced and combines the integrated perspectives of three mobile operators, a major manufacturer and an innovative video technology company, in addition to leading academic partners and research institutes.

FLAVIA

FLexible Architecture for Virtualizable wireless future Internet Access

Project website: www.ict-flavia.eu
Funded by: European Union. ICT Programme FP7
Duration: July 2010 to June 2013
Project partners: Consorzio Nazionale Interuniversitario per le Telecommunicazioni, Alvarion, NEC Europe Ltd., Telefonica Research, Sequans Communications, MobiMesh s.r.l., Ben Gurion University of the Negev, Institute for Information Transmission Problems of the Russian Academy of Science, Universidad Carlos III de Madrid, Hamilton Institute of the National University of Ireland Maynooth

Wireless networks importance for the Future Internet is raising at a fast pace as mobile devices increasingly become its entry point. However, **today's wireless networks are unable to rapidly adapt to evolving contexts and service needs due to their rigid architectural design**.

We believe that the wireless Internet's ability to keep up with innovation directly stems from its reliance on the traditional layer-based Internet abstraction. Especially, the Link Layer interface appears way too abstracted from the actual wireless access and coordination needs. **FLAVIA fosters a paradigm shift towards the Future Wireless Internet**: from pre-designed link services to programmable link processors. The key concept is to expose flexible programmable interfaces enabling service customization and performance optimization through software-based exploitation of low-level operations and control primitives, e.g., transmission timing, frame customization and processing, spectrum and channel management, power control, etc.

FLAVIA's approach is based on three main pillars: i) lower the interface between hardware-dependent layers and upper layers, ii) apply a hierarchical decomposition of the MAC/PHY layer functionalities, and iii) open programmable interfaces at different abstraction levels. To prove the viability of this new architectural vision, FLAVIA will prototype its concept on two wireless technologies currently available, 802.11 and 802.16, representing today's two main radio resource allocation philosophies: contention-based and

scheduled. Moreover, FLAVIA will assess the applicability of the proposed architecture concepts to the emerging 3GPP standards.

FLAVIA's concept will allow **boosting innovation and reducing the cost of network upgrades**. Operators, manufacturers, network designers, emerging third-party solution developers, and even spontaneous end users, will be able to easily and rapidly optimize and upgrade the wireless network operation, quickly prototype and test their new protocols, and adapt the wireless access operation to emerging scenarios or service needs.

PASITO

Telecommunications Service Analysis Platform (Plataforma de experimentación de servicios de telecomunicaciones)

Project website: www.rediris.es/proyectos/pasito
Funded by: State Secretariat for Telecommunications and the Information Society (*Secretaría de Estado de Telecomunicaciónes y para la Sociedad de la Información-SETSI*) of the Spanish Ministry of Industry, Energy and Tourism (*Ministerio de Industria, Energía y Turismo - MINETUR*), previously known as the Spanish Ministry of Industry, Tourism and Trade (*Ministerio de Industria, Turismo y Comercio - MITYC*)
Duration: September 2007 to May 2013
Project partners: Red.es/RedIRIS, CESCA (Centre de Supercomputació de Catalunya), CESGA (Centro de Supercomputación de Galicia), CICA (Centro Informático Científico de Andalucía), Red académica i2BASQUE, Universidad del País Vasco (UPV/EHU), Fundación i2CAT, Universidad Autónoma de Madrid (UAM), Universidad Carlos III de Madrid, Universidad de Granada (UGR), Universidad de Murcia (UMU), Universidad Politécnica de Cataluña (UPC), Universidad Politécnica de Madrid (UPM), Universidad Politécnica de Valencia (UPV), Universidad de Vigo (UVIGO).

The platform for telecommunications services analysis (PASITO) is **a distributed tests laboratory, which offers engineers the chance to construct, refine and evaluate test scenarios for telecommunication services**.

The laboratory contributes to:

- Optimizing communications resources
- Designing and adapting new services to the current needs
- Certifying equipment and services

PASITO is a public infrastructure, based upon the Spanish RedIRIS academic network. It uses varied technologies to enable it to test a wide range of telecommunication services and at the same time guarantee that its activities are isolated from the rest of the academic network's services. This avoids interference with other activities that are in operation within the Spanish scientific community.

The platform's main research areas are:

- Internet architectures
- Communication protocols
- Transport technologies with service quality
- Virtualization and auto-configuration of networks and services
- Technologies and tools to monitor networks and services
- Optical services for intensive data projects
- Large scale information distribution technologies
- Peer-to-peer systems
- Mobility services
- Technologies to improve network security
- Standards for new generation collaboration services

4.2.2. Projects awarded in 2013 and commencing in 2014

ATOMICDFS

Seeking Efficient Atomic Implementations of Distributed Data Storage

Funded by: Marie Curie Intra-European Fellowship (IEF) for Career Development. European Union. ICT Programme FP7
Scientist in charge: Dr. Antonio Fernández Anta, IMDEA Networks Institute
Name of researcher: Dr. Nicolas Nicolaou, University of Cyprus
Duration: The commencement date is to be confirmed. The project will have a total duration of 24 months.

Distributed Storage Systems provide availability and survivability of data by replicating them in geographically dispersed network locations. A major problem with data distribution is consistency. How does the system detect the latest-value of the replicated data? The most natural and easy to understand consistency guarantee is **atomicity**. Atomicity ensures that a read operation returns the value of the preceding write operation and that value is at least as recent as the value returned by any preceding read operation.

Researchers, over the last two decades, have developed numerous atomic implementations for the asynchronous message passing environment considering the simplest form of **data storage**: a **read/write** register. In this proposal we aim to elevate the applicability of the proposed solutions by using them for the **development of an atomic distributed file system (ADFS)** for the asynchronous, message passing crash prone environment. Large-scale objects, like files, degrade the operation latencies of the proposed algorithms when data are replicated and delivered over asynchronous channels to the replica hosts. On the other hand segmenting files into very small pieces and running an instance of the atomic implementation over each segment object may increase the request load on the replica hosts.

So this project will investigate the trade-offs between file fragmentation, fragment distribution, and operation latency. We need to specify precisely how file replication will be carried out and how clients will locate and retrieve the latest version of the file they desire. For this purpose we need to develop efficient fragmentation algorithms that minimize the read and write operation latency while at the same time do not incur excessive overhead on server requests.

We plan to implement and deploy our developed algorithms both in single processor simulation environments as well as in planetary-scale real time networks.

SEARCHLIGHT

A new communication paradigm for future very high speed wireless networks

Funded by: European Union. European Research Council (ERC Grants)
Duration: April 2014 to April 2019

The ubiquity and flexibility of wireless access to the Internet played a very significant role in the tremendous growth in mobile devices such as smartphones, tablet PCs, and laptops over the past years. As a consequence, **a larger and larger fraction of Internet traffic is**

delivered wirelessly. How to deal with this growth is one of the most important challenges for future wireless networks. State-of-the-art wireless communication already operates close to Shannon capacity and **the only viable option to further increase data rates is to increase the communication bandwidth.** High bandwidth channels are only available in the very high frequency part of the radio spectrum. However, this part of the spectrum suffers from high attenuation and signal absorption, restricting communication primarily to line-of-sight (LOS) scenarios.

This in turn requires **a radical rethinking of wireless networking.** In analogy to the evolution of wired Ethernet from a shared medium to a fully switched network, we envision that future wireless networks will consist of many highly directional LOS channels for communication between access points (APs) and end devices. Such an environment is extremely dynamic and channels may appear and disappear over very short time intervals, in particular for mobile devices when persons move about in their vicinity. At the same time, such channels experience very little interference and resources (time, frequency, signal processing, etc.) that would otherwise be used to handle interference can now be used to further increase achievable data rates between sender and receiver. To provide sufficiently many LOS channels, APs may have to be deployed ubiquitously and may vastly outnumber mobile devices.

We propose to design and build a wireless network architecture that maintains a number of directional LOS channels between several APs and (mobile) end devices through transmit beamforming and beam steering. Data is transmitted simultaneously via all of these channels. An end device uses multiple antennas to receive and decode several such data streams, and the higher the number of received streams, the higher the data rate achieved at the receiver. The main complexity of the design lies in the selection of APs as well as the beamforming directions of their antennas, given the large number of end devices that future wireless networks will have to support. To aid and speed up this decision process, the system maintains an up-to-date map of the radio environment and learns likely sequences of beamforming patterns and succession of APs. This further allows to intelligently switch off APs to improve energy efficiency. We believe that **such a design is the key element for the scalability of future wireless networks.**

NetIDE

An integrated development environment for portable network applications

Project website: www.netide.eu
Funded by: European Union. ICT Programme FP7
Duration: January 2014 to December 2016
Project partners: CREATE-NET: Center for REsearch And Telecommunication Experimentation for NETworked communities, IMDEA Networks Institute, Universität Paderborn, Telefónica I+D, Thales, Fujitsu Technology Solutions (FTS), INTEL Corporation, CZ.NIC

Nowadays, while most of the programmable network apparatus vendors support OpenFlow, a number of fragmented control plane solutions exist for proprietary software-defined networks (SDN). Thus, network application developers need to re-code their solutions every time they encounter a network infrastructure based on a different controller. Moreover, different network developers adopt different solutions as abstract control plane programming languages (e.g. Frenetic, Procera), leading to not reusable and shareable source code for network programs.

Despite having OpenFlow as the candidate for a standard interface between the controller and the network infrastructure, interworking between different controllers and network devices is hindered and walled gardens are emerging. **NetIDE will deliver a single integrated development environment to support the whole development lifecycle of network controller programs in a vendor-independent fashion.**

NetIDE will approach the problem by proposing an architecture that will allow different representations to be used to program the network and different controllers to execute the network programs. In this respect, **the core work will be the definition of a common language able to cover different network programming styles: the NetIDE IRF (Intermediate Representation Format).** Around IRF we will explore fundamental research topics, such as: development of controller agnostic Network Apps (applications that control network behavior) and Network Services (services that support the task of network controllers); cross-controller debugging and profiling of network programs; heterogeneous network programming; network programming with simulators in the loop.

NetIDE IRF will be supported by a developer toolkit to allow creation of Network Apps and by a Network App Engine supporting the execution and testing of NetIDE IRF-based applications. **NetIDE will result in one-stop solution for the development of SDN applications that covers all the development lifecycle.**

scientific activities

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IMDEA Networks Institute monitors and evaluates its scientific results in order to obtain a sound appraisal of the degree of fulfillment of its strategy and objectives, optimizing the management of its resources and maximizing its impact. The pursuit of excellence is at the core of all of our activities.

5.1. Awards

5.1.1. Project Awards

iJOIN granted a Runner-up Award to the Best European Cooperative R&D Project 2013 in the Ninth madri+d Awards

iJOIN (Interworking and JOINt Design of an Open Access and Backhaul Network Architecture for Small Cells based on Cloud Networks) is a project involving 12 partners, headed by Dr. Albert Banchs Roca, Deputy Director of IMDEA Networks Institute. 9 October 2013

iJOIN focuses on "small cell" technology, which is of key importance for taking advantage of limited and strategic resources, such as the radio wave spectrum. This project positions the Community of Madrid at the forefront of scientific leadership in a highly innovative sector.

5.1.2. Paper Awards

Vissicchio, L. Vanbever, C. Pelsser, L. Cittadini, P. François, O. Bonaveture (IETF/IRTF APPLIED NETWORKING RESEARCH PRIZE (ANRP2013))

Improving Network Agility with Seamless BGP Reconfigurations

Prize awarded by the Internet Engineering Task Force (IETF) and the Internet Research Task Force (IRTF). 28 July 2013

5.1.3. Researcher Awards

Albert Banchs (2013 EXCELLENCE PRIZE – UNIVERSITY CARLOS III OF MADRID (5TH EDITION), MODALITY: YOUNG RESEARCH STAFF)

"Premio de excelencia 2013 – Universidad Carlos III de Madrid (5ª edición), modalidad: Joven personal investigador".

Prize awarded by the Social Council of University Carlos III of Madrid. The prize is sponsored by the said Council and Banco Santander. 8 May 2013

awards

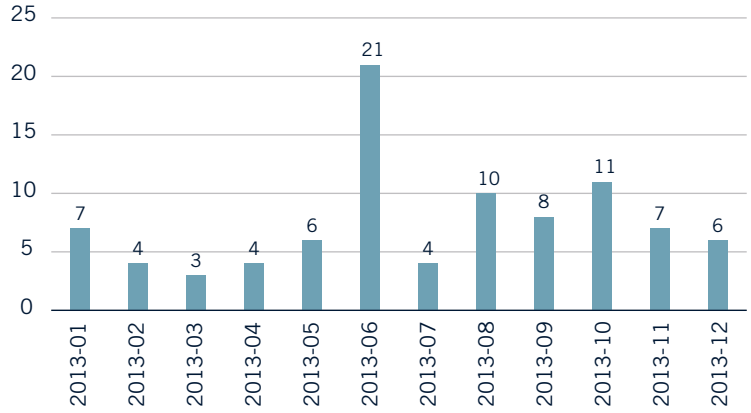
5.2. Publications

IMDEA Networks published 104 papers in 2013; including 2 PhD Theses, 4 Masters Theses and 7 standardization items (see section 6.1).

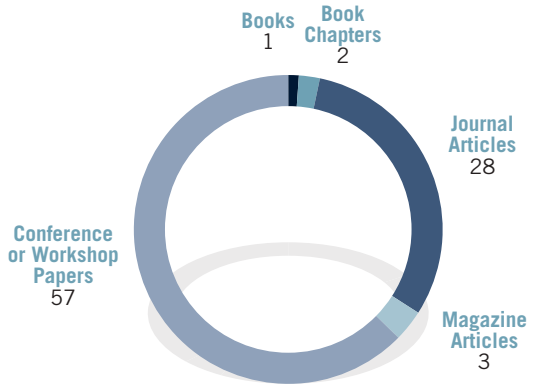
1 Paper Award | 1 Book | 2 Book Chapters | 28 Journal Articles | 3 Magazine Articles | 57 Conference or Workshop Papers | 2 PhD Theses | 4 Masters Theses

2013

number of publications per month



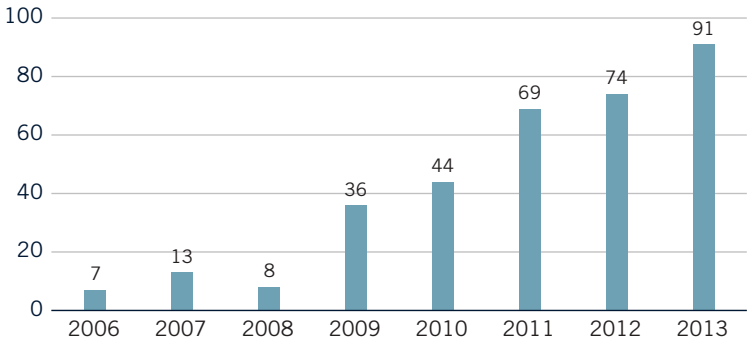
publications by type



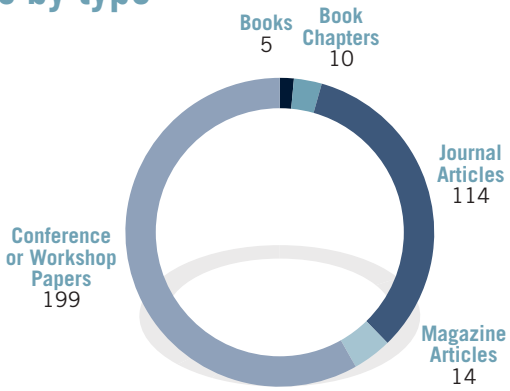
publications

2006-2013

number of publications (peer-reviewed)



publications by type



Publications 2013 [104]

Books [1]

1. **Antonio Puliafito, Antonio Fernández Anta, Symeon Papavassiliou (August 2013)**
Proceedings of the 12th IEEE International Symposium on Network Computing and Applications (IEEE NCA 2013)
IEEE Computer Society.

Book Chapters [2]

2. **Iljitsch van Beijnum, Rolf Winter (June 2013)**
Inter-Domain Traffic Engineering using the Origin Preference Attribute
IGI Global, 18-38. ISBN ISBN13: 9781466643055

3. **Itamar Hartstein, Mordechai Shalom, Shmuel Zaks (January 2013)**
On the Complexity of the Regenerator Location Problem - Treewidth and Other Parameters
Springer Berlin Heidelberg, 42-55. ISBN 978-3-642-38015-0

Journal Articles [28]

4. **Marco Ajmone Marsan, Luca Chiaraviglio, Delia Ciullo, Michela Meo (December 2013)**
On the Effectiveness of Single and Multiple Base Station Sleep Modes in Cellular Networks
Computer Networks Journal, 57 (17). pp. 3276-2390. ISSN 1389-1286

5. **Matteo Danieletto, Nicola Bui, Michele Zorzi (December 2013)**
RAZOR: A Compression and Classification Solution for the Internet of Things
Sensors — Open Access Journal, 14 (1). pp. 68-94. ISSN 1424-8220

6. **Chenying Hou, Fa Zhang, Antonio Fernández Anta, Lin Wang, Zhiyong Liu (December 2013)**
A Hop-by-hop Energy Efficient Distributed Routing Scheme
ACM SIGMETRICS Performance Evaluation Review, 41 (3). pp. 101-106. ISSN 0163-5999

7. **Antonio Fernández Anta, Miguel A. Mosteiro, Jorge Ramón Muñoz (November 2013)**
Unbounded Contention Resolution in Multiple-Access Channels
Algorithmica, 67 (3). pp. 295-314. ISSN 0178-4617

8. **Anna Nagurney, Dong Li, Tilman Wolf, Sara Saberi (November 2013)**
A Network Economic Game Theory Model of a Service-Oriented Internet with Choices and Quality Competition
NETNOMICS: Economic Research and Electronic Networking, 14 (1-2). pp. 1-25. ISSN 1385-9587

9. **Albert Banchs, Andres Garcia-Saavedra, Pablo Serrano, Joerg Widmer (October 2013)**
A Game Theoretic Approach to Distributed Opportunistic Scheduling
IEEE/ACM Transactions on Networking, 21 (5). pp. 1553-1556. ISSN 1063-6692

10. **Rubén Cuevas, Michal Kryczka, Ángel Cuevas, Sebastian Kaune, Carmen Guerrero, Reza Rejaie (October 2013)**
Unveiling the Incentives for Content Publishing in Popular BitTorrent Portals
IEEE/ACM Transactions on Networking, 21 (5). pp. 1421 -1435. ISSN 1063-6692

11. **Rubén Cuevas, Michal Kryczka, Ángel Cuevas, Carmen Guerrero, Arturo Azcorra (September 2013)**
Connectivity Properties of Real BitTorrent Swarms
KSII Transactions on Internet and Information Systems, 7 (9). pp. 2246-2267. ISSN 1976-7277

12. **Agustín Santos, Antonio Fernández Anta, Luis López Fernández (September 2013)**
Quid Pro Quo: A Mechanism for Fair Collaboration in Networked Systems
PLOS ONE, 8 (9). pp. e66575. ISSN 1932-6203

13. **Albert Banchs, Balakrishnan Prabhakaran (August 2013)**
Special section on pervasive wireless networking
Pervasive and Mobile Computing, ISSN 1574-1192

14. **Evgenia Christoforou, Antonio Fernández Anta, Chryssis Georgiou, Miguel A. Mosteiro, Ángel Sánchez (August 2013)**
Applying the dynamics of evolution to achieve reliability in master–worker computing
Concurrency and Computation: Practice and Experience, ISSN 1532-0634

15. **Marc Portoles-Comeras, Albert Cabellos-Aparicio, Pablo Serrano, Josep Mangues-Bafalluy, José Núñez-Martínez, Marc Solé, Albert Banchs, Jordi Domingo-Pascual (August 2013)**
Modeling and Exploiting the Relation Between Packet Losses and Hidden Traffic
IEEE Wireless Communications Letters, 2 (4). pp. 391-394. ISSN 2162-2337

16. **Pablo Salvador, Vincenzo Mancuso, Pablo Serrano, Francesco Gringoli, Albert Banchs (August 2013)**
VoIPiggy: Analysis and Implementation of a Mechanism to Boost Capacity in IEEE 802.11 WLANs Carrying VoIP traffic
IEEE Transactions on Mobile Computing, ISSN 1536-1233

17. **Fabio Giust, Carlos Jesús Bernardos, Antonio De la Oliva (June 2013)**
HDMM: Deploying client and network-based Distributed Mobility Management. A hybrid approach
Telecommunication Systems, Special Issue: Mobility Management for Flat Networks, ISSN 1018-4864

18. **Stefano Vissicchio, Laurent Vanbever, Cristel Pelsser, Luca Cittadini, Pierre Francois, Olivier Bonaventure (June 2013)**
Improving Network Agility With Seamless BGP Reconfigurations
IEEE/ACM Transactions on Networking, 21 (3). pp. 990-1002. ISSN 1063-6692

19. **Matthew Andrews, Antonio Fernández Anta, Lisa Zhang, Wenbo Zhao (May 2013)**
Routing and Scheduling for Energy and Delay Minimization in the Powerdown Model
Networks: An International Journal, 61 (3). pp. 226-237. ISSN 0028-3045

20. **Evgenia Christoforou, Antonio Fernández Anta, Chryssis Georgiou, Miguel A. Mosteiro, Ángel Sánchez (May 2013)**
Crowd computing as a cooperation problem: an evolutionary approach
Journal of Statistical Physics, 151 (3). pp. 654-672. ISSN 0022-4715

21. **Francois Clad, Pascal Mérindol, Jean-Jacques Pansiot , Pierre Francois (May 2013)**
Graceful Convergence in Link-State IP Networks: A Lightweight Algorithm Ensuring Minimal Operational Impact
IEEE/ACM Transactions on Networking, PP (99). ISSN 1063-6692

22. **Qing Wei, Imad Aad, Luca Scalia, Joerg Widmer, Philipp Hofmann, Luis Loyola (March 2013)**
E-mac: An elastic mac layer for ieee 802.11 networks
Wireless Communications and Mobile Computing, 13 (4). pp. 393-409. ISSN 1530-8677 (online)

23. **Antonio De la Oliva, Ignacio Soto, María Calderón, Carlos Jesús Bernardos, M. Isabel Sanchez (February 2013)**
The costs and benefits of combining different IP mobility standards
Computer Standards & Interfaces, 35 (2). pp. 205 - 217. ISSN 0920-5489

24. **Martin Farach-Colton, Antonio Fernández Anta, Miguel A. Mosteiro (February 2013)**
Optimal Memory-aware Sensor Network Gossiping (or How to Break the Broadcast Lower Bound)
Theoretical Computer Science, 472. pp. 60-80. ISSN 0304-3975

25. **Antonio Fernández Anta, Miguel A. Mosteiro, Christopher Thraves (February 2013)**
An early-stopping protocol for computing aggregate functions in Sensor Networks
Journal of Parallel and Distributed Computing, 73 (2). pp. 111-121. ISSN 0743-7315

26. **Manuel Urueña, Rubén Cuevas, Ángel Cuevas, Albert Banchs (February 2013)**
A Model to Quantify the Success of a Sybil Attack Targeting RELOAD/Chord Resources
IEEE Communications Letters, 17 (2). pp. 428-431. ISSN 1089-7798

27. **Arash Asadi, Vincenzo Mancuso (January 2013)**
A Survey on Opportunistic Scheduling in Wireless Communications
IEEE Communications Surveys & Tutorials, 15 (4). pp. 1671-1688. ISSN 1553-877X

28. **Antonio Fernández Anta, Luis F. Chiroque, Philippe Morere, Agustín Santos (January 2013)**
Sentiment Analysis and Topic Detection of Spanish Tweets: A Comparative Study of NLP Techniques
Procesamiento del Lenguaje Natural, 50. pp. 45-52. ISSN 1135-5948

29. **Marco Gramaglia, Carlos Jesús Bernardos, María Calderón (January 2013)**
Virtual Induction Loops Based on Cooperative Vehicular Communications
Sensors — Open Access Journal, 13 (2). pp. 1467-1476. ISSN 1424-8220

30. **Mikel Larrea, Antonio Fernández Anta, Sergio Arévalo (January 2013)**
Implementing the weakest failure detector for solving the consensus problem
International Journal of Parallel, Emergent and Distributed Systems, ISSN 1744-5760 (Print), 1744-5779 (Online)

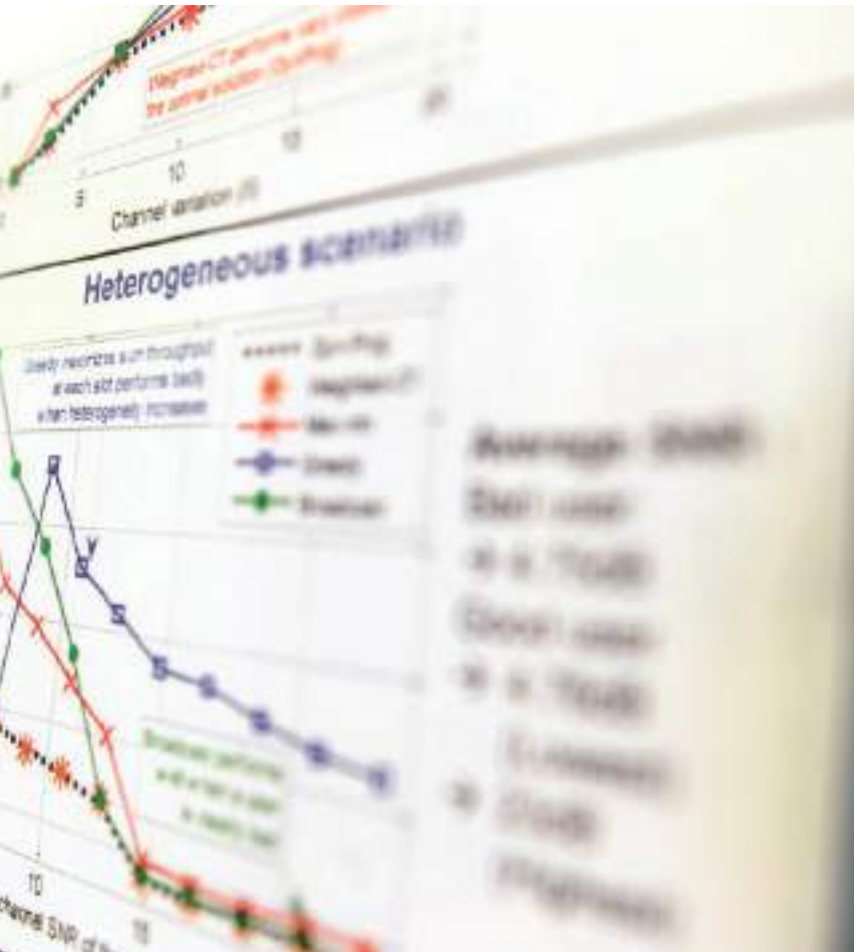
31. **Pablo Serrano, Paul Patras, Andrea Mannocci, Vincenzo Mancuso, Albert Banchs (January 2013)**
Control Theoretic Optimization of 802.11 WLANs: Implementation and Experimental Evaluation
Computer Networks Journal, 57 (1). pp. 258-272. ISSN 1389-1286

Magazine Articles [3]

32. M. Isabel Sanchez, Manuel Urueña, Antonio De la Oliva, José A. Hernández, Carlos Jesús Bernardos (October 2013)
On providing mobility management in WOBANs: Integration with PMIPv6 and MIH
IEEE Communications Magazine, 51 (10). pp. 172-181. ISSN 0163-6804

33. Haifa Raja Maamar, Azzedine Boukerche, Emil Petriu (June 2013)
Streaming 3D Meshes over Thin Mobile Devices
IEEE Wireless Communications Magazine, 20 (3). pp. 136-142. ISSN 1536-1284

34. Carlos Jesús Bernardos, Ulas C. Kozat, Joerg Widmer, Michele Zorzi (March 2013)
Video over mobile networks [Guest editorial]
IEEE Network, 27 (2). pp. 6-7. ISSN 0890-804



Conference or Workshop Papers [57]

35. Marco Ajmone Marsan, Michela Meo (December 2013)
Network Sharing and its Energy Benefits: a Study of European Mobile Network Operators (Paper)
In: The 11th IEEE Global Communications Conference, Exhibition & Industry Forum (IEEE GLOBECOM 2013), 9 - 13 December 2013, Atlanta, USA

36. Maram Bani Younes, Azzedine Boukerche (December 2013)
Performance Evaluation of a Context-Aware Path Recommendation Protocol for VANETs (Paper)
In: The 11th IEEE Global Communications Conference, Exhibition & Industry Forum (IEEE GLOBECOM 2013), 9 - 13 December 2013, Atlanta, USA

37. Evgenia Christoforou, Antonio Fernández Anta, Chryssis Georgiou, Miguel A. Mosteiro, Ángel Sánchez (December 2013)
Reputation-based Mechanisms for Evolutionary Master-Worker Computing (Paper)
In: The 17th International Conference On Principles Of DIstributed Systems (OPODIS 2013), 16-18 Dec 2013, Nice, France

38. Shahzad Ali, Gianluca Rizzo, Marco Ajmone Marsan, Vincenzo Mancuso (November 2013)
Impact of Mobility on the Performance of Context-Aware Applications Using Floating Content (Paper)
In: The 2nd International Conference on Context-Aware Systems and Applications (ICCASA 2013), 25 – 26 November 2013, Phu Quoc, Vietnam

39. Hassan Ali-Ahmad, Claudio Cicconetti, Antonio De la Oliva, Vincenzo Mancuso, Malla Reddy Sama, Pierrick Seite, Sivasothy Shanmugalingam (November 2013)
An SDN-based Network Architecture for Extremely Dense Wireless Networks (Paper)
In: The IEEE Software Defined Networks for Future Networks and Services Conference (SDN-4FNS 2013), 11-13 November 2013, Trento, Italy

40. **Arash Asadi, Vincenzo Mancuso (November 2013)**
On the Compound Impact of Opportunistic Scheduling and D2D Communications in Cellular Networks (Paper)
In: The 16th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (ACM/IEEE MSWiM 2013), 3 - 8 November 2013, Barcelona, Spain

41. **Arash Asadi, Vincenzo Mancuso (November 2013)**
WiFi Direct and LTE D2D in Action (Paper)
In: The 6th Wireless Days Conference 2013, 13 - 15 November 2013, Valencia, Spain

42. **Carla Panarello, Alfio Lombardo, Giovanni Schembra, Michela Meo, Marco Ajmone Marsan (November 2013)**
Power Management and TCP Congestion Control: Friends or Foes? (Paper)
In: The 22nd ITC Specialist Seminar on Energy Efficient and Green Networking (ITC SSEEGN 2013), 20 - 22 November 2013, Christchurch, New Zealand

43. **Hassan Ali-Ahmad, Claudio Cicconetti, Antonio De la Oliva, Martin Draexler, Rohit Gupta, Vincenzo Mancuso, Laurent Roullet, Vincenzo Sciancalepore (October 2013)**
CROWD: An SDN Approach for DenseNets (Paper)
In: The 2nd European Workshop on Software Defined Networks (EWSDN 2013), 10-11 October 2013, Berlin, Germany

44. **Juan Miguel Carrascosa, Roberto González, Rubén Cuevas, Arturo Azcorra (October 2013)**
Are trending topics useful for marketing?: visibility of trending topics vs traditional advertisement (Paper)
In: The 1st ACM conference on Online social networks (COSN 2013), 7 - 8 October 2013, Boston, USA

45. **Francois Clad, Pascal Mérindol, Stefano Vissicchio, Jean-Jacques Pansiot , Pierre Francois (October 2013)**
Graceful Router Updates in Link-State Protocols (Paper)
In: The 21st IEEE International Conference on Network Protocols (ICNP 2013), 7 - 10 October 2013, Göttingen, Germany

46. **Federico M. Facca, Elio Salvadori, Holger Karl, Diego R. López, Pedro Andrés Aranda Gutiérrez, Dejan Kostić, Roberto Riggio (October 2013)**
NetIDE: First steps towards an integrated development environment for portable network apps (Paper)
In: The 2nd European Workshop on Software Defined Networks (EWSDN 2013), 10 - 11 October 2013, Berlin, Germany

47. **Peter Perešíni, Dejan Kostić (October 2013)**
Is the Network Capable of Computation? (Paper)
In: The 3rd International Workshop on Rigorous Protocol Engineering (WRiPE 2013), 7 October 2013, Gottingen, Germany

48. **Peter Perešíni, Maciej Kuzniar, Dejan Kostić (October 2013)**
OpenFlow Needs You! A Call for a Discussion About a Cleaner OpenFlow API (Paper)
In: The 2nd European Workshop on Software Defined Networks (EWSDN 2013), 10 - 11 October 2013, Berlin, Germany

49. **Yingjie Zhou, Nicholas F. Maxemchuk, Xiangying Qian, Yasser Mohammed (October 2013)**
A Weighted Fair Queuing Algorithm for Charging Electric Vehicles on a Smart Grid (Paper)
In: The 3rd IEEE Online Conference on Green Communications (OnlineGreenCom 2013), 29 - 31 October 2013, Piscataway, NJ, USA

50. **Pradeep Bangera, Sergey Gorinsky (October 2013)**
An Economic Perspective on Traffic Attraction by Internet Transit Providers (Poster)
In: The 21st IEEE International Conference on Network Protocols (IEEE ICNP 2013), 7 - 10 October 2013, Göttingen, Germany

51. **Reza Farahbakhsh, Ángel Cuevas, Rubén Cuevas, Reza Rejaie, Michal Kryczka, Roberto González, Noel Crespi (September 2013)**
Investigating the Reaction of BitTorrent Content Publishers to Anti-Piracy Actions (Paper)
In: The 13th IEEE International Conference on Peer-to-Peer Computing (IEEE P2P 2013), 9 - 11 September 2013, Trento, Italy

52. **Antonio Fernández Anta, Dariusz R. Kowalski, Miguel A. Mosteiro, Prudence W. H. Wong (September 2013)**
Station Assignment with Applications to Sensing (Paper)
In: The 9th International Symposium on Algorithms and Experiments for Sensor Systems, Wireless Networks and Distributed Robotics (ALGOSENSORS 2013), 5 - 6 September 2013, Sophia Antipolis, France

53. **Andra Lutu, Cristel Pelsser, Marcelo Bagnulo, Kenjiro Cho (September 2013)**
The Aftermath of Prefix Deaggregation (Paper)
In: The 25th International Teletraffic Congres (ITC 2013), 10 - 12 September 2013, Shanghai, China

54. **Miriam Marciel, Foivos Michelinakis, Roderick Fanou, Pedro J. Muñoz-Merino (September 2013)**
Enhancements to Google Course Builder: Assessments Visualisation, YouTube Events Collector and Dummy Data Generator (Paper)
In: XV Simposio Internacional de Tecnologías de la Información y las Comunicaciones en la Educación (SINTICE 2013), 17 - 20 September 2013, Madrid, Spain

55. **M. Isabel Sanchez, Carlos Jesús Bernardos, Antonio De la Oliva, Pablo Serrano (September 2013)**
Energy consumption savings with 3G offload (Paper)
In: The 1st International Workshop on Cloud Technologies and Energy Efficiency in Mobile Communication Networks (CLEEN 2013), 2 September 2013, Las Vegas, Nevada, USA

56. **Yi Zhang, Łukasz Budzisz, Michela Meo, Alberto Conte, Ivaylo Haratcherev, George Koutitas, Leandros Tassiulas, Marco Ajmone Marsan, Sofie Lambert (September 2013)**
An Overview of Energy-efficient Base Station Management Techniques (Paper)
In: The 24th Tyrrhenian International Workshop on Digital Communications - Green ICT (TIWDC 2013), 23 - 25 September 2013, Genoa, Italy

57. **Antonio Fernández Anta, Chryssis Georgiou, Dariusz R. Kowalski, Elli Zavou (August 2013)**
Online Parallel Scheduling of Non-uniform Tasks: Trading Failures for Energy (Paper)
In: The 19th International Symposium on Fundamentals of Computation Theory (FCT 2013), 19 - 21 August 2013, Liverpool, England, UK

58. **Maciej Kuzniar, Peter Peresini, Nedeljko Vasić, Marco Canini, Dejan Kostić (August 2013)**
Automatic failure recovery for software-defined networks (Paper)
In: The 2nd ACM SIGCOMM Workshop on Hot Topics in Software Defined Networks (HotSDN 2013), 16 August 2013, Hong Kong, China

59. **Peter Perešíni, Maciej Kuzniar, Nedeljko Vasić, Marco Canini, Dejan Kostić (August 2013)**
OF.CPP: Consistent Packet Processing for OpenFlow (Paper)
In: The 2nd ACM SIGCOMM Workshop on Hot Topics in Software Defined Networking (HotSDN 2013), 16 August 2013, Hong Kong, China

60. **Agustín Santos, Katia Leal, Luis F. Chiroque (August 2013)**
Building an HLA-based distributed simulation: a metadata approach (Paper)
In: The 17th IEEE/ACM International Symposium on Distributed Simulation and Real Time Applications (DS-RT 2013), 30 October - 1 November 2013, Delft, The Netherlands

61. **Lin Wang, Fa Zhang, Chenying Hou, Jordi Arjona Aroca, Zhiyong Liu (August 2013)**
Incorporating Rate Adaptation into Green Networking for Future Data Centers (Paper)
In: The 12th IEEE International Symposium on Network Computing and Applications (NCA 2013), 22 - 24 August 2013, Cambridge, MA, USA

62. **Shahzad Ali, Gianluca Rizzo, Balaji Rengarajan, Marco Ajmone Marsan (July 2013)**
A Simple Approximate Analysis of Floating Content for Context-Aware Applications (Paper)
In: The 14th ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc 2013), 29 July - 1 August 2013, Bangalore, India

63. **Claudio Cicconetti, Arianna Morelli, Martin Draexler, Karl Holger, Vincenzo Mancuso, Vincenzo Sciancalepore, Rohit Gupta, Antonio De la Oliva, M. Isabel Sanchez, Pablo Serrano, Laurent Roullet (July 2013)**
The Playground of Wireless Dense Networks of the Future (Poster)
In: The 22nd Future Network & MobileSummit (FutureNetw 2013), 3 - 5 July 2013, Lisbon, Portugal

64. **Antonio Fernández Anta, Chryssis Georgiou, Dariusz R. Kowalski, Joerg Widmer, Elli Zavou (July 2013)**
Measuring the Impact of Adversarial Errors on Packet Scheduling Strategies (Paper)
In: The 20th International Colloquium on Structural Information and Communication Complexity (SIROCCO 2013), 1 - 3 July 2013, Ischia, Italy

65. **Mordechai Shalom, Prudence W. H. Wong, Shmuel Zaks (July 2013)**
Profit Maximization in Flex-Grid All-Optical Networks (Paper)
In: The 20th International Colloquium on Structural Information and Communication Complexity (SIROCCO 2013), 1 - 3 July 2013, Ischia, Italy

66. **Marco Ajmone Marsan, Giusepina Bucalo, Alfonso Di Caro, Michela Meo, Yi Zhang (June 2013)**
Towards zero grid electricity networking: Powering BSs with renewable energy sources (Paper)
In: The 12th IEEE International Conference on Communications Workshops (ICC 2013), 9 - 13 June 2013, Budapest, Hungary

67. **Jordi Arjona Aroca, Antonio Fernández Anta, Miguel A. Mosteiro, Christopher Thraves (June 2013)**
Power-efficient Assignment of Virtual Machines to Physical Machines (Paper)
In: XXI Jornadas de Concurrencia y Sistemas Distribuidos (JCSD 2013), 19 - 21 June 2013, San Sebastián, Spain

68. **Arman Boyacı, Tinaz Ekim, Mordechai Shalom, Shmuel Zaks (June 2013)**
Graphs of Edge-Intersecting Non-splitting Paths in a Tree: Towards Hole Representations (Paper)
In: The 39th International Workshop on Graph-Theoretic Concepts in Computer Scienc (WG 2013), 19 - 21 June 2013, Lübeck, Germany

69. **Antonio De la Oliva, Pablo Serrano, Pablo Salvador, Albert Banchs (June 2013)**
Performance Evaluation of the IEEE 802.11aa Multicast Mechanisms for Video Streaming (Paper)
In: The 14th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2013), 4 - 7 June 2013, Madrid, Spain

70. **Maulik Desai, Nicholas F. Maxemchuk, Thierry E. Klein (June 2013)**
A Packet Encoding Algorithm for Network Coding with Multiple Next Hop Neighbor Consideration and its Integration with Delta Routing (Paper)
In: The 14th IEEE International Symposium and Workshops on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2013), 4 - 7 June 2013, Madrid, Spain

71. **Fabio Giust, Antonio De la Oliva, Carlos Jesús Bernardos (June 2013)**
Mobility Management in Next Generation Mobile Networks (Poster)
In: The 14th IEEE International Symposium and Workshops on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2013), 4 - 7 June 2013, Madrid, Spain

72. **Adrian Loch, Matthias Hollick, Thomas Nitsche, Joerg Widmer, Alexander Kuehne, Klein Anja (June 2013)**
CSI Feedback in OFDMA Wireless Networks with Multiple Sender-Receiver Pairs (Poster)
In: The 14th IEEE International Workshop on Signal Processing Advances for Wireless Communications (SPAWC 2013), 16 - 19 June 2013, Darmstadt, Germany

73. **José Luis Lopéz-Presa, Luis F. Chiroque, Antonio Fernández Anta (June 2013)**
Novel Techniques for Automorphism Group Computation (Paper)
In: The 12th International Symposium on Experimental Algorithms (SEA 2013), 5 - 7 June 2013, Rome, Italy

74. **Thomas Nitsche, Joerg Widmer (June 2013)**
Sub-carrier Switch Off in OFDM-Based Wireless Local Area Networks (Paper)
In: The 10th IEEE International Conference on Sensing, Communication and Networking (IEEE SECON 2013), 24 - 27 June 2013, New Orleans, USA

75. **Thomas Nitsche, Joerg Widmer, Adrian Loch, Matthias Hollick (June 2013)**
EVM and RSSI Link Quality Measurements in Frequency Selective Fading Channels (Poster)
In: The 14th IEEE International Workshop on Signal Processing Advances for Wireless Communications (SPAWC 2013), 16 - 19 June 2013, Darmstadt, Germany

76. **Dejan Novaković, Nedeljko Vasić, Stanko Novaković, Dejan Kostić, Ricardo Bianchini (June 2013)**
DeepDive: Transparently Identifying and Managing Performance Interference in Virtualized Environments (Paper)
In: The 2013 USENIX Annual Technical Conference, 26 - 28 June 2013, San Jose, California, USA

77. **Balaji Rengarajan, Gianluca Rizzo, Marco Ajmone Marsan, Barbara Furletti (June 2013)**
QoS-aware greening of interference-limited cellular networks (Paper)
In: The 14th IEEE International Symposium and Workshops on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2013), 4 - 7 June 2013, Madrid, Spain

78. **Agustín Santos, Antonio Fernández Anta, Luis López Fernández (June 2013)**
Quid Pro Quo: A Fair Linking Mechanism (Poster)
In: The 14th ACM Conference on Electronic Commerce (EC 2013), 16 - 20 June 2013, Philadelphia, PA, USA

79. **Vincenzo Sciancalepore, Vincenzo Mancuso, Albert Banchs (June 2013)**
BASICS: Scheduling Base Stations to Mitigate Interferences in Cellular Networks (Paper)
In: The 14th IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM 2013), 4 - 7 June 2013, Madrid, Spain

80. **Mordechai Shalom, Prudence W. H. Wong, Shmuel Zaks (June 2013)**
Interval scheduling to maximize bandwidth provision (Paper)
In: The 11th Workshop on Models and Algorithms for Planning and Scheduling Problems (MAPSP 2013), 23 - 28 June 2013 , Abbaye des Prémontrés, Pont à Mousson, France

81. Qing Wang, Balaji Rengarajan (June 2013)
Recouping Opportunistic Gain in Dense Base Station Layouts Through Energy-Aware User Cooperation (Paper)
In: The 14th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2013), 4 - 7 June 2013, Madrid, Spain

82. Arash Asadi, Vincenzo Mancuso (May 2013)
Energy Efficient Opportunistic Uplink Packet Forwarding in Hybrid Wireless Networks (Poster)
In: The 4th International Conference on Future Energy Systems (ACM e-Energy 2013), 22 - 24 May 2013, Berkeley, California, USA

83. Angelos Chatzipapas, Vincenzo Mancuso (May 2013)
Modelling and Real-Trace-Based Evaluation of Static and Dynamic Coalescing for Energy Efficient Ethernet (Paper)
In: The 4th International Conference on Future Energy Systems (ACM e-Energy 2013), 22 - 24 May 2013, Berkeley, California, USA

84. Víctor M. López Millán, Vicent Cholvi, Luis López, Antonio Fernández Anta (May 2013)
Improving Resource Location with Locally Precomputed Partial Random Walks (Paper)
In: The 1st International Conference on Networked Systems (NETYS 2013), 2 - 4 May 2013, Marrakech, Morocco

85. Shahzad Ali, Gianluca Rizzo, Balaji Rengarajan, Marco Ajmone Marsan (April 2013)
A Simple Approximate Analysis of Floating Content for Context-Aware Applications (Poster)
In: The 32nd IEEE International Conference on Computer Communications (INFOCOM 2013). Student Poster Session, 14 - 19 April 2013, Turin, Italy

86. Andra Lutu, Marcelo Bagnulo, Olaf Maennel (April 2013)
The BGP Visibility Scanner (Paper)
In: The 16th IEEE International Global Internet Symposium (GI 2013), 19 April 2013, Turin, Italy

87. Peter Peresini, Maciej Kuzniar, Nedeljko Vasić, Marco Canini, Dejan Kostić (April 2013)
Consistent Packet Processing - Because Consistent Updates Are Not Enough (Poster)
In: The 10th USENIX Symposium on Networked Systems Design and Implementation (NSDI 2013), 2 - 5 April 2013, Lombard, Illinois, USA

88. Vincenzo Sciancalepore, Xavier Costa-Perez, Antonio Capone (April 2013)
RIA-ICCS: Intercell Coordinated Scheduling Exploiting Application Reservation Information (Paper)
In: The 11th IEEE Wireless Communications and Networking Conference (WCNC 2013), 7 - 10 April 2013, Shanghai, China

89. Juan Camilo Cardona, Rade Stanojevic, Rubén Cuevas (March 2013)
On Weather and Internet Traffic Demand (Poster)
In: The Passive and Active Measurement Conference (PAM 2013), 18-19 March 2013, Hong Kong, China

90. Gek Hong Sim, Balaji Rengarajan, Joerg Widmer (January 2013)
Adaptive Modulation for Finite Horizon Multicasting of Erasure-coded Data (Paper)
In: The 5th International Conference on Communication Systems & Networks (COMSNETS 2013), 7 - 10 January 2013, Bangalore, India

PhD Theses [2]

91. Agustín Santos (June 2013)

Quid Pro Quo: Mecanismos para la asignación de tareas en entornos distribuidos

Phd thesis, Universidad Rey Juan Carlos, Madrid, Spain

Supervisors:

Dr. Antonio Fernández Anta, IMDEA Networks Institute, Madrid, Spain

Dr. Luis López Fernández, Universidad Rey Juan Carlos, Madrid, Spain

92. Michal Kryczka (February 2013)

Experimental analysis of the socio-economic phenomena in the BitTorrent ecosystem

Phd thesis, Universidad Carlos III de Madrid, Spain

Supervisors:

Dr. Arturo Azcorra, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain

Dr. Rubén Cuevas, Universidad Carlos III de Madrid, Spain

Masters Theses [4]

93. Miriam Marciel (October 2013)

Insights of YouTube View Check System

Masters thesis, Universidad Carlos III de Madrid, Spain

Supervisors:

Dr. Albert Banchs, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain

94. Foivos Michelinakis (October 2013)

Practical challenges of network optimized stored video delivery

Masters thesis, Universidad Carlos III de Madrid, Spain

Supervisors:

Dr. Joerg Widmer, IMDEA Networks Institute, Madrid, Spain

Dr. Albert Banchs, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain

95. Christian Vitale (October 2013)

Performance Bounds in Coupled Processor Systems

Masters thesis, Universidad Carlos III de Madrid, Spain

Supervisors:

Dr. Vincenzo Mancuso, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain

96. Vasileios Papadopoulos (July 2013)

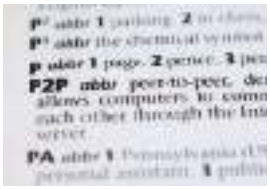
Experimental Assessment of Benchmark-oriented Network Traffic Generators

Masters thesis, Universidad Carlos III de Madrid, Spain

Supervisors:

Dr. Pablo Serrano, Universidad Carlos III de Madrid, Spain

5.3. Scientific service



IMDEA Networks conducts its scientific activities with the final objective of ensuring the widest possible dissemination of the results of the work carried out by the Institute, both within the scientific community and towards the general public. Our scientific service includes participation by our researchers at different levels of involvement in leading conferences and journals in the field, R&D committees, standardization bodies, awards, publications, projects or sponsorships.

Marco AJMONE MARSAN

Professional posts & activities

- Director. "Alta Scuola Politecnica" of the Technical Universities of Milan and Turin (Italy)
- Directive Committee member. "Gruppo 2003 per la ricerca scientifica" (the association of Italian highly cited scientists)
- Coordinator. PhD Program on Electronic Engineering .Politecnico di Torino, Turin (Italy)
- Committee member. 2014 IEEE Alexander Graham Bell Medal

Journal Editorial Boards

- Steering Committee member. IEEE/ACM Transactions on Networking Journal
- Editorial Board member. Computer Networks Journal (Elsevier)
- Editorial Board member. Performance Evaluation Journal (Elsevier)

Organization Committees

- Standing Committee member. The Annual IEEE International Conference on Computer Communications (IEEE INFOCOM), 2012 – present
- General Chair. The 32nd Annual IEEE International Conference on Computer Communications (IEEE INFOCOM 2013), Turin (Italy), 14-19 April 2013

Technical Program Committee (TPC) memberships

- The 4th International Conference on Future Energy Systems (ACM e-Energy 2013), Berkeley, California (USA), 22-24 May 2013
- The 12th IEEE International Conference on Communications (ICC 2013) – Green Communications and Networks Track, Budapest (Hungary), 9-13 June 2013
- Workshop on "Green Broadband access: Energy Efficient Wireless and Wired Network Solutions", 13 June 2013. In conjunction with ICC 2013
- The 24th Tyrrhenian International Workshop on Digital Communications (TIWDC 2013) "Green ICT", Genova (Italy), 23-25 September 2013
- The 5th Australasian Telecommunication Networks and Applications Conference (ATNAC 2013), Christchurch (New Zealand), 20-22 November 2013
- The 22nd ITC Specialist Seminar "Energy Efficient and Green Networking" (ITC SSEEGN 2013), 20-22 November 2013. In conjunction with ATNAC 2013

- The 1st International Workshop on Cloud-Processing in Heterogeneous Mobile Communication Networks (IWCPM 2013), Atlanta (USA), 13 December 2013. In conjunction with the 11th IEEE Global Communications Conference (IEEE GLOBECOM 2013), 9-13 December 2013

Arturo AZCORRA

Professional posts & activities

- Member of the Steering Board of the European Union 5G PPP from 2013 to 2015. The 5G PPP is a 7 billion € research action operating over the period 2014-2020 within the H2020 program
- Member of the Advisory Board of the Future Internet PPP, European Commission, February 2012 – present
- ERASMUS Coordinator of University of Twente (The Netherlands), DTU (Denmark) and Univ. of Krakow (Poland), amongst many others, 1998 – present
- Member of the Board of Mentors of the entrepreneurial association "The Heroes Club", May 2013 – present
- Member of the Board of Directors of the PhD School of University Carlos III of Madrid, December 2013 – present
- President of Doctoral Thesis Tribunal: Andres Garcia Saavedra. "Analysis and optimal configuration of distributed opportunistic scheduling techniques in wireless networks". University Carlos III of Madrid, November 2013
- President of Doctoral Thesis Tribunal: Elisa Rojas Sanchez. "Contribuciones en arquitecturas de redes de conmutadores transparentes Ethernet de altas prestaciones". University of Alcalá, June 2013
- Supervised PhD thesis: Michal Kryczka. "Experimental analysis of the socio-economic phenomena in the BitTorrent ecosystem". University Carlos III of Madrid, February 2013. Cum-Laude

Organization Committees

- Standing Committee member. IEEE INFOCOM, 2006 – present
- Co-Chair. Student Travel Grant Committee. IEEE INFOCOM 2013

TPC memberships

- INFOCOM 2013
- IEEE INFOCOM 2014, Toronto (Canada), 27 April – 2 May 2014

Albert BANCHS

Professional posts & activities

- International Visiting Professorship. École polytechnique fédérale de Lausanne (EPFL) (Switzerland). Academic Guest at the Computer Communications and Applications Laboratory 3, May – August 2013
- Director of the PhD program in Telematics Engineering of the University Carlos II of Madrid, 2013 – 2014
- Supervised PhD thesis: Andrés García-Saavedra. "Analysis and Optimal Configuration of Distributed Opportunistic Scheduling Techniques in Wireless Networks". University Carlos III of Madrid, November 2013 (co-supervised with Pablo Serrano Yáñez-Mingot)
- Doctoral Thesis Committee member: Michal Kryczka, "Experimental analysis of the socio-economic phenomena in the BitTorrent ecosystem". University Carlos III of Madrid, February 2013

Journal Editorial Boards

- Area editor. Computer Communications Journal (Elsevier)

Organization Committees

- General Co-Chair. The IEEE Online Conference on Green Communications (IEEE Online-GreenComm 2013), 29-31 October 2013
- Workshop Co-Chair. The 8th ACM International Workshop on Wireless Network Testbeds, Experimental Evaluation and Characterization (ACM WiNTECH 2013). Miami, Florida (USA), 30 September 2013. In conjunction with the 19th ACM Annual International Conference on Mobile Computing and Networking (ACM MobiCom 2013), Miami, Florida (USA), 30 September – 4 October, 2013
- Panel Chair. "Wireless Dense Networks: Simple rescaling or change of paradigm?". The 14th IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks (IEEE WoWMoM 2013), Madrid (Spain), 4-7 June 2013

TPC memberships

- IEEE INFOCOM 2013
- IEEE WoWMoM 2013
- The 3rd IEEE Workshop on Convergence among Heterogeneous Wireless Systems in Future Internet (IEEE CONWIRE 2013), Madrid (Spain), 4 June 2013. In conjunction with WoWMoM 2013
- ICC 2013 – Wireless Networks Symposium, Budapest (Hungary), 9-13 June 2013
- The IEEE 78th Vehicular Technology Conference (VTC2013-Fall), Las Vegas (USA), 2-5 September 2013
- The 24th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC 2013), London (UK), 8-11 September 2013
- The 25th International Teletraffic Congress (ITC 2013), Shanghai (China), 10-12 September 2013

- The 5th IEEE Latin-American Conference on Communications (IEEE LATINCOM 2013), Santiago (Chile), 24-26 November 2013
- IEEE GLOBECOM 2013
- International Workshop on Control Techniques for Efficient Multimedia Delivery (CTEMD 2013), Atlanta, Georgia (USA), 13 December 2013. In conjunction with IEEE GLOBECOM 2013
- IEEE INFOCOM 2014

Ignacio CASTRO

Organization Committees

- Publicity Chair. The 6th International Conference on COMmunication System & NETworkS (COMSNETS 2014), Bangalore (India), 7-10 January 2014

Antonio FERNÁNDEZ ANTA

Professional posts & activities

- Evaluator. GENI Project Office. Funded by the USA National Science Foundation (NSF)
- Evaluator. Promotion to the rank of Senior Lecturer in the Department of Communication Systems Engineering, Ben-Gurion University of the Negev (Israel)
- Elected "Vocal Primero" (main chairperson). Sociedad de Computación Concurrente y Distribuida (SCCD)
- Reviewer. IEEE Transactions on Computers Journal
- Reviewer. IEEE Transactions on Parallel and Distributed Systems (Springer)
- Reviewer. Journal of Computer Science and Technology (Springer)
- Reviewer. Journal of Parallel and Distributed Computing (Elsevier)
- Reviewer. Journal of Supercomputing (Springer)
- Reviewer. Computer Networks Journal (Elsevier)
- External reviewer. INFOCOM 2013
- External reviewer. The International Symposium on DIStributed Computing (DISC 2013), Jerusalem (Israel), 14-18 October 2013
- Doctoral Thesis Committee member: Andrés García Saavedra, "Analysis and Optimal Configuration of Distributed Opportunistic Scheduling Techniques in Wireless Networks". University Carlos III of Madrid, February 2013
- Doctoral Thesis Committee member: Sergio Saugar García, "Diseño e Implementación de una Arquitectura RESTful para una Infraestructura de Middleware Social". University Rey Juan Carlos, September 2013

Organization Committees

- Elected Vice Chair. Steering Committee. DISC, October 2011 - October 2013
- Promoted to Chair. Steering Committee. DISC, October 2013 - October 2015

- Steering Committee member. International Conference on Principles of Distributed Systems (OPODIS)
- Steering Committee member. The ACM International Conference on Future Energy Systems, (ACM e-Energy)
- Track Chair. The 34th International Conference on Distributed Computing Systems (ICDCS 2014), Madrid (Spain), 30 June—3 July 2014
- TPC Co-Chair. The 12th IEEE International Symposium on Network Computing and Applications (IEEE NCA 2013), Cambridge, Massachusetts (USA), 22-24 August 2013
- TPC Co-Chair. The E6 (Energy in Communication, Information, and Cyber-physical Systems) Workshop, Bangalore (India), 7 January 2013. In conjunction with COMSNETS 2013, 7-10 January 2013

TPC memberships

- COMSNETS 2013
- The 32nd ACM Symposium on Principles of Distributed Computing (PODC 2013), Montreal, Quebec (Canada), 22-24 July 2013
- The 8th International Conference on Broadband and Wireless Computing, Communication and Applications (BWCCA 2013) – Distributed Algorithms and Systems track, Compiegne (France), 28-30 October 2013
- OPODIS 2013, Nice (France), 16-18 December 2013

Pierre FRANCOIS

TPC memberships

- The 12th IFIP Networking 2013 Conference, Brooklyn, New York (USA), 22-24 May 2013

Domenico GIUSTINIANO

Journal Editorial Boards

- Guest editor of IEEE communication magazine 2014 (special issue “Enabling Next Generation Airborne Communications”)

TCP memberships

- IEEE INFOCOM 2014

Sergey GORINSKY

Organization Committees

- General Chair. IEEE WoWMoM 2013
- TPC Chair. COMSNETS 2013
- TPC Chair. The 6th IEEE International Workshop on Network Science for Communication Networks (IEEE NetSciCom 2014), Toronto (Canada), 2 May 2014. In conjunction with INFOCOM 2014
- TPC Area Chair. The 21st IEEE International Conference on Network Protocols (IEEE ICNP 2013), Göttingen (Germany), 7-11 October 2013

TPC memberships

- IEEE INFOCOM 2013
- The 33rd IEEE International Conference on Distributed Computing Systems (ICDCS 2013), Philadelphia (USA), 8-11 July 2013
- The 15th Passive and Active Measurements Conference (PAM 2014), Los Angeles, California (USA), 10-11 March 2014
- IEEE INFOCOM 2014
- The joint Workshop on Pricing and Incentives in Networks and Systems (ACM W-PIN+NetEcon 2014), Austin, Texas (USA), 6 June 2014. In conjunction with ACM SIGMETRICS 2014, 16-20 June 2014
- IEEE ICNP 2014, North Carolina (USA), 21-24 October 2014

Dejan KOSTIĆ

Professional posts & activities

- Committee member. 2013 EuroSys Roger Needham PhD Award. 2013 Eurosys Conference, Prague (Czech Republic), 14-17 April 2013
- Doctoral Thesis Committee member: Michal Kryczka, "Experimental analysis of the socio-economic phenomena in the BitTorrent ecosystem". University Carlos III of Madrid, February 2013

Organization Committees

- Chair. 2013 IMDEA Networks 5th Annual International Workshop: Reliable Networked Systems, Madrid (Spain), 5 June 2013

TPC memberships

- COMSNETS 2013
- The 3rd International Conference on Smart Grids, Green Communications and IT Energy-aware Technologies (ENERGY 2013), Lisbon (Portugal), 24-29 March 2013
- The 10th USENIX Symposium on Networked Systems Design and Implementation (NSDI 2013), Lombard, Illinois (USA), 2-5 April 2013

- The 4th International Conference on Smart Grids, Green Communications and IT Energy-aware Technologies (ENERGY 2014), Chamonix (France), 20-24 April 2013
- The 2013 USENIX Annual Technical Conference (USENIX ATC 2013), San Jose, California (USA), 26-28 June 2013. In conjunction with the 2013 USENIX Federated Conferences Week, 24-28 June 2013
- The 5th USENIX Workshop on Hot Topics in File and Storage Technologies (HotStorage 2013), San Jose, California (USA). 27-28 June 2013. In conjunction with the 2013 USENIX Federated Conferences Week, 24-28 June 2013
- The 33rd International Conference on Distributed Computing Systems (ICDCS 2013), Philadelphia (USA), 8-11 July 2013
- The 2nd ACM SIGCOMM Workshop on Hot Topics in Software Defined Networking (HotSDN 2013), Hong Kong (China), 16 August 2013. In conjunction with ACM SIGCOMM 2013 Conference, 12-16 August 2013
- ITC 2013
- The 9th ACM International Conference on emerging Networking EXperiments and Technologies (ACM CoNEXT 2013), Santa Barbara, California (USA), 9-12 December 2013
- 2014 EuroSys Conference, Amsterdam, the Netherlands, 13-16 April 2014
- NSDI 2014. Seattle, Washington (USA), 18 April 2014
- INFOCOM 2014
- The 14th IFIP International Conference on Distributed Applications and Interoperable Systems (DAIS 2014), Berlin (Germany), 3-6 June 2014
- HotSDN 2014. Chicago, Illinois (USA), 22 August 2014. In conjunction with ACM SIGCOMM 2014 Conference, 17-22 August 2014
- The 3rd European Workshop on Software Defined Networking (EWSDN 14), Budapest (Hungary), 1-3 September 2014

Vincenzo MANCUSO

Professional posts & activities

- Technical Manager. ICT CROWD (FP7 project)

Organization Committees

- Publicity Chair. ACM e-Energy 2013
- Track-Chair. The IEEE 77th Vehicular Technology Conference (VTC2013-Spring), Dresden (Germany), 2-5 June 2013
- Local arrangements Co-Chair. IEEE WoWMoM 2013

TPC memberships

- IEEE WoWMoM 2013
- The 1st International Workshop on Wireless Access Flexibility (WiFlex 2013), Kaliningrad (Russia), 4-6 September 2013
- PIMRC 2013 – MAC and Cross-Layer Design Track

- WiNTECH 2013
- IEEE online GreenComm 2013
- The 16th ACM International Conference on Modeling, Analysis, and Simulation of Wireless and Mobile Systems (MSWiM 2013), Barcelona (Spain), 3-8 November 2013
- The 11th ACM International Symposium on Mobility Management and Wireless Access (MobiWac 2013), Barcelona (Spain), 3-8 November 2013
- IFIP Wireless Days - Wireless Models and Simulations Track, Valencia (Spain), 13-15 November 2013
- IEEE GLOBECOM 2013 – Cognitive Radio and Networks Symposium
- IEEE GLOBECOM 2013 – Wireless Networking Symposium
- The 6th International Workshop on Multiple Access Communications (MACOM 2013), Vilnius (Lithuania), 16-17 December 2013

Thomas NITSCHE

Organization Committees

- Session Chair. The 10th IEEE International Conference on Sensing, Communication, and Networking (IEEE SECON 2013), New Orleans (USA), 24-27 June 2013

Joerg WIDMER

Professional posts & activities

- Doctoral Thesis Committee member: Roberto Minerva, "Will the Telco survive to an ever changing world? Technical consideration leading to disruptive scenarios". Telecom SudParis, Evry (France), June 2013
- Doctoral Thesis Committee member: Eirina Bourtsoulatze, "Rate allocation and optimized decoding in inter-session network coding". EPFL, Lausanne (Switzerland), July 2013

Journal Editorial Boards

- Associate Editor. IEEE Transactions on Communications, 2010 – present
- Editor. E-Letter, Technical Committee on Multimedia Communications (MMC), IEEE Communications Society, 2013
- Guest Editor. IEEE Network Magazine - Special Issue on "Video over Mobile Networks", 2013

Organization Committees

- General Chair. The 11th IEEE/IFIP Annual Conference on Wireless On-demand Network Systems and Services (IFIP WONS 2014), Obergurgl (Austria), 2-4 April 2014
- Publicity Co-Chair. IEEE INFOCOM 2013
- Workshop Co-Chair. IEEE CONWIRE 2013

TPC memberships

- IEEE INFOCOM 2013
- The 16th IEEE International Global Internet Symposium (GI 2013), Turin (Italy), 19 April 2013
- CoCoNet5 2013, Budapest (Hungary), 9-13 June 2013
- ICDCS 2013
- The 22nd International Conference on Computer Communications and Networks (ICCCN 2013), Nassau (Bahamas), 30 July – 2 August, 2013
- IEEE WoWMoM 2013
- ITC 2013
- Joint SmartenIT/eCOUSIN Workshop on "Social-aware Economic Traffic Management for Overlay and Cloud Applications" (SETM 2013), Zürich (Switzerland), 18 October 2013. In conjunction with the 9th International Conference on Network and Service Management (CNSM 2013), 14-18 October 2013
- The 21st ACM International Conference on Multimedia (ACM MM 2013), Barcelona (Spain), 21-25 October 2013
- ACM CoNEXT 2013
- COMSNETS 2013
- The 10th Annual IEEE Consumer Communications & Networking Conference (CCNC 2013), Las Vegas, Nevada (USA), 11-14 January 2014
- IEEE INFOCOM 2014
- IFIP Networking 2014, Trondheim (Norway), 2-4 June 2014
- The 6th IEEE Workshop on Cooperative and Cognitive Mobile Networks (CoCoNet6 2014), Sydney (Australia), 14 June 2014. In conjunction with ICC 2014, 16-20 June 2014
- ACM MobiCom 2014, Maui, Hawaii (USA), 7-11 September 2014

5.4. Keynotes, Invited Papers, Tutorials, etc.

Amongst the activities of scientific dissemination undertaken by our researchers are presentations, such as keynotes, invited papers, tutorials, lectures, demos, panels, etc., at academic conferences, universities and labs worldwide. Our researchers delivered a total of 31 of these presentations during 2013.

1. **Antonio Fernández Anta (December 2013)**
Energy related research at IMDEA Networks (Invited paper)
In: University of Liverpool, 4 December 2013, Liverpool, UK

2. **Joerg Widmer (December 2013)**
Finite Horizon Opportunistic Wireless Multicast (Invited paper)
In: COPELABS, University of Lusofona, 3 December 2013, Lisboa, Portugal

3. **Arturo Azcorra (November 2013)**
Green wireless: towards minimum per-bit linear energy consumption in wireless communications (Keynote)
In: The 16th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 2013), 3 – 8 November 2013, Barcelona, Spain

4. **Arturo Azcorra (November 2013)**
Green Wireless: Aumentar el caudal consumiendo menos energía (Invited paper)
In: VI Semana de la Ingeniería y la Arquitectura (6th Engineering and Architecture Week), 6 November 2013, Ateneo EINA (Escuela de Ingeniería y Arquitectura, Universidad de Zaragoza), Zaragoza, Spain

5. **Arturo Azcorra (November 2013)**
Green wireless: towards minimum per-bit linear energy consumption in wireless communications (Keynote)
In: The 16th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 2013), 3-8 November 2013, Barcelona, Spain

6. **Marco Ajmone Marsan (November 2013)**
Network Sharing: An Energy-Efficient Option for European Mobile Network Operators (Invited paper)
In: XIII Madrid Science Week, 12 November 2013, Madrid, Spain

7. **Ignacio De Castro (November 2013)**
On Remote Peering (Invited paper)
In: Jornadas REDIMadrid 2013, 21 November 2013, Madrid, Spain

8. **Domenico Giustiniano (November 2013)**
VLC: State of the Art and Challenges (Invited paper)
In: Class: "Visible Light Communication". Uppsala University, 27 November 2013, Uppsala, Sweden

9. **Vincenzo Mancuso (November 2013)**
Advanced Technologies for Extremely Dense and Heterogeneous Wireless Networks (CROWD project) (Invited paper)
In: The IWPC Workshop on Advanced Small Cell Deployments and Cloud Technologies, 14 November 2013, Turin, Italy

10. **Vincenzo Mancuso (November 2013)**
Panel: Research Session (Panel)
In: The IWPC Workshop on Advanced Small Cell Deployments and Cloud Technologies, 14 November 2013, Turin, Italy

11. **Marco Ajmone Marsan (October 2013)**
Test Driving the Energy Efficiency of a Wireless Network (Invited paper)
In: ETSI Workshop on Environmental Impact Assessment and Energy Efficiency, 7 October 2013, Athens, Greece

12. **Sergey Gorinsky (October 2013)**
Internet Traffic Management: Security vs. Economics (Keynote)
In: The 8th IEEE Workshop on Secure Network Protocols (NPSec 2013), in conjunction with the 21st IEEE International Conference on Network Protocols (ICNP 2013), 7 October 2013, Göttingen, Germany

13. **Héctor Cordobés de la Calle, Antonio Fernández Anta, Luis F. Chiroque, Fernando Pérez, Teófilo Redondo, Agustín Santos (September 2013)**
Graph-based Techniques for Topic Classification of Tweets (Invited paper)
In: Workshop on Sentiment Analysis (TASS 2013 – Taller de Análisis de Sentimientos), satellite event of the Spanish Society for Natural Language Processing Conference (SEPLN 2013 – Congreso de la Sociedad Española para el Procesamiento del Lenguaje Natural), 18-20 September 2013, Madrid, Spain

14. **Héctor Cordobés de la Calle, Antonio Fernández Anta, Luis F. Chiroque, Agustín Santos (September 2013)**
Técnicas basadas en grafos para la categorización de tweets por tema (Graph-based Techniques for Topic Classification of Tweets) (Invited paper)
In: Workshop on Sentiment Analysis (TASS 2013 – II Taller de Análisis de Sentimientos), 20 September 2013, Madrid, Spain

15. **Vincenzo Mancuso (September 2013)**
Science in Your Living Room (La Ciencia del Salón de tu Casa) (Invited paper)
In: Researchers' Night 2013 (La noche de los investigadores 2013), 27 September 2013, Madrid, Spain

16. **Joerg Widmer (September 2013)**
Design considerations for 60 GHz wireless networks (Invited paper)
In: Research workshop, Telefónica Research and Development, September 2013, Barcelona, Spain

17. **Sergey Gorinsky (August 2013)**
Innovations in Internet Interconnections (Invited paper)
In: Simula Research Laboratory, 27 August 2013, Fornebu, Norway

18. **Sergey Gorinsky (August 2013)**
Innovations in Internet Interconnections (Invited paper)
In: Department of Informatics, University of Oslo (UiO), 29 August 2013, Oslo, Norway

19. **Fabio Giust, Carlos Jesús Bernardos, Antonio De la Oliva, Juan Carlos Zúñiga (July 2013)**
Network-based Distributed Mobility (DMM) Demo (Demo)
In: 87th IETF Meeting, DMM WG demo session, 28 July - 2 August 2013, Berlin, Germany

20. **Shmuel Zaks (July 2013)**
On-line studies in optical networks (Invited paper)
In: The Mountain Workshop on graphs and online algorithms, 4-7 July 2013, Montserrat, Barcelona, Spain

21. **Mordechai Shalom, Prudence W. H. Wong, Shmuel Zaks (June 2013)**
Maximizing Bandwidth provision in interval scheduling with application to optical networks (Invited paper)
In: The 15th International Conference on Transparent Optical Networks (ICTON 2013), 23 - 27 June 2013, Cartagena, Spain

22. **Marco Ajmone Marsan (June 2013)**
Test Driving the Energy Efficiency of a Wireless Network (Keynote)
In: The 5th International Workshop on Hot Topics in Mesh Networking (IEEE HotMesh 2013), 4 June 2013, Madrid, Spain

23. **Marco Ajmone Marsan (June 2013)**
Panel: Collaborative programs in energy-efficient communications (Panel)
In: The 12th IEEE International Conference on Communications (ICC 2013), 12 June 2013, Budapest, Hungary

24. Albert Banchs (June 2013)
Greening wireless communications in Heterogeneous Wireless Networks (Keynote)
In: The 3rd IEEE Workshop on Convergence among Heterogeneous Wireless Systems in Future Internet (CONWIRE 2013), 4 June 2013, Madrid, Spain

25. Dejan Kostić (June 2013)
Testing of OpenFlow Networks (Invited paper)
In: NEC Laboratories Europe, June 2013, Heidelberg, Germany

26. Fabio Giust, Bessem Sayadi, Daniele Munaretto, Carlos Jesús Bernardos (May 2013)
Scaling Next Generation Mobile Video Delivery (Demo)
In: The 10th Future Internet Assembly (FIA 2013), 8 -10 May 2013, Dublin, Ireland

27. Marco Ajmone Marsan (May 2013)
Panel: Green ICT: What would be the cost of doing nothing? (Panel)
In: Future Internet Assembly (FIA) Week 2013, 9 May 2013, Dublin, Ireland

28. Shmuel Zaks (May 2013)
Optimal parallel scheduling (Invited paper)
In: The 13th Haifa Workshop on Interdisciplinary Applications of Graph Theory, Combinatorics and Algorithms, 19-21 May 2013, Haifa, Israel

29. Dejan Kostić (April 2013)
Online Testing of Distributed Systems (Invited paper)
In: University of Alcalá, , Madrid, Spain

30. Antonio Fernández Anta (March 2013)
Greening the Internet: Energy-Optimal File Distribution (Invited paper)
In: Complutense University of Madrid, 13 May 2013, Madrid, Spain

31. Ignacio De Castro (February 2013)
Exploiting Economies of Scale in Interdomain Traffic, CIPT and T4P (Invited paper)
In: Sharif University of Technology, 26 February 2013, Tehran, Iran

5.5. Major events

IEEE WOWMOM 2013, the 14th International Symposium on a World of Wireless, Mobile and Multimedia Networks

4-7 June 2013 – Madrid, Spain
http://wowmom2013.tmit.bme.hu/

Organization: From IMDEA Networks Institute, Dr. Sergey Gorinsky is the General Chair, Dr. Albert Banchs is the Panel Chair, Dr. Vincenzo Mancuso is the Local Arrangements Co-Chair and Dr. Balaji Rengarajan is the Publication Co-Chair. Dr. Mancuso and Dr. Joerg Widmer are also TPC members.

WoWMoM 2013 is the 14th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks. WoWMoM addresses research challenges and advances towards a world of wireless, mobile, and multimedia pervasive communications. The evolution of wireless networking technologies and their key role in Future Internet scenarios offer an increasing wealth of opportunities for distributing multimedia contents over wireless networks, enabling dissemination of professional contents to mobile users as well as sharing user-generated contents among them. Users will be able to retrieve, publish, and manage information, communicate with other users or devices, access and author services, create and exploit context-awareness and so on. WoWMoM 2013 aims to provide researchers and students a friendly and interactive forum for exchanging results and visions that shape the future of wireless, mobile and multimedia systems. It will feature a rich and diverse technical program involving high profile researchers from both academia and industry.

The fourteenth WoWMoM Conference was held in Madrid from June 4th to 7th, 2013 and organized by IMDEA Networks Institute and the University Carlos III of Madrid. The 2011 edition of the Conference was held at the IMT Institute for Advanced Studies Lucca, in Lucca (Italy), and the 2012 took place in San Francisco, California (USA).

IEEE WoWMoM 2013 is sponsored by the IEEE Computer Society, the University of Texas at Arlington, and the IEEE Technical Committee on Computer Communications (TCCC).

5th IMDEA Networks Annual International Workshop: Reliable Networked Systems

5 June 2013 – Madrid, Spain
events.networks.imdea.org/workshop2013

Organization: Dr. Dejan Kostić, from IMDEA Networks Institute, is the local organizer

IMDEA Networks Institute annually holds a by-invitation-only thematic workshop in Madrid. The workshop accompanies a meeting of our Scientific Council comprised of prominent researchers. In addition to talks by Scientific Council members, the workshop includes invited talks by external experts in the research theme of the workshop. The goal of the 2013 event is to foster discussion on a critical aspect of research in networking: 'Reliable Networked Systems'. The workshop was held on June 5th at University Carlos III of Madrid.

As computing resources start to become abundant, it is prudent to invest some of them in making the key networking infrastructure more reliable. Our workshop will broadly explore this issue of reliability. Software defined networking exemplifies this trend, where we are beginning to see techniques from the software verification field be applied to making the OpenFlow networks more reliable. In recent years we have seen examples of how an extreme climate can impact network resilience. Hurricanes ripping through coastal areas have raised the alarm on the insufficient resilience of communication networks when they are truly needed.

Thus, the workshop program was aimed at presenting recent research results from participants, as well as exploring new paths for increasing network reliability in an interconnected society that relies on networked systems to provide pervasive, ubiquitous communications.

Program

- **The Nornet Edge testbed for Mobile Broadband measurements,** Amund Kvalbein, Senior Research Scientist, Simula Research Laboratory. Oslo, Norway
- **Shrinking the Cloud - It's all a Mirage,** Jon Crowcroft, Marconi Professor of Communication Systems, University of Cambridge. Cambridge, UK
- **Robust Control and Management of Wireless Networks,** Edward Knightly, Professor of Electrical and Computer Engineering, Rice University. Houston. Texas. USA
- **Wilderness Survival Skills for Multihop Wireless Networks,** Matthias Hollick, Full Professor, Technische Universität Darmstadt. Darmstadt, Germany
- **Taking SDN programming to the next level,** Pedro A. Aranda Gutiérrez, Technology Specialist, Network Virtualisation Initiative, Telefonica I+D - GCTO Unit. Spain
- **Verifying Network-Wide Invariants in Real Time,** Philip Brighten Godfrey, Assistant professor, Department of Computer Science, University of Illinois at Urbana-Champaign. USA

Researchers' Night 2013
Science in Your Living Room

27 September 2013 – Madrid, Spain
www.madrimasd.org/lanochedelosinvestigadores/
ec.europa.eu/research/researchersnight/

Organization: This event is co-organized by all Institutes part of the IMDEA initiative. Dr. Vincenzo Mancuso, from IMDEA Networks, is one of the participating researchers

Science in Your Living Room was the activity held by the IMDEA Institutes during the European initiative **Researchers' Night 2013**. Its main objective was to present to the public the large amount of science and technology involved in almost every object and service around us. The audience was invited to interact and discover the appeal of the work of the researchers. The goal was to analyze, with the help of the audience, how different our life would be without science, stress the importance of science and technology for social welfare, and show how rewarding and interesting is getting involved in science and technology.

Researchers' Night is a scientific outreach project simultaneously held in over 300 European cities on a yearly basis since 2005. Promoted by the Department of Education, Youth and Sports of the Regional Government of Madrid, and coordinated by the madri+d Foundation, this project brings together Madrid universities and research centers, as well as institutions nationwide operating in the areas of science, innovation, education and culture.

IEEE OnlineGreenComm 2013, the 3th International Online Conference on Green Communications

29-31 October 2013
http://www.ieee-greencom.org/

Organization: Dr. Albert Banchs, from IMDEA Networks Institute, and Michela Meo, from Politecnico di Torino (Italy), are the General Chairs.

2013 IEEE Online Conference on Green Communications is the 3rd edition of IEEE OnlineGreenComm conducted entirely online and dedicated to addressing the challenges in energy-efficient communications and communications for green technologies.

Continuing with the experience provided the last two editions, IEEE OnlineGreenComm'13 was held entirely online, to emphasize the need for reducing global greenhouse gas emissions, avoiding the most polluting aspects of conferences: the use of mass transport systems for traveling. The conference embraces the latest online conferencing technology that will allow attendees to match the experience and networking aspects of face to face meetings. Common to all IEEE conferences, IEEE OnlineGreenComm will feature a full-fledged paper submission, review, and publication process that adheres to the high standards defined by IEEE's. This process will be supplemented with additional content from online presentations that will be made available through IEEE ComSoc Webcasts.

IEEE OnlineGreenComm covers a wide spectrum of research subjects, including green methodologies and architectures for communication technologies, communication technologies as enablers for green solutions, energy efficient in Smart Grid communications and energy management.

XIII Science Week – Madrid 2013 – Network Sharing: An Energy-Efficient Option for European Mobile Network Operators

12 November 2013 – Madrid, Spain
http://www.networks.imdea.org/whats-new/events/2013/network-sharing-energy-efficient-option-european-mobile-network-operators

Speaker: Marco Ajmone Marsan, Full Professor of Telecommunications, Electronics and Telecommunications Department, Politecnico di Torino, Italy; Research Professor, IMDEA Networks Institute, Spain

In this talk, Dr. Ajmone Marsan presented recent results of his research work on energy-efficient networking, and in the applications of ICT for energy efficiency. The event

offered an overview of the energy saving made possible by the network sharing approach, whereby all (or significant parts) of a network infrastructure are shared by different network operators. This research reveals that in most European countries the amount of energy necessary to run mobile networks can be reduced by 35 to 60%.

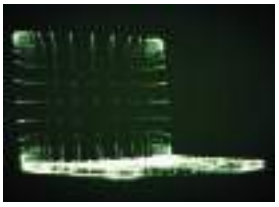
5.6. Workshops, seminars & lectures

Weekly seminars alternated invited talks with presentations by internal researchers. These events were organized together with University Carlos III of Madrid and University of Alcalá. The topics ranged from scientific presentations to technology-transfer oriented talks. Out of the 37 total number of events in which the Institute participated (including those listed on section 5.5), 21 were conducted by invited speakers. All events were held in Madrid, unless otherwise stated.

5.6.1. Invited Speakers

Content centricity as central paradigm in Content Networking
Andreas Mauthe, Reader in Networked Systems, School of Computing and Communications (SCC), Lancaster University, UK
4 December 2013

Handoff Prioritization Schemes and TDMA Scheduling in Wireless Networks
Dimitrios D. Vergados, Assistant Professor, Department of Informatics, University of Piraeus, Greece
20 September 2013



The TREND PhD School in GREEN NETWORKING
Course organizer: Marco Ajmone Marsan, Research Professor IMDEA Networks Institute and Full Professor, Politecnico di Torino
http://www.fp7-trend.eu/TREND-Phd-School
1 to 5 July 2013 – Politecnico di Torino, Turin, Italy

DeepDive: Transparently Identifying and Managing Performance Interference in Virtualized Environments
Dejan Novakovic, PhD candidate, École Polytechnique Fédérale de Laussane (EPFL), Switzerland
19 June 2013

Some combinatorial results initiated by application areas
Shmuel Zaks, Visiting Researcher, IMDEA Networks Institute ; Joan Callner-Miller Chair Professor of Computer Science, Technion – Israel Institute of Technology, Haifa, Israel
7 June 2013

Achieving Sustainable and Scalable Future Wireless Networks
Ilker Demirkol, Postdoctoral Research Associate, Department of Telematics Engineering, Universitat Politècnica de Catalunya, Barcelona, Spain
29 April 2013

What is Spotify and how it works?
Pablo Barrera, Backend Engineer, Spotify
25 April 2013

Google+ or Google-? Dissecting the Evolution of the New OSN in its First Year
Roberto González, PhD Candidate, University Carlos III of Madrid
24 April 2013

TREND-GreenTouch Joint Workshop on Green and Energy Efficient Networking
Workshop co-organizer: Marco Ajmone Marsan, Research Professor IMDEA Networks Institute and Full Professor, Politecnico di Torino
http://gt-joint-workshop.fp7-trend.eu/
19 April 2013 – Politecnico di Torino,Turin, Italy

Characterizing Diverse Link Patterns in Complex Networks
Yanhua Li, Ph.D. Candidate in Computer Science, University of Minnesota, Twin Cities, USA
12 April 2013

CAESAR: Carrier Sense-Based Ranging in Off-The-Shelf 802.11 Wireless LAN

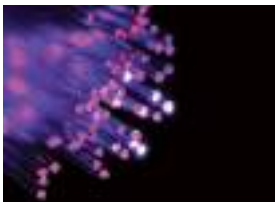
Domenico Giustiniano, Senior Researcher and Lecturer, Communication Systems Group (CSG), ETH Zurich, Switzerland

8 April 2013

Modeling Systems from Logs of their Behavior

Ivan Beschastnikh, PhD student, University of Washington, USA

14 March 2013



Optimization in optical networks

Prof. Shmuel Zaks, Chair of Excellence, Department of Telematics Engineering, University Carlos III of Madrid; Visiting Researcher, IMDEA Networks Institute ; Chair Professor of Computer Science, Institute of Technology, Haifa, Israel

12 March 2013

The hidden costs of mobile applications

Narseo Vallina-Rodriguez, PhD candidate in Computer Science, Computer Lab, University of Cambridge, UK

25 February 2013

All-path and Torii-HLMAC: beyond link-state routing protocols in shortest path bridges for campus and data center networks

Elisa Rojas. Introduction by Guillermo Ibáñez. University of Alcalá de Henares, Madrid, Spain

20 February 2013

Silver-lining: a firsthand vision of launching a technological start-up

Vishal Misra, Co-founder & CEO, Silver Lining

6 February 2013

Corridor-based routing using opportunistic forwarding in OFDMA multi-hop networks

Alexander Kuehne, Post-doc Researcher, Communications Engineering Lab, Technische Universität Darmstadt, Germany

4 February 2013

Energy Consumption Anatomy of 802.11 Devices and its Implication on Modeling and Design

Andres Garcia-Saavedra, PhD Candidate, NETCOM Research Group, University Carlos III of Madrid, Spain

23 January 2013

Low-Complexity Visible Light Networking with LED-to-LED Communication

Domenico Giustiniano, Senior Researcher and Lecturer, ETH Zurich, Switzerland

16 January 2013

The Next Generation Wireless Sensor Network Challenges for an Emergency Preparedness and Response Class of Applications: A Necessary Public Safety and Security

Prof. Dr. Azzedine Boukerche, Full Professor of Computer Science and Engineering & Canada Research Chair, University of Ottawa, Canada; Chair of Excellence, University Carlos III of Madrid; Visiting Researcher, IMDEA Networks Institute , Spain

9 January 2013

iBGP Deceptions: More Sessions, Fewer Routes

Luca Cittadini, PhD Student & Collaborator, Dipartimento di Informatica e Automazione, Università degli Studi Roma Tre, Italy

8 January 2013

5.6.2. Weekly Seminar Series

The Institute also holds a series of in-house weekly seminars to foster communication and collaboration amongst research team members. A total of 11 seminars were imparted in 2013.

5.7. Major future events

WONS 2014 – The 11th IEEE/IFIP Annual Conference on Wireless On-demand Network Systems and Services

2-4 April 2014 – Obergurgl, Austria
2014.wons-conference.org

Organization: Dr. Joerg Widmer, from IMDEA Networks Institute, and Dr. Christoph Sommer, from University of Innsbruck (Austria), are the General Chairs

Providing secure, reliable, and dependable wireless services is the primary objective of modern data networks. While enabling technology for "on-demand" services through any of the common wireless architectures, such as WiMAX, WiFi, ad hoc networks, sensor networks, and vehicular networks, has made large strides, many formidable challenges remain to be overcome, such as the integration of infrastructure-based and ad hoc networks, robust algorithms for self-organizing, reconfigurable wireless networks, on-demand service models and their performance in highly-volatile interconnect topologies as well as interoperability of different architectures.

IEEE/IFIP WONS, now in its eleventh edition, has established itself as a high-quality forum to address these challenges in the context of a conference that is rich in intense interactions and based on innovative contributions by experts in the field.

The conference aims to present original submissions of high-quality research papers on "wireless on-demand networks" that provide new insights on protocol and network design, modeling, performance evaluation, profitability models, energy efficiency, QoS models and mechanisms, practical implementations, service level aspects, and Internet integration of wireless networks.

DISC 2014 – The 28th International Symposium on DIStributed Computing

12-15 October 2014 – Austin, Texas, USA
www.disc-conference.org/wp/disc2014/

Organization: Dr. Antonio Fernández Anta, from IMDEA Networks Institute, is the Steering Committee Chair

The International Symposium on **DIS**tributed **C**omputing (DISC) is an international forum on the theory, design, analysis, implementation and application of distributed systems and networks. It is organized in cooperation with the European Association for Theoretical Computer Science (EATCS). This conference, in collaboration with PODC (the ACM Symposium on Principles of Distributed Computing), awards annually the highly recognized Edsger W. Dijkstra Prize in Distributed Computing and The Dissertation Award in Distributed Computing.

DISC has established itself as a high-quality forum to address these challenges in the context of a conference that is rich in intense interactions and based on innovative contributions by experts in the field. DISC aims to present original submissions of high-quality research papers on the topics described above.

5G Network Revolution – The 6th IMDEA Networks Annual International Workshop

11 June 2014 – Madrid, Spain
events.networks.imdea.org/workshop2014

Organization: Dr. Vincenzo Mancuso and Dr. Domenico Giustiniano from IMDEA Networks Institute are the local organizers

IMDEA Networks Institute annually holds a by-invitation-only thematic workshop in Madrid. The workshop accompanies a meeting of our Scientific Council comprised of prominent researchers. In addition to talks by Scientific Council members, the workshop includes invited talks by external experts in the research theme of the workshop. The goal of the 2014 event is to foster discussion and present disruptive visions on a critical aspect of future wireless networks. The workshop will be held on June 11th at University Carlos III of Madrid.

We are witnessing an exponential increase of wireless traffic demand due to the pervasive explosion of mobile Internet applications. It is forecasted that, by 2020, the network infrastructure will be capable of embracing trillions of devices according to a plethora of application-specific requirements in a flexible and truly mobile way. The forthcoming 5G revolution promises substantial advancements such as 1000x higher wireless area capacity for 8+ billion people and 7 trillion objects, 90% energy savings per service provided and the creation of a secure and reliable Internet. 5G will allow for real agile network setup, and will support dynamic management and coordination of very dense and heterogeneous deployments. Potential roadmaps see mobile multimedia as the next killer app, quality of experience as a primary metric for the network planning and design, and machine-to-machine communication as the root of paradigm shift in wireless innovation.

The workshop program is aimed at presenting recent research results from participants, debate on and identify priorities and challenges in the research agenda, as well as exploring new paths towards making wireless networks a true commodity for the needs of society.

ACM e-Energy 2014 – The 5th International Conference on Future Energy Systems

11-13 June 2014 – Cambridge, UK
http://conferences.sigcomm.org/eenergy/2014/

Organization: Several members and stakeholders of IMDEA Networks Institute are leading the organization of ACM e-Energy 2014. Dr. Marco Ajmone Marsan and Dr. Antonio Fernández Anta are both long-standing researchers at the Institute. Two leading international figures in networking research, Dr. Jim Kurose from University of Massachusetts at Amherst (USA) and Dr. Jon Crowcroft, from University of Cambridge (UK), are both members of IMDEA Networks' Scientific Council. Ajmone, Fernández Anta, and Kurose are Steering Committee members the ACM e-Energy conference, whereas Crowcroft is the General co-chair of the 2014 edition.

ACM e-Energy 2014 will bring together researchers, developers and practitioners working in the fields of energy, computing and communications to discuss recent research and identify future directions and major R&D challenges. The conference will address areas such as servers and communications infrastructures, services in data centers, end-systems in home and office environments, broadband access networks, sensor networks, cloud computing, smart grids and future networks such as The Internet of Things. With the backing of the Association for Computing Machinery (ACM) e-Energy 2014 has already become a scientific forum of reference in the development of green communications and computing technologies.

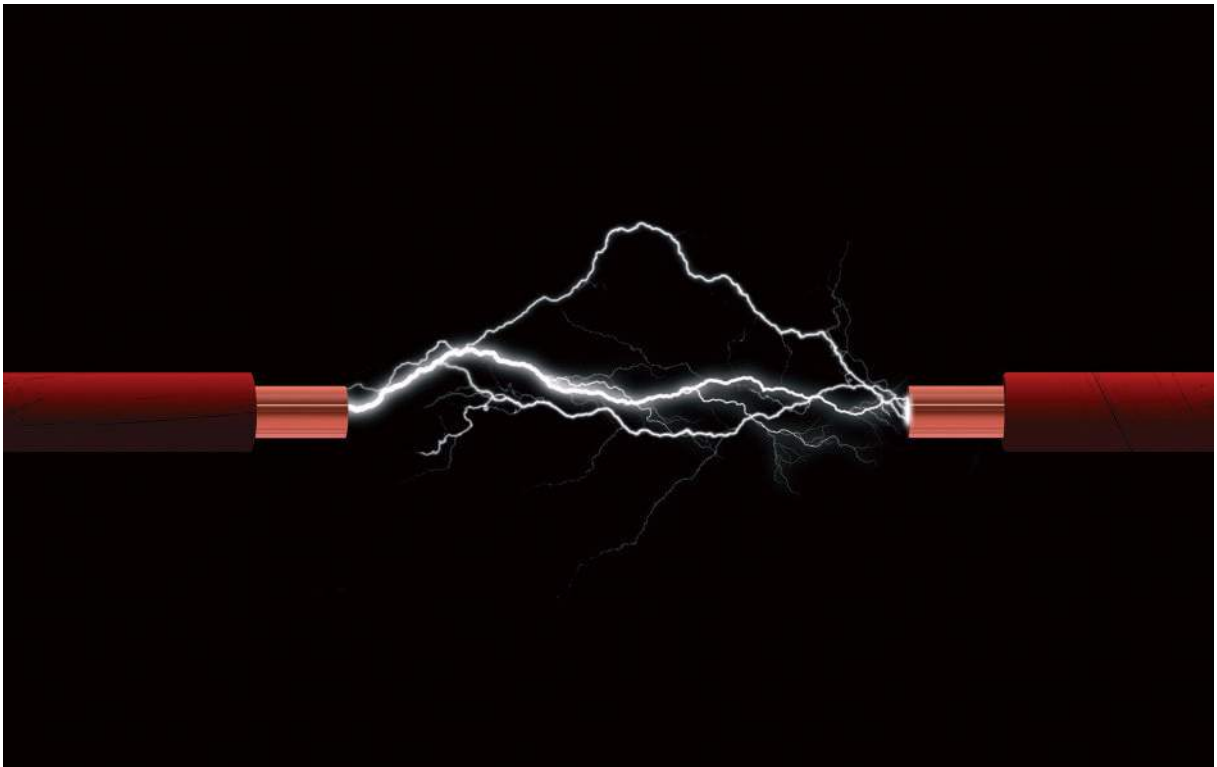
5.8. Local Scientific Partnership

IMDEA Networks Institute has established a strong scientific partnership with one of the local universities in the Madrid region, namely the **University of Alcalá (*Universidad de Alcalá - UAH*)**. This partnership involves stable research collaboration in joint activities and projects as well as an institutional collaboration in the form of UAH's participation on the Institute's Board of Trustees.

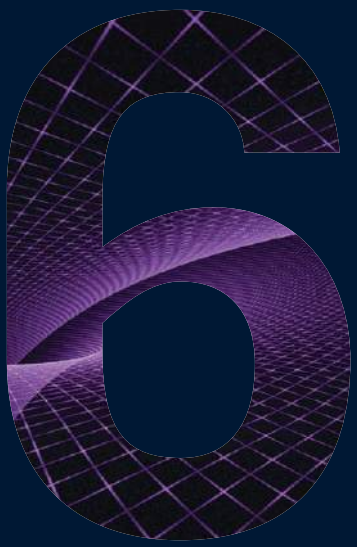
Among other activities, the cooperation between IMDEA Networks and UAH involves their joint participation in projects of a regional scope, such as the **MEDIANET project**. MEDIANET focuses on the design of a future Internet architecture that takes into account the requirements of multimedia traffic. In addition to IMDEA Networks and UAH, the other partners participating in the project are University Carlos III of Madrid and the Complutense University of Madrid.

In addition to projects, UAH and IMDEA Networks are also conducting several research activities in partnership. One of these focuses on link-level technologies, based on the design of novel architectures that implement advance link layer functions, such as combined transparent bridges and fast path Ethernet switches, among other developments. As a result of this common undertaking, several **patents** have been produced, which are co-invented by IMDEA Networks and University of Alcalá researchers. Another shared research work focuses on the design of incentive mechanisms for peer-to-peer networks, which has resulted in several high quality **publications**. As part of this collaborative research effort, Andra Lutu, a Predoctoral Researcher from IMDEA Networks, worked as a visiting researcher at UAH under the supervision of Dr. Guillermo Ibáñez Fernández from October 2013 to May 2014.

Besides the above activities, IMDEA Networks and UAH are also taking advantage of the physical proximity between the two institutions to share many of their daily labors, such as the **biweekly scientific seminars** organized by IMDEA Networks, University of Alcalá and University Carlos III of Madrid.



impact and technology transfer



6.1. Contribution to standardization bodies [81]

6.2. Technology transfer [85]

annual report 2013

6.1. Contribution to standardization bodies

Many different vendors manufacture networking equipment, network-attached devices, and software running on such devices. Without strong coordination to achieve interoperability among the solutions supported by manufacturers, network operators have to rely on de-facto proprietary mechanisms. These typically hinder flexibility in the evolution of deployed infrastructures and services, and prevent deployment of solutions in multi-vendor environments. As a result, operators tend to only accept solutions that have been officially agreed upon by vendors within a standardization body.

Standardization is thus considered an inherent part of the research work performed at IMDEA Networks Institute, as it facilitates the impact of our work on the industry.

The **IEEE Standards Association (IEEE SA)** is one of the premier standards organizations working on the lower layers of the network model. The most widely known series of IEEE standards are 802.3 (Ethernet) and 802.11 (Wi-Fi). Many researchers at University Carlos III of Madrid NETCOM and IMDEA Networks Institute perform joint research on the 802.11 wireless protocols standardized by the IEEE SA.

The **IETF (Internet Engineering Task Force)** works across all layers of the network model in as far as such work relates to the Internet, with perhaps a core focus on IP at the network layer and the protocols such as TCP running directly on top of IP.

Several of our researchers are participating in the above standardization bodies:

- **Pierre Francois** is active in standardization in the routing area and in the operations and management area of the IETF. His main contributions to the IETF are dedicated to turn the research and engineering findings stemming out of his collaboration with ISPs and router vendors into IETF standards and peer reviewed informational IETF documents.

- **Fabio Giust**, **Juan Camilo Cardona and Isabel Sánchez**, the three of them Pre-doc Researchers at IMDEA Networks, also currently work in standardization within the IETF and the IEEE (I. Sánchez).

We would like to highlight here our most relevant University Carlos III of Madrid collaborator, who occupies a prominent role within the IEEE:

- **Antonio de la Oliva**, Visiting Professor at University Carlos III of Madrid, is participating in the IEEE standardization effort by notably vice-chairing the IEEE 802.21 TGb and serving as Technical Editor of the upcoming IEEE 802.21d specification. His work serves as a point of union between the knowledge developed within different research projects (such as MEDIEVAL, CARMEN, CROWD or iJOIN) and the technical contributions stemming from these projects, which are turned into the IEEE 802 family of standards.

6.1.1. IETF

OFIB

OFIB is a work-item in the RTGWG Working Group of the Routing area of the IETF. The goal of this work is to define a mechanism that sequences the router FIB updates to maintain consistency throughout the network during a convergence event, in order to avoid forwarding loops and associated packet loss. The standardization process for this work has been concretized into an experimental RFC, RFC6976 [1].

An alternative, simpler, solution to the same problem is currently being investigated, and is the subject of a new IETF draft presented at the IETF RTG RTGWG working group [2].

Segment Routing

IMDEA Networks Institute participates to the standardization of a new technology, called Segment Routing [3]. Segment Routing aims at providing flexibility in the definition of paths across Service Provider networks. A new working group of the routing area, SPRING, has since then been created to host the works dedicated to this new technology. IMDEA Networks plays a role as editor of the document describing the use-cases for this technology, co-authored with many Routing platform vendors and Internet Service Providers [4]. IMDEA Networks also participates in a draft aimed at providing resiliency in such networks [5].

Making BGP filtering a habit: Impact on policies

Juan Camilo Cardona started standardization work at the GROW Working Group of the IETF OPS Area, in 2012. The goal of this project is to present potential issues related to the partial dissemination of overlapping IP prefixes in the Interdomain Internet routing system. Such practice may be damaging for the business of neighboring Autonomous Systems, as IP transit would happen over unexpected paths across their network. In 2013, the document summarizing these findings has been accepted as an IETF OPS GROW working group document [6].

BGP Add-Paths

Add-Paths is a BGP enhancement that allows a BGP router to advertise multiple distinct paths for the same prefix/NLRI. This provides a number of potential benefits, including reduced routing churn, faster convergence and better load balancing. Add-paths is currently being standardized within the IDR Working Group of the Routing area of the IETF. draft-ietf-idr-add-paths-guidelines-05 [7], co-authored by Pierre Francois in collaboration with AT&T, Alcatel-Lucent, and Cisco Systems, is a working group item of IDR aimed at providing network operators the tools needed to address their specific applications and to manage the scalability impact of Add-Paths. This document has evolved based on feedback from operators and vendors, to analyze new variants of the technology, focused on applications of the technology for Content Distribution Networks.

A new work item was proposed to the IDR working group, in collaboration with Cisco Systems, and Cumulus networks, which suggests letting an Add-paths enabled router tag the paths that it advertises with information allowing the receiver to obtain information about the status of the paths in sender BGP state [8]. Such feature is particularly useful for monitoring purposes aimed at performing inter-domain traffic monitoring.

Distributed Mobility Management

The number of mobile users and their traffic demand is expected to be ever-increasing in future years, and this growth can represent a limitation for deploying current mobility management schemes that are intrinsically centralized, e.g., Mobile IPv6 and Proxy MobileIPv6. For this reason it has been waved a need for distributed and dynamic mobility management approaches, with the objective of reducing operators' burdens, evolving to a cheaper and more efficient architecture. Two drafts have been submitted, one proposing a client-based solution for distributed mobility management (DMM) derived from the Mobile IPv6 standard [9], and another describing multiple solutions for a network-based DMM architecture inspired by the well known Proxy Mobile IPv6 [10]. The proposals are supported by University Carlos III of Madrid and IMDEA Networks Institute.

In addition, following our credo (see section 2.5), which shows our determination to validate our ideas through implementation and demonstration, IMDEA Networks researchers have spent very significant resources in providing a first implementation of the DMM technology, key for the future deployments of cellular networks. The prototype was demonstrated at the 87th IETF meeting in Berlin, Germany, and it showed how to apply the proposed DMM protocol to a common use case such as video streaming over mobile networks. The demo was very well received, fostering joint research activities with other players in the industry [11].

6.1.2. IEEE

In 2013, IMDEA Networks has actively participated in the IEEE (802.21 WG and IEEE 802 EC SG OMNIRAN), providing results from European-funded CROWD project. During 2013, there have been two activities worth highlighting. First, the IEEE 802.21d has reached a mature level allowing the starting of the Letter Ballot process (procedure in order to grant acceptance of the draft standard by the WG). This work has been pushed by IMDEA members by providing several key contributions solving some of the comments received in this process, such as [12]. Regarding IEEE 802.21, we have also contributed to the definition of new scenarios in [13].

Second, during 2013 a new initiative has been taking form in the IEEE 802. The so-called OMNIRAN Study Group (now approved as IEEE 802.1cf) aims at creating a stage-2 functional specification, allowing engineers to understand how to create complex IEEE 802-based networks. This new task group is also researching on how to enable the new Software Defined Networking paradigm in 802 technologies. This last use case has been pushed by IMDEA Networks and UC3M, becoming the most prominent contributor and driver of this proposal.

References

[1] http://tools.ietf.org/html/RFC6976

[2] http://tools.ietf.org/html/draft-litkowski-rtgwg-uloop-delay-01

[3] http://tools.ietf.org/html/draft-filsfils-rtgwg-segment-routing-01

[4] http://tools.ietf.org/html/draft-filsfils-rtgwg-segment-routing-use-cases-01

[5] http://tools.ietf.org/html/draft-francois-segment-routing-ti-lfa-00

[6] http://tools.ietf.org/html/draft-ietf-grow-filtering-threats-01

[7] http://tools.ietf.org/html/draft-ietf-idr-add-paths-guidelines-05

[8] http://tools.ietf.org/html/draft-bgp-path-marking-00

[9] https://tools.ietf.org/html/draft-bernardos-dmm-cmip-00

[10] https://tools.ietf.org/html/draft-bernardos-dmm-pmip-02

[11] DMM Prototype Demonstration: "Network-based Distributed Mobility Management", C.J. Bernardos, A. De La Oliva, F. Giust, J.C. Zúñiga. Presented by C.J. Bernados and F. Giust at the 87th IETF meeting, Berlin, Germany, July 2013,

[12] MN Initiated Join/Leave operation explanation in D002, Antonio de la Oliva (UC3M), Albert Banchs (IMDEA Networks), Presented on the 15th of March. https://mentor.ieee.org/802.21/dcn/13/21-13-0086-00-MuGM-mn-initiated-join-leave-operation-explanation-in-d002.docx

[13] New scenarios for MIIS, Antonio de la Oliva (UC3M), M. Isabel Sanchez (IMDEA Networks), Presented on the 16th of May. https://mentor.ieee.org/802.21/dcn/13/21-13-0091-00-0000-new-scenarios-for-miis.pptx

6.2. Technology transfer

We direct our work towards strengthening **collaboration ties with industry**, particularly through joint participation in projects and technology transfer. We aim to develop technologies that have genuine socio-economic impact; that is to say, projects that deliver value and that can be transferred to industry and, ultimately, to society. In order to ensure that our focus remains on addressing real-world problems and that our development activities result in generating value, we continue to build on our strong links with the business community both in the Madrid region of Spain and in the rest of the World.

Our technology transfer strategy is aimed to ensure that the Institute's research activities remain relevant, that its innovations are diffused and their full value to society realized through **various transfer processes** such as licensing and the sale of patents, creation and support of spin-off companies in the region that seek to commercialize products exploiting innovations developed within the Institute.

We carry out several forms of collaboration, including direct contracts with industry, as well as participation in joint projects financed by public entities. The projects listed in section 4 include both types of partnerships with specific listings of those enterprises and organizations currently working with us.

Joint, funded research projects enable us to establish solid ties to business. We are engaged in various research projects with private sector collaborators.

ÁBACO - Development of an Open Source Distributed Platform for the Management and Distribution of Multi-Device Digital Content

(Plataforma Distribuida Basada en Código Abierto para la Gestión y Distribución de Contenidos Digitales Multidispositivo)

Project website: abaco.zed.com
Funded by: ZED Worldwide S.A., through the Spanish Ministry of Industry, Energy and Tourism (*Ministerio de Industria, Energía y Turismo - MINETUR*), previously known as the Spanish Ministry of Industry, Tourism and Trade (*Ministerio de Industria, Turismo y Comercio - MITYC*) - AVANZA program
Duration: November 2013 to September 2014
Project partners: Fundación I+D del Software Libre – FIDESOL, ZED Worldwide, S.A, V-Sistemas, IMDEA Networks Institute

The objective pursued by the project "ÁBACO – Open Source Distributed Platform for the Management and Distribution of Multi-device Digital Content" is to develop an **open source distributed system** to address the current various challenges and needs in the field of **generation, distribution and management of digital content.** The platform also aims to create a more competitive environment for the development of this strategic industry.

The platform will be equipped with the maximum technological flexibility and different software elements in it will perform tasks to manage, distribute and transcode multi-media digital content.

ÁBACO shall deliver **a set of services that allow customers to access and manage digital content with the capacity to adapt to the needs and requirements of the user,** on the basis of the capabilities and characteristics of the devices from which the request originates. The project objectives therefore are:

- Development of multi-platform technologies for direct conversion of content from a digital format to another
- Creation of a technological architecture that allows content access on all end devices and regardless of bandwidth
- Ability to transcode audio, video and image formats
- Development of an intelligent digital content management and distribution system
- Design of a prototype platform for high availability and scalability based on open source

As part of the set of milestones associated with the project, IMDEA Networks will collaborate in the development of the following tasks:

- Definition of the architecture.
- Design and development of algorithms.
- Definition of the basic and advanced features.

ORÁCULO - Technological platform for real-time data packet analysis

(Plataforma tecnológica para el análisis de paquetes de datos en tiempo real)

Project website: www.glass.u-tad.com/rdi/Oraculo/
Funded by: ZED Worldwide S.A., through the Spanish Ministry of Industry, Energy and Tourism (*Ministerio de Industria, Energía y Turismo - MINETUR*), previously known as the Spanish Ministry of Industry, Tourism and Trade (*Ministerio de Industria, Turismo y Comercio - MITYC*) - AVANZA program
Duration: October 2013 to June 2014
Project partners: Project partners: ZED Worldwide, S.A, IMDEA Networks Institute

The overall objective of this project is **to develop a new technological platform for detailed real-time analysis of data packets passing through the network of telephone operators, and their correlation with a user's session**. ORÁCULO's aims are:

- Development of technologies to obtain comprehensive information of each data packet that is transmitted through the network of a given service provider, with multiprotocol support and transparent integration within the network, all in real time
- Availability of interfaces for various network elements
- Integration with data networks and voice over IP (VoIP)
- Development of tools for the management of server infrastructure

Thanks to the possibility of having knowledge of the information transmitted and its association to each user, **ORÁCULO will be a platform that will**:

- Improve the user experience on existing services, by adapting them to each user
- Design new services based on navigation and information transmitted by users
- Reduce the massive capital investment and development time for the creation of new services, thanks to the availability of a base technology
- Establish new revenue for developers and service providers
- Promote the digital economy, in short, with the opening up of new business models

In summary, ORÁCULO will provide a platform for the creation of enhanced user experience, the development of new revenue streams and high flexibility in potential business models for service providers, through the detailed analysis of each data packet traversing its network.

As part of the set of milestones associated with the project, **IMDEA Networks** is responsible for carrying out the task of **"Development of algorithms for analyzing Big Data modeling behaviors"**. The Institute's skills and experience in the area of Big Data analysis ensure it has the necessary competencies to develop the project.

TALENTUM - Fundación SEPI- Telefónica Scholarship Program: Talentum Startups 2014

Project website: https://talentum.telefonica.com/
Funded by: Fundación SEPI (Sociedad Estatal de Participaciones Industriales) – Telefónica España
Duration: December 2013 to June 2014
Socios de proyecto: Telefónica, IMDEA Networks Institute

Telefónica Talentum Startups is a comprehensive program intended to find and attract talent within Spain. It is a **funded scholarship plan** that seeks **to promote innovative young talent**, providing the tools and support needed to encourage them to participate in the creation of a new European digital world. Through practical training, this scholarship program offers **university students with entrepreneurial skills** the opportunity to experience at close-hand the realities of professional life, thus encouraging their early integration into the labor market. Internship students at IMDEA Networks will receive **tutored practical training** at the same time as performing tasks to **support advanced research projects** in the field of information and communications technology (ICT).

SOCAM - Multi-device Open Source Operating System

(Sistema Operativo de Código Abierto Multi-dispositivo)

Project website: www.glass.u-tad.com/rdi/Socam/
Funded by: ZED Worldwide S.A., through the Spanish Ministry of Industry, Energy and Tourism (*Ministerio de Industria, Energía y Turismo- MINETUR*), previously known as the Spanish Ministry of Industry, Tourism and Trade (*Ministerio de Industria, Turismo y Comercio - MITYC*) - AVANZA program
Duration: October 2011 to September 2013
Project partners: ZED Worldwide, S.A, Factory Holding Company 25, IMDEA Networks Institute

The main technological objective of the project is the **development of an innovative operating system, based on open source code, that will imply a new paradigm in the area of Operating Systems for Internet-connected devices**, providing an appropriate ecosystem for the massive development of the services and mobile applications industry, while at the same time allowing for the extraction of all the potential capabilities (processing, battery consumption, screen, memory, database access, sensors, chips, etc) of any present of future connected device (mobile telephones, tablets, television, M2M, etc.), creating a new common user experience independently from the device and facilitating the creation of new applications (embedded, on the cloud, downloadable, etc.) thanks to the adoption of the operating system, that reduces the investment risk of the services and applications development companies and activates the high potential and growth rates of the sector.

Cisco University Research Program Fund

SILICON VALLEY community foundation

BGP Route Servers: scaling and convergence

Funded by: Cisco University Research Program Fund, a corporate advised fund of Silicon Valley Community Foundation
Duration: August 2012 to July 2013

Route Servers are used at Internet eXchange Points to allow the exchange of traffic among members, without requiring the establishment of an explicit eBGP session between them. Route servers maintain eBGP sessions with participating members, and perform route reflection among these. Support for differentiated policies, scalability, and convergence time make the development of efficient Route Server platforms challenging. Nevertheless, router servers have proven their utility, considering the number of BGP paths that they track in some major IXPs. Acknowledging that fact, Cisco Systems has recently released a version of IOS which supports the Route Server capability, mainly building on Virtual Routing and Forwarding instances, commonly used for BGP/MPLS VPNs. In

this project, we identify the **key investigation tracks for the route server technology**, and we draw the lines of the planned collaboration with Keyur Patel of Cisco Systems on improving its support in IOS.

Improving Routing in Service Provider Networks

Funded by: Cisco Systems
Duration: Starting on November 2012 (renewed on an annual basis)
Project partners: Cisco Systems, IMDEA Networks Institute

Following the requirements from Service Provider Network operators and data center network operators, research and development in the field of networking aims at **providing network architectures that allow for a flexible, scalable, and manageable definition of transit paths across a network.** Dr. Pierre Francois, Research Assistant Professor at IMDEA Networks Institute, will collaborate with Cisco Systems to carry out research in this direction, by researching on the protocol suite supporting the Segment Routing technology, a new network architecture defined to meet these emerging requirements.

Pierre Francois will contribute to the research, prototyping, and standardization of techniques aimed at providing resilient services in a Segment Routing network.

Potential benefits of this research

- Protocols allowing Internet Service Provider networks to define flexible transit paths across their network
- Support of services with tight SLA over IP infrastructures
- Resiliency of SDN networks

Potential applications

- Management tools allowing to better operate cloud networks
- Internal Transit Cost reduction for network operators

6.2.1. Industry partners

Our technology transfer activities have led to **a significantly increased portfolio of companies we collaborate with**. During 2013 they were the following:

Alcatel-Lucent Bell Labs (USA & France)

Alvarion

Cisco Systems

Commissariat à l'Energie Atomique et aux Energies Alternatives

Docomo Communications Laboratories Europe

Factory Holding Company 25

Fastweb SPA (FW)

France Telecom SA (FT)

Hewlett Packard Italiana SRL

Huawei Technologies Dusseldorf GmbH (HWDU)

Intecs Informatica e Tecnologia del Software S.P.A.

Intel Mobile Communications France

Interdisciplinary Institute for Broadband Technology (IBBT)

LiveU

MobiMesh s.r.l.

NEC Europe Ltd.

Nokia

Portugal Telecom Inovaçao

Sagemcom Broadband SAS

Sequans Communications

Sigma Orionis

Signalion GmbH

Telefónica S.A.

Telefónica I+D

Technicolor R&D

Telecom Italia S.p.a.

V-Sistemas

ZED Worldwide, S.A

We continue to build firm relationships and sound collaborative arrangements with these companies and other key players in the field, including various regional, national and international bodies.

IMDEA Networks Institute collaborates with the Madrid-region network of Scientific Parks and Clusters (Madrid Network) that brings together industry and research institutes in the region. We are members of the ICT Audiovisual Cluster (*Cluster Audiovisual*) and of the ICT Security and Trust Cluster (*Cluster de Seguridad y Confianza*). We also collaborate with RedIRIS, the Spanish National Research and Education Network, and with REDIMadrid, the Research Network of Madrid.

ICT Audiovisual Cluster

ICT Security and Trust Cluster (Cluster de Seguridad y Confianza)

RedIRIS

REDIMadrid

personnel

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director

The Director is the CEO of the Institute. He is appointed by the Board of Trustees amongst scientists with a well-established international reputation in computer networking. The Director fosters and supervises the activities of IMDEA Networks, and establishes the distribution and application of the available funds in accordance with the Institute's strategic goals and within the limits established by the Board of Trustees. The Director reports regularly to the Board. He is aided by the Scientific Council in determining the scientific research strategy and associated policies. The Director is also assisted by the Deputy Director, the Research Strategy Manager and the General Manager.

Dr. Arturo AZCORRA
Director

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Short Bio:

Arturo Azcorra holds a double appointment as Full Professor at the University Carlos III of Madrid (UC3M) (Madrid, Spain) in the Telematics Engineering Department and Director of IMDEA Networks, where he conducts his research activities. He has returned to his post as Director of IMDEA Networks in June 2012, after a period, from May 2010 to February 2012, during which he held the position of Director General at the Centre for the Development of Industrial Technology (CDTI), an agency of the Spanish Ministry of Economy and Competitiveness (MINECO), previously known as the Spanish Ministry of Science and Innovation (*Ministerio de Ciencia e Innovación – MICINN*). He previously held the position of Director General for Technology Transfer and Corporate Development also at the MICINN.

He graduated from Loy Norrix High School (Michigan, USA) in 1980. In 1986, he received his M.Sc. degree in Telecommunications Engineering from the *Universidad Politécnica de Madrid* (Polytechnic University of Madrid) (Madrid, Spain), with the "Sobresaliente" (Outstanding) grade, and was subsequently awarded the Price Waterhouse Prize for Best Student. He then obtained his Ph.D. from the same university in 1989. His Ph.D. received the National Award for Best Thesis (*Premio Nacional a la Mejor Tesis Doctoral*), jointly granted by the *Asociación Profesional de Ingenieros de Telecomunicación* (Professional Association of Telecommunication Engineers) and the then-named *Asociación Nacional de Industrias Electrónicas*, ANIEL (The National Association of Electronic Industries) (today ANIEL is known as AMETIC, *Asociación de Empresas de Electrónica, Tecnologías de la Información, Telecomunicaciones y Contenidos Digitales*). In 1993, he obtained an MBA from the *Instituto de Empresa* (one of the World's most prestigious business schools), graduating first in his class.

He was an Associate Professor at the *Universidad Politécnica de Madrid* from 1987 to 1998. In 2000, he was appointed Deputy Vice-Provost for Academic Infrastructures at the UC3M. He worked in this role until 2007, teaching and also developing the application of Information Technologies to research. He previously worked at ICSI University of California, Berkeley (Berkeley, USA) as a Visiting Professor in 1999, and then, in 2002, at the Massachusetts Institute of Technology (MIT) (Massachusetts, USA).

Arturo Azcorra is an IEEE Senior Member and an ACM SIGCOMM Member. He has participated in and directed 49 European research and technological development projects, including ESPRIT, RACE, ACTS, IST and ICT programs. He previously held the position of Coordinator of the international Networks-of-Excellence (NoE) E-NEXT (Emerging Networking Experiments and Technologies) and CONTENT (Excellence in Content Distribution Network Research), part of the European Commission's VII Framework Program.

He has also performed direct consulting and engineering work for institutions, such as the European Space Agency, MFS-Worldcom, Madrid Regional Government, RENFE, REPSOL and the Spanish Ministry of Science and Technology. Arturo Azcorra is the founder of the ACM CoNEXT conference series, of which he was the first General Chair. He is a member of the Standing Committee of the IEEE INFOCOM Conference since 2005, and has chaired prestigious international conferences such as IEEE INFOCOM, ACM CoNEXT and PROMS-IDMS. He has authored over one hundred technical publications in journals and international and national conferences. His publications in national and international magazines, books and conferences number over 100 titles.

deputy director

The Deputy Director provides assistance to the Director in the fostering and supervision of the scientific activities of the Institute and of its administrative management.

Dr. Albert BANCHS

Deputy Director

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Short Bio:

Albert Banchs obtained his Telecommunication Engineering degree at the Polytechnic University of Catalonia in 1997, and the PhD from the same university in 2002. His PhD thesis, supervised by Professor Sebastia Sallent, addressed the issue of fairly sharing the network resources among users both in the wired and wireless Internet. Albert Banchs received for his PhD the mention of European Doctor and was awarded by COIT (the Spanish official association of Telecommunication Engineers) the ONO prize to the best Spanish PhD thesis on Broadband Networks.

From April to December 1997, Albert Banchs worked in the Networks Group of the International Computer Science Institute (ICSI), Berkeley, California. His work at ICSI focused on active networks research. From January to August 1998 he was with the Telefonica I+D Labs in Madrid, Spain, where he was appointed coordinator of an 8-people development team working on the videoconference over IP project. In September 1998 he joined NEC Network Laboratories in Heidelberg, Germany. He started as a Research Staff Member and was promoted to Senior Research Staff Member in April 2001. At NEC, Albert Banchs worked on a number of projects, including multicast over ADSL, DiffServ and 802.11e standardization.

Since October 2003, Dr. Banchs is with the University Carlos III of Madrid, where he currently holds the position of Associate Professor. Since October 2009, he is also Deputy Director of IMDEA Networks. His research interests include performance evaluation and resource allocation in wireless networks. Current major effort is on the coordination of the European project iJOIN.

research professors

Research Professors are our most published and cited researchers. They are recognized and respected leaders in their field of research. They have already made a difference. Their expertise and research interests have a significant impact on the Institute's scientific output and on the careers of their charges.

Dr. Marco AJMONE MARSAN

Research Professor

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Short Bio:

Marco Ajmone Marsan is a full professor at the Electronics and Telecommunications Department of the Politecnico di Torino in Italy, and a part-time research professor at IMDEA Networks Institute in Leganes, Spain.

Marco Ajmone Marsan obtained degrees in EE from the Politecnico di Torino in 1974 and the University of California, Los Angeles (UCLA) in 1978. Since 1974 he has been at Politecnico di Torino, in the different roles of an academic career, with an interruption from 1987 to 1990, when he was a full professor at the Computer Science Department of the University of Milan.

Marco Ajmone Marsan has been doing research in the fields of digital transmission, distributed systems and networking. He has published over 350 papers in the leading conferences and journals of his research area.

He is also coauthor of two books. His publications received over 8,500 citations, and 16 of his papers received more than 100 citations each.

His h-index is equal to 43 using Publish or Perish (see also http://scholar.google.com/citations?hl=en&user=oPrHUW0AAAAJ), and he is listed by Thomson among the "ISI highly cited researchers".

Marco Ajmone Marsan is the founder and the leader of the Telecommunication Networks Group at Politecnico di Torino. He has tutored many PhD students at Politecnico di Torino, and has been part of the jury of several PhD candidates abroad.

He was the coordinator of the Network of Excellence TREND (Toward Really Energy-efficient Network Design) funded by the EC within FP7 in the area of green networking.

Marco Ajmone Marsan has been a member of the editorial board and of the steering committee of the "ACM/IEEE Transactions on Networking". He is a member of the editorial boards of the journals "Computer Networks" and "Performance Evaluation" of Elsevier. He was in the organizing committee of several leading networking conferences, and general chair of INFOCOM 2013.

Marco Ajmone Marsan is a Fellow of the IEEE, and a member of the Academy of Sciences of Torino. He received the best paper award at the 1982 International Conference on Distributed Computing Systems, Fort Lauderdale, USA, and at the 23rd International Teletraffic Congress (ITC 23), San Francisco, 2011. He received a honorary degree in Telecommunication Networks from the Budapest University of Technology and Economics in 2002.

Marco Ajmone Marsan was the Vice-Rector for Research, Innovation and Technology Transfer at the Politecnico di Torino from 2005 to 2009. From

2002 to 2009 he was the Director of the Istituto di Elettronica e Ingegneria dell'Informazione e delle Telecomunicazioni of the Italian National Research Council. He was the Italian delegate in the ICT and IDEAS committees of FP7.

Dr. Nicholas F. MAXEMCHUK

Research Professor

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Short Bio:

Nicholas Maxemchuk, a networking pioneer, holds a permanent double appointment as Professor at the world-leading Columbia University of New York City (New York, USA) and Research Professor at IMDEA Networks.

He holds a M.Sc. in Electrical Engineering and a Ph.D. in Systems Engineering, both from the University of Pennsylvania (Philadelphia, USA). Before joining Columbia University and IMDEA Networks, Nick Maxemchuk held the position of Technical Leader at AT&T Research Laboratories (1996 – 2001) and, prior to that, was the Head of Distributed Systems Research Department at AT&T Bell Laboratories (1976 – 1996). From 1968 to 1976 he was a member of the technical staff at the RCA David Sarnoff Research Center in Princeton, New Jersey.

Many of his far-sighted contributions to computer-communications networking have been years ahead of their time and have led to the development of groundbreaking new systems. His invention of Dispersity Routing in the 1970s, for example, has recently been applied to ad hoc networks. In 2006, his achievements in the field were recognized by the world's leading professional association for the advancement of technology, the IEEE, when he was awarded the prestigious 2006 IEEE Koji Kobayashi Computers and Communications Award.

Amongst other awards that he has been given, some of the most noteworthy are the RCA Laboratories Outstanding Achievement Award in 1970, the Bell Laboratories Distinguished Technical Staff Award in 1984, the IEEE's Leonard G. Abraham Prize Paper Award in 1985 and 1987, and the William R. Bennett Prize Paper Award in 1997. He was also made a fellow of the IEEE in 1989, and received the 1996 R&D 100 award for his work on document marking

As well as owning 30 patents and publishing three books, Nicholas Maxemchuk has co-authored over 100 publications. His strong reputation as an eminent scientist has earned him many editorial and advisory positions with organizations including the IEEE, ACM, NSF Expert Group and the United Nations. He has published three award winning papers and had two of his publications voted into the Communication Society50th Anniversary Issue. He is a member of the Board of Governors of the Armstrong Foundation and also works as a Consultant on Data Networks in Transportation Networks for The National Academies/Transportation Research Board.

Dr. Joerg WIDMER

Research Professor (tenured)
& Research Strategy Manager

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Short Bio:

Joerg Widmer is Research Professor at IMDEA Networks Institute in Madrid, Spain. He received his M.S. and PhD degrees in computer science from the University of Mannheim, Germany in 2000 and 2003, respectively. His research focuses primarily on wireless networks, ranging from MAC layer design and interference management to future mobile network architectures. From 2005 to 2010, he was manager of the Ubiquitous Networking Research Group at DOCOMO Euro-Labs in Munich, Germany, leading several projects in the area of mobile and cellular networks. Before, he worked as post-doctoral researcher at EPFL, Switzerland on ultra-wide band communication and network coding. He was a visiting researcher at the International Computer Science Institute in Berkeley, CA, USA and University College London, UK. Joerg Widmer authored more than 100 conference and journal papers and three IETF RFCs, holds several patents, serves on the editorial board of IEEE Transactions on Communications, and regularly participates in program committees of several major conferences. Recently he was awarded an ERC consolidator grant as well as a Spanish Ramon y Cajal grant. He is senior member of IEEE and ACM.

research associate professors

Research Associate Professors are typically researchers with several years' experience who assume a position of responsibility in leading the day-to-day activities of our research teams.

Dr. Antonio FERNÁNDEZ ANTA

Research Associate Professor

PhD: University of Southwestern Louisiana (now University of Louisiana at Lafayette). USA
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Short Bio:
Antonio Fernández Anta was promoted to the position of Research Professor at IMDEA Networks Institute in March 2014. Previously he was a Full Professor at the *Universidad Rey Juan Carlos* (URJC) in Madrid, where he has been on the Faculty since 1998. He was before on the Faculty of the *Universidad Politécnica de Madrid*, where we received an award for his research productivity. He has been a postdoc at the Massachusetts Institute of Technology from 1995 to 1997. He has almost 20 years of research experience, with a steady productivity of more than 5 papers per year on average. He has published in top conferences and journals like INFOCOM, STOC, FOCS, PODC, DISC, Journal of the ACM, SIAM Journal on Computing, or IEEE Transactions on Computers. He is Chair of the Steering Committee of DISC and has served in the TPC of numerous conferences and workshops. He is a senior member of the IEEE since 2002 and of the ACM since 2007. Antonio Fernández Anta received his M.Sc. and Ph.D. degrees in Computer Science from the University of Louisiana in 1992 and 1994, respectively. He completed his undergraduate studies (*Licenciado and Diplomado en Informática*) at the *Universidad Politécnica de Madrid*, Spain, in 1988 and 1991 respectively, having received awards at the university and national level for his academic performance.

Dr. Sergey GORINSKY

Research Associate Professor

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Short Bio:
Sergey Gorinsky received an Engineer degree from Moscow Institute of Electronic Technology, Zelenograd, Russia in 1994 and M.S. and Ph.D. degrees from the University of Texas at Austin, USA in 1999 and 2003 respectively. From 2003 to 2009, he served on the tenure-track faculty at Washington University in St. Louis, USA. Dr. Gorinsky currently works as a tenured Research Associate Professor at IMDEA Networks Institute, Madrid, Spain. The areas of his primary research interests are computer networking, distributed systems, and network economics. His research contributions include multicast congestion control resilient to receiver misbehavior, analysis of binary adjustment algorithms, efficient fair transfer of bulk data, network service differentiation based on performance incentives, and economic perspectives on Internet interconnections and routing. His work appeared at top conferences and journals such as ACM SIGCOMM, IEEE INFOCOM, ACM CoNEXT, IEEE/ACM Transactions on Networking, and IEEE Journal on Selected Areas in Communications. Sergey Gorinsky delivered keynote addresses at NPSec 2013 and RAIT 2012. He has served on the TPCs (technical program committees) of SIGCOMM (2012), INFOCOM (2006-2014), ICNP (2008, 2010-2014), and other networking conferences. Prof. Gorinsky co-chaired the TPCs of COMSNETS 2013, NetSciCom 2014, E6 2012, HSN 2008, and FIAP 2008, served as a TPC vice-chair for ICCCN 2009 and TPC area chair for ICNP 2013.

Dr. Dejan KOSTIĆ

Research Associate Professor

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Short Bio:

Dejan Kostić obtained his Ph.D. in Computer Science at the Duke University. He spent the last two years of his studies and a brief stay as a postdoctoral scholar at the University of California, San Diego. He received his Master of Science degree in Computer Science from the University of Texas at Dallas, and his Bachelor of Science degree in Computer Engineering and Information Technology from the University of Belgrade (ETF), Serbia. From 2006 until 2012 he worked as a tenure-track Assistant Professor at the School of Computer and Communications Sciences at EPFL (*Ecole Polytechnique Fédérale de Lausanne*), Switzerland. In 2010, he received a European Research Council (ERC) Starting Investigator Award. In 2012, he joined IMDEA Networks Institute (Madrid, Spain) as a Research Associate Professor with tenure.

His interests include Distributed Systems, Computer Networks, Operating Systems, and Mobile Computing.

Dr. José Félix KUKIELKA

Research Associate Professor

PhD: University of California at Berkeley. USA
Previous Position: Visiting Professor. University Carlos III of Madrid. Spain
Research: Wideband Access to Private Networks; Quality of Service in Wireless networks; Service-aware Wireless Routing; Wireless Protocol Optimization for High-throughput Data and Voice
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Short Bio:

José Félix Kukielka is Research Associate Professor at IMDEA Networks. From 2003 until 2007, he worked at the UC3M as Ramón y Cajal Researcher. He obtained his undergraduate degree at the *Universidad Nacional Autónoma de México* (Federal District, Mexico) in 1972, and went on to complete a M.Sc. and a Ph.D., both at the University of California, Berkeley (Berkeley, USA).

He has been the Technical Director of REDIMadrid from 2007 until 2009. REDIMadrid was created in collaboration with the UC3M in 2003. It is a regional research network for education and research institutions based in the Madrid Region. The program contributes to the consolidation of a dedicated, high-performance telecommunications infrastructure for its scientific community. Such infrastructure eases and promotes collaborative work, the establishment of eminent working groups and participation in national and international networks.

José Félix Kukielka has 23 years of industrial experience in designing, manufacturing and marketing communications products and Radio Frequency for the semi-conductor and telecommunications industries. Throughout his career, he has worked in both academia and industry, working for Grupo AIA (Spain), Alcatel España, Philips Consumer Communications (Le Mans, France), Alcatel Telecom (Spain) and Avantek, Inc. (California, USA).

He was elected Associate Member of the Technical Team for Alcatel-Lucent Technical Academy (ALTA). He is the creator of the "Kukielka Configuration", a topology for microwave monolithic integrated circuit amplifiers with multiple feedback loops that is characterized by an excellent gain-bandwidth product, implemented successfully in several semiconductor technologies.

research assistant professors

Research Assistant Professors at IMDEA Networks Institute are bright researchers at the beginning of their research career, who want to establish a strong research group based on their research vision. They lead their own team of Pre-doc and Post-doc researchers and collaborate with top Research Associate Professors. Research Assistant Professors are not required to teach, so they can focus full-time on research if they so wish.

Dr. Pierre FRANCOIS

Research Assistant Professor

PhD: Université catholique de Louvain. Belgium
Previous Position: Post-Doc Researcher. Fonds national de la recherche scientifique (FNRS). Belgium
Research: IP Routing; IS-IS; OSPF; BGP; MPLS; Segment Routing; Network Management
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Short Bio:

Dr. Francois received his B.Sc. in Economics and Management Science from the *Facultés Notre Dame de la Paix* in Namur, Belgium, where he also holds a Masters in Computer Science. He received his Ph.D. from *Université catholique de Louvain*. He is very active on standardization and holds an extensive list of IETF contributions. Dr. Francois also maintains an active profile within the international scientific community and has participated in several research visits and collaborations with both academia and industry.

Dr. Francois was a postdoctoral researcher at *Université catholique de Louvain - Fonds National de la Recherche Scientique (FNRS)*, in Belgium, where he conducted research partially funded by the Belgian National Science Fund, the "Trilogy" EU project, (in which IMDEA Networks also collaborated), and Cisco Systems. He focused on routing features, such as BGP Add-Paths, BGP Graceful Shutdown and IPFast ReRoute. Dr. Francois is a regular invited lecturer at *Université d'Abomey-Calavi*, Republic of Benin.

Dr. Domenico GIUSTINIANO

Research Assistant Professor

PhD: University of Rome "Tor Vergata". Italy
Previous Position: Senior Researcher & Lecturer. Communication Systems Group (CSG). Swiss Federal Institute of Technology Zurich (ETH Zurich). Switzerland
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Short Bio:

Dr. Domenico Giustiniano is Research Assistant Professor at IMDEA Networks.

Before joining IMDEA, he was a Senior Researcher and Lecturer in the Communication System Group (CSG) of ETH Zurich, and Post-Doctoral Researcher at Disney Research Zurich (2010-2012) and at Telefonica Research Barcelona (2008-2010). He holds a PhD in Telecommunication Engineering from the University of Rome Tor Vergata. Dr. Giustiniano devotes most of his current research to emerging areas in the field of wireless networking and localization systems. The original contributions he has made to his field of research are exemplified by first-author publications in top dissemination venues such as ACM MobiCom, ACM CoNEXT and IEEE INFOCOM, and in journals such as IEEE/ACM Transactions on Networking and IEEE Transactions on Wireless Communications, and best paper award at IFIP Wireless Days'12 for his contribution on visible light networking with LED-to-LED communication. His approach to scientific work oriented to devise solutions to real-world problems based on real-world assumptions is further proved by four patents.

Dr. Vincenzo MANCUSO

Research Assistant Professor

PhD: University of Palermo. Italy
Previous Position: Post-Doc Researcher. INRIA Sophia Antipolis. France
Research: Network modeling; Measurements; Performance Analysis; Wireless Dense Networks; HetNets; D2D; eICIC; Context-aware Wireless Services; EEE; Green IT
Contact: vincenzo.mancuso@imdea.org
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Short Bio:

Dr. Vincenzo Mancuso obtained his master degree in Electronics from University of Palermo, Italy, in 2001, and a PhD in Electronics, Computer Science and Telecommunications from the same University in 2005. After the PhD, he has collaborated with University of Roma ''Tor Vergata'' and University of Palermo. He has been visiting scholar at the ECE Department of Rice University, Houston, Texas, and postdoc in the MAESTRO team at INRIA Sophia Antipolis, France. Since September 2010, Vincenzo is with IMDEA Networks Institute, working on analytical and experimental projects on wireless networks (802.11, 802.16/LTE, D2D) and energy efficient network protocols.

My current research work is centered on the following areas: Scheduling and inter-cell interference management in very dense cellular data networks; analysis and performance evaluation of inband and outband D2D communication schemes; analysis and implementation of context-aware mechanisms for mobile devices; experiments with modified 802.11 driver/firmware; modeling, measurements, and experiments with 802.3az (EEE links).

Dr. Balaji RENGARAJAN

Research Assistant Professor

PhD: The University of Texas at Austin. USA
Previous Position: Graduate PhD Student
Research: Measurement, Modeling and Performance Evaluation of Wireless Networks, Ad-hoc and Sensor Networks
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Short Bio:

Dr. Balaji Rengarajan joined IMDEA Networks in 2010 as a Research Assistant Professor and left in June 2013. He received his Ph.D. and M.S. in electrical engineering from the University of Texas at Austin in 2009 and 2004 respectively, and his B.E. in Electronics and Communication from the University of Madras in 2002. He was the recipient of a 2003 Texas Telecommunications Engineering Consortium (TxTEC) graduate fellowship and a 2010 Marie-Curie "Amarout Europe Programme" fellowship. He is also the recipient of the best paper award at the 23rd International Teletraffic Congress (ITC), 2011. His main research interests include the measurement, modeling and performance evaluation of wired and wireless networks.

Dr. Gianluca RIZZO

Research Assistant Professor

PhD: EPFL Lausanne. Switzerland
Previous Position: System engineer - Utility Communications. ABB Switzerland. Switzerland
Research: Performance Evaluation of Communication Networks; Network Calculus; Quality of Service
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Short Bio:

Gianluca Rizzo was born in Galatina (Lecce), Italy, in 1975. He received the degree in electronic engineering from the Politecnico di Torino, Torino, Italy, in 2001. From September 2001 to December 2003, he has been a researcher in Telecom Italia Lab, Torino, Italy. From January 2004, to October 2008, he has been at EPFL Lausanne, where he received his PhD in computer science. From November 2008 to August 2009 he has been with ABB Switzerland. From September 2009 to March 2013 he was a Research Assistant Professor at IMDEA Networks Institute.

visiting professors

Visiting Professors share our research interests and spend their sabbatical with us for either one or two terms. They usually have several years' post-doctoral research experience and are interested in extending their horizons with a temporary assignment in a new environment.

Dr. Azzedine BOUKERCHE

Visiting Professor

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid (Cátedra de Excelencia)
University of origin: University of Ottawa. Canada
PhD: McGill University. Montreal. Canada
Research: Sensor Networks; Mobile Ad hoc Networks; Vehicular Networks, Mobile and Pervasive Computing; Wireless multimedia; QoS Service Provisioning; Performance Evaluation and Modeling of Large-scale Distributed Systems; Distributed Computing; Large-scale Distributed Interactive Simulation and Parallel Discrete Event Simulation
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Personal website: http://www.site.uottawa.ca/~boukerch/

Short Bio:
Dr. Boukerche is currently a Full Professor and holds a Canada Research Chair position in distributed simulation and wireless and mobile networking at the University of Ottawa. He received his Ph.D. degree in Computer Science from McGill University, Canada. He is the Founding Director of PARADISE Research Laboratory at uOttawa, and the Founding Director of the NSERC DIVA Strategic Research Centre, the first network ever hosted at uOttawa.

Dr. Boukerche's scientific track record gives testimony to a meritorious career. He has authored nearly 550+ peer-reviewed journal and conference publications and serves on the editorial board of some of the main and prestigious periodicals in the field of communications and computer networks: IEEE Transactions on Vehicular Technology, IEEE Wireless Communication Magazine, Elsevier's Ad Hoc Networks, and Wiley's International Journal of Wireless Communication and Mobile Computing, to mention but a few. In addition, his curriculum of scientific service includes diverse chairing roles on various IEEE/ACM International conferences and workshops, including key venues for the diffusion of computer science and networking scientific results, such as IEEE Globecom, IEEE ICC, IEEE WoWMoM, IEEE ISCC or ACM MSWiM, among others.

Prof. Boukerche is the recipient of the Ontario Distinguished Researcher Award, the Ontario Early Researcher Award (previously known as Premier of Ontario Research Excellence Award (PREA)), the Canada Research Chair, the G. S. Glinski Award for Excellence in Research, the IEEE ComSoc Distinguished Speaker, and the IEEE Meritorious Service Award, and he was named a member of the of the IEEE Computer Society Golden Core, amongst other prizes and recognitions of his contributions to the advancement of computer science, and wireless networking and communication. Prof. A. Boukerche is a Fellow of the Canadian Academy of Engineering, a Fellow of The Engineering Institute of Canada, and a Fellow of The American Association for the Advancement of Science

Dr. Shmuel ZAKS

Visiting Professor

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid (Cátedra de Excelencia)
University of origin: Joan Callner-Miller Chair Professor of Computer Science. Technion – Israel Institute of Technology. Haifa. Israel
PhD: Computer Science, 1979. University of Illinois at Urbana-Champaign. USA
Research: Theory of Distributed Computing; ATM and Optical Networks; Combinatorial and Graph Algorithms; Combinatorics and Graph Theory; Discrete Mathematics
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Short Bio:
Shmuel Zaks received his BSc (cum laude) and MSc in Mathematics from the Technion, Israel, in 1971 and 1972, and PhD in Computer Science from the University of Illinois at Urbana-Champaign, USA, in 1979. He then joined the Department of Computer Science at the Technion, Haifa, Israel, where he is a Professor and the incumbent of the Joan Callner-Miller Chair in Computer Science. He has been a visiting profesor in many universities (including MIT, University of Rome "La Sapienza" and University of l'Aquila (Italy), University of Liverpool (UK), Hong Kong University of Science & Technology, Carleton University (Canada), and research centers (including IBM TJ Watson Research Center (USA), INRIA Sophia Antipolis (France) and Create-Net (Italy)), and he spent February-July 2013 as a visiting professor at Universidad Carlos III de Madrid and IMDEA Networks Institute in Madrid. He was on the program committees of over 30 conferences, chair of DISC 1992 and SIROCCO 2007, member of the steering committees of DISC and SIROCCO, and chair of the steering committee of DISC. Professor Zaks is the author of over 150 journal and conference papers. His research areas include Distributed Computing, Graph and Combinatorial Algorithms, Discrete Mathematics, and Theory of Networking (especially Optical Networks).

A map of the world displaying the international academic background of IMDEA Networks personnel

pre-doc researchers

Our Pre-doc Researchers are young, aspiring researchers who occupy a salaried position in our research team whilst undertaking their Ph.D. at a leading Madrid University for up to five years. Most of our Pre-doc Researchers enter the Ph.D. program at University Carlos III of Madrid (UC3M). IMDEA Networks Institute has a far-reaching collaboration agreement with UC3M which includes the provision of a Postgraduate program for our early-stage researchers. In the future we may have similar arrangements with other Madrid Universities.

Omar AHMAD SAN JOSE

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Telecommunications Engineering. University Carlos III of Madrid. Madrid. Spain
MSc: Telematics Engineering; Interuniversity Master's degree on Multimedia and Communications. University Carlos III of Madrid. Madrid. Spain; Communications. Chalmers University of Technology. Gothenburg. Sweden
Previous Position: Research Assistant. Signal Theory and Communications Department. University Carlos III of Madrid. Spain
Research: Wireless Communications; OFDM; PHY-Layer; LTE
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Shahzad ALI

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Computer Science. COMSATS Institute of Information Technology Abbottabad. Abbottabad. Pakistan
MSc: Computer Sciences. COMSATS Institute of Information Technology Abbottabad. Abbottabad. Pakistan; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Lecturer. Department of Computer Science. COMSATS Institute of Information Technology. Abbottabad. Pakistan
Research: Delay-tolerant networks; Wireless Sensor Networks; Vehicular Ad hoc Networks
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Jordi ARJONA

Pre-doc Researcher

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BSc: Telecommunications Engineering. Polytechnic University of Valencia. Valencia. Spain
MSc: Automatics, Robotics and Industrial Computer Science (coursework). Polytechnic University of Valencia. Valencia. Spain; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Systems Engineer. Indra Systems. Valencia. Spain
Research: Energy Efficiency; Data Centers; Networking
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Arash ASADI

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Electronic Engineering. Azad University. Iran
MSc: Telecommunication Engineering. MMU University. Cyberjaya. Malaysia; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Research Scholar. MMU University. Cyberjaya. Malaysia
Research: Wireless Communications; Resource Allocation; Device-to-Device Communication
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Pradeep BANGERA

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Bachelor of Engineering (B.E) in Telecommunication Engineering. Siddaganga Institute of Technology. Tumkur. India
MSc: MTech in Information and Communication Network Engineering. Manipal Institute of Technology. Manipal. India; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Research: Economic Incentives for Traffic Attraction and Prefix Hijacking in BGP; Inter-domain and Intra-domain Traffic Matrices; Qualitative and Quantitative Analysis of Internet Protocol Resource Hijacking; Accountability issues in Inter-domain Routing between ISPs
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Nicola BUI

Pre-doc Researcher
(Research Engineer)

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Information Engineering. University of Ferrara. Ferrara. Italy
MSc: Telecommunication Engineering. University of Ferrara. Ferrara. Italy
Previous Position: CEO. Patavina Technologies. Padova. Italy
Research: Mobile Networks; Optimization; Multimedia; Content Distribution Networks
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Kirill BOGDANOV

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Computer Games Development. Institute of Technology Carlow. Carlow. Ireland
MSc: High-Performance Computing. Trinity College Dublin. Dublin. Ireland
Previous Position: Software Engineer at DB2 for Linux, Unix, Windows (LUW). Team: High Availability and Disaster Recovery (HADR). IBM Corporation. Dublin. Ireland
Research: Distributed Systems; Geo Distributed Databases; Scheduling and Load Balancing
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Juan Camilo CARDONA

Pre-doc Researcher

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Previous Position: Pre-sale Engineer. ITS. Medellín. Colombia
Research: Interdomain Routing; Network Optimization; Metro and Transport Networks; OpEx and CapEx Analysis
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Angelos CHATZIPAPAS

Pre-doc Researcher

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MSc: Communications Engineering. RWTH-Aachen. Aachen. Germany; Security, Systems and Networks. University of Nice-Sophia Antipolis. Sophia Antipolis. France; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Modeling and control of a green base station. INRIA Sophia Antipolis. France
Research: Computer Networks; Energy Efficient Networks; Network Programming; Telecommunications; Renewable Energy Sources; Energy Efficient Data Centers
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Evgenia CHRISTOFOROU

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Previous Position: Research Assistant. Department of Computer Science. University of Cyprus. Cyprus
Research: Internet-based Computing; Algorithmic & Evolutionary Game Theory; Algorithmic Mechanism Design; Game Theory
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Ignacio CASTRO

Pre-doc Researcher

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Previous Position: Macroeconomics Teacher. Montero Espinosa Academy. Madrid. Spain
Research: Economics and Networked Systems; Inter-domain economics
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Luis F. CHIROQUE

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Research: Graph Theory; Social Networks; Big Data; Data Mining; Machine Learning; Teletraffic Engineering
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Luca COMINARDI

Pre-doc Researcher

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BSc: Information Engineering (curriculum Computer Science). Università degli studi di Brescia. Brescia. Italy
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Research: Software Defined Networking; Mobile IP; Wireless networks
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Roderick FANOU

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
MSc: Design Engineer in Computer Science, Networks and Telecommunications (majoring in Networks and Telecommunications). Polytechnics of Abomey Calavi (EPAC). University of Abomey Calavi (UAC). Republic of Benin
Previous Position: Intern. EUPHORBIA Sarl. Cotonou. Republic of Benin
Research: Impacts of Internet eXchange Points; Routing Architecture; Internet Measurement
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Aymen FAKHREDDINE

Pre-doc Researcher

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MSc: Advanced Wireless Communications Systems. École Supérieure d'Électricité - Supélec. Paris. France
Previous Position: Intern. Alcatel-Lucent Bell Labs. Paris. France
Research: Indoor Localization; WLAN; GPS; Tracking Algorithms
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Research: Mobility in IPv6 Networks; Routing for Multihomed/Multi-Interface Devices; IP Flow Management
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Georgios KATSIKAS

Pre-doc Researcher

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MSc: Communication Systems and Networks. National and Kapodistrian University of Athens (NKUA). Athens. Greece
Previous Position: Research Assistant. Self-Evolving Cognitive and Autonomic Networking (SCAN) Group. National and Kapodistrian University of Athens (NKUA). Athens. Greece
Research: Distributed Systems; Software-defined Networks; Software Engineering
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Andra LUTU

Pre-doc Researcher

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MSc: Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Intern. Ericsson. Romania
Research: Inter-domain Routing; Traffic Engineering; BGP; Routing Scalability
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Israel GUTIÉRREZ ROJAS

Pre-doc Researcher

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MSc: Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Research Assistant. University Carlos III of Madrid. Spain
Research: Technology Enhanced Learning; Learning Analytics; Future Web Technologies; Awareness Tools; E-assessment; Orchestrating Learning
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Michal KRYCZKA

Pre-doc Researcher

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Previous Position: Intern. Ericpol Telecom. Lodz. Poland
Research: Peer-to-Peer Technologies; Internet Measurements; Social Networking; Content Distribution; IPv4 to IPv6 Transition; Framework for Extension of Addressing Space; Steganography in Computer Files
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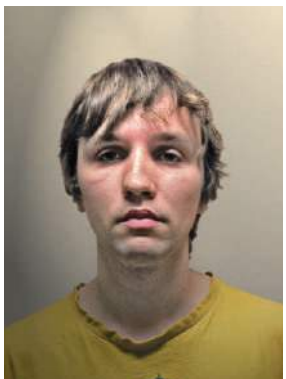

Miriam MARCIEL

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
MSc: Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Intern. Indra Systems. Madrid. Spain
Research: Online Social Networks; Content Distribution Services; Internet Measurement
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Mihai MORARU

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
MSc: Diplôme d'ingénieur. INSA de Lyon. Lyon. France; Research Masters in Informatics. INSA de Lyon. Lyon. France
Research: Distributed Systems; Data Center Networks; Privacy; Security
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Foivos MICHELINAKIS

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Electrical and Computer Engineering (5-years). National Technical University of Athens. Athens. Greece
MSc: Telematics Engineering, Communication Networks and Services. University Carlos III of Madrid. Spain
Previous Position: Analyst-programmer. Hellenic Army. Greece
Research: Network Optimization; Content Distribution Networks; Network Economics
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Thomas NITSCHE

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
MSc: Diploma in Computer Science. Technische Universitaet Muenchen. Munich. Germany
Previous Position: PhD Student. Chair for Network Architectures and Services. Technische Universitaet Muenchen. Munich. Germany
Research: Wireless Networking; Software Defined Radio; mm-Wave Wi-Fi; Wireless PHY-layer; Cross-layer Protocols
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Pablo SALVADOR

Pre-doc Researcher

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Previous Position: Student Assistant. NEC Laboratories Europe. Heidelberg. Germany
Research: Wireless Networking; Multimedia traffic; Experimental wireless
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M. Isabel SÁNCHEZ

Pre-doc Researcher

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BSc: Telecommunications Engineering. University Carlos III of Madrid. Madrid. Spain
MSc: Telecommunications Engineering. University Carlos III of Madrid; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Internship for improving academic support of a disabled student. University Carlos III of Madrid. Madrid. Spain
Research: Mobile Networks; Heterogeneous Dense Wireless Neworks; SDN; Vehicular Networks
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Vasileios PAPADOPOULOS

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Software Engineer. Alexander Technological Institute of Thessaloniki. Greece
MSc: Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Previous Position: Research Assistant. University Carlos III of Madrid. Madrid. Spain
Research: Analysis of Dynamics of IEEE 802.11 Distributed Coordination Function (DCF); Performance Evaluation of Network Traffic Generators (NTG); Power Savings in Multi-homed Handheld Devices; Energy Efficiency in Cellular Data Networks
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Christian SÁNCHEZ

Pre-doc Researcher (Systems Analyst)

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Computer Engineer. Universidad José Antonio Páez. Valencia. Venezuela
MSc: Informatics Engineering (current). University Carlos III of Madrid. Madrid. Spain
Previous Position: Development Analyst. ONUVA. Caracas. Venezuela
Research: Wideband Access to Private Networks; Quality of Service in Wireless Networks; Service-aware Wireless Routing and Wireless Protocol Optimization for High-throughput Data and Voice
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Vincenzo SCIANCALEPORE

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Computer Engineering. Politecnico di Bari. Bari. Italy
MSc: Telecommunication Engineering. Politecnico di Milano. Milano. Italy
Previous Position: Student Research Assistant. NEC Laboratories Europe. Heildeberg. Germany
Research: WiMAX; 3GPP; LTE-Advanced; Inter-Cell Coordination and Scheduling; Opportunistic Scheduling; Offloading; Genetic Algorithms; Optimization Problem; Game Theory; Distributed Algorithms
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Syed Anwar UI HASAN

Pre-doc Researcher

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MSc: Commmunications and Computer Security. Telecom ParisTech - Institut Eurecom. Sophia Antipolis. France; Telematics Engineering. University Carlos III Madrid. Spain
Previous Position: MSc Research Intern at Thales Alenia Space, Cannes, France
Research: Internet Topology; Internet Economics - Cost Structures of Realistic ISPs and Pricing Models; Network Science, Traffic Engineering - Network Planning and Performance Evaluation
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Gek Hong SIM

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Bachelor of Engineering (Honors) Electronics (majoring in Telecommunication). Multimedia University. Malaysia
MSc: Telematics Engineering. University Carlos III Madrid. Spain; Master of Engineering Science. Multimedia University. Malaysia
Previous Position: Technical Trainer. Huawei Technologies Co. Ltd. Malaysia
Research: Multicast Scheduling; Multicast Beamforming; LTE; IEEE 802.11ad WLAN
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Christian VITALE

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Telecommunication Engineering. University of Pisa. Pisa. Italy
MSc: Telecommunication Engineering. University of Pisa. Pisa. Italy
Previous Position: Student Research Assistant. NEC Europe Ltd. Heidelberg. Germany
Research: 802.11; Wireless Cellular Networks (LTE;LTE-A); Analytical Modeling; Queuing theory
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Sergio YÉBENES

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Technical Engineering in Computer Science, Systems. Polytechnic University of Madrid. Madrid. Spain
MSc: Information Technologies, Distributed systems Engineering, Communications. Polytechnic University of Madrid. Madrid. Spain
Previous position: Web Developer. Tower NetCommerce (Mobius Ltd.). Dublin. Ireland
Research: Internet Architecture; Next-Generation Networks; Internet Security; Communications Networks
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Qing WANG

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Research: Device-to-Device Communication; Visible Light Communication (VLC); Opportunistic Scheduling; Performance Evaluation; Stochastic Optimization
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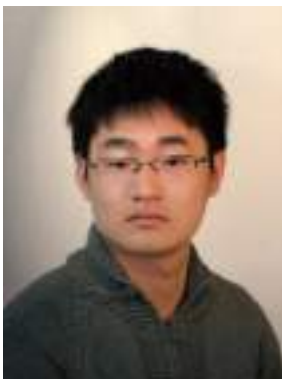

Elli ZAVOU

Pre-doc Researcher

Affiliation: IMDEA Networks Institute and University Carlos III of Madrid
BSc: Computer Science. University of Cyprus. Nicosia. Cyprus
MSc: Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
Research: Online Algorithms; Distributed and Parallel Algorithms; Distributed Networks; Energy Efficiency; Discrete and Applied Mathematics
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research support

Research Support employees at IMDEA Networks are responsible for the design, installation and maintenance of the IT infrastructure, either at the level of the entire Institute, or working closely with researchers and their groups.

Typical roles include systems administration and software engineering. These positions are similar to their industry equivalents, but enable our employees to work on cutting-edge research problems and technology in a stimulating environment.

Jonathan ALMODÓVAR

Laboratory Technician

BSc: Computer Science. University Carlos III of Madrid. Madrid. Spain
Previous Position: System Administrator. GAST Research Group. University Carlos III of Madrid. Madrid. Spain
Research: Distributed Systems; System Administration; E-learning
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Hector CORDOBÉS DE LA CALLE

Research Engineer

MSc: Telecommunications Engineering. University Carlos III of Madrid. Spain
Previous Position: Systems Architect and Developer. Motorola/ Motorola Mobility. Spain
Research: NLP; Big Data; Data and Signal Processing
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Alberto GORDILLO

Laboratory Technician

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Andrea ISIMINGER
Project Administrator

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Miguel PEÓN-QUIRÓS
Research Engineer

MSc: Computer Engineering. Complutense University of Madrid. Spain
Previous Position: Teaching Assistant. Complutense University of Madrid. Spain & Freelancer
Research: Software Defined Networking; Distributed and Network Systems; Computer Architecture; Cloud Computing
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Jorge RAMÓN MUÑOZ
Research Engineer

Qualifications: Fulbright Scholar. Purdue University. West Lafayette. Indiana. USA; MBA & MSc in Computer Science Engineering. Copenhagen Business School & University Rey Juan Carlos. Madrid. Spain
Previous Position: Business Consultant. StartupSteps. Copenhagen School of Entrepreneurship. Copenhagen. Denmark
Research: Big Data; Systems Integration; Systems architecture; Consulting
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Joel ROSENTAL
Systems Administrator

BSc: Computer Engineering. José Antonio Paéz University. Venezuela
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Agustín SANTOS
Research Engineer

PhD: University Rey Juan Carlos. Madrid. Spain
Previous Position: Entrepreneur & Lecturer. University Rey Juan Carlos. Madrid. Spain
Research: Distributed Systems; Simulation; Game theory; Big Data and Data Analysis; Natural Language Processing
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internship students

IMDEA Networks offers a Research Internship program. Eligible candidates are students who are currently undertaking a B.Sc., M.Sc. or equivalent in Computer Science, Electrical Engineering, Computer Engineering, Telecommunications, Telematics or a related field, and who wish to enhance their research potential developing the Science of Networks. Interns work closely with members of our research team, which allows them to acquire on-the-job training and gain valuable experience in computer networking science and technology.

The minimum expected internship duration is usually 3 months, but longer stays are accommodated depending on individual circumstances. Successful interns also receive special consideration for future positions on our Pre-doc Researchers team. Several of the interns listed here have benefited from the Talentum Startups 2014 project (see section 6.2.).

Sergio BÚRDALO
Supervisor: Rubén Cuevas
Research: Socio-economic Analysis of Mobile Markets; Databases; SQL; Analysis and Visualization of High-level Technical Data

Rubén CABALGANTE
Supervisor: Arturo Azcorra
Research: Arduino; Wi-Fi; Power; C; C++; Linux; Electronic

Pablo CAMARILLO
Supervisor: Pierre Francois
Research: IP Routing Protocols; IXPs (Internet Exchange Points); ISPs Network Architecture

Pablo CASTELLANOS
Supervisor: Antonio de la Oliva
Research: OpenFlow; Open vSwitch; DMM; Mobility

Carlos CILLERUELO
Supervisor: Pablo Serrano
Research: Computer Networks; High Density Networks

Guido FIORAVANTTI
Supervisor: Joerg Widmer
Research: Protocols; LTE; Data Prefetching; Transmission Optimisation

David GALERA
Supervisor: Vincenzo Mancuso
Research: Network control; LTE; WiFi; Simulation/Emulation

Alberto GONZÁLEZ
Supervisor: Arturo Azcorra
Research: Enhanced Content Placement

Luis Antonio GONZÁLEZ
Supervisor: Agustín Santos
Research: Distributed Computing Systems; Distributed Simulation; C#; Large Distributed Simulations & Real Time Applications; Scalable & Elastic Publish/Subscribe Services; Proxys, AOP

Diego GRANDE
Supervisor: Jose Félix Kukielka
Research: Wideband Access to Private Networks; Quality of Service in Wireless Networks; Service-aware Wireless Routing and Wireless Protocol Optimization for High-throughput Data and Voice

Alberto MARTÍN
Supervisor: Jose Félix Kukielka
Research: Wideband Access to Private Networks; Quality of Service in Wireless Networks; Service-aware Wireless Routing and Wireless Protocol Optimization for High-throughput Data and Voice

Noelia María PÉREZ
Supervisor: Antonio Fernández Anta
Research: Household Energy Demand Model; Renewable Energy Management; Distributed Generation & Optimization Algorithms

José Ignacio PICO
Supervisor: Carlos Jesús Bernardos
Research: OpenFlow; Backhaul Network; Small Cells; RANaaS; LTE; SDN (Software Defined Networking)

research team structure

networked systems&algorithms

Researchers:
- Dr. Arturo Azcorra
- Dr. Dejan Kostić
- Dr. Sergey Gorinsky
- Dr. Pierre François
- Dr. José Félix Kukielka

Pre-Doc Researchers:
- Pradeep Bangera
- Kirill Bogdanov
- Juan Camilo Cardona
- Ignacio de Castro
- Roderick Fanou
- Israel Gutiérrez Rojas
- Georgios Katsikas
- Michal Kryczka
- Andra Lutu
- Mihai Moraru
- Syed Anwar Ul Hasan
- Christian Sánchez
- Sergio Yébenes

wireless networking

Researchers:
- Dr. Albert Banchs
- Dr. Joerg Widmer
- Dr. Azzedine Bourkerche
- Dr. Domenico Giustiniano
- Dr. Nicholas Maxemchuk

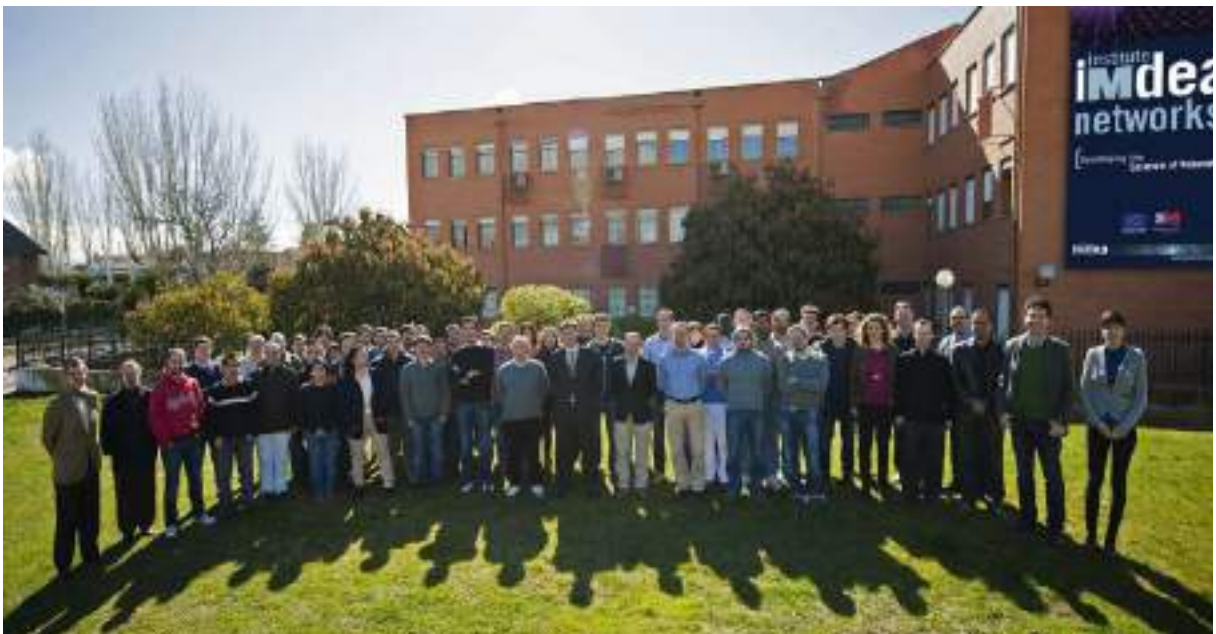
Pre-Doc Researchers:
- Nicola Bui
- Luca Cominardi
- Aymen Fakhreddine
- Fabio Giust
- Miriam Marciel
- Fovios Michelinakis
- Thomas Nitsche
- Vasileios Papadopoulos
- Pablo Salvador
- M. Isabel Sánchez
- Vincenzo Sciancalepore
- Gek Hong Sim
- Qing Wang

energy-efficient networking

Researchers:
- Dr. Marco Ajmone Marsan
- Dr. Antonio Fernández Anta
- Dr. Vincenzo Mancuso
- Dr. Balaji Rengarajan
- Dr. Gianluca Rizzo

Pre-Doc Researchers:
- Omar Ahmad
- Shahzad Ali
- Arash Asadi
- Jordi Arjona
- Angelos Chatzipapas
- Luis F. Chiroque
- Evgenia Christoforou
- Christian Vitale
- Elli Zavou

Our current team



administrative unit

The Institute is managed by the Director – Dr. Arturo Azcorra, the Deputy Director – Dr. Albert Banchs – and the General Manager - Mr. Alejandro Girod. They are accountable to the Board of Trustees to whom they report regularly.

They are supported by a small administration team who are dedicated to the efficient and effective achievement of the Institute's goals and to providing the levels of support required by its team of international researchers.

general manager

Alejandro GIROD ENTERRIA
General Manager

Qualifications: MBA. IE Business School. Madrid. Spain
Previous Position: Controlling and Strategic Planning Director at NEINVER Construction, promotion and retail. Madrid. Spain
Contact: alejandro.girod@imdea.org
Management and administration team

management and administration team

Rebeca DE MIGUEL
Operations Manager

Qualifications: Licenciatura en Ciencias de la Comunicación (Periodismo) (5-year degree in Communication Sciences (Journalism)). University of the Basque Country - UPV/EHU. Spain; BA (1st Class Hons) in History and Theory of Art & Film Studies. University of Kent at Canterbury. UK
Contact: rebeca.demiguel@imdea.org

Brian DUNNE
Human Resources Manager

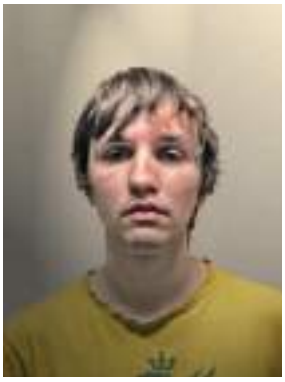
Qualifications: BBS in Business Studies and French. Trinity College Dublin. Ireland
Contact: brian.dunne@imdea.org

Ana GONZÁLEZ
Projects & Funding Manager

Qualifications: BA (Hons) "Modern European Studies". University of West London. UK; Postgraduate Diploma in "European Studies". University of West London. UK
Contact: ana.gonzalez@imdea.org

alumni network

The Institute's Alumni Network is built upon graduate Pre-doc Researchers who have obtained their Ph.D. and have left the team to further their research career in other organizations. Networking is about making contacts and building relationships. The alumni frame provides its members a supportive community of graduates who have shared experiences, values and goals that will last a lifetime. It also provides a venue through which former Pre-doc Researchers can maintain a long-term collaborative relationship with the Institute. Alumni are IMDEA Networks' ambassadors worldwide, creating awareness and opening up new communication channels with the global scientific community.



Michal KRYCZKA

Current Position: TGP Systems Integration Analyst. Accenture. Warsaw. Poland
Ph.D. Thesis: *Experimental analysis of the socio-economic phenomena in the BitTorrent ecosystem*
Ph.D. Date: Feb 2013
Ph.D. Supervisor(s): Dr. Arturo AZCORRA and Dr. Rubén CUEVAS

Marco GRAMAGLIA

Current Position: Researcher at Istituto Superiore Mario Boella. Turin. Italy
Ph.D. Thesis: *VANET-Based optimization of infotainment and traffic efficiency vehicular services*
Ph.D. Date: Sep 2012
Ph.D. Supervisor(s): Dr. María CALDERÓN PASTOR & Dr. Carlos Jesús BERNARDOS CANO

Alex BIKFALVI

Current Position: Post-doctoral Researcher and Engineer in Telecommunications at the Network Technologies and Strategies research group from Pompeu Fabra University. Barcelona. Spain
Ph.D. Thesis: *Peer-to-Peer Television for the IP Multimedia Subsystem*
Ph.D. Date: Jul 2012
Ph.D. Supervisor(s): Dr. Jaime GARCÍA-REINOSO

Paul PATRAS

Current Position: Chancellor's Fellow / Lecturer in the School of Informatics at the University of Edinburgh. Scotland
Ph.D. Thesis: *Control-Theoretic Adaptive Mechanisms for Performance Optimization of IEEE 802.11 WLANs: Design, Implementation and Experimental Evaluation*
Ph.D. Date: Mar 2011
Ph.D. Supervisor(s): Dr. Albert BANCHS

headquarters and research laboratories infrastructure

8.1. **Headquarters [121]**

8.2. **Research laboratories [121]**

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8.1. Headquarters

IMDEA Networks includes in its goals the provision of the highest international level of research and technology development capabilities geared to the advancement of future Internet technologies. Our headquarters aim to fulfill the functional requirements of a leading-edge research centre and to attract researchers from around the World.

The main objective of our office and lab space is to provide a high quality working environment for researchers. We are currently refurbishing our site at Avenida del Mar Mediterraneo in Leganes (Madrid) in order to furnish it with renovated and extended facilities. The new spaces are conceived primarily with researchers' needs and preferences in mind, including spacious premises with state-of-the-art facilities and equipment, labs adapted to the needs of our lines of research, with excellent communications and ICT infrastructure, and specific research equipment.

At our scientific laboratories we aim to transform our research results into high value-added products and services. They allow us to perform:

- The measurements and prototypes of the devices, protocols and algorithms developed by our researchers
- Simulations of highly complex baseband and medium access control systems, as well as sophisticated radio subsystems
- Radio parameter measurements involved in mobile and fixed communications and evaluation of effects on the radio spectrum of the new protocols and algorithms designed in the Institute
- The development and deployment of reliable, high-performance networked systems, of software defined networking, and of novel architectures and protocols for behavioral networking and for network economics

8.2. Research laboratories

In order to support cutting-edge research, **IMDEA Networks invests in the latest, state-of-the-art laboratories and laboratory test equipment**, endowing the Institute with the capacity of transforming research into high added value products and services.

Examples of the laboratories capabilities include:

8.2.1. Wireless Lab

- Analysis and processing of RF signals up to 7 GHz using the Agilent N9010 Signal Analyzer.

- Development of new baseband processing architectures using software-defined radio boards.

  These devices form a radio communication system where components that have been typically implemented in mixers, filters, amplifiers, modulators/demodulators, detectors, etc., are instead implemented by means of embedded computing devices, in particular Field Programmable Gate Arrays (FPGA).

- Development of experimental hardware routers using open and programmable platforms (NetFPGA).

  This equipment allows researchers to build high speed (gigabit) switches and IP router prototypes in hardware, on which to test experimental routing prototypes. This type of equipment is more realistic that the one based on the use of software only platforms.

- Research and development on mesh network topologies using Meshnode devices. These are programmable wireless nodes equipped with multiple radios that can provide network communication coverage for large areas.

- Optimization of WiMAX scheduling, queue management and cross-layer optimization using ARQ/HARQ. The newly developed algorithms are implemented on special WiMAX base stations provided by Albentia Systems under a collaborative agreement.
- The laboratories are supported by a high-performance scientific computing infrastructure consisting of a dedicated server cluster equipped with a Dell R710 (8 cores Intel Xeon E5640, 48 GB RAM, 6 TB local storage), a Dell C6100 (32 cores Intel Xeon E5640, 192 GB RAM, 24 TB storage local), and a Dell Equallogic PS610 (10 Gb/s Storage Arrays with 32 TB raw disk space).

Additionally, IMDEA Networks provides and runs an IT support infrastructure for telematic services that permits pervasive and easy access to information over different media, as well as providing the required hardware and software tools to facilitate daily operational activities, Network Research and security. It also provides telephone communications services with VoIP capability, videoconference, VPN remote secure connection, wireless access, intranet and document management systems.

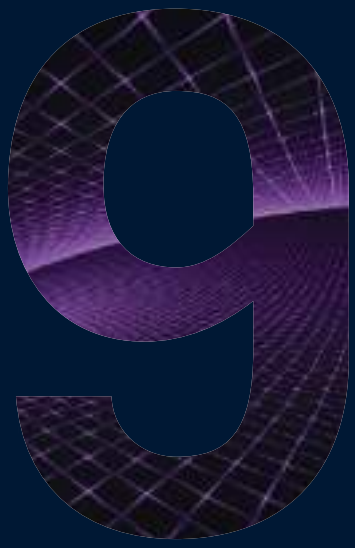
8.2.2. Networked Systems Lab

IMDEA Networks has recently updated its computing infrastructure with the following new equipment:

- A cluster of 12 servers with 12 cores, 96 GB RAM and 6 TB of hard disk space each for networked system simulations.
- 1 disk server with 24 TB of storage space
- 2 servers with 64 cores, 512 GB of RAM for system applications and Hadoop big data analytics.

All the equipment is interconnected via a 10 Gb/s high speed network.

organization



9.1. **Legal status** **[125]**

8.2. **Governing bodies & organizational structure** **[125]**

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9.1. Legal status

IMDEA Networks Institute was legally constituted under Spanish law at the end of 2006 as a public, not-for-profit Foundation. It is governed by a Board of Trustees, consisting of representatives from the various stakeholders in the Institute.

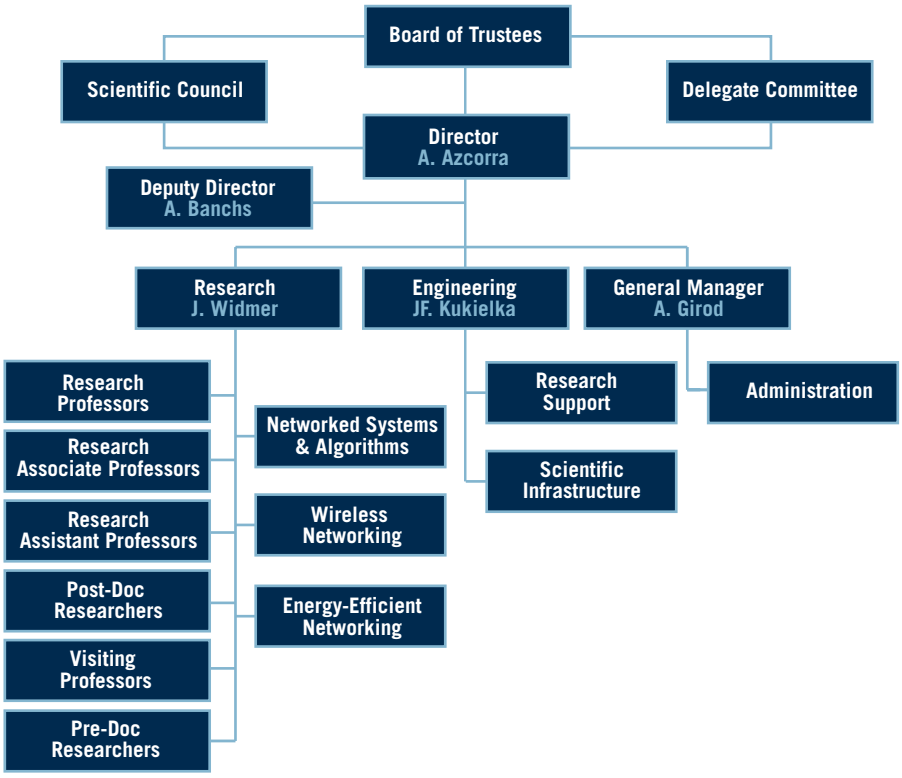
The full, registered name of the Institute is **"Fundación IMDEA Networks"**. The Institute is registered in the Register of Foundations of the Autonomous Region of Madrid (*Registro de Fundaciones de la Comunidad de Madrid*), personal sheet number 476.

Our Spanish tax identification number (CIF) is G-84912708.

IMDEA Networks' registered address is:
Avenida del Mar Mediterraneo, 22
28918 Leganes, Madrid
Spain

9.2. Governing bodies & organizational structure

9.2.1. Organizational structure



9.2.2. Board of Trustees

The Board of Trustees of IMDEA Networks Institute is its highest organ of governance, representation and administration. In accordance with the Institute's statutes, the Board of Trustees is composed of Ex Officio Members representing the Regional Government of Madrid and Elective Members who are recognized leaders in the scientific matters of the Institute. The Director and General Manager of the Institute also participate in the Board of Trustees.

President: **Prof. Dr. Ralf Steinmetz** **Vice-President:** **Excma. Sra. Dª. Lucía Figar de Lacalle**

EX OFFICIO TRUSTEES

Excma. Sra. Dª. Lucía Figar de Lacalle
Vice-President of the Board of Trustees
Regional Government Secretary for Education, Youth and Sports. Department of Education, Youth and Sports. Regional Government of Madrid (Madrid, Spain)

Ilma. Sra. D.ª Rocío Albert López-Ibor
Director General of Universities and Research. Directorate General of Universities and Research. Department of Education, Youth and Sports. Regional Government of Madrid (Madrid, Spain)

Ilmo. Sr. D. Juan Ángel Botas Echevarría
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Ilmo. Sr. D. José María Rotellar García
Vice Counselor of the Treasury. Vice Council of the Treasury. Department of Economy and Treasury. Regional Government of Madrid (Madrid, Spain)

Sr. D. José de la Sota Ríus
General Manager. Madrimasd Foundation for Knowledge (Madrid, Spain)

ELECTIVE TRUSTEES - PRESTIGIOUS SCIENTISTS

Prof. Dr. Ralf Steinmetz
President of the Board of Trustees
Full Professor & Managing Director of Multimedia Communications Laboratory (KOM). Technische Universität Darmstadt (Darmstadt, Germany)

Prof. Dr. Hari Balakrishnan
Fujitsu Professor, Department of Electrical Engineering & Computer Science. Massachusetts Institute of Technology (Massachusetts, USA)

Prof. Dr. Jim Kurose
Distinguished University Professor, Department of Computer Science. University of Massachusetts Amherst (Massachusetts, USA)

Dr. Huw Oliver
Former Technical Director, European Research Consortium. Hewlett-Packard Laboratories (Bristol, United Kingdom)

Prof. Dr. Ioannis Stavrakakis
Full Professor & Head of the Department of Informatics and Telecommunications. National and Kapodistrian University of Athens (Athens, Greece)

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Designated Representative
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Hewlett-Packard
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Ms. Irma Jiménez Guler
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INDRA
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Mr. José Luis Angoso González
Director of Innovation

SATEC
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President

TELDAT
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Dr. Juan Mulet Meliá
Director General
COTEC Foundation for Technological Innovation
(Madrid, Spain)

Mr. Carlos Nieva Martínez
Director of Tactical Planning and Implementation
Ericsson
(Madrid, Spain)

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(Madrid, Spain)
Designated Representative
Prof. Dr. Carlos Balaguer Bernaldo de Quirós
Vice-Rector of Research

Universidad Autónoma de Madrid
(Madrid, Spain)
Designated Representative
Prof. Dr. Javier Ortega García
Professor of Signal Theory and Communications
Higher Polytechnic School (Escuela Politécnica Superior)

Universidad Nacional de Educación a Distancia
(Madrid, Spain)
Designated Representative
Prof. Dr. Sebastián Dormido Bencomo
Professor of Systems and Automation Engineering
Higher Polytechnic School of Computer Science (Escuela Técnica Superior de Ingeniería Informática)

Universidad de Alcalá
(Madrid, Spain)
Designated Representative
Prof. Dr. Juan Ramón Velasco Pérez
Vice-Rector of Postgraduate Studies and Continuing Education

9.2.3. Scientific Council

The Scientific Council is a very important organ of IMDEA Networks, advising us on all aspects of the Institute's scientific activities. Among many other things, the Council proposes the incorporation and renewal of Scientific Expert members of the Board of Trustees; reviews and approves scientific appointments, and generally provides support to the Director and the Deputy Director in determining scientific research strategy and policies.

The Institute's Scientific Council is composed of internationally-prestigious researchers in the field of Telematics and Internet technologies. IMDEA Networks is greatly strengthened by the participation of these eminent scientists. The current members are:

Prof. Dr. Hari BALAKRISHNAN
Fujitsu Professor at the Department of Electrical Engineering & Computer Science, Massachusetts Institute of Technology. Massachusetts. USA

PhD: University of California, Berkeley. Berkeley. USA
Research: Networked Computer Systems, spanning Overlay and Peer-to-Peer Networks; Network Protocols and Architecture; Wireless and Sensor Networks, and Distributed Data Management

Dr. Gonzalo CAMARILLO
Standardization Director, Ericsson. Finland

PhD: Aalto University. Helsinki. Finland
Research: Signaling; Multimedia Applications; Transport Protocols; Network Security; Networking Architectures

Prof. Dr. Jon CROWCROFT
Marconi Professor of Communication Systems at University of Cambridge. Cambridge. UK

PhD: University College London. UK
Research: Opportunistic Communications; Privacy in the Cloud; Carbon Neutral Networking

Prof. Dr. Gustavo DE VECIANA
Joe J. King Professor of Electrical and Computer Engineering at The University of Texas at Austin. USA

PhD: University of California, Berkeley. USA
Research: Analysis and Design of Wireless and Wireline Telecommunication Networks; Architectures and Protocols to Support Sensing and Pervasive Computing; Applied Probability, Queuing and Information Theory

Prof. Dr. Edward KNIGHTLY

Professor of Electrical and Computer Engineering at Rice University. Houston. Texas. USA

PhD: University of California at Berkeley. Berkeley. USA
Research: Wireless Networks and Protocols; Wireless Access for Developing Regions; Dynamic Spectrum Access Networks

Prof. Dr. Jim KUROSE

Distinguished University Professor at the Department of Computer Science, University of Massachusetts Amherst. Massachusetts. USA

PhD: Columbia University of New York City. Nueva York. USA
Research: Network Protocols and Architecture; Network Measurement; Sensor Networks; Multimedia Communication; Modeling and Performance Evaluation

Dr. Huw OLIVER

Former Technical Director, European Research Consortium, Hewlett-Packard Laboratories. Bristol. UK

PhD: University College Aberystwyth. Aberystwyth. UK
Research: Computer & Network Security; Wireless OSS; Wireline Core and Access Networks

Dr. Pablo RODRIGUEZ RODRIGUEZ

Innovation and Research Director, Telefonica Digital. Spain; Director, Barcelona Telefonica R&D Lab. Spain; Adjunct Faculty Professor, Department of Computer Science, Columbia University of New York City. USA

PhD: École Polytechnique Fédérale de Lausanne (EPFL). Lausanne. Switzerland
Research: Networking; Distributed Systems; Information Theory; Wireless and Mobile; Network Economics; Social Networks

Prof. Dr. Ioannis STAVRAKAKIS

Full Professor & Head of the Department of Informatics and Telecommunications at National and Kapodistrian University of Athens. Athens. Greece

PhD: University of Virginia. Charlottesville. USA
Research: Resource Allocation Protocols and Traffic Management for Communication Networks, with recent emphasis on Peer-to-Peer, Mobile, Ad hoc, Autonomic and Social Networking

Prof. Dr. Ralf STEINMETZ

President of Board of Trustees of IMDEA Networks Institute; Full Professor & Managing Director of Multimedia Communications Lab (KOM) at Technische Universität Darmstadt. Darmstadt. Germany

PhD: Technische Universität Darmstadt. Germany
Research: Networked multimedia issues with the vision of "seamless multimedia communications"; i.e. network dependability and security (e.g. gateways, firewalls); quality of service (e.g. network engineering); content distribution networks (e.g. streaming); context aware communications (e.g. peer-to-peer mechanisms); media semantics (e.g. ontology enrichment, metadata). He relates these research issues often very closely to mobility, internet telephony, telemedia learning and serious gaming

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IMDEA Networks Institute

edition & text coordinator
Rebeca de Miguel

graphic design
base 12 diseño y comunicación

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