



# imdea networks institute

developing the **science of networks**

institute  
**iM**dea  
networks

## a n n u a l   r e p o r t

# 2014

f o r e w o r d

# foreword



**Arturo Azcorra**

Director of the IMDEA Networks Institute

April 2015

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IMDEA Networks Institute is a world reference in the Science of Networks and in Communications Technology. The Institute has put together a team of top scientists in the area of networking that is contributing to boost Madrid's competitiveness as a technology-oriented region. In addition to strengthening the technology profile of the region, IMDEA Networks' collaboration with local companies is helping to further enhance Madrid's high-tech output with cutting edge research. Moreover, 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 € 13.8m from competitive funds of which € 1.9m were budgeted for 2014. We believe that Madrid will make its mark on the 21st Century precisely by focusing on the development of products and services that incorporate the most advanced communication technologies.

IMDEA Networks focuses on an area that has a profound impact on people's lives. Internet, smartphones, Wi-Fi or social networks exemplify the profound impact of networks in society and the economy. The widespread access to networks has dramatically changed the way manufacturers produce and supply their goods, how public administrations operate, how professionals work and in general how individuals and society are shaped. The Internet socio-economic phenomenon continues to transform our lives at an amazing pace.

One of the key challenges that the Internet is facing nowadays is the rapid growth in the volume of mobile data traffic. Current wireless systems already operate close to their theoretical limits which requires a solution so the demands of the rapidly increasing data traffic volume are met.

At IMDEA Networks we are working on one of the most promising options to address the above challenge which is to increase the communication bandwidth by using the extremely high frequency band of the radio spectrum: the millimeter wave band (mm-wave). While able to support data rates that are several orders of magnitude larger than those of today's networks, communication at such high

frequencies is very challenging. It requires radically different mobile network architectures and protocols that can deal with such a dynamic environment where channels may appear and disappear over very short time intervals. Investigating efficient communication paradigms for extremely high frequency networks is a primary research focus for the Institute. This research will have a profound impact on future mobile and wireless communications' products and solutions.

IMDEA Networks has established itself as one of the world leaders on this groundbreaking technology. One of our Research Professors was awarded an ERC Consolidator Grant to work on this research area. We have also set up a very advanced experimental testbed for this technology that provides us with a unique setting to evaluate the performance of our proposals. We are designing novel and disruptive algorithms which we are patenting and publishing at top venues. And we are planning to further increase our activities on this technology as this is one of the core areas of the upcoming 5G PPP projects in which IMDEA Networks is highly involved. We are confident that our bet on this technology will be rewarded with a truly unique scientific and commercial impact in the near future.

In addition to the above achievements, 2014 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 talent to the team, the launch of new research projects and grants, as well as the effective transfer of technology, amongst others. Among our achievements, I would like to highlight the strengthening of strategic partnerships with ZED Worldwide, Telefonica and Cisco Systems which are incorporating our algorithms and developments into their commercial products. All these achievements contribute to make the Institute one of the leading networking research laboratories in the world.

My gratitude goes to the Regional Government of Madrid for its continued 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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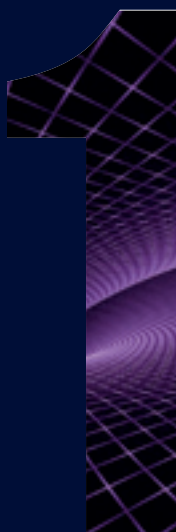
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# executive summary



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**IMDEA Networks Institute is a top international research centre in the area of networking.** 2014 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.

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.

Our scientists do not only have an excellent research record, 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 50 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 2014 the Institute graduated two new Ph.D. Students, Dr. Andra Lutu and Dr. Shahzad Ali, both of whom received the maximum distinction in their Ph.D. defense. It is worth highlighting that many of our Ph.D. students have received important distinctions and have been awarded very selective scholarships. For instance, this year, two of our Pre-doc Researchers were awarded an FPU grant.

In 2014, **the Institute has continued to reinforce its research team**. We had 2 openings for researcher positions, which received 54 high quality applications from 19 different countries. These positions were awarded to Dr. Paolo Casari and Dr. Kirill Kogan, both of



whom are outstanding and widely recognized researchers who have an excellent research record and have worked for top academic and industrial labs, such as MIT, University of Padova, Purdue University and Cisco. We also received a large number of applications (over 450) for our open Pre-doc Researcher positions, out of which 8 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 2014 is composed of **46 researchers from 16 countries at different stages of their research careers.**

A key accomplishment of 2014 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 12 projects**, which is a notable quantity considering the size of the Institute. Out of these 12 projects, 9 are European and 3 have a regional scope. During 2014, 3 regional projects (TIGRE5, BRADE and Cloud4BigData) and 4 European projects (SEARCHLIGHT, TEAM, NetIDE, ATOMICDFS) were awarded to the Institute in highly competitive calls. In 2015, another 5 European projects (MONROE, ReCRED, TYPES, mmMAGIC and Flex5ware) have been awarded.

Within the participation in projects, it is worthwhile highlighting the activity of the Institute in 5G. Currently, Europe is making a large bet on 5G technology by targeting a new partnership initiative, the **5G Public-Private-Partnership or 5G PPP**, which has a budget of around 4 billion euro, 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. The **iJOIN project**, which is coordinated by the Institute's Deputy Director, is one of the flagship European projects in the area of 5G and **has been showcased at the 5G booth of the European Commission during the Barcelona Mobile World Congress 2015**. The CROWD project, whose technical manager is one of our researchers, has been selected by the European Commission as one of the early 5G precursor projects. And the Institute's director has been voted onto the Steering Board of the European Technology Platform responsible for the coordination of the 5G PPP initiative.

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**. IMDEA Networks is currently working on 4 projects funded by industry (Armasuisse – Science and Technology, Telecom Italia, Zendos Technologies and Cisco Systems, respectively). 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. During this period, a tool for big data analysis for commercial use has been developed for ZED and a Joint Research Unit (JRU) in 5G technologies has been signed with Telefonica I+D. In addition to these, the Institute has also strong ties with other national and international companies. It is worth highlighting the collaboration with **Cisco Systems**, which is funding a research team at the Institute and has incorporated algorithms developed by this team into its products.

**The efforts made by our team to produce outstanding scientific work led to a large number of scientific publications in 2014.** However, rather than their quantity, we would like to emphasize their quality. In 2014 IMDEA Networks published 5 papers at ACM CoNEXT and 5 papers at IEEE INFOCOM, being one of the very few institutions worldwide with this number of publications at such prestigious conferences. Additionally, papers from IMDEA Networks received important awards at other top conferences, namely the best paper award at IEEE WoWMoM and the runner-up award at both IEEE ICNP and IEEE WoWMoM.

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 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 provided by Google Scholar. According to this data, the Institute's researchers have received more than **38.000 citations** in total, which corresponds to an **H index of 89** (meaning that 89 of the articles published by researchers of the Institute have received 89 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 as commercial products. Research performed at IMDEA Networks during 2014 has had a sizable impact. Our researchers have been particularly active on this front, and some of their ideas have been standard-

ized at the IETF (which is the body responsible for standardizing Internet technology) and patented (4 patent applications were filed in 2014). 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 2014, IMDEA Networks refurbished 600 additional square meters of the building, which a total of 4,000 square meters out of which 1,400 have been completely refurbished. These facilities host the most advanced equipment to evaluate and emulate the performance of the algorithms, protocols and systems developed by the Institute. This equipment has been partly funded by the Spanish Ministry of Economy and Competitiveness and by European Funds. These facilities include laboratories on Interdomain Routing, Wireless Communications, Millimeter Wave, 5G Networks and Underwater Networks.

In **summary**, the Institute's **research output** in 2014 comprises publications in book chapters (1), peer-reviewed international journals and magazines (34), presentations in international conferences (47), funded research projects (17), industry contracts (8), standardization contributions (7) and patents (3). 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. If we consider the Institute's **output in relative terms to the number of faculty researchers** (i.e., performance per faculty member and per year), the outcome is even more remarkable: in 2014 the Institute raised € 297,000/researcher\*year, published 8 papers/researcher\*year, had 1.8 ongoing projects/researcher\*year and filed 0.4 patents/researcher\*year.





a b o u t u s



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## 2.1. Profile

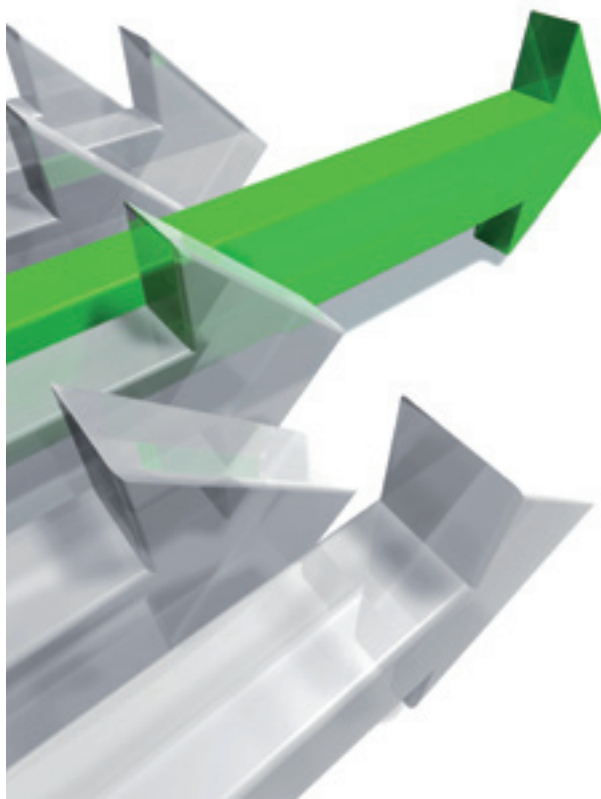
IMDEA Networks Institute is a networking research organization whose multinational team is engaged in cutting-edge fundamental science. As a growing, English-speaking Institute located in Madrid, Spain, IMDEA Networks offers a unique opportunity for pioneering scientists to develop their ideas. IMDEA 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 development** 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*

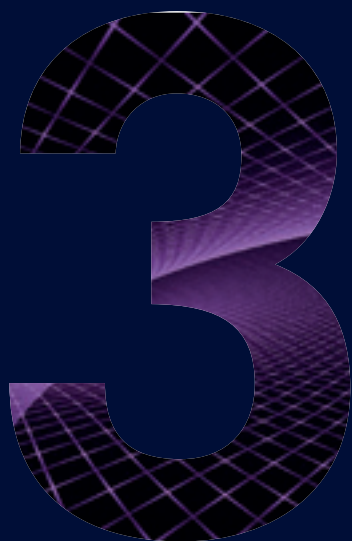
- To compete sportingly across the globe  
*We compete fairly but intensely, according to the letter and spirit of accepted standards.  
Competition drives us to be the best and most successful in our field*
- To enjoy our work  
*We enjoy what we do and share our enjoyment with each other*

## 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 three general areas presented in the following.**

### 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

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 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



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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 was executed in IMDEA Networks from November 2012 to June 2014*
- Dr. Joerg WIDMER, Research Professor (**ERC Consolidator Grant**)  
Principal Investigator of the **SEARCHLIGHT** research project

### Funded by

European Union. European Research Council (ERC Grants)



European Research Council  
Established by the European Commission

## “MARIE CURIE” AMAROUT II Europe Programme

### Awardee

- Dr. Domenico GIUSTINIANO, Research Assistant 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 Professor
- **Name of researcher** Dr. Nicolas NICOLAOU, Post-Doc Researcher

### 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

- Evgenia CHRISTOFOROU, 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



### SEARCHLIGHT

*A new communication paradigm for future very high speed wireless networks*

**Funded by:** European Union. European Research Council (Consolidator Grant)

**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**. Very high bandwidth channels are only available in the extremely high frequency part of the radio spectrum, the millimeter wave band (mm-wave). Upcoming communication technologies, such as the IEEE 802.11ad standard operating at 60GHz, are already starting to exploit this 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 the mm-wave band from 30 to 300GHz. 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.**

## Cloud4BigData

*Efficient Cloud and BigData Infrastructure*

**Project website:** [lsd1.ls.fi.upm.es/cloud4bigdata/](http://lsd1.ls.fi.upm.es/cloud4bigdata/)

**Funded by:** Department of Education, Youth and Sports of the Regional Government of Madrid, through the 2013 R&D technology program for research groups, co-financed by Structural Funds of the European Union

**Duration:** October 2014 to September 2018

**Project partners:** IMDEA Networks Institute, Universidad Politécnica de Madrid (UPM), Universidad Rey Juan Carlos



**Big Data is an emerging paradigm for large scale distributed data management that aims at being able to process large amounts of data beyond the possibilities of traditional database technologies.** Big Data leverages cloud computing to attain a highly scalable infrastructure for both computing and storage. The Cloud4BigData project will **enhance Big Data technologies and also their underlying cloud infrastructure** to attain high levels of efficiency, flexibility, scalability, high availability, QoS, ease of use, security and privacy.

Big Data is already attaining good results with batch analytical processing technologies such as MapReduce, but it has important gaps. The most important issue is the lack of support for other data management needs, namely, Online Transactional Processing (OLTP), Online Analytical Processing (OLAP) and Complex Event Processing (CEP). In Cloud4BigData we aim at providing full Big Data support for OLTP, OLAP and CEP. This implies overcoming important challenges such as scaling transactional processing, analytical query processing and complex event processing as well as the integration of these technologies in a single unified platform. What is more, many Big Data applications require the use of a combination of cloud Big Data technologies specialized for different purposes such as graph databases, key-value data stores, document-oriented databases, SQL databases, in-memory databases, column-oriented data stores, CEP, etc. **Cloud4BigData aims at providing holistic support to ease the development of Big Data applications on top on diverse cloud Big Data stores.**

## BRADE-CM

*BRAin inspired Data Engineering*

Project website: [www.brade-cm.es](http://www.brade-cm.es)

**Funded by:** Department of Education, Youth and Sports of the Regional Government of Madrid, through the 2013 R&D technology program for research groups, co-financed by Structural Funds of the European Union

**Duration:** October 2014 to September 2018

**Project partners:** IMDEA Networks Institute, Universidad Carlos III de Madrid, Universidad Complutense de Madrid, Fundación para la investigación Biomédica del Hospital Gregorio Marañón

In recent years there have been multiple examples of **bio-inspired systems**, which have eased progress in different ICT areas. Some examples are neuronal networks for learning systems or ant algorithms used to trace optimal paths in communication networks. In this context, recent advances in data acquisition techniques about the brain's anatomic-functional organization (for both humans and animals) have allowed the scientific community to start analyzing and understanding the brain's structure and its cognitive and transmission processes. This offers a unique opportunity for the **design of novel ICT systems inspired by the brain's structure, as well as by its cognitive and adaptive processes**. Recently, some of the main companies in the ICT sector such as IBM, Qualcomm or Intel have launched pioneering projects for the design of brain-inspired ICT systems, which indicates the importance of this research line for the ICT sector.

The current project represents an effort in this research line, which is both characterized by being ground-breaking and multidisciplinary. In particular, the BRADE consortium aims to contribute to it through the development of tools that promote an advance towards the **design of computation and information processing systems for large-scale data-sets (i.e., Big Data), based on the processing mechanisms used by the brain**. In order to achieve this objective, novel experimental techniques, specific instrumentation and sophisticated software will be used in order to extract and process information about the brain's anatomic-functional organization and its cognitive processes. Subsequently,



complex networks theory will be applied to the analysis of the processed data in order to elaborate analytical and simulation models of the brain's organizational structure and functional processes. These models will constitute the basis for the study and design of the aforementioned brain-inspired computation and information processing systems. In addition, these models will be a contribution of great interest and with direct application in neuroscience, contributing to expand current knowledge about the brain's organizational structure and cognitive processes.

It should be highlighted that the research teams from the different institutions making up the BRADE consortium present a combination of knowledge and strongly multidisciplinary experience in the fields of neuroscience, the development of imaging instrumentation, the modeling of complex systems and networks, and the design of information processing ICT systems. This background provides serious guarantees for the successful completion of the BRADE project.

Furthermore, the project counts with the support and collaboration of well known national and international companies as well as universities within the ICT sector. These companies provide experience in the design of information processing systems (Alcatel Lucent Bell Labs, IBN, ZED Worldwide and Medianet), the modeling of complex systems and networks (Telefonica R&D, Orange Labs and the Computer Lab at the University of Cambridge), and the development of imaging instrumentation (4DNature). Moreover, the Network for Biomedical Mental Health Research (*CIBERSAM - Centro de Investigación Biomédica en Red en Salud Mental*), which brings together some of the most prestigious Spanish research groups in the field of neuroscience, also collaborates on this project.

The research groups that are working on this project are the BDA group from IMDEA Networks Institute, the NETCOM Group from University Carlos III of Madrid, the NEUROCOM group from the Complutense University of Madrid and the BiiG group from the Foundation for Biomedical Research of the Gregorio Marañón Hospital (*Fundación para la investigación Biomédica del Hospital Gregorio Marañón*).







## TIGRE5-CM

*Tecnologías Integradas de gestión y operación de REd 5G (Integrated technologies for management and operation of 5G networks)*

*IMDEA Networks Institute is the Project Coordinator*

Project website: [www.tigre5-cm.es](http://www.tigre5-cm.es)

**Funded by:** Department of Education, Youth and Sports of the Regional Government of Madrid, through the 2013 R&D technology program for research groups, co-financed by Structural Funds of the European Union

**Duration:** October 2014 to September 2018

**Project partners:** IMDEA Networks Institute, Universidad Carlos III de Madrid, Universidad de Alcalá

The aim of the TIGRE5-CM project is **to design an architecture for future generation mobile networks, based on the SDN (Software Defined Networking) paradigm**, which simplifies the deployment, configuration and management of the network while integrating the latest technologies, both in the access network (reaching the end-user's terminal) and in the core network.

Having first identified the requirements of mobile network operators (basically lower operating costs, higher performance, flexibility, resiliency and network interoperability), the TIGRE5-CM project aims to tackle these issues through **a combination of the state of the art in wireless technologies with the SDN paradigm**. The technical and scientific challenges to be addressed are various and multidisciplinary, and they include: wireless networks, switched and data transportation networks, and next-generation optical network technologies. In order to better meet these demands, the project team is composed of four research groups with complementary knowledge of the technologies needed to complete the project.

The objectives addressed by TIGRE5-CM are the following:

- The design of an SDN network controller, including its interfaces, for 5G networks;
- the design of mechanisms for the monitoring, supervision, and protection of the control network;
- the development of mechanisms to optimize network resource efficiency, based on traffic measurement and predictions of traffic demand;
- the development of advanced switching and transportation technologies based on generic multilayer Ethernet switches and on "all optical" transport networks with quality of service support;
- the flexibility and controllability of the user terminal by the network.

This will result in a **high performance integrated architecture**, with a control plane and a data plane that support a flexible, high performing network, at moderate cost, which is also configurable and programmable, robust and interoperable, and preferably built from open source hardware and software.

Upon completion, the main results of the project are expected to be:

1. contributions to the state of the art with publications in top journals and conferences
2. contributions to standardization activities on new 5G network technologies at organizations such as the IEEE, the IETF, etc.
3. development of testbeds that highlight the main contributions of TIGRE5-CM as well as future improvements that go beyond the project's end date;
4. collaboration with regional industrial partners to foster their leadership in 5G technologies

The research groups that are working on the TIGRE5-CM project are the WNG group from IMDEA Networks Institute, the WNL Group and the ADSCOM Group from University Carlos III of Madrid and the GIST group from the University of Alcalá.

## TEAM

*Technologies for information and communications, Europe – east Asia Mobilities*

*IMDEA Networks Institute is an Associated Partner in this project*

**Project website:** [www.team-mundus.eu](http://www.team-mundus.eu)

**Funded by:** European Union – ERASMUS Mundus Programme

**Duration:** July 2014 to July 2018

**Project partners:** Korea Advanced Institute of Science and Technology, Nara Institute of Science and Technology, Technische Universität Berlin (TUB), Universidad Carlos III de Madrid, Università Degli Studi Di Trento, The University of Tokyo, Graduate School of Information Science and Technology, Aalto-Korkeakoulusaatio, Chungnam National University, Eotvos Lorand Tudományegyetem, Gwangju Institute of Science and Technology, Keio University

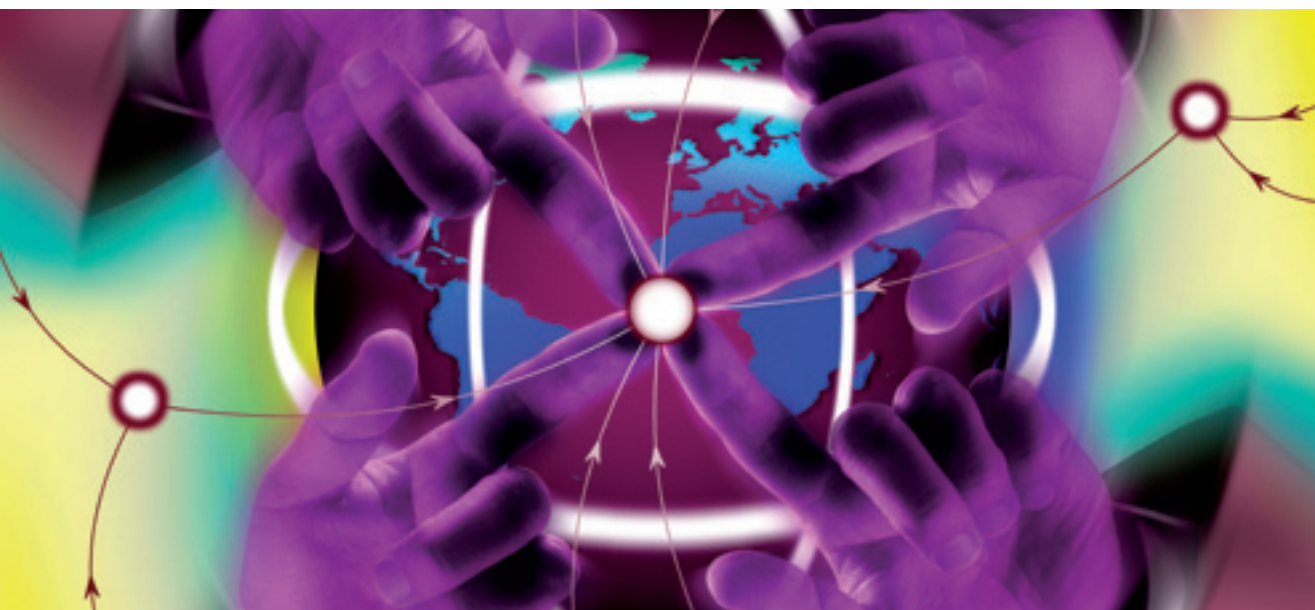
**Associated partners:** Centre National de la Recherche Scientifique, Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V., IMDEA Networks Institute, Institut National de Recherche en Informatique et en Automatique, Inter-University Research Institute Corporation Research Organization of Information and Systems, Korea Institute of Science and Technology Information, National Institute of Information and Communications Technology, Netvision Telecom, Technicolor R&D, Teknologian Tutkimuskeskus VTT, Virtual I Tech Inc.



The objective of the **International Cooperation between East Asia and Europe project**, known as TEAM (Technologies for Information and Communication, Europe – East Asia Mobilites), is to **promote institutional cooperation and mobility activities between European and East Asian Higher Education Institutions (HEIs)**. The project is coordinated by Université Pierre et Marie Curie (France).

The TEAM partnership brings together world class institutions with complementary experiences and knowledge in Information and Communication Technologies (ICT) with the common goal of **creating a network of excellence in ICT between Europe, Japan and Republic of Korea**, as well as to **innovate in doctoral training**. Through academic cooperation and exchanges, the partnership endeavors to work together as a team to develop new and innovative technologies, to enhance career prospects of young researchers and competitiveness of researchers, to promote intercultural understanding and to increase the attractiveness of European higher education.

ICT is an ever developing field of research and innovation and a key factor for economic growth. Therefore, strong expectations are placed on research and innovation in ICT to deliver solutions for societal challenges, ensuring our future. Nevertheless, the participating countries, all leaders in ICT, recognize a present and upcoming deficit of skilled and internationally oriented young talents for academia and industry. This Erasmus Mundus project will create the TEAM community of individuals and partners of higher education, research and industry, capable of adapting and working as an international TEAM. Thus it will enjoy an undeniable advantage in today's rapidly changing world.



## NetIDE

*An integrated development environment for portable network applications*



**Project website:** [www.netide.eu](http://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, Procerca), 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 the different representation 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.**



# ATOMICDFS

*Seeking Efficient Atomic Implementations of Distributed Data Storage*

Project website: <http://atomicdfs.networks.imdea.org/>

Funded by: Marie Curie Intra-European Fellowship (IEF) for Career Development. European Union. ICT Programme FP7

Scientist in charge: Dr. Antonio Fernández Anta

Name of researcher: Dr. Nicolas Nicolaou

Duration: December 2014 to November 2016

**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 the system detects 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.**



## CROWD

*Connectivity management for eneRgy Optimised Wireless Dense networks*



**Project website:** [www.ict-crowd.eu](http://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, heterogeneous 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](http://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, Università di Bologna, Centre for Research and Technology Hellas, Consiglio Nazionale delle Ricerche (CNR), École Polytechnique Fédérale de Lausanne (EPFL), Eidgenössische Technische Hochschule Zürich, 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 Netherlands 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, Université De Savoie, Université 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.





## iJOIN

*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](http://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.

## eCOUSIN

*enhanced COntent distribUtion with Social INformation*



**Project website:** <http://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.

### Redes energéticamente eficientes (Energy Efficient Networks)

Project partners: IMDEA Networks Institute, Universidad Carlos III de Madrid

On the one hand, we will 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. Particular 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 will address the energy efficiency at the application layer with a mixture of theoretical, simulation and Internet measurement techniques. We will 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.



## PROPHET

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

**Funded by:** European Union. European Research Council (Starting Grant)

**Duration:** February 2011 to June 2014. *This project was executed in IMDEA Networks from November 2012 to June 2014.*

**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.

## 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](http://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 program 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

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

**Project website:** [www.medianet-cm.es](http://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**.





#### 4.2.1. Projects commencing in 2015

### ReCRED

*From Real-world Identities to Privacy-preserving and Attribute-based CREDENTIALs for Device-centric Access Control*

**Funded by:** European Union. ICT Programme H2020

**Duration:** May 2015 to May 2018

**Project partners:** University of Piraeus Research Center, Telefónica Investigación y Desarrollo SA., Verizon Nederland B.V., certSIGN S.A., Wedia Limited, Exus Software Ltd., Upcom BvBa, De Productizers B.V., Cyprus University of Technology, Universidad Carlos III de Madrid, Consorzio Nazionale Interuniversitario per le Telecomunicazioni, Studio Professionale Associato a Baker & McKenzie, IMDEA Networks Institute

**ReCRED's ultimate goal is to promote the user's personal mobile device to the role of a unified authentication and authorization proxy towards the digital world.** ReCRED adopts an incrementally deployable strategy in two complementary directions: extensibility in the type and nature of supported stakeholders and services (from local access control to online service access), as well as flexibility and extensibility in the set of supported authentication and access control techniques; from widely established and traditional ones to emerging authentication and authorization protocols as well as cryptographically advanced attribute-based access control approaches.

**Simplicity, usability, and user privacy** is accomplished by: i) hiding inside the device all the complexity involved in the aggregation and management of multiple digital identifiers and access control attribute credentials, as well as the relevant interaction with the network infrastructure and with identity consolidation services; ii) integrating in the device support for widespread identity management standards and their necessary extensions; and iii) controlling the exposure of user credentials to third party service providers.

**ReCRED addresses key security and privacy issues such as resilience to device loss, theft and impersonation**, via a combination of: i) local user-to-device and remote device-to-service secure authentication mechanisms; ii) multi-factor authentication mechanisms based on behavioral and physiological user signatures not bound to the device; iii) usable identity management and privacy awareness tools; iv) usable tools that offer the ability for complex reasoning of authorization policies through advanced learning techniques. ReCRED's viability will be assessed via four large-scale realistic pilots in real-world operational environments. The pilots will demonstrate the integration of the developed components and their suitability for end-users, so as to show their TRL7 readiness.





**Funded by:** European Union. ICT Programme H2020

**Duration:** March 2015 to February 2018

*The commencement date is to be confirmed. The project will have a total duration of 36 months.*

**Project partners:** Simula Research Laboratory AS, IMDEA Networks Institute, Karlstads Universitet (KAU), Politecnico di Torino (PolITO), GOWEX WIRELESS, S.L., Celerway Communication AS, Telenor ASA, Netett Sverige AB

There is a strong need for **objective data about stability and performance of Mobile Broadband (MBB) networks**, and for tools to rigorously and scientifically assess their performance. In particular, it is important to measure and understand the quality as experienced by the end user. Such information is very valuable for many parties including operators, regulators and policy makers, consumers and society at large, businesses whose services depend on MBB networks, researchers and innovators.

**MONROE proposes to design, build and operate an open, European-scale, and flexible platform with multi-homing capabilities to run experiments on operational 3G/4G Mobile Broadband networks.** One of the main objectives of MONROE is to use the platform for the identification of key MBB performance parameters, thus enabling accurate, realistic and meaningful monitoring and assessment of the performance of MBB networks. MONROE also provides Wi-Fi connectivity mimicking multi-homing in smartphones with both MBB and Wi-Fi interfaces, to allow experimenting on different access technologies as well as explore new ways of combining them to increase performance and robustness.

The users of the platform are in the core of the MONROE project. First, following **FIRE**'s philosophy, MONROE offers a user-oriented closed-loop system design in which the experimental platform is open to external users, and where users are incorporated early on in the experimental design process. Second, MONROE will provide Experiments as a Service (EaaS), thus lowering the barrier for using the platform to external experimenters and users, by providing well-documented tools and adjustable, flexible, high-level scripts to execute experiments, collect results, and analyze data.

Interoperability with existing FIRE and FP7 measurement platforms, jointly with the MONROE's effort to develop business and funding models, will guarantee sustainability and usefulness of the platform.

*\* **FIRE (Future Internet Research and Experimentation)** was an initiative within the Seventh Framework Programme of the European Union (FP7) (see <http://www.ict-fire.eu/home/the-fire-landscape.html>). FIRE projects were aimed to develop an experimental platform to be directly used by third parties (i.e. not only by project participants). In H2020 FIRE+ been introduced to build upon the previous FIRE initiative. MONROE is a FIRE+ project.*

## TYPES

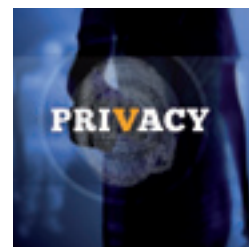
*Towards transparency and Privacy in the online advertising business*

**Funded by:** European Union. ICT Programme H2020

**Duration:** May 2015 to November 2017

**Project partners:** Fundació Barcelona Media – Yahoo Labs, Telefonica Investigación y Desarrollo, NEC Europe Ltd., WEDIA Limited, IMDEA Networks Institute, The Open University of Israel, Universidad Carlos III de Madrid, Internet Advertising Bureau Europe, UPCOM Bvba, Asociación de Usuarios de Internet

**Online advertising** generated in 2013 \$42B worth of revenue and more than 3.4 million direct and indirect jobs in Europe in 2012 alone. **It supports some of the most important Internet services such as search, social media and user generated content sites.** However, the lack of transparency regarding tracking techniques and the type of information companies collect about users is creating increasing concerns in society. Software tools for implementing total mitigation (e.g., ad blocker or cookies blocker) have been released to block any transfer of information from end users towards the online advertising ecosystem. A massive adoption of these tools by end users may cause disruptions in the digital economy by affecting the online advertising sector and leading to consequences such as losing of a large number of employments. TYPES aims to cope with this challenge by defining, implementing, and validating in pre-market status a holistic framework of technologies and tools that guarantees both transparency and privacy preservation, gives the end user control upon the amount of information he/she is willing to share, and defines privacy-by-design solutions. In particular, these tools should enable the end user: i) to configure the privacy settings so that only the information allowed by the end-user is collected by online advertising platforms; ii) to understand the flow of their information within the online advertising ecosystem and how it is being used; iii) to detect episodes of information collection occurring without consent and identify the offender; iv) to know the value of their data. **TYPES will demonstrate solutions that protect user's privacy while empowering them to control how their data is used by service providers for advertising purposes.** At the same time, TYPES will make it easier to verify whether users' online rights are respected and if personal data is exchanged for a reasonable value-added to users.



# scientific activities



- 5.1. Awards [48]
- 5.2. Publications [50]
- 5.3. Scientific service [63]
- 5.4. Keynotes, Invited Talks, Tutorials, Lectures, Demos, etc. [72]
- 5.5. Major events [75]
- 5.6. Workshops, seminars & lectures [79]
- 5.7. Major future events [82]
- 5.8. Local Scientific Partnership [84]

annual report  
2014

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

**CROWD\***, a research project in the strategic domain of future communication and ICT services infrastructures, was selected by the European Commission to join the group of “**early 5G precursor projects**”. As such, it will contribute to the early showcasing of potential technologies for the future ubiquitous, ultra-high bandwidth “5G” infrastructure.

*\* Connectivity management for eneRgy Optimised Wireless Dense networks*



AWARDS

### 5.1.2. Paper awards

**Christina Vlachou, Albert Banchs, Julien Herzen, Patrick Thiran**

*(\*Runner up to the best paper award 🏆)  
On the MAC for Power-Line Communications: Modeling Assumptions and Performance Tradeoffs.*

In: The 22<sup>nd</sup> IEEE International Conference on Network Protocols (IEEE ICNP 2014), 21-24 October 2014, The Research Triangle, North Carolina (USA)

**Adrian Loch, Matthias Hollick, Thomas Nitsche, Joerg Widmer, Alexander Kuehne, Anja Klein**

*(\*Best paper award 🏆)  
Practical Interference Alignment in the Frequency Domain for OFDM-based Wireless Access Networks.*

In: The 15<sup>th</sup> International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2014), 16-19 June 2014, Sydney (Australia)

**Gek Hong SIM, Joerg Widmer, Balaji Rengarajan**

*(\*Runner up to the best paper award 🏆)  
Opportunistic Beamforming for Finite Horizon Multicast.*

In: The 15<sup>th</sup> International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2014), 16-19 June 2014, Sydney (Australia)

### 5.1.3. Researcher awards

**Luca Cominardi**

*(Extraordinary prize to the best academic record in the 2013/14 edition of the Interuniversity Master in Telematic Engineering, Universidad Carlos III of Madrid 🏆)*

(Premio extraordinario al mejor expediente académico del curso 2013/14 del Máster Interuniversitario en Ingeniería Telemática, Universidad Carlos III de Madrid)

*Distributed Mobility Management solutions for next mobile network architectures. Masters thesis, Universidad Carlos III de Madrid.*

Master's thesis defended on September 29<sup>th</sup>, 2014.

**Evgenia Christoforou**

*(PhD Student under the supervision of Dr. Antonio Fernández Anta selected to participate in the 2nd Heidelberg Laureate Forum)*

200 young researchers from 60 countries were selected to meet leading researchers in mathematics and computer science for a week of scientific exchange and interdisciplinary dialogue across generations and beyond cultural barriers. This event featured a total of 25 Abel, Turing, Fields and Nevanlinna Laureates, winners of the highest distinctions in mathematics and computer science.

The 2<sup>nd</sup> Heidelberg Laureate Forum took place in Heidelberg, Germany, 21-26 September 2014.

## 5.2. Publications

IMDEA Networks presented its scientific work in various formats and venues during 2014. There were **110** publications, out of which **82** were peer reviewed. This is how they are structured:

1 Book Chapter | 28 Journal Articles | 6 Magazine Articles | 47 Conference or Workshop Papers | 28 Keynotes, Invited Talks, Tutorials, Lectures

The Institute's publication output during 2014 also consisted of:

2 PhD Theses | 7 Masters Theses | 7 Standardization Items | 4 Technical Reports

IMDEA Networks is ranked 385 worldwide for its normalized impact according to Scimago. The Institute ranks 19<sup>th</sup> in Spain and 167<sup>th</sup> in Western Europe.

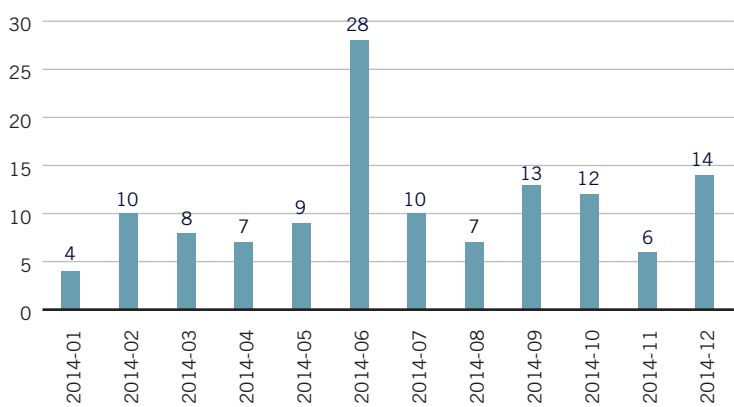


According to Google Scholar, IMDEA Networks' researchers have received around 38.000 citations in total along their research career, which corresponds to an aggregated H-index of 89.

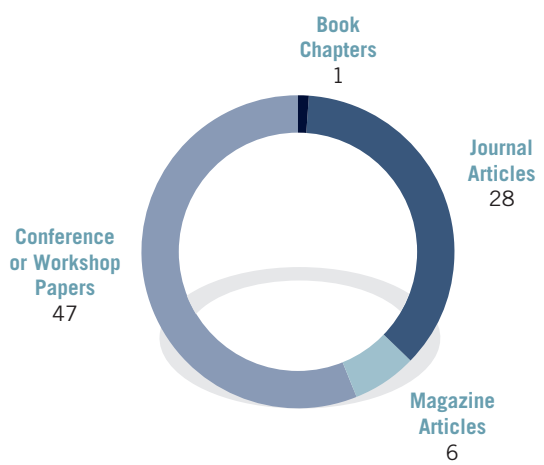


# 2014

## number of publications per month



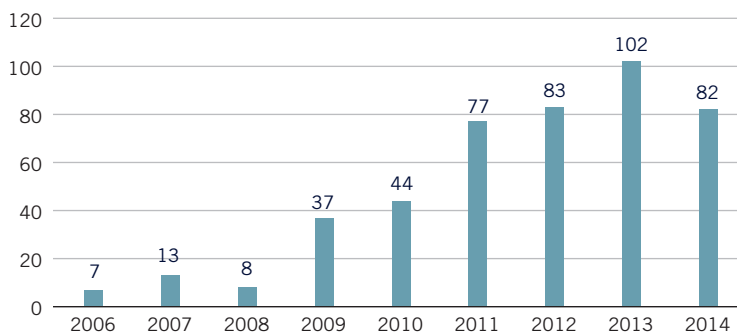
## publications by type



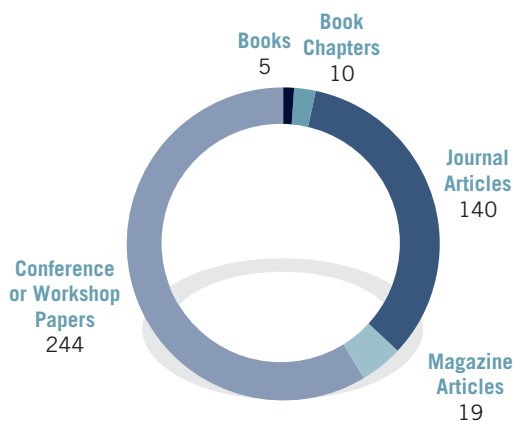


# 2006-2014

## number of publications (peer-reviewed)



## publications by type



## Publications 2014

### Book Chapters [1]

1. **Sergey Nikolenko, Kirill Kogan (October 2014)**  
*Single and Multiple Buffer Processing*  
Springer Science+Business Media New York,  
1-9. ISBN 978-3-642-27848-8

### Journal Articles [28]

2. **Shou-pon Lin, Nicholas F. Maxemchuk (December 2014)**

*The Fail Safe Operation of Collaborative Driving Systems*

Journal of Intelligent Transportation Systems: Technology, Planning, and Operations, ISSN 1547-2450

3. **Balaji Rengarajan, Gianluca Rizzo, Marco Ajmone Marsan (November 2014)**

*Energy-optimal base station density in cellular access networks with sleep modes (Accepted for publication)*

Computer Networks Journal, PP (PP). ISSN 1389-1286

4. **Qing Wang, Balaji Rengarajan, Joerg Widmer (November 2014)**

*Increasing Opportunistic Gain in Small Cells Through Energy-Aware User Cooperation*

IEEE Transactions on Wireless Communications, 13 (11). pp. 6356-6369. ISSN 1536-1276

5. **Albert Banchs, Jorge Ortin, Andres Garcia-Saavedra, Douglas J. Leith, Pablo Serrano (November 2014)**

*Thwarting Selfish Behavior in 802.11 WLAN (Accepted for publication)*

IEEE/ACM Transactions on Networking, PP (99). ISSN 1063-6692

6. **Ignacio Castro, Rade Stanojevic, Sergey Gorinsky (October 2014)**

*Using Tuangou to Reduce IP Transit Costs*

IEEE/ACM Transactions on Networking, 22 (5). pp. 1415-1428. ISSN 1063-6692

7. **Derick Leony, Pedro J. Muñoz-Merino, José A. Ruipérez-Valiente, Pardo Abelardo, Carlos Delgado Kloos (October 2014)**

*Models for the detection of emotions in the Khan Academy Platform*

Journal of Universal Computer Science (Special Issue on Massive Open Online Courses: Combining Methodologies and Architectures for a Success Learning), ISSN 0948-695X

8. **Arash Asadi, Vincenzo Mancuso (September 2014)**

*DRONEE: Dual-radio opportunistic networking for energy efficiency*

Computer Communications, 50. pp. 41-52. ISSN 0140-3664

9. **Arash Asadi, Peter Jacko, Vincenzo Mancuso (September 2014)**

*Modeling D2D communications with LTE and WiFi*

ACM SIGMETRICS Performance Evaluation Review, 42 (2). pp. 55-57. ISSN 0163-5999

10. **M. Isabel Sanchez, Marco Gramaglia, Carlos Jesús Bernardos, Antonio De la Oliva, María Calderón (August 2014)**

*On the implementation, deployment and evaluation of a networking protocol for VANETs: the VARON case*

Ad Hoc Networks, 19. pp. 9-27. ISSN 1570-8705

11. **Francois Clad, Stefano Vissicchio, Pascal Mérindol, Pierre Francois, Jean-Jacques Pansiot (July 2014)**

*Computing Minimal Update Sequences for Graceful Router-Wide Reconfigurations (Accepted for publication)*

IEEE/ACM Transactions on Networking, PP (99). pp. 1-14. ISSN 1063-6692

**12. José Luis López-Presa, Luis F. Chiroque, Antonio Fernández Anta (July 2014)**

*Novel Techniques to Speed Up the Computation of the Automorphism Group of a Graph*  
Journal of Applied Mathematics, 2014. pp. 1-15. ISSN 1687-0042

**13. Pablo Salvador, Vincenzo Mancuso, Pablo Serrano, Francesco Gringoli, Albert Banchs (July 2014)**

*VoIPiggy: Analysis and Implementation of a Mechanism to Boost Capacity in IEEE 802.11 WLANs Carrying VoIP traffic*  
IEEE Transactions on Mobile Computing, 13 (7). ISSN 1536-1233

**14. Marco Ajmone Marsan, Michela Meo (June 2014)**

*Queueing systems to study the energy consumption of a campus WLAN*  
Computer Networks Journal (Leonard Kleinrock Tribute Issue: A Collection of Papers by his Students), 66. pp. 82-93. ISSN 1389-1286

**15. Łukasz Budzisz, Fatemeh Ganji, Gianluca Rizzo, Marco Ajmone Marsan, Michela Meo, Yi Zhang, George Koutitas, Leandros Tassioulas, Sofie Lambert, Bart Lannoo, Mario Pickavet, Alberto Conte, Ivaylo Haratcherev, Adam Wolisz (June 2014)**

*Dynamic Resource Provisioning for Energy Efficiency in Wireless Access Networks: a Survey and an Outlook*  
IEEE Communications Surveys & Tutorials, 16 (4). pp. 2259-2285. ISSN 1553-877X

**16. Joerg Widmer, Andrea Capalbo, Antonio Fernández Anta, Albert Banchs (June 2014)**

*Efficient Interlayer Network Codes for Fair Layered Multicast Streaming (Accepted for publication)*  
IEEE/ACM Transactions on Networking, PP (99). ISSN 1063-6692

**17. Andres Garcia-Saavedra, Pablo Serrano, Albert Banchs (June 2014)**

*Energy-Efficient Optimization for Distributed Opportunistic Scheduling*  
IEEE Communications Letters, 18 (6). pp. 1083-1086. ISSN 1089-7798

**18. Pablo Serrano, Andres Garcia-Saavedra, Giuseppe Bianchi, Albert Banchs, Arturo Azcorra (May 2014)**

*Per-Frame Energy Consumption in 802.11 Devices and Its Implication on Modeling and Design*  
IEEE/ACM Transactions on Networking, PP (99). ISSN 1063-6692

**19. Arash Asadi, Qing Wang, Vincenzo Mancuso (April 2014)**

*A Survey on Device-to-Device Communication in Cellular Networks*  
IEEE Communications Surveys & Tutorials, 16 (4). pp. 1801-1819. ISSN 1553-877X

**20. Albert Banchs, Balakrishnan Prabhakaran (April 2014)**

*Special Section on Wireless Mobile and Multimedia Networks [Guest Editorial]*  
Pervasive and Mobile Computing, 11. pp. 1-2. ISSN 1574-1192

**21. Jordi Arjona Aroca, Antonio Fernández Anta (March 2014)**

*Bisection (Band)Width of Product Networks with Application to Data Centers*  
IEEE Transactions on Parallel and Distributed Systems, 25 (3). pp. 570-580. ISSN 1045-9219

**22. Héctor Cordobés de la Calle, Antonio Fernández Anta, Luis F. Chiroque, Fernando Pérez, Teófilo Redondo, Agustín Santos (March 2014)**

*Graph-based Techniques for Topic Classification of Tweets in Spanish*  
IJIMAI International Journal of Interactive Multimedia and Artificial Intelligence (Special issue: AI Techniques to Evaluate Economics and Happiness), 2 (5). pp. 31-37. ISSN 1989-1660

- 23. Michael Spuhler, Domenico Giustiniano, Vincent Lenders, Matthias Wilhelm, Jens Schmitt (March 2014)**

*Detection of Reactive Jamming in DSSS-based Wireless Communications*

IEEE Transactions on Wireless Communications, 13 (3). pp. 1593-1603. ISSN 1536-1276

- 24. Andrea Zanella, Nicola Bui, Angelo P. Castellani, Lorenzo Vangelista, Michele Zorzi (March 2014)**

*Internet of Things for Smart Cities*

IEEE Internet of Things Journal, ISSN 2327-4662

- 25. Albert Banchs, Antonio De la Oliva, Lucas Eznarriaga, Dariusz R. Kowalski, Pablo Serrano (February 2014)**

*Performance Analysis and Algorithm Selection for Reliable Multicast in IEEE 802.11aa Wireless LAN*

IEEE Transactions on Vehicular Technology, 63 (8). pp. 3875 -3891. ISSN 0018-9545

- 26. Francois Clad, Pascal Mérindol, Jean-Jacques Pansiot, Pierre Francois (February 2014)**

*Graceful Convergence in Link-State IP Networks: A Lightweight Algorithm Ensuring Minimal Operational Impact*

IEEE/ACM Transactions on Networking, 22 (1). pp. 300-312. ISSN 1063-6692

- 27. Rubén Cuevas, Michal Kryczka, Roberto González, Ángel Cuevas, Arturo Azcorra (February 2014)**

*TorrentGuard: Stopping scam and malware distribution in the BitTorrent ecosystem*

Computer Networks Journal, 59. pp. 77-90. ISSN 1389-1286

- 28. Evgenia Christoforou, Antonio Fernández Anta, Chryssis Georgiou, Miguel A. Mosteiro (January 2014)**

*Algorithmic Mechanisms for Reliable Master-Worker Internet-Based Computing*

IEEE Transactions on Computers, 63 (1). pp. 179-195. ISSN 0018-9340

- 29. Lin Wang, Fa Zhang, Jordi Arjona Aroca, Athanasios V. Vasilakos, Kai Zheng, Chenying Hou, Dan Li, Zhiyong Liu (January 2014)**

*GreenDCN: a General Framework for Achieving Network Energy Efficiency in Data Centers*

IEEE Journal on Selected Areas in Communications (JSAC), 32 (1). pp. 4-15. ISSN 7338716

## Magazine Articles [6]

- 30. Thomas Nitsche, Carlos Cordeiro, Adriana B. Flores, Edward W. Knightly, Eldad Perahia, Joerg Widmer (December 2014)**

*IEEE 802.11ad: Directional 60 GHz Communication for Multi-Gigabit-per-Second Wi-Fi*

IEEE Communications Magazine, 52 (12). pp. 132-141. ISSN 0163-6804

- 31. Shahzad Ali, Gianluca Rizzo, Vincenzo Mancuso, Vittorio Cozzolino, Marco Ajmone Marsan (June 2014)**

*Experimenting with Floating Content in an Office Setting*

IEEE Communications Magazine (Special Issue: Context-Aware Networking and Communications), ISSN 0163-6804

- 32. Mahdi Asadpour, Bertold Van den Bergh, Domenico Giustiniano, Karin Anna Hummel, Sofie Pollin, Bernhard Plattner (June 2014)**

*Micro Aerial Vehicle Networks: An Experimental Analysis of Challenges and Opportunities*

IEEE Communications Magazine, ISSN 0163-6804

- 33. Carlos Jesús Bernardos, Antonio De la Oliva, Pablo Serrano, Albert Banchs, Luis M. Contreras, Hao Jin, Juan Carlos Zúñiga (June 2014)**

*An Architecture for Software Defined Wireless Networking*

IEEE Wireless Communications Magazine, 21 (3). pp. 52-61. ISSN 1536-1284

- 34. Aradhana Narula-Tam, Kamesh Namuduri, Serge Chaumette, Domenico Giustiniano (May 2014)**

*Enabling Next Generation Airborne Communications [Guest Editorial]*

IEEE Communications Magazine, 52. pp. 102-103. ISSN 0163-6804

- 35. Pablo Salvador, Luca Cominardi, Francesco Gringoli, Pablo Serrano (January 2014)**

*A First Implementation and Evaluation of the IEEE 802.11aa Group Addressed Transmission Service*

ACM Computer Communication Review, 44 (1). pp. 35-41. ISSN 0146-4833



## Conference or Workshop Papers [47]

- 36. Juan Camilo Cardona, Rade Stanojevic, Nikolaos Laoutaris (December 2014)**

*Collaborative Consumption for Mobile Broadband: A Quantitative Study (Paper)*

In: The 10<sup>th</sup> ACM International Conference on emerging Networking EXperiments and Technologies (ACM CoNEXT 2014), 2-5 December 2014, Sydney, Australia

- 37. Evgenia Christoforou, Antonio Fernández Anta, Agustín Santos (December 2014)**

*A Mechanism for Fair Distribution of Resources with Application to Sponsored Search (Poster)*

In: The 10<sup>th</sup> Conference on Web and Internet Economics (WINE 2014), in conjunction with the 11<sup>th</sup> Workshop on Algorithms and the Models of Web Graph (WAW 2014), 14-17 December 2014, Beijing, China

- 38. Andreas Marcaletti, Maurizio Rea, Domenico Giustiniano, Vincent Lenders, Aymen Fakhreddine (December 2014)**

*Filtering Noisy 802.11 Time-of-Flight Ranging Measurements (Paper)*

In: The 10<sup>th</sup> ACM International Conference on emerging Networking EXperiments and Technologies (ACM CoNEXT 2014), 2-5 December 2014, Sydney, Australia

- 39. Christina Vlachou, Albert Banchs, Julien Herzen, Patrick Thiran (December 2014)**

*Analyzing and Boosting the Performance of Power-Line Communication Networks (Paper)*

In: The 10<sup>th</sup> ACM International Conference on emerging Networking EXperiments and Technologies (ACM CoNEXT 2014), 2-5 December 2014, Sydney, Australia

- 40. Ignacio Castro, Juan Camilo Cardona, Sergey Gorinsky, Pierre Francois (December 2014)**

*Remote Peering: More Peering without Internet Flattening (Paper)*

In: The 10<sup>th</sup> ACM International Conference on emerging Networking EXperiments and Technologies (ACM CoNEXT 2014), 2-5 December 2014, Sydney, Australia

**41. Qing Wang, Domenico Giustiniano (December 2014)**

*Communication Networks of Visible Light Emitting Diodes with Intra-Frame Bidirectional Transmission (Paper)*

In: The 10<sup>th</sup> ACM International Conference on emerging Networking EXperiments and Technologies (ACM CoNEXT 2014), 2-5 December 2014, Sydney, Australia

**42. Yingjie Zhou, Nicholas F. Maxemchuk, Xianying Qian, Chen Wang (November 2014)**

*The Fair Distribution of Power to Electric Vehicles: An Alternative to Pricing (Paper)*

In: The 5<sup>th</sup> IEEE International Conference on Smart Grid Communications (IEEE SmartGridComm 2014), 3-6 November 2014, Venice, Italy

**43. Javier Santofimia Ruiz, Héctor J. Pijera Díaz, José A. Ruipérez-Valiente, Pedro J. Muñoz-Merino, Carlos Delgado Kloos (October 2014)**

*Towards the Development of a Learning Analytics extension in Open edX (Paper)*

In: The 2<sup>nd</sup> International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2014), 1-3 October 2014, Salamanca, Spain

**44. Christina Vlachou, Albert Banchs, Julien Herzen, Patrick Thiran (October 2014)**

*On the MAC for Power-Line Communications: Modeling Assumptions and Performance Tradeoffs (Paper)*

In: The 22<sup>nd</sup> IEEE International Conference on Network Protocols (IEEE ICNP 2014), 21-24 October 2014, The Research Triangle, North Carolina, USA

**45. Nicola Bui, Joerg Widmer (September 2014)**

*Modeling Throughput Prediction Errors as Gaussian Random Walks (Paper)*

In: The 1<sup>st</sup> KuVS Workshop on Anticipatory Networks, 29-30 September 2014, Stuttgart, Germany

**46. Amir Darehshoorzadeh, M. Isabel Sanchez, Azzedine Boukerche (September 2014)**

*Modeling and Analysis of Opportunistic Routing in Multi-hop Wireless Networks (Paper)*

In: The 22<sup>nd</sup> IEEE International Symposium on Modeling Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS 2014), 9-11 September 2014, Paris, France

**47. José A. Ruipérez-Valiente, Pedro J. Muñoz-Merino, Carlos Delgado Kloos, Katja Niemann, Maren Scheffel (September 2014)**

*Do Optional Activities Matter in Virtual Learning Environments? (Paper)*

In: The 9<sup>th</sup> European Conference on Technology Enhanced Learning (EC-TEL 2014), 16-19 September 2014, Graz, Austria

**48. Qing Wang, Domenico Giustiniano, Daniele Puccinelli (September 2014)**

*OpenVLC: Software-Defined Visible Light Embedded Networks (Paper)*

In: The 1<sup>st</sup> ACM Workshop on Visible Light Communication Systems, in conjunction with the 20th Annual International Conference on Mobile Computing and Networking (ACM MobiCom 2014), 7 September 2014, Maui, Hawaii, USA

**49. Mahdi Asadpour, Simon Egli, Karin Anna Hummel, Domenico Giustiniano (August 2014)**

*Routing in a Fleet of Micro Aerial Vehicles: First Experimental Insights (Invited Paper)*

In: The 3<sup>rd</sup> ACM Workshop on Airborne Networks and Communications, in conjunction with the 15<sup>th</sup> ACM International Symposium on Mobile Ad Hoc Networking and Computing (ACM MobiHoc 2014), 11 August 2014, Philadelphia, PA, USA

**50. Carlos Delgado Kloos, Pedro J. Muñoz-Merino, José A. Ruipérez-Valiente, María A. Auger, Susana Briz, Vanesa de Castro, Silvia N. Santalla (August 2014)**

*A Successful Learning Experience using SPOCs (Paper)*

In: Learning with MOOCs: A Practitioner's Workshop (LWMOOC 2014), 12-13 August 2014, MIT, Boston, Massachusetts, EE.UU.

**51. Alexander Kuehne, Adrian Loch, Thomas Nitsche, Joerg Widmer, Matthias Hollick, Anja Klein (August 2014)**

*BER Enhancements for Practical Interference Alignment in the Frequency Domain (Paper)*

In: The 11<sup>th</sup> International Symposium on Wireless Communication Systems (ISWCS 2014), 26-29 August 2014, Barcelona, Spain

**52. Peter Perešini, Maciej Ku niar, Marco Canini, Dejan Kostic (August 2014)**

*ESPRES: Transparent SDN Update Scheduling (Paper)*

In: The 3<sup>rd</sup> ACM SIGCOMM Workshop on Hot Topics in Software Defined Networking (HotSDN 2014), in conjunction with ACM SIGCOMM 2014, 22 August 2014, Chicago, Illinois, USA

**53. Jordi Arjona Aroca, Antonio Fernández Anta, Miguel A. Mosteiro, Christopher Thraves, Lin Wang (July 2014)**

*Power-efficient Assignment of Virtual Machines to Physical Machines (Paper)*

In: Workshop on Adaptive Resource Management and Scheduling for Cloud Computing (ARMS-CC 2014), in conjunction with the 33<sup>rd</sup> Annual ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing (PODC 2014), 15 July 2014, Paris, France

**54. Juan Camilo Cardona, Pierre Francois, Paolo Lucente (July 2014)**

*Collection and Analysis of data for Inter-domain Traffic Engineering (Paper)*

In: I Workshop Pré-IETF, in conjunction with the 34<sup>th</sup> conference of the Brazilian Society of Computation (CSBC 2014), 28-31 July 2014, Brasília, Brazil

**55. Derick Leony, Pedro J. Muñoz-Merino, Abelardo Pardo, José A. Ruipérez-Valiente, David Arellano Martín-Caro, Carlos Delgado Kloos (July 2014)**

*Rule-based detection of emotions in the Khan Academy platform (Paper)*

In: International Workshop on Massive Open Online Courses, 15 -16 May 2014, Antigua, Guatemala

**56. Elli Zavou (July 2014)**

*Asymptotic Competitive Analysis of Task Scheduling Algorithms on a Fault-Prone Machine (Poster)*

In: The 41<sup>st</sup> International Colloquium on Automata, Languages and Programming (ICALP 2014), 7-11 July 2014, Copenhagen, Denmark

**57. Jordi Arjona Aroca, Antonio Fernández Anta (June 2014)**

*JAM: A Tabu-based Two-Stage Simulated Annealing Algorithm for the Multidimensional Arrangement Problem (Paper)*

In: The 9<sup>th</sup> International Workshop on Hybrid Metaheuristics (HM 2014), 11-13 June 2014, Hamburg, Germany

**58. Arash Asadi, Peter Jacko, Vincenzo Mancuso (June 2014)**

*Modeling Multimode D2D Communications in LTE (Paper)*

In: Workshop on MAThematical performance Modeling and Analysis (MAMA 2014), in conjunction with the International Conference on Measurement and Modeling of Computer Systems (ACM SIGMETRICS 2014), 20 June 2014, Austin, Texas, USA

**59. Pradeep Banger, Sergey Gorinsky (June 2014)**

*Economics of Traffic Attraction by Transit Providers (Paper)*

In: The 13<sup>th</sup> IFIP Networking 2014 Conference, 2-4 June 2014 , Trondheim, Norway

**60. Claudio Bottai, Claudio Cicconetti, Arianna Morelli, Michele Rosellini, Christian Vitale (June 2014)**

*Energy-Efficient User Association In Extremely Dense Small Cell Networks (Paper)*

In: The 23<sup>rd</sup> European Conference on Networks and Communications (EuCNC 2014), 23-26 June 2014, Bologna, Italy





**61. Jiri Danihelka, Domenico Giustiniano, Theus Hossmann (June 2014)**

*HyCloud: A system for device-to-device content distribution controlled by the cloud (Paper)*

In: The 15<sup>th</sup> IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2014), 16-19 June 2014, Sidney, Australia

**62. Miguel Ángel Díaz Bautista, Francisco Valera, Iván Vidal, Marcelo Bagnulo (June 2014)**

*Communication architecture of a next generation RPAS: design, deployment and campaigns (Poster)*

In: The 6<sup>th</sup> IMDEA Networks Annual International Workshop: 5G Network Revolution, 11 June 2014, Madrid, Spain

**63. Sim Gek Hong, Joerg Widmer, Balaji Rengarajan (June 2014)**

*Opportunistic Beamforming for Finite Horizon Multicast (Paper)*

In: The 15<sup>th</sup> IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2014), 16-19 June 2014, Sydney, Australia

**64. Rohit Gupta, Thomas Vogel, Nikhil Kundargi, Amal Ekbal, Arianna Morelli, Vincenzo Mancuso, Vincenzo Sciancalepore, Russell Ford, Sundeep Rangan (June 2014)**

*LabVIEW based Platform for prototyping dense LTE Networks in CROWD Project (Paper)*

In: The 23<sup>rd</sup> European Conference on Networks and Communications (EuCNC 2014), 23-26 June 2014, Bologna, Italy

**65. Shou-pon Lin, Yitian Gu, Nicholas F. Maxemchuk (June 2014)**

*A multiple stack architecture for intelligent vehicles (Paper)*

In: The 3<sup>rd</sup> IEEE Intelligent Vehicles Symposium (IEEE IV 2014), 8-11 June 2014, Dearborn, Michigan, USA

**66. Adrian Loch, Thomas Nitsche, Alexander Kuehne, Matthias Hollick, Joerg Widmer, Anja Klein (June 2014)**

*Practical Interference Alignment in the Frequency Domain for OFDM-based Wireless Access Networks (Paper)*

In: The 15<sup>th</sup> IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2014), 16-19 June 2014, Sidney, Australia

**67. Pedro J. Munoz-Merino, José A. Ruipérez-Valiente, Carlos Alario-Hoyos, Mar Pérez-Sanagustín, Carlos Delgado Kloos (June 2014)**

*Learning Analytics for the Precise Evaluation of Student Effectiveness with Educational Resources and Activities (Paper)*

In: The 1<sup>st</sup> International Workshop on Learning Analytics (WLA), in conjunction with the 9<sup>th</sup> Iberian Conference on Information Systems and Technologies (CISTI 2014), 18-21 June 2014, Barcelona, Spain

**68. Gianluca Rizzo, Balaji Rengarajan, Marco Ajmone Marsan (June 2014)**

*The value of BS flexibility for QoS-aware sleep modes in cellular access networks (Paper)*

In: The 13<sup>th</sup> IEEE International Conference on Communications Workshops (IEEE ICC 2014), W14: Workshop on Energy Efficiency in Wireless Networks & Wireless Networks for Energy Efficiency (E2Nets), 10-14 June 2014, Sydney, Australia

**69. Christina Vlachou, Albert Banchs, Julien Herzen, Patrick Thiran (June 2014)**

*Performance Analysis of MAC for Power-Line Communications (Poster)*

In: ACM SIGMETRICS 2014, International Conference on Measurement and Modeling of Computer Systems (ACM SIGMETRICS 2014), 16-20 June 2014, Austin, Texas, USA

**70. Qing Wang, Balaji Rengarajan, Joerg Widmer (June 2014)**

*Increasing Opportunistic Gain in Small Cells Through Base Station-Driven Traffic Spreading (Paper)*

In: The 15<sup>th</sup> IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2014), 16-19 June 2014, Sydney, Australia

**71. Jordi Arjona Aroca, Angelos Chatzipapas, Antonio Fernández Anta, Vincenzo Mancuso (May 2014)**

*A Measurement-based Analysis of the Energy Consumption of Data Center Servers (Paper)*

In: The 5<sup>th</sup> ACM International Conference on Energy-Efficient Computing and Networking (ACM e-Energy 2014), 11-13 June 2014, Cambridge, United Kingdom

**72. Nicola Bui, Foivos Michelinakis, Joerg Widmer (May 2014)**

*A Model for Throughput Prediction for Mobile Users (Invited Paper)*

In: The 20<sup>th</sup> European Wireless 2014 - Special Session on stochastic modeling for protocol design and optimization, 14-16 May 2014, Barcelona, Spain

**73. Agustín Santos, Antonio Fernández Anta, José A. Cuesta, Luis López Fernández (May 2014)**

*Fair Linking Mechanisms for Resource Allocation with Correlated Player Types (Paper)*

In: The 2<sup>nd</sup> International Conference on Networked sYstems (NETYS 2014), 15-17 May 2014, Marrakech, Morocco



**74. Theodoros Bourchas, Maciej Bednarek, Domenico Giustiniano, Vincent Lenders (April 2014)**

*Poster abstract: Practical Limits of WiFi Time-of-Flight Echo Techniques (Poster)*

In: The 13<sup>th</sup> ACM IEEE International Conference on Information Processing in Sensor Networks (ACM/IEEE IPSN 2014), 15-17 April 2014, Berlin, Germany

**75. Syed Hasan, Sergey Gorinsky, Constantine Dovrolis, Ramesh K. Sitaraman (April 2014)**

*Trade-offs in Optimizing the Cache Deployments of CDNs (Paper)*

In: The 33<sup>rd</sup> Annual IEEE International Conference on Computer Communications (IEEE INFOCOM 2014), 27 April - 2 May 2014, Toronto, Canada

**76. Andra Lutu, Marcelo Bagnulo, Jesus Cid-Sueiro, Olaf Maennel (April 2014)**

*Separating Wheat from Chaff: Winnowing Unintended Prefixes using Machine Learning (Paper)*

In: The 33<sup>rd</sup> Annual IEEE International Conference on Computer Communications (IEEE INFOCOM 2014), 27 April - 2 May 2014, Toronto, Canada

**77. Vincenzo Sciancalepore, Vincenzo Mancuso, Albert Banchs, Shmuel Zaks, Antonio Capone (April 2014)**

*Interference Coordination Strategies for Content Update Dissemination in LTE-A (Paper)*

In: The 33<sup>rd</sup> Annual IEEE International Conference on Computer Communications (IEEE INFOCOM 2014), 27 April - 2 May 2014, Toronto, Canada

**78. Arturo Azcorra (March 2014)**

*Benefits and challenges of cloud technologies for 5G (Invited Paper)*

In: Workshop on EU-Mexico: Exploring common research interests in the Future Internet and Cloud Computing, 20 March 2014, Athens, Greece

**79. Andra Lutu, Marcelo Bagnulo, Cristel Pelsser, Olaf Maennel (March 2014)**

*Understanding the Reachability of IPv6 Limited Visibility Prefixes (Paper)*

In: The Passive and Active Measurements Conference (PAM 2014), 10 - 11 March 2014, Los Angeles, CA, USA

**80. Peter Perešini, Maciej Ku niar, Marco Canini, Dejan Kostic (March 2014)**

*ESPRES: Easy Scheduling and Prioritization for SDN (Paper)*

In: Open Networking Summit (ONS 2014) - Research Track 2014, 3 - 5 March 2014, Santa Clara, CA, USA

**81. Arturo Azcorra (February 2014)**

*Minimizing the energy consumption of Wireless Communications (Invited Paper)*

In: MSc program of University of Valladolid, 11 February 2014, Valladolid, Spain

**82. Arturo Azcorra (January 2014)**

*A new WiFi energy model with experimental validation (Invited Paper)*

In: The 11<sup>th</sup> Italian Networking Workshop, 15-17 January 2014, Cortina d'Ampezzo, Italy



## PhD Theses [2]

### 1. Andra Lutu (November 2014)

*A System for the Detection of Limited Visibility in BGP*

**Phd thesis**, Universidad Carlos III de Madrid, Spain  
Supervisor: Dr. Marcelo Bagnulo, Universidad Carlos III de Madrid, Spain

### 2. Shahzad Ali (October 2014)

*Performance Evaluation of Floating Content for Context-aware Applications*

**Phd thesis**, Universidad Carlos III de Madrid, Spain  
Supervisors: Dr. Marco Ajmone Marsan, IMDEA Networks Institute, Madrid, Spain / Politecnico di Torino, Italy; Dr. Gianluca Rizzo, HES SO Valais, Switzerland; Dr. Vincenzo Mancuso, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain

## Masters Theses [7]

### 1. Roderick Fanou (September 2014)

*On the State of Interdomain Routing in Africa*

**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisors: Dr. Albert Banchs, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain; Dr. Pierre Francois, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain

### 2. José A. Ruipérez-Valiente (September 2014)

*Modeling and Analyzing Gamification Behavior with Badges*

**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisor: Dr. Pedro J. Muñoz-Merino, Universidad Carlos III de Madrid, Spain

### 3. Nicola Bui (September 2014)

*Mobile Network Resource Optimization under Imperfect Prediction*

**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisor: Dr. Joerg Widmer, IMDEA Networks Institute, Madrid, Spain

### 4. Luca Cominardi (Septiembre 2014)

*Distributed Mobility Management solutions for next mobile network architectures*

**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisor: Dr. Carlos Jesús Bernardos Cano, Universidad Carlos III de Madrid, Spain

### 5. Aymen Fakhereddine (Septiembre 2014)

*Towards Commoditized Time-of-Flight based Mobile Device Tracking*

**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisor: Dr. Domenico Giustiniano, IMDEA Networks Institute, Madrid, Spain

### 6. Nicola Bui (September 2014)

*Mobile Network Resource Optimization under Imperfect Prediction*

**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisor: Dr. Joerg Widmer, IMDEA Networks Institute, Madrid, Spain

### 7. Héctor Cordobés de la Calle (Julio 2014)

*Graph-based techniques for tweet classification in Spanish*

**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisor: Dr. Carmen Peláez-Moreno





### 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”, Technical universities of Milan and Turin (Italy)
- Directive Committee member: “Gruppo 2003 per la ricerca scientifica” (the association of highly-cited Italian scientists)
- Coordinator: PhD program in Electronic Engineering, Politecnico di Torino (Italy)
- Committee member: 2014 & 2015 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)
- Editorial Board member: The ACM Transactions on Modeling and Performance Evaluation of Computing Systems Journal (ACM ToMPECS)

##### Organization committees

- Standing Committee member: The Annual IEEE International Conference on Computer Communications (IEEE INFOCOM) conference series, 2012 – 2014
- Steering Committee member: The ACM International Conference on Future Energy Systems (ACM e-Energy) conference series, 2012 - 2014
- General Chair: The 32<sup>nd</sup> International Symposium on Computer Performance, Modeling, Measurements and Evaluation (IFIP WG 7.3 Performance 2014), Turin (Italy), 7-9 October 2014
- Panel chair: The 4<sup>th</sup> IFIP Conference on Sustainable Internet and ICT for Sustainability (SustainIT 2015)”, Madrid (Spain), 14-15 April 2015

##### Technical Program Committee (TPC) memberships

- The 32<sup>nd</sup> International Conference on Consumer Electronics (ICCE 2014), Las Vegas (USA), 7-10 January 2014
- The 13<sup>th</sup> IEEE International Conference on Communications Workshops (IEEE ICC 2014), Sydney, (Australia), 10-14 June 2014
- The 2<sup>nd</sup> International Workshop on Energy Efficient Wireless Communications and Networking (EEWCN 2014), in conjunction with the 3<sup>rd</sup> International Conference on



Advances in Computing, Communications & Informatics (ICACCI 2014), Delhi (India), 24-27 September 2014

- The 22<sup>nd</sup> IEEE International Conference on Network Protocols (IEEE ICNP 2014), The Research Triangle, Carolina del Norte (USA), 21-24 October 2014
- The 2014 Australasian Telecommunication Networks & Applications Conference (ATNAC 2014), Melbourne (Australia), 26-28 November 2014
- The 12th IEEE Global Communications Conference, Exhibition & Industry Forum (IEEE GLOBECOM 2014), Austin, TX (USA), 8-12 December 2014
- The 14th IEEE International Conference on Communications Workshops (IEEE ICC 2015), London (UK), 8-12 June 2015
- The 2015 Australasian Telecommunication Networks & Applications Conference (ATNAC 2015), Sydney (Australia), 25-27 November 2015
- The 13th IEEE Global Communications Conference, Exhibition & Industry Forum (IEEE GLOBECOM 2015), San Diego, CA (USA), 6-10 December 2015
- The 35th Annual IEEE International Conference on Computer Communications (IEEE INFOCOM 2016), San Francisco, CA (USA), 10-15 April 2016

## Arash ASADI

### TPC memberships

- The 2015 IEEE 81<sup>st</sup> Vehicular Technology Conference (VTC2015-Spring), Glasgow (Scotland), 11–14 May 2015



### Professional posts & activities

- Steering Board member: 5G Public-Private Partnership (PPP), European Union, 2013 - 2015. The 5G PPP is a 7,000M research action operating over the period 2014-2020 within the H2020 program
- Member: 5G Infrastructure Association, December 2013 – present
- Steering Board member: NetWorld 2020 European Technology Platform, October 2013 – present
- Partnership Board member: 5G Infrastructure Association, August 2014 – present
- ERASMUS Coordinator: University of Twente (The Netherlands), DTU (Denmark) and Univ. of Krakow (Poland), amongst various others, 1998 – present
- Member: University Carlos III of Madrid PhD School Committee to award Extraordinary Prizes to the best PhD theses, 2014
- Member: Board of Mentors of the entrepreneurial association “The Heroes Club”, May 2013 – present
- Member: International Committee to select a Distinguished Professor funded by the Science Foundation Ireland at the University of Cork, September – October 2014
- Advisory Board member: Future Internet PPP, European Commission, February 2012 - present
- Evaluation committee member: PhD program, University of Aveiro (Portugal), May - June 2014
- Member of the Board of Directors: PhD School, University Carlos III of Madrid, December 2013 - present
- President of Doctoral Thesis Tribunal: Andra Lutu, “A System for the Detection of Limited Visibility in BGP”, Universidad Carlos III of Madrid, 11 November 2014

### Organization committees

- Standing Committee member: IEEE INFOCOM conference series, 2007 - 2014

### TPC memberships

- IEEE INFOCOM 2014, Toronto (Canada), 27 April – 2 May 2014
- IEEE INFOCOM 2015, Hong Kong (China), 26 April – 1 May 2015





## Albert BANCHS

### Professional posts & activities

- Director: PhD program in Telematics Engineering, Universidad Carlos III de Madrid, 2013-2014
- Member: Radio Access and Spectrum cluster of the European commission, 2012 - present
- Steering Committee member: The IEEE Online Conference on Green Communications (IEEE OnlineGreenComm)

### Journal editorial boards

- Area Editor: Elsevier Computer Communications Journal, 2010 – present
- Editor: IEEE Transactions on Wireless Communications, 2014 - present

### TPC memberships

- IEEE INFOCOM 2014
- The 15th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2014), Sydney (Australia), 16-19 June 2014
- The 23rd European Conference on Networks and Communications (EuCNC 2014), Bologna (Italy), 23-26 June 2014
- The IEEE 25th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (IEEE PIMRC 2014), Washington, DC (USA), 2-5 September 2014

## Ignacio CASTRO

### Organization committees

- Publicity Chair: The 6<sup>th</sup> International Conference on COMMunication System & NETWORKS (COMSNETS 2014), Bangalore (India), 7-10 January 2014

### TPC memberships

- 2014 Plenary Meeting EINS – Network of Excellence in Internet Science, Bologna (Italy), 11-13 June 2014

## Luca COMINARDI

### Journal editorial boards

- Work Package 4 deputy leader in the EU FP7-ICT iJOIN project

### Organization committees

- Local Co-Chair: SustainIT 2015



## Antonio FERNÁNDEZ ANTA

### Professional posts & activities

- Evaluator. GENI Project Office. Funded by the USA National Science Foundation (NSF)
- Evaluator. Propuestas de subvenciones para INRIA, Francia.
- Evaluator. Promotion to the rank of Senior Lecturer in the Department of Communication Systems Engineering, Ben-Gurion University of the Negev (Israel)
- “Vocal Primero” (main chairperson). Sociedad de Computación Concurrente y Distribuida (SCCD)
- Doctoral Thesis Committee member: Roberto González Sánchez, “Measurements and analysis of online social networks”. Universidad Carlos III de Madrid, June 2014
- Doctoral Thesis Committee member: Alexandre Maurer, “Reliable communication despite Byzantine *failures in sparse networks*”, Laboratoire d’Informatique Paris 6 (LIP6), Université Pierre et Marie Curie, 20 November 2014

### Journal editorial boards

- 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)

### Organization committees

- Steering Committee Chair: International Symposium on DIStributed Computing (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)
- Program Vice-Chair: The 34th International Conference on Distributed Computing Systems (ICDCS 2014), Madrid (Spain), 30 June — 3 July 2014

### TPC memberships

- Track C – The 41st International Colloquium on Automata, Languages and Programming (ICALP 2014), Copenhagen (Denmark), 7-11 July 2014
- The 15th International Conference on Distributed Computing and Networking (ICDCN 2014), Coimbatore (India), 4-7 January 2014
- The 6th IEEE International Workshop on Network Science for Communications (Net-SciCom 2014)”, Toronto (Canada), 2 May 2014. In conjunction with INFOCOM 2014

## Pierre FRANCOIS

### TPC memberships

- IFIP Networking 2014, Trondheim (Norway), 2-4 June 2014

## Domenico GIUSTINIANO

### Journal editorial boards

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

### Organization committees

- General Workshop Co-Chair: FLYNET Workshop: Micro and Nano Aerial Vehicle Networks for Civilian Use, Zurich (Switzerland), 3-5 November 2014
- General Workshop Co-Chair: The 6<sup>th</sup> IMDEA Networks Annual International Workshop: 5G Network Revolution, Madrid, 11 June 2014
- General Co-Chair: SustainIT 2015

### TPC memberships

- IEEE INFOCOM 2014
- IEEE INFOCOM 2015
- The 1st ACM Mobicom 2014 Workshop on Visible Light Communication Systems, Maui, HI (USA), 7 September 2014. In conjunction with the 20th Annual International Conference on Mobile Computing and Networking (ACM Mobicom 2014)
- The ACM Mobihoc 2014 Workshop on Airborne Networks and Communications, Philadelphia, PA (USA), 11 August 2014. In conjunction with the 15<sup>th</sup> ACM International Symposium on Mobile Ad Hoc Networking and Computing (ACM MobiHoc 2014)
- The 11<sup>th</sup> IEEE International Conference on Mobile Ad hoc and Sensor Systems (IEEE MASS 2014), PA (USA), 27-30 October 2014
- IEEE PIMRC 2014
- The IFIP Wireless Days Conference (WD 2014), Rio de Janeiro (Brazil), 12-14 November 2014

## Sergey GORINSKY

### Professional posts & activities

- Member of the COMSNETS Association, a steering committee for COMSNETS conferences
- Doctoral Thesis Committee member: Marco Chiesa, “*The Role of Routing Policies in the Internet: Stability, Security, and Load-Balancing*”, Roma Tre University (Italy), June 2014

### Organization committees

- TPC Chair: IEEE NetSciCom 2014
- Best Paper Award Committee Member: The 22<sup>nd</sup> IEEE International Conference on Network Protocols (IEEE ICNP 2014), The Research Triangle, North Carolina (USA), 21-24 October 2014

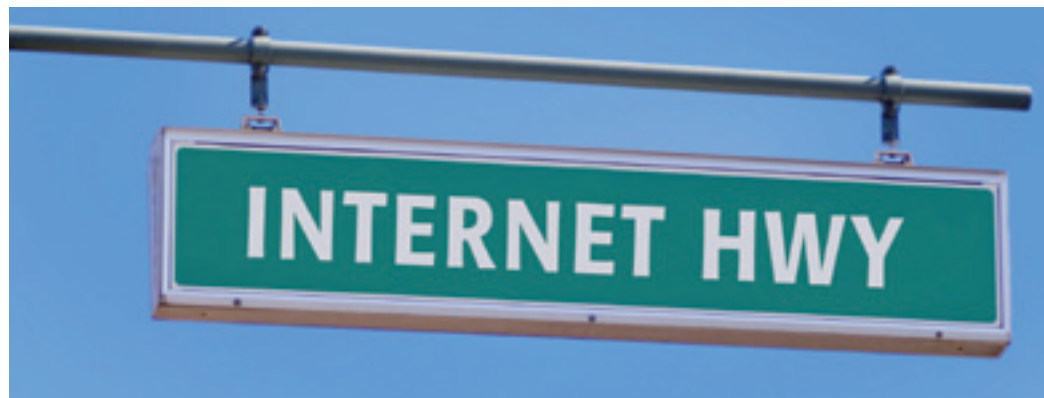
### TPC memberships

- The 15<sup>th</sup> Passive and Active Measurements Conference (PAM 2014), Los Angeles, CA (USA), 10-11 March 2014
- IEEE INFOCOM 2014
- IEEE INFOCOM 2015 (distinguished member)
- The 11th ACM International Conference on Emerging Networking Experiments and Technologies (CoNEXT 2015), Heidelberg (Germany), 1-4 December 2015
- NetEcon 2015
- The joint Workshop on Pricing and Incentives in Networks and Systems (ACM W-PIN+NetEcon 2014), Austin, TX (USA), 6 June 2014. In conjunction with ACM SIGMETRICS 2014, 16-20 June 2014
- The 10<sup>th</sup> Workshop on the Economics of Networks, Systems and Computation (NetEcon 2015), Portland, OR (US), 15 June 2015. In conjunction with ACM SIGMETRICS 2015 and ACM EC 2015, 15-19 June 2015
- IEEE ICNP 2014, North Carolina (USA), 21-24 October 2014

### Dejan KOSTIĆ

#### TPC memberships

- 2014 EuroSys Conference, Amsterdam, The Netherlands, 13-16 April 2014
- NSDI 2014, Seattle, Washington (USA), 18 April 2014
- INFOCOM 2014
- The 14<sup>th</sup> 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 3<sup>rd</sup> European Workshop on Software Defined Networking (EWSDN 14), Budapest (Hungary), 1-3 September 2014



## Vincenzo MANCUSO

### Professional posts & activities

- Technical Manager: EU FP7-ICT project CROWD

### Organization committees

- Organizer and chair of the “CROWD: Extremely dense wireless networks” special session, at the 20<sup>th</sup> European Wireless Conference (EW2014), Barcelona (Spain), 14-16 May 2014
- Publicity Chair: The 6<sup>th</sup> ACM International Conference on Future Energy Systems (ACM e-Energy 2015), Bangalore (India), 14-17 July 2015

### TPC memberships

- IEEE WoWMoM 2014
- The 7<sup>th</sup> International Workshop on Multiple Access Communications (MACOM 2014), Halmstad (Sweden), 27-28 August 2014
- EuCNC 2014
- The 12<sup>th</sup> ACM International Symposium on Mobility Management and Wireless Access (MobiWAC 2014), Montreal (Canada), 21-26 September 2014
- The 17<sup>th</sup> ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 2014), Montreal (Canada), 21-26 September 2014. In conjunction with the 17<sup>th</sup> Annual International Conference on Modeling Analysis and Simulation of Wireless and Mobile Systems (ACM MSWiM 2014)
- The 2014 IEEE Online Conference on Green Communicaitons (IEEE OnlineGreenComm 2014), 12-14 November 2014

## Pablo SALVADOR

### TPC memberships

- The 5<sup>th</sup> International Conference on Information and Communication Technology Convergence (ICTC 2014), Busan (South Korea), 22-24 October 2014
- The 11<sup>th</sup> International Conference on Autonomic and Trusted Computing (ATC-2014), Bali (Indonesia), 9-12 December 2014. In conjunction with the 11<sup>th</sup> IEEE International Conference on Ubiquitous Intelligence and Computing (UIC 2014) and the 14<sup>th</sup> IEEE International Conference on Scalable Computing and Communications (ScalCom-2014).
- The 6<sup>th</sup> International Conference on Ubiquitous and Future Networks (ICUFN 2014), Shanghai (China), 8-11 July 2014
- MACOM 2014
- The 11<sup>th</sup> International Conference on Electrical Engineering, Computing Science and Automatic Control (CCE 2014), Ciudad del Carmen, Campeche (Mexico), 29 September – 3 October 2014





## Qing WANG

### TPC memberships

- The 9<sup>th</sup> International Conference on Communications and Networking in China (ChinaCom 2014), Maoming (China), 14-16 August 2014

## Joerg WIDMER

### Journal editorial boards

- Associate Editor: IEEE Transactions on Communications, 2010 – present

### Organization committees

- General Co-Chair: The 11th IEEE/IFIP Annual Conference on Wireless On-demand Network Systems and Services (IFIP WONS 2014), Obergurgl (Austria), 2-4 April 2014
- Workshop Co-Chair: The 21th Annual International Conference on Mobile Computing and Networking (ACM Mobicom 2015)", Paris (France), 7-11 September 2015
- Demo Chair: The 16th International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2015)", Boston, MA, (USA), 14-17 June 2015

### TPC memberships

- The 10<sup>th</sup> Annual IEEE Consumer Communications & Networking Conference (CCNC 2014), Las Vegas, Nevada (USA), 11-14 January 2014
- IEEE INFOCOM 2014 & IEEE INFOCOM 2015 (distinguished member)
- IFIP Networking 2014
- IFIP Networking 2015
- The 6th IEEE Workshop on Cooperative and Cognitive Mobile Networks (CoCoNet6 2014), Sydney (Australia), 14 June 2014. In conjunction with ICC 2014, 10-14 June 2014
- The 7th IEEE Workshop on Cooperative and Cognitive Mobile Networks (CoCoNet6 2015), London (UK), 8 June 2015. In conjunction with ICC 2015, 8-12 June 2015
- ACM MobiCom 2014
- ACM MobiCom 2015
- The 10th ACM International Conference on Emerging Networking Experiments and Technologies (CoNEXT 2014), Sydney (Australia), 2-5 December 2014
- ACM CoNEXT 2015
- IEEE WoWMoM 2015
- The 7th International Conference on COMMunication Systems and NETWORKS (COM-SNETS 2015), Bangalore (India), 6-10 January 2015
- The International Conference on Networked Systems (NetSys 2015), Cottbus (Germany), 9-12 March 2015

## 5.4. Keynotes, Invited Talks, Tutorials, Lectures, Demos, 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 **28** of these presentations during 2014.

### 1. Sergey Gorinsky (December 2014)

*Remote Peering: More Peering without Internet Flattening (Invited Talk)*

In: National ICT Australia (NICTA) Research Seminar, 1 December 2014, Sydney, Australia

### 2. Rohit Gupta, Amal Ekbal, Achim Nahler Nahler, Vincenzo Mancuso, Antonio De La Oliva, Arianna Morelli, Russell Ford, Sundeep Rangan (December 2014)

*LabVIEW based Platform for prototyping dense LTE Networks (Demo)*

In: The 12th IEEE Global Communications Conference, Exhibition & Industry Forum (IEEE GLOBECOM 2014), 8-12 December 2014, Austin, TX, USA

### 3. Christian Koch, Julius Ruckert, Nicola Bui, Fivos Michelinakis, Guido Fiorafanti, David Hausheer, Joerg Widmer (December 2014)

*Demo: Mobile Social Prefetcher using Social and Network Information (Demo)*

In: The 19th IEEE International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (IEEE CAMAD 2014), 1-3 December 2014, Athens, Greece

### 4. Vincenzo Mancuso, Christian Vitale, Rohit Gupta, Karamvir Rath, Arianna Morelli (December 2014)

*A prototyping methodology for SDN-controlled LTE using SDR (Demo)*

In: ETSI workshop on Reconfigurable Radio Systems - Status and novel Standards (ETSI RSS Workshop 2014), 3-4 December 2014, Sophia Antipolis, France

### 5. Ignacio Castro (December 2014)

*Remote Peering: More Peering without Internet Flattening (Invited Talk)*

In: The 5th Workshop on Internet Economics (WIE 2014), 10-11 December 2014, University of California San Diego, La Jolla, CA, USA

### 6. Arturo Azcorra (November 2014)

*5G Communications: A Thousand Times More Network Capacity (Invited Talk)*

In: XIV Science Week Madrid 2014, 4 November 2014, Madrid, Spain

### 7. Arturo Azcorra (October 2014)

*The Cross-Factor: a relevant element in WiFi energy model (Invited Talk)*

In: University College Cork, October 2014, Cork, Ireland

### 8. Arturo Azcorra (October 2014)

*Redes 5G: La revolución de las comunicaciones (5G Networks: the communications revolution) (Invited Talk)*

In: Real Academia de Ingeniería, 23 October 2014, Madrid, Spain

### 9. Ignacio Castro (October 2014)

*Remote Peering: More Peering without Internet Flattening (Invited Talk)*

In: Berkeley NetSys Lab (Networked Systems Lab at UC Berkeley), 16 October 2014, Berkeley, CA, USA

### 10. Miguel Ángel Díaz Bautista (October 2014)

*NATalyser inhome NAT detection (Invited Talk)*

In: Leone Project Meeting, 1 October 2014, Turin, Italy



**11. Luis F. Chiroque, Héctor Cordobés de la Calle, Antonio Fernández Anta, Rafael García, Philippe Morere, Lorenzo Ornella, Fernando Pérez, Agustín Santos (September 2014)**

*Combining Graphs and Big Data to Recommend Apps (Keynote)*

In: The 1st International Workshop on Big Data Applications and Principles (BIGDAP 2014), 11-12 September 2014, Madrid

**12. Rohit Gupta, Bjoern Bachmann, Russell Ford, Sundeep Rangan, Arianna Morelli, Vincenzo Mancuso, Nikhil Kundargi, Amal Ekbal (September 2014)**

*Demo: LabVIEW based framework for prototyping dense LTE networks (Demo)*

In: The 9th ACM international workshop on Wireless network testbeds, experimental evaluation and characterization (ACM WiNTECH Workshop 2014), in conjunction with the 20th Annual International Conference on Mobile Computing and Networking (ACM MobiCom 2014), 7 September 2014, Maui, Hawaii

**13. José A. Ruipérez-Valiente, Pedro J. Muñoz-Merino, Carlos Delgado Kloos (September 2014)**

*A Demonstration of ALAS-KA: A Learning Analytics Tool for the Khan Academy Platform (Demo)*

In: The 9th European Conference on Technology Enhanced Learning (EC-TEL 2014), 16-19 September 2014, Graz, Austria

**14. Qing Wang, Domenico Giustiniano, Daniele Puccinelli (September 2014)**

*OpenVLC: Software-Defined Open Architecture for Embedded Visible Light Networks (Demo)*

In: The 1st ACM Workshop on Visible Light Communication Systems, in conjunction with the 20th Annual International Conference on Mobile Computing and Networking (ACM MobiCom 2014), 7 September 2014, Maui, Hawaii, USA

**15. Foivos Michelinakis (August 2014)**

*Mobile capacity measurements and estimation (Keynote)*

In: The 2nd International NorNet Users Workshop (NNUW-2), 28-29 August 2014, Simula Research Laboratory, Fornebu, Norway

**16. Antonio Fernández Anta, Chryssis Georgiou, Dariusz R. Kowalski, Elli Zavou (July 2014)**

*Asymptotic Competitive Analysis of Task Scheduling Algorithms on a Fault-Prone Machine (Invited Talk)*

In: The 1st Young Researcher Workshop on Automata, Languages and Programming (YRICALP 2014), 7 July 2014, Copenhagen, Denmark

**17. Arturo Azcorra (June 2014)**

*Software Architectures and Service Virtualization (Invited Talk)*

In: NetWorld2020 Expert Group Workshop, in conjunction with the 23rd European Conference on Networks and Communications (EuCNC 2014), 23 June 2014, Bologna, Italy

**18. Luca Cominardi (June 2014)**

*SDN-based Mobility Management in a Dense Small Cells scenario (Demo)*

In: The 23rd European Conference on Networks and Communications (EuCNC 2014), 23-26 June 2014, Bologna, Italy

**19. Antonio Fernández Anta (June 2014)**

*Saving Energy by Powering Down Links (Invited Talk)*

In: Network Sciences and Technologies (NeST) Workshop 2014, 26-27 June 2014, Liverpool, UK

**20. Antonio Fernández Anta (June 2014)**

*Wireless Algorithmics at IMDEA Networks (Invited Talk)*

In: Workshop on Wireless Communication 2014, in conjunction with Network Sciences and Technologies (NeST Workshop 2014), 25 June 2014, Liverpool, UK

**21. Joerg Widmer (June 2014)**

*Spectrum for the Masses: Networking in the Millimeter Wave Band (Keynote)*

In: The 13th International Conference on Ad-Hoc Networks and Wireless (ADHOC-NOW 2014), 22-27 June 2014, Benidorm, Spain

**22. Sergey Gorinsky (June 2014)**

*Service Differentiation in the Internet for All (Invited Talk)*

In: Space Internetworking 2014, 10 June 2014, Xanthi, Greece

**23. Miguel Ángel Díaz Bautista (June 2014)**

*UC3M: inHome NAT detection (Invited Talk)*

In: Leone Project Meeting, 1 June 2014, Maribor, Slovenia

**24. Andra Lutu (May 2014)**

*Understanding the Reachability of IPv6 Limited Visibility Prefixes (Invited Talk)*

In: RIPE 68, 12-16 May 2014, Warsaw, Poland

**25. Sergey Gorinsky (May 2014)**

*Innovations in Internet Interconnections (Invited Talk)*

In: University of Toronto, 5 May 2014, Toronto, Canada

**26. Marcaletti Andreas, Rea Maurizio, Domenico Giustiniano, Lenders Vincent (April 2014)**

*WINS: Tracking of Mobile Devices with WiFi Time-Of-Flight (Demo)*

In: Microsoft Indoor Localization Competition - ACM/IEEE IPSN 2014 (The 13th ACM/IEEE International Conference on Information Processing in sensor Networks), 13-14 April 2014, Berlin, Germany

**27. Andra Lutu (March 2014)**

*Understanding the Reachability of IPv6 Limited Visibility Prefixes (Invited Talk)*

In: Universidad de Alcalá, EPS (Higher Polytechnic School), 31 March 2014, Madrid, Spain

**28. Sergey Gorinsky (February 2014)**

*The Internet as a Science, in Europe (Invited Talk)*

In: National Research University of Electronic Technology (MIET), 28 February 2014, Moscow, Russia



## 5.5. Major events



### The 6<sup>th</sup> IMDEA Networks Annual International Workshop: 5G Network Revolution

11 June 2014 | Madrid, Spain

<http://events.networks.imdea.org/workshop2014.html>

**Organization:** Domenico Giustiniano and Vincenzo Mancuso from IMDEA Networks 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, 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.

#### Program

- New Spectrum and Spectrum Sharing Opportunities, Edward Knightly (Rice University, USA)
- 5G requirements. Telefónica vision, Cayetano Carbajo Martín (Telefónica SA, Spain)
- WiFi-XL: A license-free cellular network, Bozidar Radunovic (Microsoft Research, UK)
- 5G mm-wave and optical wireless links for converged multi-Gb/s access and beyond, Michael Parker (University of Essex, UK)
- Panel: Roadmap to 5G: What opportunities for network operators?, Panelists: Federico Boccardi (Vodafone, UK); Jim Kurose (*University of Massachusetts, Amherst, Massachusetts, USA*); Gustavo de Veciana (*University of Texas at Austin, USA*)
- A look to the Future Through the Rearview Mirror: 5G, Spectrum Congestion, and TVWS – or having right assumptions, Petri Mähönen (University Aachen, Germany)
- Shaping 5G, Federico Boccardi (*Vodafone, UK*)

## Researchers' Night 2014 – Your Car and an F1 Car: Science and Technology of the XXI Century

26 September 2014 | Madrid, Spain

<http://www.madrimasd.org/lanochedelosinvestigadores/>

[http://ec.europa.eu/research/researchersnight/index\\_en.htm](http://ec.europa.eu/research/researchersnight/index_en.htm)

**Organization:** This event is co-organized by all Institutes part of the IMDEA initiative. Domenico Giustiniano, from IMDEA Networks, was one of the participating researchers

On Friday, September 26<sup>th</sup> 2014 some researchers from the IMDEA research Institutes showed us how you may find in cars examples of progress accomplished by science and technologies as diverse and seemingly unrelated as software, materials or food science. Researchers at IMDEA compared -technologically speaking- an F1 car with an everyday automobile as well as the driving of an F1 pilot with any driver in terms of responsiveness, special needs for hydration and nutrition, physical training ... Furthermore, they explained the scientific and technical advances that have made possible the evolution from a single-seater to the current car to airports, computers, etc. Before the curtain fell some researchers picked up their guitars and keyboards and sang some popular songs starring ... a car.



## XIV Science Week – Madrid 2014: 5G Communications: A Thousand Times More Network Capacity

4 November 2014 | Madrid, Spain

<http://www.networks.imdea.org/whats-new/events/2014/5g-communications-thousand-times-more-network-capacity>

**Speaker:** Arturo Azcorra, Director, IMDEA Networks Institute; Full Professor, University Carlos III of Madrid, Spain

**Organization:** IMDEA Networks Institute; XIV Semana de la Ciencia – 2014 – mi+d

Only a year ago Spaniards began to enjoy 4G mobile networks, which increase tenfold the transmission rates of mobile data when compared to the third generation. 5G network development is now underway, intent on providing a network with a capacity one thousand times higher than the previous generation. But, what is 5G? How will it impact our lives and when will it become available? Who is going to make this leap in communications technology possible? Join us on this event to find out more from the hands of one of Europe's driving forces on 5G communications.









## 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 **32** total number of events in which the Institute participated, **19** were conducted by invited speakers. All events were held in Madrid.

### 5.6.1. Invited Speakers



#### **The Rise of the Sharing Economy: Estimating the Impact of Airbnb on the Hotel Industry**

Davide Proserpio, Ph.D. candidate, Department of Computer Science, Boston University, USA  
8 Jan 2014



#### **Reconstructing Barabasi-Albert networks in the number-in-hand computation model**

Ivan Rapaport, Associate Professor, Department of Mathematical Engineering, Universidad de Chile, Chile  
22 Jan 2014



#### **Stateless DNS for Efficient Private Service Discovery**

Marcel Waldvogel, Professor of Computer Science and Head of IT Infrastructure, University of Konstanz, Germany  
3 Mar 2014



#### **Utility Optimization for Multi-Transmitter Wireless Data Systems**

Lisa Zhang, Researcher on Computing Sciences Principals, Alcatel-Lucent Bell Laboratories, USA  
26 Mar 2014



#### **Architecting an Evolvable Internet with XIA**

John Byers, Professor of Computer Science & Fellow of the Rafik B. Hariri Institute for Computing and Computational Science & Engineering, Boston University, USA  
1 Apr 2014





### **Expressive and efficient data path provision**

Kirill Kogan, Post-doctoral research fellow, Department of Computer Science, Purdue University, West Lafayette, Indiana, USA

6 May 2014



### **The Throughput of Underwater Networks:**

#### **Analysis and Validation**

Paolo Casari, Senior Postdoctoral Research Fellow, Department of Information Engineering, University of Padova, Italy

8 May 2014



### **Adaptable Human-Centric Mobile and Wireless Systems**

Veljko Pejovic, Postdoctoral Research Fellow, School of Computer Science, University of Birmingham, UK

13 May 2014



### **Bitcoin. The TCP/IP of finances?**

Miguel Ortuño, Acting Associate Professor, Universidad Rey Juan Carlos, Madrid, Spain

28 May 2014



### **From Quality of Service to Chaos in wireless networks**

Imad Aad, Research Scientist, University of Bern, Switzerland

2 Jun 2014



### **Safe Connected Vehicles**

Nick Maxemchuk, Research Professor, IMDEA Networks, Spain; Professor, Columbia University of New York City, USA

10 Jun 2014



### **Harnessing Visible Light for Time Synchronization and Mobile Context Recognition**

Zhenjiang Li, Research Fellow, Nanyang Technological University (NTU), Singapore

30 Jun 2014



### Network Virtualization: Vision, Algorithms, Prototype

Stefan Schmid, Senior Research Scientist, T-Labs, Berlin, Germany

2 Jul 2014



### Publish/Subscribe for Large-Scale Social Interaction: Design, Analysis and Resource Provisioning

Vinay Setty, PhD candidate, Networks and Distributed Systems group, Department of Informatics, University of Oslo, Norway

4 Jul 2014



### Measuring Large-Scale Distributed Systems: Case of BitTorrent Mainline DHT

Jussi Kangasharju, Professor, Department of Computer Science, University of Helsinki, Finland

31 Jul 2014



### Inferring Coarse Views of Connectivity in Very Large Graphs

Reza Rejaie, Associate Professor, Department of Computer and Information Science, University of Oregon, USA

3 Oct 2014



### The Internet is not a good place

Narseo Vallina-Rodriguez, Research Scientist, Networking and Security group, International Computer Science Institute (ICSI), Berkeley, USA

13 Oct 2014



### Transport Services - Internet Transport's Last Chance?

Michael Welzl, Full professor, Department of Informatics, University of Oslo, Norway

31 Oct 2014



### Quantifying Information Overload in Social Media and its Impact on Social Contagions

Manuel Gómez Rodríguez, Tenure-track research group leader, Max Planck Institute for Software Systems, Saarbrücken, Germany

19 Nov 2014



#### Talentum Startup Internships Selection Event

IMDEA Networks and Telefonica, in collaboration with the SEPI Foundation, launch a new edition of the Talentum Startups program

4 Dec 2014

### 5.7. Major future events

## SustainIT 2015 – The 4<sup>th</sup> IFIP Conference on Sustainable Internet and ICT for Sustainability

14 – 15 April 2015 | Madrid, Spain

<http://www.networks.imdea.org/sustainit2015/>



**Organization:** IMDEA Networks participates in the Organization Committee of this conference in the following roles:

**General Co-Chair:** Domenico Giustiniano, IMDEA Networks

**General Vice-Chair:** Arturo Azcorra, IMDEA Networks & University Carlos III of Madrid, Spain

**Panel Chair:** Marco Ajmone Marsan, Politecnico di Torino, Italy and IMDEA Networks, Spain

**Finance and Registration Chair:** Nicola Bui, IMDEA Networks & University Carlos III of Madrid

**Local Organizing Committee:** Pablo Caballero and Luca Cominardi, IMDEA Networks & University Carlos III of Madrid

**Web Manager:** Qing Wang, IMDEA Networks & University Carlos III of Madrid

In the last years, the increasing social awareness about the need for containing energy consumption within sustainable rates has caught the interest of both the industrial and academic communities. In this scenario, Internet - and more generally ICT - may play a twofold role, being both a significant energy consumer and a potential actor in steering a more clever usage of energy resources.

Both aspects of the problem raise interesting scientific challenges, and require a comprehensive effort and inter-disciplinary research at all levels of abstraction. The goal of this conference is to bring together people from different research areas, and provide a forum to exchange ideas, discuss solutions, and share experiences among researchers, professionals, and application developers both from industry and academia.

# The 7<sup>th</sup> IMDEA Networks Annual International Workshop: Big Data and Cloud Computing

11 June 2015 | Madrid, Spain

<http://events.networks.imdea.org/workshop2015>

**Organization:** Antonio Fernández Anta from IMDEA Networks is the local organizer

Big Data and Cloud Computing are two paradigms that are evolving hand in hand and are revolutionizing how we live and work. The amount of data that is being generated in the world is increasing every day, and there are no indications that this trend is going to stop any time soon (if ever). The ubiquity of mobile computing devices and high speed networking, the arrival of the Internet of Things, and the evolution to smart environments (smart cities, smart factories, etc.) are generating a constant cascade of data. This is creating huge challenges to transfer, store, and process this data, leading to the development of new technologies to do so. Most of the processing of this data is done in specialized data centers that offer services to clients interested in their particular characteristics. This processing uses distributed computing paradigms intensively. The design and operation of these data centers, and in particular of their interconnection networks, to provide these “cloud” services is a challenging line of research.

The workshop will explore the state of the art on these fascinating areas of research.



## 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.

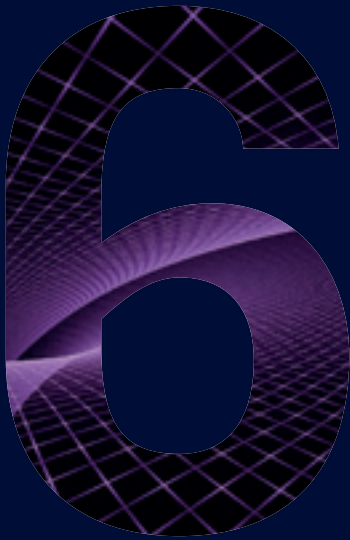
Among other activities, the cooperation between IMDEA Networks and UAH involves their joint participation in projects of a regional scope, such as the TIGRE5-CM project. TIGRE5-CM focuses on the design of an architecture for future generation mobile networks, based on the SDN paradigm. In addition to IMDEA Networks and UAH, the other partner participating in the project is the University Carlos III 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**.

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



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- 6.2. Contribution to standardization bodies [88]
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- 6.4. Other collaborations [100]

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2014

## 6.1. Patents

**Patents** are important steps in the process of **transferring technology to marketplace**. Patent creation has strong implications for the Institute: patents are incentives for their creators, as they imply recognition for their creativity and material reward when these inventions are marketable. These incentives encourage innovation, the guarantee to the continuous improvement in the quality of research and, ultimately, of human life. It is IMDEA Networks Institute's policy to share a very high percentage of financial proceeds with inventors (our researchers) as reward for their excellence and hard work.

The following are examples of our patenting activities during 2014. This is not an exhaustive list of all IMDEA Networks' patents, as we are unable to disclose some due to confidentiality agreements with the funding companies.

### Provisional Spanish Patent Application (Dec 2014)

**Title:** *Procedimientos de establecimiento y reparacion de caminos capa de transporte y puente de red-transporte (PROCEDURES FOR THE ESTABLISHMENT AND REPAIR OF TRANSPORT LAYER AND NETWORK-TRANSPORT BRIDGE PATHS)*

**Inventors:** Arturo AZCORRA, Guillermo IBÁÑEZ FERNÁNDEZ, Elisa ROJAS SÁNCHEZ, Isaías MARTÍNEZ YELMO

*Joint patent between IMDEA Networks and University of Alcalá (Spain)*

### Provisional US Patent Application (Oct 2014)

**Title:** *BEAM STEERING FOR HIGHLY DIRECTIONAL WIRELESS COMMUNICATION ON MULTI-FREQUENCY BAND ENABLED SYSTEMS USING ANGLE OF ARRIVAL DETECTION*

**Inventors:** Thomas NITSCHKE, Adriana B. FLORES MIRANDA, Edward W. KNIGHTLY, Joerg WIDMER

*Joint patent between IMDEA Networks and Rice University (USA)*

#### Overview:

The invention is a novel wireless transceiver architecture, that combines interfaces to multiple frequency bands to improve the beam alignment process for a directional interface. Systems with directional medium usage (e.g. next generation IEEE 802.11ad WiFi) focus the signal energy in direction of the receiver to overcome adverse propagation behavior. The necessary alignment process can be very complex and time consuming, as all potential directions need to be probed.



The invented architecture exploits different propagation characteristics on the frequency bands accessed by the device. On lower frequencies (e.g. legacy WiFi) omni-direction communication allows highly efficient direction estimation algorithms. By transferring the hereby obtained direction information to a directional interface, the alignment process can be significantly improved.

The invention further introduces mechanisms to prevent erroneous direction transfer. This can result from diverse propagation characteristics (multi-path propagation) on the omni-directional frequency band or direct path blockage on the directional band.

The invention accommodates detection of both adverse effects with the direction finding process, without need for further communication overhead.

## Patent in published status (Jun 2014)

**Title:** *SEGMENT ROUTING APPLICATION SEGMENT*

**Inventors:** Stefano Previdi, Clarence Filsfils, Pierre Francois

*Joint patent between Cisco Systems and IMDEA Networks*

### Overview:

A mechanism is presented based on a new type of Segment Identifier that allows operators and large enterprise networks to deploy service chaining without requiring any change in the existing applications. The application segment mechanisms are applicable to both SR-MPLS and SR-IPv6 and address the strongest requirement in terms of service chaining: preserve current applications. This mechanism allows the source (or the ingress node) to apply the service chain, without requiring any configuration or provisioning.



## 6.2. 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.



The **IAB (Internet Architecture Board)** is a body of 13 experts that plays a major role in the process of definition of Internet Protocols and, as a result, on the worldwide evolution of the Internet. The IAB oversees the technical and engineering development of the Internet by the Internet Society (ISOC). As such, it wields a lot of influence over the architectural direction towards which IETF standards evolve.



Several of our researchers are participating in the following standardization activities:

- Jim Uttaro, **Pierre Francois**, Keyur Patel, Pradosh Mohapatra, Jeffrey Haas, Roberto Fragassi, Adam Simpson (**December 2014**)  
*Best Practices for Advertisement of Multiple Paths in IBGP. draft-ietf-idr-add-paths-guidelines-07 (IETF Internet Draft)*
- **Pierre Francois**, Clarence Filsfils, Ahmed Bashandy, Bruno Decraene, Stephane Litkowski (**October 2014**)  
*Topology Independent Fast Reroute using Segment Routing. draft-francois-segment-routing-ti-lfa-00 (IETF Internet Draft)*
- Clarence Filsfils, **Pierre Francois**, Stefano Previdi, Bruno Decraene, Stephane Litkowski, Martin Horneffer, Igor Mилоjevic, Rob Shakir, Saku Ytti, Wim Henderickx, Jeff Tanstura, Sriganesh Kini, Edward Crabbe (**October 2014**)  
*Segment Routing Use Cases. draft-filsfils-rtgwg-segment-routing-use-cases-02 (IETF Internet Draft)*

- **Pierre Francois**, Clarence Filsfils, Bruno Decraene, Rob Shakir (**May 2014**)  
*Use-cases for Resiliency in SPRING. draft-francois-spring-resiliency-use-case-02 (IETF Internet Draft)*
- **Juan Camilo Cardona, Pierre Francois**, Paolo Lucente (**February 2014**)  
*Making BGP filtering a habit: Impact on policies. draft-ietf-grow-filtering-threats-02 (IETF Internet Draft)*
- **Pierre Francois, Juan Camilo Cardona**, Adam Simpson, Jeffrey Haas (**February 2014**)  
*ADD-PATH limit capability. draft-francois-idr-addpath-limit-00 (IETF Internet Draft)*
- **Pierre Francois, Juan Camilo Cardona**, Adam Simpson, Jeffrey Haas (**February 2014**)  
*ADD-PATH for Route Servers. draft-francois-idr-rs-addpaths-00 (IETF Internet Draft)*
- Stephane Litkowski, Bruno Decraene, Clarence Filsfils, **Pierre Francois** (**February 2014**)  
*Microloop prevention by introducing a local convergence delay. draft-litkowski-rtgw-uloop-delay-03 (IETF Internet Draft)*



### 6.3. 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:**

## Improving Routing in Service Provider Networks

**Funded by:** Cisco Systems

**Duration:** Starting on November 2012 (Pluri-annual duration)

**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

## Opportunistic Timing Signals for Pervasive Mobile Communication

*Research contract with the Swiss Confederation represented by Armasuisse – Science and Technology*

**Funded by:** The Swiss Confederation represented by Armasuisse – Science and Technology

**Duration:** April 2014 to March 2015

**Project partners:** Armasuisse – Science and Technology; IMDEA Networks Institute



IMDEA Networks Institute and **the Swiss Confederation represented by Armasuisse – Science and Technology** have signed a collaboration agreement to perform specialist research work. Dr. Domenico Giustiniano, Research Assistant Professor at IMDEA Networks, will contribute to the project objectives and to the scientific dissemination of the results.



The objective of this project is to devise a modular mobile positioning architecture that radically integrates **opportunistic radio-localization signals**. The vision is of a wireless mobile device that can pervasively position itself by integrating satellite navigation and network communications. We especially target areas such as the gray zone, where single technologies such as GPS fail. We aim to reach this goal addressing the following fundamental research questions: (i) how to fuse **timing signals** of satellite navigation with opportunistic signals inherent in WiFi and other radio communications (ii) how to (re-) configure the modular architecture, according to the dynamicity of both the services' demand and location ecosystem. We propose to design and build experimental prototypes to assess our architecture in real-life use cases. Our work will be organized in two core topics: (a) introduce and assess algorithms and methodologies to blend timing signals of different radio technologies, subjected to diverse sources of noise, (b) study and implement techniques (partially) to outsource the computation of the position and the reconfiguration of the modular architecture to the network in order to optimize the **mobile energy efficiency**.



## SWARMIX – Synergistic Interactions in Swarms of Heterogeneous Agents

*Collaboration Agreement for Research & Development with ETH Zürich*

**Project website:** [www.swarmix.org](http://www.swarmix.org)

**Funded by:** Swiss National Science Foundation (SNSF): Sinergia project

**Duration:** November 2013 to December 2014

**Project partners:** Swiss Federal Institute of Technology in Zürich (ETHZ); IMDEA Networks Institute

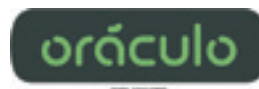
IMDEA Networks Institute and **ETH Zürich** have signed a collaboration agreement for research and development. Dr. Domenico Giustiniano, Research Assistant Professor at IMDEA Networks, will contribute to the project objectives and to the scientific dissemination of the results.

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.



## ORÁCULO - Technological platform for real-time data packet analysis

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



**Project website:** <http://www.glass.u-tad.com/rdi/Oraculo/index.html>

**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 December 2014

**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.



## iPAY - Design of New Algorithms for the Creation of a Technology Platform for Financial Intermediation in Mobile Cloud Computing

*(Diseño de Nuevos Algoritmos para la creación de una Plataforma de Tecnología de Intermediación Financiera Móvil en Cloud Computing)*

**Funded by:** ZED Worldwide S.A.

**Duration:** March 2014 to September 2014

**Project partners:** ZED Worldwide S.A., IMDEA Networks Institute

The iPay project applies the data mining technique to Big Data in order to develop algorithms that allow financial intermediation in the environment of mobile cloud computing (MCC). The aim of the project is threefold. First, we propose the design and development of graph algorithms for the analysis and detection of fraud patterns and data mining on payments. In this module we will design algorithms for the analysis of payments made by users. We will model payment data as graphs and identify behavior patterns to detect fraudulent actions performed by organized networks for money laundering, arbitration of exchange, etc. Second, we will proceed to the design of a prediction system based on a historical record of payment transactions. In this module we will design and develop algorithms to predict user behavior and identify future purchases of interest, as well as operations outside the usual casuistry which are likely to be fraudulent. Finally, for the completion of these tasks we will develop algorithms based on the state-of-the-art and will proceed to create advanced and improved versions.



## 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:** <http://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 multimedia 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.

## 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

**Project partners:** Telefónica S.A.; 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).



*Talentum Internship Students surrounded by members of the directive team and some of their research supervisors, taken at a farewell event held at IMDEA Networks*

### **Collaborations with industry commencing in 2015:**



## **Integrated System for Personalized Services and Offers in a Shopping Center**

**Funded by:** Zendos Tecnología S.L.

**Duration:** The project was launched in December 2014. The total duration of the contract is to be confirmed

**Project partners:** Zendos Tecnología S.L., IMDEA Networks Institute

The project will contribute to the development of a system that provides personally-adapted services to the customers of a shopping center. This involves defining a reference architecture for the system, which will define how to integrate and analyze multiple data inputs about customer behavior and habits, in order to provide them with a collection of personally adapted services and offers. In particular, the system will include a wireless real-time location system to locate customers in the shopping center and provide location-based services to them.

## SDN@EDGE – Software Defined Networks at the Edges

**Funded by:** EIT ICT Labs (Telecom Italia Spa sub-grants to IMDEA Networks)

**Duration:** The commencement date is to be confirmed. The project will have a total duration of 12 months

**Project partners:** Telecom Italia Spa (subgrant to IMDEA Networks Institute), Politecnico di Torino, Acreo AB, Deutsch Telekom AG, SICS, Swedish Institute of Computer Science AB, CREATE-NET, University of Bologna, Fraunhofer Gesellschaft, Orange, Ericsson AB, Université Pierre et Marie Curie -Paris 6

The overall goal of the activity is about **accelerating the exploitation of SDN and NFV in order to produce business impacts (even in the short-medium term) at the edge of fixed networks** (aggregation, access segments up to the end users premises) **and in the access mobile networks** (mobile backhaul and aggregation network). Specifically, the activity will address three objectives: i) defining SDN requirements, validation procedures and best practices in order to specify the framework to establish a Certification Center for Business Acceleration of SDN ii) deploying field trials to develop and validate three main SDN use-cases (for home GW, for edge virtual services and for reliability in mobile backhaul) iii) defining and testing new business models (e.g. typical of ecosystems) - very needed today supporting the transition towards “Softwarization”. A highly distributed test-bed provided by Partners will be the experimental environment which attracts also SME and Users to implement and accelerate scenarios with real business impact (e.g. Internet of Things, Robot as a Service).



## TALENTUM – Fundación SEPI- Telefónica Scholarship Program: Talentum Startups 2015

**Project website:** <https://talentum.telefonica.com/>

**Funded by:** Fundación SEPI (Sociedad Estatal de Participaciones Industriales) – Telefónica España

**Duration:** February 2015 to July 2015

**Project partners:** Telefónica S.A.; IMDEA Networks Institute

## Telefónica - IMDEA Networks Joint Research Unit in 5G technologies

On May 2014, IMDEA Networks Institute and Telefónica Research and Development create a Joint Research Unit (JRU) named “Telefónica - IMDEA Networks Joint Research Unit in 5G technologies”. The **development of 5G** has already become a landmark in the global competition for technological leadership. Over the next seven years, this **private-public alliance** will share a wealth of know-how and in-house capabilities to tackle the challenge of creating a blueprint for the new technology and the standards that are to define **future ICT networks**.

Located at IMDEA Networks’ headquarters in Madrid, the aim of the **JRU Telefónica I+D - IMDEA Networks** is to establish a strategic partnership that provides an operational framework for close interaction in a varied set of scientific activities. In particular, the JRU brings together a team comprising highly specialized multidisciplinary profiles ready to work collaboratively on externally-funded R&D projects. One of the main areas in which this collaboration will be reflected is the program “**Advanced 5G Network Infrastructure for Future Internet PPP**”, sponsored by the EU Commission within the “Horizon 2020” program.

The private-public alliance will share a wealth of know-how and in-house capabilities to tackle the challenge of creating a blueprint for the new technology and the standards that are to define future ICT networks. Work led by experienced researchers will focus on key **5G enablers** such as flexible functional split, joint handover optimization, 60GHz wireless networks, network function operating systems, secure virtual computing and green networking.

### 6.3.1. Industry partners

Our technology transfer activities have led to **a significantly increased portfolio of companies we collaborate with**. During 2014 they were the following:



Alcatel-Lucent Bell Labs  
(USA & France)



Amadeus



Swiss Confederation:  
Armasuisse – Science  
and Technology



Boeing



Cisco Systems



Commissariat à l'Energie  
Atomique et aux Energies  
Alternatives



CREATE-NET: Center for  
REsearch And Telecommu-  
nication Experimentation for  
NETworked communities



CZ.NIC



Ericsson



France Telecom SA (FT)



Fujitsu Technology Solutions  
(FTS)



Hewlett Packard Italiana SRL



Indra



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



INTEL Corporation



Intel Mobile Communications  
France



NEC Europe Ltd.



Nokia



Portugal Telecom Inovação



Sagemcom Broadband SAS



Sigma Orionis



Spotify



Telefónica S.A.



Telefónica I+D



Technicolor R&D



Telecom Italia S.p.a.



Signalion GmbH



Thales.



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.



## 6.4. Other collaborations

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

In 2014, the **Oficina de Proyectos Europeos Madri+d – IMDEA (Madri+d – IMDEA European Projects Bureau)** was launched as a networked structure to support the participation of its member corporations in European programs. It is made up of IMDEA Water, IMDEA Food, IMDEA Energy, IMDEA Materials, IMDEA Nanoscience, IMDEA Networks, IMDEA Software and the Foundation for Knowledge 'Madri+d' in a coordination role.

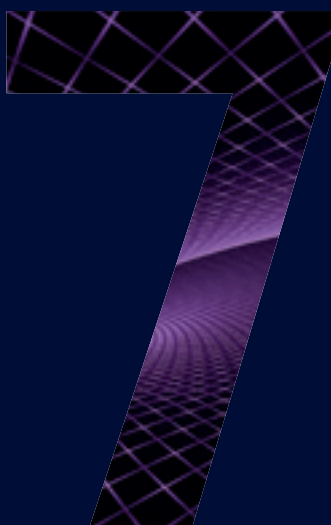


The IMDEA Centers, whose end is **to create a solid base for the generation of knowledge** within the Community of Madrid with a critical presence in each of the selected scientific fields, strive to meet the objectives established in the EU program Horizon 2020.





# 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 Institute, 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

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**PhD:** Polytechnic University of Madrid, Spain

**Research:** Carrier-grade Wireless Mesh Networks; Future Media Internet; Multi-path Protocols; Vehicular Networks

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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, REP-SOL 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

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**PhD:** Polytechnic University of Catalonia, Barcelona, Spain

**Research:** Performance Evaluation and Resource Allocation in Wireless Networks

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## Short Bio:

Dr. Albert Banchs received his Telecommunications Engineering degree from UPC BarcelonaTech, Spain, in 1997, and the PhD degree from the same university in 2002. He was a visitor researcher at ICSI, Berkeley, CA, in 1997, worked for Telefonica I+D, Spain, in 1998, and for the Network Laboratories of NEC Europe Ltd., Germany, from 1998 to 2003. Since 2003, he is with Univeristy Carlos III of Madrid, where he currently holds the position of Associate Professor. Since 2009, he also has a double affiliation as Deputy director of the IMDEA Networks research institute (he was acting director from 2009 to 2012). He was Academic Guest at ETHZ in 2012, and Visiting Professor at EPFL in 2013.

Dr. Banchs authors more than 100 conference and journal papers, including publications at top conferences such as IEEE INFOCOM, ACM CoNEXT, ACM IMC and IEEE ICNP, and at top journals such as IEEE/ACM ToN, IEEE TMC, IEEE TVT and ACM TOMCCAP. He has an H-index of 23 and has received over 2000 citations. Prof. Banchs is editor for IEEE Transactions on Wireless Communications (since 2014) and has been area editor for Computer Communications (2010-2014) and editor for IEEE Communications Letters (associate editor in 2005-2010 and senior editor in 2010-2012). He has been guest editor for a number of journals (Computer Net-

works, Computer Communications, Pervasive Mobile Computing and IEEE Wireless Communications) and has served in many TPCs (including IEEE INFOCOM, IEEE GLOBECOM, IEEE ICC, IEEE WoWMoM, IEEE PIMRC, IEEE WCNC, IEEE VTC, ITC and ACM WiNTECH). He has been general chair of IEEE Online GreenComm 2013 and ACM WiNTECH 2013, and TPC co-chair of IEEE WoWMoM 2012, European Wireless 2010 and IEEE HotMESH 2010.

Prof. Albert Banchs has been a key contributor to many EU projects. He was activity leader in the Daidalos I project (2003-2006), deputy WP leader in Daidalos II (2006-2008), the coordinator of the CARMEN project (2008-2010) and principal investigator for the projects FLAVIA (2010-2013) and MEDIEVAL (2010-2013). Currently, his main effort is the coordination of the iJOIN project (2012-2015). Dr. Banchs has also been the principal investigator of several industry contracts, is the inventor of 6 patents (3 of which have been granted, 2 in several countries) and authors a number of standardization proposals at the IETF and the IEEE. Some of the algorithms that he has devised have been incorporated to commercial products (such as the QoS Server of NEC).

Dr. Banchs has received a number of awards, including the national prize to the best PhD thesis on broadband networks, the runner-up award to the best collaborative project in the region of Madrid and the 2013 Excellence Award to Young UC3M Research Staff. He has supervised 3 PhD theses, all of them recipient of the Outstanding PhD award of University Carlos III of Madrid, and has received the SATIN award of the CONTENT Network of Excellence for his paper at IEEE INFOCOM 2009, the AT4Wireless award for his paper at the JITEL 2007 conference and the Best Paper Runner-up Award at ICNP 2014. The MEDIEVAL project was short-listed as one of the three finalists for the Future Internet award 2012. Prof. Banchs is a Senior Member of IEEE. His research interests include the resource allocation, design of novel algorithms and performance evaluation of wired and wireless networks.

# 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. Joerg WIDMER

Research Professor (tenured)  
& Research Strategy Manager

**PhD:** University of Mannheim. Germany

**Previous Position:** Manager. Docomo Euro-Labs. Munich. Germany

**Research:** Computer Networks, in particular Wireless Networking; Extremely High Frequency Communication (60GHz); Network Coding; Mobile Network Architectures; Transport Protocols

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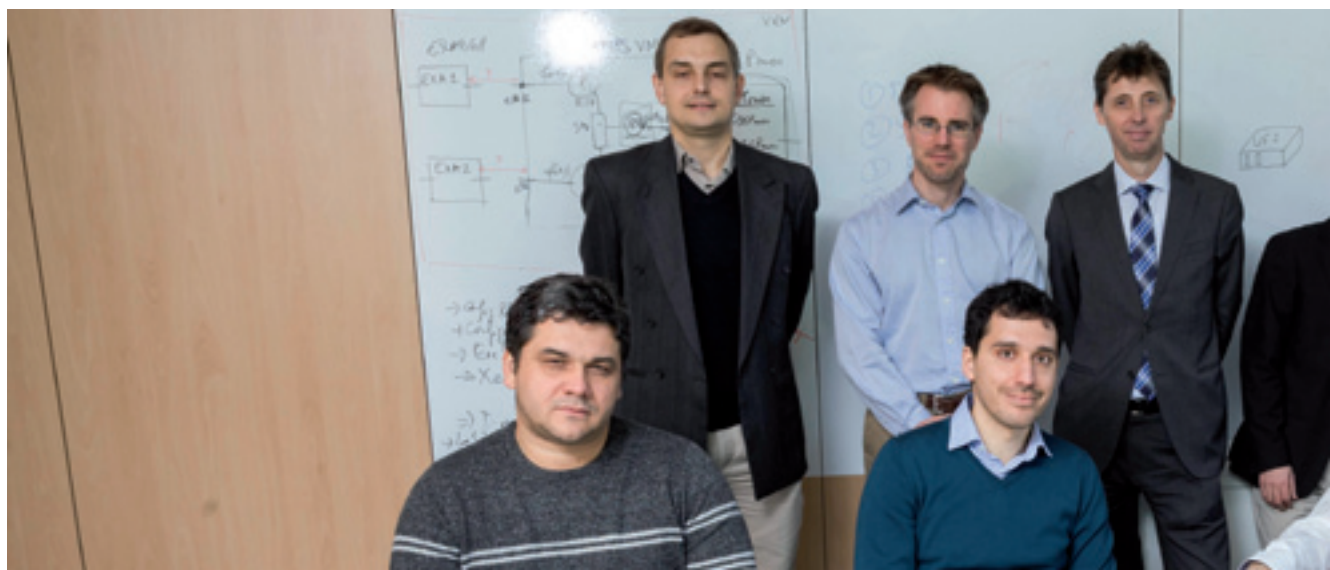
**Personal Site:** [http://people.networks.imdea.org/~joerg\\_widmer/](http://people.networks.imdea.org/~joerg_widmer/)

## Short Bio:

Joerg Widmer is Research Professor at Institute IMDEA Networks 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 Extremely High Frequency Communication (60GHz) and MAC layer design to 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 13 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.

*IMDEA Networks faculty researchers*







## Dr. Marco AJMONE MARSAN

Research Professor

**Affiliation:** IMDEA Networks Institute and Politecnico di Torino, Italy  
**PhD:** Budapest University of Technology and Economics (honoris causa), Hungary

**Research:** Network and Protocol Performance; Green Networking; Crowdsourcing Systems

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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 an 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. Antonio FERNÁNDEZ ANTA

Research Professor

**PhD:** University of Southwestern Louisiana (now University of Louisiana at Lafayette), USA

**Previous Position:** Full Professor. Universidad Rey Juan Carlos, Madrid, Spain

**Research:** Communications and networks; Parallel and Distributed Processing; Algorithms; Discrete and Applied Mathematics; Big Data and Network Analysis

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### Short Bio:

Dr. Antonio Fernández Anta is a Research Professor at IMDEA Networks. Previously he was a Full Professor at the Universidad Rey Juan Carlos (URJC) and was on the Faculty of the Universidad Politécnica de Madrid (UPM), where we received an award for his research productivity. He was a postdoc at MIT from 1995 to 1997. He has more than 20 years of research experience, with a productivity of more than 5 papers per year on average. He is Chair of the Steering Committee of DISC and has served in the TPC of numerous conferences and workshops. He received his M.Sc. and Ph.D. from the University of Louisiana in 1992 and 1994, respectively. He completed his undergraduate studies at the UPM, having received awards at the university and national level for his academic performance. He is Senior Member of ACM and IEEE.





**Dr. Nicholas F. MAXEMCHUK**  
Research Professor

**Affiliation:** IMDEA Networks Institute and Columbia University in the City of New York. USA

**PhD:** University of Pennsylvania. USA

**Research:** Random Coding Network Services; Advanced Network Design for QoS Deployment; Traffic Engineering in Wireless Networks

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**Personal Site:**

<http://www.ee.columbia.edu/~nick/>

#### Short Bio:

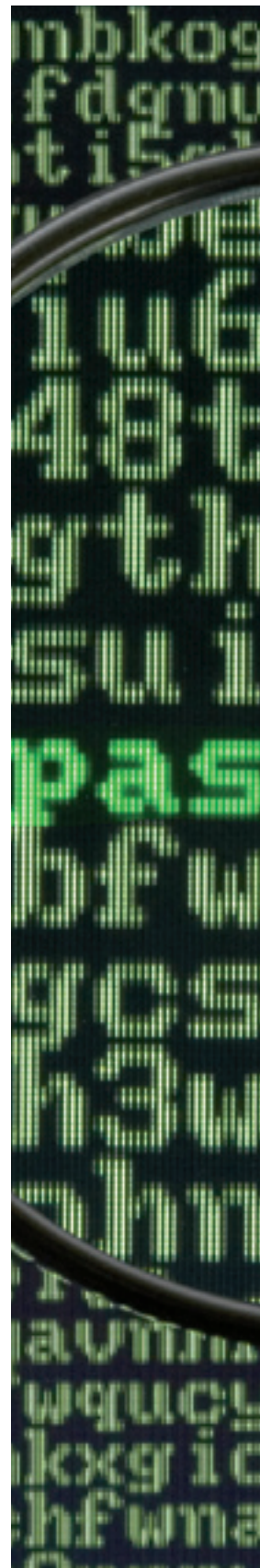
Nicholas Maxemchuk, a networking pioneer, holds a permanent double appointment as Professor at the world-leading Columbia University of New York City (New York, USA) and Research Professor at IMDEA Networks.

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 Society 50th 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.





# 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. Pierre FRANCOIS

Research Associate 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:

Pierre Francois obtained his Ph.D degree in computer science from Université catholique de Louvain, Belgium, in 2007. He is now a Research Associate at the IMDEA

Networks Institute, where he carries out applied research on in collaboration with ISPs on network management. Pierre Francois is also a consultant on routing technologies at Cisco Systems. His work includes several papers published in top conferences and journals within the networking field, as well as multiple Internet Engineering Task Force (IETF) Working Group documents and RFCs, in various working groups of the IETF Routing and IETF Operations and Management areas.



## Dr. Sergey GORINSKY

Research Associate Professor

**PhD:** University of Texas at Austin, USA

**Previous Position:** Assistant Professor. Washington University in St. Louis, USA

**Research:** Computer Networking; Distributed Systems; Network Economics

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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, ACM CoNEXT, IEEE INFOCOM, 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), CoNEXT (2015), INFOCOM (2006-2015), ICNP (2008, 2010-2014), and other networking conferences. Prof. Gorinsky co-chaired the TPCs of COMSNETS 2013, NetSciCom 2014, E6 2012, HSN 2008, FIAP 2008, served as a TPC vice-chair for ICCCN 2009 and TPC area chair for ICNP 2013. He is a member of the COMSNETS Association, a steering committee for COMSNETS conferences.



### Dr. Dejan KOSTIĆ

Research Associate Professor

**PhD:** Duke University. Durham. NC. USA

**Previous Position:** EPFL (École Polytechnique Fédérale de Lausanne). Switzerland

**Research:** Distributed Systems; Computer Networks; Operating Systems; Mobile Computing

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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 Kukiélka 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 Kukiélka 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 "Kukiélka 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. 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

**Research:** Next Generation Wireless Networks; Visible Light Communication Networks; Mobile Indoor Localization; Unmanned Aerial Vehicle Networks; Collaborative Spectrum Sensing

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## Short Bio:

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

Before joining IMDEA, he was a Senior Researcher and Lecturer at ETH Zurich. He also worked as Post-Doctoral Researcher at Disney Research Zurich and at Telefonica Research Barcelona. 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 wireless networking and wireless pervasive systems.

The original contributions he has made to his field of research are exemplified by publications in top conference venues such as ACM MobiCom, ACM CoNEXT (4), IEEE INFOCOM, ACM/IEEE IPSN, 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 communication networks. His approach to scientific work oriented to devise solutions to real-world problems based on real-world assumptions is further proved by five patents.

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





## Dr. Vincenzo MANCUSO

Research Assistant Professor

**PhD:** University of Palermo, Italy

**Previous Position:** Post-Doc Researcher, INRIA Sophia Antipolis, France

**Research:** Opportunistic Wireless Architectures; Infrastructure-less Communications

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### Short Bio:

For more than 10 years, during and after my PhD obtained from University of Palermo (Italy), my research interest has been focusing on the various aspects of cost-effective solutions to enable the efficiency, high throughput and fairness in IP networks. In this field, I also contributed by participating to several European and national projects (in Italy, France, and Spain). At first, influenced by my PhD advisor G. Bianchi, I was interested in proposing solutions for QoS in resource-limited DiffServ IP networks, and so I worked on the characterization and control of IP data traffic. Then my research interest has moved to the support for marked-oriented broadband applications, such as the real time streaming. The work was in particular oriented towards network infrastructures with large coverage, such as cellular networks, vehicular networks, and satellite networks. Then, after having established a collaboration with prof. E. Knightly and his network group at Rice University, Houston, I switched my research focus to new network solutions that were promising low-cost and broadband access to billions of potential users: mesh networks using 802.11 and 802.16 technologies. My work in this field has been both analytical and experimental, with a particular interest for fairness and scheduling issues. Since joining

as post-doc the MAESTRO team in INRIA, in collaboration with prof. E. Altman, my research interest has been shifting to the optimization of wireless networks, and in particular on green deployments for next generation of cellular networks (LTE and HSPA+). In IMDEA Networks, I have focused on analytical and experimental projects on reconfigurable dense cellular networks (802.11, 802.16/LTE), opportunistic wireless networks (WiFi Direct, LTE Direct) and energy efficient network protocols (IEEE 802.3az).

I have participated in several European, French, Italian and Spanish research projects, and my ongoing research activities are mainly part of European projects (ICT CROWD and H2020 MONROE) and Madrid regional projects (TIGRE5-CM).

My publication record includes more than 60 peer reviewed journal articles and conference papers, among which 6 INFOCOM papers and several IEEE transactions, letters and magazines.

# post-doc researchers

Visiting Post-doctoral Researchers at IMDEA Networks Institute are early-stage, post-doctorate researchers who are looking to establish their research career, working with top research professors and a team of young, pre-doctorate researchers.



## Dr. Francois CLAD

Post-Doc Researcher

**BSc:** Computer Science. University of Strasbourg. France

**MSc:** Computer Networks and Embedded Systems. University of Strasbourg. France

**PhD:** Computer Science. University of Strasbourg. France

**Research:** IP Routing; Segment Routing; Internet Measurements

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### Short Bio:

Francois Clad received his B.Sc. and M.Sc. degrees in Computer Science from the University of Strasbourg (France) in 2009 and 2011 respectively. He continued as a Ph.D. student in the Network research group at the same university until 2014. During this period his research mainly focused on convergence issues of intra-domain routing protocols in ISP networks. He is author of several papers on

this subject, which were published in top conferences and journals within the networking field.

Francois Clad joined the IMDEA Networks Institute in 2014 as a post-doctoral researcher, where he is working on intra-domain routing improvement under a Cisco Systems, Inc. consulting contract.



## Dr. Nicolas NICOLAOU

Post-Doc Researcher (Marie Curie Fellow)

**BSc:** Computer Science. University of Cyprus. Nicosia. Cyprus

**MSc:** Computer Science and Engineering. University of Connecticut. Storrs. USA

**PhD:** Computer Science and Engineering. University of Connecticut. Storrs. USA

**Previous Position:** Visiting Lecturer. University of Cyprus. Nicosia. Cyprus

**Research:** Fault-Tolerant Distributed Algorithms; Distributed Storage Systems; Parallel Algorithms; Wireless and Sensor Networks; Security Evaluation and Analysis of Voting Technologies

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### Short Bio:

Nicolas Nicolaou is a Marie Curie Fellow at IMDEA Networks Research Institute since Decem-

ber 2014 with Scientist in Charge Dr. Antonio Fernandez Anta, a Research Associate Professor at the Institute. Previously he held the position of Visiting Lecturer at the University of Cyprus in Nicosia (2011-2013) and he served as a Special Scientist at the Cyprus University of Technology (2013-2014). Before that he worked as a Research Assistant in the Dependable Distributed Systems Lab at the University of Connecticut USA, and as a Senior Research Assistant in the VoTeR Lab at the same University. Nicolas obtained a Ph.D. in 2011 and an M.S. in 2006 from the Department of Computer Science and Engineering at the University of Connecticut. He obtained his B.S. in Computer Science from the University of Cyprus in 2003. His main research interests focus on the analysis, design and implementation of practical and robust distributed and parallel algorithms, design and implementation of algorithms for consistent distributed storage systems, ad-hoc mobile and sensor networks and evaluation and exploitation of voting technologies. His research was published in top conferences like PODC, DISC, SPAA, and journals like JPDC, IEEE Transactions on Information Forensics and Security in the fields of distributed computing, networks and security. For his work he received funding from the Cyprus Research Promotion Foundation (2010-2011) and secured an Intra-European Marie-Curie Fellowship (2014-2016).





### Dr. Elisa ROJAS

Post-Doc Researcher

**BSc:** Telecommunications Engineer. University of Alcalá. Alcalá de Henares. Madrid. Spain

**MSc:** Communication and Information Technologies. University of Alcalá. Alcalá de Henares. Madrid. Spain

**PhD:** Communication and Information Technologies. University of Alcalá. Alcalá de Henares. Madrid. Spain

**Previous position:** Postdoc Researcher. University of Alcalá. Alcalá de Henares. Madrid. Spain

**Research:** Routing; Bridging; Ethernet; Data Center; Software Defined Networking

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### Short Bio:

Elisa Rojas received her M.S. and Ph.D. in Communication and Information Technologies engineering from the University of Alcalá, Spain, in 2011 and 2013 respectively. She worked at Telefonica I+D for 3 years and then joined the Telematics Engineering area of the University of Alcalá in 2010, where her research interests are mainly high performance and scalable Ethernet networks, especially focused on data center networks. She is author of several publications and patents on these subjects, some of them about the ARP-Path and Tori-HLMAC protocols. After working for IMDEA Networks for six months in 2014, currently she is working for Telcaria Ideas S.L. and her work is focused on SDN and NFV.

*IMDEA Networks research team of postdocs, pre-doctoral researchers and engineers*





# 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.



**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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**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

**Previous Position:** Research Scholar. MMU University. Cyberjaya. Malaysia

**Research:** Wireless Communications; Resource Allocation; Opportunistic Scheduling; Cooperative Communications; D2D Communications

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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; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain

**Previous Position:** CEO. Patavina Technologies. Padova. Italy

**Research:** Content Distribution Networks; Network Optimization; Anticipatory Networking; Internet Of Things

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**Pablo CABALLERO**

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Audiovisual Engineering. University Carlos III of Madrid. Madrid. Spain

**Previous Position:** Internship student. NEC Laboratories Europe. Heidelberg. Germany

**Research:** Wireless Communications; Algorithms; Network optimization

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## Roberto CALVO PALOMINO

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Computer Science. University Rey Juan Carlos. Madrid. Spain

**MSc:** Telematics and Computer Science Systems. University Rey Juan Carlos. Madrid. Spain

**Previous Position:** Researcher at LibreSoft and Robotic group. University Rey Juan Carlos. Madrid. Spain

**Research:** Collaborative Spectrum Sensing; Machine Learning; Tracking Algorithms; RGB-D sensors; Augmented Reality

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## Juan Camilo CARDONA

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Telecommunications Engineering. University of Santo Tomás. Medellín. Colombia

**MSc:** Communications Engineering. Technische Universität München. München. Germany; Telematics Engineering. University Carlos III of Madrid. Spain

**Previous Position:** Pre-sale Engineer. ITS. Medellín. Colombia

**Research:** Network Optimization; Metro and Transport Networks; Inter-domain Routing; Technoeconomical Analysis

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## Ignacio CASTRO

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and Internet Interdisciplinary Institute, Open University of Catalonia

**BSc:** Economics. University of Amsterdam. Amsterdam. The Netherlands

**MSc:** Development Economics. Autonomous University of Madrid. Madrid. Spain

**Previous Position:** Macroeconomics Teacher. Montero Espinosa Academy. Madrid. Spain

**Research:** Internet; Economics

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## Angelos CHATZIPAPAS

Pre-doc Researcher

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**BSc:** Computer Engineering and Informatics (5-years). University of Patras. Patras. Greece

**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:** Energy Efficient Networking

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## Luis F. CHIROQUE

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Telematics Engineering. Polytechnic University of Madrid. Madrid. Spain

**Research:** Graph Theory; Social Networks; Big Data; Data Mining; Machine Learning

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## Luca COMINARDI

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Information Engineering (curriculum Computer Science). Università degli studi di Brescia. Brescia. Italy

**MSc:** Computer Science (curriculum Information Technologies and Intelligent Systems). Università degli studi di Brescia. Brescia. Italy; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain

**Research:** Software Defined Networking; Network Function Virtualization; Wireless Networks

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## Evgenia CHRISTOFOROU

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Computer Science. University of Cyprus. Nicosia. Cyprus

**MSc:** Computer Science. University of Cyprus. Nicosia. Cyprus

**Previous Position:** Research Assistant. Department of Computer Science. University of Cyprus. Cyprus

**Research:** Internet-based Computing; Crowdsourcing; Algorithmic & Evolutionary Game Theory; Algorithmic Mechanism Design; Game Theory

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## Miguel Ángel DÍAZ BAUTISTA

Pre-doc Researcher

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**BSc:** Computer Science. University Carlos III of Madrid. Madrid. Spain

**MSc:** Telematics Engineering (current). University Carlos III of Madrid. Madrid. Spain

**Previous Position:** Research scholarship. University Carlos III of Madrid. Madrid. Spain

**Research:** NATs; UAVs

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**Carlos DONATO**

Pre-doc Researcher

**Affiliation:** Institute IMDEA Networks and University Carlos III of Madrid

**BSc:** Telematics Engineering. University Carlos III of Madrid. Spain

**Previous Position:** Internship student. NEC Laboratories Europe. Heidelberg. Germany

**Research:** Wireless Communications; Mobile Networks; Computer Networks; Network Programming

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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; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain

**Previous Position:** Intern. EUPHORBIA Sarl. Cotonou. Republic of Benin

**Research:** Impacts of Internet eXchange Points (IXPs) on the Interdomain Routing in Africa; Routing Architecture; Internet measurement

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**Aymen FAKHREDDINE**

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Telecommunications Engineering. Institut National des Postes et Télécommunications (INPT). Rabat. Morocco

**MSc:** Advanced Wireless Communications Systems. École Supérieure d'Électricité - Supélec. Paris. France; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain

**Previous Position:** Intern. Alcatel-Lucent Bell Labs. Paris. France

**Research:** Indoor Localization; WLAN; GPS; Tracking Algorithms

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**Andra LUTU**

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**Previous Position:** Politehnica University of Bucharest. Romania

**BSc:** Networks and Software for Telecommunications. "Politehnica" University of Bucharest. Romania

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**Previous Position:** Intern. Ericsson. Romania

**Research:** Inter-domain Routing; Traffic Engineering; BGP; Routing Scalability

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## Foivos MICHELINAKIS

Pre-doc Researcher

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**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:** Mobile Networks; Content Distribution Networks; Network Economics

**Joining Date:** Oct 2012

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## José A. RUIPÉREZ-VALIENTE

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Telecommunications Systems. Catholique University of San Antonio. Murcia. Spain

**MSc:** Telecommunication Engineering. University Carlos III of Madrid. Spain

**Previous Position:** Programmer. Accenture Technology Solutions. Spain

**Research:** Learning Analytics; Educational Data Mining; Technology-Enhanced Learning; Visualizations

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## Thomas NITSCHÉ

Pre-doc Researcher

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**MSc:** Diploma in Computer Science. Technische Universität München. Munich. Germany

**Previous Position:** PhD Student. Chair for Network Architectures and Services. Technische Universität München. 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

**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Telecommunications Engineering. University Carlos III of Madrid. Madrid. Spain

**MSc:** Telecommunications Engineering. University Carlos III of Madrid. Madrid. Spain; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain

**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:** Mobility; Wireless Networks; Dense Heterogeneous Networking; SDN; Vehicular Networks  
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## Christian SÁNCHEZ

Pre-doc Researcher (Systems Analyst)

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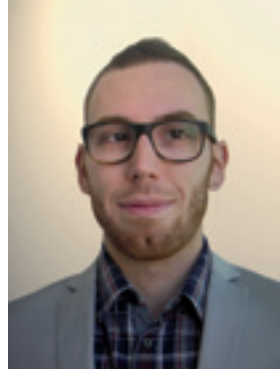
**BSc:** Computer Engineer, Universidad José Antonio Páez, Valencia, Venezuela

**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

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**BSc:** Computer Engineering, Politecnico di Bari, Bari, Italy

**MSc:** Telecommunication Engineering, Politecnico di Milano, Milano, Italy

**Previous Position:** Student Research Assistant, NEC Laboratories Europe, Heilberg, Germany

**Research:** Wireless Communications; Resource Allocation; Opportunistic Scheduling; LTE-A; Cooperative Communications; Game Theory; Distributed Algorithms; D2D Communications

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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:** MAC layer design; 60GHz; IEEE802.11ad; Multicast scheduling

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## Sergio N. TAMUREJO MORENO

Pre-doc Researcher

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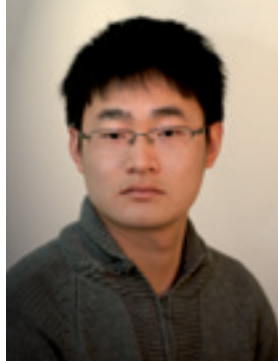
**BSc:** Audiovisual Systems Engineering. University Carlos III of Madrid. Madrid. España

**MSc:** Telematics Engineering. University Carlos III of Madrid. Madrid. España

**Previous Position:** Enterprise Architect. INDRA Systems. Madrid. España

**Research:** Software Defined Networking; Large Scale Networks Measurement, Analytics and Simulation; Programming Communication Services and Protocols

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## Qing WANG

Pre-doc Researcher

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**BSc:** Communication & Information Engineering. University of Electronic Science and Technology of China. Chengdu. China

**MSc:** Communication & Information Engineering. University of Electronic Science and Technology of China. Chengdu. China; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain

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

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## Christian VITALE

Pre-doc Researcher

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**BSc:** Telecommunication Engineering. University of Pisa. Pisa. Italy

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**Previous Position:** Student Research Assistant. NEC Europe Ltd. Heidelberg. Germany

**Research:** Green Networking; IEEE 802.11; 4G; Queueing Theory; Performance Evaluation

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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

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**Research:** Online Algorithms; Distributed and Parallel Algorithms; Distributed Networks; Energy Efficiency; Discrete and Applied Mathematics

**Contact:** elli.zavou@imdea.org



# external PhD students

Our External PhD Students are young, aspiring researchers who are supervised or co-supervised by a member of the IMDEA Networks' research team. Most of the External PhD Students to IMDEA Networks are undertaking the Ph.D. program at University Carlos III of Madrid (UC3M).



**Jordi ARJONA**

External PhD Student

**Affiliation:** University Carlos III of Madrid

**Supervisor:** Dr. Antonio Fernández Anta. IMDEA Networks Institute. Madrid. Spain

**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

**Contact:** jorge.arjona@imdea.org



**Fabio GIUST**

External PhD Student

**Affiliation:** University Carlos III of Madrid

**Supervisor:** Dr. Carlos Jesús Bernardos Cano. Universidad Carlos III de Madrid. Spain

**BSc:** Telecommunications Engineering. University of Padova. Padova. Italy

**MSc:** Telecommunications Engineering. University of Padova. Padova. Italy

**Previous Position:** Intern. Alcatel-Lucent Bell Labs. France

**Research:** Mobility in IPv6 Networks; Routing for Multihomed/Multi-Interface Devices; IP Flow Management

**Contact:** fabio.giust@imdea.org



# research support

Research Support employees at IMDEA Networks Institute 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  
**Contact:** jonathan.almodovar@imdea.org



**Pablo CAMARILLO**  
Research Engineer

**BSc:** Telematics Engineering. University Carlos III of Madrid. Madrid. Spain

**Previous Position:** Internship Student. IMDEA Networks Institute. Madrid. Spain

**Research:** IP Routing protocols; ISP Network Architecture; Segment Routing  
**Contact:** pablo.camarillo@imdea.org



**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  
**Contact:** hector.cordobes@imdea.org



**Rafael GARCÍA**  
Research Engineer

**BSc:** Computer Science. University of Córdoba. Spain

**MSc:** Computational Sciences. University of Amsterdam. The Netherlands

**Previous Position:** R&D Manager. Entropy Computational Services. Madrid. Spain

**Research:** Big Data; Data Science; Computational Science; Natural Computing  
**Contact:** rafael.garcia@imdea.org





**Rosa GÓMEZ**

Research Administrator

**BSc:** Economics. University of Málaga. Málaga. Spain

**MSc:** Master in Economics of Science and Innovation. Barcelona Graduate School of Economics. Barcelona. Spain; Master in Economics and Finance. Centro de Estudios económicos Financieros (CEF). Madrid. Spain

**Previous Position:** R&D Project Manager. e-Helth Foundation (FeSalud). Spain

**Contact:** rosa.gomez@imdea.org



**Philippe MORERE**

Research Engineer

**BSc:** Engineering Sciences. Enseirb-Matmeca. University of Bordeaux 1. France

**MSc:** Computer Sciences & Telecommunications. Enseirb-Matmeca. University of Bordeaux 1. France

**Research:** NLP; Machine Learning; Big Data; Distributed Systems

**Contact:** philippe.morere@imdea.org



**Joel ROSENTAL**

Systems Administrator

**BSc:** Computer Engineering. José Antonio Paéz University. Venezuela

**MSc:** Informatics Engineering. University Carlos III of Madrid. Spain

**Contact:** joel.rosental@imdea.org

**Andrea ISIMINGER**

Project Administrator

**Qualifications:** BA. (Major: English; Minor: German). Northern Illinois University. USA

**Contact:** andrea.isiminger@imdea.org

**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

**Contact:** miguel.peon@imdea.org

**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

**Contact:** agustin.santos@imdea.org



# 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 Telefonica Scholarship Program: Talentum Startups 2014 (see p. 94).

## Guillermo BIELSA

**Supervisor:** Joerg Widmer

**Research:** 60 GHz Communication; IEEE 802.11ad; Wireless Testbed Experiments and Performance Evaluation

## 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

## Patricia CALLEJO

**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

## 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

## Ginés GARCÍA

**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 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

## Diego LUCERO

**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

**Funded by:** Cátedra Telefónica at University Carlos III of Madrid

## Cristina MÁRQUEZ

**Supervisor:** Pierre Francois

**Research:** IP Routing; BGP; Network Management

## 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)

## Giulia RESMINI

**Supervisor:** Vincenzo Mancuso

**Research:** D2D Communication; Wi-Fi and LTE Network Interfaces

## Diego SIERRA

**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



# research team structure

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annual report  
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insular  
**imdea networks**

## networked systems&algorithms

### Researchers:

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

### Pre-Doc Researchers:

- Juan Camilo Cardona
- Ignacio Castro
- Miguel Ángel Díaz Bautista
- Roderick Fanou
- Andra Lutu
- José A. Ruipérez-Valiente
- Christian Sánchez
- Sergio N. Tamurejo Moreno

## wireless networking

### Researchers:

- Dr. Albert Banchs
- Dr. Joerg Widmer
- Dr. Domenico Giustiniano
- Dr. Nicholas Maxemchuk

### Pre-Doc Researchers:

- Nicola Bui
- Pablo Caballero
- Roberto Calvo Palomino
- Luca Cominardi
- Carlos Donato
- Aymen Fakhreddine
- Foivos Michelinakis
- Thomas Nitsche
- 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

### Pre-Doc Researchers:

- Shahzad Ali
- Arash Asadi
- 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 ENTERRÍA

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](mailto:alejandro.girod@imdea.org)

*Admin and research support 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 (1<sup>st</sup> Class Hons) in History and Theory of Art & Film Studies. University of Kent at Canterbury. UK

**Contact:** [rebeca.demiguel@imdea.org](mailto: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](mailto: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](mailto: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.



## Andra LUTU

**Current Position:** Postdoctoral Fellow. Simula School of Research and Innovation (SSRI). Simula Research Laboratory. Fornebu. Norway

**Ph.D. Thesis:** *A system for the detection of Limited Visibility in BGP*

**Ph.D. Date:** Nov 2014

**Ph.D. Supervisor(s):** Dr. Marcelo BAGNULO



## Shahzad ALI

**Current Position:** Assistant professor. Department of Computer Science. COMSATS Institute of Information Technology Abbottabad. Pakistan

**Ph.D. Thesis:** *Performance Evaluation of Floating Content for Context-aware Applications*

**Ph.D. Date:** Oct 2014

**Ph.D. Supervisor(s):** Dr. Marco AJMONE MARSAN, Dr. Gianluca RIZZO & Dr. Vincenzo MANCUSO



## 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:** Research Fellow. IEIIT-CNR. 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:** Software Engineer. Midokura. Barcelona. Spain; Part-time Lecturer. Network Technologies and Strategies Research Group. 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

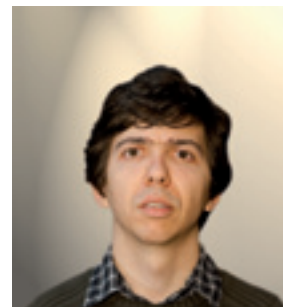
## Paul PATRAS

**Current Position:** Chancellor's Fellow / Lecturer in the School of Informatics at the University of Edinburgh. Scotland

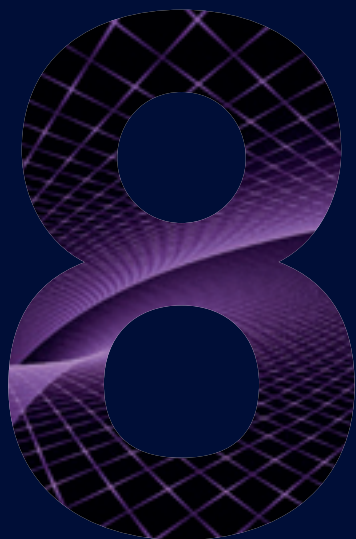
**Ph.D. Thesis:** *Control-Theoretic Adaptive Mechanisms for Performance Optimization of IEEE 802.11 WLANs: Design, Implementation and Experimental Evaluation*

**Ph.D. Date:** Mar 2011

**Ph.D. Supervisor(s):** Dr. Albert BANCHS



# h e a d q u a r t e r s a n d r e s e a r c h l a b o r a t o r i e s i n f r a s t r u c t u r e



8.1. Headquarters [130]

8.2. Research laboratories [131]

a n n u a l r e p o r t

# 2014





## 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.

These laboratories are used for:

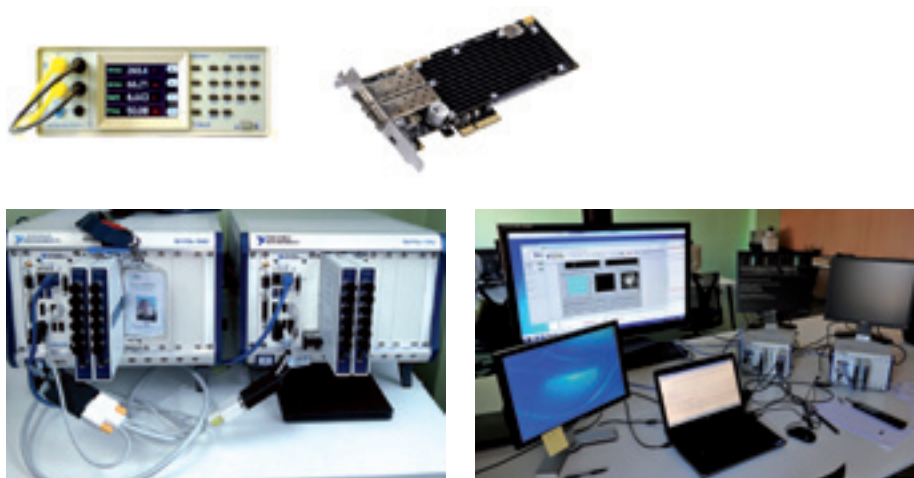
- Constructing prototypes and measuring the devices, protocols and algorithms developed by the researchers.
- Simulating complex base-band and medium access systems, as well as sophisticated radio subsystems.
- Measuring radio parameters involved in mobile, fixed and satellite communications, designing and characterizing radiating elements, and measuring the effects on the radio electric spectrum of new protocols and algorithms designed by the Institute.

Examples of the laboratories capabilities include:

### 8.2.1 Wireless and Big Data Laboratory

#### Measurements/Monitoring

- WiFi monitoring platform for the evaluation of QoE with mobile access points
- Analysis of social network info to infer pre-fetching strategies (eCOUSIN project)
- Measurement-based characterization of network traffic and energy consumption (wireless and wired)



## 8.2.2 Mobile Communications Laboratory



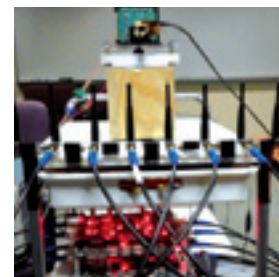
- **Large 802.11 testbeds**
  - Mesh, relay, piggybacking, 802.11aa, 802.11ac
  - Modified firmware (FLAVIA project) for modified MAC
  - Central and distributed control of MAC
- **OFDM/OFDMA (LTE-like)**
  - FPGA testbed with NI-PXI equipment (CROWD project)
  - FPGA MANGO boards
- **802.11+Bluetooth context-aware communications**
  - Android smartphones generating and exchanging content
- **WiMAX**
  - Indoor P2P testbed



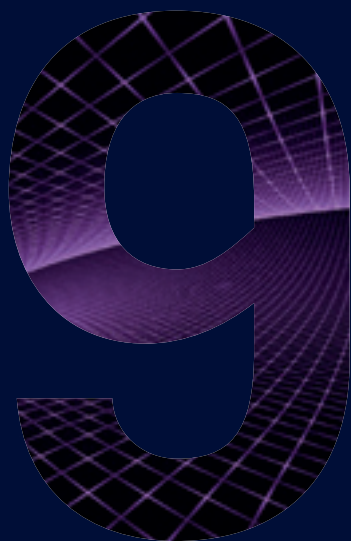
## 8.2.3 Milimeter and Interdomain Routing Laboratory

Recently the wireless lab has acquired 60 GHz equipment:

- **Vubiq mm-Wave Frontends**
  - Transmission of arbitrary wave forms
  - High gain directional antennas with variable beam width
  - Signal strength measurement and emulation of sectorized directional systems
- **WiGig Enabled Docking Station**
  - Dell D5000 dock with Latitude E7440 notebook
  - Electronically steerable antenna array
  - Evaluation of off-the-shelf mm-Wave system
- **Dual-Band Setup (joint work with Rice University)**
  - WARP SDR based direction interference on 2.4 GHz
  - Sectorized mm-Wave system based on Vubiq front-ends
  - Evaluation of dual-band beam steering



# o r g a n i z a t i o n



9.1. Legal status [134]

9.2. Governing bodies & organizational structure [134]

a n n u a l   r e p o r t  
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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.

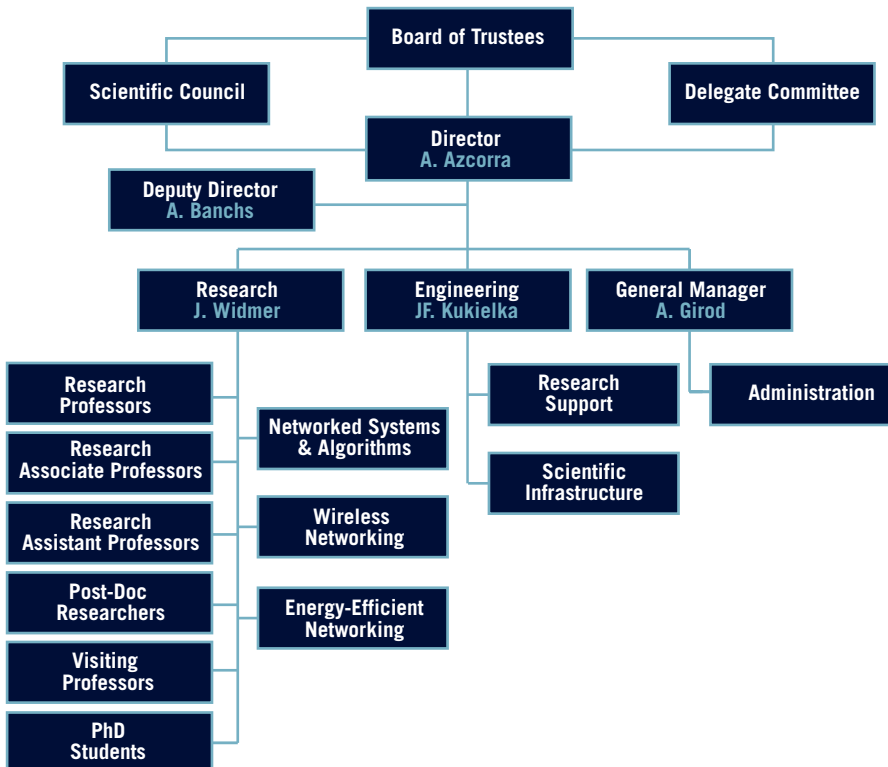
Our Spanish tax identification number (CIF) is G-84912708.

IMDEA Networks Institute’s 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:** Excm. Sra. D<sup>a</sup>. Lucía Figar de Lacalle

### EX OFFICIO TRUSTEES

#### **Excm. Sra. D<sup>a</sup>. 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<sup>a</sup> Lorena Heras Sedano**

*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**

*Deputy Director of Research. Sub-directorate General of Research. Directorate General of Universities and Research. Department of Education, Youth and Sports. Regional Government of Madrid (Madrid, Spain)*

#### **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 Ríos**

*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)*  
 Resigned from this position in November 2014

#### **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)*

## ELECTIVE TRUSTEES – COMPANIES



### Telefónica I+D

*Designated Representative*

Mr. David Pablo Del Val Latorre  
President and CEO, Telefonica I+D (R&D)



### Hewlett-Packard

*Designated Representative*

Ms. Irma Jiménez Guler  
Director of Institutional Relations



### INDRA

*Designated Representative*

Mr. José Luis Angoso González  
Director of Innovation



### SATEC

*Designated Representative*

Mr. Luis Alberto Rodríguez-Ovejero  
Alonso  
Sole Administrator



### TELDAT

*Designated Representative*

Mr. Antonio García Marcos  
President

## ELECTIVE TRUSTEES – COMPANY EXPERTS



### 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)

## ELECTIVE TRUSTEES – INSTITUTIONAL TRUSTEES: UNIVERSITIES

### Universidad Carlos III de Madrid

(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 – Dr. Arturo Azcorra and the Deputy Director – Dr. Albert Banchs – 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



**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



**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, meta-data). He relates these research issues often very closely to mobility, internet telephony, telemedia learning and serious gaming

**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. Pablo RODRIGUEZ RODRIGUEZ**

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