

imdea networks institute

developing the **science of networks**

institute  
**iM**dea  
networks

a n n u a l   r e p o r t



f o r e w o r d

# foreword



**Arturo Azcorra**

Director of the IMDEA Networks Institute

May 2016

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2015

IMDEA Networks Institute is a top research institute in the Science of Networks and Communication Technology worldwide. In 2015, the Institute has continued to boost Madrid's competitiveness as a technology-oriented region. The institute has not only strengthened the technology profile of the region, but its collaboration with local companies has also helped to 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 € 15.7m from competitive funds, of which € 1.9m were budgeted for 2015. Our ultimate goal is to help Madrid make its mark on the 21st Century by focusing on the development of products and services that incorporate the most advanced network and communication technologies.

IMDEA Networks focuses on an area that has a profound impact on people's lives. Over the last decades, the Internet, smartphones, Wi-Fi and social networks have transformed society and the economy. Indeed, 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, and will continue to do so in the future with the deployment of new communication technologies and paradigms.

One of the most promising technologies where the networking research community is currently working on is that of 5G networks. 5G represents a change of paradigm for future networks, pushing for a revolutionary technology with the goal of satisfying new requirements in terms of throughput, latency and scalability for use cases as extreme as augmented reality or the connection of billions of devices.

Currently, Europe betting on 5G technology with a new partnership initiative: the 5G Public-Private-Partnership or 5GPPP. This initiative, which will deliver the technology for mobile communications of the coming decade, has an estimated budget of around 7 billion euro, jointly funded

by the private sector and the European Commission. In line with this initiative, IMDEA Networks has a strong focus on this groundbreaking technology and has established itself as one of the world leaders in the area. To name just a few of our related activities, IMDEA Networks has coordinated the iJOIN project (which is one of the first flagship European projects in 5G), has been technical manager for the CROWD project (selected as one of the early 5G precursor projects) and is currently participating in two European projects of the 5GPPP.

While very substantial efforts have been devoted to the design of the algorithms and protocols required for 5G, the most critical challenge that remains is the experimental validation of these solutions in real-life testbeds. In order to address this issue, Telefonica and IMDEA Networks have jointly founded the 5TONIC initiative, establishing a laboratory that provides an open research and innovation ecosystem in which industry and academia come together to boost technology and business innovative ventures. This laboratory will serve to showcase the capabilities and interoperability of pre-commercial 5G equipment, services and applications by leading global companies in the 5G arena. In parallel, a multilateral agreement has been recently signed around this initiative by the regional government of Madrid, the Ministry of Industry, Energy & Tourism, Telefonica I+D, Ericsson and AMETIC (in addition to IMDEA Networks). All these activities position Madrid at the forefront of scientific leadership in a sector characterized by a high level of innovation.

As well as the above, 2015 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. 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.

# t a b l e o f c o n t e n t s

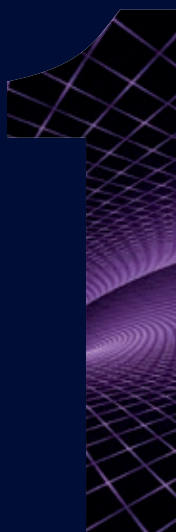
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# executive summary



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**IMDEA Networks Institute is a top international research center in the area of computer networks.** 2015 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 a very selective recruitment process we have continued 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 in 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 have 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 MIT, UC Berkeley, Columbia University, ETHZ, EPFL, Politecnico di Torino or Rice University. Additionally, many of our researchers have received important **awards and prizes** for their research work and achievements.

Our scientists not only have an excellent research record, but also possess an **extensive background in industry**. Most of them have been employed at 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 2015 the Institute graduated five new PhD Students: Dr. Jordi Arjona Aroca, Dr. Fabio Giust, Dr. Ignacio de Castro, Dr. Thomas Nitsche and Dr. Vincenzo Sciancalepore. It is worth highlighting that many of our PhD Students have received important distinctions and have been awarded highly selective scholarships. For instance, Qing Wang was recently awarded the "National Award for Outstanding Self-financed Chinese Students Abroad" and Elli Zavou has participated in the third edition of the Heidelberg Laureate Forum, which is an internationally renowned event.

In 2015, **the Institute has continued to reinforce its research team**. This year our team experienced a substantial increase in the number of Pre-doc and Post-doc Researchers

hired for (and funded by) the various projects and contracts in which the institute is involved. We also received a large number of applications (about 400) from 52 countries for our open Pre-Doc Researcher positions, out of which 9 excellent candidates were selected. Additionally, we hired 4 Post-doc Researchers: Dr. Marco Gramaglia, previously a Research Fellow at IEIT-CNR (Italy), Dr. Aditya Amah, previously Post-doc at ETH Zurich (Switzerland), Dr. Adrian Loch, previously Research Associate Technische Universität Darmstadt (Germany) and Dr. Danilo De Donno, previously Post-doctoral Fellow in the Electromagnetic Lab at University of Salento (Italy).

A key accomplishment of 2015 has been our participation in research projects. These projects bring to the Institute external funding, highly productive collaborations with prominent research institutions and industrial partners, and the opportunity to transform our research ideas into practical deployments. During 2015 IMDEA Networks participated in **17 projects**, which is a notable quantity considering the size of the Institute. Out of these 17 projects, 13 are European, 1 is national and 3 have a regional scope. 5 new European projects (TYPES, ReCRED, mmMAGIC, FLEX5GWARE, NOTRE) were awarded to the Institute in highly competitive calls.

Within the participation in projects, it is worthwhile highlighting the activity of the Institute in 5G. Currently, Europe is betting on 5G technology with the **5G Public-Private-Partnership or 5G PPP** and, in line with this European scale initiative, IMDEA Networks is also putting a strong research effort on this groundbreaking technology. In 2015, two of the Institute's European **projects on 5G technology** (iJOIN and CROWD) finished, both receiving an evaluation of 'excellent'. It should be emphasized that IMDEA Networks played a key role in both projects, as the coordinator of iJOIN and the technical manager of CROWD. Some of the **results obtained were showcased at the 5G booth of the European Commission during the Barcelona Mobile World Congress 2015**. Last but not least, the Institute's director has been elected chairman of the 5G Expert Group from **NetWorld2020**, the European Technology Platform (ETP) for communications networks and services.



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**. In 2015 IMDEA Networks has worked on 4 projects funded by industry (Armasuisse – Science and Technology, Zendos Technologies, Telefónica I+D and Cisco Systems). 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. A noteworthy example of such local alliances is the **strategic partnership** with **Telefonica I+D**, which provides a stable long-term framework to conduct joint research work. The institute maintains a Joint Research Unit (JRU) in 5G technologies with Telefonica I+D. The two institutions have recently launched a very ambitious initiative, **5TONIC**, a **Research and Innovation Laboratory focusing on 5G Technologies** in



which industry and academia come together to boost technology and business innovative ventures. Additionally, Telefonica I+D has continued to fund excellent Internship Students through the TALENTUM program.

**The efforts made by our team to produce outstanding scientific work led to a large number of scientific publications in 2015.** However, rather than their quantity, we would like to emphasize their quality. In 2015 IMDEA Networks has continued to publish at top conferences (5 papers at IEEE INFOCOM, 3 papers at ACM CoNEXT and 1 paper at IEEE ICNP), being one of the very few institutions worldwide with this number of publications at such prestigious conferences. 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 **44.000 citations** in total, which corresponds to an **H index of 96** (meaning that 96 of the articles published by researchers of the Institute have received 96 citations or more).

**These figures place the Institute not only ahead of other Spanish organizations, but also at the forefront of European networking research.**

Among the various research results achieved by the Institute, we would like to highlight one that had a very substantial **impact on the media**: the paper on 'Understanding the detection of fake view fraud in Video Content Portals'. This work focused on one of the hottest topics in today's Internet: the business behind advertising, which is the main economic driver behind the network. Our results showed that online video portals are charging marketers for advertisements even when the actual viewer of the ad is in reality a robot rather than a human being. Such finding had a very profound impact on the main players behind the Internet business. A number of well-established international media such as the Financial Times, BBC, The Guardian, The Times, the Brazilian O Globo and the Italian Corriere della Sera published the story, in addition to national big players such as El País and Europa Press. Following the first wave of media coverage, major industrial players reacted promptly and expressed their concern after the revelation of the research findings, and the Financial Times (among others) followed up with a second article requesting Google to address the issue of fraud.



Last, but not least, another major activity over the past year concerns **the extension of our 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. The building of IMDEA Networks has a total of 4,000 square meters, of which 1,500 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, including laboratories on Interdomain Routing, Wireless Communications, Millimeter Wave, 5G Networks and Underwater Networks. In 2015, the equipment hosted by these laboratories has continued to expand with the most advanced networking devices.

In **summary**, the Institute's **research output** in 2015 comprises publications in books (1), book chapters (2), peer-reviewed international journals and magazines (29), presentations in international conferences (72), funded research projects (17), industry contracts (4), standardization contributions (1), patents (2) and PhD theses defended (5). 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 2015 the Institute raised € 210.929/researcher\*year, published 11.4 papers/researcher\*year, had 2.7 ongoing projects/researcher\*year and had 0.6 PhD theses defended/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*

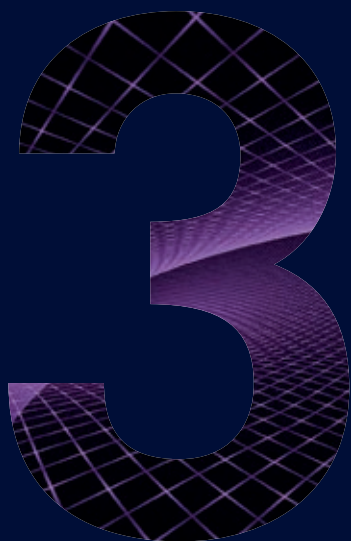
- To compete sportingly across the globe  
*We compete fairly but intensely, according to the letter and spirit of accepted standards. Competition drives us to be the best and most successful in our field*
- To enjoy our work  
*We enjoy what we do and share our enjoyment with each other*

## 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



3.1. **Networked Systems and Algorithms** [16]

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3.3. **Energy-efficient Networking** [19]

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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 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 economic 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



4.1. Funding awards [22]

4.2. Externally-funded research projects,  
attracting European Union, National  
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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. Joerg WIDMER, Research Professor (**ERC Consolidator Grant**)  
Principal Investigator of the **SEARCHLIGHT** research project. *This project is executed by IMDEA Networks and runs from April 2014 to March 2019.*

#### Funded by

European Union. European Research Council (ERC Grants)



**European Research Council**  
Established by the European Commission

### “MARIE CURIE” AMAROUT II Europe Programme

#### Awardees

- Dr. Paolo CASARI, Research Assistant Professor
- Dr. Domenico GIUSTINIANO, Research Assistant Professor
- Dr. Kirill KOGAN, 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. Joerg WIDMER, Research Professor
- Dr. Vincenzo MANCUSO, Research Assistant 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*)

## Grant to promote youth employment and the implementation of the Youth Guarantee system in R&D+I

*(Ayudas para la promoción de empleo joven e implantación de la garantía juvenil en I+D+i)*



### Awardees

- Alejandro REYES, Junior Software Developer

### Funded by

National Programme for the Promotion of Talent and Its Employability in R&D+I. Spanish Ministry of Economy and Competitiveness (*Ministerio de Economía y Competitividad - MINECO*)

## 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 March 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**.



## BRADE-CM

*BRAIn inspired Data Engineering*

Project website: <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:** <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 deploy-

ment, 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.





## Cloud4BigData

*Efficient Cloud and BigData Infrastructure*

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

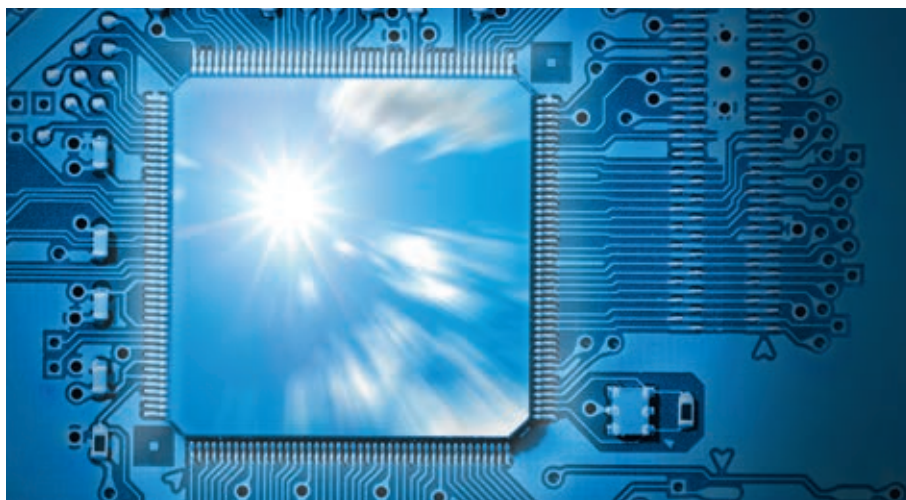
**Funded by:** Department of Education, Youth and Sports of the Regional Government of Madrid, through the 2013 R&D technology program for research groups, co-financed by Structural Funds of the European Union

**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.**



## TEAM

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

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

Project website: <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 Förderung 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 Mobilities), 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.



Project website: <http://www.recred.eu/>

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 Ltd., 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.

## MONROE

*Measuring Mobile Broadband Networks in Europe*

Monroe

**Project website:** <https://www.monroe-project.eu/>

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

**Duration:** March 2015 to February 2018

**Project partners:** Simula Research Laboratory AS, IMDEA Networks Institute, Karlstads Universitet (KAU), Politecnico di Torino (PoliTO), Celerway Communication AS, Telenor ASA, Nextworks

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*

Project website: [www.types-project.eu](http://www.types-project.eu)

Funded by: European Union. ICT Programme H2020

Duration: June 2015 to December 2017

Project partners: Eurecat – Technology Centre of Catalonia, NEC Europe Ltd., Wedia Ltd., Asociación de Usuarios de Internet (AUI), IMDEA Networks Institute, The Open University of Israel, Universidad Carlos III de Madrid, Internet Advertising Bureau (IAB) Europe, UPCOM Bvba, Telefónica I+D

**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.



## mmMAGIC

*Milimetre-Wave Based Mobile Radio Access Network for Fifth Generation Integrated Communications*



**Project website:** <https://5g-ppp.eu/mmmagic/>

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

**Duration:** July 2015 to June 2017

**Project partners:** Samsung Electronics Ltd. (UK), Ericsson AB, Aalto University (Aalto Korkeakoulusaatio), Alcatel-Lucent Deutschland AG, Commissariat à l'Energie Atomique et aux Energies Alternatives, Fraunhofer-Gesellschaft Zur Foerderung Der Angewandten Forschung E.V., Huawei Technologies Dusseldorf GmbH (HWDU), INTEL Mobile Communications GmbH, IMDEA Networks Institute, Nokia Solutions and Networks Sp. z o.o., Nokia Solutions and Networks Oy, Orange, Telefónica I+D, University of Bristol, Qamcom Research and Technology AB, Chalmers University of Technology, Keysight Technologies Denmark Aps, Technische Universität Dresden, Rohde & Schwarz GmbH & Co. KG

The mmMAGIC (Millimetre-Wave Based Mobile Radio Access Network for Fifth Generation Integrated Communications) project will **develop and design new concepts for mobile radio access technology (RAT) for mmwave band deployment**. This is envisaged as a key component in the 5G multi-RAT ecosystem and will be used as a foundation for global standardization. The project will thus enable ultrafast mobile broadband services for mobile users, supporting UHD/3D streaming, immersive applications and ultra-responsive cloud services.

The consortium brings together major infrastructure vendors (Samsung, Ericsson, Alcatel-Lucent, Huawei, Intel and Nokia), major European operators (Orange, Telefonica), leading research institutes and universities (Fraunhofer HHI Institute, CEALETI, IMDEA Networks, Universities Aalto, Bristol, Chalmers and Dresden), measurement equipment vendors (Keysight Technologies, Rohde & Schwarz) and one SME (Qamcom). To complement its strong industry leadership and academic excellence, the project has an Advisory Board drawn from major European telecommunications regulators in Germany, France, Finland, Sweden and the UK.

A new radio interface, including novel network management functions and architecture components will be proposed, taking as guidance 5G PPP's KPI and exploiting the use of novel adaptive and cooperative beam-forming and tracking techniques to address the specific challenges of mm-wave mobile propagation. The project will undertake extensive radio channel measurements in the 6-100 GHz range, and will develop and validate advanced channel models that will be used for rigorous validation and feasibility analysis of the proposed concepts and system, as well as for usage in regulatory and standards fora. **The ambition of the project is to pave the way for a European head start in 5G standards, including 3GPP, and to secure essential IPRs to European industry, strengthening European competitiveness.**

5G







## Flex5GWare

*Flexible and efficient hardware/software platforms for 5G network elements and devices*

*IMDEA Networks Institute participates as a third party of Universidad Carlos III de Madrid*

Project website: <https://5g-ppp.eu/flex5gware>

Funded by: European Union. ICT Programme H2020

Duration: July 2015 to June 2017

**Project partners:** INTEL Mobile Communications GmbH, Alcatel-Lucent Deutschland AG, Commissariat à l'Energie Atomique et aux Energies Alternatives, Consorzio Nazionale Interuniversitario per le Telecomunicazioni, Fundació Centre Tecnològic de Telecomunicacions de Catalunya, Fraunhofer Institute for Applied Solid State Physics IAF, IMINDS VZW, Katholieke Universiteit Leuven, NEC Europe Ltd., Sequans Communications, Telecom Italia S.p.a., Tecnologías, Servicios Telemáticos y Sistemas S.A, Universidad Carlos III de Madrid, Teknologian Tutkimuskeskus VTT, WINGS ICT Solutions, Ericsson AB, Lunds Universitet, Università di Pisa

The **overall objective of Flex5Gware is to deliver highly reconfigurable hardware (HW) platforms together with HW-agnostic software (SW) platforms targeting both network elements and devices and taking into account increased capacity, reduced energy footprint, as well as scalability and modularity**, to enable a smooth transition from 4G mobile wireless systems to 5G. This approach is necessary so that 5G HW/SW platforms can meet the requirements imposed by the anticipated exponential growth in mobile data traffic (1000 fold increase) together with the large diversity of applications (from low bit-rate/power for M2M to interactive and high resolution applications).

Flex5Gware will adopt **a holistic approach performing research and implementations** on key building blocks of 5G (and co-operations among them) **to provide versatile, flexible, reconfigurable, efficient operations for HW/SW platforms**. The development of this concept entails many system design challenges that will be solved through disruptive technologies. E.g., analogue components to enable massive MIMO for mmWave, full duplex (simultaneous transmission and reception) for 5G waveforms, or reconfigurable SW architectures with interface abstractions for flexible control and management mechanisms across heterogeneous wireless devices and access networks.

**Flex5Gware will evaluate and demonstrate the developed 5G technologies in terms of proofs-of-concept**, which will be showcased in a demonstration event where all the partners in the consortium will participate. The Flex5Gware consortium includes large industry leaders from infrastructure providers (ALUD, EAB and NEC), semiconductor manufacturers (IMC) and network operators (TI) as well as leading research institutions and academia and is reinforced with the participation of three SMEs. This powerful consortium ensures a huge impact of the Flex5Gware results.





## HyperAdapt

*Modeling and Online Performance Optimization of Adaptive Networks*



**Funded by:** Spanish Ministry of Economy and Competitiveness (Ministerio de Economía y Competitividad), State Program for Research, Development and Innovation Aimed at Society's Challenges (Programa Estatal de Investigación, Desarrollo e Innovación Orientada a los Retos de la Sociedad), Call 2014 – RDI Projects Within the 2013-2016 Nationwide Plan for Scientific and Technical Research and Innovation (Proyectos de I+D+i, en el marco del Plan Estatal de Investigación Científica y Técnica y de Innovación 2013-2016)

**Duration:** January 2015 to December 2016

While the origins of **Software-Defined Networking (SDN)** date back to the 90s, this research area has not gained popularity until recently. The definitive impulse to SDN has been given with **the creation of the Open Networking Foundation (ONF) in 2011, dedicated to the promotion and adoption of SDN**. Among other activities, the ONF has created and manages the OpenFlow standard. OpenFlow is a protocol that allows a controller to access and modify the forwarding plane (i.e., the routing tables) of routers and switches of a network.

In this project we will explore the intensive **use of SDN for making the Internet scalable, manageable, and adaptable at an industry-grade level**. To achieve this goal we will advance along three lines of research. Firstly, we will evaluate the potential impact of SDN concepts at a fundamental level, working with idealized models of networks and traffic patterns that allow providing provable guarantees. This first line will provide the theoretical foundations that can then be applied to the other two areas we plan to explore. These are intra-domain routing and wireless access solutions. We find these two areas extremely interesting and of high potential impact, because they are the building blocks of the mobile Internet architecture whose traffic demand is currently growing exponentially.

It is worth mentioning that this project considers much richer SDN models than those offered by current versions of OpenFlow. In our models, by means of the SDN underlying protocol, the controller has essentially complete information of the state of all the network elements, and has full control to change them. **One expected outcome of this project is the identification of extensions worth to be added to OpenFlow or any other SDN system.**



**Project website:** <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, Fraunhofer IPT, Telcaria

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

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

NetIDE will approach the problem by proposing an architecture that will allow 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, IMDEA Networks Institute, Signalion GmbH, Universidad Carlos III de Madrid, Universität Paderborn, Avea – Türk Telekom

**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.





- 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.



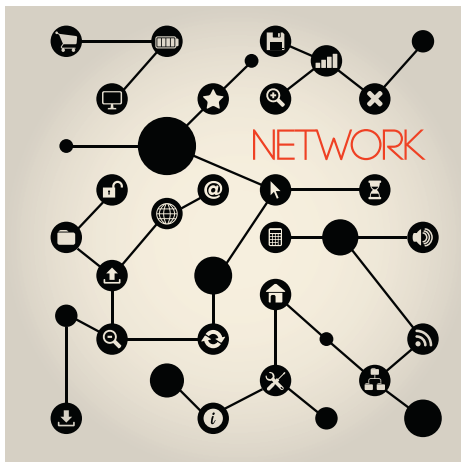
Project website: [www.ict-ecousin.eu](http://www.ict-ecousin.eu)

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 socialcontent 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.







## 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: <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.



#### 4.2.1. Projects commencing in 2016

### Datacenter with High Efficiency

*Optimizing Organization and Scheduling of Datacenter Resources*

**Funded by:** The National Science Foundation of China (NSFC)

**Duration:** January 2016 to December 2020

**Project partners:** Institute of Computing Technology, Chinese Academy of Sciences (ICT), IMDEA Networks Institute, Temple University (USA), Florida International University (USA), Huazhong University of Science and Technology (China)

The number of **data centers** is rapidly growing, and the use of datacenters are increasingly widespread. However, the **efficiency** of the datacenters is very low. Typical resource utilization is about 5% to 25% according to some statistics. Also, the **power consumption** is very high and inefficient. This inefficiency of datacenters wastes hardware and software resources as well as energy, which may hinder further development and usage of datacenters themselves, and also is harmful to the environment. This research investigates techniques that improve efficiency of datacenters through resource organization, allocation, and scheduling. In particular multi-objective optimization models and algorithms will be developed for improving efficiency of datacenters. The objective of this research is to meet the service demands of datacenters while decreasing their resource consumption.





## NOTRE

*Network for sOcial compuTing REsearch*

Project website: <http://notre.socialcomputing.eu/>

Funded by: European Union. H2020-Twinn 2015

Duration: January 2016 to December 2018

Project partners: Cyprus University of Technology (CUT), Foundation for Research and Technology - Hellas (FORTH-ICS), IMDEA Networks Institute, Université de Genève (UNIGE), Heinrich Heine - Universität Düsseldorf (UDUS)

The vision of NOTRE is to develop a network that will strengthen and enhance the potential of the newly established **Social Computing Research Centre (SCRC) at the Cyprus University of Technology (CUT)** for stimulating scientific excellence and innovation capacity in the area of **social aspects of computing**. NOTRE proposes an interdisciplinary approach towards the close network collaboration between SCRC of CUT, a research active university in a low-performing member state, and four internationally-leading counterparts specializing in: (a) online social networks and their analysis; (b) entertainment, games, virtual reality and educational technologies; (c) Social Computing for social inclusion; and (d) Social Computing and social change.

SCRC through this proposal does not only aim to access the core research groups of the leading counterparts, and their collaborators, but also recognizes the **multidisciplinarity** of the field and will try to establish itself as an intermediary between them.

The NOTRE network will follow a series of interlinked activities, such as short term staff exchanges, expert visits and short-term on-site training, workshops, conference attendance, organization of joint summer school type activities, and dissemination and outreach activities. Such activities with world-renowned EU partners (IMDEA Networks; MIRALab of Universite de Geneve; Institute of Computer Science of the Foundation for Research and Technology Hellas -FORTH-ICS; and the Department of Political Science of the University of Dusseldorf - UDUS), will be instrumental for significantly strengthening SCRC's research efforts, enhancing the network's innovation capacity and research profile, and stimulating scientific excellence in the emerging multidisciplinary field of Social Computing. The effective knowledge transfer and sharing through NOTRE will also push for research advancements linked to the Smart Specialization Strategy of Cyprus.

**IMDEA Networks participates in NOTRE as a leading institution in the research and study of online social networks.**



# scientific activities



- 5.1. Awards [48]
- 5.2. Publications [50]
- 5.3. Scientific service [65]
- 5.4. Invited Papers, Keynotes, Invited Talks, Tutorials,  
Lectures, Demos, etc. [74]
- 5.5. Major events [77]
- 5.6. Workshops, seminars & lectures [83]
- 5.7. Local Scientific Partnership [86]

annual report  
2015

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. Paper awards

**Christian Vitale, Vincenzo Sciancalepore, Arash Asadi and Vincenzo Mancuso**

*Best Paper Award* 🏆

*Two-level Opportunistic Spectrum Management for Green 5G Radio Access Networks*

In: The 5th IEEE Online Conference on Green Communications (OnlineGreenComm 2015), 10-12 November 2015, Virtual conference

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

*\*2<sup>nd</sup> Best Demo Award* 🏆

*Using Video Visualizations in Open edX to Understand Learning Interactions of Students*

In: The 10th European Conference on Technology Enhanced Learning, EC-TEL 2015, 15-18 September 2015, Toledo, Spain

**Christian Vitale, Vincenzo Mancuso, Gianluca Rizzo**

*Honorable Mention* 🏆

*Modelling D2D Communications in Cellular Access Networks via Coupled Processors*

In: The 7th International Conference on COMmunication Systems & NETworkS (COMSNETS 2015), 6-10 January 2015, Bangalore, India

### 5.1.2. R&D awards

**IMDEA Networks Institute - Factory Holding Company 25 S.L. of the ZED group**

*Honorable Mention to Public-Private Cooperation with Marketed Research Results* 🏆

Dr. Antonio Fernandez Anta led the Institute's research efforts on this Project Awarded at the madri+d Awards by the Foundation for Knowledge madri+d (Fundación para el Conocimiento madri+d), 22 April 2015

### 5.1.3. Other awards

**Paolo Casari**

- Best Reviewer of 2015: IEEE Journal of Oceanic engineering 🏆
- Casari's Internship Student, **Alain Olivier**, was ranked Student Poster Finalist 🏆 at the MTS/IEEE OCEANS Conference, 18-21 May 2015, Genova, Italy

**Luis F Chiroque**

*PhD Student under the supervision of Dr. Antonio Fernández Anta invited to participate in the Dagstuhl Seminar 15511 on The Graph Isomorphism Problem, 13-18 December 2015, Schloss Dagstuhl, Germany* 🏆

SPRINGER





## 5.2. Publications

IMDEA Networks presented its scientific work in various formats and venues during 2015. There were **131** publications, out of which **104** were peer reviewed. This is how they are structured:

1 book | 2 Book Chapters | 25 Journal Articles | 4 Magazine Articles | 72 Conference or Workshop Papers | 27 Invited Papers, Keynotes, Invited Talks, Tutorials, Lectures, Demos, etc.

As well as the previous there were:

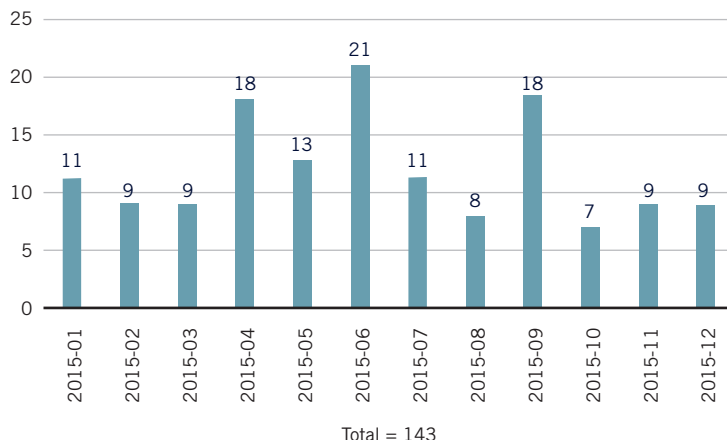
5 PhD Theses | 5 Masters Theses | 1 Standardization Item | 2 Technical Reports

According to **Google Scholar**, IMDEA Networks' researchers have received around **44.835 citations in total** along their research career, which corresponds to an **aggregated H-index of 96**.

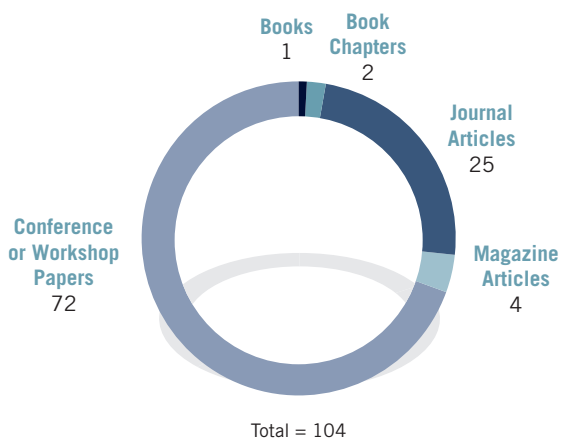


# 2015

## total number of publications per month



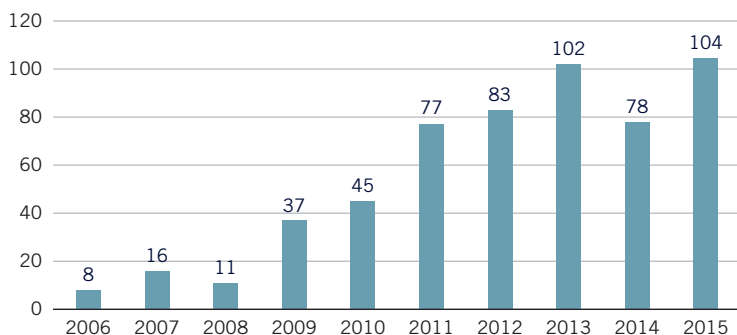
## publications by type (peer reviewed)



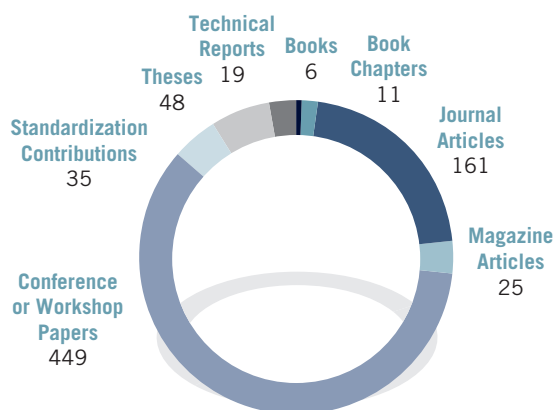


# 2006-2015

## number of publications (peer-reviewed)



## all publications by type



## Publications 2015

### Books [1]

1. Alicia Triviño, Fernando Boavida, Mario Bernardes (September 2015)

*Redes de ordenadores – Tecnologías*

Amazon Digital Services LLC. ISBN ISBN: 978-989-99107-4-4

### Book Chapters [2]

1. Pedro J. Muñoz-Merino, José A. Ruipérez-Valiente, Juan Luis Sanz Moreno, Carlos Delgado Kloos (April 2015)

*Assessment Activities in MOOCs*

In: Furthering Higher Education Possibilities through Massive Open Online Courses. IGI Global, E-Editorial Discovery, 1-308. ISBN 13: 9781466682795

2. Nicholas F. Maxemchuk, Shou-pon Lin, Yitian Gu (March 2015)

*Architectures for intelligent vehicles*

In: Vehicular Communications and Networks: Architectures, Protocols, Operation and Deployment. Elsevier, 275-299. ISBN 978-1-78242-211-2

### Journal Articles [25]

1. Jordi Arjona Aroca, Angelos Chatzipapas, Antonio Fernández Anta, Vincenzo Mancuso (December 2015)

*A Measurement-based Characterization of the Energy Consumption in Data Center Servers*

IEEE Journal on Selected Areas in Communications, 33 (12). pp. 1-15. ISSN 0733-8716

2. Andrés Sevilla, Alberto Mozo, Antonio Fernández Anta (November 2015)

*Node Sampling using Random Centrifugal Walks*  
Journal of Computational Science, pp. 34-45.  
ISSN 1877-7503

3. Francois Clad, Stefano Vissicchio, Pascal Mérindol, Pierre Francois, Jean-Jacques Pansiot (October 2015)

*Computing Minimal Update Sequences for Graceful Router-Wide Reconfigurations*

IEEE/ACM Transactions on Networking 2015, 23 (5). pp. 1373-1386. ISSN 1063-6692

4. Sergio Arévalo, Antonio Fernández Anta, Damien Imbs, Ernesto Jiménez, Michel Raynal (September 2015)

*Failure Detectors in Homonymous Distributed Systems (with an Application to Consensus)*  
*Journal of Parallel and Distributed Computing*, 83. pp. 83-95. ISSN 0743-7315

5. Angelos Chatzipapas, Vincenzo Mancuso (September 2015)

*An M/G/1 Model for Gigabit Energy Efficient Ethernet Links with Coalescing and Real-Trace-Based Evaluation*

IEEE/ACM Transactions on Networking, ISSN 1063-6692

6. Víctor M. López Millán, Vicent Cholvi, Luis López Fernández, Antonio Fernández Anta (September 2015)

*Improving resource location with locally precomputed partial random walks*

Computing, 97 (9). pp. 871-891. ISSN 0010-485X

7. Joerg Widmer, Andrea Capalbo, Antonio Fernández Anta, Albert Banchs (August 2015)

*Efficient Interlayer Network Codes for Fair Layered Multicast Streaming*

IEEE/ACM Transactions on Networking, 23 (4). pp. 1107-1120. ISSN 1063-6692

**8. Pablo Serrano, Andres Garcia-Saavedra, Giuseppe Bianchi, Albert Banchs, Arturo Azcorra (August 2015)**

*Per-Frame Energy Consumption in 802.11 Devices and Its Implication on Modeling and Design*  
IEEE/ACM Transactions on Networking, 23 (4).  
ISSN 1063-6692

**9. Juan Miguel Carrascosa, Rubén Cuevas, Roberto González, Arturo Azcorra, David García (July 2015)**

*Quantifying the Economic and Cultural Biases of Social Media through Trending Topic*  
PLOS ONE, 10 (7). pp. 1-14. ISSN 1932-6203

**10. Antonio Fernández Anta, Chryssis Georgiou, Dariusz R. Kowalski, Elli Zavou (July 2015)**

*Online Parallel Scheduling of Non-uniform Tasks: Trading Failures for Energy*  
Theoretical Computer Science, 590. pp. 129-146. ISSN 0304-3975

**11. Pedro J. Muñoz-Merino, José A. Ruipérez-Valiente, Carlos Alario-Hoyos, Mar Pérez-Sanagustín, Carlos Delgado Kloos (June 2015)**

*Precise Effectiveness Strategy for analyzing the effectiveness of students with educational resources and activities in MOOCs*  
Computers in Human Behavior (Special issue: Learning Analytics, Educational Data Mining and data-driven Educational Decision Making), 47. pp. 108-118. ISSN 0747-5632

**12. José A. Ruipérez-Valiente, Pedro J. Muñoz-Merino, Derick Leony, Carlos Delgado Kloos (June 2015)**

*ALAS-KA: A learning analytics extension for better understanding the learning process in the Khan Academy platform*  
Computers in Human Behavior (Special issue: Learning Analytics, Educational Data Mining and data-driven Educational Decision Making), 47. pp. 139-148. ISSN 0747-5632

**13. Andra Lutu, Marcelo Bagnulo, Cristel Pelsser, Kenjiro Cho, Rade Stanojevic (April 2015)**

*An Analysis of the Economic Impact of Strategic Deaggregation*  
Computer Networks Journal, 81 (C). pp. 147-163. ISSN 1389-1286

**14. Gek Hong Sim, Joerg Widmer, Balaji Rengarajan (April 2015)**

*Opportunistic Finite Horizon Multicasting of Erasure-coded Data*  
IEEE Transactions on Mobile Computing, 15 (3). pp. 705-718. ISSN 1536-1233

**15. Nicola Bui, Michele Rossi (March 2015)**

*Staying Alive: System Design for Self-Sufficient Sensor Networks*  
ACM Transactions on Sensor Networks (TOSN), 11 (3). pp. 40:1-40:42. ISSN 1550-4859

**16. Héctor Cordobés de la Calle, Luis F. Chiroque, Antonio Fernández Anta, Rafael A. García Leiva, Philippe Morere, Lorenzo Ornella, Fernando Pérez, Agustín Santos (March 2015)**

*Empirical Comparison of Graph-based Recommendation Engines for an Apps Ecosystem*  
International Journal of Interactive Multimedia and Artificial Intelligence, 3 (2). pp. 33-39. ISSN 1989-1660

**17. Antonio Fernández Anta, Chryssis Georgiou, Miguel A. Mosteiro, Daniel Pareja (March 2015)**

*Algorithmic Mechanisms for Reliable Crowdsourcing Computation under Collusion*  
PLOS ONE, 10 (3). pp. 1-22. ISSN 1932-6203

**18. Pablo Serrano, Pablo Salvador, Vincenzo Mancuso, Yan Grunenberger (March 2015)**

*Experimenting with Commodity 802.11 Hardware: Overview and Future Directions*  
IEEE Communications Surveys & Tutorials, PP (99). ISSN 1553-877X

**19. Esther M. Arkin, Antonio Fernández Anta, Joseph S. B. Mitchell, Miguel A. Mosteiro (February 2015)**

*Probabilistic bounds on the length of a longest edge in Delaunay graphs of random points in d-dimensions*

Computational Geometry: Theory and Applications, 48 (2). pp. 134-146. ISSN 0925-7721

**20. Andres Garcia-Saavedra, Albert Banchs, Pablo Serrano, Joerg Widmer (February 2015)**

*Adaptive Mechanism for Distributed Opportunistic Scheduling*

IEEE Transactions on Wireless Communications, PP (99). ISSN 1536-1276

**21. Kirill Kogan, Alejandro López-Ortiz, Sergey I. Nikolenko, Alexander V. Sirotkin (February 2015)**

*Online Scheduling FIFO Policies with Admission and Push-Out*

Theory of Computing Systems, pp. 1-22. ISSN 1432-4350

**22. Ioannis Komnios, Fani Tsapeli, Sergey Gorinsky (February 2015)**

*Cost-Effective Multi-Mode Offloading with peer-assisted communications*

Ad Hoc Networks, 25 (Part B). pp. 370-382. ISSN 1570-8705

**23. Balaji Rengarajan, Gianluca Rizzo, Marco Ajmone Marsan (February 2015)**

*Energy-optimal base station density in cellular access networks with sleep modes*

Computer Networks Journal (Special Issue: Green Communications), 78. pp. 152-163. ISSN 1389-1286

**24. Elisa Rojas, Guillermo Ibáñez, José Manuel Giménez-Guzmán, Diego Rivera, Arturo Azcorra (February 2015)**

*Torii: Multipath Distributed Ethernet Fabric Protocol for Data Centers with Zero-Loss Path Repair*  
Transactions on Emerging Telecommunications Technologies, 26 (2). pp. 179-194. ISSN 2161-3915

**25. Fabio Giust, Carlos Jesús Bernardos, Antonio De la Oliva (January 2015)**

*HDMM: Deploying client and network-based Distributed Mobility Management. A hybrid approach*

Telecommunication Systems (Special issue: Mobility Management for Flat Networks), ISSN 1018-4864

## Magazine Articles [4]

**1. Carlos Donato, Pablo Serrano, Antonio De la Oliva, Albert Banchs, Carlos Jesús Bernardos (July 2015)**

*An OpenFlow Architecture for Energy Aware Traffic Engineering in Mobile Networks*

IEEE Network (Special issue: Software Defined Wireless Networks), 29 (4). pp. 54-60. ISSN 0890-804

**2. Qing Wang, Domenico Giustiniano, Daniele Puccinelli (April 2015)**

*An Open-Source Research Platform for Embedded Visible Light Networking*

IEEE Wireless Communications, 22 (2). pp. 94-100. ISSN 1536-1284

**3. Arash Asadi, Vincenzo Sciancalepore, Vincenzo Mancuso (January 2015)**

*On the efficient utilization of radio resources in extremely dense wireless networks*

IEEE Communications Magazine, 53 (1). pp. 126-132. ISSN 0163-6804

**4. Fabio Giust, Luca Cominardi, Carlos Jesús Bernardos (January 2015)**

*Distributed mobility management for future 5G networks: overview and analysis of existing approaches*

IEEE Communications Magazine, 53 (1). pp. 142-149. ISSN 0163-6804

## Conference or Workshop Papers [72]

### 1. Antonio Fernández Anta, Chryssis Georgiou, Elli Zavou (December 2015)

*Adaptive Scheduling over a Wireless Channel under Constrained Jamming (Paper)*

In: The 9th Annual International Conference on Combinatorial Optimization and Applications (COCO A 2015), 18-20 December, 2015, Houston, Texas

### 2. Antonio Fernández Anta, Nicolas Nicolaou, Alexandru Popa (December 2015)

*Making "Fast" Atomic Operations Computationally Tractable (Paper)*

In: The 19th International Conference On Principles of Distributed Systems (OPODIS 2015), 14-17 December 2015, Rennes, France

### 3. Marc Liechti, Vincent Lenders, Domenico Giustiniano (December 2015)

*Jamming Mitigation by Randomized Bandwidth Hopping (Paper)*

In: The 11th International Conference on emerging Networking EXperiments and Technologies (CoNEXT 2015), 1-4 Dec 2015, Heidelberg, Germany

### 4. Thomas Nitsche, Guillermo Bielsa, Irene Tejado, Adrian Loch, Joerg Widmer (December 2015)

*Boon and Bane of 60 GHz Networks: Practical Insights into Beamforming, Interference, and Frame Level Operation (Paper)*

In: The 11th International Conference on emerging Networking EXperiments and Technologies (CoNEXT 2015), 1-4 Dec 2015, Heidelberg, Germany

### 5. Christian Glacet, Marco Fiore, Marco Gramaglia (December 2015)

*Temporal connectivity of vehicular networks: The power of store-carry-and-forward (Paper)*

In: 2015 IEEE Vehicular Networking Conference (VNC), 16-18 December 2015, Kyoto, Japan

### 6. Marco Gramaglia, Marco Fiore (December 2015)

*Hiding Mobile Traffic Fingerprints with GLOVE (Paper)*

In: The 11th International Conference on emerging Networking EXperiments and Technologies (CoNEXT 2015), 1-4 Dec 2015, Heidelberg, Germany

### 7. Marco Gramaglia, Marco Fiore (December 2015)

*On the level of detail of synthetic highway traffic necessary to vehicular networking studies (Paper)*

In: 2015 IEEE Vehicular Networking Conference (VNC), 16-18 December 2015, Kyoto, Japan

### 8. Clarence Filsfils, Nagendra Kumar Nainar, Carlos Pignataro, Juan Camilo Cardona, Pierre Francois (December 2015)

*The Segment Routing Architecture (Paper)*

In: The 13th IEEE Global Communications Conference, Exhibition & Industry Forum (IEEE GLOBECOM 2015), 6-10 December 2015, San Diego, California, USA

### 9. Nicola Bui, Ilaria Malanchini, Joerg Widmer (November 2015)

*Anticipatory Admission Control and Resource Allocation for Media Streaming in Mobile Networks (Paper)*

In: The 18th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (ACM MSWiM 2015), 2-6 November 2015, Cancun, Mexico

### 10. Domenico Giustiniano, Theodoros Bourchas, Maciej Bednarek, Vincent Lenders (November 2015)

*Deep Inspection of the Noise in WiFi Time-of-Flight Echo Techniques (Paper)*

In: The 18th ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (ACM MSWiM 2015), 2-6 November 2015, Cancun, Mexico

**11. Fabian Kaup, Foivos Michelinakis, Nicola Bui, Joerg Widmer, Katarzyna Wac, David Hausheer (November 2015)**

*Behind the NAT – A Measurement Based Evaluation of Cellular Service Quality (Paper)*

In: The 11th International Conference on Network and Service Management (CNSM 2015), 9-13 November 2015, Barcelona, Spain

**12. Christian Vitale, Vincenzo Sciancalepore, Arash Asadi, Vincenzo Mancuso (November 2015)**

*Two-level Opportunistic Spectrum Management for Green 5G Radio Access Networks (Paper)*

In: the IEEE Online Conference on Green Communications (IEEE OnlineGreenComm 2015), 10-12 November 2015, Virtual Conference

**13. Julien Herzen, Albert Banchs, Vsevolod Shneer, Patrick Thiran (November 2015)**

*CSMA/CA in Time and Frequency Domains (Paper)*

In: The 23rd IEEE International Conference on Network Protocols (ICNP 2015), 10-13 November 2015, San Francisco, California, USA

**14. Filippo Campagnaro, Federico Guerra, Federico Favaro, Violeta Sanjuan Calzado, Pedro Forero, Michele Zorzi, Paolo Casari (October 2015)**

*Simulation of a Multimodal Wireless Remote Control System for Underwater Vehicles (Paper)*

In: The 10th ACM International Conference on Underwater Networks & Systems (WUWNet 2015), 22-24 October 2015, Washington DC, USA

**15. Foivos Michelinakis, Gunnar Kreitz, Riccardo Petrocco, Boxun Zhang, Joerg Widmer (October 2015)**

*Passive Mobile Bandwidth Classification Using Short Lived TCP Connections (Paper)*

In: The 8th IFIP Wireless and Mobile Networking Conference (WMNC 2015), 5 October - 7 October 2015, Munich, Germany

**16. Giora Alexandron, José A. Ruipérez-Valiente, David E. Pritchard (October 2015)**

*Evidence of MOOC Students Using Multiple Accounts to Harvest Correct Answers (Paper)*

In: Learning with MOOCs II: A Workshop for Practitioners: New Approaches to Teaching & Learning, 2-3 October 2015, Columbia University, New York, USA

**17. Fiorella Guadagni, Noemi Scarpato, Patrizia Ferroni, Grazia D'Ottavi, Fernando Boavida, Mario Roselli, Graziano Garrisi, Andrea Lisi (October 2015)**

*Personal and sensitive data in the e-health-IoT universe (Paper)*

In: The 2<sup>nd</sup> EAI International Conference on Cognitive Internet of Things Technologies (COIOTE 2015), 26 October 2015, Rome, Italy

**18. Jiri Danihelka, Domenico Giustiniano, Bernhard Plattner (September 2015)**

*On a Cloud-Controlled Architecture for Device-to-Device Content Distribution (Paper)*

In: The 10th ACM MobiCom Workshop on Challenged Networks (ACM Chants 2015), in conjunction with the 21st Annual International Conference on Mobile Computing and Networking (ACM MobiCom 2015), 11 September 2015, Paris, France

**19. Shou-pon Lin, Nicholas F. Maxemchuk (September 2015)**

*A Case Study on Using Probabilistic Verification to Find Failures in a Cooperative Driving Application (Paper)*

In: The 2015 IEEE 82<sup>nd</sup> Vehicular Technology Conference (VTC2015-Fall), 6-9 September 2015, Boston, USA

**20. İñaki Ucar, Arturo Azcorra (September 2015)**  
*Deseeding Energy Consumption of Network Stacks (Paper)*

In: The 1st IEEE International Forum on Research and Technologies for Society and Industry, 16-18 September 2015, Torino, Italy

**21. Christian Vitale, Gianluca Rizzo, Balaji Rengarajan, Vincenzo Mancuso (September 2015)**

*An Analytical Approach to Performance Analysis of Coupled Processor Systems. (Paper)*

In: The 27th International Teletraffic Congress (ITC 27), 8-10 September 2015, Ghent, Belgium

**22. Qing Wang, Domenico Giustiniano, Omprakash Gnawali (September 2015)**

*Low-Cost, Flexible and Open Platform for Visible Light Communication Networks (Paper)*

In: The 2<sup>nd</sup> ACM Workshop on Hot Topics in Wireless (HotWireless 2015), in conjunction with the 21st Annual International Conference on Mobile Computing and Networking (ACM MobiCom 2015), 11 September 2015, Paris, France

**23. Diego Redondo, Pedro J. Muñoz-Merino, José A. Ruipérez-Valiente, Carlos Delgado Kloos, Héctor J. Pijeira Díaz, Javier Santofimia Ruiz (September 2015)**

*Combining Learning Analytics and the Flipped Classroom in a MOOC of maths (Paper)*

In: International Workshop on Applied and Practical Learning Analytics (WAPLA@ECTEL 2015), in conjunction with the 10th European Conference on Technology Enhanced Learning (EC-TEL 2015), 18 September 2015, Toledo, Spain

**24. Antonio Capone, Ilario Filippini, Vincenzo Sciancalepore, Denny Tremolada (August 2015)**

*Obstacle Avoidance Cell Discovery using mm-waves Directive Antennas in 5G Networks (Paper)*

In: The 9th International WDN Workshop on Cloud Cooperated Heterogeneous Cellular Networks for 5G (WDN-CN 2015 Autumn), in conjunction with the IEEE 26th Annual International Symposium on Personal, Indoor and Mobile Radio Communications (IEEE PIMRC 2015), 30 August - 2 September 2015, Hong Kong, China

**25. Renaud Hartert, Stefano Vissicchio, Pierre Schaus, Olivier Bonaventure, Clarence Filsfils, Thomas Telkamp, Pierre Francois (August 2015)**

*A Declarative and Expressive Approach to Control Forwarding Paths in Carrier-Grade Networks (Paper)*

In: The 28th Annual Conference of the ACM Special Interest Group on Data Communication (SIGCOMM) on the applications, technologies, architectures, and protocols for computer communication (ACM SIGCOMM 2015), 17-21 August 2015, London, United Kingdom

**26. Björn Richerzhagen, Dominik Stingl, Julius Ruckert, Ralf Steinmetz (August 2015)**

*Simonstrator: Simulation and Prototyping Platform for Distributed Mobile Applications (Paper)*

In: The 8th EAI International Conference on Simulation Tools and Techniques (SIMUTOOLS 2015), 24-26 August 2015, Athens, Greece

**27. Nils Richerzhagen, Dominik Stingl, Björn Richerzhagen, Andreas Mauthe, Ralf Steinmetz (August 2015)**

*Adaptive Monitoring for Mobile Networks in Challenging Environments (Paper)*

In: The 24th International Conference on Computer Communication and Networks (ICCCN 2015), 3-6 August 2015, Las Vegas, Nevada, USA

**28. Florent Becker, Antonio Fernández Anta, Ivan Rapaport, Eric Rémila (July 2015)**

*Brief Announcement: A Hierarchy of Congested Clique Models: From Broadcast to Unicast (Paper)*

In: The 34th Annual ACM Symposium on Principles of Distributed Computing (ACM PODC 2015), 21-23 July 2015, Donostia-San Sebastián, Spain

**29. Angelos Chatzipapas, Dimosthenis Pediaditis, Charalampos Rotsos, Vincenzo Mancuso, Jon Crowcroft, Moore Andrew W. (July 2015)**

*Challenge: Resolving Data Center Power Bill Disputes: The Energy-Performance Trade-offs of Consolidation (Paper)*

In: The 6th ACM International Conference on Energy-Efficient Computing and Networking (ACM e-Energy 2015), 14-17 July 2015, Bangalore, India

**30. Patrick Eugster, Alex Kesselman, Kirill Kogan, Sergey Nikolenko, Alexander V. Sirotkin (July 2015)**

*Essential Traffic Parameters for Shared Memory Switch Performance (Paper)*

In: The 22<sup>nd</sup> International Colloquium on Structural Information and Communication Complexity (SIROCCO 2015), 15-17 July 2015, Montserrat, Spain



**31. Richard J. Weiler, Wilhelm Keusgen, Michael Peter, Ilario Filippini, Vincenzo Sciancalepore, Thomas Haustein (July 2015)**

*Millimeter-Wave Small-Cell Deployment Scenarios as an Enabler for 5G Applications and Use Cases (Paper)*

In: The 24th European Conference on Networks and Communications (EuCNC 2015), 29 June - 2 July 2015, Paris, France

**32. Lin Wang, Antonio Fernández Anta, Fa Zhang, Jie Wu, Zhiyong Liu (July 2015)**

*Multi-resource energy-efficient routing in cloud data centers with network-as-a-service (Paper)*

In: The 20th IEEE Symposium on Computers and Communications (ISCC 2015), 6-9 July 2015, Larnaca, Cyprus

**33. Arash Asadi, Vincenzo Mancuso, Peter Jacko (June 2015)**

*Floating Band D2D: Exploring and Exploiting the Potentials of Adaptive D2D-enabled Networks (Paper)*

In: The 16th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2015), 14-17 June 2015, Boston, MA, USA

**34. Hany Assasa, Srinivasa Vinay Yadhav, Lars Westberg (June 2015)**

*Service Mobility in Mobile Networks (Paper)*

In: The 8th IEEE International Conference on Cloud Computing (IEEE CLOUD 2015), 27 June - 2 July 2015, New York, USA

**35. Nicola Bui, Joerg Widmer (June 2015)**

*Mobile Network Resource Optimization under Imperfect Prediction (Paper)*

In: The 16th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2015), 14-17 June 2015, Boston, MA, USA

**36. Angelos Chatzipapas, Vincenzo Mancuso (June 2015)**

*Improving the Energy Benefit for 802.3az using Dynamic Coalescing Techniques (Paper)*

In: The 35th IEEE International Conference on Distributed Computing Systems (ICDCS 2015), 29 June - 2 July 2015, Columbus, Ohio, USA

**37. Antonio De la Oliva, Xavier Costa Pérez, Arturo Azcorra, Andrea Di Giglio, Fabio Cavaliere, Dirk Tiegelbekkers, Johannes Lessmann, Thomas Haustein, Alain Mourad, Paola Iovanna (June 2015)**

*Xhaul: Towards an Integrated Fronthaul/Backhaul Architecture in 5G Networks (Paper)*

In: The 24th European Conference on Networks and Communications (EuCNC 2015), 29 June - 2 July 2015, Paris, France

**38. Antonio Fernández Anta, Chryssis Georgiou, Elli Zavou (June 2015)**

*Adaptive Scheduling over a Wireless Channel under Constrained Jamming (Paper)*

In: Doctoral Consortium en Tecnologías Informáticas, XXIII Jornadas de Concurrency y Sistemas Distribuidos (JCSD 2015), 10-12 June 2015, Málaga, Spain

**39. Michela Meo, Yi Zhang, R. Gerboni, Marco Ajmone Marsan (June 2015)**

*Dimensioning the Power Supply of a LTE Macro BS Connected to a PV Panel and the Power Grid (Paper)*

In: The IEEE International Conference on Communications - Smart City & Smart World (IEEE ICC 2015), 8-12 June 2015, London, UK

**40. José A. Ruipérez-Valiente, Pedro J. Muñoz-Merino, Carlos Delgado Kloos (June 2015)**

*A Predictive Model of Learning Gains for a Video and Exercise Intensive Learning Environment (Poster)*

In: The 17th International Conference on Artificial Intelligence in Education (AIED 2015), 22-26 June 2015, Madrid, Spain



**41. Vincenzo Sciancalepore, Ilario Filippini, Vincenzo Mancuso, Antonio Capone, Albert Banchs (June 2015)**

*A semi-distributed mechanism for Inter-cell Interference Coordination exploiting the ABSF paradigm (Paper)*

In: The 12th Annual IEEE International Conference on Sensing, Communication, and Networking (IEEE SECON 2015), 21-25 June 2015, Seattle, USA

**42. Auroux Sebastien, Draexler Martin, Morelli Arianna, Vincenzo Mancuso (June 2015)**

*Dynamic Network Reconfiguration in Wireless DenseNets with the CROWD SDN Architecture (Paper)*

In: The 24th European Conference on Networks and Communications (EuCNC 2015), 29 June - 2 July 2015, Paris, France

**43. Christian Vitale, Gianluca Rizzo, Vincenzo Mancuso (June 2015)**

*A Coupled Processors Model for 802.11 Ad Hoc Networks Under Non Saturation (Paper)*

In: The IEEE International Conference on Communications - Smart City & Smart World (IEEE ICC 2015), 8-12 June 2015, London, UK

**44. Nicholas F. Maxemchuk, Gu Yitian, Li Shou-pon (June 2015)**

*A fail safe broadcast protocol for collaborative intelligent vehicles (Paper)*

In: The 16th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2015), 14-17 June 2015, Boston, Massachusetts, USA

**45. Albert Banchs, Marcus Breitbach, Xavier Costa-Perez, Uwe Doetsch, Simone Redana, Cinzia Sartori, Hans Schotten (May 2015)**

*A NOvel Radio Multiservice adaptive network Architecture for 5G networks (Paper)*

In: The 1<sup>st</sup> International Workshop on 5G Architecture (5GArch 2015), in conjunction with the 2015 IEEE 81<sup>st</sup> Vehicular Technology Conference (VTC2015-Spring), 11-14 May 2015, Glasgow, Scotland

**46. Pablo Caballero, Xavier Costa-Perez, Konstantinos Samdanis, Albert Banchs (May 2015)**

*RMSC: A Cell Slicing Controller for Multi-tenant Mobile Networks (Paper)*

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

**47. Filippo Campagnaro, Federico Favaro, Federico Guerra, Violeta Sanjuan Calzado, Michele Zorzi, Paolo Casari (May 2015)**

*Simulation of Multimodal Optical and Acoustic Communications in Underwater Networks (Paper)*

In: OCEANS 2015 MTS/IEEE Genova, 18-21 May 2015, Genova, Italy

**48. Antonio Capone, Ilario Filippini, Vincenzo Sciancalepore (May 2015)**

*Context Information for Fast Cell Discovery in mm-wave 5G Networks (Paper)*

In: The 21<sup>st</sup> European Wireless Conference (EW 2015), 20-22 May 2015, Budapest, Hungary

**49. Ignacio Castro, Aurojit Panda, Barath Raghavan, Scott Shenker, Sergey Gorinsky (May 2015)**

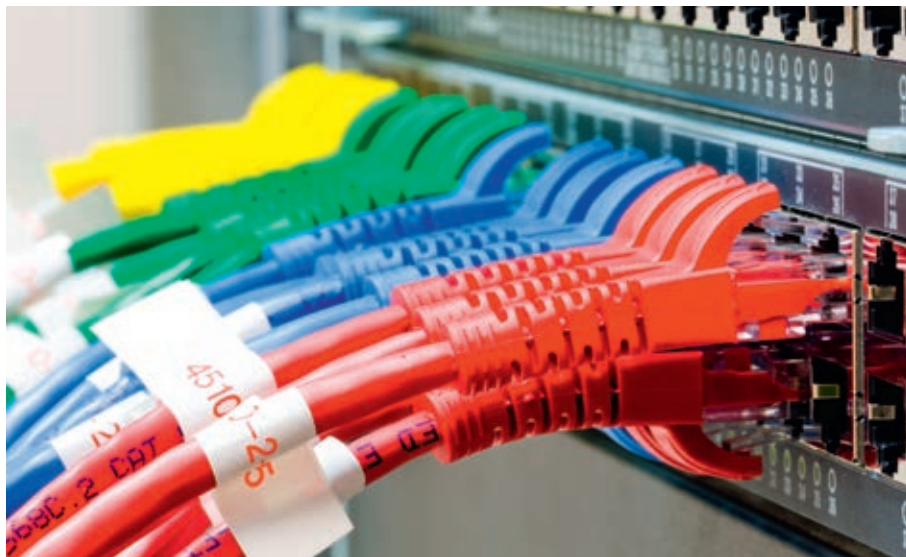
*Route Bazaar: Automatic Interdomain Contract Negotiation (Paper)*

In: The 15th Workshop on Hot Topics in Operating Systems (HotOS XV 2015), 18-20 May 2015, Kartause Ittingen, Switzerland

**50. Antonio Fernández Anta, Chryssis Georgiou, Elli Zavou (May 2015)**

*Packet Scheduling over a Wireless Channel: AQT-based Constrained Jamming (Paper)*

In: The 3rd International Conference on Networked sYstems (NETYS 2015), 13-15 May 2015, Agadir, Morocco



**51. Foivos Michelinakis, Nicola Bui, Guido Fioravanti, Joerg Widmer, Fabian Kaup, David Hausheer (May 2015)**

*Lightweight Mobile Bandwidth Availability Measurement (Paper)*

In: The 14th IFIP Networking 2015 Conference, 20-22 May 2015, Toulouse, France

**52. Alain Olivier, Michele Zorzi, Paolo Casari (May 2015)**

*Modeling the Throughput of 1-persistent CSMA in Underwater Networks (Paper)*

In: OCEANS 2015 MTS/IEEE Genova, 18-21 May 2015, Genova, Italy

**53. Dario Sabella, Peter Rost, Albert Banchs, Valentin Savin, Marco Consonni, Marco Di Girolamo, Massinissa Lalam, Andreas Maeder, Ignacio Berberana (May 2015)**

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

In: The 1<sup>st</sup> International Workshop on 5G Architecture (5GArch 2015), in conjunction with the 2015 IEEE 81<sup>st</sup> Vehicular Technology Conference (VTC2015-Spring), 11-14 May 2015, Glasgow, Scotland

**54. M. Isabel Sanchez, Arash Asadi, Martin Draexler, Rohit Gupta, Vincenzo Mancuso, Arianna Morelli, Antonio De la Oliva, Vincenzo Sciancalepore (May 2015)**

*Tackling the increased density of 5G networks; the CROWD approach (Paper)*

In: The 1<sup>st</sup> International Workshop on 5G Architecture (5GArch 2015), in conjunction with the 81<sup>st</sup> IEEE Vehicular Technology Conference (IEEE VTC2015-Spring), 11-14 May 2015, Glasgow, Scotland

**55. Fabio Giust, Gerald Kunzmann, Daniele Munaretto, Carlos Jesús Bernardos, Bessem Sayadi (May 2015)**

*Caching in flat mobile networks: design and experimental analysis (Paper)*

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

**56. Shahzad Ali, Gianluca Rizzo, Vincenzo Mancuso, Marco Ajmone Marsan (April 2015)**

*Persistence and Availability of Floating Content in a Campus Environment (Paper)*

In: The 34th IEEE International Conference on Computer Communications (IEEE INFOCOM 2015), 26 April - 1 May 2015, Hong Kong, China

**57. Jordi Arjona Aroca, Antonio Fernández Anta (April 2015)**

*Empirical comparison of power-efficient virtual machine assignment algorithms (Paper)*

In: The 4th IFIP Conference on Sustainable Internet and ICT for Sustainability (SustainIT 2015), 14-15 April 2015, Madrid, Spain

**58. Nicola Bui, Stefan Valentin, Joerg Widmer (April 2015)**

*Anticipatory Quality-Resource Allocation for Multi-User Mobile Video Streaming (Paper)*

In: The 2<sup>nd</sup> Workshop on Communication and Networking Techniques for Contemporary Video, in conjunction with the 34th IEEE International Conference on Computer Communications (IEEE INFOCOM 2015), 26 April-1 May 2015, Hong Kong, China, 27 April 2015, Hong Kong, China

**59. Luis F. Chiroque (April 2015)**

*New Methods for Ranking Influence in Social Networks (Poster)*

In: The 5th PhD School on Traffic Monitoring and Analysis (TMA) 2015, in conjunction with the 7th International Workshop on Traffic Monitoring and Analysis (TMA 2015), 21-24 April 2015, Barcelona, Spain

**60. William Culhane, Kirill Kogan, Chamikara Jayalath, Patrick Eugster (April 2015)**

*Optimal Communication Structures for Big Data Aggregation (Paper)*

In: The 34th IEEE International Conference on Computer Communications (IEEE INFOCOM 2015), 26 April - 1 May 2015, Hong Kong, China

**61. Roderick Fanou, Pierre Francois, Emile Aben (April 2015)**

*On the Interdomain Topology of Africa (Poster)*

In: The 5th PhD School on Traffic Monitoring and Analysis (TMA) 2015, in conjunction with the 7th International Workshop on Traffic Monitoring and Analysis (TMA 2015), 21-24 April 2015, Barcelona, Spain

**62. Dimitrios Lymberopoulos, Domenico Giustiniano, Vincent Lenders, Maurizio Rea, Andreas Marcaletti, - et al. (Microsoft Indoor localization Competition 2014) (April 2015)**

*A Realistic Evaluation and Comparison of Indoor Location Technologies: Experiences and Lessons Learned (Paper)*

In: The ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN 2015), 13-16 April 2015, Seattle, USA

**63. Thomas Nitsche, Adriana B. Flores, Edward W. Knightly, Joerg Widmer (April 2015)**

*Steering with Eyes Closed: mm-Wave Beam Steering without In-Band Measurement (Paper)*

In: The 34th IEEE International Conference on Computer Communications (IEEE INFOCOM 2015), 26 April - 1 May 2015, Hong Kong, China

**64. Jorge Ortin, Pablo Serrano, Carlos Donato (April 2015)**

*Modeling the Impact of Start-Up Times on the Performance of Resource-on-Demand Schemes in 802.11 WLANs (Paper)*

In: The 4th IFIP Conference on Sustainable Internet and ICT for Sustainability (SustainIT 2015), 14-15 April 2015, Madrid, Spain





**65. Chuprikov Pavel, Nikolenko Sergey, Kirill Kogan (April 2015)**

*Priority Queueing with Multiple Packet Characteristics (Paper)*

In: The 34th IEEE International Conference on Computer Communications (IEEE INFOCOM 2015), 26 April - 1 May 2015, Hong Kong, China

**66. Damian Pfammatter, Domenico Giustiniano, Vincent Lenders (April 2015)**

*A Software-defined Sensor Architecture for Large-scale Wideband Spectrum Monitoring (Paper)*

In: The ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN 2015), 13-16 April 2015, Seattle, USA

**67. Alberto Tarable, Alessandro Nordio, Emilio Leonardi, Marco Ajmone Marsan (April 2015)**

*The Importance of Being Earnest in Crowdsourcing Systems (Paper)*

In: The 34th IEEE International Conference on Computer Communications (IEEE INFOCOM 2015), 26 April - 1 May 2015, Hong Kong, China

**68. Roderick Fanou, Pierre Francois, Emile Aben (March 2015)**

*On the Diversity of Interdomain Routing in Africa (Paper)*

In: The 16th International Conference on Passive and Active Measurement (PAM 2015), 19-20 March 2015, New York City, NY, USA

**69. Rohit Gupta, Bjoern Bachmann, Andreas Kruppe, Russell Ford, Sundeep Rangan, Nikhil Kundargi, Amal Ekbal, Karamvir Rathi, Arash Asadi, Vincenzo Mancuso, Arianna Morelli (March 2015)**

*LabVIEW based Software-Defined Physical/MAC layer architecture for prototyping dense LTE Networks (Paper)*

In: The 6th Wireless Innovation Forum Conference on Wireless Communications Technologies and Software Defined Radio (WInnComm 2015), 24-26 March 2015, San Diego, California, USA

**70. Anton Beitler, Andreas Tollkuhn, Domenico Giustiniano, Bernhard Plattner (January 2015)**

*CMCD: Multipath Detection for Mobile GNSS Receivers (Paper)*

In: The 2015 International Technical Meeting of The Institute of Navigation, 26-28 January 2015, Dana Point, California

**71. Christian Vitale, Vincenzo Mancuso, Gianluca Rizzo (January 2015)**

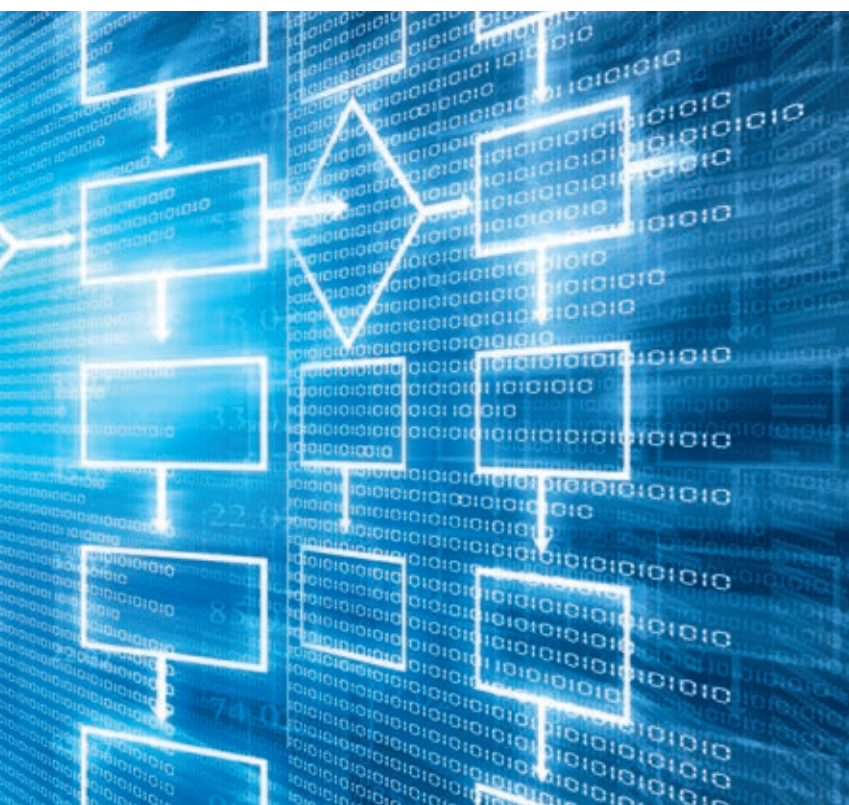
*Modelling D2D Communications in Cellular Access Networks via Coupled Processors (Paper)*

In: The 7th International Conference on Communication Systems & NETWORKS (COMSNETS 2015), 6-10 January 2015, Bangalore, India

**72. Christian Vitale, Vincenzo Mancuso, Gianluca Rizzo (January 2015)**

*Modelling D2D communications in cellular access networks via Coupled Processors (Poster)*

In: The 7th International Conference on Communication Systems & NETWORKS (COMSNETS 2015), 6-10 January 2015, Bangalore, India



## PhD Theses [5]

1. **Vincenzo Sciancalepore (November 2015)**  
*Enhancements in spectrum management techniques for heterogeneous 5G future networks*  
**Phd thesis**, Universidad Carlos III de Madrid, Spain  
Supervisors: Dr. Albert Banchs, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain
2. **Thomas Nitsche (September 2015)**  
*Enhancing Wireless local area Networks by leveraging Diverse Frequency Resources*  
**Phd thesis**, Universidad Carlos III de Madrid  
Supervisors: Dr. Joerg Widmer, IMDEA Networks Institute, Madrid, Spain
3. **Ignacio Castro (July 2015)**  
*Economics of Internet Interdomain Interconnections*  
**Phd thesis**, Internet Interdisciplinary Institute - Open University of Catalonia (IN3 - UOC), Barcelona, Spain  
Supervisors: Dr. Sergey Gorinsky, IMDEA Networks Institute, Madrid, Spain
4. **Fabio Giust (March 2015)**  
*Distributed Mobility Management for a Flat Architecture in 5G Mobile Networks: Solutions, Analysis and Experimental Validation*  
**Phd thesis**, Universidad Carlos III de Madrid, Spain  
Supervisors: Dr. Carlos Jesús Bernardos, Universidad Carlos III de Madrid, Spain
5. **Jordi Arjona Aroca (February 2015)**  
*Structural Issues and Energy Efficiency in Data Centers*  
**Phd thesis**, Universidad Carlos III de Madrid, Spain  
Supervisors: Dr. Antonio Fernández Anta, IMDEA Networks Institute, Madrid, Spain

## Masters Theses [5]

1. **Sergio N. Tamurejo Moreno (September 2015)**  
*Tools for a Multi-Controller SDN Architecture*  
**Masters thesis**, IMDEA Networks Institute  
Supervisors: Dr. Carmen Guerrero, Universidad Carlos III de Madrid, Spain
2. **Carlos Donato (September 2015)**  
*Analysis and implementation of an Infrastructure-on-Demand scheme for 802.11 WLANs*  
**Masters thesis**, Universidad Carlos III de Madrid  
Supervisors: Dr. Pablo Serrano, Universidad Carlos III de Madrid, Spain
3. **Roberto Calvo Palomino (September 2015)**  
*Radio-Signal Correlation for Collaborative Wide-band Spectrum Monitoring System*  
**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisors: Dr. Domenico Giustiniano, IMDEA Networks Institute, Madrid, Spain
4. **Luis F. Chiroque (February 2015)**  
*New Methods for Ranking Influence in Social Networks*  
**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisors: Dr. Antonio Fernández Anta, IMDEA Networks Institute, Madrid, Spain
5. **Pablo Caballero (January 2015)**  
*Resource Allocation for elastic traffic in mobile networks shared by multiple operators*  
**Masters thesis**, Universidad Carlos III de Madrid, Spain  
Supervisors: Dr. Albert Banchs, IMDEA Networks Institute, Madrid, Spain / Universidad Carlos III de Madrid, Spain





### 5.3. Scientific service

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

#### Marco AJMONE MARSAN

##### Professional posts & activities

- Director: “Alta Scuola Politecnica”, 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: 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

- Steering Committee member: The ACM International Conference on Future Energy Systems (ACM e-Energy) conference series, 2012 - 2017
- Panel chair: the 4<sup>th</sup> IFIP Conference on Sustainable Internet and ICT for Sustainability (IFIP/IEEE SustainIT 2015), Madrid (Spain), 14-15 April 2015

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

- The 14<sup>th</sup> 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 13<sup>th</sup> IEEE Global Communications Conference, Exhibition & Industry Forum (IEEE GLOBECOM 2015), San Diego, CA (USA), 6-10 December 2015
- The International Conference on Advances in Computing, Communications & Informatics, Special Session on Energy Efficient Wireless Communications and Networking (IEEE ICCACI 2015), Ernakulam, Kerala (India), 10-13 August 2015
- The 1<sup>st</sup> International Workshop on Sustainability, Implementation and Resilience of Energy-Aware Networks (SIREN 2016), Kauai (Hawaii), 15-18 February 2016

- The 35<sup>th</sup> Annual IEEE International Conference on Computer Communications (IEEE INFOCOM 2016), San Francisco, CA (USA), 10-15 April 2016
- The IEEE ICCE 2016 (International Conference on Communications and Electronics), Ha Long Bay (Vietnam) 27-29 July 2016
- The 28<sup>th</sup> International Teletraffic Congress (ITC 28), Würzburg (Germany), 12-16 September 2016
- The 5<sup>th</sup> International Conference on Advances in Computing, Communications and Informatics (GNDS 2016), Jaipur (India), 21-24 September 2016
- IEEE GLOBECOM 2016, Washington, DC (USA), 4-8 December 2016
- The 26<sup>th</sup> IEEE International Telecommunication Networks and Applications Conference (ITNAC 2016), Dunedin (New Zealand), 7-9 December 2016
- IEEE INFOCOM 2017, Istanbul (Turkey), 14-16 June 2017

## Arash ASADI

### TPC memberships

- The 2015 IEEE 81<sup>st</sup> Vehicular Technology Conference (VTC2015-Spring), Glasgow (Scotland), 11-14 May 2015
- The 24<sup>th</sup> European Conference on Networks and Communications (EUCNC 2015), Paris (France), 29 June – 2 July 2015







## Arturo AZCORRA

### 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: Advanced 5G Network 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 – present
- Member: Board of Mentors of the entrepreneurial association “The Heroes Club”, May 2013 – present
- Advisory Board member: Future Internet PPP, European Commission, February 2012 – present
- Member of the Board of Directors: PhD School, University Carlos III of Madrid, December 2013 – present

### Organization committees

- Member: The Annual Conference of the ACM Special Interest Group on Data Communication (SIGCOMM) on the applications, technologies, architectures, and protocols for computer communication (ACM SIGCOMM), 2007-2015

### TPC memberships

- IFIP/IEEE SustainIT 2015
- IEEE INFOCOM 2015
- IEEE INFOCOM 2016

## Albert BANCHS

### Professional posts & activities

- Steering Board member: the IEEE Online Conference on Green Communications (IEEE OnlineGreenComm), 2014-present
- Member: Steering Board of European Wireless, 2010-2015
- Sponsorship chair: the 11<sup>th</sup> International Conference on emerging Networking EXperiments and Technologies (ACM CoNEXT 2015), Heidelberg, Germany, December 2015
- Director: PhD program in Telematics Engineering, Universidad Carlos III de Madrid, 2013 – present
- Member: Radio Access and Spectrum cluster of the European Commission, 2012 – present
- Member: IEEE Communications Quality and Reliability Technical Committee, 2002 – present
- Member: IEEE Communication Systems Integration and Modeling Technical committee, 2005 – present

### Journal editorial boards

- Area Editor: Computer Communications Journal, 2010 – present
- Editor: IEEE Transactions on Wireless Communications (Elsevier), 2014 – present
- Editor: IEEE Journal of Selected Areas in Communications, Series on Green Communications and Networking", 2015 – present

### TPC memberships

- The 27<sup>th</sup> International Teletraffic Congress (ITC 27), Ghent (Belgium), 8-10 March 2015
- IEEE INFOCOM 2015
- VTC2015-Spring
- TPC co-chair of the First International Workshop on 5G Architecture (5GArch 2015), Glasgow, UK, May 2015
- European Wireless 2015, Budapest (Hungary), 20-22 May 2015
- The 16<sup>th</sup> IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (IEEE WoWMoM 2015), Boston (USA), 14-17 June 2015
- EUCNC 2015
- The 26<sup>th</sup> IEEE Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (IEEE PIMRC 2015), Hong Kong, 30 August – 2 September 2015

## Nicola BUI

### Organization committees

- Finance and Registration Chair: IFIP/IEEE SustainIT 2015

### TPC memberships

- IFIP/IEEE SustainIT 2015





## Paolo CASARI

### Professional posts & activities

- R&D project proposal reviewer, Israel Ministry of Science, Technology and Space

### Organization committees

- Senior member: IEEE INFOCOM

### TPC memberships

- Publicity Co-Chair: Jornadas Nacionales de Ciberseguridad (JNIC 2015), León (Spain) 14-16 September 2015
- Member: the 10<sup>th</sup> ACM International Conference on Underwater Networks & Systems (WUWNet 2015), Washington (USA), 22-24 October 2015
- Member: Giovanni Toso Best Student Paper Committee, WUWNet 2015, Washington (USA), 22-24 October 2015
- Member: IEEE GLOBECOM 2015
- Distinguished Member: IEEE INFOCOM 2016

## Luca COMINARDI

### Organization committees

- Local Co-Chair: IFIP/IEEE SustainIT 2015

## Antonio FERNÁNDEZ ANTA

### Professional posts & activities

- Referee for the Croucher Innovation Awards, Croucher Foundation, Hong Kong, September 2015
- Evaluator: national call for research projects, Spanish Ministry of Economy and Competitiveness (MINECO) (Retos y Excelencia 2015)

### Journal editorial boards

- Editor: the Computer Journal, Oxford Journals
- Reviewer: IEEE Journal on Selected Areas in Communications
- Reviewer: Journal of Parallel and Distributed Computing (Elsevier)
- Reviewer: Performance Evaluation (Elsevier)
- Reviewer: Theoretical Computer Science (Elsevier)
- Reviewer: Computer Networks Journal (Elsevier)
- Reviewer: Theory of Computing Systems (Springer)

- Reviewer: Journal of Computer Science and Technology (Springer)
- Reviewer: Journal of Universal Computer Science (Graz University of Technology)
- Reviewer: Journal of the ACM (JACM)
- Reviewer: IEEE Transactions on Communications

#### **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)
- Member of the Board of Directors of COMSOTEC (Asociación para el estudio de Sistemas Complejos Sociotecnológicos), a newly created Spanish society
- Member of the Executive Committee of JNIC 2015 (Jornadas Nacionales de Investigación en Ciberseguridad), León (Spain), 14-16 September 2015
- “Vocal Primero” (Main Chairperson) of Sociedad de Computación Concurrente y Distribuida (SCCD), organizing the annual “Jornadas de Concurrencia y Sistemas Distribuidos”

#### **TPC memberships**

- ACM Symposium on Principles of Distributed Computing (PODC 2015), Donostia, San Sebastián (Spain), 21-23 July 2015
- Program Co-Chair: the 13th IEEE International Symposium on Parallel and Distributed Processing with Applications (IEEE ISPA-15), Helsinki, Finland, 20-22 August 2015
- The 19<sup>th</sup> International Conference On Principles Of DIstributed Systems (OPODIS 2015), Rennes (France), 14-17 December 2015

### **Pierre FRANCOIS**

#### **TPC memberships**

- IFIP Networking 2015, Toulouse (France), 20-22 May 2015

### **Domenico GIUSTINIANO**

#### **Organization committees**

- General Co-Chair: IFIP/IEEE SustainIT 2015
- Demo Chair: Workshop on Micro Aerial Vehicle Networks, Systems, and Applications for Civilian Use (DroNet 2015), Florence (Italy). In conjunction with the 13<sup>th</sup> International Conference on Mobile systems, Applications and Services (MobiSys 2015), 18-22 May 2015

### TPC memberships

- IFIP/IEEE SustainIT 2015
- IEEE INFOCOM 2015
- Workshop on Visible Light Communication and networking (VLCN 2015). In conjunction with IEEE International Conference on Communications, London (UK), 8-12 June 2015
- Workshop on Challenged Networks (CHANTS 2015). In conjunction with the 21<sup>st</sup> Annual International Conference on Mobile Computing and Networking (ACM MobiCom 2015), Paris (France), 7-11 September 2015
- PhD forum of The 23<sup>rd</sup> IEEE International Conference on Network Protocols (ICNP 2015), San Francisco (USA), 10-13 November 2015
- Distinguished TPC Member Award of the 2016 IEEE Infocom Technical Program Committee
- MadCom Workshop, New Wireless Communication Paradigms for the Internet of Things. In conjunction with the International Conference on Embedded Wireless Systems and Networks (EWSN 2016), 15-17 February 2016

### Sergey GORINSKY

#### Professional posts & activities

- Evaluator: Doctoral forum of IFIP/IEEE SustainIT 2015
- Co-coordinator of IMDEA Networks-UC3M research seminars

#### Organization committees

- Steering Committee member: COMSNETS Association, a steering committee for COMSNETS conferences
- Committee member: Best Paper Award at ICNP 2015, San Francisco (USA), 10-13 November 2015
- Committee member: Best Paper Award at ACM CoNEXT 2015, Heidelberg (Germany), 1-4 December 2015
- Innovators Committees member at COMSNETS 2016, Bengaluru (India), 5-9 January 2016
- General Co-chair: COMSNETS 2017, Bengaluru (India), 4-8 January 2017

#### TPC memberships

- Distinguished member: IEEE INFOCOM 2015 & IEEE INFOCOM 2016
- The 29<sup>th</sup> Annual Conference of the ACM Special Interest Group on Data Communication (SIGCOMM) on the applications, technologies, architectures, and protocols for computer communication (ACM SIGCOMM 2016), Florianópolis, Brazil, August 22-26 2016
- AINTEC 2016, Bangkok, Thailand, 30 November - 2 December 2016
- IFIP Networking 2016, Vienna, Austria, 17-19 May 2016
- ITC 28 2016

- The 10<sup>th</sup> Workshop on the Economics of Networks, Systems and Computation (NetEcon 2015), Portland (EE.UU.), 15 June 2015. In conjunction with ACM SIGMETRICS 2015 and ACM EC 2015, Portland (USA), 15-19 June 2015
- ICNP 2015, San Francisco (USA), 10-13 November 2015
- ICNP 2016, Singapore, 8-11 November 2016
- The 11<sup>th</sup> ACM International Conference on Emerging Networking Experiments and Technologies (ACM CoNEXT 2015), Heidelberg (Germany), 1-4 December 2015
- ACM CoNEXT 2016, Irvine (USA), 12-15 December 2016

### Kirill KOGAN

#### TPC memberships

- The 7<sup>th</sup> International Conference on COMMunication Systems and NETworkS (COM-SNETS 2015), Bangalore (India), 6-10 January 2015
- The 23rd IEEE Annual Symposium on High-Performance Interconnects (HOTI), Santa Clara, California (USA), 26-28 August 2015
- The 16<sup>th</sup> International Conference on High Performance Switching and Routing (IEEE HPSR 2015), Budapest (Hungary), 1-4 July 2015

### Adrian LOCH

#### TPC memberships

- EDAS Chair: the 2016 Millimeter-wave Networking Workshop. In conjunction with IEEE INFOCOM 2016

### Vincenzo MANCUSO

#### Professional posts & activities

- Technical Manager: European research project ICT CROWD
- Technical Manager: European research project H2020 MONROE

#### Journal editorial boards

- Editor: IEEE Journal on Selected Areas in Communications - Series on Green Communications and Networking (JSAC SGCN)
- Editor: IEEE Wireless Communications Special Issue on Device-to-Device (D2D) Communications with Social Awareness, 2015-2016
- Guest Editor: Elsevier PHYCOM Special Issue on D2D Communications, 2015







### Organization committees

- 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 2015
- Workshop on D2D Communications. In conjunction with the 21<sup>st</sup> European Wireless Conference (EW 2015), Budapest (Hungary), 20-22 May 2015
- The 2<sup>nd</sup> International Workshop on Cloud-Processing in Heterogeneous Mobile Communication Networks (IWCPM 2015). In conjunction with IEEE ICC 2015, London (UK), 8-12 June 2015
- ITC 27
- IEEE INFOCOM 2016

### Gek Hong SIM

- Reviewer: IFIP Networking 2015
- Reviewer: IEEE PIMRC 2015 – Track 2: MAC & Cross-Layer Design
- Reviewer: IEEE INFOCOM 2015
- Reviewer: IFIP Networking 2016

### Joerg WIDMER

#### Journal editorial boards

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

### Organization committees

- Demo Chair: IEEE WoWMoM 2015
- Workshop Co-Chair: ACM MobiCom 2015

### TPC memberships

- COMSNETS 2015
- The International Conference on Networked Systems (NetSys 2015), Cottbus (Germany), 9-12 March 2015
- Distinguished member: IEEE INFOCOM 2015
- IFIP Networking 2015
- The 7<sup>th</sup> IEEE Workshop on Cooperative and Cognitive Mobile Networks (CoCoNet6 2015), London (UK), 8 June 2015. In conjunction with ICC 2015, 8-12 June 2015
- IEEE WoWMoM 2015
- ACM Sigcomm (Posters/Demos), London (UK), 17-21 August 2015
- IEEE Conference on Local Computer Networks, (LCN 2015), Clearwater Beach, Florida (USA), 26-29 October 2015
- ACM CoNEXT 2015



## 5.4. Invited Papers, 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 **27** of these presentations during 2015.

### 1. Marco Ajmone Marsan (November 2015)

*Powering Cellular Networks with Renewable Energy Sources (Keynote)*

In: The 2<sup>nd</sup> International Telecommunication Networks and Applications Conference (ITNAC 2015), 18-20 November 2015, Sydney, Australia

### 2. Joerg Widmer (November 2015)

*Efficient Networking in Millimeter Wave Bands (Invited Talk)*

In: TU Munich, , Munich, Germany

### 3. Fernando Boavida, Andreas Kliem, Thomas Renner, Jukka Riekk, Christophe Jouvray, Michal Jacovi, Stepan Ivanov, Fiorella Guadagni, Paolo Gil, Alicia Triviño (October 2015)

*People-Centric Internet of Things—Challenges, Approach, and Enabling Technologies (Invited Paper)*

In: The International Workshop on Future Internet and Smart Networks (FI&SN 2015), in conjunction with the 9th International Symposium on Intelligent Distributed Computing, 7-9 October 2015, Guimarães, Portugal

### 4. Ignacio Castro, Sergey Gorinsky (September 2015)

*Remote Peering: Findings and Questions (Invited Talk)*

In: The 10th European Peering Forum (EPF10), 21-23 September 2015, Madrid, Spain

### 5. Qing Wang, Shengrong Yin, Omprakash Gnawali, Domenico Giustiniano (September 2015)

*Demo: OpenVLC1.0 Platform for Research in Visible Light Communication Networks (Demo)*

In: The 21st Annual International Conference on Mobile Computing and Networking (ACM

MobiCom 2015), 7-11 September 2015, Paris, France

### 6. Antonio Fernández Anta, Luis F. Chiroque (September 2015)

*Research on Social Networks and Complex Systems on IMDEA Networks (Invited Talk)*

In: The 1st Meeting of the COMSOTEC Association for the Study of Socio-Technological Complex Systems (COMSOTEC 2015), 9-11 September 2015, Santander, Spain

### 7. Sergey Gorinsky (September 2015)

*Routes and Interconnectivity: An Internet Trend and an Architectural Proposal (Invited Talk)*

In: Ericsson Hungary Research, 2 September 2015, Budapest, Hungary

### 8. Héctor J. Pijeira Díaz, Javier Santofimia Ruiz, José A. Ruipérez-Valiente, Pedro J. Muñoz-Merino, Carlos Delgado Kloos (September 2015)

*Using Video Visualizations in Open edX to Understand Learning Interactions of Students (Demo)*

In: The 10th European Conference on Technology Enhanced Learning (EC-TEL 2015), 15-18 September 2015, Toledo, Spain

### 9. Sergey Gorinsky (August 2015)

*Routes and Interconnectivity: An Internet Trend and an Architectural Proposal (Invited Talk)*

In: University of Cambridge, 13 August 2015, Cambridge, United Kingdom

### 10. Joerg Widmer (August 2015)

*Efficient Networking in Millimeter Wave Bands (Lecture)*

In: EIT ICT Labs summer school on Future Networking Systems, KTH, Stockholm, Sweden

**11. Antonio Fernández Anta, Chryssis Georgiou, Dariusz R. Kowalski, Elli Zavou (July 2015)**

*Competitive Analysis of Task Scheduling Algorithms on a Fault-Prone Machine and the Impact of Resource Augmentation (Invited Paper)*

In: The 2<sup>nd</sup> Workshop on Adaptive Resource Management and Scheduling for Cloud Computing (ARMSCC 2015), in conjunction with the ACM Symposium on Principles of Distributed Computing (ACM PODC 2015) 20 July 2015, San Sebastian, Spain

**12. Domenico Giustiniano, Qing Wang (July 2015)**

*OpenVLC, an Open-Source Platform for the Internet of Light (Invited Talk)*

In: IEEE Summer Topicals Meeting Series 2015 - Visible Light Communications (VisC) topical meeting, 13-15 July 2015, Nassau, Bahamas

**13. Paolo Casari (June 2015)**

*Underwater radiocommunications: An alternative to acoustics? (Invited Talk)*

In: Proyecto UNDERWORLD - Sesión de Sensibilización del Centro Demostrador TIC Marino Marítimo - Reevaluación de radiocomunicaciones submarinas: Situación actual y retos (Plataforma Oceánica de Canarias), 23 June 2015, Gran Canaria, Islas Canarias, Spain

**14. Dariusz R. Kowalski, Prudence W. H. Wong, Elli Zavou (June 2015)**

*Fault Tolerant Scheduling of Non-uniform Tasks under Resource Augmentation (Invited Talk)*

In: The 12th Workshop on Models and Algorithms for Planning and Scheduling Problems (MAPSP 2015), 8-12 June 2015, La Roche-en-Ardenne, Belgium

**15. Evgenia Christoforou, Antonio Fernández Anta, Agustín Santos (June 2015)**

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

In: XXIII Jornadas de Concurrency y Sistemas Distribuidos, 10-12 Jun 2015, Malaga, Spain

**16. Joerg Widmer (June 2015)**

*Efficient Networking in Millimeter Wave Bands (Invited Talk)*

In: Massachusetts Institute of Technology, June 2015, Cambridge, MA, United States

**17. Joerg Widmer (June 2015)**

*Efficient Networking in Millimeter Wave Bands (Invited Talk)*

In: New York University, New York, NY, United States

**18. Joerg Widmer (June 2015)**

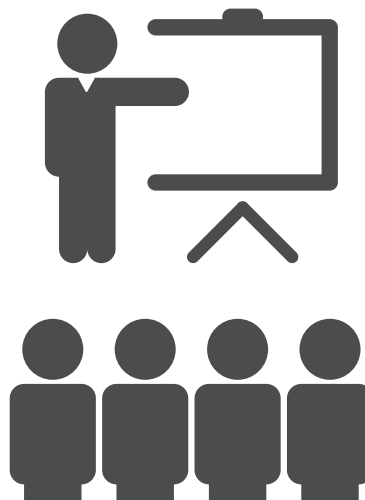
*Prediction-based Optimization in Mobile Networks (Invited Talk)*

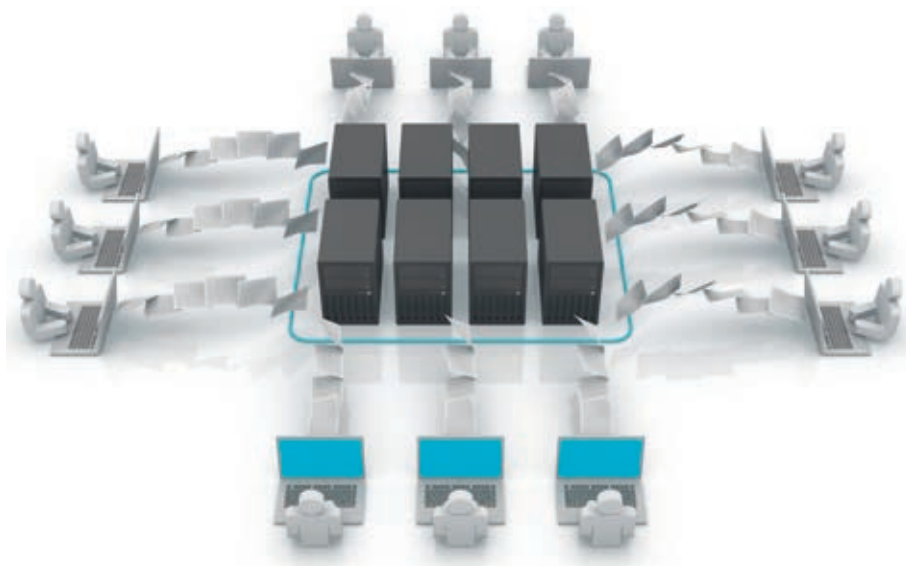
In: The 47th Meeting of the VDE/ITG Section 5.2.4, Stuttgart, Germany

**19. Roderick Fanou, Pierre Francois, Emile Aben (May 2015)**

*On the Diversity of Interdomain Routing in Africa (Presentation) (Invited Talk)*

In: RIPE 70 Meeting, 11-15 May 2015, Amsterdam, the Netherlands





**20. Joerg Widmer (May 2015)**

*Efficient Networking in Millimeter Wave Bands (Keynote)*

In: The 13th International Conference on Wired & Wireless Internet Communications (WWIC 2015), 25-27 May 2015, Málaga, Spain

**21. Roberto Calvo Palomino, Damian Pfammatter, Domenico Giustiniano, Vincent Lenders (April 2015)**

*Demonstration Abstract: A Low-cost Sensor Platform for Large-scale Wideband Spectrum Monitoring (Demo)*

In: The ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN 2015), 13-16 April 2015, Seattle, USA

**22. Christian Koch, Nicola Bui, Julius Ruckert, Guido Fiorafanti, Foivos Michelinakis, Stefan Wilk, Joerg Widmer, David Hausheer (March 2015)**

*Demo: Media Download Optimization through Prefetching and Resource Allocation in Mobile Networks (Demo)*

In: The 6th ACM Multimedia Systems 2015 Conference (MMSys 2015), 18-20 March 2015, Portland, Oregon, USA

**23. Miguel Ángel Díaz Bautista (February 2015)**

*NATalyser inhome NAT detection (Invited Talk)*

In: Leone Project Meeting, 1 February 2015, London, UK

**24. Arturo Azcorra (January 2015)**

*Trends in EU research for 5G Networks (Invited Talk)*

In: The 12th Italian Networking Workshop, 14-16 January 2015, Cavalese, Italy

**25. Sergey Gorinsky (January 2015)**

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

In: Budapest University of Technology and Economics (BME), 5 January 2015, Budapest, Hungary

**26. Joerg Widmer (January 2015)**

*Design Considerations for Extremely High Frequency Wireless Networks (Invited Talk)*

In: The 12th Italian Networking Workshop, Cavalese, Italy

**27. Joerg Widmer (January 2015)**

*Efficient Networking in Millimeter Wave Bands (Invited Talk)*

In: RWTH Aachen, Aache

## 5.5. Major 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://workshop2015.networks.imdea.org/>



**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.

## Program

- **Social media fingerprints of unemployment**, Esteban Moro (*Universidad Carlos III de Madrid, Spain*)
- **Programming the Cloud with PyCOMPSs: a task-based approach**, Rosa Badia (*Barcelona Supercomputing Center - Centro Nacional de Supercomputación, Spain*)
- **Apache Flink Streaming**, Seif Haridi (*KTH/SICS, Sweden*)
- **Managing Elasticity in a Cloud PaaS**, José Manuel Bernabeu-Aubán (*Kumori Systems & ITI, Spain*)
- **Big data for the travel industry: hype or hope?**, Israel Herraiz (*Amadeus Travel Intelligence, Amadeus IT Group SA*)
- **The Web: Source of Big Data with a Measurement Perspective**, Marco Mellia (*Politecnico di Torino, Italy*)



## Researchers' Night 2015 – Science and movie scientists: Does reality surpass fiction?

25 September 2015 | Madrid, Spain

[www.madrimasd.org/lanochedelosinvestigadores/?lan=en](http://www.madrimasd.org/lanochedelosinvestigadores/?lan=en)

[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. Arturo Azcorra, Director of IMDEA Networks, was one of the participating researchers

How do science and movies get along? Is it true that, most of the times, truth is stranger than fiction?

Without a doubt, today's motion picture industry owes much of its success to science. Science has given films many plots, roles, cinematic techniques and tools for the design of film sound and image. Does science owe its success to movies too? In Science and movie scientists: Does reality surpass fiction? using the area of science in which they are experts as a starting point, researchers from the IMDEA Institutes will show us the many facets of the film industry and science. To do so, following the layout of a live talk show, they will speak of the image of science and movie scientists, of the sciences that nurture the so-called seventh art,... and, above all, of themselves; of what has driven them to pursue their research, and if their character, drive and work are similar to what is shown in movies.

Hand in hand with these researchers, we will learn both similarities and differences between «real science» and «movie science» and we will hear things as curious as the fact that the film that accumulates more scientific errors is Armageddon: 168, according to the NASA, which uses this film as part of its training asking its technicians and engineers to find them. Or the fact that visual effects and digital cosmetic software helped out in making the actors in Troy and 300 a lot more muscular. And the fact that The Day After Tomorrow's plot -New York flooding in a few days because of climate change- is scientifically impossible. Science and movie scientists: Does reality surpass fiction? will allow us to discover that the invention of filmmaking itself was a great scientific-technical advance and, its further development, an example of growth in various scientific and technological areas such as Nanoscience, energy, materials, software, networks,... and, if we focus on the actors' physiques, water and food, too.

## XV Science Week – Madrid 2015: Internet of People – An Approach to People-Centric Internet of Things

4 November 2015 | Madrid, Spain

<http://www.networks.imdea.org/whats-new/events/2015/people-centric-internet-things-challenges-approach-and-enabling-technologies>



**Speaker:** Prof. Dr. Fernando Boavida, Full Professor, Faculty of Science and Technology, University of Coimbra, Portugal; Visiting Professor, IMDEA Networks Institute, Madrid

**Organization:** IMDEA Networks Institute; XV Semana de la Ciencia – 2015 – mi+d

Technology now offers the possibility of delivering a vast range of low-cost people-centric services to citizens. Internet of Things (IoT) supporting technologies are becoming robust, viable and cheaper. Mobile phones are increasingly more powerful and disseminated. On the other hand, social networks and virtual worlds are experiencing an exploding popularity and have millions of users. These low-cost technologies can now be used to create an Internet of People (IoP), a dynamically configurable integration platform of connected smart objects that allows enhanced, people-centric applications. As opposed to things-centric ones, IoP combines the real, sensory world with the virtual world for the benefit of people while it also enables the development of sensing applications in contexts such as e-health, sustainable mobility, social networks enhancement or fulfilling people's special needs. This talk identifies the main challenges, a possible approach, and key enabling technologies for a people-centric society based on the Internet of Things.







## I IMDEA Conference – Science, Industry & Society

6 November 2015 | Madrid, Spain

**Organization:** IMDEA initiative

IMDEA Materials, one of the seven IMDEA Institutes, opened its doors for the 1<sup>st</sup> IMDEA Conference: Science, Business & Society. The event was opened by the President of the Community of Madrid, Cristina Cifuentes, and by the Spanish Secretary of State for Research, Development and Innovation (R&D&I), Carmen Vela. All IMDEA Directors were present. Representing IMDEA Networks, Dr. Vincenzo Mancuso gave an account of the Institute's work on 5G Research.

More than 300 invitees were received by the Director of IMDEA Materials, Javier Llorca, who qualified the conference as “the end of the beginning” for the IMDEA initiative. The IMDEA Institutes are now beginning a new phase full of optimism due to the fact that they have fulfilled their initial objectives, and will continue to strive to achieve the ambitious goals for which the institutes were established.

The I IMDEA Conference served to prove that in our community many hold a strong belief in science and technology, considering them “safe values” in order to improve the welfare in society.







## 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 **45 total number of events** in which the Institute participated, **22** 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**

Stefan Schmid, Senior Research Scientist, TU Berlin / Telekom Innovation Laboratories (T-Labs), Berlin, Germany  
23 Jan 2015



#### **The Routing Continuum in Wireless Sensor Networks**

Omprakash Gnawali, Assistant Professor, University of Houston, USA  
6 Feb 2015



#### **Integrating Smart Phones into Emergency Networks via Wi-Fi Tethering**

Paul Müller, Professor of Computer Science, Kaiserslautern University of Technology, Germany  
2 Mar 2015



#### **Looking forward with Information Centric Networks**

Daniel Corujo, Research Fellow, University of Aveiro, Portugal  
26 Mar 2015



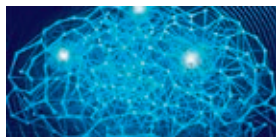
#### **Integrating Smart Phones into Emergency Networks via Wi-Fi Tethering**

Krishna Kant, Temple University, USA  
13 Apr 2015



#### **RoCoCo: Receiver-initiated Opportunistic Data Collection and Command Multicasting for WSN**

Andreas Reinhardt, TU Clausthal, Germany  
16 Apr 2015



### **RIASC: Towards coordinated resilience networks based on Software defined Networks**

Javier Alonso López, Research Manager and Acting Research Director, Research Institute of Applied Sciences in Cybersecurity - University of Leon, Spain; Visiting Assistant Professor, Duke University, USA

23 Apr 2015



### **Future Adaptive Communication Systems Technology**

Ralf Steinmetz, Chair of Excellence, Department of Telecommunications Engineering, UC3M; Visiting Researcher, IMDEA Networks; Managing Director, Multimedia Communications Lab (KOM) & Full Professor, Technische Universität Darmstadt, Germany

20 May 2015



### **Policy Management for the Cloud (presentation 1) / Load Balancer as a Service for the Cloud (presentation 2)**

Pablo Martinez de la Cruz, Lead Innovation and Solution Engineer, Ericsson Madrid R&D Center, Spain

8 Jun 2015



### **Preparing Income Tax Returns in the Cloud | Entropy as a Measure of Privacy**

Nicholas F. Maxemchuk, Professor at Columbia University in the City of New York (USA) and Research Professor at IMDEA Networks Institute, Spain

10 Jun 2015



### **Entrepreneurship in Startups and large companies**

David del Val, President and CEO, Telefonica Research and Development; Director, Product Innovation, Telefonica, Spain

17 Jun 2015



### **Adaptive Overlays: Peer-assisted Event Dissemination and Distributed Data Collection for Dynamic Mobile Networks**

Nils Richerzhagen and Björn Richerzhagen, PhD students, Multimedia Communications Lab (KOM), Technische Universität Darmstadt, Germany

23 Jun 2015



#### **The interference problem in multi-channel wireless networks**

Alexandru Popa, Assistant Professor, Nazarbayev University, Astana, Kazakhstan

24 Jun 2015



#### **Informing Protocol Design Through Crowdsourcing: the Case of Pervasive Encryption**

Anna Maria Mandalari, PhD Candidate, Telematics Department, University Carlos III of Madrid

8 Jul 2015



#### **Information Centric Networking: Addressing Information at the Network Level**

Antonio Carzaniga, Professor, Faculty of Informatics, USI - Università della Svizzera italiana, Switzerland

13 Jul 2015



#### **Patrolling by faulty robots**

Jurek Czyzowicz, Adjunct Professor, University of Ottawa, Carleton University, University of Liverpool and Warsaw University

29 Jul 2015



#### **Understanding the Detection of Fake View Fraud in Video Content Portals**

Miriam Marciel, Early Stage Researcher at NEC Laboratories, Heidelberg, Germany

16 Sep 2015



#### **Studying Human Behavior through Digital Traces: Polarization and Emotions in the Bitcoin Ecosystem**

Dr. David García Becerra, ETH Zurich, Switzerland

17 Sep 2015



#### **Boosting Efficiency in Smart Wearable Devices through Biometric Signal Compression**

Michele Rossi, University of Padova, Italy

23 Sep 2015



#### **Using SDN/OpenFlow in real life networks**

Alexander Shalimov, PhD, Moscow State University

28 Sep 2015



### Some Approaches to Wireless Sensor Networks, IoT, and the Internet of People

Dr. Fernando Boavida, Full Professor, University of Coimbra, Portugal  
30 Sep 2015



### Measuring the Mixing Time of a Network

Antonio Carzaniga, Università della Svizzera Italiana (USI), Switzerland  
25 Nov 2015

## 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.

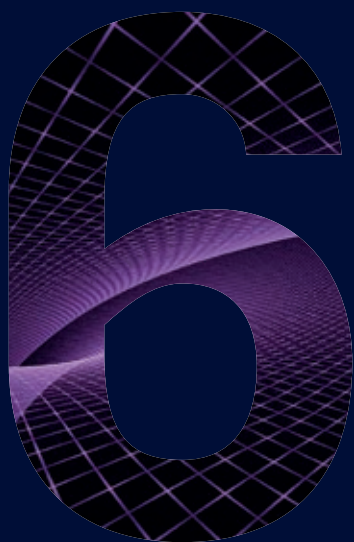


Among other activities, the cooperation between IMDEA Networks and UAH involves their joint participation in projects of a regional scope, such as **MEDIANET**, completed in 2014, and **TIGRE5-CM**, ongoing until 2018. The TIGRE5-CM project focuses on integrated technologies for management and operation of 5G networks. In addition to IMDEA Networks and UAH, the third project partner is University Carlos III of Madrid. Elisa Rojas from UAH also participated as a Post-Doc Researcher in **NetIDE**, a research project carried out by IMDEA Networks with a clear focus on an integrated development environment for portable network applications. Deepening this spirit of collaborative work, one of our PhD graduates, Andra Lutu, undertook a 6 month research fellowship at UAH. 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. An additional joint patent application, which is currently under evaluation, presents procedures to establish and repair paths at the transport and network levels.

Other 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 as well as the **launch of an ICT teaching line in technological institutes**.

# impact and technology transfer



- 6.1. Patents [88]
- 6.2. Contribution to standardization bodies [90]
- 6.3. Technology transfer [91]
- 6.4. Other collaborations [100]

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2015



## 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 2015.

### Spanish Patent Granted (Feb 2016)

**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)*

#### Overview:

The present invention describes mechanisms that, in a network of transparent bridges, both seek and establish a specific path for each new TCP connection established between two terminals. The new path is established by the border bridge connected to the source terminal when receiving a TCP segment type SYN to establish a connection, encapsulating the said segment within a special path request packet that is resent by all network links and is responded to in unicast mode by the border bridge of the destination terminal through an acceptance package in which the SYN + ACK response segment of terminal S is encapsulated, the said packet confirming both the TCP connection as well as the chosen path between A and S. The path is automatically cleared after a certain period of time without the use of the connection or through exchanges of FIN segments in both directions of the connection.

# 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 NITSCHÉ, 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.



## 6.2. Contribution to standardization bodies

Many different vendors manufacture network-ing 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 multivendor 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 standardization activities and in 2015, the following standardization document was published:

- **Juan Camilo Cardona, Pierre Francois, Paolo Lucente (June 2015)**  
*Impact of BGP filtering on Inter-Domain Routing Policies. draft-ietf-grow-filtering-threats-06 (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, as well as the 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:

## MATISSE - Pervasive Mobile Location and Spectrum Sensing Systems

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



**Funded by:** Armasuisse – Science and Technology

**Duration:** April 2015 to March 2016

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

The spectrum data usage and the user location knowledge are essential information to build any communication protocol and service. MATISSE has two-fold objectives: (i) solve the poor knowledge of the electro-magnetic spectrum usage by introducing cyber-physical nodes that will be capable of monitoring the spectrum at very large scale and (ii) devise and build a pervasive localization system that can make possible to pin-point the position of a mobile device regardless of the environmental conditions. For the first objective, we aim to build a customized embedded device for monitoring the spectrum, and introduce novel signal processing and decoding mechanisms for fusing the data of multiple nodes. For the second objective, we will design and build a mobile device-centric system that uses opportunistic timing signals for positioning and tracking and address the research and practical challenges to solve the limitations of timing protocols.

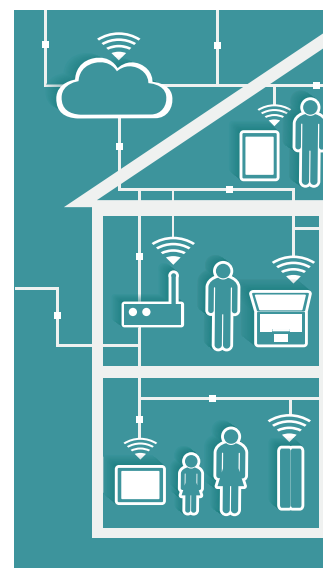
## Wireless Network Deployment and Wi-Fi Based Indoor Localization

**Funded by:** Zendos Tecnología S.L.

**Duration:** December 2014 to December 2015

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

The project involves optimizing the Wi-Fi coverage in a large closed space to provide high quality wireless access to a large number of potential users. The system will include a wireless real-time location system to locate users in the indoor large area, which will be used to provide location-based services to them.



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

**Funded by:** Zendos Tecnología S.L.

**Duration:** February 2015 to August 2015

**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.

## Opportunistic Timing Signals for Pervasive Mobile Communication

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

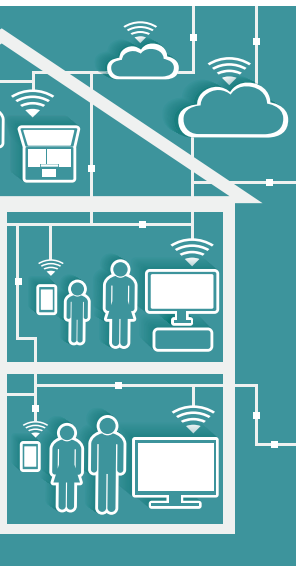
**Funded by:** The Swiss Confederation represented by Armasuisse – Science and Technology

**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**.

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

*Telefonica*  
*talentum*

**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 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).





## 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.

**Research contracts commencing in 2016:**



## SPECTRUMCOP-IMDEA - Technologies for Collaborative Detection of Spectrum Anomalies

**Funded by:** Armasuisse – Science and Technology

**Duration:** March 2016 – February 2017

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

The SPECTRUMCOP-IMDEA project has the overarching goal of providing the turnkey technologies to bring a concrete application to the **Electrosense network**. In the context of this project, we aim to pervasively **monitor the spectrum** such that the backend will swiftly detect any anomaly and misuse in the spectrum usage. SPECTRUMCOP-IMDEA will study the necessary theoretical and practical concepts, and propose solutions that will be analysed in testbeds managed by IMDEA as well as in the overall Electrosense network.



Other forms of collaboration with the private sector are:

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

IMDEA Networks and Telefónica Research and Development continue collaborating on their Joint Research Unit (JRU), which was created in May 2014. The JRU is also known under the name '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.



## 5TONIC - An Open Research and Innovation Laboratory focusing on 5G technologies

**5TONIC** is an open research and innovation laboratory focusing on 5G technologies that was **founded by Telefonica and IMDEA Networks Institute** in 2015. The **first laboratory of 5G excellence in Spain** also counts with **Ericsson Spain** and **INTEL** amongst its members.

**The objective of 5TONIC is to create a global open environment** where members from industry and academia work together in specific **research and innovation projects related to 5G technologies** with a view to boost technology and business innovative ventures. The laboratory promotes joint project development and entrepreneurial ventures, discussion fora, events and conference sites, all in an international environment oriented to achieve the highest technological impact in the area of 5G.

5G networks are considered **the gateway to the age of “intelligent everything”** that awaits us. The development of 5G has thus become a landmark in the global competition for technological leadership.

5TONIC will serve to show the capabilities and interoperation of pre-commercial 5G equipment, services and applications by leading global companies in the 5G arena. Apart from the initial members, 5TONIC welcomes new members to join and gain from the benefits of an advanced research and innovation laboratory, oriented to research, debate, field-testing and demonstration of all technologies and equipment to support 5G communications, services and applications.

The main **5TONIC Research & Innovation Laboratory** site will be located at IMDEA Networks Institute, a research institute on the forefront of technological innovation and with an extensive track record in European 5G Research Projects. IMDEA Networks is one of the main leaders at European level in the field of 5G networks. Among 5G research projects carried out by the Madrid Institute are the ongoing **SEARCHLIGHT**, **TIGRE-CM** and **CLOUD-4BIGDATA** projects, and the recently concluded **CROWD** and **iJOIN** projects.



### 6.3.1. Industry partners

Our technology transfer activities have led to **a significantly increased portfolio of companies we collaborate with**. During 2015 and taking into account the projects listed above as commencing in 2016 they are the following:



Alcatel-Lucent Bell Labs  
Alcatel-Lucent Deutschland  
AG



Avea - Türk Telekom



Swiss Confederation:  
Armasuisse – Science  
and Technology



Studio Professionale  
Associato a Baker & McKenzie



Celerway Communications AS



certSIGN S.A.



Cisco Systems



De Productizers B.V.



Ericsson



Eurecat – Technology Centre  
of Catalonia



France Telecom SA (FT)



Fujitsu Technology Solutions  
(FTS)



Exus Software Ltd.



Hewlett Packard Italiana SRL



Huawei Technologies  
Dusseldorf GmbH (HWDU)



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



INTEL Corporation  
Intel Mobile Communications  
France



Internet Advertising Bureau  
(IAB) Europe



Keysight Technologies  
Denmark Aps



NEC Europe Ltd.





Netvision Telecom



Nextworks Engineering Forward



Nokia Solutions and Networks Sp. z o.o.  
Nokia Solutions and Networks Oy



Orange



Qamcom Research and Technology AB



Rohde & Schwarz GmbH & Co. KG



Sagemcom Broadband SAS



Samsung Electronics Ltd. (UK)



Sequans Communications



Sigma Orionis



Signalion GmbH



Technicolor R&D



Tecnologías, Servicios Telemáticos y Sistemas S.A.



Telcaria



Telecom Italia S.p.a.



Telefónica S.A.



Telefónica I+D



Telenor ASA



Thales



Upcom BvBa



Verizon Nederland B.V.



Teknologian Tutkimuskeskus VTT



Wedia Ltd.



WINGS ICT Solutions



Zendos Tecnología S.L.



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

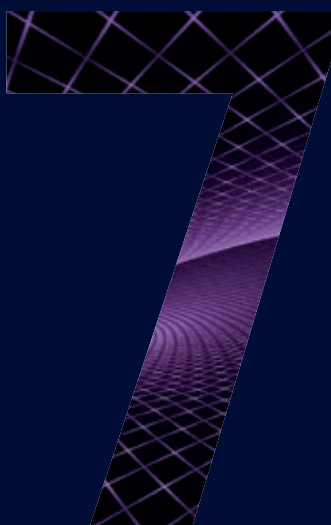
In 2015, Madri+d and the IMDEA initiative continue collaborating on the initiative launched the previous year: the **Oficina de Proyectos Europeos Madri+d – IMDEA (Madri+d – IMDEA European Projects Bureau)**. The collaboration was launched as a networked structure to support the participation of its members in European programs. It is made up of IMDEA Water, IMDEA Food, IMDEA Energy, IMDEA Materials, IMDEA Nanoscience, IMDEA Networks, IMDEA Software and the Madrimasd Knowledge Foundation in a coordination role.



The IMDEA Institutes 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:** 5G Networks and Services; Network Virtualization and Softwarization; Drone Communications; On-line Social Networks Data Analytics; Mammal Brain Cartography and Topology

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**Personal site:** [http://people.networks.imdea.org/~arturo\\_azcorra/](http://people.networks.imdea.org/~arturo_azcorra/)

## Short Bio:

Arturo Azcorra holds a double appointment as Full Professor at the University Carlos III of Madrid (UC3M) in the Telematics Engineering Department and Director of IMDEA Networks, where he conducts his research activities. He 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), the Spanish agency to fund advanced industrial research. He previously held the position of Director General for Technology Transfer and Corporate Development at the then Spanish Ministry of Science and Innovation.

He graduated from Loy Norrix High School (Michigan, USA) in 1980. In 1986, he received his MSc degree in Telecommunications Engineering from the Polytechnic University of Madrid, with the "Sobresaliente" (Outstanding) grade, and was subsequently awarded the Price Waterhouse Prize for Best Student. He then obtained his PhD from the same university in 1989. His PhD received the National Award for Best Thesis, jointly granted by the professional Association of Telecommunication Engineers (COIT-

AEIT) and the National Association of Electronic Industries (then ANIEL, today AMETIC). 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 Polytechnic University of 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 at Berkeley as a Visiting Researcher in 1999, and late in 2002, at the Massachusetts Institute of Technology.

Arturo Azcorra is an IEEE Senior Member and an ACM SIGCOMM Member. He has participated in and directed 55 European research and technological development projects, including ESPRIT, RACE, ACTS, IST and ICT programs. He previously held the position of Coordinator of the international Networks-of-Excellence (NoE) E-NEXT (Emerging Networking Experiments and Technologies) and CONTENT (Excellence in Content Distribution Network Research),

part of the European Commission's VII Framework Program.

He has also performed direct consulting and engineering work for institutions, such as the European Space Agency, MFS-Worldcom, Madrid Regional Government, RENFE, REPSOL and the Spanish Ministry of Science and Technology. Arturo Azcorra is the founder of the ACM CoNEXT conference series, of which he was the first General Chair. He is a member of the Standing Committee of the IEEE INFOCOM Conference since 2005, and has chaired prestigious international conferences such as IEEE INFOCOM, ACM CoNEXT and PROMS-IDMS. His publications in national and international magazines, books and conferences number over 170 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

**Contact:** [albert.banchs@imdea.org](mailto:albert.banchs@imdea.org)

**Personal Site:** [http://people.net-works.imdea.org/~albert\\_banchs/](http://people.net-works.imdea.org/~albert_banchs/)

## 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 Visiting 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 has been with University 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 and 2015.

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 JSAC, IEEE TMC and IEEE TVT. Prof. Banchs is editor for IEEE Transactions on Wireless Communications (since 2014) and the Series on Green Communications and Networking of IEEE JSAC (since 2015), 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 Networks, 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 WiTECH). He has been general chair of IEEE Online GreenComm 2013 and ACM WiTECH 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 (2008-2010) and the iJOIN projects (2012-2015) and principal investigator for the projects FLAVIA (2010-2013) and MEDIEVAL (2010-2013). Currently, his main effort is on the 5GNORMA project (2015-2017). Dr. Banchs has also been the principal investigator of several industry contracts, is the inventor of 5 patents (4 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 videoconference service of Telefonica and 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 4 PhD theses, three 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 Distinguished Lecturer and a Senior Member of the 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

**Contact:** joerg.widmer@imdea.org

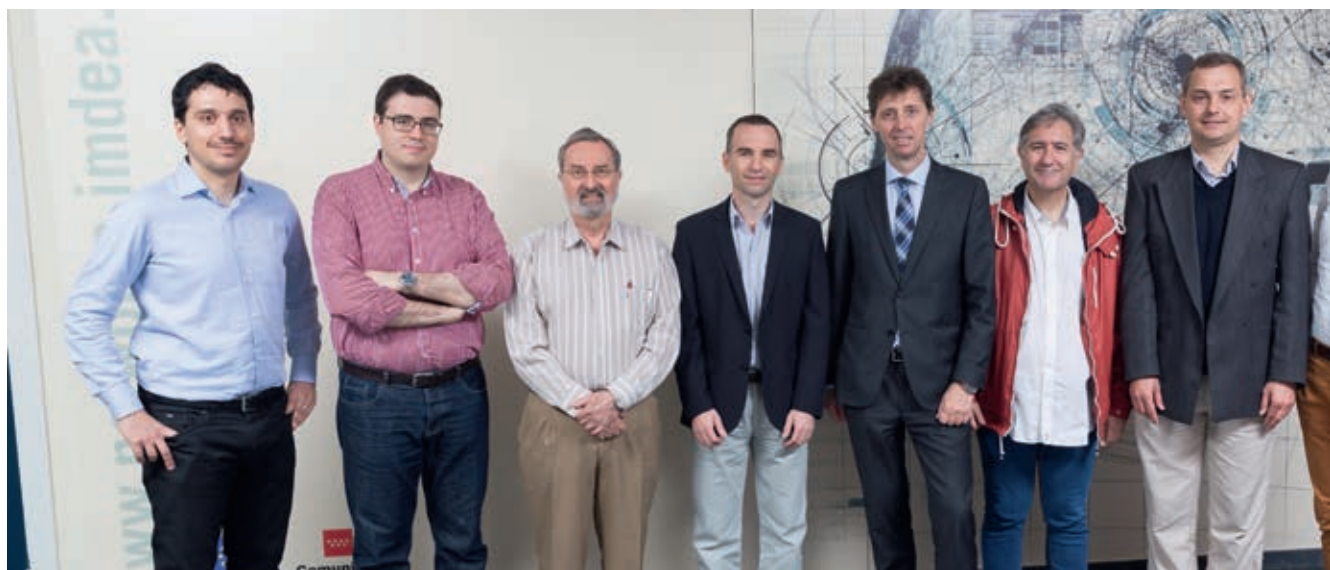
**Personal Site:** [http://people.networks.imdea.org/~joerg\\_widmer/](http://people.networks.imdea.org/~joerg_widmer/)

## Short Bio:

Joerg Widmer is Research Professor at IMDEA Networks Institute in Madrid, Spain. He received his M.Sc. 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 millimeter-wave communication 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, he 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 a 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

**Contact:** marco.ajmone@imdea.org

**Personal Site:** <http://www.tlc-networks.polito.it/ajmone/>

### 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 his degrees in Electronics Engineering from Politecnico di Torino in 1974 and the University of California, Los Angeles (UCLA) in 1978, respectively. 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, networking and distributed systems. He has published over 350 papers in the leading conferences and journals of his research area. He is also coau-

thor of two books. His publications have received over 11, 500 citations. Of his publications, 22 have received more than 100 citations each. His h-index is equal to 45 using Publish or Perish (see also Google Scholar), 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 a large number of Master and PhD students at Politecnico di Torino, and has been part of the jury of several PhD candidates abroad.

He was the Project 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", "Performance Evaluation" of Elsevier and Transactions on Modeling and Performance Evaluation of Computing Systems of ACM. 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:** Parallel and distributed processing; Algorithms; Social computing; Social networks analysis; Communications and networks; Big data; Machine learning; Discrete and applied mathematics

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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 part of the Faculty of the Universidad Politécnica de Madrid (UPM), during which period he received an award for his research productivity. Dr. Fernández 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 was a Post-doc Researcher at MIT from 1995 to 1997, and now has more than 20 years of research experience, with a productivity of more than 130 papers in important international and national journals and conferences. These papers have more than 2,900 citations, resulting in an H-index of 27 (Google Scholar). He has one patent co-authored. He has been Chair of the Steering Committee of DISC and member in the SC of ACM e-Energy and OPODIS. He has chaired and served in the TPC of numerous conferences and workshops (ICDCS, OPODIS, PODC, DISC, NCA, ISPA). He is a Senior Member of the IEEE and the ACM. He is the researcher in charge of the FP7 EU project AtomicDFS, and has been the PI of various research projects and contracts (Cloud4BigData, Clouds, SOCAM, H2020 ReCred).



# 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 PhD 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 is a tenured Research Associate Professor at IMDEA Networks Institute, Madrid, Spain, where he leads the NetEcon (Network Economics) research group. Dr. Gorinsky received his PhD and M.Sc. degrees from the University of Texas at Austin (USA) in 2003 and 1999, respectively and his Engineer degree from Moscow Institute of Electronic Technology (Zelenograd, Russia) in 1994. From 2003 to 2009, he served on the tenure-track faculty at Washington University in St. Louis, USA.

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 has 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, 2016), CoNEXT (2015, 2016), INFOCOM (2006-2016; Distinguished Member: 2015, 2016), ICNP (2008, 2010-2016), 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 and ICNP 2016. He is a member of the COMSNETS Association, a steering committee for COMSNETS conferences.



### 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. Paolo CASARI

Research Assistant Professor

**PhD:** Information Engineering, University of Padova. Italy

**Previous Position:** Senior Postdoctoral Researcher. University of Padova. Italy

**Research:** Underwater networks; localization; mm-wave communications; visible-light communications; cloud computing; network convergence

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**Personal Site:** [http://people.networks.imdea.org/~paolo\\_casari/](http://people.networks.imdea.org/~paolo_casari/)

## Short Bio:

Paolo Casari is a Research Assistant Professor at IMDEA Networks Institute, where he leads the Ubiquitous Wireless Networking group. He holds a PhD in Information Engineering from the University of Padova, Italy (2008). He was formerly a Senior Postdoctoral Fellow at the University of Padova, Italy, where from 2008 to 2014 managed a group of 11 people working on all aspects of underwater communications and networks. He collaborated to several funded projects including CLAM (FP7), RACUN (European Defence Agen-

cy), as well as many international efforts funded by the US ARO, ONR and NSF. He was appointed Technical Manager of two projects.

His interests lie in the broad area of wireless communications, resource sharing and allocation in different types of network, with special focus on challenged networks. As of 2015, he co-authored more than 70 papers appeared in international journals and conferences. He is a Senior Member of the IEEE and a member of the ACM.

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







**Dr. Domenico GIUSTINIANO**  
 Research Assistant Professor

**PhD:** Telecommunication Engineering, 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:** Visible Light Communication Systems; Distributed Spectrum Monitoring Systems; mm-wave Communication Systems; Mobile Indoor Localization Systems

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#### Short Bio:

Dr. Domenico Giustiniano is leader of the Pervasive Wireless Systems group. 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 pervasive wireless 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 (5), IEEE INFOCOM, ACM/IEEE IPSN (2), and in journals such as IEEE Journal on Selected Areas in Communications, 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. The activity of Dr. Giustiniano creates bridges between high scientific work, targeting publications in top venues, and practical work, as demonstrated by his leadership role in initiatives such as the OpenVLC project, an open-source platform for research in visible light communication networks. His approach to scientific work oriented to devise solutions to real-world problems based on real-world assumptions is proved by five patents and by the project Award (2010) of all Telefonica Corporation for the innovation and visibility to the company and versus the clients. His supervision quality is exemplified by the award received by one of his PhD students, Qing Wang with the '2014 Chinese Government Award for Outstanding Self-Financed Students Abroad'. He is a recipient of the Fellowship 'MARIE CURIE' AMAROUT Europe Programme.



**Dr. Kirill KOGAN**  
 Research Assistant Professor

**PhD:** Communication Systems Engineering, Ben-Gurion University of the Negev. Israel

**Previous Position:** Postdoctoral Fellow. Purdue University. West Lafayette. Indiana. USA

**Research:** Cloud and Fog Computing, Software-defined Networking, Network Functions Virtualization, Admission Control and Buffer Management, Packet Classification

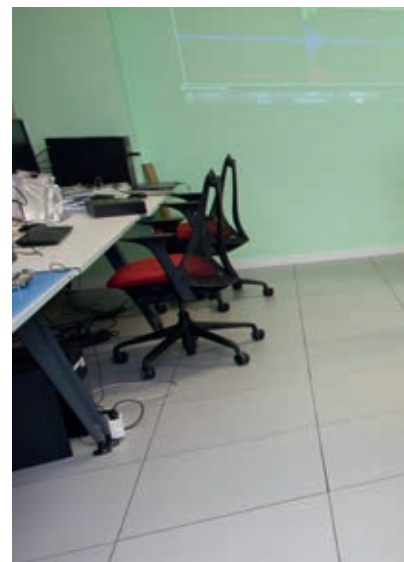
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#### Short Bio:

Dr. Kirill Kogan is a Research Assistant Professor at IMDEA Networks Institute since January 2015. During the last decade (2000-2012) Kirill Kogan worked as a Technical Leader at Cisco Systems. During this time he gained enough theoretical and practical experience to formalize his PhD (2008-2012) at Ben-Gurion University (Israel). During 2012 he joined University of Waterloo (Canada) as a Postdoctoral Fellow, and later the Purdue University (USA).

The original contributions he has made to this field of research are exemplified by publications in top dissemination venues such as the international conferences ACM SIGCOMM, IEEE INFOCOM and ACM PODC. He has also authored papers in top-tier journals within his area of expertise such as IEEE/ACM Transactions on Networking, IEEE Transactions on Communications or Distributed Computing.





**Dr. Vincenzo MANCUSO**  
Research Assistant Professor

**PhD:** Electronic Engineering, Computer Science and Telecommunication Engineering, University of Palermo, Italy

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

**Research:** Opportunistic Wireless Networks; 5G; Wireless Measurements; Performance Analysis

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#### Short Bio:

Dr. Vincenzo Mancuso is a Research Assistant Professor since in IMDEA Networks since September 2010. Previously, he has built his research experience first by working with University of Palermo (Italy) from which he received a Ph.D. in Electronics, Computer Science and Telecommunications in 2005, followed by Rice University (Houston, TX, USA), and INRIA Sophia Antipolis (France). His research activities focus on analysis, design, and experimental evaluation of protocols and architectures for wireless cellular networks. He is also currently working on analysis and optimization of power saving strategies for packet

cellular networks with device-to-device communication schemes.

His past activities have also focused on fairness in mesh networks, streaming in vehicular and satellite networks, QoS and measurement-based admission control in IP networks. Dr. Vincenzo Mancuso has authored more than 70 conference and journal papers (among which 7 papers in IEEE INFOCOM, 3 papers in ACM SIGCOMM e-Energy, 1 article in IEEE/ACM TON, 1 article in IEEE Transactions on Mobile Computing, and 1 article in IEEE JSAC). He has been involved in many national and international projects, including H2020 MONROE (as Technical Manager), H2020 Flex5Gware (as IMDEA co-PI), ICT CROWD (as Project Technical Manager and IMDEA's PI), ICT FLAVIA, IST FIFTH, IST SatNex, CELTIC IMAGES, MEDIANET and E2NET.





# 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. Aditya AMAH**

Post-Doc Researcher

**BSc:** Electronics Engineering. Satya Wacana Christian University. Salatiga. Indonesia

**MSc:** Electrical Engineering and Information Technology. Technische Universität Darmstadt. Germany

**PhD:** Electrical Engineering and Information Technology. TU Darmstadt. Germany

**Research:** Cooperative communication; Relaying; Beamforming

**Contact:** aditya.amah@imdea.org

#### Short Bio:

Dr. Amah received his B.Sc. degree in Electronics Engineering from Satya Wacana Christian University (Salatiga, Indonesia) in 2000. He went on to obtain both his M.Sc. and PhD degrees in Electrical Engineering and Information Technology from TU Darmstadt (Germany), in 2007 and 2011, respectively.

Prior to his incorporation to IMDEA Networks, Dr. Amah occupied several academic roles. After working for Schlumberger during 2001, he joined Petra Christian University (Surabaya, Indonesia) as Academic Staff from 2002 to 2005. Later on, after concluding his PhD, he undertook a Postdoc position at ETH Zurich (Switzerland) from 2011 to 2014. His main areas of interest lie in cooperative communication, relaying and beamforming.



**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 Pre-doctoral Researcher 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 the author

of several papers on this subject which were published in top conferences and journals within the networking field. Francois Clad joined IMDEA Networks in 2014 as a Post-doctoral Researcher, where he is working on intra-domain routing improvement under a Cisco Systems, Inc. consulting contract.



**Dr. Danilo DE DONNO**  
Post-Doc Researcher

**BSc:** Telecommunications Engineering. Politecnico di Milano. Milan. Italy

**MSc:** Telecommunications Engineering. Politecnico di Milano. Milan. Italy

**PhD:** Information Engineering. University of Salento. Lecce. Italy

**Previous Position:** Postdoctoral Fellow. Electromagnetic Lab. Innovation Engineering Department. University of Salento. Lecce. Italy

**Research:** Millimeter-wave communications, mobile networks, software defined radio

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**Personal website:** [http://people.networks.imdea.org/~daniilo\\_dedonno/](http://people.networks.imdea.org/~daniilo_dedonno/)

#### Short Bio:

Dr. Danilo De Donno joined the Pervasive Wireless Systems Group and the Wireless Networking Group at IMDEA Networks Institute in July 2015 as a Post-Doc Researcher. His main areas of interest lie in the areas of mm-Wave communications and wireless LANs.

Daniilo De Donno obtained his Bachelor's Degree in Telecommunications Engineering from the Politecnico di Milano, Italy, in 2005. In 2008 he obtained the Master's Degree in Telecommunications Engineering from the Politecnico di Milano with a thesis titled "Optimization of Gateway Positions in Wireless Sensor Net-

works: Models and Algorithms". In 2012 he completed his PhD in Information Engineering at the Innovation Engineering Department of the University of Salento, Lecce (Italy) after presenting a dissertation on the topic "EM Enabling Technologies for Smart Wireless Systems: SDR, RFID, and GPU computing". From July 2011 to December 2011, he was a Short-Term Scholar at the School of Electrical and Computer Engineering of the Georgia Institute of Technology in Atlanta (USA). From June 2012 to June 2015, he was a Postdoctoral Fellow at the Electromagnetic Lab Lecce (EML2) of the University of Salento (Italy).



**Dr. Marco GRAMAGLIA**  
Post-Doc Researcher

**BSc:** Computer Engineering. Politecnico University of Turin. Turin. Italy

**MSc:** Computer Engineering. Politecnico University of Turin. Turin. Italy; Telematics Engineering. University Carlos III of Madrid. Madrid. Spain

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

**Previous Position:** Research Fellow. IEIT-CNR (Institute of Electronics, Computer and Telecommunication Engineering - National Research Council of Italy). Turin. Italy

**Research:** Vehicular Networks; Wireless Networks; 5G Networking; Mobile Networking; Data Analysis

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#### Short Bio:

Marco Gramaglia is a Post-doc researcher at IMDEA Networks Institute, working directly under the supervision of Albert Banchs. Before joining IMDEA Networks, he worked as a Postdoctoral Research Fellow at IEIT-CNR, Turin, Italy and as a Researcher at Istituto Superiore Mario Boella in the same city. Between 2008 and 2012 Marco was a Research Assistant at IMDEA Networks and a Ph.D. candidate at the Telematics

Department of University Carlos III of Madrid. He holds a Ph.D. and an M.Sc in Telematics Engineering from University Carlos III of Madrid and an M.Sc in Computer Science from Politecnico di Torino. His research is focused on the mobility aspects of wireless networking, especially vehicular ad-hoc networks and 5G Networks.



**Dr. Adrian LOCH**

Post-Doc Researcher

**BSc:** Telecommunications Engineering. Universidad Politécnica de Madrid. Madrid. Spain

**MSc:** Electrical Engineering. Technische Universität Darmstadt. Darmstadt. Germany

**PhD:** Computer Science. Technische Universität Darmstadt. Darmstadt. Germany

**Previous Position:** Research associate. Secure Mobile Networking Lab. Technische Universität Darmstadt. Darmstadt. Germany

**Research:** Wireless Networking; Millimeter-wave Communications; Cross-layer Optimization; Software-defined Radio; Cooperative Communications

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**Personal website:** [http://people.networks.imdea.org/~adrian\\_loch/](http://people.networks.imdea.org/~adrian_loch/)

#### Short Bio:

Adrian Loch joined the Wireless Networking Group at IMDEA Networks in April 2015 as a post-doc researcher. His main areas of interest lie in cooperative communications for both wireless access and wireless multihop networks, including routing issues as well as practical validation on wireless testbeds. Currently, he focuses on millimeter-wave communications and, in particular, wireless local area networks such as the IEEE 802.11ad standard.

Prior to joining IMDEA Networks, he graduated in Electrical Engineering from Universidad Politécnica de Madrid (ETSIT UPM) and Technische Universität Darmstadt in 2011 after completing an international double degree program. After that, he obtained his PhD in Computer Science from Technische Universität Darmstadt in March 2015. During his PhD, he was a research associate at the Secure Mobile Networking Lab, contributing to the Research Priority Program Cocoon.



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

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**Personal website:** [http://people.networks.imdea.org/~nicolas\\_nicolaou](http://people.networks.imdea.org/~nicolas_nicolaou)

#### Short Bio:

Dr. Nicolas Nicolaou is a Marie Curie Fellow at IMDEA Networks Research Institute since December 2014. He 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 (UConn), and a B.Sc. in Computer Science from the University of Cyprus (UCY) in 2003. Previously he held the position of Visiting Lecturer at UCY (2011 -2013) and he served as a Special Scientist at the Cyprus University of Technol-

ogy (2013-2014). Before that he worked as a Research Assistant in the Dependable Distributed Systems Lab at UConn, and as a Senior Research Assistant in the VoTeR Lab at the same university. 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. Agustín SANTOS

Post-Doc Researcher

**BSc:** Computer Science. Polytechnic University of Madrid. Spain

**PhD:** Computer Science. University Rey Juan Carlos. Madrid. 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](mailto:agustin.santos@imdea.org)

#### Short Bio:

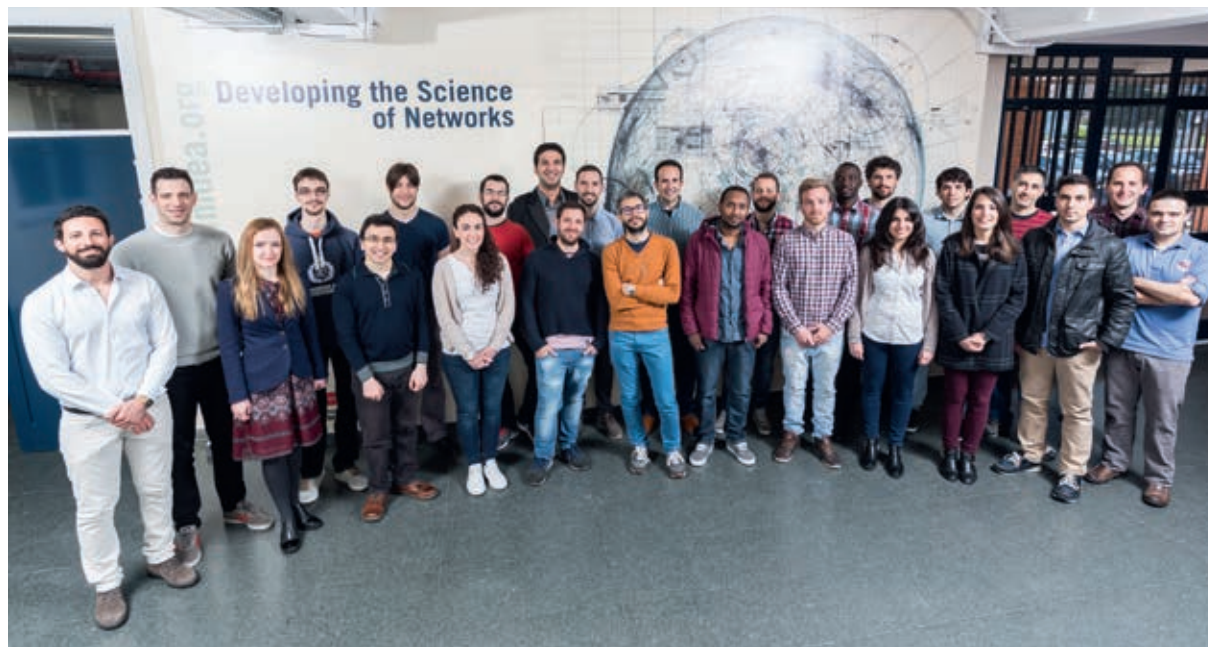
Agustín Santos Méndez is currently a Visiting Scholar at the Harvard School of Engineering and Applied Sciences - Economics & Computer Science Research Group, and an Adjunct Assistant Professor at University Rey Juan Carlos in Computer Science and Engineering. Since 2013 he also collaborates with IMDEA Networks Institute working on projects related to social networks, machine learning, recommendation engines and distributed resource allocation.

His early career included more than twenty years as CEO and co-founder of several start-up companies. He also has a strong background in the development of multinational projects in many different areas (compilers, distributed systems,

simulation, system integration, etc).

He obtained his PhD in Computer Science from the Universidad Rey Juan Carlos in 2013. His research interests are diverse covering areas such as game theory, design of mechanisms for resource allocation (fair allocation) and distributed systems. His main research interest is on decentralized resource allocation problems as they arise in large distributed computational systems.

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



# visiting professors

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



## Dr. Fernando BOAVIDA

Visiting Professor

**Position:** Full Professor. Faculty of Science and Technology. University of Coimbra. Coimbra. Portugal

**PhD:** Informatics. University of Coimbra. Coimbra. Portugal

**Research:** Wireless Sensor Networks; Mobility; Quality of Service; Computer Networks

**Contact:** fernando.boavida@imdea.org

**Personal Site:** <https://apps.uc.pt/mypage/faculty/uc24338/en>

**Joining & leaving dates:** September 2015 – July 2016

### Short Bio:

Fernando Boavida received his PhD in Informatics Engineering in 1990, and he currently is Full Professor at the Department of Informatics Engineering (DEI) of the Faculty of Sciences and Technology of the University of Coimbra. He was the founder of the Laboratory of Communications and Telematics (LCT) of DEI, the Strategic Director for Communications and Information Technology of the University of Coimbra from October 2003 to December 2015, the Director of the Department of Informatics Engineering from February 2004 to January 2008, and the Director of the Centre for Informatics and Systems of the University of Coimbra (<http://cisuc.uc.pt>) from October 2013 to September 2015.

His main research interests are wireless sensor networks, mobility, quality of service, and computer networks in general. He is author/co-author of more than 170 international publications (books, book chapters, refereed journals and conference proceedings) and 50 national publications. He was the chairman of the Program Committee of QoIS'2001, IDMS-PROMS'2002, NETWORKING 2006, WWIC 2007, FMN 2008, EWSN 2010, FMN 2012, IWQoS 2012, ACM SIGCOMM FhMN 2013, Mobiquitous 2015, and WoWMoM 2016 international conferences/workshops. He has been involved in numerous program committees of major international conferences, including INFOCOM 2006 and 2007. He participated in many European projects, such as E-NEXT (FP6 Network of Excellence on Emerging Networking Experiments and Technologies) EuQoS (End-to-end Quality of Service support over heterogeneous networks, IST-FP6-2004-004503), WEIRD (WiMAX Extension to Isolated Research Data networks, IST FP6 Integrated Project 034622), OpenNet (Open Interconnect for the Internet Community, IST-FP6 Specific Support Action 035185), CONTENT (Content Networks and Services for Home Users, IST-FP6-0384239), GINSENG (Performance Control in Wireless Sensor Networks", ICT-FP7-224282)

and MICIE (Tool for systemic risk analysis and secure mediation of data ex-changed across linked CI information infrastructures", ICT-FP7-225353).

He is a senior member of the IEEE and a licensed Professional Engineer. He is a member of the Editorial Advisory Board of the Computer Communications journal.





## Dr. Antonio CARZANIGA

Visiting Professor

**Position:** Professor, Faculty of Informatics, Università della Svizzera Italiana (USI). Lugano. Switzerland

**PhD:** Computer Science. Electronics and Information Department. Politecnico di Milano. Italy

**Research:** Future Internet Architecture; Information Centric Networking; Content-Based Routing; Publish/Subscribe Systems; Software Engineering; Software Reliability; Software Fault Tolerance

**Contact:** antonio.carzaniga@imdea.org

**Personal Site:** <http://www.inf.usi.ch/carzaniga/>

**Joining & leaving dates:** October 2015 – January 2016

### Short Bio:

Antonio Carzaniga is a Professor at the Faculty of Informatics of Università della Svizzera italiana (USI) (Switzerland) which he joined as an Assistant Professor when the Faculty was founded in 2004. From 2001 to 2007 he was an Assistant Research Professor in the Department of Computer Science at the University of Colorado at Boulder. He received the Laurea degree in Electronic Engineering and the PhD degree in Computer Science from Politecnico di Milano, Italy, in 1994 and 1999, respectively. Dr. Carzaniga serves as an Associate Editor of ACM Transactions on Software Engineering and Methodology. He also co-chaired a number of international conference committees, including the Technical Program Committee of the 2nd ACM Conference on Information-Centric Networking (ICN 2015), and repeatedly served on the program committees of various international conferences, including the major conferences in software engineering and middleware.

Antonio Carzaniga has conducted research and published papers in

the areas of mobile code, distributed configuration management, testing and validation of distributed systems, distributed publish/subscribe middleware, and advanced networking architectures. Antonio's work has been quite influential in some areas. Most notably, his 2001 paper on the Siena distributed publish/subscribe system, published in ACM Transactions on Computer Systems, is highly cited and one of the five most cited articles of all times of that prestigious journal. Also, Antonio received the ICSE Most Influential Paper Award of ACM SIGSOFT and IEEE TCSE in 2007 for the ICSE'97 paper "Designing Distributed Applications with Mobile Code Paradigms".

Currently, Antonio Carzaniga's primary research interests are in the areas of future internet architectures, and in particular, information centric networking (ICN) which is a natural continuation of his long-standing and highly cited research in distributed publish/subscribe systems and content-based communication. His goal is to architect a more functional and expressive network, one that does more for applications than connecting end-points, but also more than incorporating parts of the Web at the network level. Specifically, Antonio Carzaniga is working on an ICN architecture that, unlike in the mainstream ICN, combines "push" and "pull" information flows, supports expressive descriptors as well as very efficient locators, features loop-free routing to single or multiple destinations, and does not require per-packet in-network state. Antonio has formulated such a network architecture, and is working on both the algorithmic and systems aspects of routing and forwarding, as well as on many other ideas to make the network scalable, robust, and secure.





**Dr. Manuel CEBRIÁN RAMOS**  
Visiting Professor

**Position:** Senior Scientist. NICTA. Melbourne. Australia

**PhD:** Computer Science. Universidad Autónoma de Madrid. Madrid. Spain

**Research:** Social and Financial Networks; Crowdsourcing; Urban Economics; Behavioral Game Theory; Evolutionary Dynamics

**Contact:** manuel.cebrian@imdea.org

**Personal Site:** <http://web.media.mit.edu/~cebrian/>

**Joining & leaving dates:** May – August 2015

#### Short Bio:

Dr. Manuel Cebrian is research team leader with the Data61 Unit at CSIRO in Melbourne, Australia. He is currently the Scholar-in-Residence at Graphext, a platform for creating vertical knowledge networks from digital feeds and finding expertise in the public conversation. Cebrian is a founding member of Scalable Cooperation, a MIT Media Lab research group. He serves as a member of UNICEF Advisory Board for Data Science and has held positions with the University of California at

San Diego, MIT, Brown University, Telefonica Research, as well as IMDEA Networks and Facebook, where he was a visiting scientist. Cebrian earned a Ph.D. in computer science from Universidad Autonoma de Madrid, where his thesis received the Dissertation of the Year Award for his pioneering work on plagiarism networks.

Cebrian's work lies at the intersection of the computer and social sciences. His primary interests include social and financial networks, crowdsourcing, urban economics, and behavioral game theory. His work has been supported by grants from the Australian Research Council, the US National Science Foundation, DARPA, the US Army Research Office, the Spanish Ministry of Science and Technology, and the Masdar Institute of the United Arab Emirates. Cebrian's contributions were recognized with the Richard E. Newton Award for Excellence in Research in 2015.

Cebrian is particularly interested in understanding to what extent can social networking make it easier to find people and solve real-world problems. His efforts are best illustrated by his participation in the 2009 DARPA Network Challenge, the 2011 DARPA Shredder Challenge, and the 2012 Department of State Tag Challenge. Recent articles by Nature, The Economist, and New Scientist summarize the exciting challenges in this area, put in perspective by a brief history of social search.



**Dr. Ralf STEINMETZ**  
Visiting Professor

**Position:** Managing Director of Multimedia Communications Lab (KOM) & Full Professor at Technische Universität Darmstadt. Darmstadt. Germany

**PhD:** Electrical Engineering. Technische Universität Darmstadt. Darmstadt. Germany

**Research:** Scalable Quality of Service; Content Distribution Networks; Context Aware Communications; Adaptive Mobile Networking; Knowledge Media; Serious Games  
**Contact:** [ralf.steinmetz@imdea.org](mailto:ralf.steinmetz@imdea.org)  
**Personal Site:** <http://www.kom.tu-darmstadt.de/en/kom-multimedia-communications-lab/people/staff/ralf-steinmetz/>

**Joining & leaving dates:** January – August 2015

#### Short Bio:

Prof. Dr.-Ing. Ralf Steinmetz is a Full Professor at the Department of Electrical Engineering and Information Technology as well as at the Dept. of Computer Science at TU Darmstadt (Germany). Since 1996 he is Managing Director of the "Multimedia Communications Lab", until end of 2001, he directed a Fraunhofer Institute. In 1999

he founded the Hessian Telemedia Technology Competence Center (httc e.V.) in which he continues to hold a chair position. For nearly 10 years he has served as Hessian's advisor for information and communications technology. He is a member of the Scientific Council and President of the Board of Trustees of the international research institute IMDEA Networks, Madrid, Spain. He has been awarded with a Chair of Excellence at the University Carlos III of Madrid.

Together with more than 30 researchers, he works towards his vision of "seamless adaptive multimedia communications". With his team he has contributed to over 800 refereed publications. He has edited and co-authored a set of multimedia books which reflect the major issues: the initial version was the worldwide first in-depth technical book on multimedia technology. He has served as editor-in-chief of ACM TOMM, editor of various IEEE, ACM, and other journals. He was awarded as Fellow of both the IEEE and the ACM.

# emeritus professors

Emeritus Professors are eminent Research Professors who are acclaimed for their many years of service to IMDEA Networks. With their dedication they have brought prominence and international repute to the Institute.



**Dr. Nicholas F. MAXEMCHUK**  
Emeritus Professor

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

**PhD:** Systems Engineering. University of Pennsylvania. USA

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

**Contact:** [nicholas.maxemchuk@imdea.org](mailto:nicholas.maxemchuk@imdea.org)

**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 Dispersivity 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.

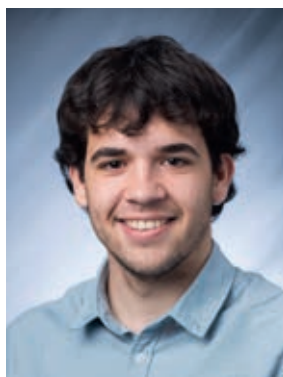
Amongst other awards that he has been given, some of the most noteworthy are the RCA Laboratories Outstanding Achievement Award in 1970, the Bell Laboratories Distinguished Technical Staff Award in 1984, the IEEE's Leonard G. Abraham Prize Paper Award in 1985 and 1987, and the William R. Bennett Prize 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.

# 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.



**Edgar ARRIBAS**  
Pre-Doc Researcher

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

**BSc:** Mathematics. University of Valencia. Valencia. Spain

**Previous Position:** Research Collaborator and Professor Assistant. Department of Applied Mathematics. University of Valencia. Valencia. Spain

**Research:** D2D communications; Network Stability; Graph Theory; Analytical Methods Design

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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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**Hany ASSASA**  
Pre-Doc Researcher

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

**BSc:** Electronics and Telecommunication Engineering (5-years). Damascus University. Damascus. Syria

**MSc:** Electronic Engineering. Politecnico di Torino. Torino. Italy; Degree of Master of Science (120 credits), Master's Programme Research on Information and Communications Technologies. KTH Royal Institute of Technology. Stockholm. Sweden

**Previous Position:** Core Network Packet Switch Engineer. Huawei Technologies Co. Ltd. Damascus. Syria

**Research:** Wireless Networks; Next Generation Networks Architecture; Software Defined Radio and Networking; Wireless PHY & MAC Layers; IEEE 802.11ad; Millimeter-Wave Communication

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**Dario BEGA**  
Pre-Doc Researcher

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

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

**MSc:** Telecommunication Engineering. University of Pisa. Pisa. Italy  
**Previous Position:** Security Consultant. Communication Valley Reply. Milan. Italy

**Research:** Wireless Networks; Mobility; Software Defined Networking; Security

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## Guillermo BIELSA

Pre-Doc Researcher

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

**BSc:** Communication System Engineering. University Carlos III of Madrid. Madrid. Spain

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

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

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## Patricia CALLEJO

Pre-Doc Researcher

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

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

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

**Research:** Social Networks; Online Advertising; Privacy; Data Analytics; Machine Learning

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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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## 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

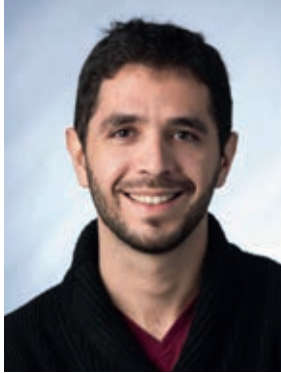
**MSc:** Telematics and Computer Science Systems. University Rey Juan Carlos. Madrid. Spain

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

**Research:** Spectrum sensing; Embedded Systems; Signal Processing; Distributed Systems; Collaborative decisions and Big Data

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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; Techno-Economical Analysis

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## Angelos CHATZIPAPAS

Pre-Doc Researcher

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

**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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## 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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## 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

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

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

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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

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

**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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## 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 (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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## Carlos DONATO

Pre-Doc Researcher

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

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

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

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

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

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## Elizaveta DUBROVINSKAYA

Pre-Doc Researcher

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

**BSc:** BA in Automatics, Telemechanics and Telecommunications (with honors). Saint-Petersburg State Transport University. Sankt Petersburg. Russia

**MSc:** Digital Communications. Christian-Albrechts Universität zu Kiel. Kiel. Germany

**Previous Position:** Board Member at Teleone OÜ. Tallinn. Estonia

**Research:** Underwater Communications; Underwater Localization Algorithms; Digital Signal Processing

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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:** WLAN indoor localization; Tracking algorithms; GPS; Hybrid localization systems

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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) setups; Interdomain routing in Africa; Routing Architecture; Internet measurement and Content Delivery Networks

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## Yonas Mitike KASSA

Pre-Doc Researcher

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

**BSc:** Computer Science. Alemaya University. Dire Dawa. Ethiopia

**MSc:** Computer and Communication Networks Engineering. Politecnico di Torino. Turin. Italy

**Research:** Online Social Networks; Online Advertising; Privacy; Large Scale Data Analytics; Machine Learning; Network Measurement; Content Distribution Networks

**Contact:** yonas.kassa@imdea.org





## Foivos MICHELINAKIS

Pre-Doc Researcher

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

**BSc:** Electrical and Computer Engineering (5-years). National Technical University of Athens. Athens. Greece

**MSc:** Telematics Engineering, Communication Networks and Services. University Carlos III of Madrid. Spain

**Previous Position:** Analyst-programmer. Hellenic Army. Greece

**Research:** Mobile Networks; Network Optimization; Content Distribution Networks

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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; Radiowave Propagation; Wireless PHY-layer; Cross-layer Protocols

**Contact:** thomas.nitsche@imdea.org

## Nuria MOLNER SIURANA

Pre-Doc Researcher

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

**BSc:** Mathematics. University of Valencia. Valencia. Spain

**Previous Position:** Position: IRTIC (Institute of Robotics and Information and Communication Technologies). Paterna. Valencia. Spain

**Research:** Optimization of integrated fronthaul/backhaul networks; resource allocation

**Contact:** nuria.molner@imdea.org



## Joan PALACIOS BELTRÁN

Pre-Doc Researcher

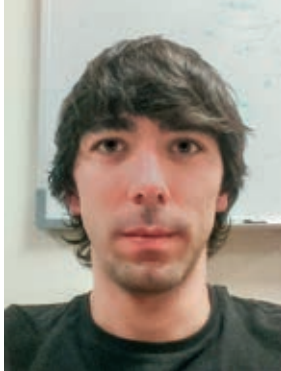
**Affiliation:** IMDEA Networks Institute and University Carlos III of Madrid

**BSc:** Mathematics. University of Valencia. Valencia. Spain

**Research:** mmWave; Wireless Network Algorithms; Beam-Forming; Channel Estimation; Mobility Models Estimation and Prediction

**Contact:** joan.palacios@imdea.org





## Antonio Ángel PASTOR VALLES

Pre-Doc Researcher

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

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

**Previous position:** Internship Student. Telefonica Talentum Startups scholarship at IMDEA Networks Institute. Madrid. Spain

**Research:** Complex Networks; Machine Learning; Connectomics; Brain-Machine Interfaces

**Contact:** antonio.pastor@imdea.org

**Joining & leaving dates:** September - October 2015



## 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:** Educational Data Mining; Learning Analytics; Information Visualization; Data Science

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## Maurizio REA

Pre-Doc Researcher

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

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

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

**Previous Position:** Researcher. ETH Zürich. Switzerland

**Research:** WLAN Indoor Localization; Wireless Networks and Data Analysis; Context Awareness for mmWaves

**Contact:** maurizio.rea@imdea.org



## 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 communications

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## M. Isabel SÁNCHEZ

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; 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:** IP Mobility; Wireless Networks; Dense Heterogeneous Networking; SDN; Vehicular Networks; Mobile Broadband Networks; Connectivity management

**Contact:** mariaisabel.sanchez@imdea.org

## Christian SÁNCHEZ

Pre-Doc Researcher (Systems Analyst)

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

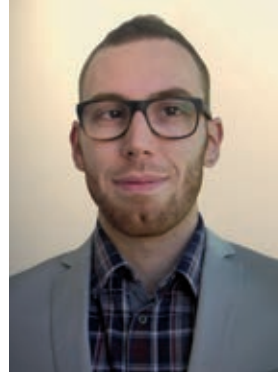
**BSc:** Computer Engineer. Universidad José Antonio Páez. Valencia. Venezuela

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

**Previous Position:** Development Analyst. ONUVA. Caracas. Venezuela

**Research:** Wideband Access to Private Networks; Quality of Service in Wireless Networks; Service-aware Wireless Routing and Wireless Protocol Optimization for High-throughput Data and Voice

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## Vincenzo SCIANCALEPORE

Pre-Doc Researcher

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

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

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

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

**Research:** WiMAX; 3GPP; LTE-Advanced; Inter-Cell Coordination and Scheduling; Opportunistic scheduling; Offloading; Genetic Algorithms

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## Sofía SILVA BERENGUER

Pre-Doc Researcher

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

**BSc:** Telematics Engineering. University of Montevideo. Montevideo. Uruguay

**Previous Position:** Senior Security and Stability Engineer. LACNIC. Montevideo. Uruguay

**Research:** Internet; Routing; Security; Domain Name System (DNS); Resource Public Key Infrastructure (RPKI); Domain Name System Security Extensions (DNSSEC); Anycast; Internet Exchange Points (IXP)

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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:** 60 GHz millimeter wave, scheduling, multicast scheduling

**Contact:** allysom.sim@imdea.org



## Christian VITALE

Pre-Doc Researcher

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

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

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

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

**Research:** 5G Cellular Networks, Performance Evaluation, Green Networking, Queueing Theory

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## Sergio N. TAMUREJO MORENO

Pre-Doc Researcher

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

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

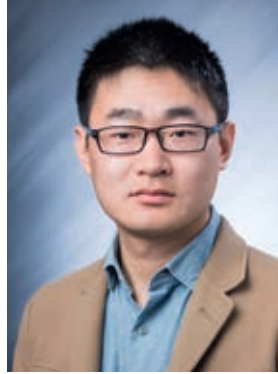
**Previous Position:** Enterprise Architect. INDRA Systems. Madrid. España

**Research:** Software Defined Networking; Large Scale Networks Measurement, Analytics and Virtualization

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## Qing WANG

Pre-Doc Researcher

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

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

**Contact:** qing.wang@imdea.org

## Elii ZAVOU

Pre-Doc Researcher

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

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

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

**Research:** Online Algorithms; Task Scheduling; Distributed and Parallel Algorithms; Distributed Networks; Fault-Tolerance; Discrete and applied Mathematics; Energy Efficiency

**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.



**Jordi ARJONA AROCA**

External PhD Student

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

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

**BSc:** Telecommunications Engineering. Polytechnic University of Valencia

**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. Valencia. Spain

**Research:** Energy Efficiency; Data Centers; Networking; Cloud Computing

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



**Pablo CABALLERO**

External PhD Student

**Affiliation:** University of Texas at Austin. USA

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

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

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

**Research:** Wireless Communications; Network optimization; Cellular Networks

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**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



**Jeanet BIRKKJÆR**  
Project Administrator

**BSc:** BA in International Marketing Communication. University of Southern Denmark. Kolding. Denmark  
**MSc:** MA in International Marketing Communication. Aarhus University. Aarhus School of Business. Aarhus. Denmark  
**Previous Position:** Executive Project Administrator in Global Business Strategies and Strategic Outsourcing. IBM. ISC. Madrid. Spain  
**Contact:** jeanet.birkkjaer@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:** Segment Routing; ISP network architecture  
**Contact:** pablo.camarillo@imdea.org



**Veronica CARRASCO**  
Project Administrator

**BA:** Social Sciences; Diploma in Tourism. Universidad Complutense de Madrid. Madrid. Spain  
**MA:** Commercial Management and Marketing. IMF Business School. Universidad San Pablo CEU. Madrid. Spain  
**Previous Position:** Travel Coordinator. Universidad Carlos III de Madrid. Madrid. Spain  
**Contact:** veronica.carrasco@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

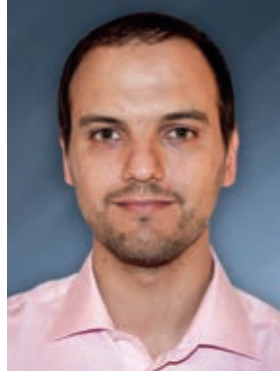
**BSc:** Computer Science. University of Córdoba. Spain

**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



## Alberto GORDILLO

Research Engineer

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

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

**Previous Position:** Systems Administrator. University Carlos III of Madrid. Madrid. Spain

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## Borja FERNÁNDEZ VICO

Research Engineer

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

**Previous Position:** Lead Software Developer Engineer & Project Manager. MOBILIFE S.L. Madrid. Spain

**Research:** Agile Development; Business Intelligence; Ruby on Rails; Test Automation; Best Practices

**Contact:** borja.fernandez@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-Health Foundation (FeSalud). Spain

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

## Francisco Javier HERVÁS

Project Administrator

**BSc:** Bachelor's Degree in Business Administration

**MSc:** Master in Management of Human Resources. Universidad Autónoma de Madrid. Madrid. Spain

**Previous Position:** R&D Consultant. CYTSA. Spain

**Contact:** franciscojavier.hervas@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



**Alejandro REYES**

Junior Software Developer

**BSc:** Telecommunication Engineer. Specialization: Systems and Telecommunication Networks. University Carlos III of Madrid. Madrid. Spain

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

**Previous Position:** Product & Project Manager. Jet Multimedia-Digital Virgo Spain. Madrid. Spain

**Research:** Agile development; Computer Networks; Business Intelligence; Ruby on Rails

**Contact:** alejandro.reyes@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





# 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 2015 (see p. 94).

## Margarita ALBENDEA ALBALADEJO

**Supervisor:** José 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

## Patricia CALLEJO

**Supervisor:** José 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

## Manuel CASARIEGO

**Supervisor:** Carlos Jesús Bernardos Cano  
**Research:** 5GEx; SDN; NFV; Network Simulation

## Paolo CASTAGNO

**Supervisor:** Vincenzo Mancuso  
**Research:** D2D Communications; Game Theory

## Carlos CONTRERAS

**Supervisor:** José 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

## Carlos CUADRADO

**Supervisor:** Joerg Widmer  
**Research:** Wireless Networks; IEEE 802.11ad; LTE; Network Simulation

## Guido FIORAVANTI

**Supervisor:** Joerg Widmer  
**Research:** Protocols; LTE; Data Prefetching; Transmission Optimization

## Ginés GARCÍA AVILÉS

**Supervisor:** José 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

## Rafael LEÓN MIRANDA

**Supervisor:** Arturo Azcorra  
**Research:** Routing; Software Defined Networking

## Diego LUCERO

**Supervisor:** José 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

## Rubén MARTÍN VÁZQUEZ

**Supervisor:** José 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

## Adrian MARTÍNEZ

**Supervisor:** Albert Banchs  
**Research:** Multipath-tcp protocol, mptcp proxy

## Pablo MORENO MUÑOZ

**Supervisor:** José 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

## Alain OLIVIER

**Supervisor:** Paolo Casari  
**Research:** Wireless Networks; Medium Access Control; Long Propagation Delay Networks; Millimeter Waves; Indoor Positioning

## Víctor SÁNCHEZ

**Supervisor:** Pierre Francois  
**Research:** Development of visualization tools for inter-domain IP routing economics analysis

## Diego SIERRA

**Supervisor:** José 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

## Irene TEJADO GARCÍA

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

# research team structure

135

## networked systems&algorithms

### Research Director

· Dr. Arturo Azcorra

### Researchers

· Dr. Sergey Gorinsky  
· Dr. Pierre François  
· Dr. José Félix Kukiélka  
· Dr. Kirill Kogan

### Pre-Doc & Post Doc Researchers

· Dr. Francois Clad  
· Patricia Callejo  
· Juan Camilo Cardona  
· Ignacio Castro  
· Luca Cominardi  
· Miguel Ángel Díaz Bautista  
· Roderick Fanou  
· Fabio Giust  
· Yonas Mitike Kassa  
· Nuria Molner Siurana  
· José Antonio Ruipérez-Valiente  
· Pablo Salvador  
· Christian Sánchez  
· María Isabel Sánchez  
· Sergio N. Tamurejo Moreno

## wireless networking

### Research Director

· Dr. Joerg Widmer

### Researchers

· Dr. Nicholas Maxemchuk  
· Dr. Domenico Giustiniano  
· Dr. Paolo Casari

### Pre-Doc & Post Doc Researchers

· Dr. Aditya Amah  
· Dr. Danilo De Donno  
· Dr. Adrian Loch  
· Hany Assasa  
· Guillermo Bielsa  
· Nicola Bui  
· Pablo Caballero  
· Roberto Calvo Palomino  
· Carlos Donato  
· Elizaveta Dubrovinskaya  
· Aymen Fakhreddine  
· Foivos Michelinakis  
· Thomas Nitsche  
· Joan Palacios Beltrán  
· Maurizio Rea  
· Gek Hong Sim  
· Qing Wang

## energy-efficient networking

### Research Director

· Dr. Albert Banchs

### Researchers:

· Dr. Marco Ajmone-Marsan  
· Dr. Antonio Fernández Anta  
· Dr. Vincenzo Mancuso

### Pre-Doc & Post Doc Researchers

· Dr. Marco Gramaglia  
· Dr. Nicolas Nicolaou  
· Dr. Agustín Santos  
· Jordi Arjona Aroca  
· Edgar Arribas  
· Arash Asadi  
· Dario Bega  
· Angelos Chatzipapas  
· Luis. F. Chiroque  
· Evgenia Christoforou  
· Vincenzo Sciancalepore  
· 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)

*Imdea Networks 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 are now furthering their research careers. 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.



**Vincenzo SCIANCALEPORE**

**Current Position:** Research Scientist, NEC Deutschland GmbH, Germany

**Ph.D. Thesis:** Enhancement in Spectrum Management Techniques for Heterogeneous 5G Future Networks (Nov 2015)

**Ph.D. Supervisor:** Dr. Albert Banchs



**Thomas NITSCHÉ**

**Current Position:** Wissenschaftlicher Mitarbeiter/Research Fellow, Fraunhofer Institute for Embedded Systems and Communication Technologies ESK, Munich, Germany

**Ph.D. Thesis:** Enhancing Wireless local area Networks by leveraging Diverse Frequency Resources (Sep 2015)

**Ph.D. Supervisor:** Dr. Joerg Widmer



**Ignacio CASTRO**

**Current Position:** Post-doctoral Research Assistant, Queen Mary University of London, UK

**Ph.D. Thesis:** Economics of Internet Interdomain Interconnections (Jul 2015)

**Ph.D. Supervisor:** Dr. Sergey GORINSKY



**Fabio GIUST**

**Current Position:** Research scientist, NEC Laboratories Europe, Heidelberg, Germany

**Ph.D. Thesis:** Distributed Mobility Management for a Flat Architecture in 5G Mobile Networks: Solutions, Analysis and Experimental Validation (Mar 2015)

**Ph.D. Supervisor:** Dr. Carlos Jesús BERNARDOS CANO





**Jordi ARJONA AROCA**

**Current Position:** Postdoctoral Researcher. Cloud Computing Group. Bell Labs. Dublin. Ireland

**Ph.D. Thesis:** Structural Issues and Energy Efficiency in Data Centers (Feb 2015)

**Ph.D. Supervisor:** Dr. Antonio FERNÁNDEZ ANTA

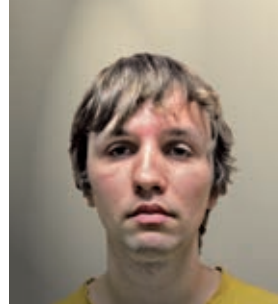


**Shahzad ALI**

**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 (Oct 2014)

**Ph.D. Supervisors:** 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 (Feb 2013)

**Ph.D. Supervisors:** Dr. Arturo AZCORRA and Dr. Rubén CUEVAS



**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 (Jul 2012)

**Ph.D. Supervisors:** Dr. Jaime GARCÍA-REINOSO

**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 (Nov 2014)

**Ph.D. Supervisor:** Dr. Marcelo BAGNULO

**Agustín SANTOS**

**Current Position:** Post-Doc Researcher. IMDEA Networks Institute. Madrid. Spain

**Ph.D. Thesis:** Quid Pro Quo: Mecanismos para la asignación de tareas en entornos distribuidos (Jun 2013)

**Ph.D. Supervisors:** Dr. Antonio Fernández Anta & Dr. Luis López Fernández

**Marco GRAMAGLIA**

**Current Position:** Post-Doc Researcher. IMDEA Networks Institute. Madrid. Spain

**Ph.D. Thesis:** VANET-Based optimization of infotainment and traffic efficiency vehicular services (Sep 2012)

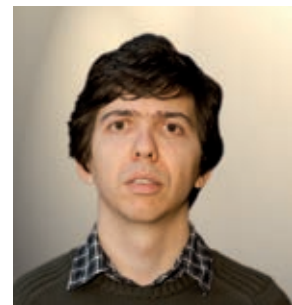
**Ph.D. Supervisors:** Dr. María CALDERÓN PASTOR & Dr. Carlos Jesús BERNARDOS CANO

**Paul PATRAS**

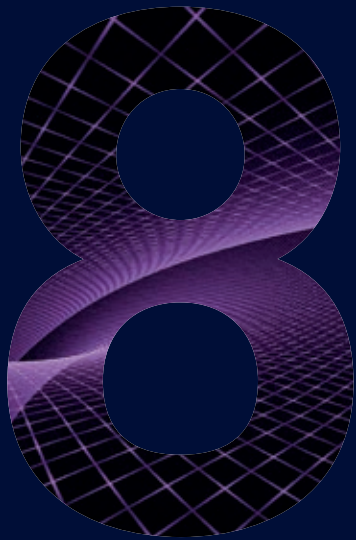
**Current Position:** Chancellor's Fellow / Lecturer in the School of Informatics at the University of Edinburgh. Scotland

**Ph.D. Thesis:** Control-Theoretic Adaptive Mechanisms for Performance Optimization of IEEE 802.11 WLANs: Design, Implementation and Experimental Evaluation (Mar 2011)

**Ph.D. Supervisors:** 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 [141]

8.2. Research laboratories [142]

a n n u a l r e p o r t

2015





## 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 center 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.

In 2015 we continue to improve the building:

- Focused on the reception hall, creating a modern and spacious area.
- Installed a new alarm system.
- Started a new concierge service.

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.

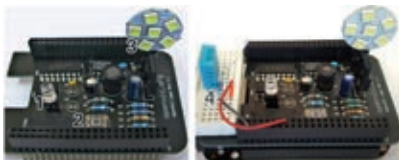
These laboratories are used for:

- 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:

### Pervasive Wireless System Group Testbed

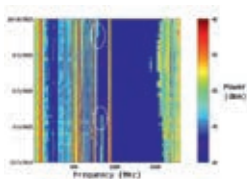
- Visible light communication system testbed
  - OpenVLC platform



- Time-of-flight localization testbed



- Wideband and distributed spectrum monitoring testbed



## 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)



## 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

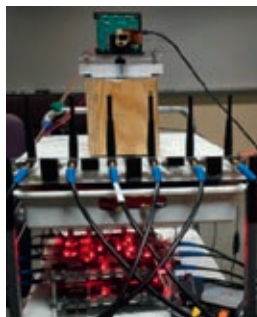


## Milimeter and Interdomain Routing Laboratory

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



### The 5TONIC Laboratory

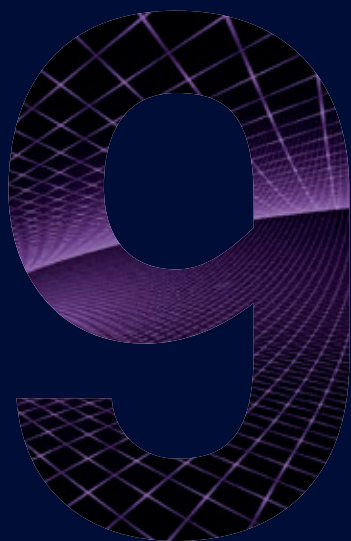
The 5TONIC Laboratory will provide infrastructure to support a wide range of systems, functionality, services and applications allowing the deployment, analysis, testing, trial and demonstration of choice technologies currently considered the driving forces of 5G development. With the 2020 horizon in sight, the private-public 5TONIC initiative aims to tackle the challenge of creating a blueprint for the new technologies and standards that are to define future ICT networks, the backbone of the “networked society”.



The Laboratory will support a wide range of systems, functionality, services and applications, including user terminals and outdoors equipment if needed, as well as edge and cloud based back-office functionality. This is a non-exhaustive list of equipment available in the two main research areas of the Laboratory:

- 5G Virtual Software Network Area
  - 1 high-power server to deploy Virtual Network Functions (VNFs)
  - 4 servers to deploy the Management and Orchestration (MANO) functionalities for Network Functions Virtualization (NFV).
  - 20 mini-PC computers to test NFV components.
  - 50 single-board computers to test and deploy OpenFlow switches.
  - 20 laptops for programmers to connect to the previous equipment.
  - 5 Micro Air Vehicles (MAVs) to deploy 5G points of presence.
- 5G Wireless Systems Area
  - 2 eNodeB with 8 FPGA cards
  - 4 radio frequency transceivers
  - 1 real-time controller

# o r g a n i z a t i o n



9.1. Legal status [146]

9.2. Governing bodies & organizational structure [146]

a n n u a l   r e p o r t  
2015



## 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.

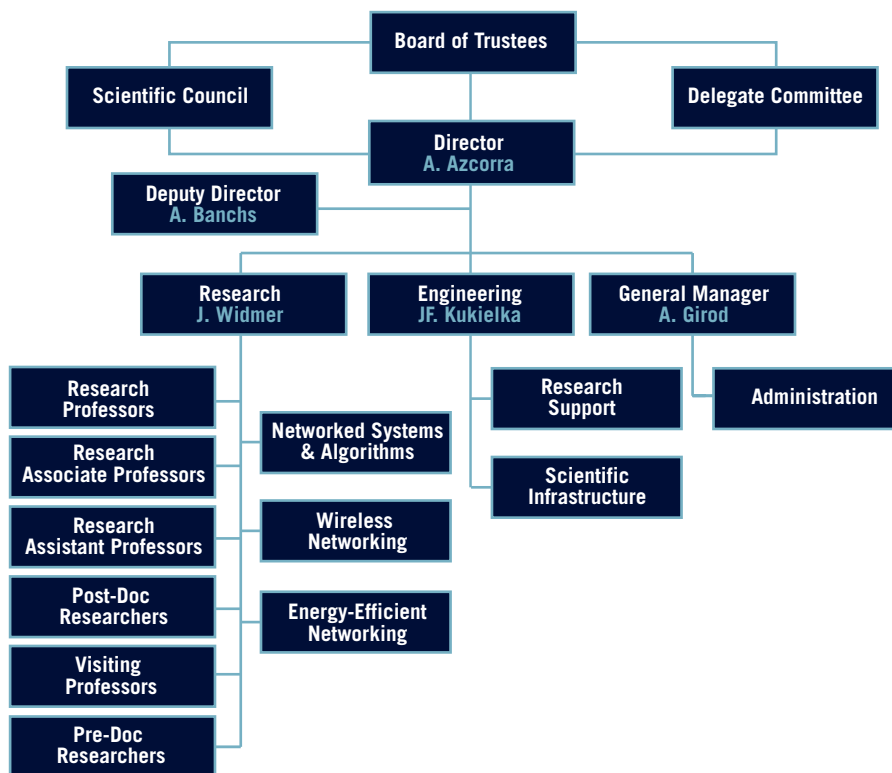
Our Spanish tax identification number (CIF) is G-84912708.

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:** Excmo. Sr. D. Rafael van Grieken Salvador

### EX OFFICIO TRUSTEES

#### **Excmo. Sr. D. Rafael van Grieken Salvador**

*Vice-President of the Board of Trustees*

*(Succeeded Excmo. Sra. D<sup>a</sup>. Lucía Figar de Lacalle in August 2015)*

*Regional Government Secretary for Education, Youth and Sports Department of Education, Youth and Sports Regional Government of Madrid (Madrid, Spain)*

#### **Ilmo. Sr. D. José Manuel Torralba Castelló**

*(Succeeded Ilma. Sra. D.<sup>a</sup> Lorena Heras Sedano in August 2015)*

*Director General of Universities and Research Directorate General of Universities and Research Department of Education, Youth and Sports Regional Government of Madrid (Madrid, Spain)*

#### **Sr. D. Rafael A. García Muñoz**

*(Succeeded Sr. D. Juan Ángel Botas Echevarría in August 2015)*

*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)*

#### **Sr. D. José de la Sota Ríos**

*Scientific-Technical Coordinator Madrimasd Knowledge Foundation (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. Gustavo de Veciana**

*Cullen Trust Professor, Department of Electrical and Computer Engineering The University of Texas at Austin (Austin, Texas, USA)*

#### **Dr. Huw Oliver**

*Former Technical Director, European Research Consortium, Hewlett-Packard Laboratories (Bristol, United Kingdom)*

#### **Prof. Dr. Ioannis Stavrakakis**

*Full Professor & Head of the Department of Informatics and Telecommunications National and Kapodistrian University of Athens (Athens, Greece)*

#### **Prof. Dr. Mario Gerla**

*Professor at the Computer Science Department University of California (UCLA) (Los Angeles, USA)*

## ELECTIVE TRUSTEES – COMPANIES



### Telefónica I+D

*Designated Representative*

Mr. David Del Val Latorre  
President and CEO, Telefonica I+D (R&D)



### INDRA

*Designated Representative*

To be appointed



### SATEC

*Designated Representatives*

Mr. Luis Alberto Rodríguez-Ovejero Alonso  
President

Mr. Isaac Gil Rabadán  
Director of Human Resources & Processes



### TEL DAT

*Designated Representatives*

Mr. Antonio García Marcos  
President

Mr. Ignacio Villaseca Costero  
Director General



### ATOS Spain

Appointed. Pending formal acceptance

## ELECTIVE TRUSTEES – COMPANY EXPERTS



### Dr. Juan Mulet Meliá

Former 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. Francisco Javier Prieto  
Fernández  
(Succeeded Prof. Dr. Carlos Balaguer  
Bernaldo de Quirós in December 2015)  
Vice-Rector for Science Policy



### 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*

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Vice-Rector of Postgraduate Studies and  
Continuing Education



### Universidad Rey Juan Carlos

(Madrid, Spain)

*Designated Representative*

Prof. Dr. D. Luis Pastor Pérez  
(Succeeded Prof. Dr. Fernando Suárez  
Bilbao in December 2015)  
Professor of Computer Architecture and  
Technology



### 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:



**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:** Computer Science, University  
College London (UCL). England.  
UK

**Research:** Opportunistic Commu-  
nications; Privacy in the Cloud;  
Carbon Neutral Networking



**Prof. Dr. Gustavo DE  
VECIANA**

Cullen Trust Professor of  
Electrical and Computer  
Engineering at the University  
of Texas at Austin. USA

**PhD:** Electrical Engineering, Uni-  
versity of California at Berkeley.  
USA

**Research:** Analysis and Design of  
Wireless and Wireline Telecommu-  
nication Networks; Architectures  
and Protocols to Support Sensing  
and Pervasive Computing; Applied  
Probability, Queuing and Informa-  
tion Theory



**Prof. Dr. Mario GERLA**

Professor at the Computer  
Science Department,  
University of California  
(UCLA). Los Angeles. USA

**PhD:** Engineering. University of  
California. USA

**Research:** Design and performance  
evaluation of Ad Hoc wireless  
networks; Routing; multicast and  
congestion management in tacti-  
cal networks; Vehicular ad hoc  
networks; Wireless security and pri-  
vacy; Cognitive radios and dynamic  
spectrum sharing; Urban vehicular  
traffic management for congestion  
and pollution mitigation; Mobile  
health and wireless patient moni-  
toring; Underwater sensor networks



**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

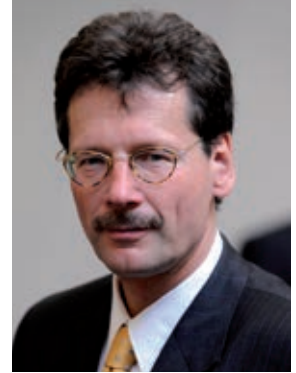


**Prof. Dr. Ioannis STAVRAKAKIS**

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:** Electrical Engineering. Technische Universität Darmstadt. Darmstadt. Germany

**Research:** Scalable Quality of Service; Content Distribution Networks; Context Aware Communications; Adaptive Mobile Networking; Knowledge Media; Serious Games

**Prof. Dr. Jim KUROSE**

Assistant Director at the Directorate for Computer & Information Science & Engineering (CISE), National Science Foundation (NSF). 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**

CEO, Telefonica Innovation Alpha. Spain

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

**Research:** Networking; Distributed Systems; Information Theory; Wireless and Mobile; Network Economics; Social Networks







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