annual report

# 2020

www.networks.imdea.org

imdea **networks** institute

developing the
**science of networks**

institute
**iMdea**
**networks**

# foreword

**Arturo Azcorra**
Director of the
IMDEA Networks Institute
April 2021

annual report 2020

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IMDEA Networks Institute is a top research institute in the Science of Networks and Communication Technology worldwide. The Institute is carrying out fundamental, systems-oriented research with a strong emphasis on technology transfer to industry and standard bodies. The profound impact of computer networks on all aspects of the economy and society was particularly visible over the last year, with much of the work life carried out remotely and even entertainment and social life taking place online rather than in person, due to restrictions imposed to counter the global pandemic.

While the pandemic clearly slowed down some aspects of research, at the same time it delivered important impulses to shape the Institute's research direction. The Internet and digital transformation not only helped to cope better with the impact of the pandemic, but network science can help to better understand and respond to the pandemic itself. One project of particular prominence in this area is the CoronaSurveys project led by IMDEA Networks. Participants fill out a simple survey about Covid-19 in their area. From the data collected daily in the surveys, the researchers have been able to obtain estimates which, as they have verified, are very close to the most accurate data on the incidence of the disease available, such as those obtained from expensive serological studies. Such information is critical especially for countries where official data is unreliable or not available. To this end, IMDEA Networks' researchers developed new data analysis techniques and in a first-of-its-kind design apply the Network Scale-up Method estimation technique on online data collected continuously and at a global scale. The project has global dimensions, covering 150 countries and 60 languages, and was listed top 10 in the XPRIZE Pandemic Response Challenge as well as a finalist in the COVID-19 Symptom Data Challenge.

At the same time, health-related data is extremely privacy sensitive and must be treated with the utmost care. The privacy researchers at IMDEA Networks closely investigated Covid-19 contact tracing apps and uncovered potential leakage of information both in the Spanish Radar COVID app as well as Google's and Apple's Exposure Notifications System, a framework to facilitate digital contact tracing during the COVID-19 pandemic. All these vulnerabilities were duly disclosed so that the developers were able to fix them. These examples highlight the important contributions of the security researchers at IMDEA Networks to identify and mitigate potential risks to the privacy of citizens.

Finally, mobile networks themselves can help to overcome some of the limitations inherent to the aforementioned contact tracing apps, and can provide critical data to inform epidemiologists and health authorities. IMDEA Networks' researchers showed how anonymized Call Detail Records collected by mobile operators for billing purposes can be used to derive accurate contagion heatmaps in close to real-time, and in a privacy preserving manner that does not leak fine grained location of individuals. This allows to model an epidemic's spread and the risk of contagion. Furthermore, future mobile 5G and 6G wireless location systems are likely to play a primary role in contact tracing and group movement monitoring. IMDEA Networks is at the forefront of wireless localization and analytics research, including how cellular operators should handle such sensitive location data.

The important lessons learned from the current pandemic will ensure that much better tools will be available in case of any eventual future pandemic. As every year, 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 an international success.

We would like to dedicate this annual report to our colleague Kirill Kogan, who passed away during 2020. His scientific findings left a strong footprint in the institute as well as the research community and he will be very much missed.

a n n u a l   r e p o r t

2020

w w w . n e t w o r k s . i m d e a . o r g

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# executive summary

# 1

## A research team of technical leaders

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. At the same time, our scientists also possess an extensive industry background. Most of them have been employed at leading industry research laboratories, and have been granted many 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 2020, the Institute has continued to reinforce its research team. Among the researchers added to our team, we would like to highlight the incorporation of Guillermo Suarez Tangil and Jaya Prakash Varma Champati as Research Assistant Professors. Both of whom are highly reputed researchers with extensive experience in their respective areas. Before joining IMDEA, Dr. Suarez had been at two top universities, namely King's College London and University College London. He has an outstanding publication record, with 39 publications in the best journals and conferences in the field, and has an H-index of 20, quite remarkable for a researcher at his career stage. Dr. Champati also came from a top university, KTH in Sweden, with an excellent research record as well, with publications in journals such as IEEE Transactions and conferences such as IEEE INFOCOM.

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 PhD theses at IMDEA Networks. In 2020 the Institute graduated 7 new PhD Students and hired 18 new pre-doc researchers. The steady flow of highly qualified doctors produced by the institute is an important contribution to the national and European economy.

The awards and prizes received by our researchers for their research work and achievements testify to their international reputation. This year, Arturo Azcorra received the MSWIM "Reginald Fessenden" Award for his "Pioneering contribution to the midhaul and core of 5G networks"; this is a very prestigious award granted to the top scientists in the field. Narseo Vallina and his co-authors were the Research Award Emilio Aced on Protection of Personal data granted by the Spanish Agency for Data Protection. Albert Banchs, Marco Fiore and coauthors received the Conference Best Paper Award of the IEEE Communication Systems Integration and Modelling (CSIM) Technical Committee for their paper at IEEE INFOCOM 2019.

## The excellence of our scientific results

The efforts made by our team to produce outstanding scientific work led to a large number of scientific publications in 2020, in addition to prizes for the high quality of our scientific results. In particular, IMDEA researchers received awards for their papers at top conferences such as ACM MSWiM 2020 and the IEEE Symposium on S&P.

It is particularly worth highlighting the impact that IMDEA Networks had this year on the best conferences in our area. We published papers at the very top conferences in the areas, such as IEEE INFOCOM, ACM MOBICOM, and ACM Mobisys, and have served in the Technical Program Committees of such conferences. IMDEA Networks is among a selected group of European institutions that have published consistently in these venues for many years. Furthermore, Joerg Widmer has been appointed TPC co-chair for IEEE INFOCOM 2022, which ranks #1 in conferences according to Google scholar. This confirms the leading roles that our professors play in the research community.

The excellence of IMDEA Networks' results has been recognized by Computer Science Rankings (csrankings.org), which provides a metrics-based ranking of top computer science institutions around the world based on their presence at the most prestigious publication venues. In the five-year period comprised between 2016 and 2020, CSRankings places IMDEA Networks in the 1st position in Europe on Measurement & Performance Analysis, the 2nd position in Mobile Computing, and the 18th in Computer Networks. This puts IMDEA Networks among the selected few topmost European institutions in the area of networking.

## Contributing to a knowledge-based economy

The ultimate goal of IMDEA Networks is to produce high quality research results that contribute to a knowledge-based economy. Our strategy to transfer scientific and technological developments to industry over the last year has led to various new collaborations in addition to strengthening the existing partnerships with some of our key industrial collaborators.

Our researchers are currently contributing to 19 ongoing research projects that have attracted funding from various sources: 8 European projects, 4 national projects and 3 financed by the regional government of Madrid, in addition to 8 contracts with industrial partners and 4 other projects funded by international bodies. Among those, we would like to emphasize the DAEMON project, a project on dedicated intelligence for 6G networks coordinated by IMDEA Networks.

Among industry collaborations, it is worth mentioning the strategic partnerships maintained by IMDEA: Telefonica, which co-founded 5TONIC with IMDEA Networks and has a Joint Research Unit (JRU), in addition to participating in many research projects together. Ericsson is a key partner of 5TONIC and collaborates with IMDEA in multiple fronts, including research projects as well as in of the leading Masters in the world on SDN and NFV. NEC collaborates with IMDEA Networks on many fronts and has established a Joint Research Unit (JRU) with IMDEA Networks.

## Communicating our results

In addition to producing results of the highest technical quality and applying them to improve the life of the citizens, it is also very important for the Institute that these positive contributions to society are conveyed to the general public, to prospective PhD students, scientists, academics and specialists from other areas; all in all, to decision-makers, stakeholders, and collaborators, so that they can appreciate the benefits of having such a research institute located in Madrid.

Over the last years we have been consistently appearing in national and international, specialized and generic media with a large outreach, and this year has been no exception. ABC, El País, La Vanguardia, RTVE, Telemadrid, Newtral, Agencia SINC, EFE, Europa Press, Redes Telecom, Business Insider, Zona Movilidad, Study Finds, Total Telecom, Science X Network, are some of the circa 180 unique media outlets that carried our news during 2020.

Building on our results of 2020, in the year ahead we look forward to making more impactful scientific discoveries, establishing fruitful collaborations, launching exciting new research initiatives and increasing our outreach, all in the interest of society.

# about us

# 2

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## 2.1.  Profile

**IMDEA Networks Institute** is a **research organization on computer and communication networks** whose multinational team is engaged in cutting-edge fundamental science and technology. As an English-speaking institute located in Madrid, Spain, IMDEA Networks offers a unique opportunity for pioneering scientists to develop their ideas. IMDEA Networks has established itself internationally at the forefront in the **development of future network principles and technologies**. Our **team** of highly reputed researchers is designing and creating today the networks of tomorrow.

*Some keywords that define us*: *5G, Big Data, blockchains and distributed ledgers, cloud computing, content-delivery networks, data analytics, energy-efficient networks, fog and edge computing, indoor positioning, Industry 4.0., Internet of Things (IoT), machine learning, millimeter- wave communication, mobile computing, network economics, network measurements, network security, networked systems, network protocols and algorithms, network virtualization (software defined networks – SDN and network function virtualization – NFV), privacy, social networks, underwater networks, vehicular networks, wireless networks and more…*

## 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 Vision

**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 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.

## 2.4. Our Mission

Our mission is to create value by **leading research in protocol, algorithm and systems developments** that enable the **Digital Knowledge Society**. 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 optimal working conditions and the most attractive and best-equipped environ- ment in which researchers can focus on this process of innovation and scientific advance.

**RESEARCH PROGRAMMES**
- Global Computing Group [Antonio Fernández Anta]
- Internet Analytics Group [Narseo Vallina-Rodríguez]
- NETCOM Lab [Arturo Azcorra, Albert Banchs]
- NetEcon Group [Sergey Gorinsky]
- Opportunistic Architectures Lab [Marco Ajmone Marsan and Vincenzo Mancuso]
- Pervasive Wireless Systems Group [Domenico Giustiniano]
- Wireless Networking Group [Joerg Widmer]
- Data Transparency Group (DTG) [Nikolaos Laoutaris]
- Networks Data Science Group [Marco Fiore]
- Edge Networks Group [Jaya Prakash Varma Champati]
- Cybersecurity Group [Guillermo Suárez-Tangil]

## 2.5. The Institute in figures

The core strength of the Institute is its international **research team, consisting of talented researchers from 18 different nationalities,** which carries out new scientific discoveries in Computer Networks, and foster the development of emerging technologies.

| 58 | 21 | 51% | 60,34% | 11 |
|---|---|---|---|---|
| researchers | nationalities | PhDs | foreign researchers | research groups |
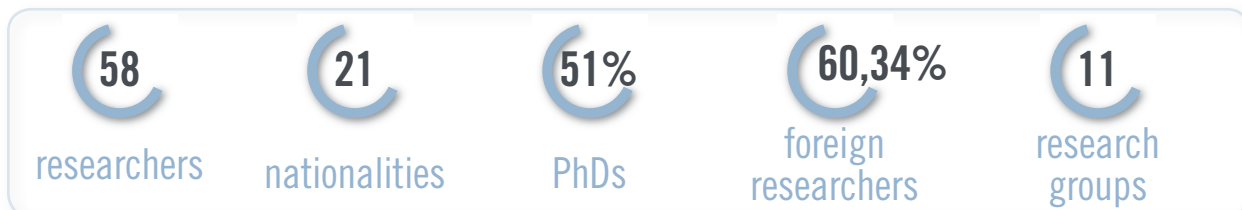
**The facilities of IMDEA Networks Institute**
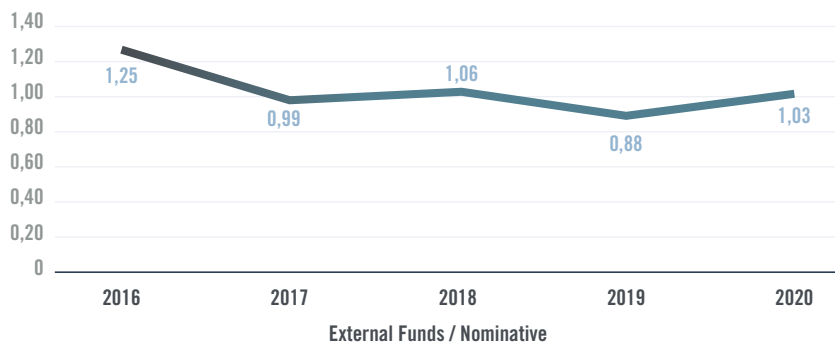The building and laboratories of IMDEA Networks Institute are located at Leganés, Madrid

**402 m$^2$** of research labs

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.
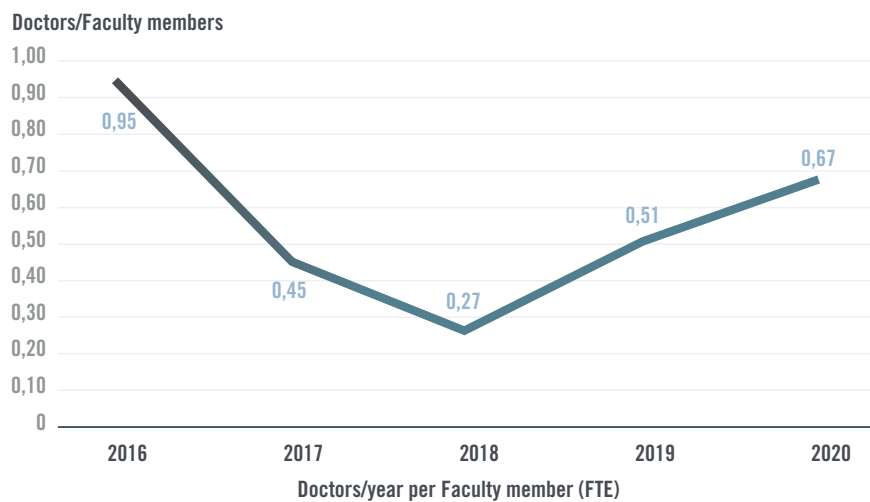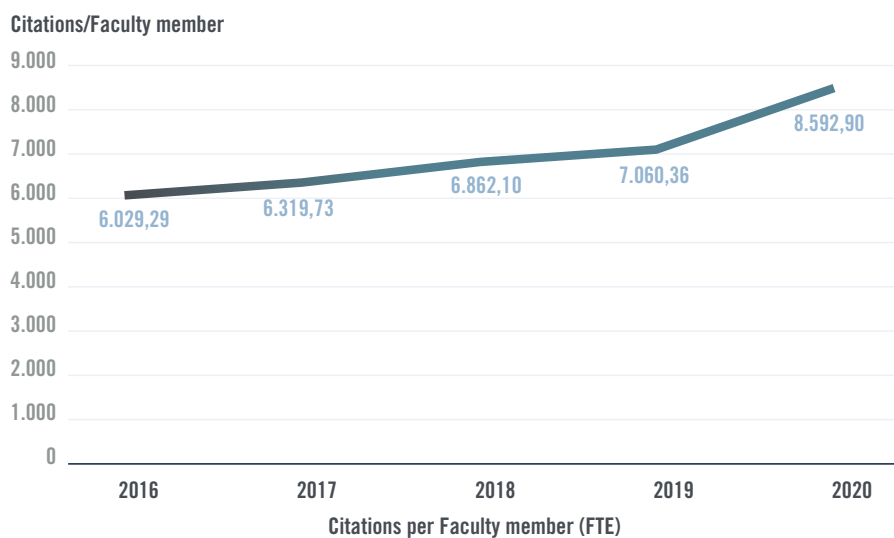
**We bring Money to Madrid: Self Funding**

1,40
1,20
1,00
0,80
0,60
0,40
0,20
0

1,25
0,99
1,06
0,88
1,03

2016    2017    2018    2019    2020

**External Funds / Nominative**

**We produce Talent for Madrid: Doctors graduated/year**

Doctors/Faculty members

1,00
0,90
0,80
0,70
0,60
0,50
0,40
0,30
0,20
0,10
0

0,95
0,45
0,27
0,51
0,67

2016    2017    2018    2019    2020

**Doctors/year per Faculty member (FTE)**

**We produce Leadership for Madrid: Citations**

Citations/Faculty member

9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0

6.029,29
6.319,73
6.862,10
7.060,36
8.592,90

2016    2017    2018    2019    2020

**Citations per Faculty member (FTE)**

**Those who can imagine anything, can create the impossible**

*Alan Turing*

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**networks**

## We produce internationalization of Madrid: Nationalities (Cumulative & Current)

Nationalities per year: 2016: 18, 2017: 20, 2018: 18, 2019: 18, 2020: 21

Cumulated nationalities: 2016: 30, 2017: 34, 2018: 35, 2019: 37, 2020: 39

— Nationalities per year — Cumulated nationalities
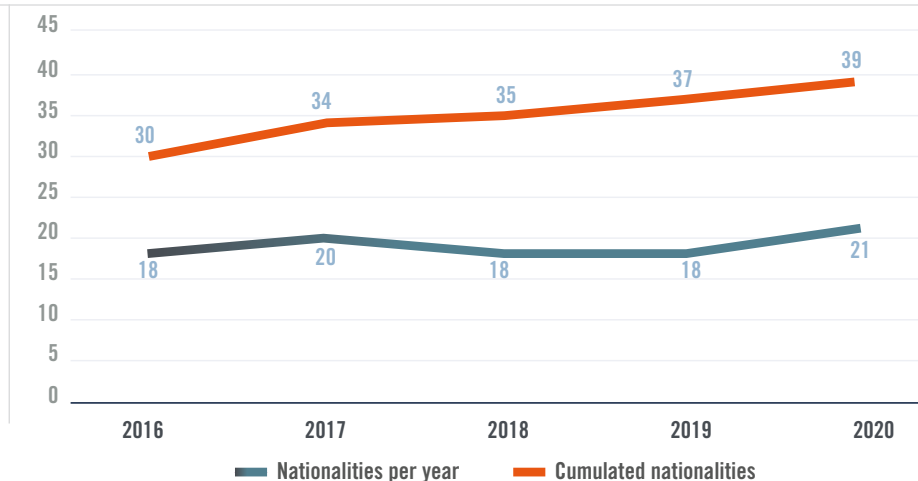
## We produce Leadership for Madrid: CS-Ranking (Europe)

2012-2016 | 2013-2017 | 2014-2018 | 2015-2019 | 2016-2020

Computer networks: 14, 14, 16, 17, 18
Mobile computing: 16, 11, 5, 3, 2
Measurement & perf. analysis: 4, 5, 3, 2, 1

CS Ranking for Europe

— Computer networks — Mobile computing — Measurement & perf. analysis
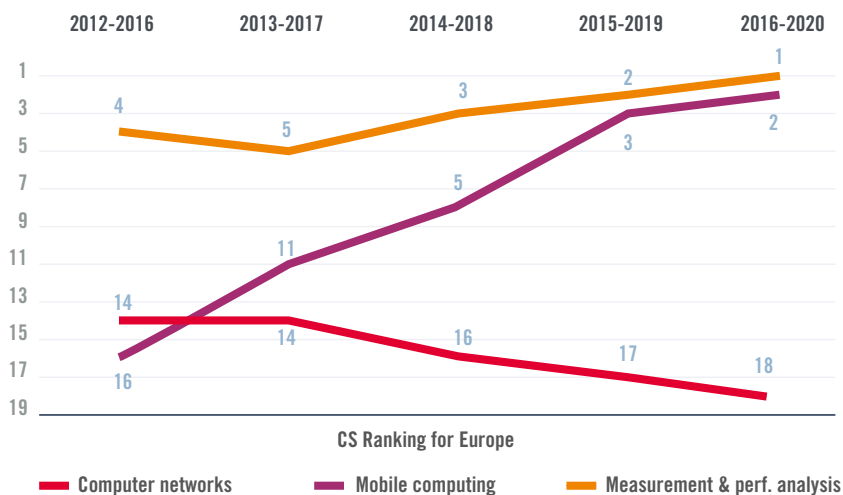
### Computer Networks

1 ▶ ETH Zurich
2 ▶ Technion
3 ▶ Hebrew University of Jerusalem
3 ▶ University College London
5 ▶ EPFL
6 ▶ KTH Royal Institute of Technology
7 ▶ Max Planck Society
7 ▶ University of Cambridge
9 ▶ University of Kent
10 ▶ TU Berlin

10 Universidade de Lisboa
10 University of Edinburgh
13 Queen Mary University of London
14 Humbolt University of Berlin
14 TU Darmstadt
16 Lancaster University
16 Tel Aviv University
18 Cyprus University of Technology
18 IMDEA Networks Institute

### Mobile Computing

1 ▶ University of Oxford
2 ▶ IMDEA Networks Institute
3 ▶ TU Delft
4 ▶ ETH Zurich
5 ▶ University of Edinburgh
6 ▶ University of Cambridge
7 ▶ TU Darmstadt
7 ▶ Uppsala University
9 ▶ Max Planck Society
10 ▶ Politecnico di Milano

### Measurement & Performance Analysis
#### CS-Rank 2016-2020

1 ▶ IMDEA Networks Institute
2 ▶ ETH Zurich
3 ▶ EPFL
4 ▶ Max Planck Society
5 ▶ Tu Berlin
5 ▶ University of Vienna
7 ▶ Brandenburg University of Technology
8 ▶ University College London
9 ▶ Imperial College London
9 ▶ University of Cambridge

## 2.6. Organizational Structure

BOARD OF TRUSTEES

SCIENTIFIC COUNCIL

DELEGATE COMMITTEE

DIRECTOR
A. AZCORRA

DEPUTY DIRECTOR
A. BANCHS

RESEARCH
J. WIDMER

RESEARCH SUPPORT
R. GIRONA

RESEARCH PROFESSORS

NETWORKED SYSTEMS & ALGORITHMS

RESEARCH ASSOCIATE PROFESSORS

WIRELESS NETWORKING

RESEARCH ASSISTANT PROFESSORS

NETWORK MEASUREMENTS & ANALYTICS

POST-DOC RESEARCHERS

VISITING PROFESSORS

PRE-DOC RESEARCHERS

ADMINISTRATION

RESEARCH ENGINEERING & SUPPORT

SCIENTIFIC INFRASTRUCTURE

## 2.6.1. 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. Eduardo Sicilia Cavanillas**

## 2.6.2. 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

**Position:** Head of Implementation Components, Ericsson. Finland

**PhD:** Aalto University. Helsinki. Finland

**Research:** Signaling; Multimedia applications; Transport protocols; Network security; Networking architectures

### Prof. Dr. Jon CROWCROFT

**Position:** Marconi Professor of Communication Systems at University of Cambridge. Cambridge. UK

**PhD:** Computer Science, University College London (UCL) (England, UK)

**Research:** Opportunistic Communications; Privacy in the Cloud; Carbon Neutral Networking

### Prof. Dr. Gustavo DE VECIANA

**Position:** Cullen Trust Professor of Electrical and Computer Engineering at the University of Texas at Austin. USA

**PhD:** Electrical Engineering, University of California at Berkeley. USA

**Research:** Analysis and Design of Wireless and Wireline Telecommunication Networks; Architectures and Protocols to Support Sensing and Pervasive Computing; Applied Probability, Queuing and Information Theory

### Dr. Jim KUROSE

**Position:** Distinguished University Professor of Information and Computer Sciences at the University of Massachusetts at Amherst. MA. USA.

**PhD:** Columbia University. United States

**Research:** Computer network protocols and architecture, network measurement, sensor networks, multimedia communication, development of asynchronous learning materials and pedagogy (particularly the use of Internet-based multimedia material)

### Prof. Dr. Edward KNIGHTLY

**Position:** 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. Pablo RODRIGUEZ RODRIGUEZ

**Position:** Moonshots Ambassador at X, the moonshot factory. Mountain View, CA. USA

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

**Research:** Networking; Distributed Systems; Information Theory; Wireless and Mobile; Network Economics; Social Networks

### Prof. Dr. Ralf STEINMETZ

**Position:** 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. Ioannis STAVRAKAKIS

**Position:** Full Professor & Head Department of Informatics and Telecommunications. National and Kapodistrian University of Athens. Athens. Greece

**PhD:** Electrical Engineering. University of Virginia. Charlottesville. USA

**Research:** Analysis and Design aspects of Networking Technologies ranging from Link to Application Layers: Social, Mobile, Ad Hoc, Autonomic, Information Centric, Delay-tolerant and Future Internet Networking; Network Resource Allocation Algorithms & Protocols, Traffic Management & Performance Evaluation; Content Dissemination, Placement & (Cooperative) Replication in Unstructured P2P and Social Networks; (Human-Driven) Decision Making in Competitive Environments

### Dr. Heinrich J. STÜTTGEN

**Position:** Independent consultant

**PhD:** Computer Science, Associative Memory Architecture, University of Dortmund. Germany

**Research:** Network Architecture and Protocols; Software Defined Networking; Internet of Things (IoT)

# research areas

# 3

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

The research work at IMDEA Networks is led by **Joerg Widmer**, who is the **Research Director** of the Institute and therefore responsible for its research direction.

Currently, our scientific work focuses on the following three general areas:

## 3.1. Networked Systems and Algorithms

**Scientific Director of "Networked Systems and Algorithms":** **Arturo Azcorra**.

Any network has a structure and needs protocols to achieve its objectives. The researchers of IMDEA Networks Institute have an extensive expertise in architectures and protocols for communication networks, e.g., for network topology design, routing, forwarding, packet classification, 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 and online algorithms. 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 explore tradeoffs between simplicity and expressiveness of packet processing engines, new abstractions for heterogeneous control planes, and network virtualization techniques. We also work on networking aspects that pertain to cloud computing.

## 3.2. Wireless Networking

**Scientific Director of "Wireless Networking":** Joerg Widmer.

Given the scarcity of wireless spectrum resources and the rising demand for mobile applications, optimizing wireless communication and improving wireless network architectures 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 scalability, interference and the unpredictability of the wireless medium.
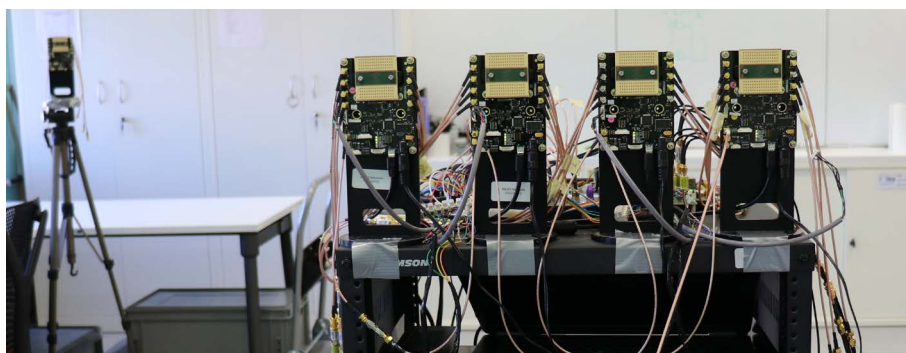
IMDEA Networks is involved in a number of different wireless research areas. We are investigating emerging wireless technologies such as extremely high frequency communication for 5G and wireless LAN and Visible Light Communication, which promise to increase wireless data rates by an order of magnitude or more. Our work on capacity improvements also focuses on topics such as ultra-dense networks, 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.

At the same time, mobile network architectures need to support these new technolo- gies as well as new use cases, and thus become more flexible. We perform research on network architectures for 5G and beyond, specifically focusing on software-defined networks (SDN)-based architectures and network function virtualization (NFV). In addition, wireless networks are becoming more heterogeneous as they are gaining traction in more diverse use cases such as the Internet of Things (IoT) and intermittently connected or delay-tolerant networks, unmanned aerial vehicular networks. The research activities span medium access control (MAC), routing, error control and transport protocols, both as standalone entities and as part of cross-layer design frameworks. To improve the flexibility and programmability of future wireless technologies, we also explore novel programmable interfaces that expose low-level operations to foster network evolution and enable performance optimization and service customization. For a number of the above use case scenarios, efficient and accurate device localization is highly useful.

We recognize the importance of bridging the gap between theoretic results and applied wireless research and have deployed a range of wireless testbeds (for mm-wave, visible light communication, 5G, IEEE 802.11, and others) on which we implement and evaluate our ideas.

## network measurements&analytics

### 3.3. Network Measurements and Analytics

**Scientific Director of "Network Measurements and Analytics": Albert Banchs.**

The rapid evolution of the Internet, comprising the fixed network, mobile portable systems and the Internet of Things (IoT) has given birth to a rich ecosystem of applications, personalization and services that is changing the way billions of users communicate and interact with their environment. This digitalization of the world has allowed new innovative applications with new levels of personalization and the ability to interact the environment. However, this trend is also producing large volumes of data, which may raise privacy and security threats unseen in previous networked technologies while also generating unknown traffic patterns and performance bottlenecks which can have a negative impact on the network and user experience.

At IMDEA Networks, we are involved in novel research efforts to empirically illuminate how users, networks, devices and applications interact, behave and perform in the wild.

Our research is particularly focused on conducting analytical measurements of real-world networked systems, with a strong interest in understanding their use (and abuse) as well as the performance, privacy and security challenges present in emerging networking technologies. Our research team also develops Big Data solutions to analyze and process large-scale traffic-, network- and application-generated data fast and correctly.

At IMDEA Networks, we engage and collaborate with users, cyber-activists, industry and regulators to identify and address important problems of societal, industrial and academic interest from a practical angle. Often times, our researchers are responsible for developing practical tools to assist the different stakeholders to understand how users, devices, networks, services, and applications interconnect, perform and behave behind the scenes.

## 3.4 Headquarters and research laboratories infrastructure

### 3.4.1 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 continuously refurbishing our site at Avenida del Mar Mediterráneo 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.

The area of the building already remodeled in 2020 amounted to 2.764 m$^2$.
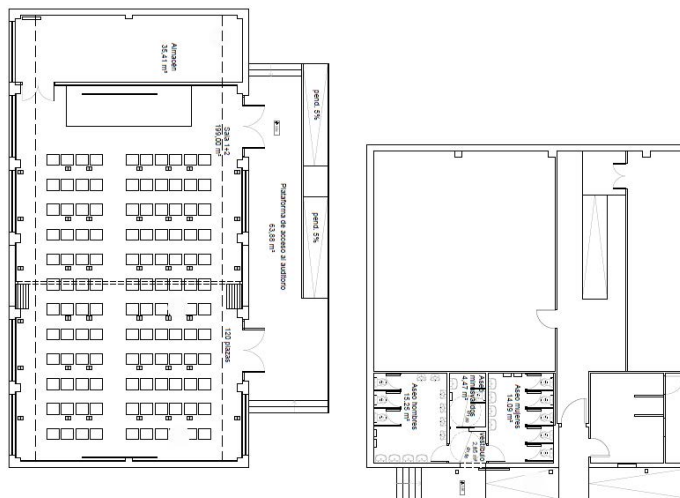


- **Auditorium**: The works for the refurbishment of the Auditorium have taken place in 2020. With a total surface of 200 m$^2$, it can be divided into two independent meeting rooms using a movable acoustic wall. It includes a storeroom where the IT equipment and other elements can be stored, and It is fully equipped with a complete audiovisual system consisting of: projectors, screens, speakers, cameras, etc. The scope of the works, included the renovation of the 5TONIC bathrooms, that will be shared with the Auditorium from now on.

- **High-speed fiber connection**:  At the beginning of the third quarter of 2019, the connection to REDIMadrid, the Community of Madrid's research data network, was made through a 10Gb/s redundant fiber for the exclusive use of IMDEA Networks. In 2020, and alternative fiber route has been installed in the scope of the redundancy works. The fiber serves both, IMDEA Networks and 5TONIC laboratory.

- **COVID-19 protective measures**: In response to the COVID-19 pandemic, since the declaration of the first state of alarm on March 14, 2020, numerous measures have been adopted to provide the Institute's members with a safe environment and spaces for the development of their activity. Specifically, protective screens have been installed in all posts located in open areas, hydroalcoholic gel dispensers have been installed throughout spaces and there are surgical masks, nitrile gloves, alcohol and other disinfectant sprays available for everyone. The maximum capacity of offices, meeting rooms and laboratories has also been limited, marking disabled spaces, and teleworking and videoconferencing have been encouraged. In addition, all personnel have received a training course on COVID-19 and a contingency plan and protocols for action in the event of infection have been drawn up.

- **Main entrance, parking and backyard refurbishments**: In 2020, the works regarding refurbishment and waterproofing of the roof of the passageway which links the 3 buildings of the Institute began, within the scope of the refurbishment projects of the Institute's main entrance, parking lot and backyard, which are expected to be completed in 2021.

### 3.4.2 Research laboratories

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.

The 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.

IMDEA Networks is aware of the importance of having the best equipment to perform experimental work. We invest in the latest technologies.

A Dell PowerEdge R7525 server, in which 2 NVIDIA A100 GPUs have been installed, and 2 Dell PowerEdge R740xd servers have been purchased in order to provide the Institute with sufficient computational resources to carry out large-scale mobile traffic analysis, modeling and forecasting projects for networks at a country level, for which it is necessary to be able to handle hundreds of GB of data, as well as for research in artificial intelligence.

Eight TRX-BF/01 R2 evaluation boards to analyze millimeter waves have been purchased, and they are being used to develop experimental platforms for the in-depth study of signal processing algorithms which can be used in modern and future communications systems.

For the study on emerging wireless communications, such as extremely high frequency communications for 5G and wireless LANs and visible light communication, a Dell PowerEdge T140 server has been acquired.

ASUS RT-AC58U high-speed wireless connectivity routers have been purchased to conduct studies to understand modern indoor positioning algorithms and their implementation in commercial devices used for Internet of Things solutions.

To improve the Institute's WiFi network, so it also reaches the Auditorium, 5 Aerohive 250, 350C and 305C1 access points have been purchased, as well as a Dell Networking N2024P Switch.

### The 5TONIC Laboratory

The 5TONIC Laboratory provides infrastructure to support a wide range of systems, functionality, services and applications allowing the deployment, analysis, testing, trial and demonstration of choice technologies driving the 5G development.

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.

In 2020 carried out a number of activities in order to pursue two objectives:

1. Support for the development of new technological solutions for 5G.

2. Support for the implementation and deployment of new use cases that take advantage of 5G capabilities.

As an example of the projects launched for pursuing the first objective, 5TONIC members Telefónica, Ericsson, UC3M and IMDEA Networks collaborated in a joint proof of concept project to deploy a 40 Gbit/s bidirectional link on the E-band (70-80 GHz) between IMDEA's building and the Polytechnic campus of UC3M.

In terms of new use cases, the activity of the lab was necessarily affected by the pandemic situation, but was able, through a combination of remote and on-site work, to reach some significant achievements. In this sense, it was able to support the implementation of use cases for the ICT project 5G EVE, 5G Vinni, 5G DIVE and 5Growth, in collaboration with companies like ASTI and Innovalia.

In order to fulfill these objectives, 5TONIC has continued the expansion of its infrastructure. In this sense, 5TONIC completed the deployment of a cloud-native 5G Core supporting Stand Alone (SA) connectivity. This means that 5TONIC already has the capability to run 5G independent of the existing 4G infrastructure that is also deployed at the lab. 5TONIC thus became one of the first open research and innovation labs in the world offering 5G SA capabilities for validating vertical applications. It also increased the 5G coverage area within the Institute building, using for these purposes Ericsson's Dots, an indoor solution with a very low footprint that facilitates its installation.

Again, 5TONIC presence in different events has been severely limited, like the participation of Arturo Azcorra in the Mobile World Congress 2020, due to their cancellation. In compensation, the lab has an active participation in online events, like the webinars organized by the 5G EVE and 5G Vinni projects.

During 2020, 5TONIC also has incorporated several new collaborators to cooperate in several use cases, including DeepSight AI Labs and Telcaria.

# research projects, grants and fellowships

# 4

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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. 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.

### 4.1.1 International

## The NortonLifeLock Research Group Graduate Fellowship

**Awardee**
- Julien Gamba (PhD Student).

**Funded by**
NortonLifeLock

### 4.1.2 National

## Ramón y Cajal Grants
*(Programa Ramón y Cajal)*

**Awardee**
- Dr. Vincenzo MANCUSO, Research Associate Professor

**Funded by**
Spanish Ministry of Economy, Industry and Competitiveness *(Ministerio de Economía, Industria y Competitividad - MINECO)*

# Juan de la Cierva Formation Grants 2017 and 2019

### Awardees
- Dr. Claudio FIANDRINO, Post-Doc Researcher
- Dra. Amanda GARCÍA-GARCÍA, Post-Doc Researcher
- Dr. Borja GENOVÉS, Post-Doc Researcher

### Funded by
Spanish Ministry of Science, Innovation and Universities (MICINU), National Pro- gramme for the Promotion of Talent and Its Employability, part of the National Plan for Scientific and Technical Research and Innovation

# Juan de la Cierva Incorporation Grants 2019

### Awardees
- Dr. Claudio FIANDRINO, Post-Doc Researcher

### Funded by
Spanish Ministry of Economy, Industry and Competitiveness (MINECO), National Pro- gramme for the Promotion of Talent and its Employability

# Grants for training university teachers – FPU
*(Ayudas para la Formación del Profesorado Universitario)*

### Awardees
- Edgar ARRIBAS, PhD Student
- Dolores GARCÍA, PhD Student
- Yago LIZARRIBAR, PhD Student
- Joan PALACIOS BELTRÁN, PhD Student

### Funded by
Spanish Ministry of Universities (Ministerio de Universidades)

# Grants to promote youth employment, cofinanced by the European Social Fund 2018 – Technicians and managers

*(Ayuda para la promoción de empleo joven cofinanciado por el Fondo Social Europeo 2018 – Técnicos y gestores*

**Awardees:**
- Elvira CONTI, Junior Project Administrator
- Marta DORADO, Junior Science Communicator
- Rubén RUPÉREZ, R&D laboratory technician

**Funded by:**
Ministry of Economy, Industry and Competitiveness (MINECO)

**4.1.3 Regional**

# Youth Employment Initiative (YEI) – Programa de Empleo Juvenil

*(Convocatoria de ayudas para la contratación de investigadores predoctorales e investigadores postdoctorales cofinanciadas por Fondo Social Europeo 2018-2019)*

**Awardee**
- Dr. Marius PARASCHIV, Post-Doc Researcher
- Dr. Giuseppe SANTAROMITA, Post-Doc Researcher

**Funded by**
European Social Fund (Youth Employment Initiative), Department of Education and Research, Regional Government of Madrid

# Talent Attraction Grant – Modality 1: Researchers With Experience

**Awardee**
- Marco FIORE (Research Associate Professor)

**Funded by**
Consejería de Ciencia, Universidades e Innovación de la Comunidad de Madrid

## 4.2 Ongoing projects

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 probabilities of success in achieving its stated goals.

# BANYAN

*Big dAta aNalYtics for radio Access Networks*

Funded by: European Union H2020-ICT-2019 (Information and Communication Technology) Grant
Duration: April 2020 to November 2023

As mobile services consumed by people and machines become increasingly diversified and heterogeneous, 4G/5G networks are asked to meet a growing variety of Quality of Service (QoS) requirements. Network slicing, enabled by Network Function Virtualization (NFV), is a promising paradigm to increase the agility and elasticity of the mobile network via logical slices that can be formed and composed dynamically, so as to adapt to the fluctuations in the demands for different mobile services. BANYAN pursues a tight academic-industrial cooperation, which will allow developing key tools for data-driven 5G RAN, as well as properly training early-stage researchers who are urgently needed by industry, academia, etc.

More info

# PIMCITY

*Building the next generation personal data platforms*

Funded by: European Union H2020-ICT-2018-2020 (Tecnología de la información y la comunicación).
Duration: December 2019 to August 2022

Web economy has been revolutionized by unprecedented possibility of collecting massive amounts of user personal data, which lead the web to become the largest data market and created the biggest companies in our history.

Unfortunately, this change has deep consequences for users, who, deprived of any negotiation power, are compelled to blindly provide their data for free access to services. Data collection is opaque, fragmented and disharmonic, so that users have no control over their personal data, and, thus, on their privacy. Personal Information Management Systems (PIMS) aim to give users back control over their data, while creating transparency in the market. However, so far, they have failed to reach business maturity and sizeable user bases. PIMCity offers tools to change this scenario.

More info

# MINTS

*Millimeter-wave Networking and Sensing for Beyond 5G*

Funded by: European Union H2020-MSCA-ITN-2019 (Marie Skłodowska-Curie Innovative Training Networks)
Duration: November 2019 to October 2023

The global telecommunications market has become tremendously competitive due to the emergence of new Asian players and saturation of traditional products (e.g., mobile broadband), which has decelerated the growth of the EU's telecommunications market. Thus, without dramatic innovation to open up new markets, EU's telecommunications industry is at risk. However, new markets such as industry 4.0 and autonomous driving demands extremely high data rates which can only be provided at mmWave frequencies. To successfully overcome mmWave challenges, a closely integrated, skilled and multi-disciplinary team is needed to co-create innovative technology and applications. The ETN for MIllimeter-wave NeTworking and Sensing for Beyond 5G (MINTS) offers the first training program on mmWave networks that covers the full stack from physical layer to application.

More info

# ECID
*Edge Computing for Intelligent Driving*

Funded by: Spanish Ministry of Science and Innovation
Duration: June 2020 to May 2023

Assisted driving encompasses a number of technical challenges, from requiring connectivity with ultra-high reliability and imperceptible delays, and disposing of powerful and flexible (migrable) storage and computing engines for coordinated and distributed road traffic control, to imposing legal privacy-preserving attributes and the possibility of logging traffic events and assisted driving decisions in an auditable way (for instance, in case of legal disputes upon traffic accidents). Considering the complexity of making assisted driving control decisions for several coordinated players, and the need to actuate them at sub-second timescales, ECID proposes to leverage on edge/cloud computing and artificial intelligence spread and federated in the context of wireless access network infrastructures, and will develop decentralized and secure architectures of distributed ledgers (offer the capability of logging events and the responsibility of actions in a trustworthy way and with minimum risk of malicious tampering).
More info

# ODIO
*The Open Digital Identity Observatory*

Funded by: Spanish Ministry of Science and Innovation
Duration: June 2020 to May 2023

The ODIO coordinated project aims at addressing the challenge posed by the widespread access, dissemination and abuse of users personal attributes and behavioral data in Internet services. The risks of such practices go beyond privacy issues and include identity theft, discrimination, fraud, extortion, and manipulation. The MOOSE subproject focuses on assessing the privacy and security risks associated to the use and abuse of end-users digital identity in the web and mobile devices. The project aims to develop transparency tools to perform a multi-dimensional characterization of the online tracking industry present in these services, and the dynamics and relationships between companies for the creation and dissemination of user profiles and identities for advertising purposes and data brokerage..
More info

# ENLIGHT'EM
*European Training Network in Low-energy Visible Light IoT Systems*

Funded by: European Union H2020-MSCA-ITN-2018 (Marie Skłodowska-Curie Innovative Training Networks) Grant.
Duration: June 2019 to May 2023

An Innovative Training Networks (ITN) project, type which aims to train a new generation of creative, entrepreneurial and innovative early-stage researchers, able to face current and future challenges and to convert knowledge and ideas into products and services for economic and social benefit. Light Emitting Diodes (LEDs) are driving a revolution in lighting systems (superior energy efficiency), and are already entering the Internet of Things (IoT) market with embedded sensory functionalities. By bringing connectivity to every LED bulb, Visible Light Communication (VLC) offers the opportunity to write the next chapter of the LED revolution with the language of ubiquitous networks VLC systems for the IoT to design and demonstrate sustainable networking solutions. ENLIGHT'EM will train a new generation of innovators and provide them with the know-how to contribute to the development of the IoT in the world of 5G and beyond.
More info

*This project has received funding from the European Union's Horizon 2020 research and innovation programme under Marie Skłodowska-Curie grant agreement No.814215.*

# EDGEDATA-CM
*An infrastructure for highly decentralized hybrid systems*

Funded by: Department of Education and Research of the Regional Government of Madrid, through the 2018 R&D technology program for research groups, co-financed by the Operational Programs of the European Social Fund (ESF) and the European Regional Development Fund (ERDF).
Duration: January 2019 to December 2022

Innovation technologies, cloud computing, IoT, big data and high speed WIFI networks have made possible applications that were inconceivable few decades ago. As a result, the quality of life is improving and better commercial decisions are taken thanks to data analysis. In recent years, as a result of the innovation and new needs there was a boom in distributed systems applied to different contexts such as IoT that has led to new computational paradigms (fog computing, edge computing, cloud computing, blockchain…). Its main goal is to go beyond the state of the art in terms of new architectures for these technologies as well as to propose hybrid solutions combining them.
More info

European Regional Development Fund
Investing in your future

European Union
European Social Fund
Investing in jobs and skills

# TAPIR-CM
*Advanced techniques to enhance the intelligence of 5G networks*

Funded by: Department of Education and Research of the Regional Government of Madrid, through the 2018 R&D technology program for research groups, co-financed by the Operational Programs of the European Social Fund (ESF) and the European Regional Development Fund (ERDF)
Duration: January 2019 to December 2022

Its aim is to design architectural solutions for 5th generation (5G) and beyond mobile networks. To this end, the project will leverage as enablers SDN (Software Defined Networking) and network functions virtualization (NFV) to boost the transformation of current networks into software-centric paradigm, enabling flexibility and agility in the whole system lifecycle. The evolution of the SDN architecture itself enables high scalability and programmability and, therefore, it is an important objective of the project. The second enabler component will resort to is machine learning. The capability to forecast with high accuracy the behavior and characteristics of data traffic that mobile users will consume through machine learning techniques is pillar to improve the performance of multiple of network functions, including scheduling, mobility management, orchestration and resource allocation, among the others.
More info

# LOCUS
*LOCalization and analytics on-demand embedded in the 5G ecosystem, for Ubiquitous vertical applicationS*

Funded by: European Union H2020-ICT-2018-2020 (Information and Communication Technology) Grant.
Duration: November 2019 to October 2022

Context-awareness is essential for many existing and emerging applications. Context information greatly relies on location information of people and things. But navigation satellite systems are denied in indoor environments, current cellular systems fail to provide high-accuracy localization, other local localization technologies (e.g. WI-FI or BT) imply high deployment/maintenance/integration costs. Raw spatiotemporal data are not sufficient by themselves and need to be integrated with tools for the analysis of the behaviour of physical targets, to extract relevant feature of interests. LOCUS will improve the functionality of 5G infrastructures to: i) provide accurate and ubiquitous location information as a network-native service and ii) derive more complex features and behavioural patterns out of raw location and physical events, and expose them to applications via simple interfaces.
More info

# MYP-SOCRATES
*Large Scale Collaborative Detection and Location of Threats in the Electromagnetic Space*

Funded by: NATO Emerging Security Challenges Division – Science for Peace and Security Programme (SPS). Grant G5461.
Duration: June 2018 to October 2021

Create the foundations for an accurate, autonomous, fast and secure system that identifies intruders in the electromagnetic space, before the threat can become serious, learning about its physical layer features and its geographic location.
More info

# 5G-EVE
*5G European Validation platform for Extensive trials*

Funded by: European Union. H2020-ICT-2018-1
Duration: July 2018 to June 2021

We are at the "eve" of a fundamental transition in 5G, and the aspiration of 5G-EVE is to create the foundations for a pervasive roll-out of end-to-end 5G networks in Europe. It is one of three 5G PPP infrastructure projects started on 1st July 2018, whose goal is to implement and test advanced 5G infrastructures in Europe. The 5G-EVE concept is based on further developing and interconnecting existing European sites in Greece, Spain, France, and Italy to form a unique 5G end-to-end facility, which will enable experiments with: (a) heterogeneous access, including NR, licensed/unlicensed spectrum, advanced spectrum management; (b) Mobile Edge Computing, backhaul, core/service technologies; (c) means for site interworking and multi-site/domain/technology slicing/orchestration. 5G-EVE will be initially compliant with 3GPP Rel. 15 and, later on, with Rel. 16.
More info

# COLLABORATE
*Developing a Strongly Consistent, Fault-Tolerant, Long-Lived Distributed Storage System with Failure Prediction Mechanism*

Funded by: Cyprus Research Promotion Foundation. RPF/POST-DOC/0916/0090 - COL-LABORATE.
Duration: May 2019 to October 2021

Distributed Storage Systems (DSS) encompass the technology powering modern cloud data storage services such as DropBox and Google Drive that are used by millions of users as networked platforms for collaborative applications and data storage. Algorithms for DSS ensure data availability and survivability by replicating data in geographically

dispersed network locations. However, a major problem with data distribution is consistency, especially when the storage is accessed concurrently by multiple processes; a key to enabling collaboration. Numerous strategies have been devised to mitigate these issues, however, a robust and efficient solution remains elusive. This project proposes a novel atomic DSS built on top of asynchronous message-passing, failure-prone, commodity devices and its goal is to enhance the practicality of atomic data storage by combining three services: (i) Fragmentation, (ii) Reconfiguration, and (iii) Failure Prediction.
More info

## PinPoint 5G+
*Accurate, Pervasive and Low-Latency Positioning to Innovate 5G Networks and Beyond*

Funded by: Spanish Ministry of Science, Innovation and Universities
Duration: January 2019 to December 2021

Positioning data is the cornerstone to enable data analytics and applications in the location-based service (LBS) market. At the same time, positioning data can bring dramatic benefits to the 5th generation of cellular networks and beyond (5G+) for the management and control of networks that are getting increasingly denser and more heterogeneous. Yet todays cellular systems fail to provide accurate, pervasive and low-latency localization. The result is a plethora of fragmented localization systems based on diverse radio technologies and protocols that do not interoperate. This project aims to extend the functionalities of network to (i) provide accurate and ubiquitous locations of physical entities as a network-native service based on the integration of 5G+ technologies, and (ii) exploit position data to optimize the allocation of network resources based on anticipatory networking concepts.
More info

## SMOOTH
*GDPR Compliance Cloud Platform for Micro Enterprises*

Funded by: European Union. H2020 Cibersecurity PPP
Duration: May 2018 to January 2021

According to the last official available 2015  data, almost 93% of all enterprises in Europe in the non-financial business sector have less than 10 employees. However, when it refers to the imminent General Data Protection Regulation (GDPR)'s application, MEnts are the most vulnerable due to their lack of expertise and resources to invest in their adoption. It is urgent to develop solutions that assist MEnts in smoothly adopting the GDPR, safeguarding the interests of the EU citizens on data privacy and security, avoiding the negative socioeconomic consequences entailed to breaches for MEnts, and,

by extension, benefitting the European society. SMOOTH addresses this challenge from two complementary focuses, with the aim of becoming the reference tool platform to adopt the GDPR in this context: creating awareness on the importance of being compliant with the GDPR (SMOOTH will deliver a practical GDPR interactive handbook tailored specifically to MEnts) and assisting to effectively adopt and comply with the GDPR.
More info

# 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

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

# SYMBIOSIS
*A Holistic Opto-Acoustic System for Monitoring Marine Biodiversities*

Funded by: European Union. H2020-BLUE GROWTH 2017
Duration: November 2017 to December 2020

SYMBIOSIS is devised as a blend of cost effective autonomous optical and acoustic components for the characterization, classification, and biomass evaluation of six target species of pelagic fish that are important to the fishery industry, and that reflect on the health of their own environment. The acoustic unit includes an active underwater acoustic array of 15+10  elements, to detect, classify, evaluate the biomass of, and localize the chosen pelagic fish species within a range of 500 m. Acoustics trigger the optical component (encompassing two frames of six underwater optical cameras each), and will perform machine learning-based classification and biomass evaluation in low light conditions, thus validating acoustic detections.
More info

{SYMBI⊙SIS}

# DiSCOEdge

*Distributed storage and computing on the edge (of the network)*

Funded by: Spanish Ministry of Science, Innovation and Universities
Duration: January 2018 to December 2020

Today's mobile networks are populated by all sorts of devices which offer —in addition to a significant amount of sensing capabilities and myriad services to the user— a wealth of processing power, inexpensive storage and a wide range of computational and networking resources. Often times, the computation resources available on end-devices and other network elements remain highly underused. This inefficient use of resources is a consequence of the dominating cloud computing model in which the vast majority of online services and applications offload computationally expensive tasks to centralised and large scale cloud infrastructure services like Amazon EC2 even when they have computational resources available in their proximity. This project will study opportunities, technologies, marketing strategies and policies to advance the fog computing paradigm.
More info

## Industrial PhDs Programme 2019.
## Smart 5G Networks

Funded by: Programme for the execution of Industrial PhDs. Regional Government of Madrid
Duration: February 2020 to September 2020

The goal of this project is to propose a mobile network architecture that meets the requirements of the different vertical industries targeted by 5G. The proposed architecture will lie on top of the 5G platform, consisting of baseline components compliant with the latest release of 3GPP. On top of the baseline components, we will include modules that provide functionality required for the different vertical use cases that is not available within the underlying platform. These modules will employ standard interfaces to configure and manage the underlying modules.

More info

## A Comprehensive Simulation Model For IEEE 802.11ay for the ns-3 Network Simulator

Funded by: The National Institute of Standards and Technology (NIST) of the U.S. Department of Commerce
Duration: September 2019 to August 2020

Wireless communications in the millimeter-wave (mmWave) band bring unprecedented capabilities to achieve wireline performance in wireless networks and alleviate the congestion problem of current wireless technologies. However, efficient wireless networking in this band is extremely challenging compared to wireless technologies operating in the microwave band. IEEE 802.11ay is the next generation multi-gigabit standard to support wireless networking at 60 GHz. It is envisioned to achieve extremely high data-rates of up to 300 Gbps, using sophisticated physical layer techniques including multiple-input and multiple-output (MIMO) communication, channel bonding and aggregation, advanced beamforming techniques, and high order modulation schemes.

More info

# scientific activities

# 5

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

## 5.1. Awards

### 5.1.1. Paper Awards

**'AEPD EMILIO ACED AWARD 2020 ('DATA PROTECTION AWARDS 2020')**
(Spanish Data Protection Agency, 7 April 2021, Madrid)
**Álvaro Feal, Paolo Calciati, Narseo Vallina-Rodriguez, Carmela Troncoso, Alessandra Gorla**
*Angel or Devil? A Privacy Study of Mobile Parental Control Apps*

**SECOND PRIZE OF THE THREE BEST POSTERS**
(3rd BYMAT Conference - Bringing Young Mathematicians Together, 1-3 December 2020, Valencia, Spain)
**Elisa Cabana**
*How shrinkage can be used for robust methods*

**BEST PAPER AWARD**
The 23rd International ACM Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 2020), Virtual event (previously at Alicante, Spain), 16-20 November 2020
**Dolores Garcia, Joan Palacios, Jesús Omar Lacruz, Joerg Widmer**
*A Mixture Density Channel Model for Deep Learning-Based Wireless Physical Layer Design*

**HONORABLE MENTION - BEST PAPER AWARD RUNNER-UP**
(The 18th ACM International Conference on Mobile Systems, Applications, and Services MobiSys 2020, 16-19 Jun 2020, Toronto, Canada)
**Jesus Omar Lacruz, Dolores Garcia, Pablo Jimenez, Joan Palacios, Joerg Widmer**
*MmFLEX: An Open Platform for Millimeter-Wave Mobile Full Bandwidth Experimentation*

**BEST PRACTICAL PAPER AWARD**
(The 41st IEEE Symposium on Security and Privacy, 18-20 May 2020, San Francisco, CA, USA)
**Julien Gamba, Mohammed Rashed, Abbas Razaghpanah, Juan Tapiador, Narseo Vallina-Rodriguez**
*An Analysis of Pre-installed Android Software*

### 5.1.2. Researcher Awards

**ACM MSWIM 2020 REGINALD FESSENDEN AWARD**
**Arturo Azcorra (November 2019)**
The Director of IMDEA Networks Institute, Professor of Telematics Engineering at University Carlos III of Madrid and Vice-President of 5TONIC, received the prestigious

Reginald Fessenden Award for his contributions to the development of 5G technology. Granted by the ACM-MSWIM International Conference, the award recognises scientific contributions in the fields of wireless communications, networking and mobile systems.

### IEEE FELLOW

#### Joerg Widmer (January 2020)

The Research Professor and Research Director of IMDEA Networks was awarded by the prestigious Institute of Electrical and Electronics Engineers (IEEE) Grade of Fellow for his contribution to the field of wireless networks and millimeter-wave communications. IEEE is the most important international professional organization for the advancement and application of technology in the field of electrical and electronic engineering (fewer than 0.1% of voting members are selected annually for this distinction).

### 5.1.3. R&D Awards

### ML5G-PHY [CHANNEL ESTIMATION]. ITU ARTIFICIAL INTELLIGENCE/MACHINE LEARNING IN 5G CHALLENGE

#### Dolores Garcia Marti, Joan Palacios, Joerg Widmer (December 2020)

ITU AI/ML 5G Challenge - Applying AI/ML in 5G networks. 15-17 December 2020. The ML5G-PHY channel estimation challenge attacks one of the most difficult problems in the 5G physical layer: acquiring channel information to establish a millimeter-wave MIMO link (initial access) considering a hybrid MIMO architecture. Approaches in the challenge will lead to important insights into what can be achieved using data-driven and/or model-based approaches.

The IMDEA Networks team participated in the challenge ITU-ML5G-PS-025: ML5G-PHY- Channel Estimation with the name "ML-DOJO". They ranked 1st in the competition.

## 5.2. Publications

IMDEA Networks presented its scientific work in various formats and venues during 2020. There were **93** publications, out of which **88** were peer reviewed. This is how they are structured:

4 Book Chapters | 32 Journal Articles | 4 Magazine Articles | 45 Conference and Workshop Papers | 5 Conference and Workshop Posters & Demos | 3 Invited Papers, Keynotes, Invited Talks, Tutorials, Lectures, etc.

As well as the previous there were:

7 PhD Theses

According to **Google Scholar**, IMDEA Networks' researchers have received around **89.939 citations in total** along their research career, which corresponds to an **aggregated H-index of 128**.

publications

# 2006-2020

## number of publications (peer-reviewed)

| Year | Value |
|------|-------|
| 2006 | 8 |
| 2007 | 16 |
| 2008 | 11 |
| 2009 | 37 |
| 2010 | 45 |
| 2011 | 70 |
| 2012 | 76 |
| 2013 | 95 |
| 2014 | 79 |
| 2015 | 109 |
| 2016 | 99 |
| 2017 | 123 |
| 2018 | 114 |
| 2019 | 94 |
| 2020 | 88 |

## all publications by type

- Technical Reports 3
- Books 10
- Book Chapters 21
- Journal Articles 327
- Magazine Articles 47
- Theses 91
- Standardization Contributions 35
- Invited Papers, keynotes, Invited Talks, Tutorials, Lectures, etc 218
- Conference and Workshop Poster & Demos 64
- Conference and Workshop Papers 596

# 2020

## total number of publications per month



Total = 102
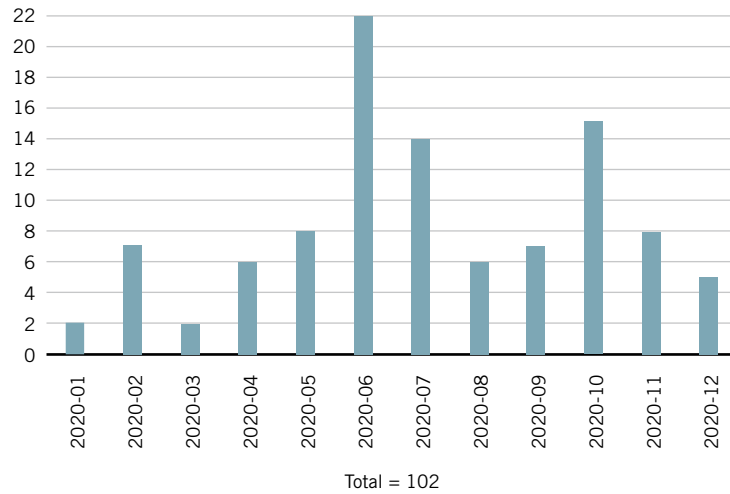
## publications by type (peer reviewed)
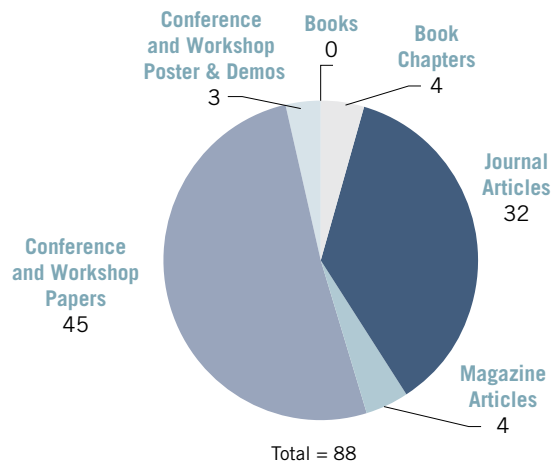


Conference and Workshop Poster & Demos
3

Books
0

Book Chapters
4

Journal Articles
32

Magazine Articles
4

Conference and Workshop Papers
45

Total = 88

**Genius is one percent inspiration,
ninety-nine percent perspiration**

*Thomas Edison*

institute
**iMdea**
**networks**

## Publications 2020

### Book Chapters [4]

**1. Per-Olov Östberg, Thang Le Duc, Paolo CASARI, Rafael GARCÍA, Antonio FERNÁNDEZ ANTA (July 2020)**

*Application Optimisation: Workload Prediction and Autonomous Autoscaling of Distributed Cloud Applications (pp. 51.68 , Palgrave Macmillan).*

**2. Domenico GIUSTINIANO, Vincent Lenders, Sofie Pollin (June 2020)**

*Large Scale Collaborative Detection and Location of Threats in the Electromagnetic Space (Springer).*

**3. ARRIBAS, Edgar and MANCUSO, Vincenzo (May 2020)**

*Millimeter Wave Meets D2D: A Survey. In: Wiley 5G Ref: The Essential 5G Reference Online. Wiley.*

**4. Claudio FIANDRINO, Andrea Capponi, Dzmitry Kliazovich, Pascal Bouvry (February 2020)**

*Crowdsensing architectures for smart cities (pp. 527 - 542, Elsevier).*

### Journal Articles [32]

**1. Antonio PASTOR, Rubén Cuevas, Ángel Cuevas, Arturo AZCORRA (December 2020)**

*Establishing Trust in Online Advertising With Signed Transactions*
IEEE Access. 10.1109/
ACCESS.2020.3047343. Volumen 9.

**2. José A. Ayala-Romero, Andrés García-Saavedra, Marco Gramaglia, Xavier Costa-Pérez, Albert BANCHS, Juan J. Alcaraz (December 2020)**

*vrAIn: Deep Learning based Orchestration for Computing and Radio Resources in vRANs*
IEEE Transactions on Mobile Computing. 10.1109/TMC.2020.3043100. IEEE Communications Society. ISSN: 1536-1233.

**3. Francesco SPINELLI, Vincenzo MANCUSO (November 2020)**

*Towards enabled industrial verticals in 5G: a survey on MEC-based approaches to provisioning and flexibility*

**4. Albert BANCHS, Gustavo DE VECIANA, Vincenzo Sciancalepore, Xavier Costa-Pérez (November 2020)**

*Resource Allocation for Network Slicing in Mobile Networks*
IEEE Access. DOI:10.1109/
ACCESS.2020.3040949. Volumen 8 , IEEE. ISSN: 2169-3536.
IEEE Communications Surveys & Tutorials. IEEE Communications Society. ISSN: 1553-877X.

**5. Vincenzo MANCUSO, Paolo Castagno, Matteo Sereno, Marco AJMONE MARSAN (October 2020)**

*Modeling MTC and HTC Radio Access in a Sliced 5G Base Station*
IEEE Transactions on Network and Service Management. https://doi.org/10.1109/
TNSM.2020.3034688. IEEE Communications Society. ISSN: 1932-4537.

**6. Ginés GARCÍA, Carlos DONATO, Marco Gramaglia, Pablo Serrano, Albert BANCHS (October 2020)**

*ACHO: A framework for flexible re-orchestration of virtual network functions*
Computer Networks. Volumen 180, Elsevier.

**7. Kim Mun-Suk, Tanguy Ropitault, Su Kyoung Lee, Nada Golmie, Hany ASSASA, Joerg WIDMER (October 2020)**

*A Link Quality Estimation-based Beamforming Training Protocol for IEEE 802.11ay MU-MIMO Communications*

IEEE Transactions on Communications. https://doi.org/10.1109/TCOMM.2020.3030956. IEEE Communications Society. ISSN: 0090-6778.

**8. Edgar ARRIBAS, Antonio FERNÁNDEZ ANTA, Dariusz R. Kowalski, Vincenzo MANCUSO, Miguel A. Mosteiro, Joerg WIDMER, Prudence W. H. Wong (October 2020)**

*Optimizing mmWave Wireless Backhaul Scheduling*

IEEE Transactions on Mobile Computing. 10.1109/TMC.2019.2924884. Volumen 19, IEEE Communications Society. ISSN: 1536-1233.

**9. Edgar ARRIBAS, Vincenzo MANCUSO, Vicent Cholvi (October 2020)**

*Coverage Optimization with a Dynamic Network of Drone Relays*

IEEE Transactions on Mobile Computing. DOI: 10.1109/TMC.2019.2927335. Volumen 19, IEEE Communications Society. ISSN: 1536-1233.

**10. Vadim Kirilin, Aditya Sundarrajan, Sergey GORINSKY, Ramesh K. Sitaraman (October 2020)**

*RL-Cache: Learning-Based Cache Admission for Content Delivery*

IEEE Journal on Selected Areas in Communications. Volumen 38.

**11. Dingwen Yuan, Hsuan-Yin Lin, Joerg WIDMER, Matthias Hollick (October 2020)**

*Optimal and approximation algorithms for joint routing and scheduling in millimeter-wave cellular networks*

IEEE/ACM Transactions on Networking. DOI: 10.1109/TNET.2020.3006312. Volumen 28, Co-sponsored by the IEEE Communications Society, the IEEE Computer Society, and the ACM with its Special Interest Group on Data Communications (SIGCOMM). ISSN: 1063-6692.

**12. Edgar ARRIBAS, Vincenzo MANCUSO (September 2020)**

*Achieving Per-Flow Satisfaction with Multi-Path D2D*

Ad Hoc Networks. https://doi.org/10.1016/j.adhoc.2020.102162. Volumen 106 , Elsevier. ISSN: 1570-8705.

**13. Federico Montori, Luca Bedogni, Claudio FIANDRINO, Andrea Capponi, Luciano Bononi (September 2020)**

*Performance evaluation of hybrid crowdsensing systems with stateful CrowdSenSim 2.0 simulator*

Computer Communications. Volumen 161.

**14. Gianluca Rizzo, Marco AJMONE MARSAN, Torsten Braun, Gaetano Manzo (July 2020)**

*Optimal strategies for floating anchored information with partial infrastructure support*

Vehicular Communications. https://doi.org/10.1016/j.vehcom.2020.100287. Elsevier. ISSN: 2214-2096.

**15. Marco FIORE, Panagiota Katsikouli, Elli Zavou, Mathieu Cunche, Francoise Fessant, Dominique Le Hello, Ulrich Matchi Aivodji, Baptiste Olivier, Tony Quertier, Razvan Stanica (July 2020)**

*Privacy in trajectory micro-data publishing: a survey*

Transactions on Data Privacy. Volumen 13.

**16. Amr AbdelKhalek ABDELNABI, Vincenzo MANCUSO, Marco AJMONE MARSAN (July 2020)**

*Outage of Millimeter Wave Links With Randomly Located Obstructions*

IEEE Access. DOI: 10.1109/ACCESS.2020.3010551. Volumen 8 , IEEE. ISSN: 2169-3536.

**17. Elizaveta DUBROVINSKAYA, Veronika Kebkal, Oleksiy Kebkal, Konstantin Kebkal, Paolo CASARI (July 2020)**

*Underwater Localization via Wideband Direction-of-Arrival Estimation Using Acoustic Arrays of Arbitrary Shape*

Sensors — Open Access Journal. https://doi.org/10.3390/s20143862. Volumen 20 , MDPI AG, Basel, Switzerland. ISSN: 1424-8220.

**18. Ralph Holz, Jens Hiller, Johanna Amann, Abbas Razaghpanah, Thomas Jost, Narseo VALLINA-ROD-RÍGUEZ, Oliver Hohlfeld (July 2020)**

*Tracking the deployment of TLS 1.3 on the Web: A story of experimentation and centralization*

ACM SIGCOMM Computer Communication Review. 10.1145/3411740.3411742. Volumen 50 , ACM. ISSN: 0146-4833.

**19. Ralph Holz, Marco Mellia, Olivier Bonaventure, Hamed Haddadi, Matthew Caesar, Sergey GORINSKY, Gianni Antichi, Joseph Camp, kc Klaffy, Bhaskaran Raman, Anna Sperotto, Aline Viana, Steve Uhlig (July 2020)**

*Update on ACM SIGCOMM CCR Reviewing Process: Towards a More Open Review Process*

ACM SIGCOMM Computer Communication Review. Volumen 50.

**20. Roberto CALVO PALOMINO, Hector CORDOBÉS DE LA CALLE, Markus Engel, Markus Fuchs, Pratiksha Jain, Marc Liechti, Sreeraj Rajendran, Matthias Schäfer, Bertold Van den Bergh, Sofie Pollin, Domenico GIUSTINIANO, Vincent Lenders (June 2020)**

*Electrosense+: Crowdsourcing Radio Spectrum Decoding using IoT Receivers*

Computer Networks. Volumen 174 , Elsevier. ISSN: 1389-1286.

**21. Vitalii Demianiuk, Sergey Nikolenko, Pavel CHUPRIKOV, Kirill KOGAN (June 2020)**

*New Alternatives to Optimize Policy Classifiers*

IEEE/ACM Transactions on Networking. https://doi.org/10.1109/TNET.2020.2979400. Volumen 28 , Co-sponsored by the IEEE Communications Society, the IEEE Computer Society, and the ACM with its Special Interest Group on Data Communications (SIGCOMM). ISSN: 1063-6692.

**22. Antonio FERNÁNDEZ ANTA, Theophanis Hadjistasi, Nicolas Nicolaou, Alexandru Popa, Alexander A. Schwarzmann (May 2020)**

*Tractable low-delay atomic memory*

Distributed Computing. DOI: https://doi.org/10.1007/s00446-020-00379-y. Springer Science+Business Media. ISSN: 0178-2770.

**23. Patricia CALLEJO, Ángel Cuevas, Rubén Cuevas, Mercedes Esteban-Bravo, José M Vidal-Sanz (May 2020)**

*Tracking Fraudulent and Low-Quality Display Impressions*

Journal of Advertising. May 2020

**24. Paolo Castagno, Vincenzo MANCUSO, Matteo Sereno, Marco AJMONE MARSAN (May 2020)**

*A Simple Model of MTC Flows Applied to Smart Factories*

IEEE Transactions on Mobile Computing. https://doi.org/10.1109/TMC.2020.2993223. IEEE Communications Society. ISSN: 1536-1233.

**25. Maria Scalabrin, Guillermo BIELSA, Adrian LOCH, Michele Rossi, Joerg WIDMER (May 2020)**

*Machine Learning Based Network Analysis using Millimeter-Wave Narrow-Band Energy Traces*

IEEE Transactions on Mobile Computing. 10.1109/TMC.2019.2907585. Volumen 19 , IEEE Communications Society. ISSN: 1536-1233.

**26. Jona Baysens, Qing Wang, Ander GALISTEO, Domenico GIUSTINIANO, Sofie Pollin (April 2020)**

*A Cell-free Networking System with Visible Light*

IEEE/ACM Transactions on Networking. 10.1109/TNET.2020.2966322. Volumen 28 , Co-sponsored by the IEEE Communications Society, the IEEE Computer Society, and the ACM with its Special Interest Group on Data Communications (SIGCOMM). ISSN: 1063-6692.

**27. Sébastien Henri, Ginés GARCÍA, Pablo Serrano, Albert Banchs, Patrick Thiran (April 2020)**

*Protecting against Website Fingerprinting with Multihoming*

Proceedings on Privacy Enhancing Technologies. Volumen 2020 , Sciendo.

**28. Paolo CASARI, Filippo Campagnaro, Elizaveta DUBROVINSKAYA, Roberto Francescon, Amir Dagan, Shlomo Dahan, Michele Zorzi, Roee Diamant (March 2020)**

*ASUNA: A Topology Data Set for Underwater Network Emulation*

IEEE Journal of Oceanic Engineering. https://doi.org/10.1109/JOE.2020.2968104. IEEE. ISSN: 0364-9059.

**29. Dario BEGA, Marco Gramaglia, Albert BANCHS, Vincenzo Sciancalepore, Xavier Costa-Pérez (March 2020)**

*A Machine Learning approach to 5G Infrastructure Market optimization*

IEEE Transactions on Mobile Computing. DOI: 10.1109/TMC.2019.2896950. Volumen 19 , IEEE Communications Society. ISSN: 1536-1233.

**30. Dario BEGA, Marco Gramaglia, Marco Fiore, Albert BANCHS, Xavier Costa-Pérez (February 2020)**

*DeepCog: Optimizing Resource Provisioning in Network Slicing with AI-based Capacity Forecasting*

IEEE Journal on Selected Areas in Communications. DOI: 10.1109/JSAC.2019.2959245. Volumen 38 , IEEE. ISSN: 0733-8716.

**31. Castagno Paolo, Vincenzo MANCUSO, Sereno Matteo, Marco AJMONE MARSAN (February 2020)**

*Limitations and sidelink-based extensions of 3GPP cellular access protocols for very crowded environments*

Computer Networks. Volumen 168 , Elseiver. ISSN: 1389-1286.

**32. Swetank Kumar Saha, Shivang Aggarwal, Hany ASSASA, Adrian LOCH, Naveen Muralidhar Prakash, Roshan Shyamsunder, Daniel Steinmetzer, Dimitrios Koutsonikolas, Joerg WIDMER, Matthias Hollick (January 2020)**

*Performance and Pitfalls of 60 GHz WLANs Based on Consumer-Grade Hardware*

IEEE Transactions on Mobile Computing. IEEE Communications Society. ISSN: 1536-1233.

## Magazine Articles [4]

**1. Dario BEGA, Marco Gramaglia, Ramón Pérez, Marco FIORE, Albert BANCHS, Xavier Costa-Pérez. (December 2020)**

*AI-Based Autonomous Control, Management, and Orchestration in 5G: From Standards to Algorithms*

IEEE Network. 10.1109/MNET.001.2000047. Volumen 34, IEEE.

**2. Pavel CHUPRIKOV, Sergey Nikolenko, Kirill Kogan (July 2020)**

*Towards declarative self-adapting buffer management*

ACM SIGCOMM Computer Communication Review. https://doi.org/10.1145/3411740.3411745. Volumen 50 , ACM. ISSN: 0146-4833.

**3. Dario BEGA, Marco Gramaglia, Andrés García-Saavedra, Marco FIORE, Albert BANCHS, Xavier Costa-Pérez (June 2020)**

*Network Slicing Meets Artificial Intelligence: an AI-based Framework for Slice Management*

IEEE Communications Magazine. 10.1109/MCOM.001.1900653. Volumen 58.

**4. Claudio FIANDRINO, Chaoyun Zhang, Paul Patras, Albert BANCHS, Joerg WIDMER (April 2020)**

*A Machine Learning-based Framework for Optimizing the Operation of Future Networks*

IEEE Communications Magazine. IEEE Communications Society. ISSN: 0163-6804.

## Conference or Workshop Papers [45]

**1. Maurizio REA, Domenico GIUSTINIANO, Joerg WIDMER (December 2020)**
*Virtual Inertial Sensors with Fine Time Measurements*
The 17th IEEE International Conference on Mobile Ad-Hoc and Smart Systems (IEEE MASS 2020). Delhi NCR, India.

**2. Dolores GARCÍA MARTI, Joan PALACIOS, Jesús Omar LACRUZ, Joerg WIDMER (November 2020)**
*A Mixture Density Channel Model for Deep Learning-Based Wireless Physical Layer Design*
The 23rd International ACM Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 2020). Virtual event (previously at Alicante, Spain).

**3. Christian Quadri, Vincenzo MANCUSO, Marco AJMONE MARSAN, Gian Paolo Rossi (November 2020)**
*Platooning on the Edge*
The 23rd International ACM Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 2020). Virtual event (previously at Alicante, Spain).

**4. Greta Vallero, Daniela Renga, Michela Meo, Marco AJMONE MARSAN (November 2020)**
*Processing ANN Traffic Predictions for RAN Energy Efficiency*
The 23rd International ACM Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM 2020). https://doi.org/10.1145/3416010.3423222.

**5. Shehroze Farooqi, Álvaro FEAL, Tobias Lauinger, McCoy Damon, Zubair Shafiq, Narseo VALLINA-RODRÍGUEZ (October 2020)**
*Understanding Incentivized Mobile App Installs on Google Play Store*
The 20th ACM Internet Measurement Conference (ACM IMC 2020). Virtual event.

**6. Anja Feldmann, Oliver Gasser, Franziska Lichtblau, Enric Pujol, Ingmar Poese, Christoph Dietzel, Daniel Wagner, Matthias Wichtlhuber, Juan Tapiador, Narseo VALLINA-RODRÍGUEZ, Oliver Hohlfeld, Georgios Smaragdakis (October 2020)**
*The Lockdown Effect: Implications of the COVID-19 Pandemic on Internet Traffic*
The 20th ACM Internet Measurement Conference (ACM IMC 2020). Virtual event.

**7. Matic Srdjan, Iordanou Costas, Smaragdakis Georgios, Nikolaos LAOUTARIS (October 2020)**
*Identifying Sensitive URLs at Web-Scale*
The 20th ACM Internet Measurement Conference (ACM IMC 2020). Virtual event.

**8. Pelayo VALLINA, Victor Le Pochat, Álvaro FEAL, Marius PARASCHIV, Julien GAMBA, Time Burke, Hohlfeld Oliver, Tapiador Juan, Narseo VALLINA-RODRÍGUEZ (October 2020)**
*Mis-shapes, Mistakes, Misfits: An Analysis of Domain Classification Services*
The 20th ACM Internet Measurement Conference (ACM IMC 2020). Virtual event.

**9. Marcos Tileria, Jorge Blasco, Guillermo SUÁREZ-TANGIL (October 2020)**
*WearFlow: Expanding Information Flow Analysis To Companion Apps in Wear OS*
The 23rd International Symposium on Research in Attacks, Intrusions and Defenses (RAID 2020). Virtual event.

**10. Marius PARASCHIV, Ricardo PADRINO, Paolo CASARI, Antonio FERNÁNDEZ ANTA (October 2020)**
*Very Small Neural Networks for Optical Classification of Fish Images and Videos*
Global OCEANS 2020: Singapore – U.S. Gulf Coast. Virtual Conference.

**11. Muhammad Sarmad Shahab MIR, Borja GENO-VÉS GUZMÁN, Ander GALISTEO, Domenico GIUSTINIANO (September 2020)**
*Non-linearity of LEDs for VLC IoT applications*
"Light Up the IoT" – Workshop Co-located with ewsn 2020. London, UK (virtual).

**12.** **Chaoyun Zhang, Marco FIORE, Ziemlicki Cezary, Paul Patras (September 2020)**

*Microscope: Mobile Service Traffic Decomposition for Network Slicing as a Service*

The 26th Annual International Conference on Mobile Computing and Networking (MobiCom 2020). Online (previously London, United Kingdom).

**13.** **Marco Gramaglia, Vincenzo Sciancalepore, Ramón Pérez, Francisco Javier Fernández-Maestro, Pablo Serrano, Albert BANCHS (September 2020)**

*Experimenting with SRv6: a Tunneling Protocol supporting Network Slicing in 5G and beyond*

IEEE 25th International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD 2020). Virtual Conference.

**14.** **Vicent Cholvi, Antonio FERNÁNDEZ ANTA, Chryssis Georgiou, Nicolas Nicolaou, Michel Raynal (September 2020)**

*Atomic Appends in Asynchronous Byzantine Distributed Ledgers*

The 16th European Dependable Computing Conference (EDCC 2020). Munich, Germany.

**15.** **Roberto CALVO PALOMINO, Arani Bhattacharya, Gerome Bovet, Domenico GIUSTINIANO (August 2020)**

*LSTM-based GNSS Spoofing Detection Using Low-cost Spectrum Sensors*

The 21st IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2020). Cork, Ireland.

**16.** **Giulia ATTANASIO, Claudio FIANDRINO, Joerg WIDMER (August 2020)**

*Event-based Vision: Understanding Network Traffic Characteristics*

The 21st IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2020). Cork, Ireland.

**17.** **Rizzo Gianluca, Noelia PÉREZ PALMA, Marco AJMONE MARSAN, Vincenzo MANCUSO (August 2020)**

*A Walk Down Memory Lane: On Storage Capacity in Opportunistic Content Sharing Systems*

The 21st IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2020). Cork, Ireland.

**18.** **Oluwasegun OJO, Augusto García-Agundez, Benjamin Girault, Harold Hernández, Elisa CABANA, Amanda GARCÍA-GARCÍA, Payman Arabshahi, Carlos Baquero, Paolo CASARI, Ednaldo José Ferreira, Davide Frey, Chryssis Georgiou, Mathieu Goessens, Anna Ishchenko, Ernesto Jiménez, Oleksiy Kebkal, Rosa Elvira Lillo, Raquel Menezes, Nicolas Nicolaou, Antonio Ortega, Paul Patras, Julian C. Roberts, Efstathios Stavrakis, Yuichi Tanaka, Antonio FERNÁNDEZ ANTA (August 2020)**

*CoronaSurveys: Using Surveys with Indirect Reporting to Estimate the Incidence and Evolution of Epidemics*

The KDD Workshop on Humanitarian Mapping. San Diego, California USA.

**19.** **Francesco SPINELLI, Luigi Iannone, Jerome Tollet (July 2020)**

*Multi-Cloud Chaining with Segment Routing.*

The 19th IFIP Networking 2020 Conference (NETWORKING 2020)

**20.** **Catherine Han, Irwin Reyes, Álvaro FEAL, Joel Reardon, Primal Wijesekera, Narseo VALLINA-RODRÍGUEZ, Amit Elazari Bar On, Kenneth. A Bamberger, Serge Egelman (July 2020)**

*The Price is (Not) Right:Comparing Privacy in Free and Paid Apps*

The 20th Privacy Enhancing Technologies Symposium (PETS 2020). Montreal, Canada.

**21.** **Álvaro FEAL, Paolo Calciati, Narseo VALLINA-RODRÍGUEZ, Carmela Troncoso, Alessandra Gorla (July 2020)**

*Angel or Devil? A Privacy Study of Mobile Parental Control Apps*

Proceedings of Privacy Enhancing Technologies (PoPETS). Volumen 2020, The 20th Privacy

Enhancing Technologies Symposium (PETS 2020). Montreal, Canada.

**22.** **Somma Gaetano, Constantine AYIMBA, Casari Paolo, Romano Simon Pietro , Vincenzo MANCUSO (July 2020)**

*When Less is More: Core-Restricted Container Provisioning for Serverless Computing*
The 3rd International Workshop on Network Intelligence (NI 2020): Learning and Optimizing Future Networks. Online (previously Toronto, Canada).

**23.** **Dario BEGA, Marco Gramaglia, Marco FIORE, Albert BANCHS, Xavier Costa-Pérez (July 2020)**

*AZTEC: Anticipatory Capacity Allocation for Zero-Touch Network Slicing*
The 39th IEEE International Conference on Computer Communications (IEEE INFOCOM 2020). Online (previously Toronto, Canada).

**24.** **Dolores GARCÍA MARTÍ, Jesús Omar LACRUZ, Pablo Jiménez Mateo, Joerg WIDMER (July 2020)**

*POLAR: Passive object localization with IEEE 802.11ad using phased antenna arrays*
The 39th IEEE International Conference on Computer Communications (IEEE INFOCOM 2020). Online (previously Toronto, Canada).

**25.** **Mohamed Lamine MOULAY, Rafael GARCÍA, Vincenzo MANCUSO, Antonio FERNÁNDEZ ANTA, Pablo Rojo, Javier Lázaro (July 2020)**

*A Novel Methodology for the Automated Detection and Classification of Networking Anomalies*
The 3rd International Workshop on Network Intelligence (NI 2020): Learning and Optimizing Future Networks, in conjunction with IEEE INFOCOM 2020. Toronto.

**26.** **Ander GALISTEO, Patrizio Marcocci, Marco Zuniga, Lorenzo Mucchi, Borja GENOVÉS GUZMÁN, Domenico GIUSTINIANO (June 2020)**

*Filtering Visible Light Reflections with a Single-Pixel Photodetector*
The 17th International Conference on Sensing, Communication and Networking (SECON 2020). Como, Italy.

**27.** **Marco Gramaglia, Pablo Serrano, Albert BANCHS, Ginés GARCÍA, Andrés García-Saavedra, Ramón Pérez (June 2020)**

*The case for serverless mobile networking*
The 19th IFIP Networking 2020 Conference (NETWORKING 2020).Virtual conference.

**28.** **Ana Paula Couto da Silva, Daniela Renga, Michela Meo, Marco AJMONE MARSAN (June 2020)**

*On the Use of Small Solar Panels and Small Batteries to Reduce the RAN Carbon Footprint*
The 18th Mediterranean Communication and Computer Networking Conference (IEEE Med-ComNet 2020). Virtual event (previously at Arona, Italy).

**29.** **Cristina Márquez, Marco Gramaglia, Marco FIORE, Albert BANCHS, Zbigniew Smoreda (June 2020)**

*Identifying Common Periodicities in Mobile Service Demands with Spectral Analysis*
The 18th Mediterranean Communication and Computer Networking Conference (IEEE Med-ComNet 2020). Online (previously Arona, Italy).

**30.** **Maurizio REA, Domenico GIUSTINIANO, Guillermo BIELSA, Danilo DE DONNO, Joerg WIDMER (June 2020)**

*Beam Search Strategy for MillimeterWave Networks with Out-of-Band Input Data*
The 18th Mediterranean Communication and Computer Networking Conference (IEEE Med-ComNet 2020). Arona, Italy.

**31.** **Nicola Blefari-Melazzi, Stefania Bartoletti, Luca Chiaraviglio, Flavio Morselli, Eduardo Baena, Giacomo Bernini, Domenico GIUSTINIANO, Mythri Hunukumbure, Gürkan Solmaz, Kostas Tsagkaris (June 2020)**

*LOCUS: Localization and analytics on-demand embedded in the 5G ecosystem*
The 29th European Conference on Networks and Communications (EuCNC 2020). Dubrovnik, Croatia.

**32. Ramón Pérez, Jaime García-Reinoso, Aitor Zabala, Pablo Serrano, Albert BANCHS (June 2020)**
*A Monitoring Framework for Multi-Site 5G Platforms*
The 29th European Conference on Networks and Communications (EuCNC 2020). Dubrovnik, Croatia.

**33. Jiaxiao Zheng, Gustavo DE VECIANA, Albert BANCHS (June 2020)**
*Constrained Network Slicing Games: Achieving service guarantees and network efficiency*
The 18th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOPT 2020). Virtual conference (previously Volos, Greece).

**34. Lucía UGUINA (June 2020)**
*Contributions to real-time monitoring and analysis of heterogeneous learning environments*
Learning Analytics Summer Institute Spain 2020 (LASI Spain 2020). Valladolid, Spain.

**35. Brecht Reynders, Franco Minucci, Erma Perenda, Hazem Sallouha, Roberto CALVO PALOMINO, Yago LIZARRIBAR, Markus Fuchs, Matthias Schafer, Markus Engel, Bertold Van den Bergh, Sofie Pollin, Domenico GIUSTINIANO, Gerome Bovet, Vincent Lenders (June 2020)**
*SkySense: Terrestrial and Aerial Spectrum Use-Analysed Using Lightweight Sensing Technology with Weather Balloons*
The 18th Annual International Conference on Mobile Systems, Applications, and Services (ACM MobiSys 2020). Toronto, ON, Canada.

**36. Jesús Omar LACRUZ, Dolores GARCÍA MARTÍ, Pablo Jiménez Mateo, Joan PALACIOS, Joerg WIDMER (June 2020)**
*mm-FLEX: An Open Platform for Millimeter-Wave Mobile Full-Bandwidth Experimentation*
The 18th Annual International Conference on Mobile Systems, Applications, and Services (ACM MobiSys 2020). Toronto, ON, Canada.

**37. Ander GALISTEO, Ambuj Varshney, Domenico GIUSTINIANO (June 2020)**
*Two to Tango: Hybrid Light and Backscatter Networks for Next Billion Devices*
The 18th ACM International Conference on Mobile Systems, Applications, and Services (ACM Mobisys 2020). Toronto, Canada.

**38. Vicent Cholvi, Juan Echagüe, Antonio FERNÁNDEZ ANTA, Christopher Thraves (June 2020)**
*Stability Under Adversarial Injection of Dependent Tasks*
The 8th International Conference on Networked Systems (NETYS 2020). Marrakech, Morocco.

**39. Andrés Sevilla, Antonio FERNÁNDEZ ANTA (June 2020)**
*Routing in Generalized Geometric Inhomogeneous Random Graphs*
The 8th International Conference on Networked Systems (NETYS 2020). Marrakech, Morocco.

**40. Luca Chiaraviglio, Giuseppe Bianchi, Nicola Blefari-Melazzi, Marco FIORE (May 2020)**
*Will the Proliferation of 5G Base Stations Increase the Radio-Frequency "Pollution"?*
IEEE 91st Vehicular Technology Conference (VTC2020-Spring). Antwerp, Belgium.

**41. Julien GAMBA, Mohammed Rashed, Abbas Razaghpanah, Juan Tapiador, Narseo VALLINA-RODRÍGUEZ (May 2020)**
*An Analysis of Pre-installed Android Software*
The 41st IEEE Symposium on Security and Privacy (IEEE S&P 2020). San Fransisco, CA, USA.

**42. Syed Suleman Ahmad, Muhammad Daniyal Dar, Zareed Zaffar, Narseo VALLINA-RODRÍGUEZ, Rishab Nithyanand (April 2020)**
*Apophanies or Epiphanies: How Crawlers Can Impact Our Understanding of the Web*
The Web Conference 2020 (WWW 2020). Taipei, Taiwan.

**43.** **Lucía UGUINA, Iria Estévez-Ayres, Jesús Arias-Fisteus, Carlos Delgado Kloos (April 2020)**

*Application of learning analytics to study the accuracy of self-reported working patterns in self-regulated learning questionnaires*

2020 IEEE Global Engineering Education Conference (EDUCON). Porto, Portugal.

**44.** **Sandra Siby, Marc Juarez, Claudia Diaz, Narseo VALLINA-RODRÍGUEZ, Carmela Troncoso (February 2020)**

*Encrypted DNS –> Privacy? A Traffic Analysis Perspective*

The 27th Annual Network and Distributed System Security Symposium (NDSS 2020) . San Diego, California, USA.

**45.** **Álvaro FEAL, Julien GAMBA, Narseo VALLINA-RODRÍGUEZ, Primal Wijesekera, Joel Reardon, Serge Egelman, Juan Tapiador (January 2020)**

*Don't accept candies from strangers: An analysis of third-party SDKs*

Computers, Privacy and Data Protection Conference (CPDP 2020). Brussels, Belgium.

## Conference and Workshop Posters & Demos [5]

**1.** **Elisa CABANA (December 2020)**

*How shrinkage can be used for robust methods (Poster)*

3rd BYMAT Conference - Bringing Young Mathematicians Together. Valencia, Spain.

**2.** **Sergey GORINSKY (October 2020)**

*Welcome Message from the ICNP 2020 General Chair (Other)*

The 28th IEEE International Conference on Network Protocols (IEEE ICNP 2020). Madrid, Spain.

**3.** **Adriana MORENO, Jesús Omar LACRUZ, Joerg WIDMER (May 2020)**

*Open Source RFNoC-Based Testbed for Millimeter-Wave Experimentation Using USRP Software Defined Radios (Poster)*

IEEE International Symposium on Circuits & Systems (ISCAS 2020). Sevilla, Spain.

**4.** **Borja Nogales, Iván Vidal, Víctor SÁNCHEZ AGÜERO, Francisco Valera, Luis. F González, Arturo AZCORRA (February 2020)**

*OSM PoC 10 Automated Deployment of an IP Telephony Service on UAVs using OSM (Demo, peer-reviewed)*

ETSI-OSM PoC 10. Madrid, Spain.

**5.** **Muhammad Sarmad Shahab MIR, Borja GENOVÉS GUZMÁN, Deepak Solanki, Guenter Marent, Domenico GIUSTINIANO (February 2020)**

*Poster: Integration between Home Automation and Visible Light Communications (Other)*

International Conference on Embedded Wireless Systems and Networks. Lyon, France.

## Invited Papers, Keynotes, Invited Talks, Tutorials, Lectures, etc. [3]

**1.** **Antonio FERNÁNDEZ ANTA (November 2020)**

*CoronaSurveys: Using Indirect Reporting to Estimate the Incidence of Epidemics (Keynote)*

The 2nd Symposium on Biases in Human Computation and Crowdsourcing (BHCC 2020). Cyprus.

**2.** **Antonio FERNÁNDEZ ANTA (November 2020)**

*CoronaSurveys: Using Indirect Reporting to Estimate the Incidence of Epidemics (Invited Talk)*

ITeG Lecture Series 2020/2021. University of Kassel, Kassel, Germany.

**3.** **Tobias Meuser, Oluwasegun OJO, Daniel Bischoff, Antonio FERNÁNDEZ ANTA, Ioannis Stavrakakis, Ralf STEINMETZ (June 2020)**

*Hide Me: Enabling Location Privacy in Heterogeneous Vehicular Networks (Keynote)*

The 8th International Conference on Networked Systems (NETYS 2020). Marrakech, Morocco.

## PhD Theses [7]

**1. Joan Palacios (October 2020)**

*Initial Access and Beam-Steering Mechanisms for mmWave Wireless Systems*

Phd thesis: Departamento de Teoría de la Señal y Comunicaciones - Universidad Carlos III de Madrid, España

Director: Joerg Widmer, IMDEA Networks Institute, Madrid, España

**2. Patricia Callejo (September 2020)**

*Design And Development Of A Worldwide-Scale Measurement Methodology And Its Application In Network Measurements And Online Advertising Auditing*

Phd thesis: Departamento de Ingeniería Telemática - Universidad Carlos III de Madrid, España.

Director: Rubén Cuevas, Universidad Carlos III, Madrid, España

**3. Edgar Arribas (July 2020)**

*Optimization Methods for Efficient Relay Techniques in Cellular Networks*

Phd thesis: Departamento de Ingeniería Telemática - Universidad Carlos III de Madrid, España

Director: Vincenzo Mancuso, IMDEA Networks Institute, Madrid, España

**4. Maurizio Rea (June 2020)**

*Time-based indoor positioning and context information using commodity WiFi chipsets*

Phd thesis: Departamento de Ingeniería Telemática - Universidad Carlos III de Madrid, España

Director: Domenico Giustiniano, IMDEA Networks Institute, Madrid, España

**5. Ander Galisteo (June 2020)**

*Visible Light Communication Networks for IoT and its Applications*

Phd thesis: Departamento de Ingeniería Telemática - Universidad Carlos III de Madrid, España

Directores: Domenico Giustiniano, IMDEA Networks Institute, Madrid, España

**6. Dario Bega (April 2020)**

*Deep Learning solutions for next generation slicing-aware mobile networks*

Phd tesis: Departamento de Ingeniería Telemática - Universidad Carlos III de Madrid, España

Directores: Albert Banchs (IMDEA Networks Institute, Madrid, España / Universidad Carlos III de Madrid); Xavier Costa Pérez (I2Cat Research Center, NEC Laboratories Europe)

**7. Yonas Mitike Kassa (February 2020)**

*Leveraging online advertising platforms to measure and characterize digital inequalities*

Phd thesis: Departamento de Ingeniería Telemática - Universidad Carlos III de Madrid, España

Director/es: Rubén Cuevas, 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

**Professional posts & activities**
- Scientific Committee Member: LINCS - Paris, France

**Journal Editorial Boards**
- 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)
- Editorial Board member: Springer Nature Computer Science (Springer)

**TPC Memberships**
- 39th IEEE International Conference on Computer Communications (IEEE INFOCOM 2020), 6-9 July 2020 (Virtual conference)
- 30th International Telecommunication Networks and Application Conference (ITNAC 2020), 25-27 November 2020, Melbourne, Australia
- 32nd Teletraffic in the era of beyond-5G and AI (ITC 32), 22-24 September 2020, Osaka, Japan
- IEEE International Conference on Communications (ICC 2020), 7-11 June 2020 (Virtual Conference)
- IEEE Global Communications Conference (Globecom 2020). 8–10 December 2020 (In-person) / 7-11 December 2020 (Virtual Conference), Taipei, Taiwan.
- International Conference on Computing, Networking and Communications (ICNC 2020), 17-20 February 2020, Hawaii, USA.
- 18th Mediterranean Communication and Computer Networking Conference (MedComNet 2020), 17-19 June 2020. (Virtual Conference).
- ITU Kaleidoscope (ITU-K 2020), 7-11 December 2020. (Virtual Conference).

### Hany ASSASA

**TPC Memberships**
- Workshop on ns-3 (ACM WNS3 2020), 17-18 June 2020 (Virtual Event)

## Arturo AZCORRA

### Professional posts and activities

- Chairman of the Vision Group of 5GIA. December 2018 - present.
- Chair of the "Vision and Societal Challenges" workgroup of the 5G Infrastructure
- Association. November 2018 – present
- Member of the Board of Directors of the National Scientific Society for Telematics
- (ATEL). January 2016 – present (now, Scientific Society of Telematic Engineering (SCITEL)
- Vice-President of the 5TONIC Laboratory. October 2015 – present
- Deputy Director of the Master in Connected Industry 4.0, Universidad Carlos III de
- Madrid, 2018 to present
- Member of the Executive Committee of the Doctorate School of Univ. Carlos III of
- Madrid. 9 December 2015 – present
- Deputy Director of the Master in Network Function Virtualization and Software Defined
- Networks for 5G, Universidad Carlos III de Madrid

### Technical Program Committees

- TPC member of IEEE INFOCOM 2020

## Albert BANCHS

### Journal editorial boards

- Editor: IEEE/ACM Transactions on Networking, 2016-2020

### TPC memberships

- 39th IEEE International Conference on Computer Communications (IEEE INFOCOM 2020), 6-9 July 2020. (Virtual conference)
- IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM 2020), 31 August-3 September 2020, Cork, Ireland. (Virtual Conference)
- European Conference on Networks and Comunication (EuCNC 2020), 15-18 June
- 2019, Dubrovnik, Croatia (Virtual Conference)
- International Workshop on Network Intelligence (NI 2020), 6 July 2020,Toronto, Canada (Virtual Conference).

## Suman BANERJEE

### Organization committees

- Steering Committee member, ACM Mobicom 2020

### TPC memberships

- ACM International Conference on Mobile Computing and Networking (Mobicom 2020), 21-25 September 2020, London, United Kingdom

## Antonio FERNÁNDEZ ANTA

### Journal editorial boards
- Editor of The Computer Journal, Oxford Journals

### TPC Membership
- 40th IEEE International Conference on Distributed Computing Systems (ICDCS 2020), 29 November - 1 December 2020. Singapore.
- 2nd Tokenomics Conference on Blockchain Economics, Security and Protocols (Tokenomics 2020), 26-27 October, Toulouse, France
- 1st International Workshop on Distributed Ubiquitous Computing: Systems, Applications, and Networking (DUCSAN 2020) (Co-located with PerCom2020), 27 March, Austin, Texas, USA

### Organization committees
- Co-chair of the Track Grid, Cloud, Internet and Middleware Computing and Communication (GCIM), ICCCN 2020, August 2020.
- Local Organizer co-chair of the 28th IEEE International Conference on Network Protocols (ICNP 2020), 13-16 October, Madrid, Spain
- Co-founder and co chair of the 1st workshop on Energy Efficiency at the Edge, WEEE 2020 (Co-located with ACM e-Energy2020), 26 June 2020, Melbourne, Australia.

## Claudio FIANDRINO

### Journal editorial board
- IEEE Networking Letters

### Organization committees
- The 28th IEEE International Conference on Network Protocols (ICNP 2020), 13-16 October, Madrid, Spain. (Registration Chair).

### TPC Memberships
- IEEE International Conference on Communications (ICC 2020), 7-11 June 2020. (Virtual Conference)
- The 10th Workshop on Management of Cloud and Smart City System (MOCS
- 2020). (Virtual Conference).
- The 29th International Conference on Computer Communications and Networks (ICCCN 2020), 3-6 August, Hawaii, USA. (Virtual Conference).
- The 16th International Conference on Mobility, Sensing and Networking (MSN 2020),
- 17-19 December, Tokyo, Japan. (Virtual Conference).
- IEEE Global Communications Conference (Globecom 2020). 8–10 December 2020 (In-person) / 7-11 December 2020 (Virtual Conference), Taipei, Taiwan

## Marco FIORE

### Professional posts & activities

- Expert evaluator, call "Appel Automne 2020", Labex DigiCosme of the Ministry of Higher Education and Research (MESR) of France.
- Expert evaluator, call "H2020 2018-2020 Mobility for Growth", European Commission.
- Expert evaluator, call "Appel Générique 2020", National Research Agency (ANR) of France.

### Journal editorial boards

- Technical Editor, IEEE Network Magazine.
- Recommender, Peer Community In Complex Network.
- Associate Editor, Frontiers in Sustainable Cities, specialty section on "Urban Transportation Systems and Mobility".
- Associate Editor, IEEE Access.
- Editorial Board member, MDPI Future Internet.
- Technical Committee member, Elsevier Computer Communications.

### Organization committees

- Steering Committee member, ACM Wireless of the Students, by the Students, and for the Students (S3) Workshop
- Steering Committee member, Network Traffic Measurement and Analysis (TMA) Conference

### TPC Memberships

- 39th IEEE International Conference on Computer Communications (IEEE INFOCOM 2020), 6-9 July 2020. (Virtual conference)
- IEEE/IFIP Network Traffic Measurement and Analysis Conference (TMA 2020), 10-11 June 2020, Berlin, Germany. (Virtual Conference)
- IEEE Global Communications Conference (Globecom 2020), 8–10 December 2020 (In-person) / 7-11 December 2020 (Virtual Conference), Taipei, Taiwan
- IEEE International Conference on Communications (ICC 2020), 7-11 June 2020 (Virtual Conference)
- IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks (WoWMoM 2020), 31 August-3 September 2020, Cork, Ireland. (Virtual Conference)
- IEEE Vehicular Networking Conference (VNC 2020), 16-18 December 2020. (Virtual Conference)
- IEEE Network Science Society Conference (NetSci 2020), 17-25 September, Roma, Italy. (Virtual Conference)
- International Conference on Complex Networks and Their Applications (Complex Networks 2020), 1-3 December, Madrid, Spain. (Virtual Conference)
- IEEE IEEE Annual Consumer Communications and Networking Conference (CCNC 2020), 10-13 January 2020, Las Vegas, USA
- IEEE 5G World Forum (WF-5G 2020), 10-12 September. (Virtual Event)

- IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC 2020), 31 August -3 September, London, United Kingdom. (Virtual Conference).
- ACM International Workshop on WIreless Network Testbeds, Experimental evaluation and CHaracterization (WiNTECH 2020), 25 September 2020, London, United Kingdom. (Virtual Conference)
- International Workshop on Network Intelligence (NI 2020), 6 July 2020, Toronto, Canada. (Virtual Conference)
- Workshop on Intelligent Cloud Computing and Networking (ICCN 2020), 3-5 September 2020. Turin, Italy
- Internet of Things Crowdsensing for Smart Cities (IoT-SenCity 2020), 22-26 June, Como, Italy. (Virtual Conference)
- Rencontres Francophones sur la Conception de Protocoles, l'Évaluation de Performance et l'Expérimentation des Réseaux de Communication (CoRes 2020), 28-29 September, Lyon, France
- Workshop on Mobility in the Evolving Internet Architecture (MobiArch 2020), 25 September, London, United Kingdom. (Virtual Conference)

### Álvaro GARCÍA-RECUERO

**TPC Memberships**
- The 9th International Conference on Complex Networks and their Applications (COMPLEX NETWORKS 2020), 1-3 December, Madrid, Spain.

### Borja GENOVÉS

**TPC Memberships**
- International Conference on Embedded Wireless Systems and Networks (EWSN 2020), 17-19 February 2020, Lyon, France.
- The 26th Annual International Conference on Mobile Computing and Networking (MOBICOM 2020), 21-25 September, London, United Kingdom. (Virtual Conference

### Domenico GIUSTINIANO

**Organization committees**
- Financial Chair of ACM CoNEXT 2020

**Editorial board**
- Editorial Board of Computer Networks (Elsevier) as an Area Editor.

**TPC Memberships**
- ACM International Conference on Mobile Computing and Networking (Mobicom 2020), 21-25 September 2020, London, United Kingdom.
- 16th IEEE International Conference on Sensing, Communication and Networking (INFOCOM 2021), 10-13 May 2021. (Virtual Conference).
- 14th ACM Workshop on Wireless Network Testbeds, Experimental evaluation \& Characterization (WiNTECH 2020), 25 September 2020. London, United Kingdom.

## Sergey GORINSKY

**Journal editorial boards**
- Editorial Board Member: ACM SIGCOMM Computer Communication Review

**Organization committees**
- Steering Committee Member: COMSNETS Association
- The 28th IEEE International Conference on Network Protocols (ICNP 2020), 13-16 October 2020, Madrid, Spain. (General Chair).

**TPC Memberships**
- 9th ACM Workshop on Hot Topics in Networks (HotNets 2020), 4-6 November 2020, Chicago, Illinois, USA.
- International Symposium on Theory, Algorithmic Foundations, and Protocol Design for Mobile Networks and Mobile Computing (ACM Mobihoc 2020), 11-14 October 2020. (Virtual Conference).
- 16th IEEE International Conference on Sensing, Communication and Networking (INFOCOM 2021), 10-13 May 2021. (Virtual Conference).

## Nikolaos LAOUTARIS

**Professional posts & activities**
- General Chair ACM CoNEXT'20

**Organization committees**
- Tutorials Co-Chair for ACM FAT 2020
- Technical Program Committee member for ACM FAT 2020

## Vincenzo MANCUSO

**Journal editorial boards**
- Editor for IEEE Transactions on Green Communications and Networking (TGCN) for the "Energy Efficiency in Wireless Communications and Networking" area

**Organization committees**
- Demos/Posters Chair for IEEE ICNP 2020, Madrid, October 2020
- General Chair for MedComNet 2021 (reported here because the organization started in October 2020)

**TPC Membership**
- 39th IEEE International Conference on Computer Communications (IEEE INFOCOM 2020), 6-9 July 2020 (Virtual conference)
- 19th IFIP Networking Conference 2020, 22-25 June 2020, Paris, France
- CLEEN2020 (workshop co-located with IEEE ICC 2020- IEEE International Conference on Communications (ICC 2020), 7-11 June 2020 (Virtual Conference)
- 18th Mediterranean Communication and Computer Networking Conference (MedCom-Net 2020), 17-19 June 2020. (Virtual Conference)
- IEEE International Black Sea Conference on Communications and Networking (IEEE BlackSeaCom 2020), 26-29 May 2020
- The 29th International Conference on Computer Communications and Networks (ICCCN 2020), 3-6 August, Hawaii, USA
- 4th International Conference on Computing and Network Communications (CoCoNet'20), 14-17 October 2020, Chennai, India
- International Conference on Embedded Wireless Systems and Networks (EWSN 2021), 17-19 February 2021, Delft, the Netherlands
- 16th IEEE International Conference on Sensing, Communication and Networking (INFOCOM 2021),10-13 May 2021. (Virtual Conference).

## Guillermo SUÁREZ-TANGIL

**Organization committees**
- Virtualization Chair for ICNP'20
- Publicity Chair for RAID'20

## Narseo VALLINA-RODRÍGUEZ

**TPC membership**
- ACM International Conference on Mobile Computing and Networking (Mobicom 2020), 21-25 September 2020, London, United Kingdom.
- ACM SIGSAC Conference on Computer and Communications Security (CCS), 9-13 November. (Virtual Conference).
- ACM Internet Measurements Conference (IMC), 27-29 October 2020, Pittsburgh, Pennsylvania, USA. (Virtual Conference).
- 20th Privacy Enhancing Technologies Symposium (PETS 2020), 14-18 July 2020. (Virtual Conference).

## Joerg WIDMER

### Professional posts & activities

- Chair of working group IFIP TC 6 WG 6.2 - Network and Internetwork Architectures
- Steering committee member IFIP Networking, since 2019

### Journal editorial boards

- Associate Editor: IEEE Transactions on Mobile Computing
- Editor: Computer Networks Journal (Elsevier)

### TPC Memberships

- 39th IEEE International Conference on Computer Communications (IEEE INFOCOM 2020), 6-9 July 2020 (Virtual conference)
- 19th IFIP Networking Conference 2020, 22-25 June 2020, Paris, France.
- ACM International Conference on Mobile Computing and Networking (Mobicom 2020), 21-25 September 2020, London, United Kingdom.
- ACM International Conference on Emerging Networking Experiments and Technologies (CoNEXT 2020), 1-4 December, Barcelona, Spain.
- 14th ACM Workshop on Wireless Network Testbeds, Experimental evaluation \& Characterization (WiNTECH 2020), 25 September 2020. London, United Kingdom.
- ACM Workshop on Millimeter Wave Networks and Sensing Systems (ACM mmNets 2020), 25 September 2020, London, United Kingdom.

# dissemination events

**Green light for the Earth**

Luz verde para la Tierra

## 5.4. Outreach

### 5.4.1 Major events

This kind of events were reduced, due to the situation caused by Covid-19... we are ready to organise new initiatives!

# 34th Digital Economy and Telecommunications Meeting

*2-4 September 2020*

Arturo Azcorra, director of IMDEA Networks, professor at UC3M (University Carlos III of Madrid) and vice-president of 5TONIC emphasized the importance of supporting research in Spain, at the country's 34th Meeting of the Digital Economy and Telecommunications, organized by AMETIC from 2 to 4 September, together with Banco Santander and with the support of the Menéndez Pelayo International University (UIMP).

Azcorra highlighted the need to invest not only in public research programs in 5G, but in research in the ICT sector in general: "Since 2013, the European Union has spent 700 million euros on 5G research. Germany, France, Finland and other countries have launched strong public 5G research programs, while in Spain, with the exception of Catalonia, we have had no public 5G research programs. At the same time, zero euros have been earmarked for ICT research from the recently approved, 1-billion-euro Action Plan for Science."

More info

# 28th annual edition of the IEEE International Conference on Network Protocols (ICNP 2020)

*13-16 October 2020*

IMDEA Networks Institute hosted IEEE ICNP 2020, the premier conference covering all aspects of network protocol research, including design, analysis, specification, verification, implementation, and performance. It was the first time ever for ICNP to come to Spain. Due to the coronavirus pandemic, ICNP 2020 proceeded as a hybrid conference, with the in-person participation limited to a handful of local attendees. Sergey Gorinsky (Research Associate Professor) was the General Chair of the conference.

More info



**NEWS**      **VIDEO**

# Science and Innovation Week of Madrid: Green Light for the Earth

*11 November 2020*

The researchers from IMDEA Networks Domenico Giustiniano (Research Associate Professor), Borja Genovés Guzmán (Post-Doc Researcher) and Muhammad Sarmad Shahab Mir (PhD Student) participated in the Science and Innovation Week 2020, organized by the madri+d Foundation for Knowledge. The demo 'Green Light for the Earth' showcased the first prototype of a battery-free IoT device that leverages the advantages of two cutting-edge technologies: LiFi and RF backscatter.

More info

# Madrid's European Researchers' Night 2020

*27 November 2020*

IMDEA Networks participated in this event promoted by the Department of Science, Universities and Innovation and coordinated by madri+d since 2009. A pan-European initiative, taking place simultaneously in more than 300 cities across Europe, funded by the European Union under the Horizon 2020 Programme.

Our Director Arturo Azcorra represented the institute in the event 'Great Women Researchers on the big screen', where researchers from the seven IMDEA Institutes presented the life and work of women who stood out in the world of science. He talked about the actress Hedy Lamarr, a surprising pioneer of wireless communications. The demo 'Green Light for the Earth' was presented online at this activity too.

Furthermore, researchers as Nina Grosheva, Dayrene Frómeta and Muhammad Sarmad Shahab Mir talked (through a video disseminated by social networks) about her experience as awardees of the Marie Skłodowska-Curie actions for another of the initiatives of these online meetings.

More info

### 5.4.2. Workshops, seminars & lectures

Weekly seminars alternated invited talks with presentations by internal researchers. These events were organized together with prestigious institutions such as University Carlos III of Madrid, Technische Universität Darmstadt, International Computer Science Institute (California), Max Planck Institute for Informatics (Saarbrücken) and King's College London. The topics ranged from scientific presentations to technology-transfer oriented talks. All events were held in Madrid. Out of the 20 total number of events in which the Institute participated during 2020, 9 of our events were conducted by invited speakers. We list the latter here:

**How to Protect Software through Patents and Trade Secrets**
Nuria Marcos, Jose Carlos Erdozain, and Gabriel Castilla Penalva (PONS IP, Madrid, Spain)
*29 September 2020*

**Reassessing User Privacy in a Hyperconnected Internet**
Srdjan Matic, postdoctoral researcher at TU Berlin, Berlin, Germany
*10 April 2020*

**When criminals are mastering the Internet: emerging threats and challenges**
Guillermo Suárez de Tangil, Assistant Professor at King's College London, London, England
*8 April 2020*

**My journey after IMDEA Networks; from doing research to working in a digital transformation company, StratioBD**
Elli Zavou, Software Developer at StratioBD, Madrid, Spain
*4 March 2020*

**Age of Information: Analysis and Optimization**
Jaya Prakash, Postdoctoral Researcher at KTH Royal Institute of Technology, Swedeny
*3 March 2020*

**Towards Understanding the Information Ecosystem Through the Lens of Multiple Web Communities**
Savvas Zannettou, Postdoctoral Researcher at the Max Planck Institute for Informatics, Germany
*2 March 2020*

**Empirically Grounding Models of Censorship**
Michael Carl Tschantz, Researcher at the International Computer Science Institute, California, United States
*7 February 2020*

**Deconstructing Stellar Consensus**
Álvaro García Pérez, Post-Doctoral Researcher, IMDEA Software Institute, Madrid, Spain
*22 January 2020*

**Have You Ever Rebooted a Digital City? Introducing the emergenCITY Project**
Matthias Hollick, Full Professor at Technische Universität Darmstadt, Germany
*9 January 2020*

**Media impact 2019**

## 32
Web news

## 12
Press releases

## 550
Social networks posts

## 5.801
Social networks followers 2020

1.536    200    198    3.307    560

### national, international, local

Local
10

National
106

International
180

### media content

General Interest
97

Specialised
204

AlphaGalileo Foundation

EurekAlert! AAAS
The Global Source for Science News

SiNC
La ciencia es noticia

notiweb m+d
Boletín de noticias de I+D+i

Globedia

PHYS·ORG

10 años | dcyt

total telecom

Newtral

TheScientist
MAGAZINE OF THE LIFE SCIENCES

EL PAÍS

ABC

LA VANGUARDIA

R&T REDES&TELECOM

Science X

economiadehoy.es

ZONA MOVILIDAD

fundación para el conocimiento madri+d

EFE:

ACTIVO LEGANÉS

MCPRO

ScienceDaily

europa press

## Some media impacts



**TeleMadrid**

**Diez investigaciones "made in Madrid" de las que está pendiente todo el planeta ciencia**

More info



**EL PAÍS**

*El investigador que propone recibir un salario a cambio de nuestros datos*

More info

## rtve

### Un nuevo empujón al 5G

More info



**ARTURO AZCORRA**
CATEDRÁTICO DE LA U. CARLOS III Y DIRECTOR DE IMDEA NETWORKS

## ABC

*EEl tejido industrial español busca su oportunidad de reconexión en el 5G*

More info

## StudyFinds
Research studies first.

# Privacy at risk: Over 150 million websites include sensitive content, track users visiting them

by Chris Melore

**f Share**   **🐦 Tweet**

**MADRID, Spain** — Regardless of how much consumers to protect themselves, many accept their privacy is at risk every time they go online. A new report on website tracking likely won't add any comfort to this perception. Researchers say their review finds more than 150 million websites contain sensitive content. Even more concerning, information about your activity in these places can be tracked and shared with others.

Researchers say this a major issue when looking at international laws restricting the collection and processing of personal data online. The European General Data Protection Regulation (GDPR) specifically includes any information revealing racial and ethnic origins, political opinions, religious beliefs, or union membership status. Legislation also protects data on a person's health, sex life, or sexual orientation.

## ZONA MOVILIDAD

El artículo "Un análisis del software de Android preinstalado" es premiado por varias organizaciones

# LA VANGUARDIA

[More info](#)

MAD-
CORONAVIRUS
PANDEMIA

## Rivas y Arganda se unen a un proyecto que mide la incidencia de la pandemia

f  t  💬 0

REDACCIÓN 02/08/2020 14:42

Rivas Vaciamadrid, 2 ago (EFE).- El proyecto científico Coronasurveys, impulsado desde el instituto madrileño Imdea Networks y enfocado a medir la incidencia de la pandemia a mediados de marzo en España, se ha aliado con la asociación ciudadana de Rivas y Arganda 'CriptourbanIA' para lanzar una encuesta digital específica para esas dos localidades.

El objetivo es ofrecer datos sobre la evolución de la pandemia de la COVID-19 a lo largo del tiempo, de manera continua y "con el más alto nivel de fiabilidad posible" en esas dos localidades del sureste de la Comunidad de Madrid, según indica el instituto en un comunicado.

## 5.5 Local Scientific Partnership

IMDEA Networks Institute has a strong scientific collaboration with a number of the local universities in the Madrid region. Among those, it is worth highlighting the partnerships with University Carlos III of Madrid (UC3M) and University of Alcalá (UAH) involving stable research collaboration in joint activities and projects. Furthermore, there is also an institutional collaboration in the form the participation of UC3M and UAH on the Institute's Board of Trustees.

Among other activities, the cooperation between IMDEA Networks and the local universities involve their joint participation in funded research projects. The regional project TAPIR-CM, which is currently ongoing, involves UC3M and UAH as participants under the coordination of IMDEA Networks. Furthermore, UC3M and IMDEA Networks jointly participate in several ongoing European projects, such as 5G-EVE, and they are both members of the 5TONIC laboratory.

With respect to teaching, IMDEA Networks is delivering, jointly with Ericsson and UC3M and with the participation of UAH, an M.Sc. degree on 5G, SDN and NFV. This Master is very successful and is strengthening the technological profile of the Madrid region.

Another important activity where IMDEA Networks is collaborating with the local universities is in the context of SCITEL, the Scientific Society of Telematic Engineering. IMDEA Networks, UC3M and UAH are very important members of this association, and are contributing to organize various activities in the framework of this association, such as the national conference on Telematics (JITEL).

Besides the above activities, IMDEA Networks, UC3M and UAH are also taking advantage of the physical proximity between the three institutions to share many of their daily activities, such as the scientific seminars organized by IMDEA Networks, which count with the participation of UC3M and UAH. Furthermore, it is also worth highlighting the personnel mobility between IMDEA Networks and University Carlos III and University of Alcalá.

Through these collaborations with local scientific partners, IMDEA Networks provides an important contribution to strengthening the scientific standing of the Madrid region in the area of Telematics.

# impact and technology transfer

# 6

annual report
# 2020
www.networks.imdea.org

## 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.

# USA Patent Application (October 2020)

**Title:** *Method for determining geometric information on mmwave network devices*

**Inventors:** Guillermo BIELSA LÓPEZ, Joan PALACIOS BELTRAN, Paolo CASARI, Joerg WIDMER, Adrian LOCH NAVARRO

**Rights:** IMDEA Networks Institute

**Overview**: A method for determining geometric information of mmWave network devices comprising collecting measures, by at least one of the devices, of signal strength and SNR of a transmission received from another device of the mmWave network; estimating angle information of the received signals to generate a set of informed particles comprising initial values of state of each informed particle and input in a modified particle filter; the modified particle filter evolving the sets of informed particles and past particles to obtain a set of evolved particles which, in turn, is evolved to obtain a set of posterior particles delivered by the modified particle filter. Finally, the modified particle filter delivers as output final values of geometric information of the at least one device extracted from the delivered set of posterior particles.

**Application number:** US20200252148A1**.** (Granted: 2020-10-27)

# European Patent Application (October 2020)

**Title**: *Method and system for network slice allocation*

**Inventors**: Vincenzo SCIANCALEPORE, Xavier COSTA-PEREZ, Albert BANCHS, Marco GRAMAGLIA

**Rights**: IMDEA Networks Institute

**Overview**: The invention relates to a method and system for efficient network slice allocation, e.g., in a 5G network. A novel interaction between tenants and infrastructure providers. In particular, a method and system are provided for dynamically and online evaluating network slices requests defined by their SLA requirements and associated payoff. Embodiments of the invention jointly consider SLA requirements and payoffs to maximize a utility function, e.g., overall network resource utilization.

**Application number**: EP3396997B1. (Granted: 2020-10-14)

## 6.2. Technology transfer & impact

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

Our technology transfer strategy is aimed to ensure that the Institute's research activities remain relevant, that its innovations are diffused and their full value to society realized through various transfer processes such as licensing and the sale of patents, creation and support of spin-off companies in the region that seek to commercialize products exploiting innovations developed within the Institute. We carry out several forms of collaboration, including direct contracts with industry, as well as participation in joint projects financed by public entities. Our projects 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:

**6.2.1. Ongoing Industry contracts**

# Deep Learning for Efficient LoS MIMO Backhaul

**Funded by:** HUAWEI TECHNOLOGIES Italia S.r.l.
**Duration:** July 2020 to June 2021

The tremendous capacity increases in radio access envisioned for 5G and beyond mobile net- works has increased the requirements for efficient ultra-high speed wireless backhaul. Unfortunately, the increase of spectral efficiency of SISO systems has saturated long ago and current MIMO systems are characterized by too complex processing and too expensive deployment, limiting their commercial success.

The aim of this project is to leverage on Deep Learning (DL) techniques to improve performance and reduce implementation complexity of LoS MIMO backhaul communication systems. Specifically, the goal is to define a learning approach that can cope with the diverse hardware imperfections and channel environments found in LoS MIMO links with antenna spacing much lower than the optimal distance

# NetPredict3 - Automated interpretation of network traffic traces

**Funded by:** NOKIA Spain
**Duration:** October 2020 to April 2021

The project is proposed as a continuation of the NetPredict projects: Identification of predictive variables of anomalies in network traffic, completed in 2019 and NetPredict 2: Detection of anomalies in network traffic and identification of possible causes, completed in July 2020.

The final goal of Netpredict 3 is the implementation of a set of advanced machine learning models that allow the automatic interpretation of the causes of the variations in the performance of various network protocols and applications, and their evolution over time. The models developed will be exhaustively evaluated, and the results will be collected in anacademic paper to be submitted to a high-level international conference.

## ZertiaData - Solución de inteligencia basada en análisis de datos de clientes

**Funded by:** Zertia Telecomunicaciones, SL.
**Duration:** October 2020 to December 2020

R&D consulting in the definition of the global system architecture and the design of the data analysis system for the development of an intelligence solution based on the analysis of customer data.

## ARMASUISSE CompPos

**Funded by:** Armasuisse – Science and Technology
**Duration:** April 2020 to December 2020

ComPos will have as first objective (o1) the design of a general framework for uplink data compression in crowdsourced spectrum sensing platform, using both PSD and IQ inputs to reduce the network bandwidth used by every spectrum sensor as well as backend storage requirements. The second objective (o2) of the project is positioning of real wireless emitters with distributed spectrum sensing architectures.

## User level traffic prediction in cellular network

**Funded by:** Huawei Technologies (China)
**Duration:** November 2019 to October 2020

Massive MIMO (MM) is an important technique in (beyond) 5G that greatly improves spectral efficiency by increasing the number of antenna elements. This increases the overhead of Channel State Information (CSI) estimation and obtaining accurate CSI is a fundamental problem in massive MIMO systems. In this project, we focus on scheduling uplink Sounding Reference Signals (SRS) that carry pilot symbols for CSI estimation. In high loaded scenarios, the amount of resources available for SRS is limited and would be vastly inefficient of the unability to refresh outdated channel estimates frequently. To this end, we design a solution that leverages ML to estimate future traffic allocations and triggers SRS to obtain a channel estimate right before the traffic arrives.

## NetPredict2 - Detección de anomalías en tráfico de red e identificación de posibles causas

**Funded by:** NOKIA
**Duration:** January 2020 to July 2020

The final objective of Netpredict 2 is the implementation of a set of advanced machine learning models that allow the automatic detection of network anomalies, and their classification according to the type of problem. The models developed will be exhaustively evaluated, and the results will be collected in an academic article with the aim of sending it to the IEEE INFOCOM 2021: IEEE International Conference on Computer Communications 2021 conference.

## AppCensus - Analysis of Third Party SDKs and Endpoints for AppCensus

**Funded by:** AppCensus
**Duration:** June 2020 to June 2020

This project has two main objectives:
• Augmenting and sanitizing existing data using a dataset that identifies fingerprints, category, and ownership of SDKs found within apps.
• Improving the storage and collection of data in a future-forward fashion.

## NetAlarm - Identificación de anomalías en el tráfico de red y la generación automática de alarmas

**Funded by:** SATEC
**Duration:** March 2020 to April 2020

IMDEA will develop a methodology for the identification of network anomalies that will enrich the existing system with new types of alarms that, in a preventive way, detect problems and inefficiencies in the network.

# 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 technologi- cal leadership. Over a period of seven years up to 2020, 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 is 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 shares 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 Diego R. López from Telefónica I+D and Arturo Azcorra, Joerg Widmer and Albert Banchs, from IMDEA Networks, focuses 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, INTEL, Commscope, University Carlos III of Madrid, InterDigital and Altran amongst its members. In 2020 DeepSight AI Labs and Telcaria became 5TONIC collaborators.

The objective of 5TONIC is to create a global open environment where members from 94 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 is located at IMDEA Networks. The Institute 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 5G EVE and 5G Vinni, as well as 5G Growth.

**5TONIC Members**

Telefónica

iMdea institute networks

ERICSSON

intel.

COMMSCOPE®

uc3m

ALTRAN

INTERDIGITAL

**5TONIC Collaborators**

NOKIA

ASTI
MOBILE ROBOTICS
Transforming the future together

IFEMA
Feria de Madrid

ROHDE&SCHWARZ

luzwavelabs

Saguna

celling
5G solutions

UTEK

innovalia

**New 5TONIC Collaborators**

Telcaria

DeepSight AILabs
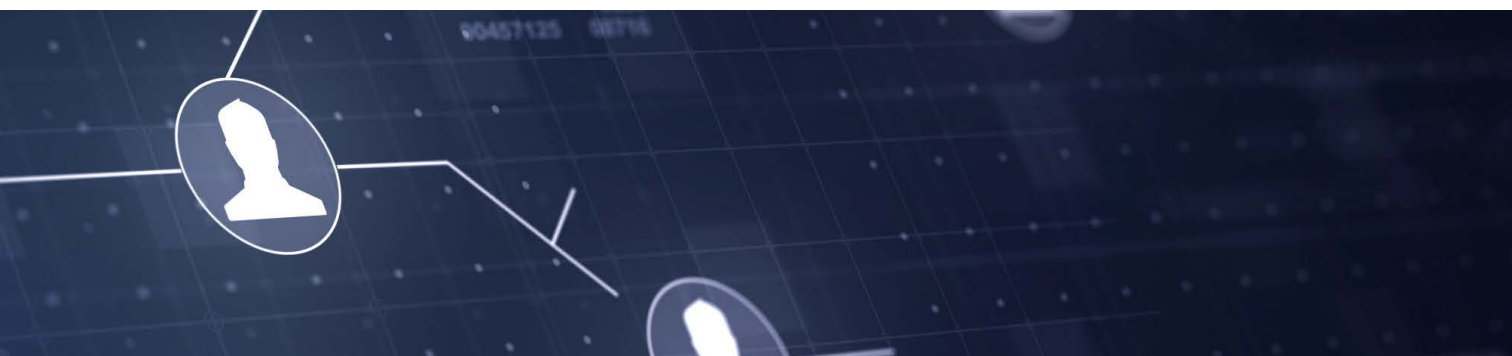
## 6.2.3 Industry partners

Our technology transfer activities have led to a significantly increased portfolio of companies we collaborate with. During 2020, they were the following:

Altran Innovación S.L.U.

AppCensus, Inc.

Ares2T

Asti Mobile Robotics SA

Big Data Analytics SA

Cliqz GmbH

CommScope Technologies LLC

Électricité de France

Electrosense

Ericsson AB

Ericsson España S.A.

Ericson Hellas S.A Tilepikoinoniakoy Ilinox

Ericsson Telecomunicazioni S.p.A.

Ermes Cyber Security SRL

Eurescom-European Institute for Research and Strategic Studies in Telecommunications gmbh

EvoLogics GmbH

Fastweb SPA

FORD OTOMOTIV SANAYI ANONIM SIRKETI

FSTechnology S.p.A.

FundingBox Accelerator Sp. z.o.o.

HUAWEI Technologies Italia S.r.l.

Huawei

IBM Ireland Limited

IDC Italia S.r.l.

Incelligent Idiotiki Kefalaiou-chikietaireia

Intel Corporation Iberia S.A.

Interdigital Europe Ltd

LightBee SL

Lstech España SL

Naver France

NEC Laboratories Europe GmbH

Nextworks

Nokia Bell Labs France

Nokia Ireland Limited

Nokia Solutions and Networks Hellassole Shareholder Socie-te Anonymeorks Hellas Sa

Nokia Solutions & Networks Oy

Nokia Spain S.A.

Orange Polska Spolka Akcyjna

Orange Romania SA

Orange S.A.

Organismos tilepikoinonion tis ellados ote ae

puLiFi Limited

Ranplan Wireless Network Design LTD

Safran Passenger Innovations Germany GmbH

Samsung Electronics (UK) Limited

Satec

Signify Netherlands B.V.

Telcaria Ideas S.L.

Telecom Italia S.p.a.

Telefónica I+D S.A.

Toshiba Europe Limited

Trenitalia Spa

Velmenni OÜ

Viavi Solutions France SAS

WINGS ICT Solutions

Wireless and More s.r.l.

Zertia Telecomunicaciones

Zumtobel Lighting GmbH

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.

# personnel

# 7

annual report
2020
w w w . n e t w o r k s . i m d e a . o r g

# 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 Deputy Director, the Research Director and the General Manager also assist the Director.

# 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. Arturo AZCORRA**
Director

**Research:** 5G Networks and Services; Network Virtualization and Softwarization; Drone Communications; On-line Social Networks Data Analytics; Mammal Brain Cartography and Topology
**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/arturo-azcorra/

**Short Bio**
Dr. Arturo Azcorra graduated in 1980 from Loy-Norrix High School, Michigan. He received his Telecommunication Engineering degree from Universidad Politécnica de Madrid in 1986, and the Doctor degree in 1989 from the same University. He currently is a full professor at Universidad Carlos III de Madrid, and he's also Director of the International Research Institute IMDEA Networks, a very relevant research institution in Europe. On the professional area, Arturo Azcorra is an IEEE Communications Society Senior Member, an Internet Society member, an ACM-SIGCOMM member, a founding member of the Association for Telematics, and also president of the said Association.

**Dr. Albert BANCHS**
Deputy Director

**Research:** Wireless Networks; 5G Networks; Performance Evaluation; Algorithm Design
**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/albert-banchs/

**Short Bio**
Dr. Albert Banchs received his M.Sc. and Ph.D. degrees from the Polytechnic University of Catalonia (UPC-BarcelonaTech) in 1997 and 2002, respectively. He is currently a Full Professor with the University Carlos III of Madrid (UC3M), with double affiliation as Deputy Director of the IMDEA Networks institute. Before joining UC3M, he was at ICSI Berkeley in 1997, at Telefonica I+D in 1998, and at NEC Europe Ltd. from 1998 to 2003. He was an Academic Guest at ETHZ in 2012, a Visiting Professor at EPFL in 2015 and 2013 and a Fulbright scholar at University of Texas at Austin in 2019. Prof. Banchs authors over 150 publications in international conferences and journals, and is the co-inventor of several patents.

# 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 Director

**Research:** Wireless Networking; Millimeter-Wave Communication; Wireless Sensing and Localization; Mobile Network Architectures
**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/joerg-widmer/

**Short Bio**
Dr. Joerg Widmer is Research Professor and Research Director of IMDEA Networks in Madrid, Spain. Before, he held positions at DOCOMO Euro-Labs in Munich, Germany and EPFL, Switzerland. His research focuses on wireless networks, ranging from extremely high frequency millimeter-wave communication and MAC layer design to mobile network architectures. He authored more than 200 conference and journal papers, 3 IETF RFCs, and 13 patents. He received an ERC consolidator grant, the Friedrich Wilhelm Bessel Award of the Humboldt Foundation, a Ramon y Cajal grant, as well as nine best paper awards. He is Fellow of the IEEE and Distinguished Member of the ACM.

## Dr. Marco AJMONE MARSAN
Research Professor

**Research:** Cellular Networking; Green Networking; Network and Protocol Performance; Crowdsourcing Systems
**Personal Site:**
https://www.telematica.polito.it/public/faculty/marco-ajmone-marsan

**Short Bio**
Marco Ajmone Marsan is full professor at Politecnico di Torino and research professor at IMDEA Networks Institute. He obtained degrees from Politecnico di Torino, UCLA, and Budapest University of Technology and Economics (honorary). His main research fields are performance evaluation and networking. He was member of the editorial board and chair of the steering committee of the "ACM/IEEE Transactions on Networking" and is now in the editorial boards of "Computer Networks", "Performance Evaluation", and "ACM TOMPECS". He is Fellow of the IEEE, member of the Academy of Sciences of Torino and Academia Europaea, general chair of Infocom 2013 and ICC 2023.

### Dr. Suman BANERJEE
Research Professor

**University of origin:** University of Wisconsin-Madison. WI. USA

**Short Bio**

Suman Banerjee received the undergraduate degree from IIT Kanpur in computer science and engineering and was a gold medalist in his graduating class, and the MS and PhD degrees from the University of Maryland. His PhD dissertation was the university's nomination for the ACM Doctoral Dissertation Award. He is a professor in computer sciences with UW-Madison where he is the founding director of the WiNGS laboratory, which broadly focuses on research in wireless and mobile networking systems. While at Wisconsin, he received the CAREER award from the US National Science Foundation and the inaugural Rockstar Award from ACM SIGMOBILE for early career achievements and contributions in his field. He has authored more than 100 technical papers in leading journals and conferences in the field, including the ACM/IEEE Transactions on Networking, the ACM/IEEE Transactions on Mobile Computing, ACM Sigcomm, ACM MobiCom, IEEE Infocom, ACM MobiSys, ACM CoNEXT, ACM IMC, IEEE Dyspan, and more. It also includes various award papers from conferences such as ACM MobiCom, ACM CoNEXT, and IEEE Dyspan. He served as the chair of ACM SIGMOBILE between 2013 and 2017. He is a member of the IEEE.

### Dr. Antonio FERNÁNDEZ ANTA
Research Professor

**Research:** Communications and Networks; Parallel and Distributed Processing; Algorithms; Discrete and Applied Mathematics; Distributed Ledgers; Data Analysis
**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/antonio-fernandez-anta/

**Short Bio**

Antonio Fernandez Anta is Research Professor at IMDEA Networks. Previously he was a on the Faculty of the Universidad Rey Juan Carlos (URJC), and the Universidad Politécnica de Madrid (UPM), where he received a research performance award. He was a postdoc at MIT (1995-1997), and spent sabbatical years at Bell Labs and MIT Media Lab. He has been awarded the Premio Nacional de Informática "Aritmel" in 2019 and is Mercator Fellow of the SFB MAKI in Germany since 2018. He received his M.Sc. and Ph.D. from the University of Louisiana. He is a Senior Member of ACM and IEEE.

### Dr. Nikolaos LAOUTARIS
Research Professor

**Research:** Privacy; Transparency/Data Protection; Economics of Networks and Information; Intelligent Transportation; Distributed Systems; Protocols; Network Measurements
**Personal Site:**
http://laoutaris.info/

**Short Bio**

Dr. Nikolaos Laoutaris is a research professor at IMDEA Networks Institute in Madrid. Prior to that, he was director of data science at Eurecat and chief scientist of the Data Transparency Lab, which he co-founded in 2014 during his 10-year tenure as a researcher and senior researcher of Telefonica Research in Barcelona. Before Telefonica, he was a postdoc fellow at Harvard University and Marie Curie postdoc fellow at Boston University. He got his PhD in computer science from the University of Athens in 2004.

# 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. Marco FIORE
### Research Associate Professor

**Research:** Mobile networking; Data Science; Network Intelligence; Traffic analysis; Remote Sensing
**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/marco-fiore/

**Short Bio**

Dr. Marco Fiore is a Research Associate Professor at IMDEA Networks Institute, where he leads the Networks Data Science group on research activities at the interface of mobile networking and applied data science. Dr. Fiore received a PhD degree from Politecnico di Torino, Italy, and a Habilitation à Diriger des Recherches from Université de Lyon, France. He held tenured positions at INSA de Lyon, France, and Consiglio Nazionale delle Ricerche, Italy, and was a visiting researcher at Rice University, USA, Universitat Politècnica de Catalunya, Spain, and University College London, UK. Dr. Fiore is a recipient of Marie Curie and Royal Society research fellowships. His research has attracted funding from European, national and regional agencies, and has been presented in major journals and conferences in the networking field.

## Dr. Domenico GIUSTINIANO
### Research Associate Professor

**Research:** 5G/6G, Wireless, IoT, LiFi, Localization
**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/domenico-giustiniano/

**Short Bio**

Dr. Domenico Giustiniano is Research Associate Professor (tenured) at IMDEA Networks Institute and leader of the Pervasive Wireless Systems group. Dr. Giustiniano is leader of the OpenVLC project, an open-source platform for research in visible light communication networks and co-founder of the non-profit Electrosense association, a crowd-sourcing initiative to collect and analyze spectrum data. Before joining IMDEA, he was a Senior Researcher and Lecturer at ETH Zurich. He also worked for a total of four years as Post-Doctoral Researcher in industrial research labs (Disney Research Zurich and Telefonica Research Barcelona). He holds a PhD in Telecommunication Engineering from the University of Rome Tor Vergata (2008).

## Dr. Sergey GORINSKY
Research Associate Professor

**Research:** Computer Networks; Distributed Systems; Network Economics
**Personal Site:**
https://networks.imdea.org/p/sergey-gorinsky

### Short Bio

Dr. 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 Ph.D. and M.S. degrees from the University of Texas at Austin, USA in 2003 and 1999 respectively and 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. Dr. Gorinsky distinguished himself through extensive service to the profession, such as TPC chairing of ICNP 2017, general chairing of SIGCOMM 2018 and ICNP 2020, and proposal evaluation for the European Research Council (ERC Starting Grants).

## Dr. Vincenzo MANCUSO
Research Associate Professor

**Research:** Design of Opportunistic and Sliced Mobile Networks; Measurements and Assessment of Mobile Networks; Wireless Access and Edge Networks; Performance Evaluation, Machine Learning
**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/vincenzo-mancuso/

### Short Bio

Dr. Vincenzo Mancuso is tenured Research Associate Professor at IMDEA Networks Institute, Madrid, Spain, and recipient of a Ramon y Cajal research grant. Previously, he was with INRIA (Sophia Antipolis, France), Rice University (Houston, TX, USA) and University of Palermo (Italy), from where he obtained his MSc and PhD. He authored more than 120 peer-reviewed publications focusing on Internet QoS and on the analysis, design, and experimental evaluation of opportunistic and adaptive protocols and architectures for wireless networks. He is currently working on analysis and optimization of opportunistic and sliced wireless access networks, which includes measurements and assessment of mobile networks, and on the use of (explainable) machine learning techniques for the identification of the causes of network performance problems and for the allocation of communication and computing resources to services.

# 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 PhD Students and post-doctoral 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. Jaya Prakash Varma CHAMPATI
### Research Assistant Professor

**Research:** Age of Information; Edge computing; Internet of Things; Approximation Algorithms; Network Calculus; Markov Decision Processes; Bandit Algorithms

**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/jaya-prakash-varma-champati/

**Short Bio**

Jaya Prakash Champati is an Assistant Professor at IMDEA Networks Institute, where he leads the Edge Networks group. His general research interest is in the co-design of communication and computation for emerging applications in Cyber-Physical Systems (CPS), the Internet of Things (IoT), and edge computing systems. Prior to joining IMDEA, he was a post-doctoral researcher in the division of Information Science and Engineering, EECS, KTH Royal Institute of Technology, Sweden. He obtained his PhD in Electrical and Computer Engineering from, the University of Toronto, Canada in 2017, and his master of technology degree from the Indian Institute of Technology (IIT) Bombay, India in 2010. Prior to joining PhD, he worked at Broadcom Communications, where he was part of developing the LTE MAC layer. He was a recipient of the best paper award at IEEE National Conference on Communications, 2011.

## Dr. Guillermo SUAREZ-TANGIL
### Research Assistant Professor

**Research:** Cibersecurity and Cibercrime; Malware Analysis; Mass marking fraud; security and privacy in the social web

**Personal Site:**
https://networks.imdea.org/team/imdea-networks-team/people/jaya-prakash-varma-champati/

**Short Bio**

Guillermo Suarez-Tangil is Assistant Professor IMDEA Networks. His research focuses on modeling emerging threats in online communities and ing effective mitigation strategies. His background is on systems security and malware analysis and detection. In particular, in the study of smart malware, ranging from the detection of advanced obfuscated malware to automated analysis of targeted malware. Guillermo is also part of the Cybersecurity research group at King's College London (KCL). Before joining KCL, he has been senior research associate at University College London (UCL) where he has explored the use of program analysis to study malware. He has also been actively involved in other research directions aiming at detecting and preventing of Mass-Marketing Fraud (MMF) and security and privacy in the social web.

Prior to that, he held a post-doctoral position at Royal Holloway, University of London (RHUL) where he was part of the development team of CopperDroid, a tool to dynamically test malware that uses machine learning to model malicious behaviors. He also holds a solid expertise on building novel data learning algorithms for malware analysis. He obtained his PhD on smart malware analysis in Carlos III University of Madrid with distinction and received the Best National Student Academic Award--a competitive award given to the best Thesis in the field of Engineering between 2014-2015 with about 1% acceptance rate (about 100 Cum Laude Thesis were invited to compete for the only award).

## Dr. Narseo VALLINA-RODRÍGUEZ

Research Assistant Professor

**Research:** Network and Traffic Measurements; Protocol Analysis; Mobile Privacy and Security; IoT
**Personal Site:**
https://people.networks.imdea.org/~narseo_vallina/

**Short Bio**

Narseo Vallina-Rodriguez (Ph.D. in CS at the University of Cambridge, 2014) is an Assistant Research Professor at IMDEA Networks, and a Research Scientist at ICSI, USA. He is also a co-founder of App-Census Inc. His research interests fall in the areas of network measurements, and online privacy and security. Narseo has received several industry grants (e.g., Google Faculty Research Awards, Data Transparency Lab Grant), and best paper awards at the 2020 IEEE Symposium on Security and Privacy (S&P), USENIX Security'19, ACM IMC'18 and ACM CoNEXT'14. His ground-breaking work in the mobile privacy domain has influ-

enced policy changes and security improvements in the Android platform, and has been recognized by EU regulators through the AEPD Emilio Aced Award and the CNIL-INRIA Privacy Protection Award, both in 2019. International media like The Washington Post, The NYT, The Guardian, or the Financial Times have covered Narseo's research.

*IMDEA Networks Faculty researchers*



Genius is one percent inspiration, ninety-nine percent perspiration
*Thomas Edison*

# post-doc researchers

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 (PhD students).

## Dr. Hany ASSASA
Post-Doc Researcher

**Research:** Millimeter-Wave Networking, WiGig/IEEE 802.11ad, Network Simulation (ns-3), Wireless MAC Layer Design, Wireless Networking, Next Generation Networks Architecture, and Software Defined Radio and Networking
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/hany-assasa/

### Short Bio
Dr. Hany Assasa joined the Wireless Networking Group at IMDEA Networks in August 2019 as a post-doc researcher. His main research interests are primarily in the field of wireless systems covering various disciplines such as wireless networking protocols, prototypes and testbeds, communication, and signal processing techniques. He obtained his Ph.D. in Telematics Engineering from Universidad Carlos III de Madrid in July 2019. During his Ph.D., he was a research assistant at the Wireless Networking Group at IMDEA Networks, working on millimeter-wave wireless networks. Before his Ph.D., he completed a double degree master program at both Politecnico di Torino and the Royal Institute of Technology (KTH).

## Dr. Elisa CABANA
Post-Doc Researcher

**Research:** Machine Learning; Statistics; Robust data analysis; Outlier detection
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/elisa-cabana/

### Short Bio
Dr. Cabana joined the Data Transparency Group of Prof. Nikolaos Laoutaris in April 2020. Her primary research interests are outlier detection and robust data analysis. She obtained her Ph.D. in Mathematical Engineering at the University Carlos III of Madrid with a research about robust methods based on shrinkage with application to outlier detection, regression, and classification, which conducted to different publications in scientific journals, as well as conferences and awards in national and international events. She is currently working with Prof. Nikolaos Laoutaris in developing a method for epidemic spread detection and risk of contagion based on mobile phone data.

### Dr. Roberto CALVO-PALOMINO
Post-Doc Researcher

**Research:** Collaborative Spectrum Sensing, Collaborative Algorithms, Distributed Systems, large scale deployments
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/roberto-calvo-palomino/

**Short Bio**
Dr. Roberto Calvo-Palomino is a postdoctoral researcher working at IMDEA Networks Institute of Madrid in the Pervasive Wireless Systems Group. He received his Ph.D (2019) at IMDEA Networks Institute associated to Universidad Carlos III of Madrid (UC3M). He worked as senior software engineer for 5 years in the industry. His main interests are related to IoT, data analysis, collaborative-smart systems deployed at large scale and collaborative/distributed algorithms to build smart crowdsourcing platforms. Nowadays his research lines are focused on collaborative wideband spectrum monitoring, spoofing signal detection, effective spectrum data compression and signal transmitter localization using software-defined radios.

### Dr. Claudio FIANDRINO
Post-Doc Researcher

**Research:** Multi-Access Edge/Fog Computing; Learning-driven Network Optimization; mm-Wave Communications; Mobile Crowdsensing
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/claudio-fiandrino/

**Short Bio**
Claudio is a postdoctoral researcher at IMDEA Networks Institute, Madrid, Spain. He joined the Wireless Networking Group in December 2016 after having obtained his Ph.D. degree at the University of Luxembourg in November 2016. He received the Bachelor Degree in Ingegneria Telematica in 2010 and the Master Degree in Computer and Communication Networks Engineering in 2012 both from Politecnico di Torino. Claudio has been awarded with two Spanish Juan de la Cierva grants and the Best Paper Awards in IEEE Cloudnet 2016, in ACM WiNTECH 2018 and IEEE GLOBECOM 2019. He is member of IEEE and ACM, served as Publication and Web Chair at IEEE CloudNet 2014, Publicity Chair at ACM/IEEE ANCS 2018, leading Workshop Co-Chair at MoCS 2019, TPC Co-Chair at IEEE CAMAD 2019-2021 and Registration Chair at IEEE ICNP 2020. Claudio is a member of the Editorial Board team of IEEE Networking Letters. His primary research interests include multi-access edge/fog computing, learning-driven network optimization and mobile crowdsensing.

### Dr. Álvaro GARCÍA-RECUERO
Post-Doc Researcher

**Research:** Distributed Systems; Complex Networks; Security and Privacy
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/alvaro-garcia/

**Short Bio**
Dr. Álvaro García-Recuero is a postdoctoral researcher working at IMDEA Networks Institute of Madrid within the Data Transparency Group. He holds a Ph.D. in Computer Science by Université de Rennes 1 (UR1), developed at the French National Research Institute of Informatics and Automatics since 2017. His PhD dissertation proposes a privacy-preserving design of a protocol for abuse detection over the Internet, namely decentralised Private Set Intersection (dPSI) by using BLS digital signatures, while Data Minimisation is employed for achieving reduced protocol runtime in future decentralised deployments. In the past, he has worked at different R&D laboratories in Europe doing state of the art work in Big Data (INESC-ID Lisboa), Privacy (INRIA) and even Networks as a visiting postdoctoral scholar in Queen Mary University of London in UK.

### Dr. Borja GENOVÉS-GUZMÁN
Post-Doc Researcher

**Research:** Next Generation Wireless Networks; Visible Light Communication (VLC); LiFi systems; Mobile Communications
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/borja-genoves-guzman/

**Short Bio**
Postdoctoral researcher (granted with Juan de la Cierva - Formación) in the Pervasive Wireless Systems Group of IMDEA since September 2019. My research interests focus on new techniques to improve the efficiency of visible light communication systems. I manage the MSCA-ITN ENLIGHT'EM project. In 2019, I obtained my Ph.D. in Multimedia and Communications of the University Carlos III of Madrid. I was a Visiting Scholar with The University of Southampton and The University of Edinburgh. I have participated in several national and European projects, and I received the First Prize in Graduation National Awards from the Ministry of Education, Culture and Sports of Spain.

### Dr. Marius PARASCHIV
Post-Doc Researcher

**Research:** Data Valuation; Statistical Learning; Optimization Algorithms
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/marius-paraschiv/

#### Short Bio
Joined the Human Centric Data Economy group of Prof. Nikolaos Laoutaris in April 2019. His primary research interests are in geometric deep learning (application of machine learning algorithms to graph data). Prior to this, he has worked on a series of projects and collaborations with other IMDEA faculty members, including a comprehensive study of domain classification services and their relative inconsistencies as well as producing a computer vision model. A second research interest is related to the notions of "data value" and the value of individual data providers to a particular service, from an economic but also an information-theoretic perspective.

### Dr. Maurizio REA
Post-Doc Researcher

**Research:** mmWave networks; Beam Search Algorithms; Signal Processing
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/marius-paraschiv/

#### Short Bio
Maurizio Rea is Post-Doc Researcher at IMDEA Networks Institute, Madrid, Spain. He holds a PhD in Telematics Engineering from the University Carlos III of Madrid (June 2020). He received his M.Sc. in 2015 in Telecommunications Engineering from the University of Palermo, Italy. He also received a M.Sc. from the University Carlos III of Madrid in 2016. Before joining IMDEA, he worked as Researcher at ETH Zurich where he focused his research on indoor localization systems. His interests include data analysis, wireless communication, mmWave networks, beamforming algorithms, channel state information, angle of arrival algorithms and context-aware mechanisms.

### Dr. Giuseppe SANTAROMITA
Post-Doc Researcher

**Research:** Wireless Networks; 5G; Localization
**Personal Site:** https://networks.imdea.org/team/imdea-networks-team/people/marius-paraschiv/

#### Short Bio
Dr. Giuseppe Santaromita joined the Pervasive Wireless Systems Group led by Dr. Domenico Giustiniano at IMDEA Networks in May 2020. He received his Ph.D. in Information and Communication Technologies at the University of Palermo (Italy), with a focus on physical layer flexibility to improve the performance of high-capacity and ultra-dense wireless networks. He is a member of IEEE and ACM. His main research interest at IMDEA involves low-latency, high-accuracy localization methods for wireless networks, mainly on 5G New Radio networks.

# pre-doc researchers

Our PhD Students 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 these 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.



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

## Sergi ALCALÁ-MARÍN
Pre-Doc Researcher

**BSc:** Telecommunications Engineering. Universitat Politècnica de Catalunya. Spa
**MSc:** Advanced Telecommunication Technologies. Universitat Politècnica de Catalunya. Spain
**Previous Position:** Manager. Universitat de Barcelona. Spain
**Research:** Beyond 5g, Deep Learning, Wireless communications, Network performance analysis, Network performance measurement; Mobile networks.

## Sobhi ALFAYOUMI
Pre-Doc Researcher

**BSc:** Communications & Computer Engineering - University of Al-Azhar. Gaza. Gaza, Palestine
**MSc:** ICT for Internet and Multimedia, "Telecommunications Engineering" - University of Padova, Italy
**Previous Position:** Machine learning engineer. Railway Measurement Technology S.r.l.
**Research:** Machine learning; Wireless Networks; 5G Networks; Network Slicing; Scheduling Algorithm

## Santiago ANDRÉS
Pre-Doc Researcher

**BSc:** Telecommunication Engineering. Universidad Politécnica of Madrid. Spain
**Previous Position:** Principal Consultant. Axon Consulting. Madrid. Spain
**Research:** Data Economics; Privacy; Transparency & Data Protection; Economics of Networks

## Giulia ATTANASIO
Pre-Doc Researcher

**BSc:** Telecommunication Engineering. Politecnico di Torino. Turin. Italy
**MSc:** Communications and Computer Networks Engineering. Politecnico di Torino. Turin. Italy
**Research:** Low-latency communications; machine learning

## Constantine AYIMBA
Pre-Doc Researcher

**BSc:** Electrical and Electronic Engineering. University of Nairobi. Nairobi. Kenya
**MSc:** Wireless Communications. Lund University. Lund. Sweden
**Previous Position:** Service Engineer. Ericsson. Nairobi. Kenya
**Research:** Network Function Virtualization; Cloud Services; Machine Learning

## Alejandro BLANCO
Pre-Doc Researcher

**BSc:** Telecommunication Technologies Engineering. University Carlos III of Madrid. Madrid. Spain
**MSc:** Double Master's Degree. Telecommunications Engineering & Multimedia and Communications. University Carlos III of Madrid. Madrid. Spain
**Previous Position:** Junior Consultant. Everis. Madrid. Spain
**Research:** Mobile Network; LTE; Software Defined Radio (SDR); Measurements; Data Traffic

## Laura CARUSO
Pre-Doc Researcher

**BSc:** Information Engineering - Università degli studi di Padova. Padua, Italy
**MSc:** Telecommunications Engineering - Università degli studi di Padova. Padua, Italy
**Research:** NFV; 5G; MEC; edge networks

## Tianyue CHU
Pre-Doc Researcher

**BSc:** Double Bachelor's Degree. Mathematics and Applied Mathematics & Finance - Shenzhen University. Shenzhen, China
**MSc:** Statistics - Shenzhen University. Shenzhen, China
**Previous Position:** Research Assistant. Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences. Shenzhen. China
**Research:** Machine learning; Statistics

### Alan COLLET
Pre-Doc Researcher

**BSc:** Engineering Sciences - Polytechnic Institute of Bordeaux. Bordeaux, France
**MSc:** Telecommunication Engineering - ENSEIRB-MATMECA. Bordeaux, France
**Previous Position:** Computer Sciences - Illinois Institute of Technology. Chicago, United States
**Research:** Apply AI to networks; network intelligence; intent-based networking

### Stavros ELEFTHERAKIS
Pre-Doc Researcher

**BSc:** Mathematics - University of Crete. Heraklion, Greece
**MSc:** Applied and Computational Mathematics - University of Crete. Heraklion, Greece
**Previous Position:** Teaching Assistant. Department of Mathematics and Applied Mathematics. University of Crete
**Research:** Machine learning; Deep Learning; 5G Localization; Partial Differential Equations; Applied Statistics

### Álvaro FEAL
Pre-Doc Researcher

**BSc:** Computer Engineering. Universidade da Coruña. A Coruña. Spain
**MSc:** Software and Systems. Polytechnic University of Madrid. Madrid. Spain
**Previous Position:** Research intern. IMDEA Software Institute. Madrid. Spai
**Research:** Privacy and Security; Regulatory Compliance; Mobile Comput

### Dayrene FRÓMETA
Pre-Doc Researcher

**BSc:** Electronics and Telecommunication Engineering - Technological University of Havana José Antonio Echeverría (CUJAE). Havana, Cuba
**MSc:** Communication Systems - Pontifical Catholic University of Rio de Janeiro (PUC-Rio). Rio de Janeiro, Brazil
**Previous Position:** Lecturer. Department of Telematics, Technological University of Havana José Antonio Echeverría (CUJAE). Havana. Cuba
**Research:** Next Generation Wireless Networks; Visible Light Communication (VLC); LiFi systems; Millimeter-wave (mm-wave) systems

### Julien GAMBA
Pre-Doc Researcher

**BSc:** Computer science. University of Strasbourg. Strasbourg. France
**MSc:** Computer Networks and Embedded Systems. University of Strasbourg. Strasbourg. France
**Previous Position:** Internship Student; ICube Laboratory. Strasbourg. France
**Research:** Network Measurements; Privacy and Security; Interdomain Routing

### Dolores GARCIA MARTI
Pre-Doc Researcher

**BSc:** Mathematics. University of Valencia. Burjasot. Spain
**MSc:** Quantum Fields and Fundamental Forces. Imperial College London. London. UK
**Research:** Machine Learning; mm-wave

### Aniketh GIRISH
Pre-Doc Researcher

**BSc:** Computer Science - Amrita Vishwa Vidyapeetham. Kerala, India
**MSc:** Cybersecurity - University Carlos III de Madrid. Madrid, Spain
**Previous position:** Research Associate - IIJ Innovation Institute, Tokyo, Japan
**Research:** Mobile and IoT privacy

### Nina GROSHEVA
Pre-Doc Researcher

**BSc:** Telecommunication and Information Engineering. Ss. Cyril and Methodius University. Skopje. North Macedonia
**MSc:** Communications Engineering. RWTH Aachen University. Aachen. Germany
**Previous Position:** Intern. German Aerospace Center. Oberpfaffenhofen. Germany
**Research:** Network Simulation (ns-3); Millimeter Wave Networking; Performance Analysis
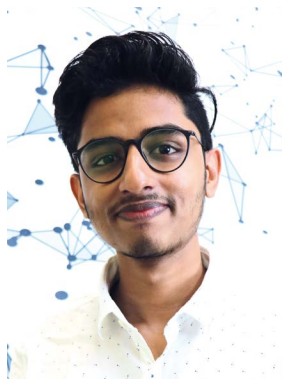
**Devriş IŞLER**
Pre-Doc Researcher

**BSc:** Computer Science and Engineering - Gaziantep Zirve University. Gaziantep, Turkey
**MSc:** Computer Science and Engineering - Koç University. Istanbul, Turkey
**Previous position:** Research Assistant. KU Leuven. Leuven. Belgium
**Research:** Applied cryptography privacy; usable security; data transparency and protection

**Pablo JIMÉNEZ MATEO**
Pre-Doc Researcher

**BSc:** Degree in Computational Mathematics - Degree in Computer Engineering. Universitat Jaume I. Castellón de la Plana. Spain
**MSc:** Intelligent Systems. Universitat Jaume I. Castellón de la Plana. Spain
**Previous Position:** Internship Student. Universitat Jaume I. Castellón de la Plana. Spain
**Research:** mmWave; Machine Learning; 5G

**Yago LIZARRIBAR**
Pre-Doc Researcher

**BSc:** Industrial Technologies Engineering. University of Navarra. San Sebastián. Spain
**MSc:** Mechanical Engineering. University of Navarra. San Sebastián. Spain
**Previous Position:** Research Assistant. Massachusetts Institute of Technology. Cambridge. MA. USA
**Research:** Collaborative Spectrum Sensing; Distributed Systems; Machine Learning

**Leonardo LO SCHIAVO**
Pre-Doc Researcher

**BSc:** Computer Science Engineering - Università degli Studi di Catania. Catania, Italy
**MSc:** Communications and Computer Networks Engineering - Politecnico di Torino. Turin, Italy
**Previous position:** Project Implementation Engineer at Amadeus IT Group. Nice. France
**Research:** Machine learning; 5G Networks; Network Slicing; Network Virtualization

**Orlando E. MARTÍNEZ-DURIVE**
Pre-Doc Researcher

**BSc:** Computer Science - University of Havana. Havana, Cuba
**MSc:** Computer Science - University of Havana. Havana, Cuba
**Previous position:** Researcher at the Faculty of Physics, University of Havana, Cuba
**Research:** Remote sensing; population estimation; land usage detection; mobile networks metadata

**Amir MEHRJOO**
Pre-Doc Researcher

**BSc:** Mechanical Engineering - Shiraz University. Shiraz, Iran
**MSc:** Business and Finance (Marketing Specialization) - University Carlos III of Madrid. Madrid, Spain
**Previous position:** Teaching Assistant. University Carlos III of Madrid. Spain
**Research:** Machine learning; Online Advertising; Data Analytics; Social Networks; Ad Transparency

**Sachit MISHRA**
Pre-Doc Researcher

**BSc:** Electronics and Communication Engineering - Jaypee University of Engineering and Technology. Guna, India
**MSc:** Computer Engineering - Politecnico di Torino. Turin, Italy
**Previous position:** Software Developer. Accenture Private Ltd.
**Research:** Mobile traffic analysis and modeling

**Nuria MOLNER**
Pre-Doc Researcher

**BSc:** Mathematics. University of Valencia. Valencia. Spain
**MSc:** Telematics Engineering. University Carlos III of Madrid. Spain
**Previous Position:** IRTIC (Institute of Robotics and Information and Communication Tehcnologies). Paterna. Valencia. Spain
**Research:** Fronthaul/Backhaul Integration and Optimization; NFV Placement Optimization; 5G Networks
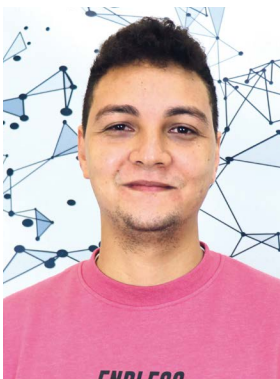
## Adriana MORENO
Pre-Doc Researcher

**BSc:** Electrical Engineering. Universidad de los Andes. Mérida. Venezuela
**Previous Position:** Lecturer on Electronics and Digital Systems. Universidad de los Andes. Mérida. Venezuela
**Research:** FPGA; GNU Radio and Millimeter Wave Communications

## Muhammad Sarmad Shahab MIR
Pre-Doc Researcher

**BSc:** Electronics Engineering - National University of Sciences and Technology. Islamabad, Pakistan
**MSc:** Smart Systems Integration - Titulación conjunta de la Universidad Heriot-Watt, UK, USN. Norway, BME. Hungary
**Previous position:** Working Student. Ovesco GmbH. Germany
**Research:** Wireless Sensor Networks; Visible light and Backscatter Communication; Smart Systems

## Oluwasegun OJO
Pre-Doc Researcher

**BSc:** B.Tech in Statistics. Federal University of Technology. Akure. Nigeria
**MSc:** Mathematical Sciences. African Institute for Mathematical Sciences. Limbe. Cameroon
**Previous Position:** Freelance Data Scientist. Upwork
**Research:** Data Science; Data Visualization; Machine Learning; Statistics; Social Networks

## Noelia PÉREZ PALMA
Pre-Doc Researcher

**BSc:** Bachelor in Computer Sciences, University of Murcia (UMU). Murcia. Spain
**Previous Position:** Project manager for network creation and optimization projects at Allocation and Supply, Landline Business, Telefónica Spain. Madrid. Spain
**Research:** Opportunistic Networks; Wireless Networks; D2D Communication

## Leonardo PERONI
Pre-Doc Researcher

**BSc:** Informatic and automatic engineering - Università "La Sapienza" di Roma. Rome, Italy
**MSc:** Mechatronic Engineering - Politecnico di Torino. Turin, Italy
**Previous position:** Technology Consultant. Hesplora. Florence. Italy.
**Research:** Machine learning; Computer Networks; Control theory

## Vittorio PRODOMO
Pre-Doc Researcher

**BSc:** Computer Engineering - University of Naples Federico II. Naples, Italy
**MSc:** Computer Engineering - Networks and Internet - University of Naples Federico II. Naples, Italy
**Research:** Machine Learning for Mobile Networks

### Antonio RUSSO
Pre-Doc Researcher

**BSc:** Computer Science Engineering. Università degli Studi di Napoli Federico II. Naples. Italy
**MSc:** Computer Science Engineering. Università degli Studi di Napoli Federico II. Naples. Italy
**Previous Position:** Teaching Assistant. Cybersecurity Academy (Università di Napoli Federico II). Naples. Italy
**Research:** blockchain; applied cryptography; network security; distributed systems

### Víctor SÁNCHEZ AGÜERO
Pre-Doc Researcher

**BSc:** Audiovisual Systems Engineering. University Carlos III of Madrid. Madrid. Spain
**Previous Position:** Internship Student. University Carlos III of Madrid. Madrid. Spain
**Research:** Internet Measurements; IP Routing; BGP; Data Visualization; Network Architectures; UAV/Drones

### Alessio SCALINGI
Pre-Doc Researcher

**BSc:** Computer Engineering - University of Naples Federico II. Naples, Italy
**MSc:** Computer Engineering - University of Naples Federico II. Naples, Italy
**Previous position:** Data Engineer. Alliance Healthcare
**Research:** Pervasive Wireless Systems; Anomaly Detenction

### Francesco SPINELLI
Pre-Doc Researcher

**BSc:** Cinema and Media Engineering. Politecnico di Torino. Torino. Italy
**MSc:** Communications and Computer Network Engineering. Politecnico di Torino. Torino. Italy
**Previous Position:** R&D Engineer. Telecom ParisTech. Paris. France
**Research:** Multi-Access Edge Computing; AI; NFV

### Lucía UGUINA
Pre-Doc Researcher

**BSc:** Telecommunication Technologies Engineering. University Carlos III of Madrid. Madrid. Spain
**MSc:** Computer Science and Mathematics. Universitat Rovira i Vigili / Universitat Oberta de Catalunya. Tarragona. Spain
**Previous Position:** Junior Assistant. Management Solutions. Madrid. Spain
**Research:** Learning Analytics; Data Mining; Real-Time Data

### Pelayo VALLINA-RODRIGUEZ
Pre-Doc Researcher

**BSc:** Computer Science. University Carlos III of Madrid. Madrid. Spain
**MSc:** Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
**Previous Position:** Fellow Student. NETCOM Research Group. University Carlos III of Madrid. Madrid. Spain
**Research:** Social Computing Systems; Online Advertising; User Privacy

# external PhD students

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

**Amr AbdelKhalek ABDELNABI**
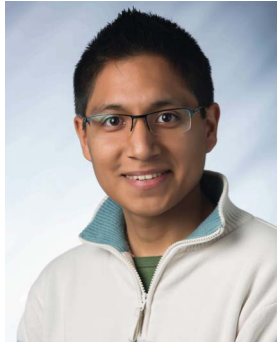External PhD Student

**BSc:** Electronics and Communication Engineering. Cairo University. Cairo. Egypt
**MSc:** Wireless Communication. Nile University. Cairo. Egypt
**Previous Position:** Research Associate. Texas A&M University (TAMUQ). Doha. Qatar
**Research:** Opportunistic Communication; Stochastic Geometry Application to Wireless networks; Cellular Networks; Wireless PHY and MAC Layers; D2D Communication; Cooperative Communication; Wireless Channel Modeling; Interference Modeling
**Personal site:** https://networks.imdea.org/team/imdea-networks-team/people/amr-abdelkhalek-abdelnabi/

**Luis F. CHIROQUE**
External PhD Student

**BSc:** Telematics Engineering. Polytechnic University of Madrid. Madrid. Spain
**MsC:** Mathematical Engineering. University Carlos III of Madrid. Spain
**Research:** Graph Theory; Network Science; Machine Learning; Big Data; Data Mining
**Personal site:** https://networks.imdea.org/team/imdea-networks-team/people/luis-f-chiroque/

**Vitalii DEMIANIUK**
External PhD Student

**BSc:** Applied Mathematics and Computer Science. National Research University of Informational Technologies, Mechanics and Optics. Russia
**MsC:** Applied Mathematics and Computer Science. National Research University of Informational Technologies, Mechanics and Optics. Russia
**Research:** Packet Classification; Software Defined Networks; Network Function Virtualization; Algorithms and Data Structures; Combinatorial Optimization
**Personal site:** https://networks.imdea.org/team/imdea-networks-team/people/vitalii-demianiuk/

**Elizaveta DUBROVINSKAYA**
External PhD Student

**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; Signal Processing
**Personal site:** https://networks.imdea.org/team/imdea-networks-team/people/elizaveta-dubrovinskaya/

**Antonio PASTOR VALLES**
External PhD Student

**MSc:** Telematics Engineering. University Carlos III of Madrid. Madrid. Spain
**Research:** Complex Networks; Machine Learning; Connectomics; Brain-Machine Interfaces
**Personal site:** https://networks.imdea.org/team/imdea-networks-team/people/antonio-pastor/

# research engineering and support

The Research Engineering & Support unit at IMDEA Networks is dedicated to supporting the continued growth in our research capacity and maximizing the impact of our research output by providing specific technical and professional expertise and assistance to ongoing research endeavors in a variety of ways. Research Engineering & Support personnel work either at the level of the entire Institute, or closely with researchers and their groups. There are roles with an engineering background that take care of the design, installation and maintenance of the IT infrastructure. Other roles may, for instance, provide administrative or operational support to project or lab management.

Typical jobs include systems administration, research (software and/or hardware) engineering, project or research administrator and laboratory technician. These positions are similar to their industry equivalents. They enable our employees to work on cutting-edge research problems and technology in a stimulating and innovative environment.

**Ángel ACOSTA**
Systems Administrator

**BSc:** Computer Engineering. José Antonio Páez University. Venezuela
**MSc:** Informatics Engineering. University Carlos III of Madrid. Spain

**Alejandro AMARO**
Junior Software Developer

**BSc:** Computer Engineering. Specialization: Computing. Universidad Carlos III de Madrid. Madrid. Spain

**Ignacio BERBERANA**
Senior Research Engineer

**MSc:** Mining Engineer. School of Mining Engineering. Polytechnic University of Madrid. Madrid. Spain
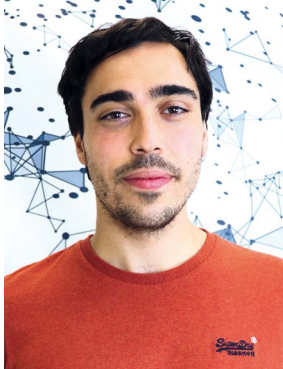**Research:** 5G; Radio Communications; RAN Virtualization

**Elvira CONTI**
Project Administrator

**BSc:** International Relationships. Rey Juan Carlos University. Madrid. Spain

**Fernando DÍEZ**
Research Engineer

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

**Marta DORADO**
Junior Science Communicator

**BSc:** Dual Bachelor's degree in Journalism and Audiovisual Communication. University Carlos III of Madrid (UC3M). Madrid. Spain
**MSc:** Journalism and Digital Communication ABC. Complutense University of Madrid (UCM). Madrid. Spain

**Rafael GARCÍA**
Research Engineer

**BSc:** Computer Science. University of Córdoba. Spain
**MSc:** Computational Sciences. University of Amsterdam. The Netherlands
**Research:** Machine learning; Data science; Dig data; Artificial intelligence.

**Dr. Amanda GARCÍA-GARCÍA**
Research Engineer

**BSc:** Telecommunications Engineering. Polytechnic University of Madrid. Madrid. Spain
**MSc:** Communications Technologies and Systems. Polytechnic University of Madrid. Madrid. Spain
**PhD:** Communications Technologies and Systems. Polytechnic University of Madrid. Madrid. Spain
**Research:** RF Engineering; Millimeter-Wave Communications; High Frequency Antenna Design; Device Fabrication

**Neftalí GONZÁLEZ**
Systems Administrator

**BSc:** IT Systems Engineer. Universidad Rey Juan Carlos. Móstoles. Spain

**Susana HERNÁNDEZ**
Project Administrator

**BSc:** Biology (Specialization: Biotechnology) - EQF Level 7 Certificate (Master). Complutense University of Madrid. Madrid. Spain
**MSc:** Food Science and Technology - EQF Level 7 Certificate. Complutense University of Madrid. Madrid. Spain

**Manuel HERRERA**
Software Developer

**BSc:** Higher Degree in Cross-Platform Application Development. IES Zaidín Vergeles. Granada. Spain

**Francisco Javier HERVÁS**
Project Administrator

**BSc:** Business Administration. Universidad Autónoma de Madrid. Spain
**MSc:** Management of Human Resources. Universidad Autónoma de Madrid. Spain

**Anna IANNARELLA**
Program Manager

**BSc:** Electrical Engineering. Simón Bolívar University. Caracas. Venezuela
**MSc:** Corporate Finance Specialist. Simón Bolívar University. Caracas. Venezuela

**Manuel Ángel JIMÉNEZ**
Research Engineer

**BSc:** Telecommunications Engineering. Universidad de Sevilla. Spain

**Dr. Jesús Omar LACRUZ**
Research Engineer

**BSc:** Electrical Engineering. University of the Andes. Mérida. Venezuela
**MSc:** Electronic System Engineering. Polytechnic University of Valencia. Valencia. Spain
**PhD:** Electronic Engineering. Polytechnic University of Valencia. Valencia. Spain
**Research:** mm-Wave; FPGA design; Signal Processing; Digital Communications

**Mohamed Lamine MOULAY**
Research Engineer

**BSc:** Communication and Electronics Engineering. Applied Science University. Amman. Jordan
**MSc:** Multimedia and Communications. University Carlos III of Madrid. Madrid. Spain
**Research:** AMC; Wireless Communications; Docker: Python; Linux

**Ricardo PADRINO**
Research Engineer

**BSc:** Electronic Engineering. Universidad Complutense de Madrid. Madrid. Spain; Physics (3-years). Universidad Complutense de Madrid
**Research:** Deep Learning; Computer Vision; Automatic Algorithms; Autonomous Robot-Vehicles; Electronic Design

**Rafael RUIZ**
Systems Administrator

**BSc:** Industrial Electronics and Automation Engineering. Universidad Politécnica de Cartagena. Spain
**MSc:** (Finishing the Master's Degree) Industrial Electronics. Universidad Politécnica de Madrid. Madrid. Spain

**Rubén RUPÉREZ**
R&D laboratory technician

**BSc:** Industrial Technology Engineering. University Carlos III of Madrid. Madrid. Spain
**MSc:** Industrial Engineering. University Carlos III of Madrid. Madrid. Spain
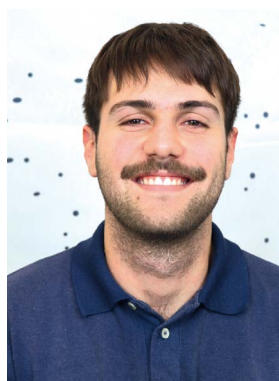
# internship students

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 a special consideration for future positions on our PhD Student team.

We also have a program in place for Visiting PhD Students from partner universities or research organizations to undertake an internship at IMDEA Networks under the direction of one of our faculty members. This program enables them to develop new skills and gain expertise in an enriching new environment.

**Giuseppe AVINO**
**University of origin:** Politecnico de Torino (Torino, Italy)

**Paula ENCINAR**
**University of origin:** Universidad Carlos III de Madrid (Madrid, Spain)

**Alejandro RODRÍGUEZ**
**University of origin:** Universidad Carlos III de Madrid (Madrid, Spain)

**Candela CARRILLO**
**University of origin:** Universidad Carlos III de Madrid (Madrid, Spain)

**David Kaspar HAGEMAN**
**University of origin:** Aalborg University (Denmark)

**Francisco Javier SACIDO**
**University of origin:** Universidad Carlos III de Madrid (Madrid, Spain)

**Irene DE GRUIJTER**
**University of origin:** Universidad Carlos III de Madrid (Madrid, Spain)

**Baalázs NÉMETH**
**University of origin:** University of Technology and Economics (Budapest, Hungary)

# administrative unit

**Ramón GIRONA**
General Manager

**Qualifications:** BSc: Computer Science. Universidad de las Palmas de Gran Canaria (ULPGC). Canary Islands. Spain; Industrial Engineering. Universidad Politécnica de Canarias (UPC). Canary Islands. Spain; MBA: Instituto Universitario de Empresa. Madrid. Spain

**Rebeca DE MIGUEL**
Senior Operations Manager

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

**Brian DUNNE**
Senior Human Resources Manager

**Qualifications:** BBS in Business Studies and French. Trinity College Dublin. Ireland

**Ana GONZÁLEZ**
Senior Projects & Funding Manager

**Qualifications:** BA (Hons) "Modern European Studies". University of West London. UK; Postgraduate Diploma in "European Studies". University of West London. UK

*Admin and research support team*

**Pilar SÁEZ**
HR Project Administrator

**Qualifications:** Labour Relations. Complutense University of Madrid. Madrid. Spain; Postgraduate Diploma in "Executive Compensation and Benefits". Centro de Estudios Garrigues. Madrid. Spain

# alumni network

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

The members of the alumni network appear listed here following the most recent graduation date up to the end of 2020.

**Dr. Joan PALACIOS**
**Current Position:** Post-Doc Researcher. The University of Texas at Austin. Austin. Texas. USA
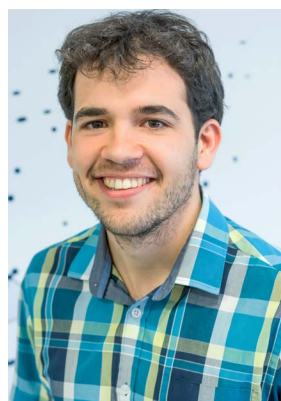**Ph.D. Date:** 23 October 2020

**Dr. Patricia CALLEJO**
**Current Position:** Postdoctoral fellow. UC3M-Santander Big Data Institute (IBiDat). Madrid. Spain
**Ph.D. Date:** 8 September 2020

**Dr. Edgar ARRIBAS**
**Current Position:** Profesor Doctor. Applied Mathematics and Statistics- CEU San Pablo University. Madrid. Spain
**Ph.D. Date:** 29 July 2020

**Dr. Maurizio REA**
**Current Position:** Post-Doc Researcher. IMDEA Networks Institute. Madrid. Spain
**Ph.D. Date:** 12 June 2020

**Dr. Ander GALISTEO**
**Current Position:** Senior Firmware Engineer. Dojo Five: The Embedded Experts. St. Paul, Minnesota. USA
**Ph.D. Date:** 3 June 2020

**Dr. Dario BEGA**
**Current Position:** Core Network Research Specialist. Nokia Bell Labs. Munich. Germany
**Ph.D. Date:** 17 April 2020

**Dr. Yonas Mitike KASSA**
**Current Position:** Research Scientist. Eurecat. Spain
**Ph.D. Date:** 14 February 2020

**Dr. Pavel CHUPRIKOV**
**Current Position:** Post-Doc Researcher. Universita della Svizzera Italiana. Lugano. Switzerland
**Ph.D. Date:** 14 November 2019

**Dr. Carlos DONATO**
**Current Position:** Project Manager. Zhilabs. A Samsung Company. Madrid. Spain
**Ph.D. Date:** 7 November 2019

**Dr. Guillermo BIELSA**
**Current Position:** Specialized Client Engineering- Connectivity and Networks. Telefónica España. Madrid. Spain
**Ph.D. Date:** 26 July 2019

**Dr. Hany ASSASA**
**Current Position:** System Engineer. Pharrowtech. Leuven. Belgium
**Ph.D. Date:** 23 July 2019

**Dr. Roberto CALVO-PALOMINO**
**Current Position:** Associate Professor. Department of Signal Theory and Communications, Telematics and Computing. Universidad Rey Juan Carlos. Madrid. Spain
**Ph.D. Date:** 10 July 2019

**Dr. Foivos MICHELINAKIS**
**Current Position:** Postdoctoral Fellow. Simula Metropolitan Center for Digital Engineering (SimulaMet). Oslo. Norway
**Ph.D. Date:** 19 September 2018

**Dr. Aymen FAKHREDDINE**
**Current Position:** Senior Researcher. Institute of Networked and Embedded Systems, Alpen-Adria-Universität. Klagenfurt. Austria
**Ph.D. Date:** 14 June 2018

**Dr. Roderick FANOU**
**Current Position:** Post Doc. San Diego SuperComputer Center (SDSC). Center for Applied Internet Data Analysis (CAIDA)/University of California San Diego (UCSD). San Diego. USA
**Ph.D. Date:** 14 December 2017

**Dr. Christian VITALE**
**Current Position:** Research Associate. KIOS Research and Innovation Centre of Excellence (KIOS CoE). Nicosia. Cyprus
**Ph.D. Date:** 9 June 2017

**Dr. José A. RUIPÉREZ-VALIENTE**
**Current Position:** Juan de la Cierva Researcher. Department of Information and Communications Engineering. Universidad de Murcia. Murcia. Spain
**Ph.D. Date:** 31 May 2017

**Dr. Evgenia CHRISTOFOROU**
**Current Position:** Research Associate (Transparency in Algorithms Group) at the CYENS-Centre of Excellence, Nicosia, Cyprus
**Ph.D. Date:** 25 May 2017

**Dr. Nicola BUI**
**Current Position:** Senior Research Engineer. Bastille. Boston. Massachusetts. USA
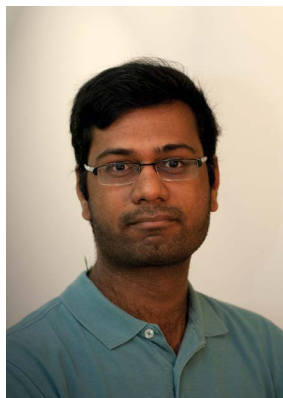**Ph.D. Date:** 12 May 2017

**Dr. Angelos CHATZIPAPAS**
**Current Position:** Lead Software Engineer. Lloyds Banking Group. London. United Kingdom
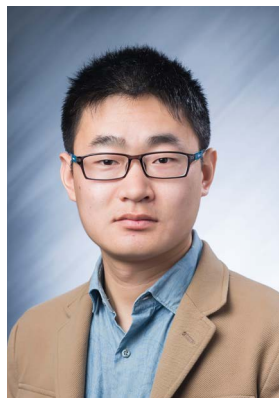**Ph.D. Date:** 25 November 2016

**Dr. Elli ZAVOU**
**Current Position:** Software Developer. StratioBD. Madrid. Spain
**Ph.D. Date:** 30 September 2016

**Dr. Syed Anwar UL HASAN**
**Current Position:** Product developer/Co-founder. PriceFlier. Hyderabad. Telangana. India
**Ph.D. Date:** 20 June 2016

**Dr. Qing WANG**
**Current Position:** Assistant Professor. Delft University of Technology - TU Delft. Delft. The Netherlands
**Ph.D. Date:** 19 May 2016

**Dr. Juan Camilo CARDONA**
**Current Position:** Software Engineer. Cisco Systems. Barcelona. Spain
**Ph.D. Date:** 6 May 2016

**Dr. Pablo SALVADOR**
**Current Position:** Scrum Master. Paradigma Digital. Madrid. Spain
**Ph.D. Date:** 8 April 2016

**Dr. Gek Hong SIM**
**Current Position:** Post-doc Researcher. TU Darmstadt. Germany
**Ph.D. Date:** 30 March 2016

**Dr. M. Isabel SANCHEZ**
**Current Position:** Postdoctoral Fellow. Simula Research Laboratory. Oslo. Norway
**Ph.D. Date:** 8 March 2016

**Dr. Arash ASADI**
**Current Position:** Research Group leader & Athene Young Investigator. Secure Mobile Networking Lab (SEEMOO). Technische Universität Darmstadt. Germany
**Ph.D. Date:** 8 March 2016

**Dr. Vincenzo SCIANCALEPORE**
**Current Position:** Research Scientist. NEC Laboratories Europe. Heidelberg. Germany
**Ph.D. Date:** 27 November 2015



**Dr. Thomas NITSCHE**
**Current Position:** Wissenschaftlicher Mitarbeiter/Research Fellow. Fraunhofer Institute for Embedded Systems and Communication Technologies ESK. Munich. Germany
**Ph.D. Date:** 25 September 2015



**Dr. Ignacio CASTRO**
**Current Position:** Post-doctoral Research Assistant. Queen Mary University of London. UK
**Ph.D. Date:** 20 July 2015



**Dr. Fabio GIUST**
**Current Position:** Senior System Architect. Athonet. Vicenza. Italy
**Ph.D. Date:** 5 March 2015



**Dr. Jordi ARJONA AROCA**
**Current Position:** Research line coordinator. Instituto Tecnológico de Informática (ITI). Valencia. Spain
**Ph.D. Date:** 13 February 2015



**Dr. Andra LUTU**
**Current Position:** Researcher. Telefonica Research and Development. Barcelona. Spain
**Ph.D. Date:** 11 November 2014



**Dr. Agustín SANTOS**
**Current Position:** Public Officer. Spanish Public Administration. Madrid. Spain
**Ph.D. Date:** 3 June 2013



**Dr. Michal KRYCZKA**
**Current Position:** Manager. Accenture. Warsaw. Poland
**Ph.D. Date:** 7 February 2013

**Dr. Marco GRAMAGLIA**
**Current Position:** Post-Doc Researcher. Universidad Carlos III de Madrid. Madrid. Spain
**Ph.D. Date:** 26 September 2012

**Dr. Alex BIKFALVI**
**Current Position:** Software Engineer. Adevinta. Barcelona. Spain
**Ph.D. Date:** 18 July 2012

**Dr. Paul PATRAS**
**Current Position:** Reader and Chancellor's Fellow. School of Informatics. University of Edinburgh. United Kingdom
**Ph.D. Date:** 18 March 2011

**Learning never exhausts the mind**

*Leonardo da Vinci*

## networked systems&algorithms

**Research Director**
· Dr. Arturo Azcorra

**Researcher Professors**
· Dr. Sergey Gorinksy
· Dr. Jaya Prakash Varma Champati

**Pre-Doc & Post-Doc Researchers**
· Patricia Callejo
· Laura Caruso
· Vitalii Demianiuk
· Amir Mehrjoo
· Nuria Molner
· Leonardo Peroni
· Víctor Sánchez Agüero
· Lucía Uguina

## wireless networking

**Research Director**
· Dr. Joerg Widmer

**Researcher Professors**
· Dr. Suman Banerjee
· Dr. Marco Fiore
· Dr. Domenico Giustiniano
· Dr. Marco Ajmone-Marsan

**Pre-Doc & Post-Doc Researchers**
· Dr. Hany Assasa
· Dr. Roberto Calvo-Palomino
· Dr. Claudio Fiandrino
· Dr. Amanda García
· Dr. Borja Genovés Guzmán
· Dr. Jesús Omar Lacruz
· Dr. Maurizio Rea
· Dr. Giuseppe Santaromita
· Sergi Alcalá-Marín
· Giulia Attanasio
· Alejandro Blanco
· Alan Collet
· Elizaveta Dubrovinskaya
· Stavros Eleftherakis
· Dayrene Frómeta
· Ander Galisteo
· Dolores García
· Nina Grosheva
· Pablo Jiménez Mateo
· Yago Lizarribar
· Leonardo Lo Schiavo
· Orlando E. Martínez-Durive
· Muhammad Sarmad Shahab Mir
· Sachit Mishra
· Adriana Moreno
· Joan Palacios
· Rafael Ruiz
· Alessio Scalingi

## network measurements&analytics

**Research Director**
· Dr. Albert Banchs

**Researcher Professors**
· Dr. Antonio Fernández Anta
· Dr. Nikolaos Laoutaris
· Dr. Vincenzo Mancuso
· Dr. Guillermo Suárez-Tangil
· Dr. Narseo Vallina-Rodríguez

**Pre-Doc & Post-Doc Researchers**
· Dr. Elisa Cabana
· Dr. Álvaro García-Recuero
· Dr. Marius Paraschiv
· Amr Abdelnabi
· Santiago Andrés
· Edgar Arribas
· Constantine Ayimba
· Tianyue Chu
· Alan Collet
· Dario Bega
· Álvaro Feal
· Julien Gamba
· Rafael García
· Aniketh Girish
· Devriş Işler
· Oluwasegun Ojo
· Noelia Pérez Palma
· Francesco Spinelli
· Ricardo Padrino
· Vittorio Prodomo
· Antonio Russo
· Pelayo Vallina-Rodríguez

*Our current team*