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annual report 2011

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foreword

Albert Banchs
Deputy Director of Institute IMDEA Networks
May 2012

Over the last decade, the Internet has had a profound impact on people's lives. The way manufacturers produce and supply their goods, how public administrations operate, how professionals work and, in general, how individuals and society at large communicate, has drastically changed with the wide-spread adoption of the Internet. Far from stabilizing, the Internet socio-economic phenomenon continues to transform our everyday life at an amazing pace. The recent proliferation of mobile handheld devices with flat-rate data plans has revolutionized information access, making the notion of network access *everywhere* and *anytime* a reality. At the same time, the popularity of social networks has altered human interaction to an immeasurable degree. In the near future, we will see other equally significant developments, such as the proliferation of Internet technologies on TV sets and the widespread deployment of the Internet of things.

The continuous evolution of the Internet offers a plethora of new business opportunities. Currently, one of the most attractive emerging trends is the exploitation of social data. The widespread usage of social networks is generating a vast amount of information about user preferences, tastes, habits, etc., which amounts to an unprecedented record of knowledge that can be exploited and utilized for many different purposes, such as for instance to better tailor products and services to customers' needs. One of our research lines is precisely focused on the development of the technology required to gather, process and analyze this increasingly rich data.

Over the past years, Institute IMDEA Networks has succeeded in putting together a team of top scientists that has left its mark on the European research landscape and is contributing to boost Madrid's competitiveness as a technology-oriented region. 2011 has further consolidated the Institute as one of the leading networking research laboratories in Europe. This year has been a great success on many fronts, including the quality and international recognition of the publications authored by our researchers, the attraction of new research projects and grants, and the effective transfer of the technology produced by the Institute, amongst others.

From all of our achievements in 2011, one that I would like to particularly highlight is the new collaborations initiated with Madrid-based companies, which add to our existing network of local partnerships. These collaborations help the companies in our region to enhance their high-tech output with cutting edge research findings. We believe that it is precisely by focusing on the development and manufacture of products and services incorporating the most advanced technology known, and increasing their competitiveness thus, that Spain may efficiently combat the current economic crisis and make its mark on the 21st Century.

My gratitude goes to the Regional Government of Madrid for its continuous support, as well as to all those who are contributing to transform this exciting project into a daily reality of commendable achievement.

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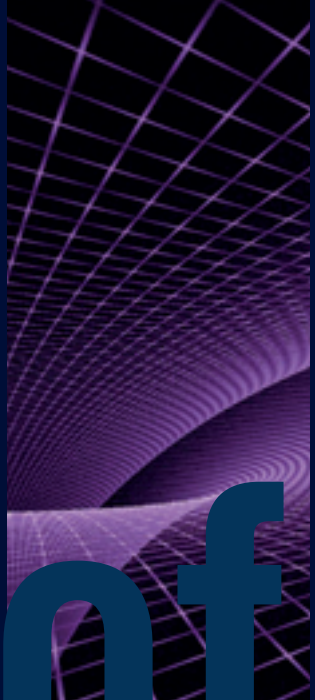

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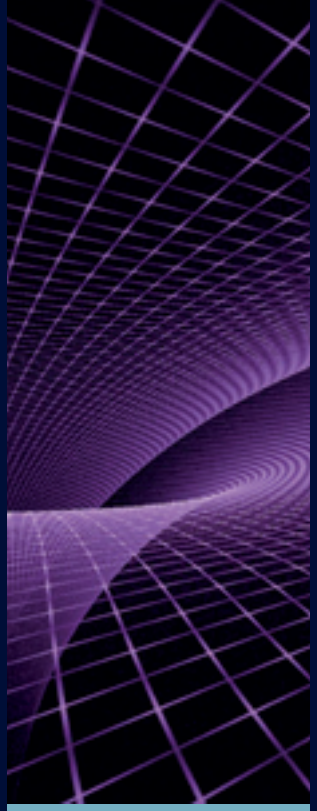
executive summary



This year has further consolidated Institute IMDEA Networks as a pre-eminent internationally-recognized research Institute, achieving excellence in the development of the science of networks. *2011 has been a great year in a number of ways. Our strategy to transfer scientific and technological developments and knowledge to industry and, ultimately, society, has led to various new collaborations with industrial partners to create products and services, in addition to strengthening the existing ones. We have also been very successful in several highly competitive public calls to secure funding to conduct new research projects. Through our extremely selective recruitment process we were able to attract outstanding scientists to strengthen our research team. Our research work - focused on innovative technological solutions to real-world problems - has been published in the most prestigious venues within our field. All these achievements have received the recognition of the scientific community as well as our stakeholders.*

The research team of IMDEA Networks consists of **top technical leaders**. All IMDEA Networks researchers hold an **outstanding research record** that includes publications in the most prestigious venues in the field, and many of them have received important awards and prizes for their research work and achievements. In addition, our scientists possess significant **industry experience**. Besides graduating from, or having worked for, top-level international universities (such as Columbia University, Politecnico di Torino, MIT, UT Austin, UC Berkeley, EPFL or Rice University,) our researchers also have an extensive industry background, having been employed in leading industry research laboratories (such as NEC, Telefonica, AT&T, Alcatel, Philips, NTT Docomo or Telecom Italia). What is more, they have been granted over 40 patents during their professional careers. This background is essential to carry out **research that can be transferred to companies** and in turn be transformed into profitable products that will **stimulate economic growth and job creation**.

During 2011 **we have further strengthened our research team**. We had one opening for a researcher position, which received 171 high quality applications from 41 different countries. The position was awarded to a top researcher that has brought in valuable skills and business collaborations. We also received a large number of applications (over 200) for our research assistant positions, out of which 10 outstanding candidates were selected. This highly selective process guarantees that we are attracting first rate scientists to the Institute. With the new incorporations, the IMDEA Networks team is currently composed of **46 researchers from 20 different countries at all levels of their research careers**.

A key accomplishment of 2011 has been our participation in **research projects**. These projects bring external funding, highly productive collaborations with top research institutions and industrial partners, and the opportunity to transform our research ideas into practical deployments. IMDEA Networks is **currently working on 9** projects, which is a notable quantity considering the size of the Institute. Out of these 9 projects, 4 are

European, 1 is funded by the National Science Foundation of China, 2 are national projects and 2 have a regional scope.

IMDEA Networks has also been particularly successful in securing **new** projects. During 2011, we prepared the proposals for the **European projects CROWD, iJOIN and eCOUSIN**, which have subsequently been awarded by the European Commission in a very competitive call in which only 36 out of 195 proposals were granted funding. In that call, CROWD ranked 4th out of the 195 proposals, iJOIN ranked 6th, and eCOUSIN ranked 25th. The Institute was also efficacious at a national level, being awarded the project E2NET, which starts in 2012. It is worthwhile highlighting that **IMDEA Networks is the coordinator of iJOIN**. This is the first time that a Research and Technological Development (RTD) European project is coordinated by an IMDEA institute. The coordination of a European project yields many benefits and advantages, including a substantial level of visibility as well as the participation in project clusters and other relevant R&D initiatives. It also represents an important recognition from the European Commission as well as from other key socio-economic players and decision-makers.

In addition to research projects funded by public institutions, a substantial part of the external funding attracted by IMDEA Networks originates from **direct collaborations with industry**. While IMDEA Networks has strong ties with the international private sector, collaboration with local companies is at least as crucial (if not more) due to the value that it brings to the Madrid region. One prominent example of such local alliances is the contract with **Albentia Systems**, which has led to an improvement in the performance of their **WiMAX products** by incorporating our research results. Another contract with a local company is the one recently signed with **ZED**. This contract focuses on **exploiting the data generated by social networks**, which we believe represents a decidedly attractive business opportunity.

The efforts made by our team to produce outstanding scientific work led to a large number of publications in 2011. However, rather than the quantity, we would like to emphasize the **quality of our publications**. We are very proud to be the only Spanish institution - and one of a privileged few European organizations - to have published during this year at **ACM SIGCOMM, IEEE INFOCOM and ACM CoNEXT**, which are the three most prestigious conferences in our field. In addition, two of our publications received **Best Paper Awards**: one at the reputed International Teletraffic Congress and the other at the Mobiworld Workshop, co-located with INFOCOM. We believe that these achievements position us - nationally as well as internationally - **at the forefront of the development of the science of networks**.

Beyond the publication of research articles, a fundamental objective of our research is to have **real-world impact**. Such impact can take various forms, such as standardization, patent licensing or knowledge transfer of scientific and technological results with the

objective of further development and exploitation in commercial products. Research performed at IMDEA Networks during 2011 has attained impact to a sizable degree. Our researchers have been particularly active in **standardization**, bringing their ideas to the **IETF** (which is the body responsible for standardizing the Internet architecture) and the **IEEE** (the world's largest professional organization for the advancement of technology and a leading developer of industry standards). These contributions have led to fruitful cooperation with companies interested in our **efforts to bridge the gap between theoretic results and practical implementation, deployment and commercialization**.

Last, but not least, another major activity over the past year concerned the **extension of our networking laboratory**. Networking science requires the rigorous validation of new algorithms and protocols. The **infrastructure for experimentation** provided by fully equipped laboratories is an essential working tool. In 2011, the Institute signed a collaboration agreement with the Spanish Ministry of Science and Innovation (now the Ministry of Economy and Competitiveness) to acquire specialized equipment for our wireless networking laboratory, indispensable to conduct research in this area.

In **summary**, the Institute's **research output in 2011** comprises of publications in peer-reviewed international journals (29), presentations in international conferences (42), research projects (9), industry contracts (3), patents (1) and standardization contributions (15). We believe that these figures show the excellence of the Institute in research and technology transfer, and provide the basis to achieve ever growing success in 2012 and beyond.

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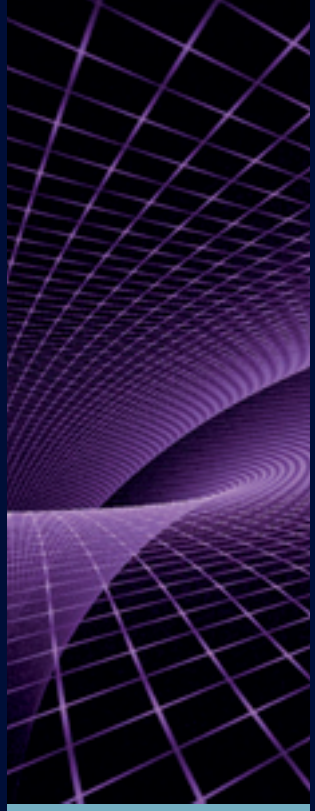
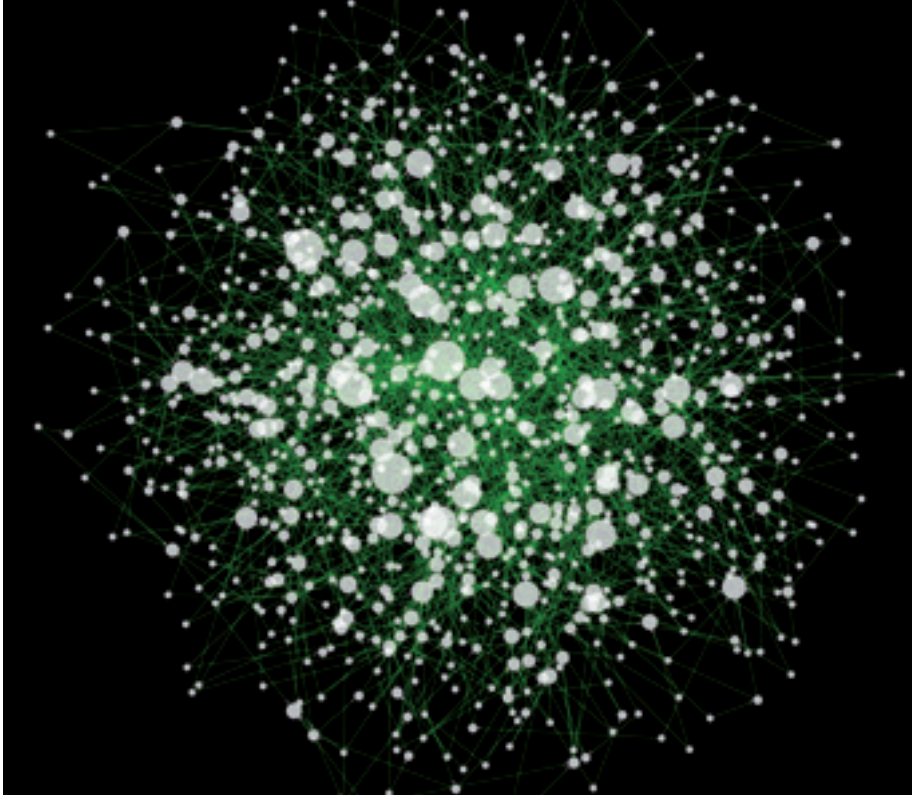
about us





2.1. Profile

IMDEA Networks is an international research organization whose multicultural team is engaged in cutting-edge science in all areas of networking. As a growing, English-speaking institute located in Madrid, Spain, IMDEA Networks offers a unique opportunity for pioneering scientists to develop their ideas. Our researchers will contribute to shaping the future of networking over the coming years.

Institute IMDEA Networks is part of the Madrid Institute for Advanced Studies (IMDEA*) initiative. IMDEA is an institutional framework promoted by the Regional Government of Madrid.

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

* The Spanish acronym for *Instituto Madrileño de Estudios Avanzados.*

- Attract and retain human capital of excellence with the aim to internationalize research within the Madrid Region
- Collaborate with Madrid's industrial sector, research centers and educational institutions

2.3. Our Mission

Our mission is to create value by leading research in protocol, algorithm and systems development that enable the Future Internet. We do this by conducting research and developing innovative and useful scientific and technical advances in the above areas, while actively promoting their successful transfer to market.

The Institute strives to provide the best working conditions and the most attractive and best-equipped environment in which researchers can focus on this process of innovation and scientific advance.

2.4. Our Values

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

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

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

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

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

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

- To respect individual brilliance
  We respect, honor and reward exceptional individual contributions when they are in the service of shared goals

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

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

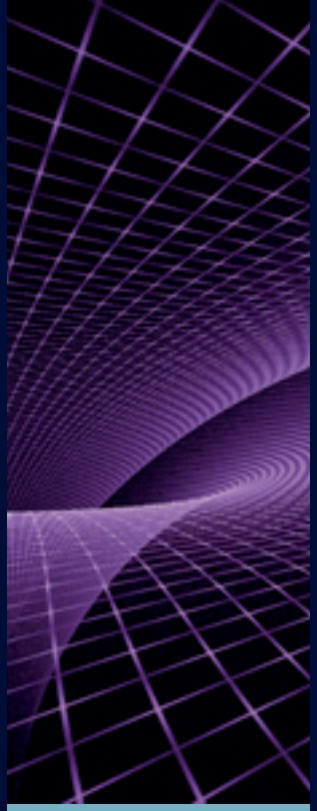
- To compete sportingly across the globe
  We compete fairly but intensely, according to the letter and spirit of accepted standards. Competition drives us to be the best and most successful in our field

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

2.5. Our Credo

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

3 research areas



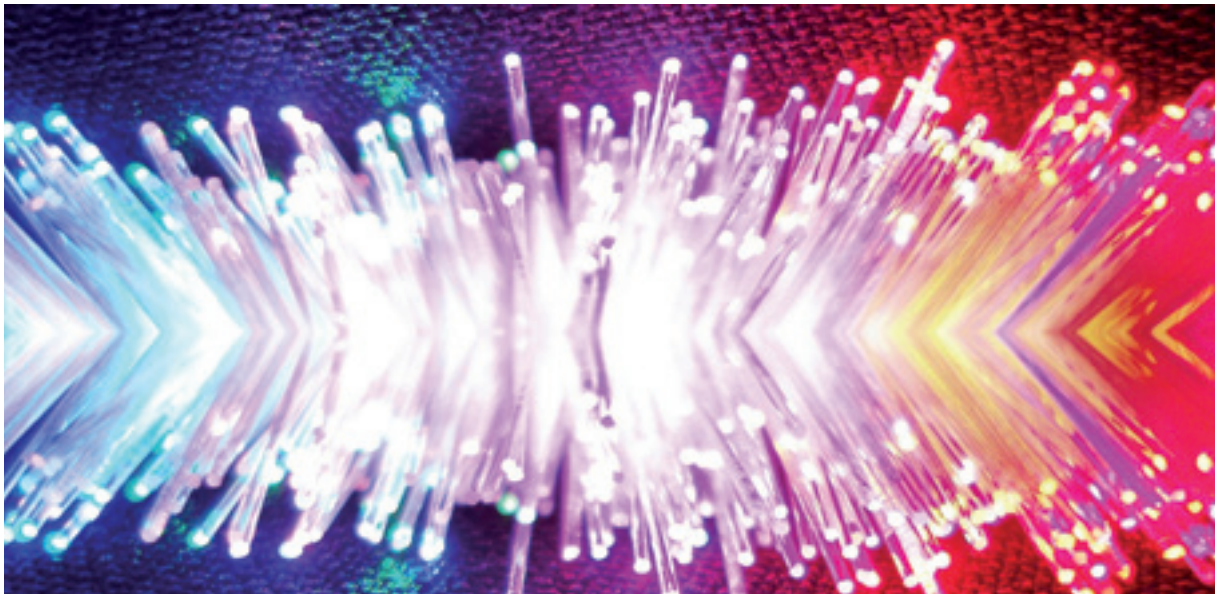
As illustrated by **our motto – *Developing the Science of Networks*** - Institute IMDEA Networks identifies and addresses major scientific and engineering challenges in communications and computer networks, and also aims to develop these results by bringing them into practical deployments. The nature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

network protocols&algorithms

3.1. Network Protocols and Algorithms

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

Our research takes a multi-disciplinary approach to the design and understanding of network protocols and architectures. We go beyond technological constraints and account also for social and economic factors. For example, our research on Internet routing and forwarding accounts for the multitude of Internet service providers (ISPs) and their individual economic interests. In working on either centralized or decentralized solutions to problems, we assume that perfect information is never available. To deal with such uncertainty, as well as selfishness of individual entities, our analysis adopts game-theoretic



techniques. Our protocol design assumes that behaviour 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.

In 2011, a significant portion of our research efforts targeted economic innovation in the Internet. We developed CIPT (Cooperative IP Transit), a new paradigm for reducing transit costs of ISPs. To strengthen the Internet connectivity between diverse ISPs, we proposed T4P (Transit for Peering), a new type of hybrid bilateral ISP relationships that continues the Internet trend towards more flexible interconnections at lower costs.

We also developed an algorithm for detecting the top-tier transit providers. Combining economic and technological perspectives, our researchers examined whether prefix deaggregation can financially benefit the deaggregating ISP in scenarios where the deaggregator is the prefix owner or intermediary. Studying more than a decade of historical records, we analyzed the evolution of an IXP (Internet eXchange Point). We also examined correlations between weather conditions and Internet usage. More on the technical side, our researchers conducted studies of Internet differentiated services, router buffer sizing, coexistence of loss-based and delay-based congestion controls, energy consumption at Internet edges, network migration, fast rerouting, and other improvements in intra-domain and inter-domain routing. The research results have been published at such top venues as ACM SIGCOMM, ACM CoNEXT, IEEE/ACM Transactions on Networking, and IEEE Journal on Selected Areas in Communications. We also disseminated the research results in various communities, including RIPE 63, EURNOG 1, PLNOG 7, as well as the IDR, RTGWG, and GROW working groups of IETF.

This research area targets the following objectives:

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

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

wireless networking

3.2. Wireless Networking

Given the scarcity of wireless spectrum resources and the rising demand for mobile applications, optimizing wireless communication is currently one of the most important and challenging research topics in networking. The proliferation of inexpensive, high-rate mobile devices and ubiquitous connectivity open up a vast spectrum of possible new services but also pose unique challenges concerning wireless interference and the unpredictability of the wireless medium.

Institute IMDEA Networks is involved in a number of different wireless research areas. Part of our efforts aim at improving existing wireless technologies such as IEEE 802.11, WiMAX, and LTE, for example through the design of opportunistic scheduling mechanisms and interference management schemes. We further have an extensive track record in the areas of ad hoc and mesh networks, in particular on routing and MAC layer design. To improve the flexibility and programmability of future wireless technologies, we explore novel programmable interfaces that expose low-level operations to foster network evolution and enable performance optimization and service customization. One of the goals of this work is to implement application specific optimizations, for example, to provide efficient wireless video streaming. Our work on wireless capacity improvements focuses on topics such as intelligent interference management, cooperative coding and network coding, improved medium access control mechanisms that make use of advanced physical layer technologies, etc.

Research efforts in 2011 mainly focused on scheduling and energy efficient wireless networking. In the area of scheduling, researchers developed algorithms and protocols for distributed opportunistic scheduling, opportunistic multicast, and opportunistic scheduling of clusters of nodes. In addition to joint work with the energy-efficient networking

group on sleep modes for base stations and access points, researchers investigated traffic offloading techniques that conserve energy on mobile terminals and the optimization of discontinuous transmission and reception strategies for energy efficient cellular networks. Further research addressed an architecture for modular MAC protocol design, as well as MAC optimizations for VoIP traffic. In addition to the existing WiMAX and IEEE 802.11 testbeds, the research group built up a software-defined radio testbed based on WARP radios and performed first experiments on it.

This research area targets the following objectives:

- Heterogeneous wireless networks
  - We are facing the proliferation of many different wireless technologies
  - Supporting them in the current Internet is highly complex
  - Existing solutions are based on technology specific interfaces
  - The wireless Internet architecture needs to be rethought for efficient support of heterogeneity

- Self organizing wireless networks
  - Scaling and increased heterogeneity require self-organization
  - Solutions needed to track and exploit changing spatial traffic loads
  - Complex dynamics of wireless system and user behavior are involved
  - Significant performance gain and energy savings can be achieved

energy-efficient networking

3.3. Energy-efficient Networking

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

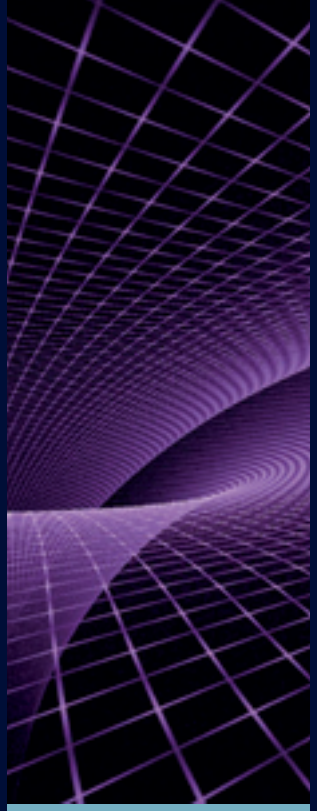
This research area targets the following objectives:

- Design of energy-efficient algorithms and protocols (energy-efficient ICT):
  ICT accounts for a substantial portion of the total energy consumption. We need solutions that reduce consumption without affecting service quality. Novel algorithms that adapt the network infrastructure to the variations of traffic demand over time are required.

- Support for smart energy management (ICT for energy efficiency):
  Communications can help reduce energy consumption in many activities. This poses new requirements on networking solutions. Novel protocols and algorithms for smart energy management are needed.

The work of our researchers this year has been mostly focused in the area of energy-efficient ICT. They have explored energy saving in wireless and wired networks. In particular, they have researched sleep modes for the base stations of cellular access networks, New Generation Networks, and IEEE 802.11-based WLANs. On the other hand, in the wired world, they have studied how to save energy at modems, home gateways, and DSL Access Multiplexers, by switching some of them off. Finally, they have also proposed models to compute energy savings in Energy-Efficient Ethernet.

4 research projects, grants and fellowships



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. These awards confer prestige on the awardee as well as on the organization he is affiliated to.

RAMÓN Y CAJAL GRANTS | "MARIE CURIE" AMAROUT EUROPE PROGRAMME | FPU SCHOLARSHIPS

Ramón y Cajal Grants

(Programa Ramón y Cajal)

Awardees: Dr. Sergey GORINSKY, Senior Researcher

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

«MARIE CURIE» AMAROUT Europe Programme

Awardees: Dr. Pierre FRANCOIS, Staff Researcher
Dr. Sergey GORINSKY, Senior Researcher
Dr. Dariusz KOWALSKI, Visiting Researcher
Dr. Vincenzo MANCUSO, Staff Researcher
Dr. Balaji RENGARAJAN, Staff Researcher
Dr. Gianluca RIZZO, Staff Researcher
Dr. Joerg WIDMER, Senior Researcher

Funded by: European Union. ICT Programme FP7-PEOPLE COFUND

FPU Scholarships

(Becas del Programa de Formación de Profesorado Universitario)

Awardees: Institute IMDEA Networks was granted 4 out of 26 (15%) scholarships awarded nationally to researchers in «Electronic Technology and Communications» in 2008.
Alex BIKFALVI, Research Assistant
Marco GRAMAGLIA, Research Assistant
Michal KRYCZKA, Research Assistant
Paul PATRAS, Research Assistant

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

4.2. Externally-funded research 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.

4.2.1. Ongoing Projects

CLOUDS

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

Institute IMDEA Networks is an Associated Group in this project.

Project website: http://lsd.ls.fi.upm.es/clouds
Funded by: Department of Education and Employment, Regional Government of Madrid (*Consejería de Educación y Empleo, Comunidad de Madrid*)
Duration: January 2010 - December 2013
Project partners: Laboratorio de Sistemas Distribuidos (grupo LSD) at Universidad Politécnica de Madrid, Spain; LADyR (Distributed Algorithms and Networks Laboratory) and Grupo LS (Laboratorio de Sistemas) at Universidad Rey Juan Carlos, Madrid, Spain

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

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

NEC

(Collaboration Agreement for Research & Development with NEC Europe Ltd.)

Funded by: NEC Europe Ltd.
Duration: May 2011 - April 2012

Description: This project focuses on technology enhancements for WiFi-enabled mobile phones centred on research and development in the area of QoS and power saving. Two main activities will be performed: i) design and implementation of a generic power saving module able to emulate different power saving protocols and adapt to variable QoS needs and ii) implementation of an NEC proprietary power saving algorithm based on Wi-Fi Direct. In addition, research in this area is expected to lead to joint patent applications and publications.

The project will consist of the following tasks:

1. Design and implementation of a generic power saving module able to emulate different power saving protocols and adapt to variable QoS needs. The design should identify the different components of available Wi-Fi power saving algorithms and design software architecture able to emulate the different protocols and variations of them by simply combining in different manners the identified components.
2. Implementation of an NEC proprietary power saving algorithm based on Wi-Fi Direct. The implementation will be based on Linux/Android open source drivers, as specified by NEC. A non binding example of the required implementation is:
   - Platform: ath9k open source driver for Linux
   - Protocol: Notice of Absence (NoA) Protocol defined in Wi-Fi Direct.
   - Algorithm: NEC power saving algorithm.

3. Research in the area of Wi-Fi QoS and power saving with special focus on Wi-Fi smartphones.

EINS

(Network of Excellence in Internet Science)

Project website: www.internet-science.eu/
Funded by: European Union. ICT Programme FP7
Duration: December 2011 – May 2015
Project partners: Alcatel-Lucent Bell Labs, USA, Alma Mater Studiorum, Universita di Bologna, Centre for Research and Technology Hellas, Consiglio Nazionale delle Ricerche (CNR), École Polytechnique Fédérale de Lausanne (EPFL), Eidgenössische Technische

Hochschule Zürich, Institute IMDEA Networks, Chinese Academy of Sciences, Korea Advanced Institute of Science and Technology, London School of Economics and Political Science (LSE), National and Kapodistrian University of Athens, National ICT Australia (NICTA), Oxford Internet Institute, University of Oxford, Politecnico di Torino (Nexa Center), Royal Netherland Academy for Arts and Science, Sigma Orionis, Stockholms Universitet, Technicolor R&D, Paris, Technische Universität München, Technische Universiteit Delft, Universidad Autónoma de Madrid (UAM), Universität Passau, Universite De Savoie, Universite Pierre et Marie Curie (UPMC), Universitetet i Oslo, University of Cambridge, University of Essex, University of Lancaster, University of Ljubljana, University of Southampton, University of Warwick, University of Waterloo

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

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

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

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

- Lay the foundations for an Internet Science, based i.a. on Network Science and Web Science, aiming at understanding the impact of the «network effect» on human societies & organizations, as for technological, economic, social & environmental aspects
- Provide concrete incentives for academic institutions and individual researchers to conduct studies across multiple disciplines, in the form of online journals, conferences, workshops, PhD courses, schools, contests, and open calls

FLAVIA

(FLexible Architecture for Virtualizable wireless future Internet Access)

Project website: www.ict-flavia.eu
Funded by: European Union. ICT Programme FP7
Duration: July 2010 – June 2013
Project partners: Consorzio Nazionale Interuniversitario per le Telecommunicazioni, Alvarion, NEC Europe, Telefonica Research, Sequans Communications, MobiMesh s.r.l., Ben Gurion University of the Negev, Institute for Information Transmission Problems of the Russian Academy of Science, Universidad Carlos III de Madrid (UC3M), Hamilton Institute of the National University of Ireland Maynooth

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

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

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

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

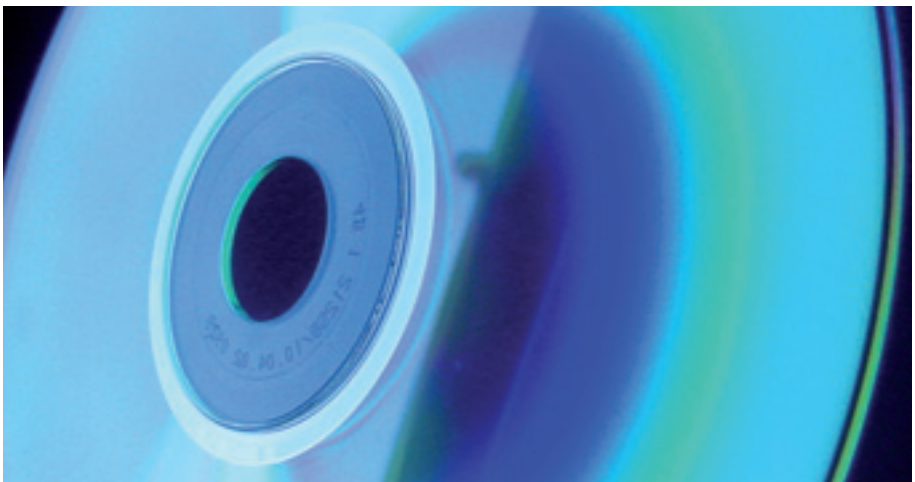
FLAVIA's concept will allow **boosting innovation and reducing the cost of network upgrades**. Operators, manufacturers, network designers, emerging third-party solution developers, and even spontaneous end users, will be able to easily and rapidly optimize and upgrade the wireless network operation,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

Green Network

(Theory and Technique for Reducing Network Energy Consumption)

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

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



MEDIANET

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

Project website: www.medianet-cm.es
Funded by: Department of Education and Employment, Regional Government of Madrid (*Consejería de Educación y Empleo, Comunidad de Madrid*)
Duration: January 2010 - December 2013
Project partners: NETCOM Research Group of Universidad Carlos III de Madrid, DSA Research group of Universidad Complutense de Madrid, GIST Research Group of Universidad de Alcalá de Henares, Institute IMDEA Networks

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

MEDIEVAL

(MultimEDia transport for mobIlE Video AppLications)

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

Project website: www.ict-medieval.eu
Funded by: European Union. ICT Programme FP7
Duration: July 2010 – June 2013
Project partners: ALCATEL – LUCENT BELL Labs France, Telecom Italia S.p.a., Portugal Telecom Inovaçao, Docomo Communications Laboratories Europe, Comsys, Communication & Signal Processing Ltd, LiveU, Instituto de Telecomunicacoes, Universidad Carlos III de Madrid, Consorzio Ferrara Ricerche, Universita Degli Studi di Padova, EURECOM

Description: **Video is a major challenge for the future Internet**. This traffic type is foreseen to account for close to 90 percent of consumer traffic already by 2012. However, the current Internet, and in particular the mobile Internet, was not designed with video require-

ments in mind and, as a consequence, its architecture is very inefficient when handling video traffic. It is the vision of this consortium that, as video is going to represent the majority of the traffic, the future Internet architecture should be tailored to efficiently support the requirements of this traffic type. Specific enhancements for video should be introduced at all layers of the protocol stack where needed, ideally supporting an incremental deployment.

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

The technology developed by the project will be designed taking into account the requirements of network operators for commercial deployment, and will aim at improving the Quality of Experience by users as well as reducing the associated costs for operators. Standardization and early incremental testing are considered key success factors for MEDIEVAL.

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

PASITO

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

Project website: www.rediris.es/proyectos/pasito
Duration: Starting on September 2007 - TBD
Funded by: State Secretariat for Telecommunications and the Information Society (SETSI) of the Spanish Ministry of Industry, Energy and Tourism (MINETUR), previously known as the Spanish Ministry of Industry, Tourism and Trade (MITYC)
Project partners: Red.es/RedIRIS, CESCA (Centro de Supercomputación de Cataluña), CESGA (Centro de Supercomputación de Galicia), CICA (Centro Informático Científico de Andalucía), red académica vasca I2BASK, Universidad del País Vasco (UPV/EHU), Fundación I2CAT, Institute IMDEA Networks, Universidad Autónoma de Madrid (UAM), Universidad Carlos III de Madrid (UC3M), Universidad de Granada (UGR), Universidad de

Murcia (UMU), Universidad Politécnica de Cataluña (UPC), Universidad Politécnica de Madrid (UPM), Universidad Politécnica de Valencia (UPV),Universidad de Vigo (UVIGO)

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

The laboratory contributes to:

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

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

The platform's main research areas are:

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

SOCAM

(Sistema Operativo de Código Abierto Multi-dispositivo – Multi-Device Open Source Operating System)

Funded by: Spanish Ministry of Industry, Energy and Tourism (MINETUR), previously known as the Spanish Ministry of Industry, Tourism and Trade (MITYC) - AVANZA program
Duration: 1 October 2011 – 31 September 2013
Project partners: ZED Worldwide, S.A, Factory Holding Company 25, Institute IMDEA Networks

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

TREND

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

Institute IMDEA Networks is a Collaborating Institution in this project.

Collaborating researcher from IMDEA Networks: Marco Ajmone Marsan, Chief Researcher
Project website: http://www.fp7-trend.eu/
Funded by: European Union. ICT Programme FP7
Duration: September 2010 – September 2013
Project partners: Politecnico di Torino (PoliTO), Alcatel-Lucent Bell Labs France (ALBLF), Huawei Technologies Dusseldorf GmbH (HWDU), Telefonica Investigación y Desarrollo SA (TID), France Telecom SA (FT), Fastweb SPA (FW), Universidad Carlos III de Madrid (UC3M), Interdisciplinary Institute for Broadband Technology (IBBT), Technische Universität Berlin (TUB), École Polytechnique Fédérale de Lausanne (EPFL), Consorzio Nazionale Interuniversitario per le Telecommunicazioni (CNIT), Panepistimio Thessalias - University of Thessaly (UTH)

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

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

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

- What is the real power consumption of ICT?
- What are the means to best reduce the energy consumption of today's networks without compromising requirements in network and service performance?
- What are the best suited engineering criteria and principles to actively support energy efficiency along the sequence of network design, planning, and operation?
- What changes in the design of network equipment are necessary in the short and long term in order to obtain the largest possible energy saving?
- Which communication and management paradigms and protocols will be able to mediate and ensure the most effective distributed energy control?
- What are the most promising and sustainable long-term approaches to energy efficient networking, assuming that a clean slate network design is possible, and what are potential migration strategies to achieve this?
- What kind of mutually beneficial incentives can be proposed to network operators, service providers, and users, in order to maximize energy efficiency?

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

WiMAX Scheduling Optimization

Funded by: Albentia Systems, S.A.
Duration: November 2010 – November 2011 (extendable until November 2014)

Description: The purpose of this collaboration agreement is the promotion of joint research projects between Institute IMDEA Networks and Albentia, focusing on **high quality research with direct relevance to industry** in the field of communication networks and new information technologies.

The collaboration between the parties targets the following areas:

- Optimization of WiMAX scheduling and queue management
- Cross-layer optimization using ARQ/HARQ
- Implementation of the algorithms on a WiMAX base station
- Performance analysis in a WiMAX testbed

4.2.2. Projects awarded in 2011 and commencing in 2012

CROWD

(Connectivity management for eneRgy Optimised Wireless Dense networks)

Funded by: European Union. ICT Programme FP7
Duration: September 2012 – February 2015
Project partners: Intecs Informatica e Tecnologia del Software S.P.A., Alcatel Lucent Bell Labs France, France Telecom S.A., Institute IMDEA Networks, Signalion GmbH, Universidad Carlos III de Madrid, Universität Paderborn

Description: **Wireless traffic demand is currently growing exponentially**. This growing demand can only be satisfied by increasing the density of points of access and combining different wireless technologies. Mobile network operators have already started to push for denser, heterogeneous deployments; however, current technology needs to steer towards efficiency, to avoid unsustainable energy consumption and network performance implosion due to interference. While some efforts have already been devoted to evolving the technology, these efforts mostly take a restricted PHY perspective and do not consider higher-layer mechanisms, which are required to fully optimise global performance. In this context, **CROWD promotes a paradigm shift in the future Internet architecture towards global network cooperation, dynamic network functionality configuration and fine, on demand, capacity tuning.**

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

eCOUSIN

(enhanced COntent distribUtion with Social INformation)

Funded by: European Union. ICT Programme FP7
Duration: September 2012 – February 2015
Project partners: France Telecom S.A., Alcatel Lucent Bell NV Belgium, Institute IMDEA Networks, Institut Telecom, Alcatel-Lucent Germany, Technische Universität Darmstadt, Telecom Italia SpA, The Chancellor, University of Cambridge, Universidad Carlos III de Madrid

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

rithms that exploit social information for placing and delivering contents in an optimized manner with a special focus on mobile environments. We envision that all these will be fundamental components of the future Internet architecture. The eCOUSIN consortium comprises two leading network operators, two major manufacturers of telecommunication equipment, one research institute and four universities. All of them are strong actors in the areas of this project, and their complementary nature ensures the impact of the eCOUSIN outcomes on both the industrial and scientific domains.

E2NET

(Energy Efficient Networks - Redes Energéticamente Eficientes)

Funded by: Spanish Ministry of Economy and Competitiveness (*MINECO – Ministerio de Economía y Competitividad*), previously known as the Spanish Ministry of Science and Innovation (*MICINN - Ministerio de Ciencia e Innovación)*
Duration: January 2012 – December 2014
Project partners: Institute IMDEA Networks, Universidad Carlos III de Madrid

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

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

Particular care will be taken to define models that convey as much as possible the technological aspects of current and future network elements. For instance, models for

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

On the other hand, we will address the energy efficiency at the application layer with a mixture of theoretical, simulation and Internet measurement techniques. We will consider **content distribution applications** since they are **responsible for the major portion of the current Internet traffic**.

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

I-JOIN

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

Institute IMDEA Networks is the Project Coordinator

Funded by: European Union. ICT Programme FP7
Duration: September 2012 – February 2015
Project partners: Institute IMDEA Networks, NEC Europe Ltd, Telecom Italia S.p.A., Sagemcom Energy & Telecom, Telcordia Poland SP. Z O.O., Intel Mobile Communications France, Hewlett Packard Italiana SRL, Commissariat à l'Energie Atomique et aux Energies Alternatives, Universität Bremen, University of Surrey, Technische Universität Dresden

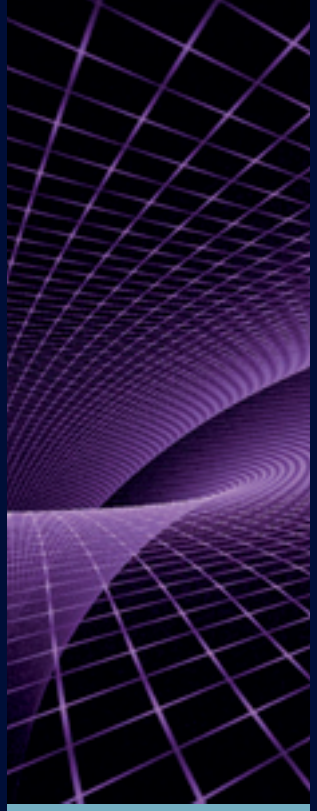
Description: The last decades brought an **exponential increase in mobile traffic volume**. This will continue and a 1000-fold increase by 2020 has been forecasted. **Small-cells promise to provide the required data rates through an increased spatial utilisation of the spectrum.**

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

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

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

5 scientific activities



5.1. Publications

29 Articles | 1 Book Section | 42 Conference or Workshop Items | 1 Book | 1 PhD Thesis | 10 Masters Thesis
Total number of items: 84

5.1.1. Best Paper Award

The following publications have received a Best Paper Award:

B. Rengarajan, G. Rizzo, M. Ajmone Marsan
Bounds on QoS-Constrained Energy Savings in Cellular Access Networks with Sleep Mode
The 23rd International Teletraffic Congress (ITC 2011)
6-9 September, 2011 (San Francisco, USA)

F. Giust, A. de la Oliva, C.J. Bernardos
Flat Access and Mobility Architecture: an IPv6 Distributed Client Mobility Management Solution
3rd IEEE International Workshop on Mobility Management in the Networks of the Future World (MobiWorld 2011), co-located with the 30th IEEE International Conference on Computer Communications (IEEE INFOCOM 2011)
10 April, 2011, (Shanghai, China)

5.1.2. Article

1. **Ajmone Marsan, Marco** and **Fernández Anta, Antonio** and **Mancuso, Vincenzo** and **Rengarajan, Balaji** and **Reviriego Vasallo, Pedro** and **Rizzo, Gianluca** (2011) *A Simple Analytical Model for Energy Efficient Ethernet.* IEEE Communications Letters (99). pp. 1-3. ISSN 1089-7798

2. **Ajmone Marsan, Marco** and **Meo, Michela** (2011) *Energy efficient wireless Internet access with cooperative cellular networks.* Computer Networks Journal, Special Issue: Wireless for the Future Internet, 55 (2). ISSN 1389-1286

3. **Baldoni, Roberto** and **Fernández Anta, Antonio** and **Ioannidou, Kleoni** and **Milani, Alessia** (2011) *The impact of mobility on the geocasting problem in mobile ad-hoc networks: Solvability and cost.* Theoretical Computer Science, 412 (12-14). pp. 1066-1080.

4. **Barceló, Jaume** and **Bellalta, Boris** and **Cano, Cristina** and **Sfairopoulou, Anna** and **Oliver, Miquel** and **Verma, Kshitiz** (2011) *Towards a Collision-Free WLAN: Dynamic Parameter Adjustment in CSMA/E2CA.* EURASIP Journal on Wireless Communications and Networking, Special issue: «Multiple Access Communications in Future-Generation Wireless Networks». ISSN 1687-1499

5. **Bikfalvi, Alex** and **García-Reinoso, Jaime** and **Vidal, Ivan** and **Valera, Francisco** and **Azcorra, Arturo** (2011) *P2P vs. IP multicast: Comparing approaches to IPTV streaming based on TV channel popularity.* Computer Networks, 55 (6). pp. 1310-1325.

6. **Budzisz, Łukasz** and **Stanojević, Rade** and **Schlote, Arieh** and **Baker, Fred** and **Shorten, Robert** (2011) *On the Fair Coexistence of Loss- and Delay-Based TCP.* IEEE/ACM Transactions on Networking, 19 (6). pp. 1811-1824.

7. **Conte, Alberto** and **Feki, Afef** and **Chiaraviglio, Luca** and **Ciullo, Delia** and **Meo, Michela** and **Ajmone Marsan, Marco** (2011) *Cell Wilting and Blossoming for Energy Efficiency.* IEEE Wireless Communications, 18 (5). pp. 50-57. ISSN 1536-1284

8. **Cuevas, Rubén** and **Cuevas, Ángel** and **Urueña, Manuel** and **Banchs, Albert** (2011) *Applying Low Discrepancy Sequences for Node-ID Assignment in P2PSIP.* IEEE Communications Letters, 15 (2). pp. 256-258. ISSN 1089-7798

9. **De La Oliva, Antonio** and **Soto, Ignacio** and **Banchs, Albert** and **Lessmann, Johannes** and **Niephaus, Christian** and **Melia, Telemaco** (2011) *IEEE 802.21: Media independence beyond handover.* Computer Standards & Interfaces, 33 (6). pp. 556-564.

10. **Fernández Anta, Antonio** and **Mosteiro, Miguel A.** and **Thraves, Christopher** (2011) *Deterministic Recurrent Communication and Synchronization in Restricted Sensor Networks.* Discrete Mathematics and Theoretical Computer Science, 13 (1). pp. 95-112.

11. **Gramaglia, Marco** and **Bernardos, Carlos Jesús** and **Calderón, María** (2011) *Seamless internet 3G and opportunistic WLAN vehicular connectivity.* EURASIP Journal on Wireless Communications and Networking. ISSN 1687-1499

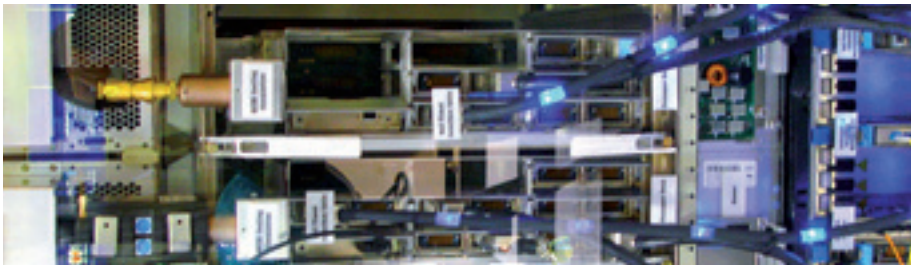
12. **Gramaglia, Marco** and **Soto, Ignacio** and **Bernardos, Carlos Jesús** and **Calderón, María** (2011) *Overhearing-Assisted Optimization of Address AutoConfiguration in Position Aware-VANETs.* IEEE Transactions on Vehicular Technology, 60 (7). pp. 3332-3349. ISSN 0018-9545

13. **Korger, Ulrike** and **Hartmann, Christian** and **Kusume, Katsutoshi** and **Widmer, Joerg** (2011) *Quality of service implications of power control and multiuser detection based cross-layer design.* EURASIP Journal on Wireless Communications and Networking, Special Issue on Multiple Access Communications in Future-Generation Wireless Networks, 2011 (9).

14. **Kryczka, Michal** and **Cuevas, Rubén** and **Cuevas, Ángel** and **Guerrero, Carmen** and **Azcorra, Arturo** (2011) *Measuring BitTorrent Ecosystem: Techniques, Tips and Tricks.* IEEE Communications Magazine, 49 (9). pp. 144-152. ISSN 0163-6804

15. **López Millán, Víctor M.** and **Cholvi, Vicent** and **López, Luis** and **Fernández Anta, Antonio** (2011) *A Model of Self-Avoiding Random Walks for Searching Complex Networks.* Networks: an International Journal. ISSN 0028-3045

16. **Mancuso, Vincenzo** and **Alouf, Sara** (2011) *Reducing Costs and Pollution in Cellular Networks.* IEEE Communications Magazine, Green communications issue, 49 (8). pp. 63-71. ISSN 0163-6804



publications

17. **Melia, Telemaco** and **Bernardos, Carlos Jesús** and **De La Oliva, Antonio** and **Giust, Fabio** and **Calderón, María** (2011) *IP Flow Mobility in PMIPv6 Based Networks: Solution Design and Experimental Evaluation.* Wireless Personal Communications, 61 (4). pp. 603-627. ISSN 0929-6212

18. **Munaretto, Daniele** and **An, Chunlei** and **Widmer, Joerg** and **Timm-Giel, Andreas** (2011) *Resilient data gathering and communication algorithms for emergency scenarios.* Springer Telecommunication Systems Journal, 48 (3-4). pp. 317-327.

19. **Munaretto, Daniele** and **Jurca, Dan** and **Widmer, Joerg** (2011) *A resource allocation framework for scalable video broadcast in cellular networks.* Springer Mobile Networks and Applications, 16 (6). pp. 794-806.

20. **Patras, Paul** and **Banchs, Albert** and **Serrano, Pablo** and **Azcorra, Arturo** (2011) *A Control Theoretic Approach to Distributed Optimal Configuration of 802.11 WLANs.* IEEE Transactions on Mobile Computing, 10 (6). pp. 897-910.

21. **Patras, Paul** and **Banchs, Albert** and **Serrano, Pablo** (2011) *A Control Theoretic Scheme for Efficient Video Transmission over IEEE 802.11e EDCA WLANs.* ACM Transactions on Multimedia Computing, Communications and Applications. (In Press)

22. **Podlesny, Maxim** and **Gorinsky, Sergey** (2011) *Leveraging the Rate-Delay Trade-off for Service Differentiation in Multi-Provider Networks.* IEEE Journal on Selected Areas in Communications, 29 (5). pp. 997-1008.

23. **Rengarajan, Balaji** and **de Veciana, Gustavo** (2011) *Architecture and Abstractions for Environment and Traffic Aware System-Level Coordination of Wireless Networks.* IEEE/ACM Transactions on Networking, 19 (3). pp. 721-734. ISSN 1063-6692

24. **Rengarajan, Balaji** and **de Veciana, Gustavo** (2011) *Practical adaptive user association policies for wireless systems with dynamic interference.* IEEE/ACM Transactions on Networking, 19 (6). pp. 1690-1703. ISSN 1063-6692

25. **Wei, Qing** and **Aad, Imad** and **Scalia, Luca** and **Widmer, Joerg** and **Hofmann, Philipp** and **Loyola, Luis** (2011) *E-mac: An elastic mac layer for ieee 802.11 networks.* Wiley Wireless Communications and Mobile Computing. ISSN 1530-8677 (online) (In Press)

26. **Widyawan, Widyawan** and **Pirkl, Gerald** and **Munaretto, Daniele** and **Fischer, Carl** and **An, Chunlei** and **Lukowicz, Paul** and **Klepal, Martin** and **Timm-Giel, Andreas** and **Widmer, Joerg** and **Pesch, Dirk** (2011) *Virtual lifeline: Multimodal sensor data fusion for robust navigation in unknown environments.* Pervasive and Mobile Computing.

27. **Zdarsky, Frank** and **Robitzsch, Sebastian** and **Banchs, Albert** (2011) *Security analysis of wireless mesh backhauls for mobile networks.* Journal of Network and Computer Applications, Special Issue on Efficient and Robust Security and Services of Wireless Mesh Networks.

28. **Zhou, Congzhou** and **Maxemchuk, Nicholas** (2011) *Distributed Bottleneck Flow Control in Mobile Ad Hoc Networks.* Journal of Network Protocols and Algorithms, 3 (1). ISSN 1943-3581

29. **Zhou, Congzhou** and **Maxemchuk, Nicholas** (2011) *Scalable max–min fairness in wireless ad hoc networks.* Ad Hoc Networks, 9 (2). pp. 112-119. ISSN 15708705

5.1.3. Book Section

30. **Kowalski, Dariusz R.** and **Sens, Pierre** and **Fernández Anta, Antonio** and **Pierre, Guillaume** (2011) *Introduction.* In: Euro-Par 2011 Parallel Processing - 17th International Conference, Euro-Par 2011, Bordeaux, France, August 29 - September 2, 2011, Proceedings, Part I. Lecture Notes in Computer Science (6852). Springer, p. 554. ISBN 978-3-642-23399-9

5.1.4. Conference or Workshop Item

31. **Ajmone Marsan, Marco** and **Meo, Michela** (2011) *Green Wireless Networking: Three Questions.* In: The 10th IEEE IFIP Annual Mediterranean Ad Hoc Networking Workshop (Med-Hoc-Net 2011), 12-15 June 2011, Favignana island, Sicily, Italy.

32 **Ajmone Marsan, Marco** and **Chiaraviglio, Luca** and **Ciullo, Delia** and **Meo, Michela** (2011) *Switch-Off Transients in Cellular Access Networks with Sleep Modes.* In: 4th International Workshop on Green Communications (GreenComm4), 9 June 2011, Kyoto, Japan.

33. **Amram, Noam** and **Fu, Bo** and **Kunzmann, Gerald** and **Melia, Telemaco** and **Munaretto, Daniele** and **Randriamasy, Sabine** and **Sayadi, Bessem** and **Widmer, Joerg** and **Zorzi, Michele** (2011) *Qoe-based transport optimization for video delivery over next generation cellular networks.* In: 2011 IEEE Workshop on multiMedia Applications over Wireless Networks (MediaWiN), organized in association with the IEEE Symposium on Computers and Communications (ISCC 2011), 28 June 2011, Kerkyra, Corfu, Greece.

34. **Arjona Aroca, Jordi** and **Fernández Anta, Antonio** (2011) *Bisection Width of Multidimensional Product Graphs.* In: Young Researchers Forum (YRF 2011), co-located with the 36th International Symposium on Mathematical Foundations of Computer Science (MFCS 2011), 22 -26 August 2011, Warsaw, Poland.

35. **Arkin, Esther M.** and **Fernández Anta, Antonio** and **Mitchell, Joseph S. B.** and **Mosteiro, Miguel A.** (2011) *Probabilistic Bounds on the Length of a Longest Edge in Delaunay Graphs of Random Points in d-Dimensions.* In: The 23rd Canadian Conference on Computational Geometry (CCCG 2011), 10-12 August, 2011, Toronto, Canada.

36. **Bangera, Pradeep** and **Gorinsky, Sergey** (2011) *Impact of Prefix Hijacking on Payments of Providers.* In: 3rd International Conference on COMmunication Systems and NETworkS (COMSNETS 2011), 4 - 8 January, 2011, Bangalore, India.

37. **Barceló, Jaume** and **Bellalta, Boris** and **Oliver, Miquel** and **Banchs, Albert** (2011) *Collision-Free Operation in Wireless Ad-Hoc Networks.* In: MACOM 2011 : 4th International Workshop on Multiple Access Communications Bookmark and Share, 12-13 September, 2011, Trento, Italy.

38. **Biermann, Thorsten** and **Scalia, Luca** and **Widmer, Joerg** and **Karl, Holger** (2011) *Backhaul design and controller placement for cooperative mobile access networks.* In: 2011 IEEE 73rd Vehicular Technology Conference: VTC2011-Spring, 15-18 May 2011, Budapest, Hungary.

39. **Chatzipapas, Angelos** and **Alouf, Sara** and **Mancuso, Vincenzo** (2011) *On the Minimization of Power Consumption in Base Stations using on/off Power Amplifiers.* In: IEEE Online Conference on Green Communications (IEEE Greencom 2011), 26-29 September, 2011.

40. **Christoforou, Evgenia** and **Fernández Anta, Antonio** and **Georgiou, Chryssis** and **Mosteiro, Miguel A.** (2011) *Algorithmic Mechanisms for Internet Supercomputing under Unreliable Communication.* In: The 10th IEEE International Symposium on Network Computing and Applications (IEEE NCA11), 25 - 27 August, 2011, Cambridge, Massachusetts, USA.

41. **Christoforou, Evgenia** and **Fernández Anta, Antonio** and **Georgiou, Chryssis** and **Mosteiro, Miguel A.** (2011) *Brief Announcement: Algorithmic Mechanisms for Internet-Based Computing under Unreliable Communication.* In: The 25th International Symposium on DIStributed Computing (DISC 2011), 20-22 September, 2011, Rome, Italy.

42. **De La Oliva, Antonio** and **Eznarriaga, Lucas** and **Bernardos, Carlos Jesús** and **Serrano, Pablo** and **Vidal, Albert** (2011) *IEEE 802.21: A shift in the Media Independence.* In: Future Network and

MobileSummit 2011 Conference, 15 - 17 June 2011, Warsaw, Poland.

43. **Desai, Maulik** and **Maxemchuk, Nicholas** (2011) *A Case for Packet Deflection in Structured Wireless Topologies.* In: 30th IEEE International Performance Computing and Communications Conference 2011, 17-19 November 2011, Orlando, Florida, USA.

44. **Dietl, Guido** and **Sciora, Matthieu** and **Zeitler, Georg** and **Bauch, Gerhard** and **Widmer, Joerg** (2011) *A Quantize-and-Forward Scheme for Future Wireless Relay Networks.* In: 2011 IEEE Vehicular Technology Conference (VTC Fall), 5-8 September, 2011, San Francisco, CA, USA.

45. **Farach-Colton, Martin** and **Fernández Anta, Antonio** and **Milani, Alessia** and **Zaks, Shmuel** (2011) *Brief Announcement: Opportunistic Information Dissemination in Mobile Ad-Hoc Networks: - Adaptiveness vs. Obliviousness and Randomization vs. Determinism.* In: The 25th International Symposium on DIStributed Computing (DISC 2011), 20-22 September, 2011, Rome, Italy.

46. **Fernández Anta, Antonio** and **Mosteiro, Miguel A.** and **Muñoz, Jorge Ramón** (2011) *Unbounded Contention Resolution in Multiple-Access Channels.* In: Distributed Computing - 25th International Symposium, DISC 2011, Rome, Italy, September 20-22, 2011.

47. **Garcia-Saavedra, Andres** and **Serrano, Pablo** and **Banchs, Albert** and **Hollick, Matthias** (2011) *Energy-efficient fair channel access for IEEE 802.11 WLANs.* In: 12th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM), 20-24 June 2011, Lucca, Italy.

48. **Giust, Fabio** and **Bernardos, Carlos Jesús** and **Figueiredo, Sergio** and **Neves, Pedro** and **Melia, Telemaco** (2011) *A hybrid MIPv6 and PMIPv6 distributed mobility management: The MEDIEVAL approach.* In: Computers and Communications (ISCC), 2011 IEEE Symposium on, Corfu, Greece.

49. **Giust, Fabio** and **De La Oliva, Antonio** and **Bernardos, Carlos Jesús** (2011) *Flat access and mobility architecture: An IPv6 distributed client mobility management solution.* In: The 3rd IEEE International Workshop on Mobility Management in the Networks of the Future World (Mobiworld 2011), co-located with The 30th IEEE International Conference on Computer Communications (IEEE INFOCOM 2011), 10-15 April 2011, Shanghai, China.

50. **Giust, Fabio** and **De La Oliva, Antonio** and **Bernardos, Carlos Jesús** and **Ferreira da Costa, Rui Pedro** (2011) *A network-based localized mobility solution for Distributed Mobility Management.* In: International Workshop on Mobility Management for Flat Networks (MMFN 2011), collocated with the 14th International Symposium on Wireless Personal Multimedia Communications (WPMC), 3-7 October, 2011, Brest, France.

51. **Goma, Eduard** and **Canini, Marco** and **López-Toledo, Alberto** and **Laoutaris, Nikolaos** and **Kostic, Dejan** and **Rodríguez, Pablo** and **Yagüe Valentín, Pablo** and **Stanojević, Rade** (2011) *Insomnia in the Access or How to Curb Access Network Related Energy Consumption.* In: ACM Special

Interest Group on Data Communication Annual Conference on the applications, technologies, architectures, and protocols for computer communication (ACM SIGCOMM 2011), 15-19 August, 2011, Toronto, Ontario, Canada.

52. **Gramaglia, Marco** (2011) *Optimized IPv6 Internet access from vehicles in multi-hop and heterogeneous environments.* In: 12th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM) – Ph.D. Forum, 20-24 June 2011, Lucca, Italy.

53. **Gramaglia, Marco** and **Bernardos, Carlos Jesús** and **Calderón, María** and **De La Oliva, Antonio** (2011) *Performance evaluation of a tree-based routing and address autoconfiguration for vehicle-to-Internet communications.* In: ITS Telecommunications (ITST), 2011 11th International Conference on, 23-25 August 2011, Saint-Petersburg, Russia.

54. **Gramaglia, Marco** and **Calderón, María** and **Bernardos, Carlos Jesús** (2011) *TREBOL: Tree-Based Routing and Address Autoconfiguration for Vehicle-to-Internet Communications.* In: 2011 IEEE 73rd Vehicular Technology Conference: VTC2011-Spring, 15-18 May 2011, Budapest, Hungary.

55. **Gramaglia, Marco** and **Serrano, Pablo** and **Hernández, José A.** and **Calderón, María** and **Bernardos, Carlos Jesús** (2011) *New Insights from the Analysis of Free Flow Vehicular Traffic in Highways.* In: 12th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM), 20-24 June 2011, Lucca, Italy.

56. **Joseph, Vinay** and **de Veciana, Gustavo** (2011) *Stochastic Networks with Multipath Flow Control: Impact of Resource Pools on Flow-Level Performance and Network Congestion.* In: ACM SIGMETRICS 2011, International Conference on Measurement and Modeling of Computer Systems. Part of Federated Computing Research Conference (FCRC) 2011, 7-11 June, 2011, San Jose, California, USA.

57. **Kryczka, Michal** and **Cuevas, Rubén** and **Guerrero, Carmen** and **Azcorra, Arturo** (2011) *Unrevealing the structure of live BitTorrent Swarms: methodology and analysis.* In: The IEEE International Conference on Peer-to-Peer Computing (P2P 2011), 31 August - 2 September, 2011, Kyoto, Japan.

58. **Le, Long** and **Baldesari, Roberto** and **Salvador, Jose Pablo** and **Festag, Andreas** (2011) *Performance Evaluation of Beacon Congestion Control Algorithms for VANETs.* In: IEEE Global Communications Conference (IEEE GLOBECOM 2011) – Wireless Networking Symposium, 6-10 December 2010, Houston, Texas, USA.

59. **Liu, Sisi** and **Lazos, Lukas** and **Krunz, Marwan** (2011) *Thwarting inside jamming attacks on wireless broadcast communications.* In: ACM Conference on Wireless Network Security (WiSec 2011), 15-17 June 2011, Hamburg, Germany.

60. **Maeder, Andreas** and **Mancuso, Vincenzo** and **Weizman, Yaniv** and **Biton, Erez** and **Rost, Peter** and **Perez-Costa, Xavier** and **Gurewitz, Omer** (2011) *FLAVIA: Towards a Generic MAC for 4G Mobile Cellu-*

lar Networks. In: Future Network & Mobile Summit 2011, 15-17 June 2011, Warsaw, Poland.

61. **Mancuso, Vincenzo** and **Alouf, Sara** (2011) *Power save analysis of cellular networks with continuous connectivity.* In: 12th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2011), 20-24 June 2011, Lucca, Italy.

62. **Melia, Telemaco** and **Giust, Fabio** and **Manfrin, Riccardo** and **De La Oliva, Antonio** and **Bernardos, Carlos Jesús** and **Wetterwald, Michelle** (2011) *IEEE 802.21 and Proxy Mobile IPv6: A network controlled mobility solution.* In: Future Network & Mobile Summit (FutureNetw), 2011, 15-17 June, 2011, Warsaw, Poland.

63. **Mozo, Alberto** and **Lopéz-Presa, José Luis** and **Fernández Anta, Antonio** (2011) *B-Neck: A Distributed and Quiescent Max-min Fair Algorithm.* In: The 10th IEEE International Symposium on Network Computing and Applications (IEEE NCA11), 25 - 27 Agosto, 2011, Cambridge, Massachusetts, USA.

64. **Rengarajan, Balaji** and **Rizzo, Gianluca** and **Ajmone Marsan, Marco** (2011) *Bounds on QoS-Constrained Energy Savings in Cellular Access Networks with Sleep Mode.* In: The 23rd International Teletraffic Congress (ITC 2011), 6-9 September, 2011, San Francisco, USA.

65. **Stanojević, Rade** and **de Castro, Ignacio** and **Gorinsky, Sergey** (2011) *CIPT: Using Tuangou to Reduce IP Transit Costs.* In: ACM CoNEXT 2011, 6-9 December, 2011, Tokyo, Japan.

66. **Lessmann, Johannes** and **De La Oliva, Antonio** and **Sengul, Cigdem** and **Garcia-Saavedra, Andres** and **Kretschmer, Mathias** and **Murphy, Sean** and **Patras, Paul** (2011) *On the Scalability of Carrier-grade Mesh Network Architectures.* In: Future Network and MobileSummit 2011 Conference, 15 - 17 June 2011, Warsaw, Poland.

67. **Lutu, Andra** and **Bagnulo, Marcelo** (2011) *The Tragedy of the Internet Routing Commons.* In: IEE International Conference on Communications ICC 2011 - Communication QoS, Reliability and Modeling Symposium (CQRM), 4-9 June, 2011, Kyoto, Japan.

68. **Mosteiro, Miguel A.** and **Fernández Anta, Antonio** and **Ramón Muñoz, Jorge** (2011) *Brief Announcement: Unbounded Contention Resolution in Multiple-Access Channels.* In: The 30th Annual ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing (PODC 2011), 6-8 June, 2011, San Jose, California, USA.

69. **Mozo, Alberto** and **Lopéz-Presa, José Luis** and **Fernández Anta, Antonio** (2011) *Brief Announcement: B-Neck – A Dis-tributed and Quiescent Max-min Fair Algorithm.* In: The 30th Annual ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing (PODC 2011), 6-8 June, 2011, San Jose, California, USA.

70. **Oh Lee, Yong** and **Rengarajan, Balaji** and **Narasimha Reddy, A.L.** (2011) *Reaching approximate Wardrop equilibrium at reduced costs of link state updates.* In: 3rd International Conference on COMmunication Systems and NETworkS (COMSNETS 2011), 4 - 8 January, 2011, Bangalore, India.

71. **Perrucci, G. Paolo** and **Fitzek, F.H.P.** and **Widmer, Joerg** (2011) *Survey on energy consumption entities on mobile phone platform.* In: 2011 IEEE 73rd Vehicular Technology Conference: VTC2011-Spring, 15-18 May 2011, Budapest, Hungary.

72. **Tientrakool, Patcharinee** and **Ho, Ya-Chi** and **Maxemchuk, Nicholas** (2011) *Highway Capacity Benefits from Using Vehicle-to-Vehicle Communication and Sensors for Collision Avoidance.* In: 2011 IEEE Vehicular Technology Conference (VTC Fall), 5-8 September, 2011, San Francisco, CA, USA.

5.1.5. Book

73. **Fernández Anta, Antonio** and **Lipari, Giuseppe** and **Roy, Matthieu** (Editors) (2011) *Principles of Distributed Systems - 15th International Conference, OPODIS 2011, Toulouse, France, December 13-16, 2011. Proceedings.* Lecture Notes in Computer Science, 7109. Springer.

5.1.6. PhD Thesis

74. **Patras, Paul** (2011) *Control-Theoretic Adaptive Mechanisms for Performance Optimization of IEEE 802.11 WLANs: Design, Implementation and Experimental Evaluation.* PhD thesis, Universidad Carlos III de Madrid, Madrid, Spain.

5.1.7. Masters Thesis

75. **Ali, Shahzad** (2011) *Feasibility of floating content service for context aware applications.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.

76. **Arjona Aroca, Jordi** (2011) *Bisection Bandwidth of Product Networks with Application to Data Centers.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.

77. **Cardona, Juan Camilo** (2011) *Empirical characterization of Internet Exchange Points.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.

78. **Eznarriaga, Lucas** (2011) *Performance Evaluation of IEEE 802.11aa MAC Enhancements for Robust Audio Video Streaming.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.

79. **Giust, Fabio** (2011) *Client-based and Network-based solutions for Distributed Mobility Management.* Masters thesis, Institute IMDEA Networks, Madrid, Spain and Universidad Carlos III de Madrid, Madrid, Spain.

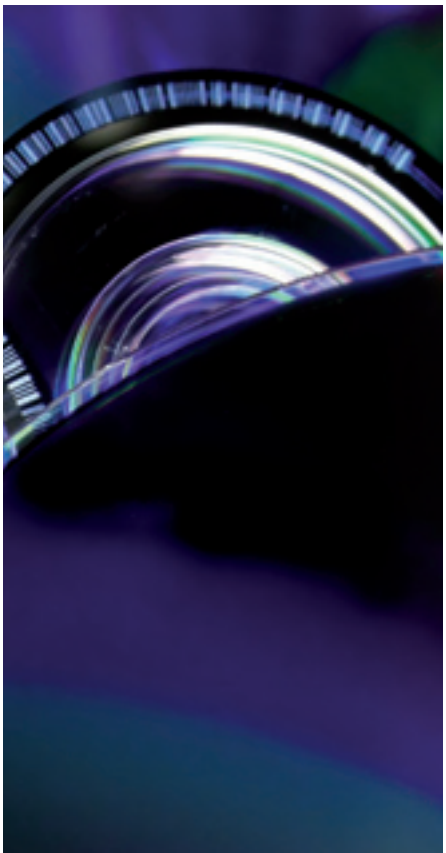
80. **Mannocci, Andrea** (2011) *Control Theoretic Optimization of 802.11 WLANs: Implementation and Experimental Evaluation.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.

81. **Salvador, Jose Pablo** (2011) *VoIPiggy: Implementation and evaluation of a mechanism to boost voice capacity in 802.11 WLANs.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.

82. **Sánchez Bueno, María Isabel** (2011) *Deployment and evaluation of a real wireless multihop heterogeneous vehicular network: lessons learned.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.

83. **Ul Hasan, Syed Anwar** (2011) *Obscure Giants: Detecting the Provider-Free ASes.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.

85. **Verma, Kshitiz** (2011) *Energy Efficient File Distribution.* Masters thesis, Universidad Carlos III de Madrid, Madrid, Spain.



5.2. 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:

M. Ajmone Marsan

- Guest editor of the Special Issue of the Transactions on Petri Nets and Other Models of Concurrency on Networks, Protocols, and Services Journal
- Chair of the Steering Committee of the IEEE/ACM Transactions on Networking Journal
- Member of the editorial board of the Elsevier Computer Networks Journal
- Member of the editorial board of the Elsevier Performance Evaluation Journal
- Member of the Italian delegation in the European Commission Information and Communication Technologies (ICT) Committee of the Seventh Framework Programme (FP7)

A. Banchs

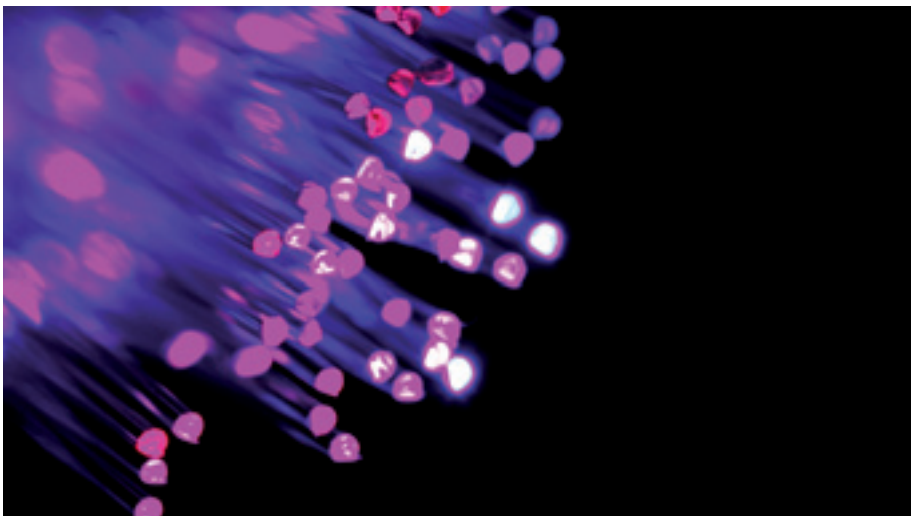
- Workshop chair of the 12th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2011)
- Keynote chair of the 16th IEEE Symposium on Computers and Communications (IEEE ISCC 2011)
- Technical Program Committee (TPC) member of WoWMoM 2011
- TPC member of the 9th IEEE Wireless Communications and Networking Conference (IEEE WCNC 2011)
- TPC member of the 23rd International Teletraffic Congress (ITC 2011)
- TPC member of the 22nd Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC 2011)
- TPC member of the 6th ACM International Workshop on Wireless Network Testbeds, Experimental evaluation and Characterization (ACM WiNTECH 2011)
- Senior Editor for IEEE Communications Letters Journal
- Area Editor for Elsevier Computer Communications Journal
- Guest Editor for the Special Issue of Elsevier Computer Communications Journal
- Member of the IEEE CSIM (Communications System and Modelling) Technical Committee of the IEEE Communication Society (ComSoc)
- Member of the IEEE CQR (Communications Quality and Reliability) Technical Committee of the IEEE Communication Society (ComSoc)

A. Fernández Anta

- Vice-Chair of the Steering Committee of the 25th International Symposium on Distributed Computing (DISC 2011)
- Co-chair of the TPC of the 15th International Conference On Principles Of Distributed Systems (OPODIS 2011)
- Editor of the book "Principles of Distributed Systems, 15th International Conference, OPODIS 2011, Toulouse, France, 13-16 December 2011, Proceedings"
- Vice-Chair of topic 8 in the 17th International Conference on Parallel Processing (Euro-Par 2011)
- Co-author of the Introduction to the book "Euro-Par 2011 Parallel Processing - 17th International Conference, Euro-Par 2011, Bordeaux, France, 29 August - 2 September 2011, Proceedings, Part I"
- TPC member of the 2011 IEEE/ACM International Conference on Green Computing and Communications (GreenCom 2011)
- TPC member of the 31st International Conference on Distributed Computing Systems (ICDCS 2011)
- TPC member of the 11th IEEE International Symposium on Communications and Information Technologies (ISCIT 2011)
- Evaluator of Research Proposals for the Cyprus Research Promotion Foundation (RPF), Cyprus
- Member of the thesis committee of Cristian Martinez Hernandez, at Universidad del Pais Vasco, Spain, 4 February 2011
- Member of the evaluation committee of Habilitation à Diriger les Recherches (HDR) of Lelia Blin, at Université Pierre et Marie Curie, Paris, France, 1 December 2011

P. Francois

- TPC member of the 10th International Conference on Networking (IFIP Networking 2011)
- Ph.D. Thesis committee member for Laurent Vanbever's Ph.D. thesis, Université catholique de Louvain, France



S. Gorinsky

- Chair of the 3rd IMDEA Networks Annual International Workshop 2011 (Internet Science)
- Publicity Chair of the 18th IEEE International Workshop on Local and Metropolitan Area Networks (IEEE LANMAN 2011)
- TPC member of the 30th Annual IEEE International Conference on Computer Communications (IEEE INFOCOM 2011)
- TPC member of the 19th IEEE International Conference on Network Protocols (ICNP 2011)
- TPC member of the 3rd International Conference on COMunication Systems and NETworkS (COMSNETS 2011)
- TPC member of IFIP Networking 2011
- TPC member of the 6th Workshop on the Economics of Networks, Systems and Computation (NetEcon 2011), co-located with The ACM Conference on Electronic Commerce (EC 2011), affiliated to the Federated Computing Research Conference (FCRC 2011)
- TPC member of the 14th IEEE Global Internet Symposium (Global Internet 2011)
- TPC member of the 18th IEEE International Workshop on Local and Metropolitan Area Networks Workshop (IEEE LANMAN 2011)
- TPC member of the 5th IEEE International Conference on Advanced Networks and Telecommunications Systems (IEEE ANTS 2011)

V. Mancuso

- TPC member of the 7th ACM workshop on Foundations of Mobile Computing (at the ACM Federated Computing Research Conference 2011) (ACM FOMC 2011)
- TPC member of the 6th IEEE Workshop on multiMedia Applications over Wireless Networks (IEEE MediaWIN 2011), co-located with IEEE ISCC 2011
- TPC member of the 54th IEEE Global Communications Conference (GLOBECOM) 2011 - Wireless Networking Symposium (IEEE GC'11 - WN)
- TPC member of the IEEE GLOBECOM 2011 - Communications QoS, Reliability, and Modeling Symposium (IEEE GC'11 – CQRM)
- TPC member of the 3rd IEEE Workshop on Hot Topics in Mesh Networking (IEEE HotMESH 2011)
- TPC member of ACM WiNTECH 2011

B. Rengarajan

- TPC member of the 3rd ACM International Workshop on Hot Topics in Planet-Scale Measurement (HotPlanet 2011)
- TPC member of the Green Communications and Networking (GCN) Workshop, co-located with IEEE INFOCOM 2011

G. Rizzo

- TPC member of the GCN Workshop, co-located with IEEE INFOCOM 2011

R. Stanojević

- TPC member of the 19th International Workshop on Quality of Service (IWQoS 2011)

J. Widmer

- General Co-Chair of MediaWin 2011
- TPC member of the 19th ACM International Conference on Multimedia 2011 (ACM MM 2011)
- TPC member of the IEEE Workshop on Internet of Things Technology and Architectures 2011 (IoTech 2011), co-located with the 8th IEEE International Conference on Mobile Ad-hoc and Sensor Systems (IEEE MASS 2011)
- TPC member of the IEEE Online Conference on Green Communications 2011 (IEEE GreenCom 2011)
- TPC member of the ACM SIGCOMM Workshop on Energy and IT: from Green Networking to Smarter Systems 2011, co-located with the 17th Annual Conference of the ACM Special Interest Group on Data Communication (SIGCOMM) on the applications, technologies, architectures, and protocols for computer communication (ACM SIGCOMM 2011)
- TPC member of the 2nd International Conference on Future Energy Systems (e-Energy 2011)
- TPC member of the 1st Network Coding Applications and Protocols Workshop (NC-Pro 2011), co-located with IFIP Networking 2011
- TPC member of WoWMoM 2011
- TPC member of the 20th International Conference on Computer Communications and Networks (ICCCN 2011)
- TPC member of the 7th International Symposium on Network Coding (NetCod 2011)
- TPC member of the 1st IEEE ICC Workshop on Advances in Mobile Networking (AMN 2011)

- TPC member of the 4th IFIP International Conference on New Technologies, Mobility and Security (IFIP NTMS 2011)
- TPC member of the 14th IEEE Global Internet Symposium 2011 (IEEE GI 2011), co-located with IEEE INFOCOM 2011
- TPC member of IEEE INFOCOM 2011
- TPC member of the 8th International Conference on Wireless On-demand Network Systems and Services (WONS 2011)
- TPC member of the 17th European Wireless Conference 2011 (EW 2011)
- Associate Editor of the IEEE Transactions on Communications Journal

5.3. Keynotes, invited talks & tutorials

- Invited talk “Energy Efficiency in Networks”, by Antonio Fernández Anta, at ICT, Chinese Academy of Sciences, Beijing, China, 4 May 2011
- Invited talk “Distance-biased Sampling of Networks”, by Antonio Fernández Anta, at LIP6 - Laboratoire d’informatique de Paris 6, Université Pierre & Marie Curie, Paris, 18 July 2011
- Invited talk “Traffic Attraction through Prefix Deaggregation: An Economic Perspective”, by Sergey Gorinsky, at the Complex Systems Physics Tea, Eotvos Lorand University (ELTE), Budapest, Hungary, 6 September 2011
- Invited talk “Traffic Attraction through Prefix Deaggregation: An Economic Perspective”, by Sergey Gorinsky, at the BCAM Seminar, Basque Center for Applied Mathematics (BCAM), Bilbao, Spain, 9 September 2011
- Invited talk «BGP Add-Paths and Prefix Independent Convergence», by Pierre Francois, at Polish Network Operators Group meeting (PLNOG7), 28-29 September 2011, and at European Network Operators’ Group meeting, 30 September 2011
- Invited talk «IP Fast Reroute Applicability», by Pierre Francois, at European Network Operators’ Group meeting, 30 September 2011
- Plenary talk «BGP Policy violation in the data-plane», by Pierre Francois, at RIPE 63,v, 31 October-4 November 2011
- Invited talk "Saving Energy by Powering Down Links", by Antonio Fernández Anta, at meeting of COST Action: IC0804, University of Thessaloniki, Thessaloniki, Greece, 7-8 November 2011
- Invited talk “CIPT: Using Tuangou to Reduce IP Transit Costs”, by Sergey Gorinsky, at the Workshop on Internet Economics (WIE 2011), La Jolla, California, USA, 2 December 2011

Institute IMDEA Networks 3rd Annual International Workshop: Internet Science

18 May 2011

Program:

- ***Media landscape in Twitter: A world of new conventions and political diversity,*** Jon Crowcroft (Marconi Professor of Communications Systems at University of Cambridge)
- ***Scaling Online Social Networks***, Pablo Rodriguez (Telefonica Research, Spain)
- ***Twitter, a Techno-Social Network***, by Miranda Mowbray (HP Labs, UK)
- ***Wide side of the Internet: Benford type distributions in Internet data***, Gábor Vattay (Eötvös Loránd University, Hungary)
- ***Improving Random Walk Estimation Accuracy with Uniform Restarts***, Konstantin Avrachenkov (INRIA Sophia Antipolis, France)
- ***Opportunistic Caching and Cooperation for Effective Information Delivery***, Leandros Tassiulas (University of Thessaly, Greece)
- ***Rethinking Video Transport***, Gustavo de Veciana (The University of Texas at Austin, USA)
- ***Perspectives in Benchmarking of Overlay Networks***, Ralf Steinmetz (Darmstadt University of Technology, Germany)
- ***How much can social metrics actually help in content distribution?***, Ioannis Stavrakakis (National & Kapodistrian University of Athens, Greece)
- ***Study of Geo-Social Networks, Social Cascades and Applications***, Cecilia Mascolo (University of Cambridge, UK)
- ***The Next Disruptive Network Technology***, Nick Maxemchuk (Columbia University, USA and Institute IMDEA Networks, Spain)
- ***Vehicular Cyber-Physical Systems, Or, Improving Your Commute***, Hari Balakrishnan (MIT, USA)
- ***The FuturICT Flagship: Creating Socially Interactive Information Technologies for a Sustainable Future***, Dirk Helbing (ETH Zurich, Switzerland)

Abstract:

Institute IMDEA Networks annually holds a by-invitation-only thematic workshop in Madrid. The workshop accompanies a meeting of our Scientific Council comprised by prominent researchers. In addition to talks by Scientific Council members, the workshop includes invited talks by external experts in the research theme of the workshop. The 2011 workshop theme is Internet science with a focus on social networking.

The Internet as a technological artifact emerged at the border between computer science and electrical engineering about 40 years ago. Since then, the Internet of hosts, routers,

and packets has dramatically expanded and become an indispensable part of the modern life. Networking insights from optimization, queuing, information, control, graph, and other theories accompanied the Internet growth. Over time, the stance of Internet technologists toward the society changed from ignoring the human factor in the technology, through the more recent focus on hardening the technology with security, to the current interest in embracing the real life with all its complexities.

Internet science is an effort to scientifically capture this new vision of the Internet as both technological and societal artifact. The holistic vision expands the realm of Internet problems beyond computer science and engineering into other disciplines such as economics, sociology, political science, law, biology, and physics. By bringing new mathematical apparatus and altogether different investigative techniques, these traditionally separate disciplines might enhance the purely technological approach to discover new successful Internet solutions. For example, while the integrated approach suggests interpreting the Internet as a complex system that is not under the full control of its engineers but rather evolves according to its own principles, physical and biological insights into complex systems and their evolution hold a promise for improving our understanding of the Internet. Furthermore, Internet science is expected to yield multidirectional knowledge transfer that enriches the traditionally non-technological disciplines.

The workshop objectives are mostly in discussing what Internet science is or, perhaps, what it should be. Is Internet science just a new name for research in computer networking and distributed systems? The intersection with which discipline is likely to give Internet science its next significant breakthrough? In particular, can Internet science revolutionize online social networking? Which specific analytic techniques and experimental methods from the social and natural sciences can enrich the traditional apparatus of Internet technology scientists? What are the right metrics for the expanded problem space? What are the concrete ways for Internet technologists to contribute to the other engaged disciplines? With the specialization being a common path to success in science, why do we expect the holistic multi-disciplinary Internet science to succeed at all?

Towards Real Energy-efficient Network Design Workshop

26-27 September 2011

Organized by TREND - The Network of Excellence on Energy Efficient Networking

Program of selected technical presentations by project partners:

- ***Opening***, Marco Ajmone Marsan (PoliTO)
- ***Power consumption in the IP, Ethernet and WDM layer of core networks***, Ward Van Heddeghem (IBBT)

- ***Energy profiling of FastWeb Points of Presence***, Marco Mellia (PoliTO)
- ***Energy saving in the core network by disruptive switching paradigms***, Achille Pattavina (PoliMI)
- ***Multi-Period Power-aware Logical Topology Design***, Filip Idzikowski (TUB)
- ***Energy-efficient Content Distribution and Network Management,*** Luca Chiaraviglio (PoliTO)
- ***Optimization and Control in the Smart grid***, George Koutitas (UTH)
- ***Sleep modes in femtocell networks***, Willem Vereecken (IBBT)
- ***Energy Saving and Capacity Gain of Micro Sites in Regular LTE Networks: Downlink Traffic Layer Analysis***, Ramin Khalili (EPFL)
- ***JEA-CNIT Activities: Development of the preliminary monitoring system***, Raffaele Bolla (CNIT)

Presentations by Collaborating Institutions:

- ***CoolCellular activities at the Technische Universität Dresden***, Christian Isheden
- ***FUB - Power consumption measurements of GMPLS test bed elements***, Alessandro Valenti
- ***IMDEA Networks presentation***, Antonio Fernández Anta
- ***DTU Fotonik and Metro-Access in energy efficient activities***, Antonio Caballero Jambrina

Other EU projects presentations:

- ***EARTH***, Dietrich Zeller (Alcatel-Lucent Deutschland AG)
- ***GreenTouch***, Dietrich Zeller (Alcatel-Lucent Deutschland AG)
- ***CHRON***, Antonio Caballero Jambrina (Danmarks Tekniske Universitet)
- ***C2POWER***, Ayman Radwan(Instituto de Telecomunicações – Aveiro)
- ***STRONGEST***, Piero Castoldi (Scuola Superiore Sant'Anna)

XI Semana de la Ciencia - Institute IMDEA Networks Open House 2011: Research and Development

18 November 2011

Program:

- ***Introducing IMDEA Networks***, Joerg Widmer (Senior Researcher, Institute IMDEA Networks)
- ***Research in theory and practice***, Vincenzo Mancuso (Staff Researcher, Institute IMDEA Networks)
- ***The United Nations of IMDEA Networks***, Andra Lutu & others (Research Assistants, Institute IMDEA Networks)
- ***Let's play: live experiments involving audience participation***

- Games moderator: Kshitiz Verma (Research Assistant, Institute IMDEA Networks)
- ***IEEE 802.3az: The Road to an Energy Efficient Ethernet***, Pedro Reviriego (Associate Professor, Universidad Antonio de Nebrija, Madrid)
- ***Is Content Publishing in BitTorrent Altruistic or Profit Driven?***, Rubén Cuevas (Assistant Professor, UC3M)
- ***Let's Talk***
  - Open debate moderator: Vincenzo Mancuso
- ***Medieval meets Carmen: a video-streaming demo***
  - Carlos Jesús Bernardos Cano (Associate Professor, UC3M)
  - Antonio de la Oliva (Visiting Professor, UC3M)
  - Lucas Eznarriaga & Fabio Giust (Research Assistants, Institute IMDEA Networks)

Abstract:

Why should I consider a future in research? What sort of opportunities does a PhD open up for me? What makes research in the science of networks such an exciting career choice? How can we ensure that the Internet can grow and adapt to ever-changing needs over the coming decades? What lies beyond the Internet? What inspires network research?

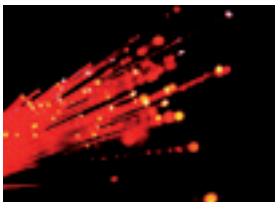
Join us on a new edition of our **Research and Development Open House Day** to explore the answers to some exciting questions. Learn what our Research Assistants, (who are themselves PhD students) do when they're not in the classroom and check out the many research paths that are open to you as a researcher once you have your doctorate. This is a rare opportunity to find out more about a range of career options from the people who really know what it's all about – our Research Assistants.

The **Institute IMDEA Networks one-day Open House event** gives you the chance to experience first-hand the full range of our computer networking research activities and collaborations via direct conversation with the researchers and students involved. The IMDEA Networks Open House will feature science and technology exhibits, displays of student posters, research presentations, networking career information and more. IMDEA Networks scientists will share with you their excitement about the institute's latest work. **More details** will be available as the day approaches, including the speakers' program.

With researchers on hand to demonstrate field work and discuss ongoing studies, the Open House is a great way to find out how we're helping society face the communication challenges of the 21st century.

5.5. Workshops, seminars, lectures

Weekly seminars alternated invited talks with presentations by internal researchers. Out of the 41 events in which the Institute participated, 15 were conducted by our researchers and 26 by invited speakers. We hereby list the latter:



Optimizing the Use of Regenerators in Optical Networks
Date: 20 December 2011
Speaker: Professor Shmuel Zaks, Department of Computer Science, Technion - Israel Institute of Technology, Haifa, Israel

10 Lessons from 10 Years of Measuring and Modeling the Internet's Autonomous Systems
Date: 15 December 2011
Speaker: Dr. Olaf Maennel, Lecturer, Loughborough University, UK

Wireless Ad Hoc Networks in the Internet: Flooding and Routing Optimizations
Date: 13 December 2011
Speaker: Dr. Juan Antonio Cordero Fuertes, Researcher, HIPERCOM research group, INRIA (CR de Paris-Rocquencourt), École Polytechnique, Paris, France

Value of Information in Optimal Flow-Level Scheduling of Users with Markovian Time-Varying Channels
Date: 28 October 2011
Speaker: Peter Jacko, Post-doc Fellow, Basque Center for Applied Mathematics (BCAM), Bilbao, Spain

Online Testing of Deployed Federated and Heterogeneous Distributed Systems
Date: 19 September 2011
Speaker: Dr. Dejan Kostic, Tenure Track Assistant Professor, Networked Systems Laboratory, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland

FLAVIA: Project Plenary Meeting

Date: 05-06 September 2011

Speaker: IMDEA Networks, UC3M, NEC Europe labs (UK/DE), IIT Moscow, Ben Gurion University (Israel), Alvarion (Israel), Telefonica I+D (Barcelona), CNIT (Italy), Sequans (France), Mobimesh (Italy), AGH (Poland), Hamilton Institute (Maynooth, Ireland)

Where are my followers? Understanding the Locality Effect in Twitter

Date: 29 June 2011

Speaker: Dr. Ruben Cuevas, Assistant Professor, UC3M, Spain

Research in Collaborative Haptic-Audio-Visual Environments

Date: 15 Jun 2011

Speaker: Dr. Abdulmotaleb El Saddik, University Research Chair and Professor, School of Information Technology and Engineering, University of Ottawa, Canada

Proportional Fairness and its Relationship with Multi-class Queuing Networks

Date: 08 Jun 2011

Speaker: Dr. Neil Walton, Assistant Professor, University of Amsterdam, Netherlands

Energy-efficient fair channel access for IEEE 802.11 WLANs

Date: 01 Jun 2011

Speaker: Andres Garcia Saavedra, PhD Candidate, NETCOM Research Group, UC3M, Spain

Game Theory for Cooperative Networks

Date: 19 May 2011

Speaker: Dr. Walid Saad, Postdoctoral Research Associate, Electrical Engineering Department, Princeton University, New Jersey, USA

Trade-offs in Implementing Atomic Multi-Writer, Multi-Reader Registers in Asynchronous Message-passing Systems

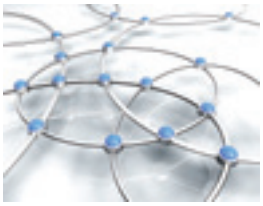
Date: 17 May 2011

Speaker: Dr. Chryssis Georgiou, Assistant Professor, Department of Computer Science, University of Cyprus, Cyprus

Traffic Localization for DHT-based BitTorrent networks

Date: 09 May 2011

Speaker: Dr. Matteo Varvello, Technical Staff, Bell-Labs, Holmdel, New Jersey, USA



Path ASSEMBLER: A BGP-Compatible Multipath Inter-domain Routing Protocol

Date: 27 April 2011

Speaker: Jose Manuel Camacho Camacho, PhD Candidate NETCOM Research Group, UC3M, Spain

Energy-Efficient Wireless Access Networks

Date: 19 April 2011

Speaker: Dr. Delia Ciullo, Post-Doc Researcher, Politecnico di Torino, Italy

Measurement-Driven Characterization of Emerging Trends in Internet Content Delivery

Date: 18 Apr 2011

Speaker: Rubén Torres, Ph.D. Candidate, Purdue University, West Lafayette, Indiana, USA

Security Solutions for Geographic Routing in Wireless Multi-hop Networks

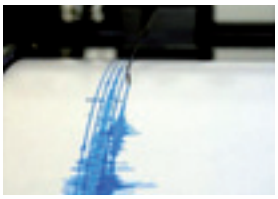
Date: 13 April 2011

Speaker: Adrian Carlos Loch Navarro, PhD Candidate, Technische Universität Darmstadt, Darmstadt, Germany

Towards an Energy-Efficient Internet Core with Near-Zero Buffers

Date: 28 March 2011

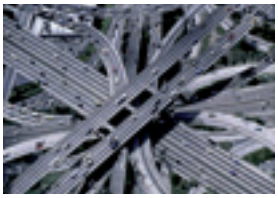
Speaker: Dr. Arun Vishwanath, Postdoc research, School of Electrical Engineering and Telecommunications, University of New South Wales, UK



I-seismograph: Observing and Measuring Internet Earthquakes

Date: 23 March 2011

Speaker: Dr. Jun Li, Associate professor, Department of Computer and Information Science, University of Oregon; Chair of Excellence (*Cátedra de Excelencia*), UC3M; Visiting Researcher, Institute IMDEA Networks



Unbounded Contention Resolution in Multiple-Access Channels

Date: 16 March 2011

Speaker: Dr. Miguel A. Mosteiro, Research Professor, Computer Science Department, Rutgers University; Researcher, Department of Telematic Systems and Computer Science, Universidad Rey Juan Carlos, Madrid, Spain

Towards a Collision-Free WLAN: Dynamic Parameter Adjustment in CSMA/E2CA

Date: 09 Mar 2011

Speaker: Dr. Jaume Barceló, Post-Doc Researcher, Netcom Research Group, UC3M, Spain

Networking and Network Security: Where I am, Where am I going?

Date: 22 February 2011

Speaker: Dr. Jun Li, Associate professor, Department of Computer and Information Science, University of Oregon; Chair of Excellence (*Cátedra de Excelencia*), UC3M; Visiting Researcher, Institute IMDEA Networks

From Science to Business

Date: 15 Feb 2011

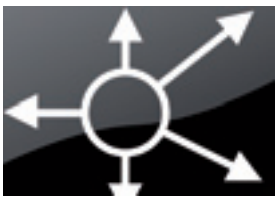
Speakers:

- Emma Crespo and Cassia Viviani Silva, UC3M Business Incubator, Madrid, Spain
- Manuel Triantáfilo, CEO, Capital Certainty S.L., Madrid, Spain
- Host: Dr. Antonio Fernández Anta, Senior Researcher, Institute IMDEA Networks

From intelligent transportation to smart grid: In quest of the killer application for multiagent system technology

Date: 01 Feb 2011

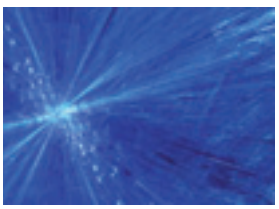
Speaker: Dr. Matteo Vasirani, Lecturer, Universidad Rey Juan Carlos, Madrid, Spain



Lecture on Advanced topics in Internet Routing with BGP

Date: 24 Jan 2011 - 27 Jan 2011

Speaker: Dr. Pierre Francois, Université de Louvain, Belgium



Networking and Meaning of Life: Second IMDEA Networks Workshop on Far-Out Ideas

Date: 19 Jan 2011

Speaker: Dr. Joerg Widmer, Dr. Sergey Gorinsky & Dr. Antonio Fernández Anta, Senior Researchers; Dr. Rade Stanojević, Dr. Vincenzo Mancuso, Dr. Balaji Rengarajan & Dr. Gianluca Rizzo, Staff Researchers, Institute IMDEA Networks

5.6. Major future events

e-Energy 2012, the Third International Conference on Future Energy Systems, Where Energy, Computing and Communication Meet

9-11 May 2012

Abstract:

e-Energy is the 3rd International Conference on Future Energy Systems, which is organized annually since 2010. Due to the increasing significance of power consumption in computing and networking, the goal of e-Energy is to bring together researchers, developers and practitioners working in this area to discuss recent and innovative results, as well as identify future directions and challenges. The continuing spread of Information and Communication Technology (ICT) has contributed much to the reduction of energy consumption in many areas of everyday life. Nevertheless ICT infrastructure continues to expand in capacity and reach, and needs to be more energy-efficient itself. Additionally, ICT can be used to optimize the production, transport and consumption of energy in other setups.

The conference addresses the varied fields of servers and communication infrastructures, services in data centers, end-systems in home and office environments, broadband access networks, sensor networks, cloud computing, smart grids and future networks such as The Internet of Things.

The third e-Energy Conference will be held from May 9th to 11th, 2012 and will be organized by Institute IMDEA Networks and the University Carlos III of Madrid. The first e-Energy Conference was held in April 2010, in Passau (Germany), and the second took place in May/June 2011 at Columbia University, in New York City (USA). e-Energy will be preceded on May 8th by the 1st International Workshop on Energy-Efficient Data Centres (E2DC 2012) and a COST Action IC0804 on Energy Efficiency in Large Scale Distributed Systems Open Meeting as well as the Tutorial "Energy Efficiency versus Quality of Experience in wireless networks: From measurements to trade-off analysis".

e-Energy 2012 is organized in cooperation with ACM SIGCOMM and technically co-sponsored by the IEEE and the IEEE Computer Society Technical Committee on Parallel Processing. It also counts with cooperation from the Technical Subcommittee on Green Communications & Computing (TSCGCC) of the IEEE Communications Society, the sponsorship of the Network of Excellence TREND (Towards Real Energy-efficient Network Design) and of the SCCD (Sociedad de Computación Concurrente y Distribuida).

WOWMOM 2013, the 12th IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks

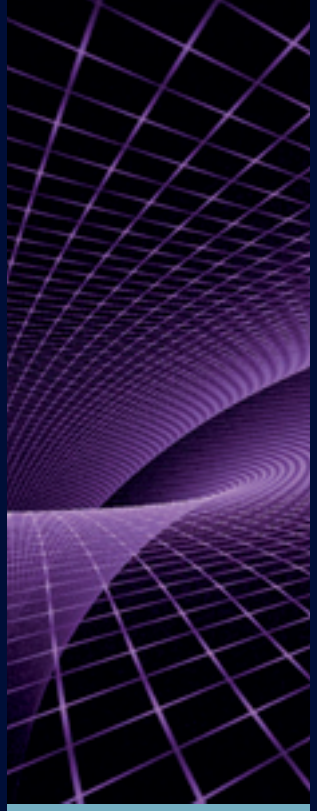
4-7 June 2013

Abstract:

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

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

Previous editions of WoMoM have been organized in cooperation with ACM SIGCOMM and technically co-sponsored by the IEEE and the IEEE Computer Society. They have also counted with the sponsorship of the University of Texas at Arlington.



6 impact and technology transfer

Institute IMDEA Networks monitors and evaluates its scientific results in order to obtain a sound appraisal 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.

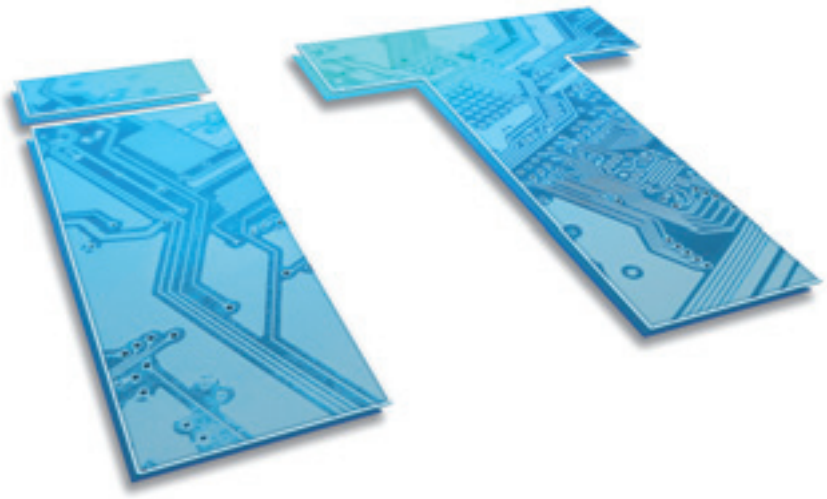
6.1. Patents

6.1.1. Announcement of patent filing for energy efficiency of computer networks

Institute IMDEA Networks, in collaboration with NEC Laboratories Europe and University Carlos III of Madrid, has announced the filing of a patent application. It will establish ***a novel method for the reduction of the energy consumption of a network by minimizing the number of active nodes involved in any given communication.***

The importance of energy saving solutions for networking has steadily increased over the last few years due to environmental and economic reasons. In order to reduce the energy footprint of current and future systems, engineers are now working on enhancements to all networking layers with the objective of optimizing their energy efficiency. Some optimizations focus on energy saving while the network is operative, and other approaches consider solutions that aim at minimizing the number of active nodes within the network. The new proposed mechanism to reduce the energy consumption of the network is elegantly simple, both in design and application. For a given network topology and traffic matrix, it produces optimal routing in terms of energy and throughput, by providing a routing system which maximizes the number of flows that can be admitted into the network while powering down (fully or partially) nodes that are not required to transport the given traffic.

This mechanism has been shown to produce excellent results in different tests, outperforming other approaches very substantially in terms of throughput as well as energy consumption. The reductions achieved correspond to up to 40% of the amount of energy consumed.



6.2. Participation on standardization bodies

Standardization wears a critical role in the field of research in Networking. Many different vendors manufacture networking equipment, network-attached devices, and software running on such devices. Without strong standardization efforts, the industry has to rely on de-facto proprietary standards, which typically hinders flexibility in the evolution of deployed infrastructures and services, and often prevents deployment in multi-vendor environments. Standardization is thus considered as an inherent part of the research work performed at IMDEA Networks, as it increases the likelihood of acceptance of our technological contributions.

The IEEE Standards Association (IEEE SA) is one of the premier standards organizations working on the lower layers in the network model. The most widely known series of IEEE standards are 802.3 (Ethernet) and 802.11 (Wi-Fi). Many researchers at UC3M NETCOM and Institute IMDEA Networks perform research on the 802.11 wireless protocols standardized by the IEEE SA.

Antonio de la Oliva, UC3M affiliate and IMDEA Networks collaborator, is participating in the IEEE standardization effort by notably vice-chairing the IEEE 802.21 TGb, leading the working group dedicated to the definition of future working items in the Ad-Hoc group, and by turning technical contributions stemming from the MEDIEVAL and CARMEN projects into the IEEE 802.21a/b/c and IEEE 802.11 standards.

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

Marcelo Bagnulo completed his term as a member of the Internet Architecture Board (IAB) in March 2011. The IAB is a body of 13 experts that plays a major role in the process

of definition of Internet Protocols and, as a result, on the worldwide evolution of the Internet. The IAB oversees the technical and engineering development of the Internet by the Internet Society (ISOC). As such, it wields a lot of influence over the architectural direction towards which IETF standards evolve. Bagnulo had the honor of being the first member of a Spanish Institution (UC3M) to be elected to the IAB. He was one of the leaders to take on the NAT64 work in the IETF BEHAVE working group that allows IPv6 clients to communicate with IPv4 servers. He is currently the co-chair of the CONEX Working Group, and finished his term as co-chair of the MEXt Working Group in July 2011. Marcelo Bagnulo has also been active at the SAVI Working Group, where he is editing 3 of the 5 main specification documents of this working group.

Iljitsch van Beijnum, a Research Assistant at IMDEA Networks, whose doctorate Bagnulo supervises, also participated in this effort, focused on allowing the FTP protocol to work through translation mechanisms. Van Beijnum was also involved in the definition of Stateful 6-to-4 NATs.

Pierre Francois, who joined IMDEA Networks as a Staff Researcher in September 2011, proceeds with his standardization activities in the Routing area, as well as in the Operations and Management area, both within the IETF. His main contributions to the IETF activity are dedicated to turn the research and engineering findings stemming out of his collaboration with ISPs and router vendors into IETF standards and peer reviewed informational IETF documents.

6.2.1. IETF

LFA Applicability

The standardization topics related to Pierre Francois's activities for the period September-December 2011 in the Routing Area relate to «IP Fast Reroute». An IETF working group document («LFA applicability in SP networks», draft-ietf-rtgwg-lfa-applicability-04) co-authored with Clarence Filsfils, distinguished engineer at Cisco Systems, underwent working group last call in the RTGWG working group. This draft presents an analysis of the applicability of an IP Fast Reroute technique called «Loop-free alternates» in Internet Service Provider Networks. This work has been performed in collaboration with Cisco Systems, France Telecom - Orange, AT&T, and Deutsche Telekom.

BGP Extended Communities

Also in the Routing Area, within the IDR working group, an IETF working group document («Assigned BGP extended communities», draft-ietf-idr-reserved-extended-communities-02) co-authored with Bruno Decraene, Senior Researcher at France Telecom - Orange, is being discussed for further standardization steps. This draft is putting a registry into place for «well-known» BGP extended communities. Its goal is to ease the standardiza-

tion of BGP features relying on BGP extended communities by providing a pool for ISPs and Router Vendors to pick values dedicated to specific BGP features.

BGP Graceful Shutdown

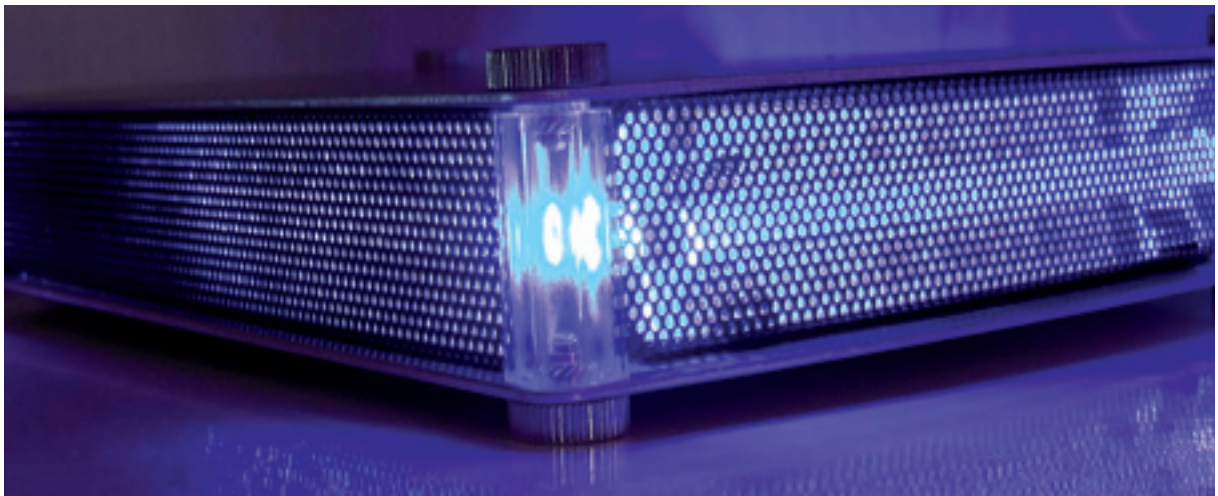
In the Operations and Management area, a «graceful shutdown» mechanism for BGP peering links is being standardized in collaboration with France Telecom -Orange, Internet Initiative Japan, and Cisco Systems. The draft capturing this work («Graceful BGP session shutdown», draft-ietf-grow-bgp-gshut-03), working group document of the GROW Working Group, describes operational procedures aimed at reducing the amount of traffic lost during planned maintenances of routers or links, involving the shutdown of BGP peering sessions. It also provides recommendations to router vendors for the support of a graceful shutdown mechanism that eases operational aspects of the solution. The authors are: Pierre Francois, Bruno Decraene, Cristel Pelsser, Keyur Patel and Clarence Filsfils.

BGP Add-Paths

Add-Paths is a BGP enhancement that allows a BGP router to advertise multiple distinct paths for the same prefix/NLRI. This provides a number of potential benefits, including reduced routing churn, faster convergence and better load balancing. Add-paths is currently being standardized within the IDR Working Group of the Routing area of the IETF. draft-ietf-idr-add-paths-guidelines-02, co-authored by Pierre Francois in collaboration with AT&T, UCLouvain, Alcatel-Lucent, and Cisco Systems, is a working group item of IDR aimed at providing network operators the tools needed to address their specific applications and to manage the scalability impact of Add-Paths. A router implementing Add-Paths may learn many paths for a prefix and must decide which of these to advertise to peers. This document analyses different algorithms for making this selection and provides recommendations based on the target application.

Origin Preference Attribute

The Origin Preference Attribute work to add a new attribute to BGP came out of the TRILOGY project and was initially brought to the IETF. In 2011, Rolf Winter at NEC and Iljitsch van Beijnum worked on a paper largely based on the specification of the attribute in draft-van-beijnum-idr-iac-02, which was accepted at SAC 2012.



NAT64 (RFCs 6146 and 6147)

Stateful NAT64 is a mechanism developed within the BEHAVE working group to allow IPv6 clients to connect to IPv4 servers through a translation device (the NAT64) with help from a modified DNS server (the DNS64). Stateful NAT64 is based on stateless NAT64 with several modifications. draft-van-beijnum-behave-frag64 and the NAT64 fragmentation presentation were meant to promote further discussion on how to handle the translation of fragmented packets in stateful and stateless NAT64s. These works were published as RFCs in April 2011.

FTP64

FTP64 was adopted by the BEHAVE working group for an application layer gateway that makes it possible for an IPv6 FTP client to connect and exchange files with an IPv4 FTP server. It has been published as RFC 6384 in October 2011. This RFC specifies an application layer gateway (ALG) that works together with NAT64 to allow the FTP protocol to work when FTP clients that only have IPv6 connectivity connect to FTP servers that only have IPv4 connectivity and don't understand the newer commands that are used with IPv6. The FTP64 ALG modifies the commands that the FTP client sends to the FTP server and the responses from the server to the client.

DMM (Distributed Mobility Management)

Carlos Jesús Bernardos, Antonio de la Oliva and Fabio Giust, all from UC3M, and the latter also a Research Assistant at IMDEA Networks, worked on «A IPv6 Distributed Client Mobility Management approach using existing mechanisms», (draft-bernardos-mext-dmm-cmip-00). This IETF Internet draft was presented in the 80th IETF meeting, held in Prague (Czech Republic), in March 2011. Later on that year, in July, at the 81st IETF meeting held in Quebec City (Canada), they produced another proposal to implement mobility in IPv6 networks: "A PMIPv6-based solution for Distributed Mobility Management" (draft-bernardos-mext-dmm-pmip-01).

Centralized solutions for IPv6 mobility management, as Mobile IPv6 (MIPv6), Proxy Mobile IPv6 (PMIPv6) and the rest of the IETF mobility standards, although simple from a logical point of view, introduce performance drawbacks and excessive costs for operators. The IETF Distributed Mobility Management (DMM) Working Group was hence created to define

the space of solutions that attempt to overcome the limitations of the centralized approach, while maintaining a simple philosophy. We participated at the very early stages of the DMM activities proposing two solutions that, based on MIPv6 and PMIPv6, respectively, re-arrange those entities and operations in order to achieve a distributed working mechanism.

6.2.2. IEEE

In 2011, Institute IMDEA Networks has actively participated in the IEEE (802.21 and 802.11 WGs), providing results from MEDIEVAL and FLAVIA projects. In particular, IMDEA Networks researchers worked in the following topics:

Vice-chairing IEEE 802.21 TGb

Antonio de la Oliva was elected as IEEE 802.21 TGb Vice-chair in July 2011. The main responsibility of the position resides in shepherding the IEEE 802.21b specification until it is finally approved by the IEEE 802 Executive Committee. The specification, which contains significant contributions from on-going (MEDIEVAL) and past (CARMEN) European projects, passed the Sponsor Ballot in November 2011 and is currently awaiting approval-which will hopefully be ratified on the March 2012 plenary meeting.

Leading of the IEEE 802.21 Future Project Planning Ad-hoc group

The IEEE 802.21a and IEEE 802.21b amendments are already completed and waiting for ratification from IEEE 802 EC. This opens the door to new projects within the IEEE 802.21. IMDEA Networks, through one of its collaborators, is currently leading the Ad-Hoc group in charge of defining the new working items. Even more, some of the ideas developed within MEDIEVAL have been proposed and accepted as working items. A new Project Authorization Request (on MIHF_ID Group Management) was prepared through the last months of 2011, and submitted for approval on January 2012. The new project, to be named IEEE 802.21 TGd, will hopefully be approved on the March 2012 meeting.

6.2.3. Contributions to IEEE 802.21a/b/c and IEEE 802.11

Apart from the above activities, several technical contributions to IEEE 802.21a/b/c and IEEE 802.11 were performed during the 2011 period. In IEEE 802.21a several contributions and comments to address the different letters and sponsor ballots were performed. The main technical contributions from MEDIEVAL and CARMEN were introduced in IEEE 802.21b during 2010 and beginning of 2011 (2011 being devoted to defending such contributions during the different ballots). IEEE 802.21c standardizes the mechanisms to enable optimized single radio handover. Some of the technical details of this approach are very similar to the issues analyzed for DMM, hence the solutions designed within MEDIEVAL have been contributed to the task group. Finally, part of the work

performed in FLAVIA was presented at the Next Wireless Generation Steering Committee (NWG SC), and was received positively.

IMDEA Networks researchers have been contributing actively and extensively to this body over the last years. In the above context, the following contributions were produced:

- Distributed Mobility Management using IEEE 802.21, Antonio de la Oliva, Fabio Giust and Carlos J. Bernardos, Presented in the 43th IEEE 802.21 meeting, held in March 2011.
- Network based Distributed Mobility Approach, Antonio de la Oliva, Fabio Giust and Carlos J. Bernardos, Presented in the 46th IEEE 802.21 meeting, held in July 2011.
- Flexibility on Channel Access Allocations, Antonio de la Oliva (UC3M), Ilenia Tinnirello (CNIT), Pablo Serrano (UC3M) and Francesco Gringoli (CNIT). Presented at the IEEE 802.11 WNG SC November 2011 meeting.

6.2.4. Technology transfer

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

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

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

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

Institute IMDEA Networks' policy to share a very high percentage of financial proceeds with inventors (our researchers) as reward for their excellence and hard work.

As an example of work addressed to patenting, in collaboration with **NEC Laboratories Europe and Universidad Carlos III de Madrid**, IMDEA Networks has worked towards the development of an invention to establish an original method for reducing the energy consumption of a network by minimizing the number of active nodes participating in a given communication. The collaborators filed a provisional patent application in 2011.

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

The above activities have led to a significantly increased portfolio of companies we collaborate with. All these companies currently include:

Albentia Systems (Madrid, Spain)

Alcatel Lucent Bell NV Belgium

ALCATEL-LUCENT BELL LABS, EE.UU.

ALCATEL-LUCENT BELL LABS, France

ALCATEL-LUCENT BELL LABS, Germany

Alvarion

Comsys Communication & Signal Processing Ltd

Docomo Communications Laboratories Europe (Munich, Germany)

Factory Holding Company 25

Fastweb SPA (FW)

France Telecom SA (FT)

Hewlett Packard Italiana SRL

Huawei Technologies Dusseldorf GmbH (HWDU)

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

Intel Mobile Communications France

LiveU

MobiMesh s.r.l.

NEC Europe Ltd.

Portugal Telecom Inovaçao

Sagemcom Energy & Telecom

Sequans Communications

Signalion GmbH

Sigma Orionis

Technicolor R&D, Paris

Telcordia Poland SP. Z O.O.

Telecom Italia S.p.a.

Telefonica Research (Telefonica Investigación y Desarrollo SA (TID))

ZED Worldwide, S.A,

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

Institute IMDEA Networks collaborates with the Madrid-region network of Scientific Parks and Clusters (Madrid Network) that brings together industry and research institutes in the region. We are members of the Audiovisual Cluster (*Cluster Audiovisual*) and the Security and Trust Cluster (*Cluster de Seguridad y Confianza*).

Madrid Network – Red de Parques y Clusters de la Comunidad de Madrid

Cluster Audiovisual

Cluster de Seguridad y Confianza

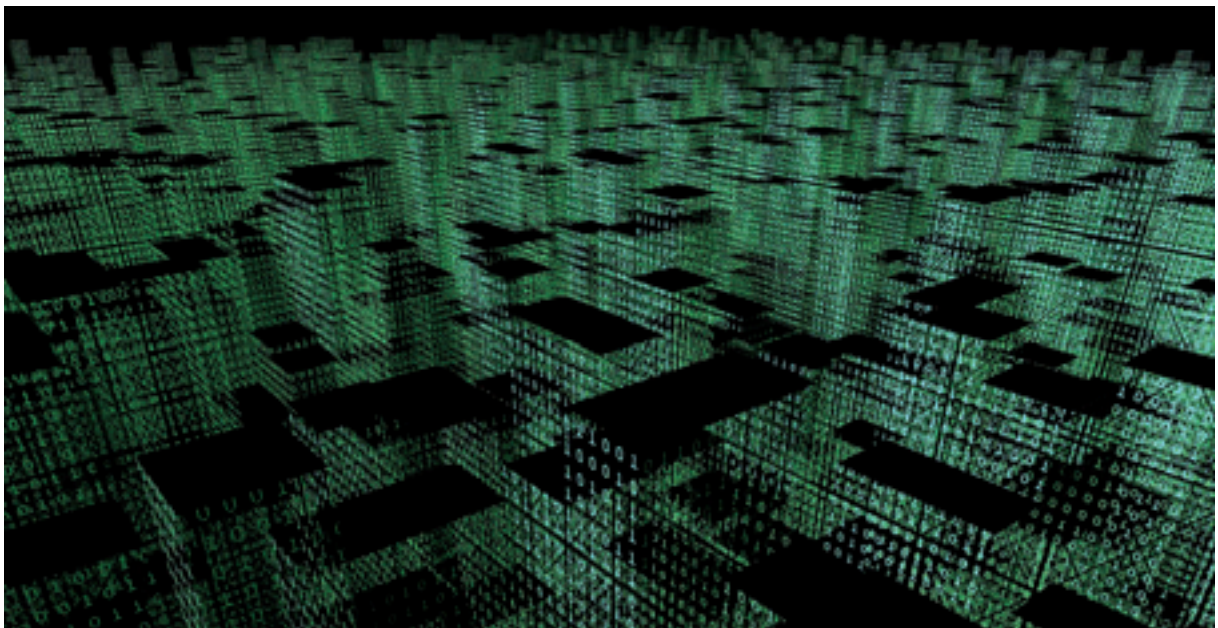
6.3. Media impact

A research study by Institute IMDEA Networks identifies who uploads the majority of the content to the P2P piracy networks (referenced by over 170 international media articles)

Report on the media impact of the joint publication by Institute IMDEA networks, the Universidad Carlos III de Madrid, Technische Universität Darmstadt and the University of Oregon

While it is not the Institute's approach to produce and broadcast results to reach the mass media, diffusion of our research activities amongst the general public contributes to create awareness of their relevance to society, improving the Institute's public profile, whilst increasing its overall visibility. Science has a capacity to catalyze positive change. It is IMDEA Networks' shared responsibility towards the individual and the community to employ adequate instruments to diffuse the benefits of its scientific output and potential widely and competently.

As already reported in 2010, the media repercussion of the publication ***Is Content Publishing in BitTorrent Altruistic or Profit Driven?*** presented at one of the leading international conferences on network research - the ACM CoNEXT 2010 held in San Diego, California (USA) from the 30 November to 3 December last - was dramatically enhanced at both a national and international level during 2011 due to two news items: the first sent out by the Press and Public Relations Service at the Institute IMDEA Networks (26/11/2010) and posted on our website to coincide with the conference kick-off, and the second released by the Universidad Carlos III de Madrid (24/01/2011), which also appeared in Madrimasd's "notiweb" service. The media repercussion was felt for about a month during 2011 since that second release.



Due to the publication of both news items and the work carried out by IMDEA Networks and the UC3M to maximize their take up, foremost national and international media echoed the results of this joint study led by the UC3M, the Institute IMDEA Networks, Technische Universität Darmstadt (TUD) and the University of Oregon. The news was carried online (in news boards, articles and blogs), in print (magazines) and the audiovisual media (in news reports and interviews that appeared on various national television channels).

The authors of the study

Rubén Cuevas (Univ. Carlos III de Madrid), Michal Kryczka (Institute IMDEA Networks and Univ. Carlos III de Madrid), Ángel Cuevas (Univ. Carlos III de Madrid), Sebastian Kaune (TU Darmstadt), Carmen Guerrero (Univ. Carlos III de Madrid), Reza Rejaie (Univ. of Oregon).

The collaboration with national and international research bodies that has made such excellent research results possible

IMDEA Networks strives to bring together scientists, researchers, institutions, governing bodies and companies that share our interest in carrying out and promoting top level, cutting-edge research in the field of network technologies. We seek to provide a consistent meeting point where individuals and institutions can foster collaboration and go on to design new lines of work, through specific research-related activities.

The levels of collaboration behind this work are as follows:

- NEC Laboratories Europe (Heidelberg, Germany) and Technische Universität Darmstadt (TUD) (Darmstadt, Germany) - Memorandum of Understanding.
- Universidad Carlos III de Madrid (UC3M) – a wide-reaching collaboration agreement.
- University of Oregon – a temporary contract (September 2009 – August 2010) that has enabled Dr. Reza Rejaie to work at the Institute IMDEA Networks as a Visiting Researcher, where he also played an active role in the NETCOM research group at the UC3M's Telematics department.

The media impact of this publication only serves to consolidate the Institute's mission to promote international collaboration throughout Europe. Collaboration with other research bodies is, and will continue to be, vital if we are to address and resolve the most pressing challenges facing the technological development of communication networks. This is one specific example of how scientific research can be of great social, political and economic relevance; this relevance can even be immediate and clearly recognized as such, when research adds scientific arguments to a discussion that affects numerous interest groups. In this particular instance, the research proved

relevant to the controversial additional stipulation of the Spanish "Ley de Economía Sostenible" (Law for a Sustainable Economy or LES), otherwise known as the "Ley SINDE", which represented the first "anti-download" legislation introduced in Spain, i.e. the first rules proposed by the Government to shut down websites that link to content subject to copyright.

The recognition generated can only serve to strengthen the bonds that unite the organizations involved in this research project still further, and to incentivize the international community to pay an interest in getting to know and collaborating with this research institution which, in spite of its youth, is already more than able to make a significant socio-economic impact.

In the words of Dr. Albert Banchs, Deputy Director of the Institute IMDEA Networks: IMDEA Networks operates in a field of knowledge that is key to today's society: that of information and communication technologies. ICT plays a vital role in our day-to-day activities, whether they are of an economic, political or cultural nature. Information in all its forms and expressions serves to generate wealth and society's capacity to understand, communicate and thereby tap knowledge determines its economic development.

Summary of the research results on network piracy

The study found that the distribution of largely copyright files on major BitTorrent portals, such as The Pirate Bay, is dominated by about 100 publishers.

Around 40 profit-making content publishers are responsible for 40 percent of BitTorrent downloads of content largely subject to copyright, such as TV series or Hollywood movies. Furthermore, 25% of downloads are associated to fake content published by either antipiracy agencies or malicious users.

The authors concluded that «Content publishing in BitTorrent is largely driven by companies with financial incentive. Therefore, if these companies lose their interest or are unable to publish content, BitTorrent traffic/portals may disappear or at least their associated traffic will significantly reduce».

Media impact

A selection of the most relevant media impact follows:

TV

TVE (Number one Spanish state-owned television cannel): 01/26/2011
"Las asociaciones de internautas estudian llevar al Constitucional la ley Sinde"
"Asociaciones de internautas proponen que se aparque la Ley Sinde y que se elimine el canon digital"

Antena3 (Spanish private television cannel): 01/30/2011
"¿Quién está detrás de los contenidos subidos a internet?"

Newspapers: ABC / El Pais / Publico / etc


¿QUIÉN SUBE LOS ARCHIVOS A INTERNET?

Cien grandes piratas manejan la Red

Un estudio de la Carlos III revela que solo un centenar de usuarios sube a internet el 66% de los archivos ilegales

700 gigas y ocho meses de trabajo

Cómo

Archivos descargados en el sur de Europa

Películas 66,7%

Animación japonesa 4,6%

TV 4,5%

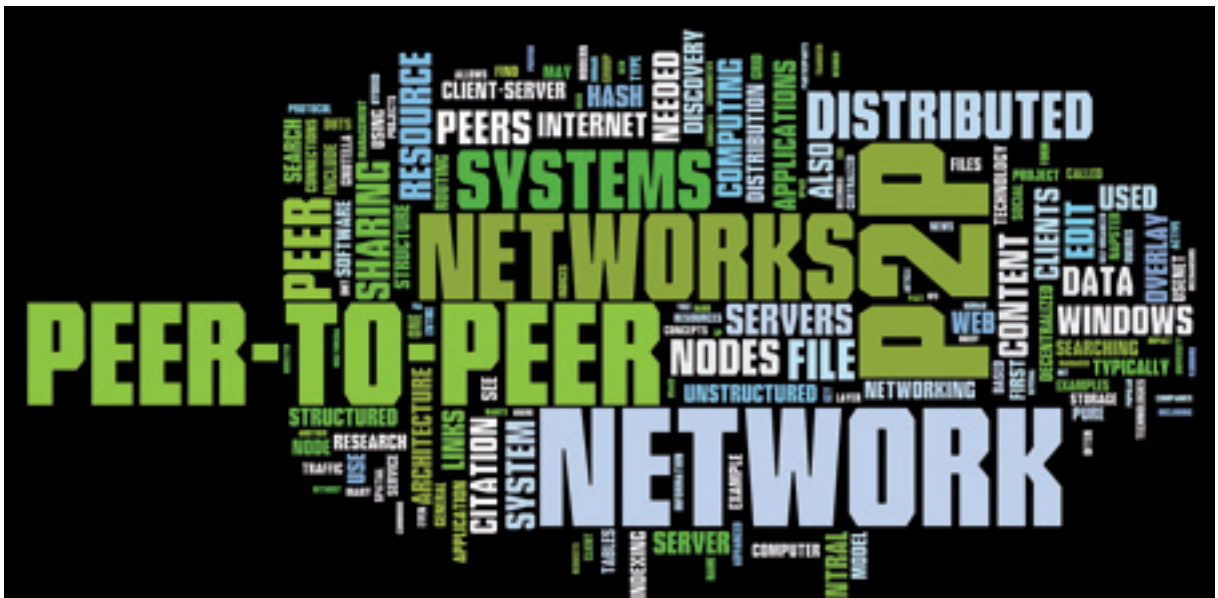
ABC (online and print news): 01/26/2011 "Cien grandes piratas manejan la red"

El País digital (online news): 01/26/2011 "¿Quién sube las películas al BitTorrent?"

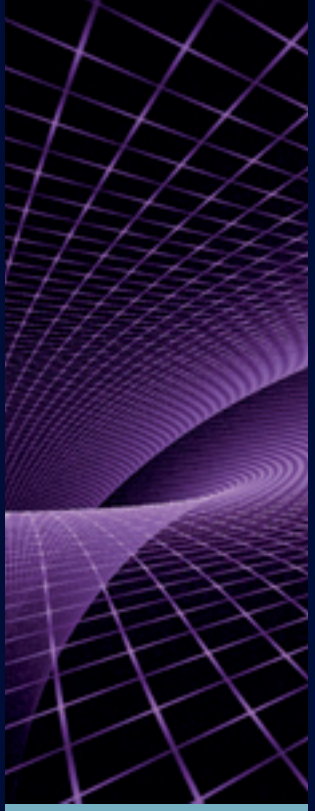
Blogs: Meneame /ars technica / Slashdot / etc.

Ars technica (one of the top technology oriented blogs at international level, together with Slashdot): 01/25/2011 "25% of files downloaded from The Pirate Bay are fakes"

International media impact: ACM TechNews / Newsguide / Redorbit.com / bit-tech /etc.



7 personnel



deputy director

The Deputy Director is responsible for managing and overseeing the scientific activities and the administration and of the institute, with the powers, duties and responsibilities conferred to it by the Board of Trustees, to which it reports.

Dr. Albert BANCHS

Deputy Director

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Short biography:

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

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

Since October 2003, Dr. Banchs is with the University Carlos III of Madrid, where he currently holds the position of Associate Professor. From 2003 to 2008 he worked on the EU projects Daidalos I and Daidalos II, where he led the activity of QoS over heterogeneous networks. Since October 2009, he is also Deputy Director of IMDEA Networks. His research interests include performance evaluation and resource allocation in wireless networks.

chief researchers

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

Dr. Marco AJMONE MARSAN

Chief Researcher

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Short biography:

Marco Ajmone Marsan holds a double appointment as Chief Researcher at IMDEA Networks (Spain) and Full Professor at the Department of Electronics (Dipartimento di Elettronica) of the Politecnico di Torino (Polytechnic University of Turin) (Italy). He is the founder of the Telecommunication Networks Group, one of the top research groups in networking in Europe, based at the Politecnico di Torino.

From 2003 to 2009 he was Director of the IEIIT-CNR (Institute for Electronics, Information and Telecommunication Engineering of the National Research Council of Italy). From 2005 to 2009 he was Vice-Rector for Research, Innovation and Technology Transfer at Politecnico di Torino.

He earned his graduate degree in Electrical Engineering (Laurea (110/110)), from the Politecnico di Torino in 1974. This was the highest degree in the field obtainable in Italy at the time. He went on to complete his M.Sc. Electrical Engineering at the University of California at Los Angeles (USA) in 1978 and, in 2002, he was awarded an "Honoris Causa" Ph.D. in Telecommunication Networks from the Budapest University of Technology and Economics.

Marco Ajmone Marsan is involved in several national and international scientific groups: He is Chair of the Italian Group of Telecommunication Professors (GTTI); Italian Delegate in the ICT Committee of the EC's 7th Framework Program; and Fellow of the IEEE. He was also principle investigator for a large number of research contracts with industries, and coordinator of several national and international research projects.

His outstanding contributions to his field were recognized in 2006, when the President of Italy, Carlo Azeglio Ciampi, awarded him the "Commendatore» of the "Ordine al Merito della Repubblica Italiana» (Commander of the Republic of Italy's Order of Merit). In 2003, he was also listed by Thomson-ISI amongst the most highly-cited researchers in Computer Science.

Dr. Nicholas F. MAXEMCHUK

Chief Researcher

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

He holds a M.Sc. in Electrical Engineering and a Ph.D. in Systems Engineering, both from the University of Pennsylvania (Philadelphia, USA). Before joining Columbia University and IMDEA Networks, Nick Maxemchuk held the position of Technical Leader at AT&T Research Laboratories (1996-2001) and, prior to that, was the Head of Distributed Systems Research Department at AT&T Bell Laboratories (1976-1996).

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

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

As well as owning 30 patents and publishing three books, Nicholas Maxemchuk has co-authored over 100 publications. His strong reputation as an eminent scientist has earned him many editorial and advisory positions with organizations including the IEEE, ACM, NSF Expert Group and the United Nations. He has published three award winning papers and had two of his publications voted into the Communication Society 50th Anniversary Issue. He is a member of the Board of Governors of the Armstrong Foundation and also works as a Consultant on Data Networks in Transportation Networks for The National Academies/Transportation Research Board.

senior researchers

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

Dr. Antonio FERNÁNDEZ ANTA

Senior Researcher

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Short biography: Antonio Fernández Anta is a Senior Researcher at Institute IMDEA Networks since the fall of 2010. Previously he was a Full Professor at the Universidad Rey Juan Carlos in Madrid, where he has been on the Faculty since 1998. Prior to that he was on the Faculty of the Universidad Politécnica de Madrid. He has been a postdoc at the Massachusetts Institute of Technology from 1995 to 1997.

Short biography:
Antonio has almost 20 years of research experience, with a steady productivity of more than 5 papers per year on average. He has published in top conferences and journals like INFOCOM, STOC, FOCS, PODC, DISC, Journal of the ACM, IEEE/ACM Transactions on Networking, SIAM Journal on Computing, or IEEE Transactions on Computers. He is vice-chair of the Steering Committee of DISC and member of the Steering Committee of Opodis. He has chaired or served in the TPC of a number of conferences and workshops. He is a senior member of the IEEE since 2002 and of the ACM since 2007.

Antonio received his M.Sc. and Ph.D. degrees in Computer Science from the University of Louisiana in 1992 and 1994, respectively. His PhD thesis studied the Cartesian product of graphs as a mean to construct efficient interconnection networks for multiprocessors. He completed his undergraduate studies (Licenciado and Diplomado en Informática) at the Universidad Politécnica de Madrid, Spain, in 1988 and 1991 respectively, having received awards at the university and national levels for his academic performance.

Dr. Sergey GORINSKY

Senior Researcher

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Short biography:
Sergey Gorinsky received an Engineer degree from Moscow Institute of Electronic Technology, Zelenograd, Russia in 1994 and M.S. and Ph.D. degrees from the University of Texas at Austin, USA in 1999 and 2003 respectively. From 2003 to 2009, he served on the tenure-track faculty at Washington University in St. Louis, USA. Dr. Gorinsky currently works as a Senior Researcher at Institute IMDEA Networks, Madrid, Spain. The areas of his primary research interests are computer networking and distributed systems. His research contributions include multicast congestion control resilient to receiver misbehavior, analysis of binary adjustment algorithms, efficient fair transfer of bulk data, network service differentiation based on performance incentives, and economic perspectives on Internet routing. His work appeared at top conferences and journals such as ACM SIGCOMM, IEEE INFOCOM, ACM CoNEXT, IEEE/ACM Transactions on Networking, and IEEE Journal on Selected Areas in Communications. Sergey Gorinsky has served on the TPCs (technical program committees) of SIGCOMM (2012), INFOCOM (2006-2013), ICNP (2008, 2010-2012), and other networking conferences. He co-chaired E6 2012 (Energy in Communication, Information, and Cyber-physical Systems 2012, a COMSNETS 2012 workshop), HSN 2008 (High-Speed Networks 2008, an INFOCOM 2008 workshop), FIAP 2008 (Future Internet Architectures and Protocols 2008, an ICCCN 2008 symposium) and served as a TPC vice-chair for ICCCN 2009. His professional services also include general co-chairing for WoWMoM 2013 and TPC co-chairing for COMSNETS 2013.

Dr. José Félix KUKIELKA

Senior Researcher

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Previous position: Visiting Professor. University Carlos III of Madrid. Spain
Research: Wideband access to private networks; Quality of Service in Wireless networks; Service-aware Wireless Routing; Wireless Protocol Optimization for High-throughput Data and Voice
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Short biography:
José Félix Kukielka is Senior Researcher at IMDEA Networks and Lecturer at the University Carlos III of Madrid (UC3M) (Madrid, Spain). From 2003 until 2007, he worked at the UC3M as Ramón y Cajal Researcher. He obtained his undergraduate degree at the Universidad Nacional Autónoma de México (Federal District, Mexico) in 1972, and went on to complete a M.Sc. and a Ph.D., both at the University of California, Berkeley (Berkeley, USA).

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

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

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

Dr. Joerg WIDMER

Senior Researcher

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Short biography:
Joerg Widmer is a Chief Researcher at Institute IMDEA Networks in Madrid, Spain. His research expertise covers computer networks and distributed systems, ranging from MAC layer design, sensor networking, and network coding to transport protocols and Future Internet architectures. From June 2005 to July 2010, he was manager of the Ubiquitous Networking Research Group at DOCOMO Euro-Labs in Munich, Germany, leading several projects in the area of mobile and cellular networks. Before joining DOCOMO Euro-Labs, he worked as post-doctoral researcher at EPFL, Switzerland on ultra-wide band communication and network coding.

Joerg Widmer received his M.S. and PhD degrees in computer science from the University of Mannheim, Germany in 2000 and 2003, respectively. In 1999 and 2000 he was a visiting researcher at the International Computer Science Institute in Berkeley, CA, USA. He authored more than 100 conference and journal papers and three IETF RFCs, holds several patents, serves on the editorial board of IEEE Transactions on Communications, and regularly participates in program committees of several major conferences. He is senior member of IEEE and ACM.

staff researchers

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

Dr. Pierre Francois

Staff Researcher

PhD: Université catholique de Louvain. Belgium
Previous position: Post-Doc Researcher. Fonds national de la recherche scientifique (FNRS). Belgium
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Short biography:

Dr. Pierre Francois is a Staff Researcher at Institute IMDEA Networks since September 2011. Pierre Francois received his B.Sc. in Economics and Management Science from the Facultés Notre Dame de la Paix in Namur, Belgium, where he also holds a Masters in Computer Science. He obtained his Ph.D. from Université catholique de Louvain in 2007. He received the IEEE INFOCOM 2007 Best Paper Award. His main topics of interest are notably IP Routing scaling and convergence, Internet Governance, Internet Routing economics, and Network measurements. Pierre Francois is active in standardization, holding an extensive list of IETF contributions.

Dr. Vincenzo MANCUSO

Staff Researcher

PhD: University of Palermo. Italy
Previous position: Post-Doc Researcher. INRIA Sophia Antipolis- Méditerranée. France
Research: Network Protocols; QoS; Wireless Networks; Green IT; Performance Analysis
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Short biography:

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

Dr. Balaji RENGARAJAN

Staff Researcher

PhD: University of Texas at Austin. USA
Previous position: Graduate Research Assistant
Research: Measurement, Modeling and Performance Evaluation of Wireless Networks, Ad-hoc and Sensor Networks
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Short biography:
Balaji Rengarajan joined IMDEA Networks in 2010 and is currently working there as a staff researcher. He received his Ph.D. and M.S. in electrical engineering from the University of Texas at Austin in 2009 and 2004 respectively, and his B.E. in Electronics and Communication from the University of Madras in 2002. He was the recipient of a 2003 Texas Telecommunications Engineering Consortium (TxTEC) graduate fellowship and a 2010 Marie-Curie "Amarout Europe Programme" fellowship. His main research interests include the measurement, modeling and performance evaluation of wired and wireless networks.

Dr. Gianluca RIZZO

Staff Researcher

PhD: EPFL Lausanne. Switzerland
Previous position: System engineer - Utility Communications. ABB Switzerland. Suiza
Research: Performance Evaluation of Communication Networks; Network Calculus; Quality of Service
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Short biography:
Gianluca Rizzo was born in Galatina (Lecce), Italy, in 1975. He received the degree in electronic engineering from the Politecnico di Torino, Torino, Italy, in 2001. From September 2001 to December 2003, he has been a researcher in Telecom Italia Lab, Torino, Italy. From January 2004, to October 2008, he has been at EPFL Lausanne, where he received his PhD in computer science. From November 2008 to August 2009 he has been with ABB Switzerland. From September 2009, he is staff researcher at Institute IMDEA Networks.

Dr. Rade STANOJEVIĆ

Staff Researcher

PhD: National University of Ireland. Maynooth. Ireland
Previous position: Post-Doc Researcher. Telefonica Research. Barcelona. Spain
Research: Performance Evaluation; Network Economics
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Short biography:
Rade Stanojević obtained his B.Sc. in Mathematics from University of Nis, Serbia and a Ph.D. from Hamilton Institute, NUIM, Ireland. His current research interests span performance evaluation, network economics and energy aware computing. His work on decentralized cloud control has been awarded the ACM SIGMETRICS 2008 Kenneth C. Sevcik Outstanding Student Paper Award and the IEEE IWQoS 2009 Best Paper Award. Since fall 2010 he is a staff researcher in the IMDEA Networks Institute, Madrid. Prior to that he was a post-doc with Telefonica Research, Barcelona.

visiting researchers

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

Dr. Dariusz KOWALSKI

Visiting Researcher

PhD: Warsaw University. Poland
University of origin: University of Liverpool. UK
Previous position: Assistant Professor. Warsaw University. Poland
Research: algorithms and data structures; foundations of distributed/ parallel/network/mobile computing and communication; fault-tolerant aspects of communication; communication algorithms for wireless networks
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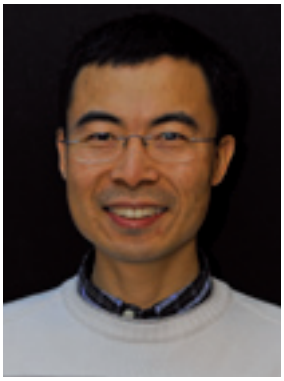
Short biography:
Dariusz Kowalski received his MSc in Mathematics in 1996 and PhD in Computer Science in 2001, both from the University of Warsaw, Poland. He was a postdoctoral researcher at the University of Quebec, Canada, at the University of Connecticut, USA, and in the Max-Planck Institute fuer Informatik, Germany. He is currently a Reader in Computer Science at the University of Liverpool, United Kingdom, and a visiting researcher at IMDEA Networks, Spain.

His areas of expertise include algorithms and data structures, fault-tolerant aspects of computer science, and distributed/ parallel/ network/ mobile computing. In the last few years he developed and analyzed several algorithms for: communication in wireless and ad hoc networks (including multi-broadcast, leader election and routing algorithms); contention-resolution in a multiple-access channel; traffic-scheduling; classical distributed computing problems, such as consensus, work scheduling, shared-memory store&collect; dynamic distributed computing problems, including group communication, rumor and work scheduling; other related aspects of distributed and network computing, including quantum model of computation, fault-tolerance, combinatorial group testing.

Currently Dr Kowalski focuses on: reliability of wireless broadcast protocols with block acknowledgment; design and analysis of better epidemic communication protocols; energy aspects of dynamic distributed work scheduling protocols; queuing aspects of distributed multi-access communication processes; models and algorithms for micro- and nano-scale wireless communication and computing.



Dr. Jun LI

Visiting Researcher

Affiliation: Institute IMDEA Networks and University Carlos III of Madrid (*Cátedra de Excelencia*)
PhD: University of California, Los Angeles. USA
University of origin: University of Oregon. USA
Research: Networking Architecture and Protocols; Network Security
Contact: lijun@cs.uoregon.edu
Personal site:
http://ix.cs.uoregon.edu/~lijun/

Short biography:
Dr. Jun Li is an associate professor in the Department of Computer and Information Science at the University of Oregon, and directs the Network Security Research Laboratory there.

He received his Ph.D. from UCLA in 2002 (with honors), M.E. from Chinese Academy of Sciences in 1995 (with Presidential Scholarship), and B.S. from Peking University in 1992, all in computer science. In 2011 he is also a «Catedra de Excelencia» (Chair of Excellence) at the University Carlos III of Madrid, Spain, and a visiting researcher at the IMDEA Networks Institute in Spain.

Specialized in computer networks, distributed systems, and their security, Dr. Jun Li is currently researching Internet monitoring and forensics, social networking, future Internet architecture, and various network security topics. He studies both direct countermeasures against network security attacks (including Internet worms, phishing, and botnets) and fundamental security issues and solutions at the network architecture and protocol level (such as security for Internet routing, DNS, and peer-to-peer networking). He has also done research on open architecture and programmable network as well as sensor networks.

He has published a book on disseminating security updates over the Internet and more than 30 peer-reviewed papers. He has also served on several USA National Science Foundation research panels and more than 50 international technical program committees. He is a 2007 recipient of the prestigious NSF CAREER award, a senior member of ACM, and a senior member of IEEE.

research assistants

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

Shahzad ALI
Research Assistant

Institute IMDEA Networks Job Title: Research Assistant
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Previous position: Department of Computer Science, COMSATS Institute of Information Technology. Abbottabad. Pakistan
Research: Wireless Sensor Networks; Vehicular Ad hoc Networks; Opportunistic Networks; Future Mobile Communication Networks
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Jordi ARJONA
Research Assistant

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Research: WSN's; WSAN's; Real Time Networks; QoS; Security
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Arash ASADI
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Previous position: Research Scholar. Multimedia University. Malaysia
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Pradeep BANGERA
Research Assistant

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Previous position: Manipal Institute of technology, Manipal University. India
Research: Routing in Vehicular Ad Hoc Networks; Security and Privacy Issues in VANET; MAC Layer Routing in VANET
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Alex BIKFALVI
Research Assistant

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Research: Peer-to-peer; Overlay Networks; Hierarchical Overlay Networks; Distributed Hash Tables; Application Level Multicast; Video Streaming; Grid Resource Discovery; Content Distribution
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Research Assistant

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Research Assistant

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Research Assistant

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Fabio GIUST
Research Assistant

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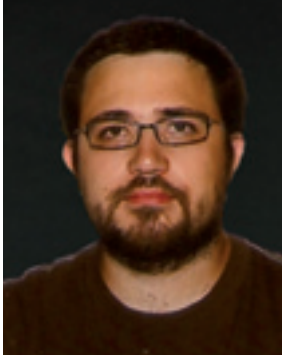

Israel GUTIÉRREZ ROJAS
Research Assistant

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Research: Internet Topology; Internet Economics - Cost structures of realistic ISPs and Pricing Models; Network Science, Traffic Engineering - Network Planning and Performance Evaluation
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Iljitsch VAN BEIJNUM
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Kshitiz VERMA
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Research: Cryptography; Number Theory; Information Security; Computer Networks
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Qing WANG
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Previous position: University of Electronic Science and Technology of China (UESTC), Chengdu, China
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Elli ZAVOU
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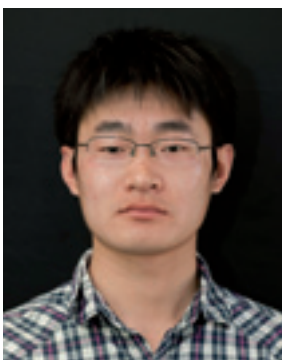

research team structure

network protocols&algorithms

Group Leader:
Dr. Sergey Gorinsky

Researchers:
- Dr. Piere Francois
- Dr. Darek Kowalski
- Dr. Rade Stanojević

Research Assistants:
- Pradeep Bangera
- Alex Bikfalvi
- Juan Camilo Cardona
- Ignacio de Castro
- Muhammad Naveed Dilber
- Michal Kryczka
- Andra Lutu
- Syed Anwar Ul Hasan
- Iljitsch van Beijnum

wireless networking

Group Leader:
Dr. Joerg Widmer

Researchers:
- Dr. José Félix Kukielka
- Dr. Vincenzo Mancuso
- Dr. Nicholas Maxemchuk

Research Assistants:
- Arash Asadi
- Andrea Capalbo
- Angelos Chatzipapas
- Lucas Eznarriaga
- Sim (Allyson) Gek Hong
- Fabio Giust
- Marco Gramaglia
- José Pablo Salvador
- Vincenzo Sciancalepore

energy-efficient networking

Group Leader:
Dr. Antonio Fernández Anta

Researchers:
- Dr. Marco Ajmone Marsan
- Dr. Balaji Rengarajan
- Dr. Gianluca Rizzo

Research Assistants:
- Shahzad Ali
- Jordi Arjona
- Israel Gutiérrez Rojas
- María Isabel Sánchez
- Kshitiz Verma
- Qing Wang
- Elli Zavou

Our current team

administrative unit

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

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

general manager

Alejandro GIROD ENTERRIA
General Manager

Qualifications: MBA. IE Business School. Madrid. Spain
Contact: alejandro.girod@imdea.org

management and administration team

Rebeca DE MIGUEL
Operations Support Manager

Qualifications: Licenciatura en Ciencias de la Comunicación (Periodismo). Universidad del País Vasco. Spain; BA (Hons) in History and Theory of Art & Film Studies. University of Kent at Canterbury. UK
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rebeca.demiguel@imdea.org

Brian DUNNE
Human Resources Manager

Qualifications: BBS in Business Studies and French. Trinity College Dublin. Ireland
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Ana GONZÁLEZ
Projects & Funding Manager

Qualifications: BA (Hons) "Modern European Studies". Thames Valley University, London. UK; Postgraduate Diploma in "European Studies". Thames Valley University, London. UK
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Joel ROSENTAL
Systems Administrator

Qualifications: Degree in Computer Engineering. Universidad José Antonio Paéz. Venezuela; Master in Informatics Engineering. Universidad Carlos III de Madrid. Spain
Contact: joel.rosental@imdea.org

alumni network

The Institute's Alumni Network is built upon graduate Research Assistants 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 Institute IMDEA Networks' ambassadors worldwide, creating awareness and opening up new communication channels with the global scientific community.

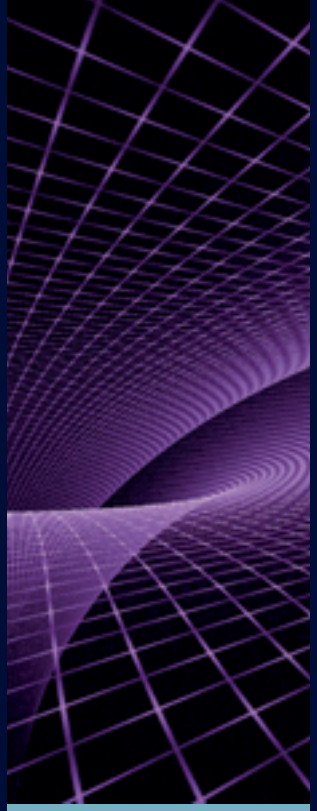
Dr. Paul PATRAS

After graduating, Dr. Patras became a research fellow at the Hamilton Institute of the National University of Ireland, Maynooth. Being the first graduate from our Research Assistantship program and having obtained his PhD from UC3M, Patras is the proud first member of our Alumni Network.

Graduation date: March 2011
Contact: patras@ieee.org

premises and research laboratories infrastructure

8



8.1. Research laboratories

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

These laboratories are used for:

- Constructing prototypes and measuring the devices, protocols and algorithms developed by the researchers.
- Simulating complex base-band and medium access systems, as well as sophistica- ted radio subsystems.
- Measuring radio parameters involved in mobile, fixed and satellite communications, designing and characterizing radiating elements, and measuring the effects on the radio electric spectrum of new protocols and algorithms designed by the Institute.

Examples of the laboratories capabilities include:

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

Generation of RF signals up to 6 GHz using the Agilent N5182A RF Vector Signal Generator

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

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

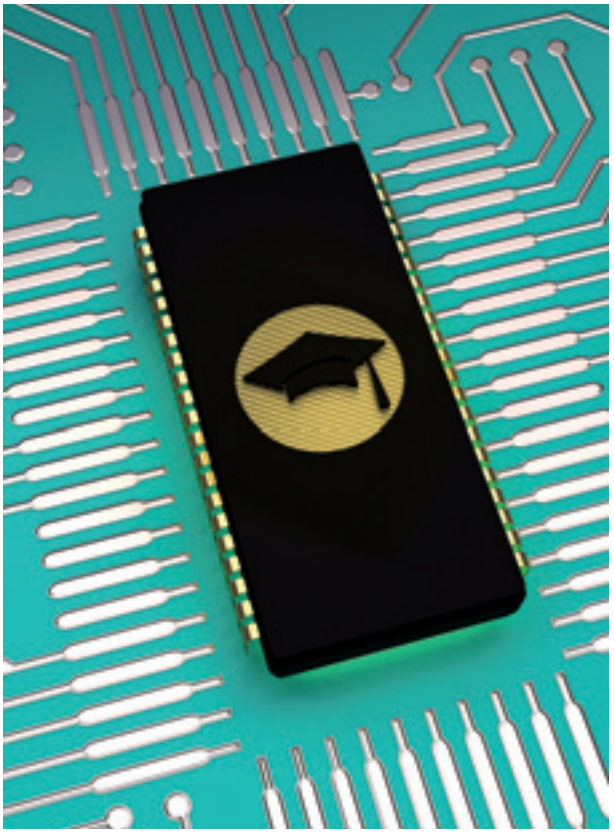
Research and development on mesh network topologies using Meshnode devices. These are programmable wireless nodes equipped with multiple radios that can provide network communication coverage for large areas.

Optimization of WiMAX scheduling, queue management and cross-layer optimization using ARQ/HARQ. The newly developed algorithms are implemented on special WiMAX base stations provided by Albentia Systems under a collaborative agreement.

The Endace DAG 7.5G2 Network Monitoring Card together with the NetOptics 10/100/1000 BaseT Tap provides 2Gbps sustained, lossless, traffic capture and inspection on 10/100/1000BASE-T and optical Gb/s Ethernet (GbE) networks.

The laboratories are supported by a high-performance scientific computing infrastructure consisting of a dedicated server cluster equipped with a Dell R710 (8 cores Intel Xeon E5640, 48 GB RAM, 6 TB local storage), a Dell C6100 (32 cores Intel Xeon E5640, 192 GB RAM, 24 TB storage local), and a Dell Equallogic PS610 (10 Gb/s Storage Arrays with 32 TB raw disk space).

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



8.2. Future purpose-built permanent research centre

IMDEA Networks will soon start building its purpose-built permanent research centre with cutting edge and well-equipped research facilities. This centre will be located in one of the science and technology parks that are being created by the joint ventures between regional public universities and the Regional Government of Madrid. Science and technology parks are high quality spaces and installations where knowledge and technology flow is stimulated and managed between universities and research institutions, companies and markets; they promote the creation and growth of innovative companies through incubation and spin-off mechanisms as well as provide other added value services. Science and technology parks provide their clients with advanced professional support services, reinforcement and promotion of research, innovation and development, collaboration mechanisms and specialized training schemes.

IMDEA Networks permanent headquarters will be constructed on a plot of land of 7,716 m^2 that has been kindly ceded by UC3M in TECNOLEGANÉS, (also known as "LEGANÉS TECNOLÓGICO") the largest Science and Technology Park in Spain, and part of the Madrid Network initiative. TECNOLEGANÉS is located in the South-East area of Madrid, alongside the Toledo road, and between two major Madrid highways, the M-40 and the M-45, which provide fast links to the airport and Madrid city center. The park is also located near UC3M's Leganes Campus. The site has a total surface of 2,804,878 square meters, and it is expected that around 500 companies will find a space to thrive there, and will in turn employ around 15,000 people. The park is being built in 3 phases: on the recently concluded first phase, 229,7 million Euros have been invested to develop a space of 507,374 m^2, which has been distributed amongst 53 businesses, generating over 2000 jobs.

IMDEA Networks will be strategically located for the development of its activities due to its proximity to the TECNOLEGANÉS' Headquarters. UC3M houses its innovation centers, university institutes, business incubators and laboratories in this park, facilitating the dissemination of knowledge, and the transfer of ideas, experiences and capabilities within the science and business communities.

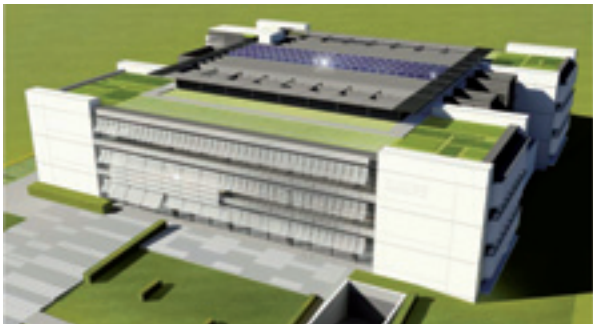
Parcel of Land – TECNOLEGANES

8.2.1. Providing a Centre for World-Class Research

Our purpose-built research centre on the TECNOLEGANÉS park is intended to fulfill the functional requirements of a leading-edge research centre and to attract researchers from around the World. Its physical presence at the park is critical with regards to the Institute's role within the international research arena and especially in respect to its technology transfer oriented objectives. The location will provide a meeting place for public and private sector researchers in order to maximize the Institute's potential as a driving force for technological evolution and economic growth.

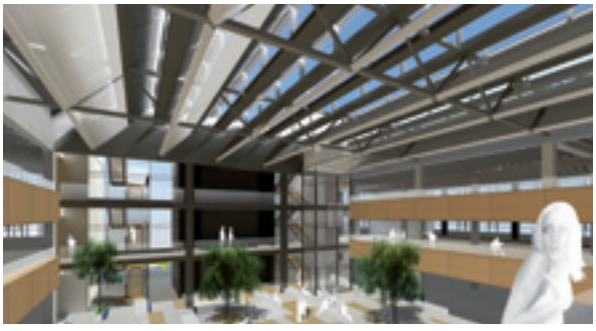
The main aim of the building design is to provision a high quality working environment for researchers. It has been conceived primarily with researchers' needs and preferences in mind, including open spaces, discussion areas, laboratories, support service etc. Thinking about the future and the natural evolution of any scientific enterprise (new research lines, projects, equipment, team members etc), the interior design will be very flexible, allowing relatively quick, easy and inexpensive reconfiguration of space to adapt to changing requirements.

Our research centre is to be built in 2 phases, comprising two adjacent and integrated buildings with an interior atrium to serve as structural meeting place and a meaningful centre point to our networking philosophy. The building will occupy approximately 4.610 m^2 on 3 floors (ground, first and second) above ground level.



Basic Design Project – Aerial view – Front entrance

Basic Design Project – Aerial view – Side view

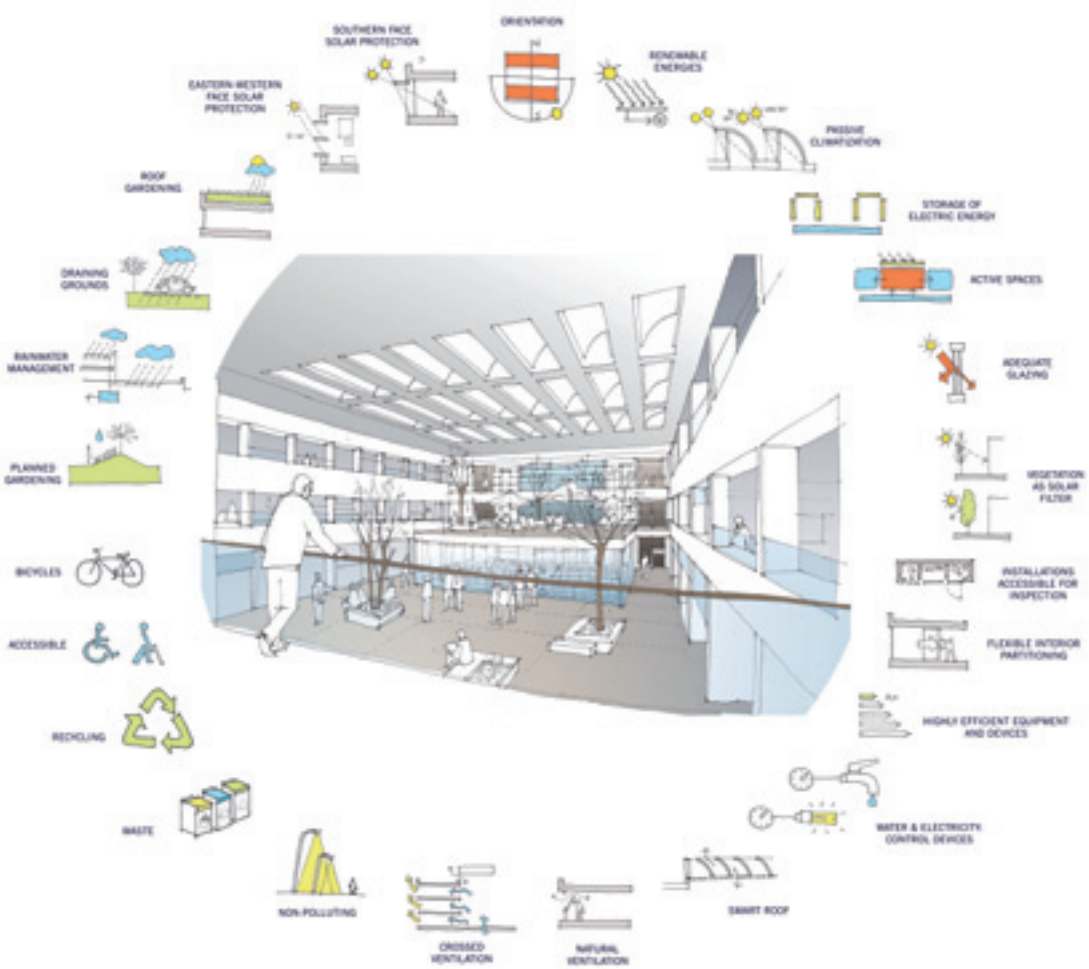


Basic Design Project –Interior views (atrium)

8.2.2. An Eco Friendly Building

Our future workplace has been designed with an array of characteristics to guarantee an environmentally friendly approach to its construction and maintenance:

- Sustainable building
- Environmentally responsible and resource-efficient
- Efficient use of energy, water, and other resources
- Taking advantage of renewable resources
- Highly efficient heating and cooling system
- Green roof
- Optimization of sunlight
- Most modern ICT for energy efficiency
- ICT for research on energy efficiency networks



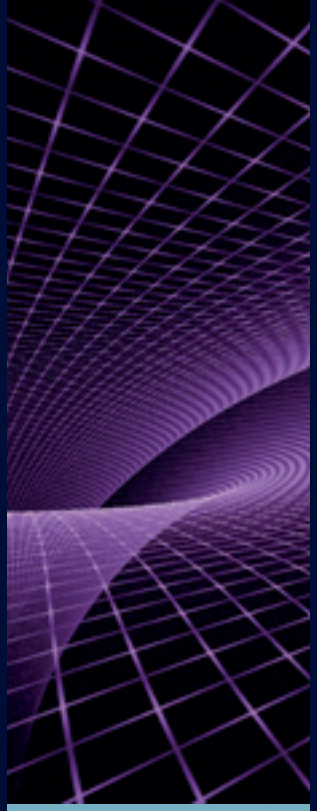
8.2.3. Networking Infrastructure and Equipment

The infrastructure and equipment to be integrated within the building are at the core of its purpose to be: to be innovative and to do innovation. They will complement the space and will fit in with the design to provide researchers with the right balance to encourage scientific ideas and experimental performance of the highest order. Thus, the building shall accommodate:

- A customized infrastructure for networking research
- The most modern and sophisticated equipment
- Laboratories and demo rooms
- Terrace with antennas
- Anechoic chamber
- Internet of Things Laboratory
- Raised floor over the entire building

8.3. Provisional headquarters

The construction of IMDEA Networks' purpose built research center will take between 2-3 years. Thus, provisional headquarters have been refurbished in office space ceded by UC3M at Avenida del Mar Mediterráneo in Leganés, near its future permanent location. This temporary office space will be utilized until the final move to the purpose built research centre is completed. It provides fully renovated facilities for researchers to carry out their work in an atmosphere of openness, collaboration and a common driving force: the pursuit of excellence.



9 organization

9.1. Legal status

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

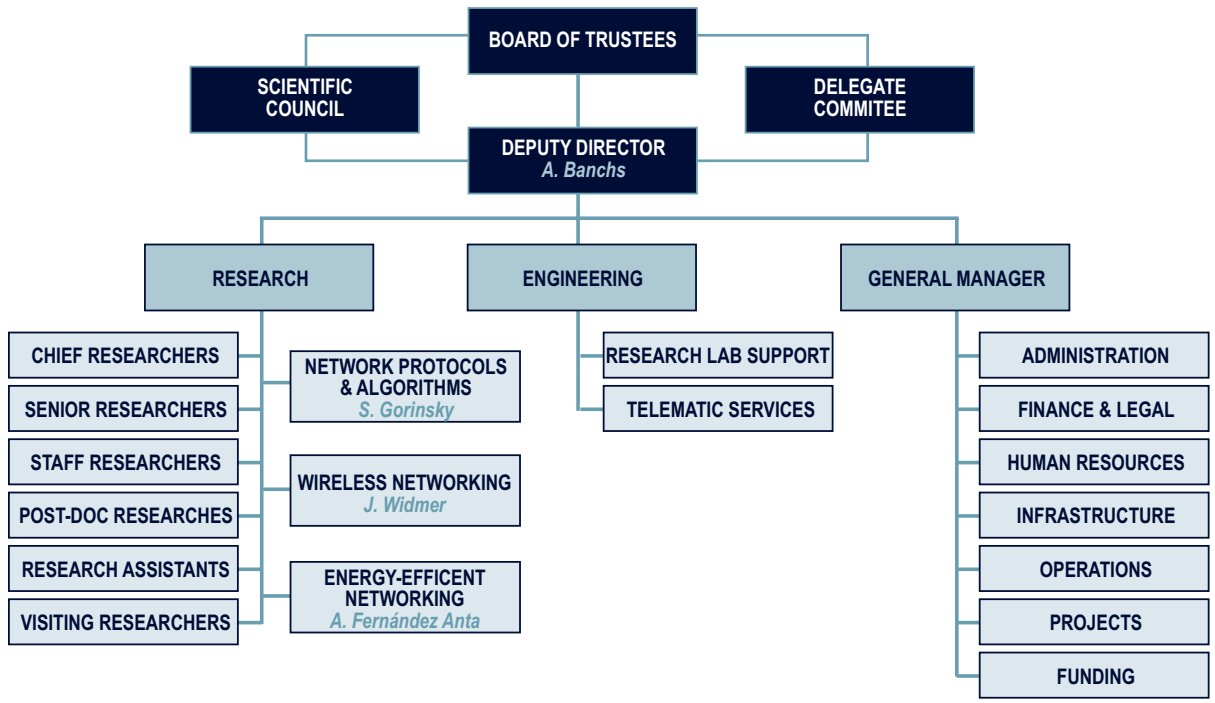
The full, registered name of the Institute is Fundación IMDEA Networks. The Institute is registered in the Register of Foundations of the Autonomous Region of Madrid (Registro de Fundaciones de la Comunidad de Madrid), personal sheet number 476.

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

Institute IMDEA Networks' registered address is:
Avenida del Mar Mediterraneo, 22
28918 Leganes, Ma

9.2. Governing bodies & organizational structure

9.2.1. Organizational structure



9.2.2. Board of Trustees

The Board of Trustees of Institute IMDEA Networks 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 Deputy Director and General Manager of the Institute also participate in the Board of Trustees. The Board is presently composed of the following members:

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

EX OFFICIO TRUSTEES

Excma. Sra. Dª. Lucía Figar de Lacalle
Regional Government Secretary for Education and Employment, Department of Education and Employment, Regional Government of Madrid (Madrid, Spain)

Ilmo. Sr. D. Jon Juaristi Linacero
Director General of Universities and Research, Directorate General of Universities and Research, Department of Education and Employment, Regional Government of Madrid (Madrid, Spain)

Ilmo. Sr. D. Jorge Sáinz González
Deputy Director of Research, Subdirectorate General of Research, Directorate General of Universities and Research, Department of Education and Employment, Regional Government of Madrid (Madrid, Spain)

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

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

ELECTIVE TRUSTEES - PRESTIGIOUS SCIENTISTS

Prof. Dr. Ralf Steinmetz
Managing Director of Multimedia Communications Lab (KOM); Full Professor at Technische Universität Darmstadt. Darmstadt. Germany

Prof. Dr. Hari Balakrishnan
Professor at the Massachusetts Institute of Technology. Massachusetts. USA

Prof. Dr. Jim Kurose
Interim Dean and Distinguished University Professor at University of Massachusetts, Amherst. Massachusetts. USA

Dr. Huw Oliver
Independent Computer & Network Security Professional at University of Bristol and the Civil Aviation Authority (former Technical Director, European Research Consortium, Hewlett-Packard Laboratories). Bristol. UK

Prof. Dr. Ioannis Stavrakakis
Full Professor at the National and Kapodistrian University of Athens. Athens. Greece

ELECTIVE TRUSTEES – COMPANIES

Telefónica I+D
Designated representative: Mr. Carlos Francisco Domingo Soriano, President and CEO, Telefonica I+D (R&D); Director of Product Development & Innovation, Telefonica Digital

Hewlett-Packard
Designated representative: Ms. Irma Jiménez Guler, Director of Institutional Relations

INDRA
Designated representative: Mr. José Luis Angoso González, Director of Innovation

SATEC
Designated representative: Mr. Luis Alberto Rodriguez-Ovejero Alonso, President

TELDAT
Designated representative: Mr. Antonio García Marcos, President

ELECTIVE TRUSTEES - COMPANY EXPERTS

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

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

ELECTIVE TRUSTEES - INSTITUTIONAL TRUSTEES: UNIVERSITIES

Universidad Carlos III de Madrid (Madrid, Spain)
Designated representative: Prof. Dr. D. Carlos Balaguer Bernaldo de Quirós, Vice-Rector of Research

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

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

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

9.2.3. Scientific Council

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

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

The current members of our Scientific Council are:

Prof. Dr. Hari BALAKRISHNAN
Professor at the Massachusetts Institute of Technology. Massachusetts. USA

PhD: University of California, Berkeley. Berkeley. USA
Research: Networked computer systems, spanning overlay and peer-to-peer networks, network protocols and architecture, wireless and sensor networks, and distributed data management

Dr. Gonzalo CAMARILLO
Principal Researcher - NomadicLab, Ericsson Research Finland.

PhD: Aalto University (Helsinki, Finland)
Research: Signaling; Multimedia applications; Transport protocols; Network security; Networking architectures

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

PhD: University College London. London. UK
Research: Opportunistic communications, privacy in the cloud, and carbon neutral networking

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

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

Prof. Dr. Edward KNIGHTLY

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

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

Prof. Dr. Jim KUROSE

Interim Dean and Distinguished University Professor at University of Massachusetts, Amherst. Massachusetts. USA

PhD: Columbia University of New York City. New York. USA
Research: Network protocols and architecture; Network measurement; Sensor Networks; Multimedia communication; Modeling and performance evaluation

Dr. Huw OLIVER

Independent Computer & Network Security Professional University of Bristol and the Civil Aviation Authority (former Technical Director, European Research Consortium, Hewlett-Packard Laboratories). Bristol. UK

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

Dr. Pablo RODRIGUEZ RODRIGUEZ

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

PhD: Ecole Polytechnique Federale de Lausanne, EPFL, Switzerland
Research: Networking; Distributed Systems; Information Theory; Wireless and Mobile; Network Economics; Social Networks

Prof. Dr. Ioannis STAVRAKAKIS

Full Professor at the National and Kapodistrian University of Athens. Athens. Greece

PhD: University of Virginia. Charlottesville. USA
Research: Resource allocation protocols and traffic management for communication networks, with recent emphasis on peer-to-peer, mobile, ad hoc, autonomic and social networking

Prof. Dr. Ralf STEINMETZ

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

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

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Institute IMDEA Networks

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