EUROPEAN UNION

European Social Fund

Investing in your Future

IMDEA Networks replacing UC3M in PIXEurope

Developing the Science of Networks

Overview of IMDEA Institutes

- Seven (+2) public International research centers founded in 2007
- Founded and funded by the Regional Government of Madrid
- All with a similar governance model and philosophy, but with some differences arising from their specific field
- All with excellent results in their specific field

instituto imdea food

institute imdea water

instituto imdea nanociencia

institute imdea networks

institute imdea software

institute imdea energy

institute imdea materials

Research Line Overview

networked systems&algorithms

High-performance networks
- *Reliable* systems
- Ensure correct functioning of large-scale networks
- New abstractions simplify network management
- SDN (Software Defined Networking) as enabler
- Quantum computing and quantum communications

Network economics
- Modeling the Internet as ensemble of independent entities and their behavior
- Continuous learning and adaptation
- Innovative network architectures, where economic-political knowledge guides the technical design

wireless networking

High-speed wireless networks
- Millimeter wave networking
- Visible light communication
- Dense small-cell networks
- Interference management

Mobile network architectures
- Zero-touch mobile networks (Artificial Intelligence)
- Quantum computing mobile networking
- 5G/6G architecture design
- Energy-efficient networks
- Cloud RAN and RAN virtualization

Heterogeneous networks
- Vehicular/aerial networks
- Wireless location and sensing systems
- Collaborative wideband spectrum monitoring

network measurements&analytics

Network measurements
- Active and Passive measurements
- Traffic characterization
- Performance evaluation

Big Data
- Applied machine learning
- Data analytics for cybersecurity (Artificial Intelligence)
- Human-data interaction (HDI)

Privacy and Security
- IoT, cyber-physical systems
- Online tracking, advertising and ad-blocking
- Mobile malware and threat detection
- Data transparency and privacy-preserving tools

Research Team

- International profiles with a solid track record
  - UC Berkeley, MIT, EPFL, ETHZ, University of Cambridge, UCL, UT Austin, Rice Univ., Boston Univ., Harvard, ...
  - 40% of our faculty (5 prof.) in the “world top 2%” ranking of Stanford Univ.
  - 5 professors amongst the top CS researchers according to Guide2Research
  - Our researchers have received prestigious individual Prizes (***Reginald Fessenden Award, Humboldt award, Aritmel National prize***) and Grants (***ERC Grantees, Marie Curie-Sklodowska Fellows, and Ramon y Cajal Fellows***)

- IMDEA Networks researchers also have a strong industry profile:
  - Experience in research industry labs (NEC, AT&T, Philips, Intel, Telefonica, Disney Labs, etc.)
  - 50 patents and have co-authored standards of high strategic value
  - Participation in committees of high relevance and impact (ICT Committee of the European Commission, 5GPPP Partnership Board, etc.)

What does IMDEA Networks offer to PIXEurope?

IMDEA Networks is an independent public research center, located in the town of Leganés, where UC3M is also located. The research in the center is focused on the development of future networks, with activity in the physical and transport layers, with relevant developments in wireless communications research involving emerging wireless technologies such as extremely high frequency communications for 5G and wireless LANs and visible light communication.

IMDEA Networks has:

- Extensive experience in European projects (**61 EU projects in total**),
- Relevant communications demonstrator testbeds (**5TONIC, ESFRI SLICES, HELIX, MIMORPH**)
- Strong collaborations with relevant industrial partners in communications sector relevant to the PIXEurope demonstrator formerly led by UC3M (**Telefonica, Ericsson, NEC, …**).

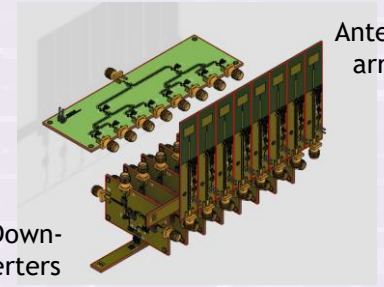
In addition, we offer:

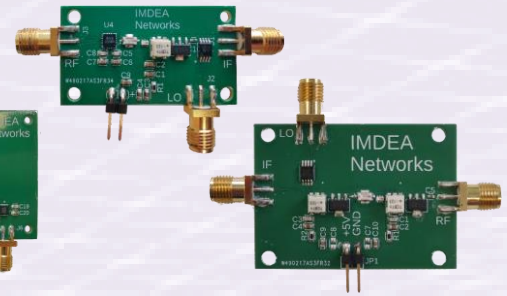
1. IMDEA Networks is an independent public research institute, **ready to accept the project**.
2. IMDEA Networks has an active collaboration agreement with UC3M, establishing a framework **enabling Prof. Guillermo Carpintero research group direct involvement** in PIXEurope at IMDEA Networks, having already identified several means for this.

Prior Experitise of IMDEA Networks Related to PIXEurope

Fully custom design of modular RF frontends for massive and distributed 6G MIMO

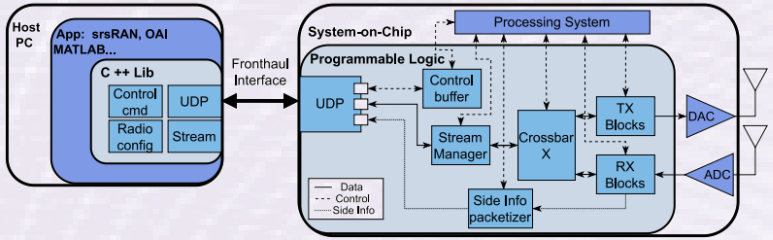
- FR3 frequency
  9-12 GHz

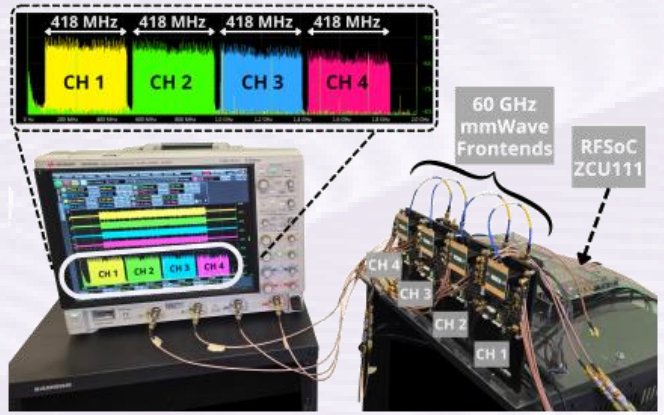




Development of real-time 5G/6G experimentation platform

- Sub-6 GHz and mmWave (24 GHz, 60 GHz)
- Up to 8 channels
- 2 GHz bandwidth/channel





ML/AI research at IMDEA

- Extensive research on AI/ML in many of our areas
- AI/ML for mobile networks
- Networks to accelerate AI/ML

Multiple A100/A200
ML compute clusters

Compromise to assume all UC3M duties

The proposal to replace the beneficiary Universidad Carlos III Madrid (UC3M) by IMDEA networks, after UC3M academic authorities expressed their will to withdraw UC3M from PIXEurope, **comes from the suggestion of former UC3M IP (Prof. Guillermo Carpintero)**.

Rationale for this proposal are:

1. IMDEA Networks research lines are focused to the development of future networks, and therefore, are **perfectly aligned with the "Small Form-factor Pluggables for PON optical transceivers" PIXEurope demonstrator,** formerly led by UC3M, the.
2. Prior to this situation, Prof. Guillermo Carpintero (UC3M) and Prof. Arturo Azcorra (IMDEA Networks) identified the strong synergies between both due to common interests in advanced communications networks which could **multiply the impact of PIXEurope**.
3. The already mentioned advantage that **IMDEA Networks offers a framework for Prof. Guillermo Carpintero to be directly involved in PIXEurope**.

Summary of UC3M duties in PIXEurope

1.- UC3M role as leader of "Functional demonstrator testing in laboratory and relevant environments" in WP9, coordinating the verification first in laboratory environment and then on relevant conditions of the project demonstrators. Lead of the demonstrator related to Small Form-factor Pluggable (SPF) for PON optical transceivers. Providing high-frequency design and test, complex modulation schemes design and test.

2.- UC3M role in WP8 development of contactless and visual inspection based on artificial intelligence algorithms. UC3M aimed to introduce high-resolution contactless inspection, through visual systems as well as contactless optical and RF probes to replace current techniques, performed commonly by visual inspection and manual alignment which limit the number of probe landings that can be performed. The objective was to develop Machine Learning and artificial intelligence (AI) methods systems to process and create feed-forward models from defect inspection and classification will be worked on.

3.- UC3M role in the design (WP4) and packaging (WP7) work-packages in the development of radiofrequency access pads and interfaces, to create dielectric structures for broadband RF connectivity.

Summary of UC3M duties in PIXEurope

1.- UC3M role as leader of "Functional demonstrator testing in laboratory and relevant environments" in WP9, coordinating the verification first in laboratory environment and then on relevant conditions of the project demonstrators. Lead of the demonstrator related to Small Form-factor Pluggables for PON optical transceivers. Providing high-frequency design and test, complex modulation schemes design and test.

One of IMDEA Networks main activities is to run a testbed for advanced communications devices and systems. This makes IMDEA Networks the perfect partner to lead the coordination of the functional demonstrators, as commonly leads teams of researchers working in the development of novel hardware and software with the objective to demonstrate the technology both at laboratory and relevant conditions.

Specifically, in the case of the **Small Form-factor Pluggables for PON optical transceivers,** IMDEA Networks has one of the most advanced laboratories in Europe for testing 5G technologies, offering realistic network conditions to test PIXEurope SFPs, promoting entreprenurial ventures that will enhance the exploitation of the technology.

Summary of UC3M duties in PIXEurope

1.- UC3M role as leader of "Functional demonstrator testing in laboratory and relevant environments" in WP9, coordinating the verification first in laboratory environment and then on relevant conditions of the project demonstrators. Lead of the demonstrator related to Small Form-factor Pluggables for PON optical transceivers. **Providing high-frequency design and test, complex modulation schemes design and test.**

IMDEA Networks research line on **Wireless networking** is involved in a number of different wireless research areas. It is relevant for this topic, since it covers emerging wireless technologies such as **extremely high frequency communication for 5G and wireless LAN and Visible Light Communication**, which promise to increase wireless data rates by an order of magnitude or more. IMDEA Networks focuses on topics such as ultra-dense networks, intelligent interference management, modulation schemes and improved medium access control mechanisms that make use of advanced physical layer technologies such as MIMO.

With the addition of the high frequency equipment (UC3M9, UC3M10 and UC3M11) planned by UC3M in the JPA, IMDEA Network laboratories will have the instruments required to develop this role.

Summary of UC3M duties in PIXEurope

2.- UC3M role in WP8 development of contactless and visual inspection based on artificial intelligence algorithms. UC3M aimed to introduce high-resolution contactless inspection, through visual systems as well as contactless optical and RF probes to replace current techniques, performed commonly by visual inspection and manual alignment which limit the number of probe landings that can be performed. The objective was to develop Machine Learning and artificial intelligence (AI) methods systems to process and create feed-forward models from defect inspection and classification will be worked on.

Machine Learning algorithms and Big-Data Processing are core technologies at IMDEA Networks **network measurement & analytics** research line. At IMDEA Network data analytics and artificial intelligence are commonly used to improve network performance. For this task, the algorithms will be used to analyze images from cameras, to control the positioning systems.

Based on available **IMDEA Networks computer cluster** to develop ML and AI algorithms, with the addition of high-speed cameras (UC3M equipment in PIXEurope) and HORIZON funding will provide the required hardware needed to development automated AI guided probing.

Summary of UC3M duties in PIXEurope

3.- UC3M role in the design (WP4) and packaging (WP7) work-packages in the development of radiofrequency access pads and interfaces, to create dielectric structures for broadband RF connectivity.

This is most likely the most critical aspect of UC3M contribution.

As pointed out already, IMDEA Networks research line in Wireless networking focuses on high-speed Wireless networks, which includes research in millimeter waves, using components and systems. The development of broadband interfaces is a key line for data center networks. However, the development of **radiofrequency access pads and interfaces for ultrawideband probing based on dielectrics is a unique technology**, developed by Prof. Guillermo Carpintero within TERAmeasure Horizon2020 Pathfinder, which generated 5 patents which have been transferred with exclusivity to LEAPWAVE TECHNOLOGIES SL, a spin-off company from UC3M located in the nearby UC3M Technology Park.

This is one of the main reasons for which we propose IMDEA Networks as a partner to take UC3M responsibilities, since it offers a unique framework that **enables Prof. Guillermo Carpintero research group direct involvement** in PIXEurope at IMDEA Networks.

Compromise to assume all UC3M duties

In summary, …

…**IMDEA Networks** is prepared to receive the tasks assigned to UC3M in PIXEurope

… establishing a framework **enabling Prof. Guillermo Carpintero research group direct involvement** in PIXEurope at IMDEA Networks

Thanks for your attention!!