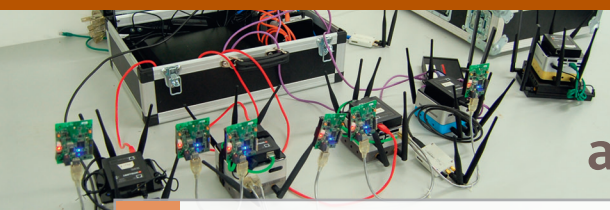
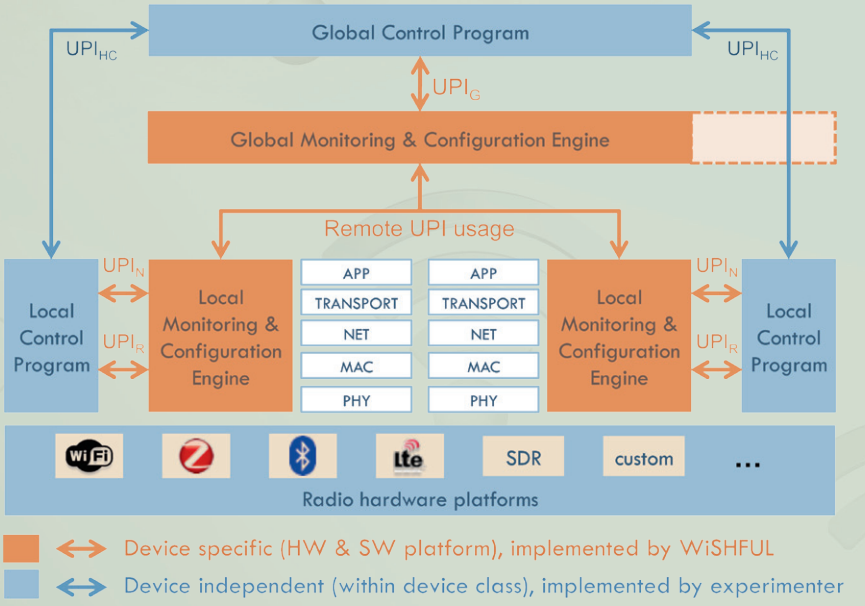


Wishful Thinking: Open software architectures for wireless testbeds

Wireless testbeds play a central role in the testing and validation of new solutions, yet the increasing complexity of these facilities represents a significant barrier to technical innovation. The WiSHFUL project aims to develop software architectures and open interfaces that will accelerate the experimentation process, as **Spilios Giannoulis** and **Ingrid Moerman** explain

A wide range of functions today are performed by wireless solutions in offices, factories and homes, and new systems and solutions continue to emerge. However, while wireless systems are growing increasingly ubiquitous, testing and validating these solutions in wireless testbeds is an ever more complex challenge, as Ingrid Moerman, overall coordinator of the WiSHFUL project, explains. "Doing an experiment on a wireless testbed for the first time is difficult, there is quite a steep learning curve," she says. Researchers in the project aim at lowering the barrier for wireless innovation by accelerating the experimentation process and thereby reducing the development costs. "One of the reasons that the WiSHFUL project was established was to examine ways to lower the overhead of experimenting on wireless systems. This includes lowering the overhead to setup up the experiment environment, getting to know the tools, and finally get familiar with the development environment related to each radio hardware and software platform," outlines Spilios Giannoulis, the technical coordinator of the project.



WiSHFUL SW architecture

Software platforms

This work is closely in line with the needs of those involved in development, who have to deal with ever more complex scenarios and a diverse range of technologies in the validation of wireless systems. Researchers in the project are developing open and flexible software platforms with Unified Programming Interfaces (UPI), which Moerman believes will help lower the barriers to innovation. "By providing experimenters with UPIs, they can control very heterogeneous wireless hardware, using similar commands. It's like talking to different devices in the same language," she says. "There are different types of UPIs with respect to certain radio and network monitoring and configuration capabilities. The number of measurements and events that we can monitor or parameters we can control is dependent on the specific technology. Some generic capabilities, such as setting the center frequency, are shared by many technologies, while other capabilities can be very technology-specific."

Some examples of how the project helps to lower the barriers to wireless innovation are presented below. For instance, LTE technology has a flexible bandwidth that can be adapted at runtime. Moerman says the project's approach allows innovators to change the bandwidth without needing to trawl through specification documents and software tools. "We have effectively made an abstraction. We hide the complexity of the hardware and just offer them the UPI interface, which is easy to use," she explains.

Another example involves around the fact that wireless innovators, while typically very technically knowledgeable, may be less familiar with other hardware platforms outside their own specialist area. "They can just set up an experiment saying – 'I'm going to have some Wi-Fi nodes, some other nodes from different technology, and I want to see what the level of interference is.' This offers huge opportunities," stresses Giannoulis. "Even if they are Wi-Fi experts, we also offer many other advanced features on top of the UPI commands to facilitate the management of full networks. For example, currently, if you want to change the configuration of a set of access points, you have to do that one by one. With the UPI functionality, you can do the configuration across the network in a centralised way with a single UPI command."

Experimentation testbeds

The initial step for a wireless innovator is to set up the experimentation environment. First, they need to select a suitable testbed, then search and reserve the wireless nodes required to build their scenario. No matter which testbed is selected, they can log in with the same authentication process, giving them the opportunity to test their system or solution in multiple different scenarios and/or wireless environments. "Once you are in the testbed you can use the same experimentation tools and run the script for your experiment, using unified tools developed in the FED4FIRE project," says

Moerman. "Once developers can work in one testbed, it's very easy for them to go and work with another testbed. Unification is very important here, not only at the testbed level, but also at the platform level. By using the UPIs, a huge number of parameters can be assessed in these wireless testbeds, allowing experimenters to rigorously test their solutions."

The majority of test-beds are currently located in a fixed environment, which is a limitation in terms of testing a solution and assessing its wider effectiveness. The way wireless signals propagate in an office environment with thick walls may be very different to how they propagate in an industrial environment for example, an issue of which Moerman is well aware. "If testing is always done in the same environment, then it's not clear if the solution can be applied in different environments or if a solution is only being optimised for that specific wireless environment. That's why we enable people to do tests in environments that are closer to reality. For this purpose we offer portable facilities that can be deployed at any location, where you can involve real users," she outlines.

WiSHFUL enabled wireless solutions

The project's research provides solid foundations for developers to thoroughly assess their solutions, which is of course an important issue in terms of their wider applicability. One area which could benefit from runtime WiSHFUL control is smart cities, as Giannoulis explains. "Wireless solutions offer a lot of additional services in a smart city, such as sensor networks that can monitor air and water quality, monitor noise, even help in utilising parking spaces efficiently. It is however difficult to guarantee the stability and reliability of wireless solutions," he points out. "A lot of the experiments we see are about offering more guarantees. A wireless network is not like a cable, which has a fixed capacity, like 100 megabytes a second, which you know is there," says Moerman. "You can never say that in a wireless network, because the capacity changes depending on the environment. A wireless link has different operating modes, each mode having a different capacity, and these operating modes needs to be adapted according to the context. WiSHFUL enables large-scale runtime adaptation"

By providing **experimenters** with **UPIs** they can **control very heterogeneous wireless hardware**, using **similar commands**

Access to WiSHFUL

The project interacts with third parties, external wireless developers and researchers, who use the testbeds together with the software platforms and UPIs. Our key researchers are keen to continue working with external parties to improve the usability and offered functionality of WiSHFUL . So far five open calls have been held to explore the wider potential of the WiSHFUL platforms and investigate how they could be enhanced further. "Three out of five calls were just about doing experiments and developing solutions. In two of the calls, external parties have extended our platforms with different technologies," continues Moerman. "For example, at the start of the project we didn't support LTE – we only had Wi-Fi and sensor technologies. Through an extension by an external party, we added LTE functionality and hardware to our offer." The WiSHFUL software will remain publically available to interested parties free of charge, even after completion of the project.

The weather or interference by other wireless systems using the same spectral band could also have a significant impact on the quality of wireless transmission for example, leading to delays caused by retransmissions. Wireless networks are therefore typically used in scenarios where any delay in transmission will not have too serious an impact. "If you are using wireless communication for critical functions in an industrial environment then you need 100 percent reliability, just like a wired connection. These issues have not yet been resolved, but WiSHFUL offers many enablers to increase overall reliability. We need to continue with research and innovation to increase spectrum efficiency, and minimise latency and packet loss," says Moerman. The WiSHFUL project will have a wider impact in these terms, giving researchers the opportunity to develop and test wireless solutions for free, helping them to accelerate the process of technical innovation. "WiSHFUL aims to change the way we experiment but also the way we control a deployed wireless network in runtime in the years to come," says Giannoulis.

WISHFUL

Wireless Software and Hardware platforms for Flexible and Unified radio and network control

Project Objectives

The WiSHFUL project aims to reduce the threshold for experimentation in view of wireless innovation creation and by increasing the realism of experimentation by offering open, flexible & adaptive software and hardware platforms for intelligent radio and network control allowing rapid prototyping of innovative end-to-end wireless solutions and systems in different vertical markets. The WiSHFUL project further offers portable wireless test facilities that can be deployed at any location allowing validation of innovative wireless solutions in the real world.

Project Funding

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Project Partners

• Interuniversitair Micro-Electronica Centrum (IMEC), Belgium • The Provost, Fellows, Foundation Scholars & the other Members of Board of The College of The Holy & Undivided Trinity of Queen Elizabeth near Dublin (TCD), Ireland • Consorzio Nazionale Interuniversitario Per Le Telecomunicazioni (CNIT), Italy • Technische Universität Berlin (TUB) Germany • nCentric Europe BVBA (NCENTRIC), Belgium • Rutgers, The State University of New Jersey (RUTGERS), United States • Seoul National University (SNU), Korea (Republic of) • Universidade Federal Do Rio De Janeiro (UFRJ), Brazil

Contact Details

Professor Ingrid Moerman
Interuniversitair Micro-Electronica Centrum (IMEC), Belgium
956KAPELDREEF 75
3001 LEUVEN
Belgium
T: +32 9 331 49 26
E: ingrid.moerman@ugent.be
W: www.wishful-project.eu


Professor Ingrid Moerman

Ingrid Moerman is a part-time professor at the Faculty of Engineering and Architecture at the Ghent University (UGent). She is also a staff member at IDLab, a core research group of imec with research activities embedded in UGent and University of Antwerp. Ingrid Moerman is coordinating the research activities on mobile and wireless networking, and is leading a research team of about 30 members at UGent. Ingrid Moerman is coordinator of the WiSHFUL project.