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

Open Call 5

Fifth WiSHFUL Open Call for Experiments

Table of Contents

1. General call objectives

The WiSHFUL project hereby announces its **fifth** and last **Open Call for Experiments**, targeting advanced solutions for intelligent control of wireless networks using the WiSHFUL software platforms and its unified programming interfaces (UPIs), and using the wireless test facilities and hardware supported by the WiSHFUL Consortium.

WiSHFUL has extended several wireless radio platforms with control plane functionality and as such offers an experimentation environment for early implementation and validation of novel end-to-end wireless solutions (IoT, 5G, LTE-WiFi coexistence, etc.) that improve resource utilization through advanced reconfigurabilty of radio and network settings. WiSHFUL further provides all the experimentation tools needed to validate innovative wireless solutions in realistic and complex use scenarios (large scale, high density, mobility, heterogeneous technologies, different interference conditions, testing in the field, etc.). WiSHFUL can also adopt new wireless technologies from external experimenters and support such technologies within a minimum amount of time and manpower effort.

More information on the scope of this fifth Open Call of the WiSHFUL project can be found in section 4 of this document

2. Call information

Project full name:	WiSHFUL - Wireless Software and Hardware platforms for Flexible and Unified radio and network controL
Project grant agreement number:	645274
Call identifier:	WiSHFUL-OC5
Call title:	Fifth WiSHFUL Open Call for Experiments
Submission deadline:	Monday 2 October 2017, at 17:00 Brussels local time
Feasibility check deadline:	Monday 25 September 2017, at 17:00 Brussels local time

For the ***feasibility check***, it is essential that the proposing party gets in contact with the WiSHFUL partner in charge of the testbed(s) or software platform(s), which are intended to be used for the proposed Experiment, to discuss its feasibility within the WiSHFUL supported test facilities and the related specific requirements. Each proposing party must therefore identify a possible Patron either by contacting an appropriate WiSHFUL partner (see section 7) or through contact@wishful-project.eu, in case support is required for selecting an appropriate WiSHFUL partner. The proposing party must submit its draft proposal to the Patron using the WiSHFUL submission portal by Monday 25 September 2017, at 17:00 Brussels local time. **In this draft proposal at least sections A, B and C needs to be fully completed.** The feedback will be provided by the Patron at the latest by Thursday 28 September 2017 EOD, and must be copied into section D of the proposal template.

Financial information:

Category / identifier	Call budget	Max. budget per experiment	Min. no. of experiments to be funded	Guaranteed support[1]
Scientific Excellence WiSHFUL-OC5-EXP-EXC	€ 370 000	€ 50 000	3	€ 35 000
Innovation by Industry WiSHFUL-OC5-EXP-IND		€ 40 000	4	
Total number of experiments to be funded			≥ 9	

Requirements related to the proposer:

- Proposers must be eligible for participation in EC H2020 projects
- Proposals will only be accepted from a **single party**.
- For the Experiments in the category 'Innovation by Industry, only proposals from small, medium and large size enterprises, including unipersonal companies and individuals, will be accepted. The WiSHFUL project encourages in particular the participation of small and medium size enterprises (SMEs) and unipersonal companies. Proposals submitted by SMEs or unipersonal companies will receive a bonus in their score (more information see section 10 of this document).
- A proposer can only be selected for funding for one proposal, even if the proposer submitted multiple proposals that are ranked high enough to be selected for funding. In the latter case, the proposer might be given the opportunity to choose the one to be retained for funding.
- Parties having been selected in previous WiSHFUL Open Calls are not eligible to participate again.
- The WiSHFUL project especially welcomes and stimulates the participation of new players in the FIRE community. Proposals submitted by such new players will receive a bonus in their score (more information see section 10 of this document).

Other conditions:

- Language in which the proposal must be submitted: English
- Proposals must follow the provided template (see section 6 of this document and Appendix A)
- Proposals (draft as well as final proposals) must be submitted through the online submission portal (accessible from http://www.wishful-project.eu/open-calls)[2]

Contact: contact@wishful-project.eu

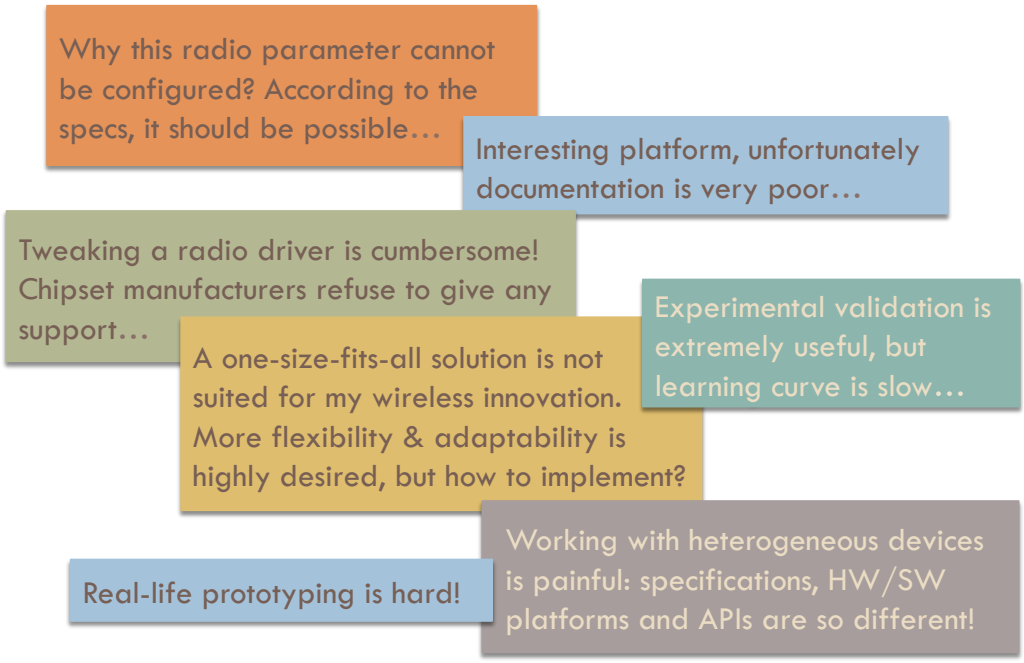
[1] An extra budget of typically € 4 000 per Experiment will be allocated to the WiSHFUL consortium partner acting as Patron for guaranteed support.

[2] Please note that the submission portal for WiSHFUL Open Call proposals is NOT the H2020 portal.

3. Background information on the WiSHFUL project

Why do we need WiSHFUL?

Experimental validation of novel wireless solutions in realistic wireless environment and under realistic wireless conditions is extremely important for gaining deeper insights (than simulations) in wireless research and for prototyping product innovations before entering the market. Unfortunately experimentation very often goes together with unexpected problems and frustrations, as illustrated through the following testimonies from experimenters.



Widely available **"off-the-shelf" hardware and software** comes in the form of radio chips which implement only the obligatory parts of the standards and arbitrarily selected optional parts of the standard, with only partially documented interfaces and with drivers being either closed or limited in functionality. Thus the flexibility of these platforms is very limited. Both researchers and wireless system developers (in particular in smaller companies!) keep complaining that even a minor tweak or adaptation may require huge effort and cost. For niche markets, radio chipset manufacturers do not want to give any support for radio driver adaptation because of too low volumes.

On the other hand, there are powerful ***Software Defined Radio*** (SDR) platforms offering excellent flexibility at the physical layer (waveform, modulation and coding schemes, spectral range, centre frequency, etc.). The problem with **SDR platforms** is that they typically lack high-level specifications and programming tools as well as standard APIs for embedded code development. Also, the flexibility has its price in performance; – on these platforms, it is hardly possible to achieve similar performance in terms of time scale as compared to professional implementations using standardized hardware radio platforms. This limits the possibility of experimentation in such critical directions like achieving low transmission latency required for wireless control applications. As a consequence, their uptake for prototyping novel end-to-end wireless solutions in the industry is slow, currently restricting their use to purely academic research.

WiSHFUL aims to address the aforementioned problems and frustrations as follows:

- By abstracting different hardware platforms through the use of a unified interface, radio and network settings of heterogeneous wireless platforms can be easily controlled without the need for deep knowledge of the hardware specifics of different radio hardware platforms.
- By offering advanced software platforms for many technologies (IEEE 802.15.4. IEEE 802.11, LTE) and hardware platforms (embedded microcontroller devices, general purpose devices with wireless network interface card(s), and software defined radios), support beyond standard configuration settings without the need for time-consuming driver hacks.
- By offering a global control framework, dynamic configurations can be executed on a whole network consisting of many devices in a synchronised way and without interrupting the operation of the network, instead of performing manual device-by-device configurations.
- By offering an intelligence framework, autonomous control strategies based on machine learning can be easily introduced
- By offering a compact portable testbed that can be deployed anywhere, experimentation is no more restricted to fixed location, but can happen in real-life environments.

What is WiSHFUL?

The WiSHFUL project is a Research and Innovation Action under the European Horizon 2020 Programme addressing the work programme topic Future Internet Research and Experimentation. The project started in January 2015 and runs for 36 months, until the end of 2017.

The WiSHFUL project offers several **software platforms** that comprise data plane and control plane functionality for advanced and **intelligent radio and network control**. The WiSHFUL project offers unified radio and network control interfaces for off-the-shelf devices as well as advanced SDR equipment that allow customizing wireless solutions for specific networking and traffic contexts. Although different wireless technologies and platforms can be very heterogeneous in terms of memory and processing capabilities and supported operating systems and software, the software platforms offered by the WiSHFUL project come **with a unified, technology-agonistic interface**, called UPI or Unified Programming Interface. The proposed unified radio control abstracts hardware specific instructions and thus enables full, vendor-independent radio configuration, while the unified network control allows rapid prototyping and adaptations of network protocol stacks in a heterogeneous, multi-vendor environment. As such experimenters can focus on network optimization without the need to dig into complex hardware and software specifications for different radio hardware platform, network protocols and software architectures.

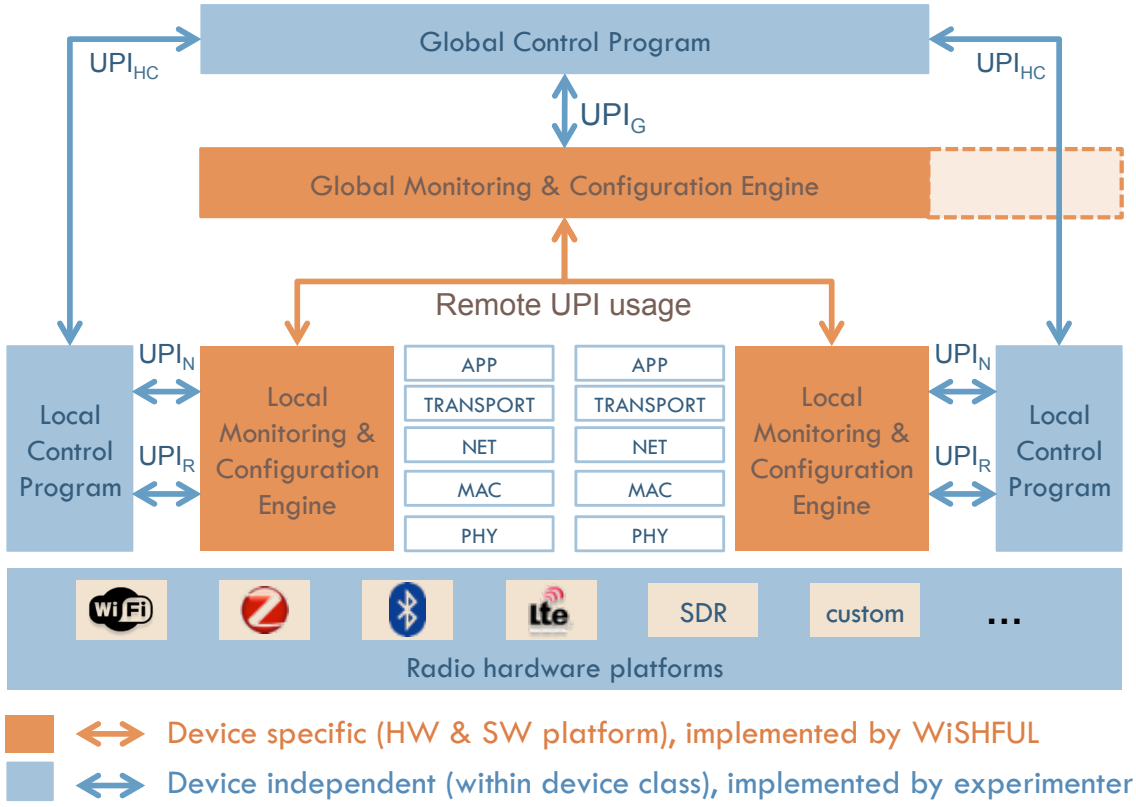


Figure 1: WiSHFUL software architecture

The **WiSHFUL software architecture** (see Figure 1) is devised to enable the definition of cognitive adaptations of radio operation and automated runtime network intelligence, by means of flexible and unified radio and network control. With flexible control we mean the possibility to maximize the configuration space of the devices, exploiting all the radio functionalities and programmable protocol logic supported by the radio and platform hardware. With unified control we mean the possibility to expose platform-independent programming interfaces over very heterogeneous hardware platforms, including standardized technologies and SDR platforms. WiSHFUL adopts the general idea of software defined networking (SDN), implemented in core IP networks, and applies it to the more heterogeneous access networks.

The terminology used in the high-level WiSHFUL software architecture is listed below:

- **Unified Programming Interface – Radio (UPI_R)**: this is a software interface consisting of a ***set of functions*** that ensures ***uniform control*** of the radio and lower MAC behaviour ***on heterogeneous devices***. The functions forming the interface are ***generic***, their implementation is hardware and platform specific, and is provided by the Local Monitoring and Configuration Engine.
- **Unified Programming Interface – Network (UPI_N)**: this is a software interface consisting of a ***set of functions*** that ensures ***uniform control*** of the upper MAC and higher layer protocol behaviour on ***heterogeneous devices***. The functions forming the interface are generic, their implementation is hardware and platform specific and is provided by the Local Monitoring and Configuration Engine.
- **Unified Programming Interface – Global (UPI_G)**: this is a software interface consisting of a set of functions that ensures uniform control of the behaviour of a **group of** heterogeneous **devices**. The functions forming the interface are generic, their implementation is deployment specific and is provided by the Global Monitoring and Configuration Engine.

- **Unified Programming Interface – Hierarchical Control (UPI_{HC})**: this is a software interface that enables custom interactions between control programs that are structured in a hierarchical way. The functions forming the interface are user-defined, their implementation may be provided by the Global Monitoring and Configuration Engine or can follow a custom design. In the latter case information between control programs can be exchanged in a custom format.
- **Local Monitoring and Configuration Engine**: the role of this engine is to provide a ***device-specific implementation of the UPI_R and UPI_N***. It ensures that the functions defined in the two UPIs execute correctly on the hardware and software platform for which they were developed.
- **Local Control Program**: it is a piece of software that ***uses the UPI_R and UPI_N*** and ***implements the algorithm/logic*** that controls the radio and network protocol stack and adapts the behaviour of the wireless system to meet the QoS requirements established by end users (or applications). It uses locally observed information. Because it uses the UPIs, the same code can be compiled and run on several heterogeneous devices within the same device class that support that UPI. Local control programs are user-defined, but several example implementations are provided by the WiSHFUL consortium. Most implementations should come from the users through open call Experiments.
- **Global Monitoring and Configuration Engine**: the role of this engine is to provide an implementation of the UPI_G that is common to a **group of nodes**. It ensures that the functions defined in the UPI execute correctly and if necessary simultaneously on the group of nodes for which they were developed. The Global Monitoring and Configuration Engine supports the remote call of local UPI functions simultaneously on a group of nodes and also other basic supporting services like automatic node discovery, discovery of node capabilities, time-scheduled execution of UPI functions at a particular point in time, time synchronisation among (heterogeneous) wireless nodes, etc.
- **Global Control Program**: it is a piece of software that uses the UPI_G and implements the algorithm/logic that controls the radio and network protocol stack of a group of nodes and adapts the behaviour of the wireless networked system to meet the QoS requirements established by end users. It uses information observed from a group of nodes. Because it uses the UPI_G, the code can be compiled and run in different deployments that support that UPI. Example implementations are provided by the WiSHFUL consortium, most implementations should come from the users through open call Experiments.
- **Device class**: represents a set of devices that are similar in terms of system architecture and capabilities. We consider three classes of devices: 1) microcontroller devices that have a radio chip, 2) general purpose devices with a wireless network interface card and 3) software defined radios.
- **Lower MAC:** The lower-level MAC (lower MAC) directly interacts with the PHY Tx and Rx cores and handles all wireless transmissions and receptions. Minimizing processing latency in the lower level MAC is critical in order to meet the channel access timing requirements. Typical lower MAC functions are: sending, receiving, CCA, back-off, inter frame spacing, CTS/RTS, ACKs, slot synchronization (adjust timing using info in synchronization beacon), next slot scheduling, superframe scheduling, channel hopping, etc.
- **Upper MAC:** The upper-level MAC (upper MAC) is responsible for inter-packet states that are not time critical. This includes among others framing and management functions where some form of negotiation between nodes is required (like association, the allocation of extra time slots, blacklisting channels for hopping sequences).

The WiSHFUL project offers implementations for the Local/Global Monitoring & configuration Engine (see orange blocks in the software architecture) and a basic set of functions for the Unified Program Interfaces (UPI_R, UPI_N, UPI_G and UPI_{HC}) for several radio hardware platforms. More

information of the supported radio HW and SW platforms and available functions supported by the UPIs can be found further in this section.

The WiSHFUL project offers **open and free of charge access to a number of advanced wireless testbeds**:

- Native testbeds offered by WiSHFUL project partners: TWIST (TU Berlin), w-iLab.t (imec), IRIS (TCD), Orbit (Rutgers University) and a FIBRE Island at UFRJ;
- Additional testbeds offered by Third Parties through WiSHFUL Open Calls for Extensions: NITOS (University of Thessaly), LOG-A-TEC 2.0 testBed at University of Jožef Stefan Institute (JSI), 5G USRP testbed of University of Leuven (KU Leuven), and the ARNO testbed at Scuola Superiore di Studi Universitari e Perfezionamento Sant'Anna (SSSA).

These testbeds offer **different wireless technologies** (such as IEEE 802.11, IEEE 802.15.4, LTE, DVB-T and SDR) and further guarantee support by skilled people. All of these testbeds are installed in either office environments or other dedicated testbed environments. Because some research requires doing measurement campaigns or actual testing in real-world environments, the WiSHFUL project also offers a portable testbed to the community (see Figure 2). The portable testbed can be deployed at any location allowing validation in the real world and involving real users.

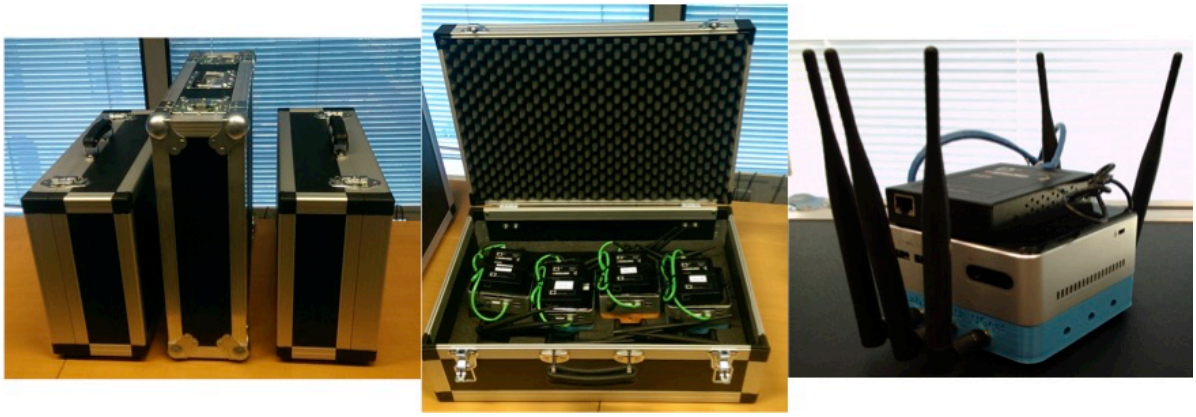
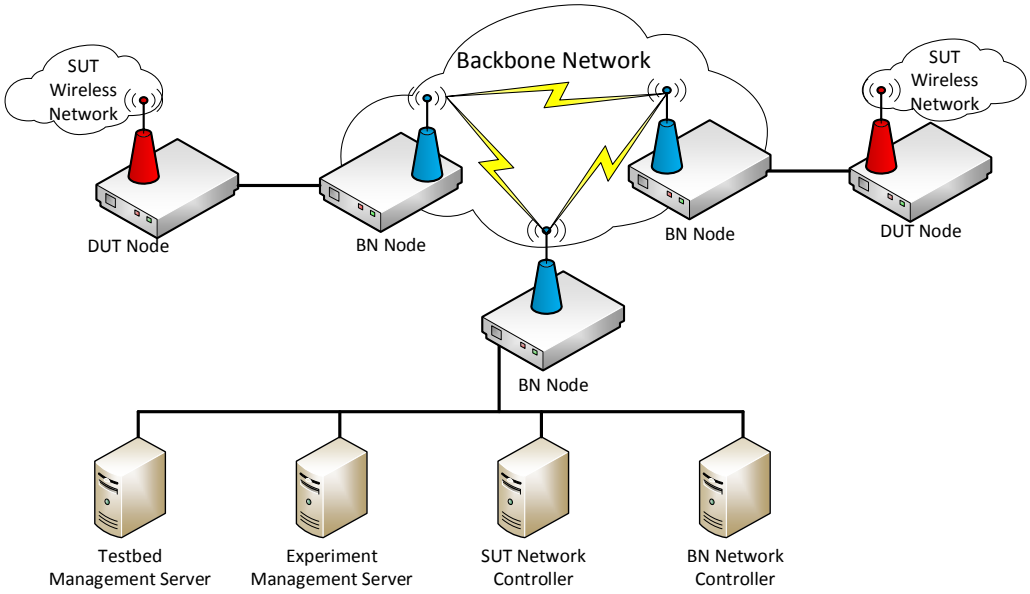


Figure 2: WiSHFUL portable testbed

The **portable testbed** offers almost identical functionality to the experimenters as if they would run their Experiments on one of the fixed testbeds:

- The experimenter can use one user account to access all WiSHFUL testbeds, including the portable testbed. The same user account can be used to access all Fed4FIRE testbeds.
- The experimenter can use one tool (jFed) to design and setup the Experiment. The same tool can be used to access multiple other testbeds inside the Fed4FIRE federation.
- The portable testbed provides powerful embedded Linux nodes (DUT – Device Under Test) to which the experimenter can gain full (root) access. The nodes are by default equipped with 2 Wi-Fi cards, an IEEE 802.15.4 sensor node and a Bluetooth USB dongle. The USB connections of the node can be used to attach extra hardware (e.g. LTE dongles or other USB compatible hardware). The experimenter has full control over the operating system and the software packages that are installed on the DUT. The DUT can also be used as a proxy to access all USB peripherals of the node, like sensor nodes. If the embedded PC provided by WiSHFUL does not satisfy the experimenter's needs, other hardware can be used as long as it can interface over Ethernet with the backbone nodes.

- To replace the fixed wired backbone, WiSHFUL provides a highly reliable wireless backbone that allows the experimenter to interact with the nodes during the Experiment (see Figure 3). The interaction with the nodes can be done using either SSH or the OMF6 Experiment control framework.
- Measurements can be collected using the OML framework. The (aggregated) live data can be sent over the wireless backbone towards an OML server, or can be stored locally and dumped to a database server after the Experiment.
- The portable testbed is packaged into ruggedized lightweight cases to ensure safe and easy transportation of the hardware.
- Deployment of the portable testbed is as easy as plug-and-play to lower the boundary for experimenters. The duration of the deployment of the portable testbed can vary from several hours to several weeks or even months. Depending on the duration of the deployment and the accessibility of the environment in which the testbed is deployed, extra fail-safe mechanisms may be activated to allow for better remote management of the portable testbed. Several ways to power the DUTs are supported: AC power, Power-Over-Ethernet or 19V battery packs.



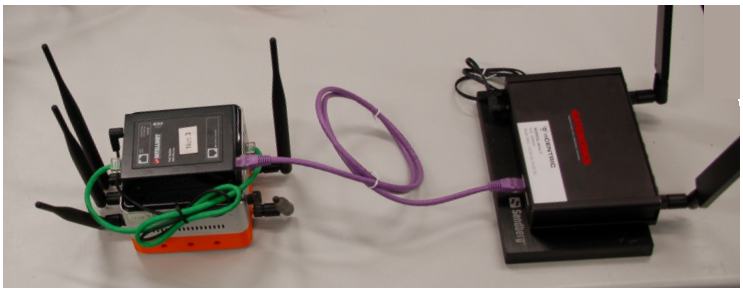


Figure 3: Architecture of WiSHFUL portable testbed (top) and a standalone node consisting of DUT and BN, powered by a battery pack (bottom)

(SUT: System Under Test, DUT: Device Under Test, BN: Backbone Node)

Platforms and testbeds supported by WiSHFUL

The table below gives an overview of the ***software platforms, radio hardware platforms and testbeds*** that are supported in the present Open Call.

Hardware	Type	Technology/ spectral range	Software supported	Testbed Support
wireless Wi-Fi card	Atheros athxk,	IEEE 802.11 a/b/g/n	Linux	w.iLab.t, TWIST, ORBIT, FIBRE@UFRJ, Portable testbed
	Broadcom b43	IEEE 802.11 b/g	Linux, Wireless MAC Processor (WMP)	w.iLab.t, Portable testbed
Wireless sensor node	RM090	IEEE 802.15.4	Contiki, TAISC, GITAR	w.iLab.t, Portable testbed
	Zolertia Z1	IEEE 802.15.4	Contiki, GITAR	w.iLab.t, Portable testbed
	Zolertia RE-Mote	IEEE 802.15.4 (dual band: 2.4 GHz + sub GHz)	Contiki, TAISC, GITAR	w.iLab.t, Portable testbed
	Jennic JN516X	IEEE 802.15.4	TinyOS	TWIST, Portable testbed
	VESNA	IEEE 802.15.4	Contiki	LOG-a-TEC testbed
		IEEE 802.15.4a (UWB)	Custom	LOG-a-TEC testbed
		Clean slate non-IEEE 802.15.4: • TI CC1101 (sub GHz) • TI CC2500 (2.4 GHz)	Custom	LOG-a-TEC testbed
	sigfox	LPWAN UNB 868 MHz	Custom	LOG-a-TEC testbed
Software Defined Radio (SDR)	WARPv3	IEEE 802.11 b/g	Wireless Mac Processor (WMP)	Portable testbed
	USRP2-N210	2.4 – 2.5 GHz 4.9 – 5.85 GHz	IRIS software radio, GNU Radio	w.iLab.t, IRIS testbed, ORBIT
	USRP2-N210	50 – 860 MHz (RX only) 800 – 1000 MHz 1.5 – 2.1 GHz 2.3 – 2.9 GHz 50 MHz – 2.2 GHz 400 MHz – 4.4 GHz	GNU Radio IRIS software radio IRIS DVB-T	IRIS testbed
	USRP2-N210 w/ beamforming	400 MHz – 4.4 GHz	GNU Radio	IRIS testbed
	USRP-B200mini	70 MHz - 6 GHz	IRIS software radio GNU radio IRIS software radio	w.iLab.t, portable testbed
	USRP X310	10 MHz – 6 Ghz	GNU radio	ORBIT, IRIS testbed, w.iLab.t

	USRP B210	70 MHz - 6 GHz	GNU radio	ORBIT
	ZedBoard Xilinx Zynq®-7000 SoC	400 MHz - 4 GHz (Analog Devices FMCOMMS1) 70 MHz -6 GHz (Analog Devices FMCOMMS2)	Contiki, TAISC, GITAR	w.iLab.t
	Xilinx ZC706 Evaluation Kit - Zynq® SoC		Contiki, TAISC, GITAR	w.iLab.t
LTE	Airspan	2.59 GHz TDD	Linux	ORBIT
	ip.access (+ SIRRAN EPC SW core)	2500-2570 MHZ (indoor uplink) 2620-2690 MHZ (indoor downlink) 2.53-2.63 GHz (outdoor)	Linux	w.iLab.t (indoor), UTH (outdoor)
	srsLTE	USRP based, 2.4-5 GHz	Linux	w.iLab.t, IRIS testbed, ORBIT, portable testbed
	OpenAir Interface	Virtual eNB, EPC	Linux	ARNO testbed
TVWS	SNE-ESHTER	470-862 MHz	Custom	LOG-a-TEC
Full Duplex Radio	NI USRP-2943R NI USRP-2952R	1.2 - 6 GHz 0.4 - 4.4 GHz	LabVIEW	KU Leuven
Antenna	RAS (Reconfigurable Antenna System)	2.4 GHz 5 GHz	Linux, Wireless Mac Processor (WMP)	w.iLab.t , Portable testbed

More detailed information on the supported software platforms can be found at http://www.wishful-project.eu/software.

More detailed information on implemented UPIs can be found on the WiSHFUL Github (https://wishful-project.github.io/wishful_upis/). The source code of UPI implementations can be found at https://github.com/wishful-project.

More information on the testbeds and radio hardware platforms can be found at http://www.wishful-project.eu/testbeds).

Sample configurations on experimentation tools use in WiSHFUL testbeds can be found at https://github.com/WirelessTestbedsAcademy/ExperimentationTools).

WiSHFUL intelligence framework

This Open Call also offers the **WiSHFUL intelligence framework** enabling intelligent network and radio control. This intelligence framework is developed in collaboration with the eWINE project (https://ewine-project.eu). The connection between the WiSHFUL software architecture for radio and network control and the intelligence framework is made by the Unified Programming Interfaces. As the UPIs are unified abstractions that span several wireless technology platforms, the

components of the intelligence framework are generic. The framework has the following components:

- The ***Data Collection Component*** is responsible for data acquisition of the network status (through interaction with the WiSHFUL UPIs, to retrieve data about radio and network operation) and the application requirements. With respect to the network status, the experimenter can specify the radio and/or network parameters he wants to monitor by choosing the parameters of interest from a predefined set of possible options (offered by the UPI interfaces) and the collection time window.
- The Data Collection Component also implements ***aggregation*** functionality to compress or summarize the amount of data for enhancing network lifetime, to extract relevant features, or to change the representation of data.
- The ***Intelligence Composition Module*** offers support for composing and configuring several algorithms available in the WiSHFUL Intelligence Repository into a self-contained intelligence engine that uses the data provided by the Data Collection Component and triggers configuration through the Action Component. The Intelligence Composition Component offers different approaches that can be selected by the experimenter for finding optimal radio and network settings. The intelligence modules will be offered as a collection of algorithms (e.g. optimisation and machine learning techniques) that can be applied for user-specific scenarios. The Intelligence Composition Component also offers modules for pre-processing data such as data cleaning (removing outliers), normalization, and data transformation.
- The ***Action Component*** represents an interface between the outputs of the intelligence algorithm and the UPI functions that enable the control of the behaviour of wireless nodes. This component translates the intelligence decisions taken by the Intelligence Composition Component in a sequence of UPI calls.

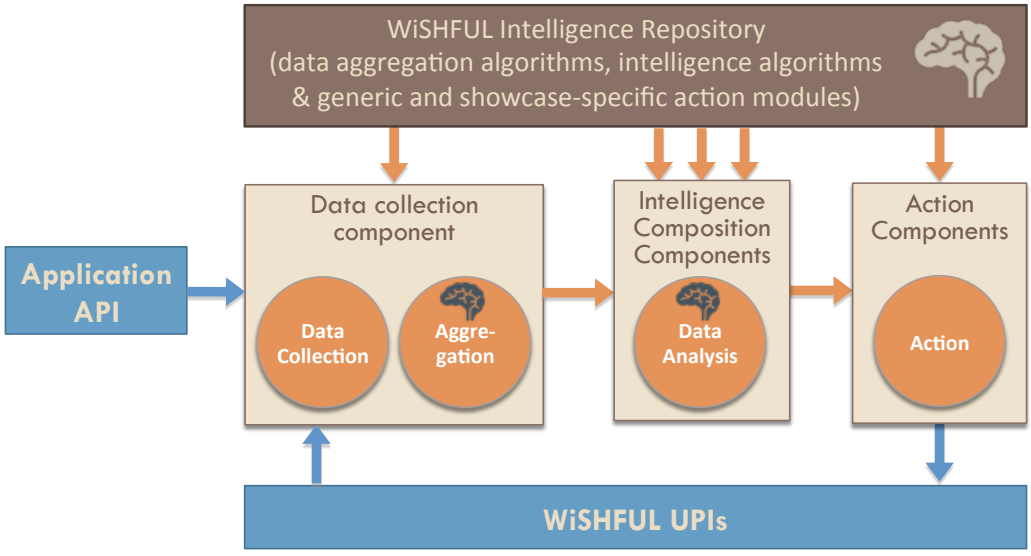


Figure 4 WiSHFUL intelligence framework

Together with the UPIs, the WiSHFUL software architecture of the intelligence framework enables reasoning about the current network state and applying actions to change the configuration of radio and network. More information can be found in WiSHFUL deliverable D10.1 “Design of software architecture for intelligent control and showcases” (https://goo.gl/Sg4jCE) and deliverable 10.2 “Results of first set of showcases using basic intelligence” (https://goo.gl/zFhSxf).

The intelligence framework has been implemented using the Node-RED tool (http://nodered.org), that serves as a front-end (an intuitive graphical user interface) for designing and executing process flows involving data collection, data aggregation, machine learning and configuration (action) steps, as illustrated in Figure 5

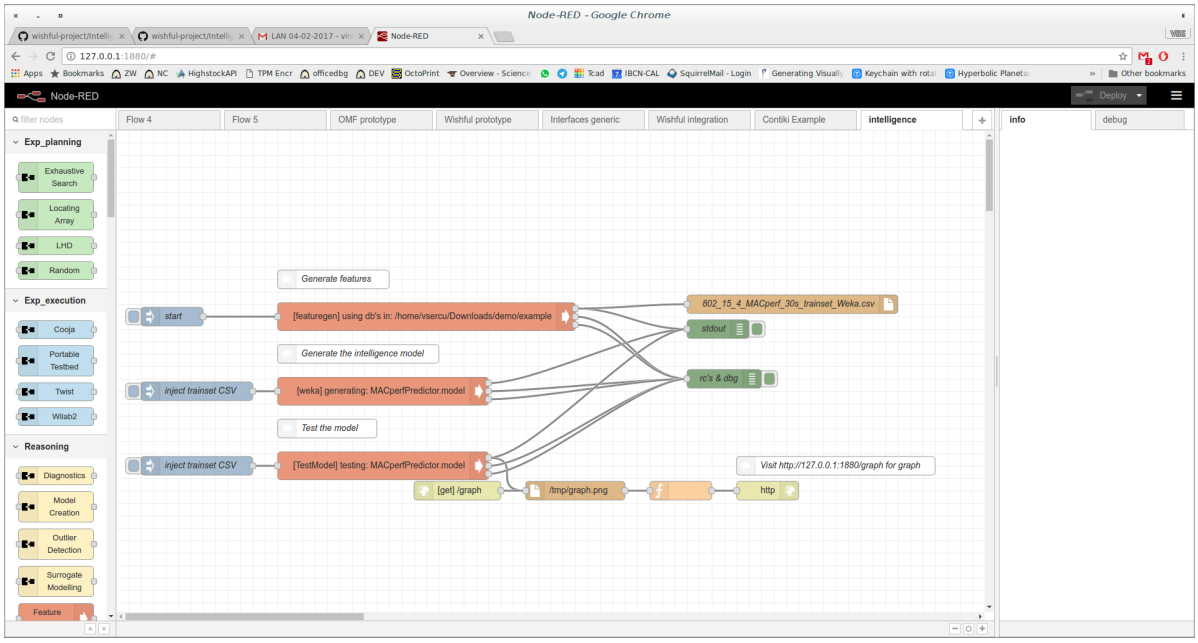


Figure 5 Process flow in Node-RED GUI for off-line modelling of MAC protocols

In the following table you can find a list of the available intelligence modules offered by WiSHFUL as well a link to the relevant repository. The list is regularly updated as more modules are implemented and offered continuously. All of the components below can be found in the general link https://github.com/wishful-project/Intelligence-Framework. The path to each component within the general repository is provided in the table as well.

Intelligence Components	**Brief description**	**Specific Path**
WiSHFUL UPI exec component	A Node-Red component implementation that supports the direct execution of UPIs from within Node-Red	/Action-Component/upi-exec
Measurement collection component	Utilising Cooja network simulator and Node-Red framework to provide a data collection component for wireless sensor networks	/Collect-Component/
Feature generation component	A intelligent component to extract features from datasets	/Intelligence-Engine/reasoning-featuregen/
WECA based model training component	A component that can accept as input datasets to train a neural network based model based on defined features.	/Intelligence-Engine/reasoning-weka/
Interference classification component	An intelligence component that can distinguish between various interference sources and identify nature of interference	/Intelligence-Engine/interference-classification/
Surrogate model creation	Surrogate models create performance-	/Intelligence-Engine/Surrogate-

and optimization	predicting models based on incomplete or noisy data. It is based on MATLAB and can be used through Node-RED	model/
802.15.4 MAC layer performance data set	MAC performance dataset from experiments with 802.15.4 nodes on the wilab2 testbed.	/Datasets/IEEE-802.15.4/
Technology classification dataset	Dataset comprised of LTE, WIFI and DVB signals captured via USRP from various locations in Ghent, Belgium.	/Datasets/Technology-classification/

4. Scope of the present call

This call solicits for **Experiments** to validate advanced solutions for controlling wireless networks using the WiSHFUL software platforms and unified programming interfaces (UPIs), and using the facilities and hardware supported by the WiSHFUL Consortium.

These Experiments should be of a short duration (maximum 6 months). Experiments can be inspired by, but not limited to, the **example showcases** implemented by the WiSHFUL consortium or by experimenters in previous Open Calls.

More details on example showcases and the results obtained can be found in:

- the WiSHFUL deliverables (http://www.wishful-project.eu/deliverables)
- the booklet with Year 1 showcase results achieved by WSHFUL partners (http://www.wishful-project.eu/sites/default/files/images/WiSHFUL_Year1_results.pdf)
- the Open Call 1 results (http://www.wishful-project.eu/OC1results)
- the booklet with Year 2 showcase results achieved by WSHFUL partners (http://www.wishful-project.eu/sites/default/files/WiSHFUL_demo_booklet_Y2.pdf)
- the Open Call 2 results (http://www.wishful-project.eu/OC2results)

Experiments can build further on top of example showcases by adding more advanced wireless monitoring and control. Experiments can focus on the control of radio, lower networking layers, and/or higher networking layers (such as control of routing and transport protocols). Experimenters can also design their own showcases using the HW platforms and UPIs currently supported by the WiSHFUL projects. Small extensions to the UPIs are possible to enable specific control and monitoring functionality required by the proposed Experiment that is not yet supported by WiSHFUL. For this purpose the required functionality must clearly be described in the proposal and discussed with the Patron. For the selected Experiments, these extensions will be supported by the Patron.

This call is split in two **categories** of Experiments:

- ***Scientific excellence*** targeting Experiments validating novel wireless solutions that clearly advance the current state-of-the-art.
- ***Innovation by Industry*** targeting Experiments validating wireless solutions that have a large potential for commercial exploitation in existing or new products or services.

Independent evaluations of the submitted proposals will be performed, in order to select the Experiments that will be supported by the project. Different categories of Experiments will be evaluated against different criteria (see section 10).

It is further required that the Experiments are performed by a single organization. In the category 'Innovation by Industry', only proposals from small and medium-size enterprises, as defined by H2020 guidelines, including unipersonal companies and individuals, will be accepted.

Benefits for an experimenter to participate in this open call are:

- Possibility to perform wireless Experiments starting from advanced flexible software platforms with clearly defined control interfaces without the need for deep technical knowledge on radio hardware platforms or network protocol implementations; This allows the experimenter to focus on advanced/intelligent control strategies for optimizing wireless network solutions, instead of digging into complex hardware and software specifications for different radio hardware platform, network protocols and software architectures.
- Easy access to all the required wireless devices, wireless software platforms and intelligence components in different testbeds with a single account and unified Experimentation tools (cf. tools for testbed access and Experimentation developed in and/or supported by the FED4FIRE/FED4FIREplus project). This allows the experimenter to focus on his core task of Experimentation, instead of on practical aspects such as learning to work with different tools for each testbed, requesting accounts on each testbed separately, etc.;
- The simplified application (and reporting) process compared to the one from the standard H2020 calls together with a rapid review process by independent external evaluators;
- An extra benefit is the dedicated support by skilled WiSHFUL members. Each proposer should seek a supporting WiSHFUL consortium partner (the Patron) that will be in charge of dedicated (advanced) support of the Experiment.

Per proposal a budget can be made available up to a maximum of 50 k€ for an Experiment of the category 'Scientific excellence' and up to a maximum of 40 k€ for an Experiment of the category 'Innovation by Industry'. In parallel, an extra budget (on average 4-5 k€ / Experiment) can be assigned to a WiSHFUL consortium partner acting as the Patron in charge of dedicated (advanced) support of the Experiment.

5. Inclusion into the consortium

Once a proposer is selected to perform the proposed Experiment, he/she will become a third party receiving financial support using Cascade Funding, and to this end needs to sign a sub-agreement with the project coordinator (imec). In the remainder of this document a 'third party using Cascade Funding' is referred to as 'Third Party'.

This implies that the administrative load for the Third Party will be minimal as only two invoices need to be submitted to imec at the end of the Experiment together with a final report describing the tasks performed and the results achieved. This final report will be required before payment will be carried out. A payment of up to 75% of the requested funding will be carried out by the project coordinator based on the evaluation of the final report. The remaining 25% will be paid following a formal approval of the report and the work at a technical project review by the European Commission (EC). More details on the payment scheme are given in section 8.

Each proposing party should seek contact with the WiSHFUL consortium and identify a WiSHFUL partner acting as "Patron". The role of the Patron is to carry out an obligatory feasibility check and to provide support during the execution of the Experiment. This Patron will also be consulted for evaluation before payment by imec of the invoices. The role of this Patron is further described in section 7.

The contract template is available in Annex B of this document. Upon submission, the proposer has to declare the acceptance of the conditions of the contract between imec and the proposer.

6. Proposal template

The use of a specific proposal format as described in this section is mandatory. The template is limited in size and is focusing on "what the proposer wants to do" and "what the expected result is".

Section A **Summary** (maximum 300 words).

The information in this section may be used in public documents and reports by the WiSHFUL consortium.

Section B **Detailed description and expected results** (minimum 4 pages, and maximum 6 pages)

This section describes the details on the planned Experiment (what does the proposer hope to obtain?, how?, why is it relevant?). This section should also include all information with respect to the State-of-the-Art, or a comparison to competing commercial wireless solutions in case of Experiments of category 'Innovation by Industry' to show the innovative character of the Experiment and the expected scientific or business impact.

Section C **Requested WiSHFUL software platforms, UPI interfaces, radio hardware platforms, testbeds** (target length 1 page)

The information in this section needs to be collected in collaboration with the WiSHFUL partner acting as Patron on this Experiment. For this section a specific format needs to be used, which is included in the proposal template.

Section D **Compliance check** (max. 1 page)

This section contains the feedback from the WiSHFUL partner acting as Patron on this Experiment. Each proposing party must contact the WiSHFUL consortium regarding its submission to identify a possible Patron. This Patron can be the WiSHFUL partner responsible for the testbed, hardware or software platform the proposer will use or extend. The proposing party must submit its draft proposal to this Patron by 25 September 2017. The feedback by the Patron is copied into this section of the proposal.

Section E **Background and qualifications** (maximum 2 pages)

This section describes the proposer and includes an overview of the activities, the proposer's qualifications, technical expertise and other information to allow the reviewers to judge the proposer's ability to carry out the Experiment.

Section F **Expected feedback to the WiSHFUL Consortium** (maximum 2 pages)

This section contains valuable information for the WiSHFUL consortium and should indicate the expected feedback the WiSHFUL consortium can expect from the use of its software platforms and/or testbeds after carrying out the Experiment. This information is essential in view of the further improving the WiSHFUL software platforms and UPIs, and the testbeds. Note that providing this feedback is one of the key motivations for the existence of the WiSHFUL Open Calls.

Section G **Requested funding** (1 page)

This section provides an overview of the budgeted costs and the requested funding. A split is made in personnel costs, other direct costs (travel, consumables, etc.) and

indirect costs.

Section H **Use of proposal information**

In this section the proposing party is asked to include some statements related to sharing information of his proposal within the WiSHFUL consortium.

Proposals are treated in a confidential way, meaning that only successful proposals must be disclosed to the WiSHFUL consortium. Open calls previously organized by other FIRE projects were very successful and have revealed that many submitted non-granted proposals also contain very interesting and valuable information that could be used for setting up collaborations or to extract ideas for further improving the federated test infrastructures. Therefore the WiSHFUL project would like to have the opportunity to collect more detailed information and further use this information, also if the proposal is not selected for funding. In any case, the WiSHFUL consortium will treat all information of a proposal confidentially.

Section I **Involvement in FIRE-projects**

In this section proposers need to list their involvement in FIRE-projects, either as partner or as proposer in Open Calls organized by FIRE-projects.

Proposals originating from new players in the FIRE community will be positively discriminated and will receive a higher score.

The full proposal template can be found in Annex A to this document.

Please note that **in the draft proposal** that will be submitted for feasibility check, **at least sections A, B and C should be fully completed**. Please be aware that the Patron will NOT review draft proposals or propose any changes to the proposal. The Patron will only give feedback on the feasibility of the proposed experiment based on the completed sections A, B and C. The feasibility check does not provide a commitment that the proposal will be selected.

7. Support during Experiment and the role of the Patron

Successful proposers in this open call have access to basic and advanced support:

A. Basic support

- Guaranteeing that the facility is up and running (e.g. answering/solving "Why can I not reach wireless node X?")
- Providing pointers to documentation on how the facility and software platforms can be used (e.g. "how to use the w-iLab.t testbed" => answer: check out our tutorial online at page x")
- Providing pointers to technical questions as far as relevant (e.g. answering "do you know how I could change the Wi-Fi channel" => answer: yes, it is described on following page: y"; irrelevant questions are for example "how to copy a directory under Linux")

B. Dedicated (advanced) support includes all of the following supporting activities by the Patron:

- Deeper study of the problem (in particular relevant for Industrial proposers): invest effort to fully understand what the proposer's goals are, suggest (alternative) ways to reach the proposer's goals. To put it more concretely (again using the example of the w-iLab.t testbed), proposers do not need to know the details of the w-iLab.t testbed or how it should be used, they will be told what is relevant to them and can focus on their problem, not on how to solve a testbed problem.

- Help with setting up the Experiments (e.g. "how to use the w-iLab.t testbed " => answer: the tutorial is there, but let me show you what is relevant for you, let me sit together with you while going through this example and let us then also make (together) an Experiment description that matches what you are trying to do).
- (Joint) solving of practical technical problems (e.g. "do you know how I could change the Wi-Fi channel" => yes, it is described on page y, in your case you could implement this as follows.., perhaps we should quickly make a script that helps you to do it more easily, ...)
- Technical consultancy during or after the Experiment (e.g. "I do get result x, but would have expected y, what could be the problem?")

It is essential that the proposer gets in contact with the WiSHFUL partner in charge of the testbed(s) and/or software platform(s) that will be used for the Experiment to discuss your Experiment and the specific requirements. Each proposing party must therefore identify an appropriate Patron. A list of possible Patrons is given below:

Partner	**Contact**	**Supported Testbeds, HW and SW**
imec	Spilios Giannoulis Spilios.giannoulis@ugent.be	Testbeds: w.iLab.t, Portable testbed
		HW: • IEEE 802.11 a/b/g/n: Atheros athxk • IEEE 802.15.4: RM090, Zolertia Z1, Zolertia RE-Mote • SDR: USRP2-N210, USRP B200mini, ZebBoard Xilinx Zynq®-7000 SoC, Xilinx ZC706 Evaluation Kit - Zynq® SoC, USRP X310 • LTE: ip.access
		SW: • IEEE 802.11: Linux • IEEE 802.15.4: Contiki, TAISC, GITAR
TCD	Maicon Kist kistm@tcd.ie & Diarmuid Collins collindi@tcd.ie	Testbed: IRIS
		HW: • SDR: USRP2-N210, USRP2-N210 w/ beamforming, USRP X310
		SW: • SDR: GNU Radio, IRIS software radio
CNIT	Pierluigi Gallo pierluigi.gallo@unipa.it	HW: • IEEE 802.11 b/g: Broadcom b43 • SDR WARPv3 • 40 RAS (Reconfigurable Antenna System) 2.4GHz and 5 GHz)
		SW: • IEEE 802.11 & SDR: Wireless MAC Processor (WMP)
TUB	Anatolij Zubow anatolij.zubow@tu-berlin.de	Testbeds: TWIST, Portable Testbed
		HW: • IEEE 802.11 a/b/g/n: Atheros athxk • IEEE 802.15.4: Jennic JN516X

		SW: • IEEE 802.11: Linux • IEEE 802.15.4: TinyOS • SDR: GNU radio
RUTGERS	Ivan Seskar seskar@winlab.rutgers.edu	Testbeds: ORBIT
		HW: • IEEE 802.11 a/b/g/n: Atheros athxk • SDR: USRP2-N210, USRP X310, USRP B210 • LTE
		SW: • IEEE 802.11: Linux • SDR: GNU Radio
UFRJ	Jose De Rezende rezende@land.ufrj.br	Testbed: FIBRE@UFRJ
		HW: • IEEE 802.11 a/b/g/n: Atheros athxk
		SW: • IEEE 802.11: Linux
Univ. of Thessaly	Thanasis Korakis korakis@uth.gr & Spilios Giannoulis Spilios.giannoulis@ugent.be	Testbed: Nitos
		HW: • IEEE 802.11: Atheros 5k-9k • WiMAX • LTE: ip.access, airspan • SDR: USRP1, USRP N210, USRP B210
		SW: • IEEE 802.11: Linux • WiMAX: Linux • SDR: GNU radio
Jožef Stefan Institute	Mihael Mohorčič miha.mohorcic@ijs.si & Spilios Giannoulis Spilios.giannoulis@ugent.be	Testbed: LOG-a-TEC
		HW: • sigfox: base station and test devices • IEEE 802.15.4 • IEEE 802.15.4a • Clean-slate non-IEEE 802.15.4: TI CC1101 and TI CC2500 • TVWS (SNE-ESHTER hardware)
		SW: • IEEE 802.15.4: Contiki • Rest: Custom
KU Leuven	Sofie Pollin Sofie.pollin@esat.kuleuven.be & Spilios Giannoulis Spilios.giannoulis@ugent.be	Testbed: KU Leuven
		HW: • Full Duplex : NI USRP-2952R, NI USRP-2943R
		SW: • Full Duplex: NI LabVIEW
Scuola Superiore	Luca Valcarenghi	Testbed: ARNO

di Studi Universitari e Perfezionamento Sant'Anna (SSSA)	luca.valcarenghi@sssup.it & Spilios Giannoulis Spilios.giannoulis@ugent.be	HW: • LTE: Virtualized eNB and EPC SW: • JuJu Charms, Linux

The proposing party must submit its draft proposal to his Patron by 25 September 2017 at 17:00. The feedback by the Patron is copied into section D of the proposal.

8. Payment scheme

As the selected proposers will be linked to the WiSHFUL consortium as third party using Cascade Funding, further referred to as 'Third Party', specific arrangements exist with respect to financial costs and payment schemes:

1. As a Third Party, the proposing party needs to include an overview of the estimated costs in its proposal at the time of submission. Costs consist of personnel costs, direct costs (such as travel, consumables, etc.) and indirect costs. The costs of a Third Party have to comply with the rules and the principles mentioned in Section I, Article 6 (Eligible and ineligible costs) of the H2020 AGA — Annotated Model Grant Agreement (see http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/amga/h2020-amga_en.pdf), in the same way as the beneficiaries, and must be recorded in the accounts of the Third Party. In other words, the rules relating to eligibility of costs, identification of direct and indirect costs and upper funding limits apply. Equally those concerning controls and audits of Section I, Article 22 of the H2020 AGA.
2. The maximum requested funding for an Experiment in this Call is set at 50 k€ for an Experiment of the category 'Scientific excellence', at 40 k€ for an Experiment of the category 'Innovation by Industry'.
3. The maximum requested funding for the WiSHFUL partner acting as the Patron for an Experiment is limited to 5 k€ euro on average. Costs in this case are related to the provision of dedicated (advanced) support.
4. As a Third Party, the selected parties for Experiments need to submit a report at the end of the Experiment (for this call this will be at the latest end of April 2018 for an Experiment, under the assumption that the Experiment starts on 1 November 2017). This report (see section 9), must include an overview of the costs incurred and will be accompanied by an invoice to the project coordinator (imec) for 75% of the costs incurred.
5. The report and the declared costs will be evaluated by the WiSHFUL consortium including the partner acting as Patron.
6. Based on this evaluation, a payment of up to 75% costs incurred, amounting to maximum 75% of the approved funding, will be carried out by the project coordinator.
7. The remaining 25% will be paid following a formal approval of the report and the work at a technical project review by the European Commission (EC). To this end a second invoice needs to be submitted to the project coordinator (imec) for the remaining 25% of the costs incurred.
8. For Open Call 5 review meetings with the EC are planned in June 2018. The exact date will be fixed at the start of the Experiment. The review meeting will be held in Ghent. At the review

meeting the results of the Experiment need to be presented, preferably through a real-life (remote) demo running in one the WiSHFUL testbeds. Either the Third Party or the Patron has to present the final results. In the latter case, the Patron should be very well informed, as 25% of the payment depends on the formal approval of the work at the review meeting.

9. Reporting

As the selected proposers will be linked to the WiSHFUL consortium as Third Party to imec, no input will be required for any of the regular project reports (WiSHFUL deliverables), which the WiSHFUL consortium needs to submit to the EC.

The Third Party only has to submit a final report after completion of the Experiment. A specific template needs to be used and will include:

Part A. ***Summary***

Part B. ***Detailed description***

This section describes the details on the Experiment

It includes:

- B.1 Concept, Objectives, Set-up and Background
- B.2 Technical Results and Lessons learned
- B.3 Impact

Please note that section B.4 should focus on scientific impact for Experiments of the category 'Scientific Excellence' and business impact for Experiments of the category 'Innovation by Industry.

Part C. ***Feedback to WiSHFUL***

This section contains valuable information for the WiSHFUL consortium and describes the Third Party's experiences while performing the Experiment starting from the available testbeds, radio hardware and software platforms. Note that the production of this feedback is one of the key motivations for the existence of the WiSHFUL open calls. It includes:

- C.1 Testbeds/Hardware/Software Resources & UPIs used
- C.2 Feedback on getting acquainted and using the testbeds offered in WiSHFUL
- C.3 Feedback on getting acquainted and using the WiSHFUL software frameworks and UPIs
- C.4 Feedback on the administration process of your proposal, Patron communication, and support received from the consortium
- C.5 Why WiSHFUL was useful?
- C.6 Other feedback
- C.7 Quote

Part D. ***Leaflet***

This section provides information that can be used to make a leaflet/poster of your Experiment for promotional purposes

This report will not only serve as an evaluation tool to judge payment of the Third Party, but will also serve as (1) input to the evaluation of the user-friendliness of the WiSHFUL testbeds, software platforms and interfaces, and (2) identification of missing gaps in both testbeds and software platforms.

Part of this report may be used by the WiSHFUL consortium for inclusion in their reporting documents to the EC and in public presentations. Inclusion of confidential information should therefore be indicated and discussed with the WiSHFUL consortium.

This report will also be used for the formal review by the European Commission. Each Third Party is expected to attend this formal review meeting with the EC. In exceptional cases (to be motivated by the Third Party), the Third Party can be represented by his Patron.

The template for the final report will be available at the start of the Experiment.

10. Criteria for evaluation of Experiments

Proposals can only be submitted by:

- Parties eligible for participation in the EC Horizon 2020 Programme;
- SMEs, unipersonal and large companies according to the definition used by the EC (for Experiments in the category 'Innovation by Industry');
- Single parties (no consortia are allowed);
- Multiple proposals may be submitted by the same party. However, in case multiple proposals are submitted, reference should be made to each submitted proposal and clear indication should be given on the complementarity of the proposals;
- Proposals submitted by new players in the FIRE community will receive a higher score.

Evaluation and ranking will be carried out by an external jury.

Selection will mainly be based upon he following criteria:

General criteria (applicable to both categories of Experiments)

1. ***Clarity and methodology*** (Cf. Section B of the Proposal Template)

   The Experiment should be scientifically and/or technically sound. There should be a clear problem statement, a solid Experiment design, a good methodology, etc.

2. ***Feasibility*** (Cf. Sections C and D of the Proposal Template)

   Experiments with low chances for success or requiring excessive support from the WiSHFUL partners will get a lower score.

3. ***Qualifications of the proposer*** (Cf. Section E of the Proposal Template)

   The proposer should exhibit prior research/development experience and the necessary qualifications to perform the Experiment

4. ***Potential for Feedback*** (Cf. Section F of the Proposal Template)

   The WiSHFUL consortium is seeking feedback regarding the available WiSHFUL software platforms, UPIs, and testbeds. Proposals that can indicate that a lot of information and feedback on the use of software platforms, UPIs, and testbeds will be provided, will get a higher score.

5. ***Value for money*** (Cf. Section G of the Proposal Template)

   The requested budget should be in line with the proposed work plan.

6. ***Involvement in FIRE projects*** (cf. Section I of the Proposal Template)

   Participation in previous FIRE projects. This criterion will not be judged by the evaluators, but by the WiSHFUL Project officer.

Specific criteria:

- Category 'Scientific Excellence':

7. ***Scientific innovation:*** the degree of scientific innovation of the solution for wireless control (cf. Section B of the proposal template)

   The score given here should reflect the degree of innovation: if an Experiment is pushing the boundaries of its domain, then it should get a higher score then Experiments testing trivial things. In order to demonstrate this criterion, the proposer is expected to clearly motivate his Experiment and indicate the State of the Art in the appropriate field.

8. ***Scientific relevance:*** potential for take-up of the results by the broader scientific community (cf. Section B of the proposal template)

   The proposed Experiment should be sufficiently relevant form a scientific point of view to be taken up by the broader scientific community. The score given here should reflect the extent to which the broader scientific community can benefit from the solution proposed in the Experiment.

9. ***Publication potential*** (cf. Section B of the proposal template)

   The expected results of the Experiment should have potential for publication in high-impact scientific journals and/or for presentation/demonstration of the results on major scientific conferences. The proposer is expected to identify publication/presentation/ demonstration opportunities.

- Category 'Innovation by Industry':

10. ***Industrial innovation***: the degree of industrial innovation of the solution for wireless control (cf. Section B of the proposal template)

    The score given here should reflect the degree of innovation: there should be a indication to which extent the proposed wireless solution is different and innovative compared to existing and/or competing commercial wireless solutions. In order to demonstrate this criterion, the proposer is expected to clearly motivate his Experiment and compare his proposed solution with existing solutions in the appropriate field.

11. ***Industrial and/or standardisation relevance:*** (cf. Section B of the proposal template)

    Potential for exploiting the results of the Experiment in commercial wireless solutions and/or for providing a verifiable impact on the standardisation process.

    This score should reflect the industrial relevance including the expected and projected impact on the company through product development.

12. ***Demonstration potential*** (cf. Section B of the proposal template)

    The expected results of the Experiment should have potential for demonstration of the results on relevant events (exhibitions, congresses, technical seminars, networking events, user group events, etc.). The proposer is expected to identify relevant demonstration opportunities.

13. ***Type of industrial innovator***: Unipersonal company, SME or large company.

The table below shows the weights and maximal scores for the different criteria.

Criterion	Short description	Weight	Maximum score
1	Clarity and methodology	1	5
2	Feasibility	1	5
3	Qualifications of the proposer	1	5
4	Potential for Feedback	2	10
5	Value for money	1	5
6	Involvement in FIRE projects	n.a.	+ 3
7	Scientific innovation	2	10
8	Scientific relevance	2	10
9	Publication potential	1	5
10	Industrial innovation	2	10
11	Industrial and/or standardisation relevance	2	10
12	Demonstration potential	1	5
13	Type of industrial innovator	n.a.	+ 3
	Maximum Total score		**55**

The proposals submitted by parties who have not yet been or are not participating in FIRE-projects or Open Calls from FIRE-projects will receive an extra 3 points (for criterion 6) on top of their total score. This measure is introduced to positively discriminate such new players and open the FIRE testbeds to a wider community.

The proposals submitted by unipersonal companies or SMEs in the category 'Innovation by Industry' will receive an extra 3 points (for criterion 13) on top of their total score. This measure is introduced to encourage participation of smaller and unipersonal companies.

The maximum score is 55. This maximum score cannot be exceeded by criterion 6 and 13.

Minimum 9 proposals will be selected, of which minimum 3 proposals of category "Scientific Excellence" and minimum 4 proposal of category "Innovation by Industry". Additional proposals will be selected based on quality (highest ranked proposals not selected so far that still fit within the call budget disregarding the category).

11. Timing of the evaluation and Experiments

The duration of the evaluation of the proposals and approval by the EU will be kept within 1 month.

In case of this specific Call, the target date for acknowledgement of selection is set at 1 November 2017.

Experiments can start at the earliest on 1 November 2017, but no later than 1 December 2017.

The deadline for the final report for an Experiment is expected 6 months after the start of the Experiment, and no later than the end of April 2017. Please note that a later start will imply a shorter (than 6 months) experiment.

The final evaluation of the Experiments will happen at a review meeting with the EC. The review meeting for Experiments is currently scheduled for June 2018 either in Ghent at imec or in Brussels at the EC. The exact date will be fixed at the start of the Experiment.

12. Submission

Submission deadline of draft proposal to WiSHFUL partner acting as Patron for feasibility check:	Monday 25 September 2017, at 17:00 Brussels local time
Submission deadline:	Monday 2 October 2017, at 17:00 Brussels local time

The proposal must be:

1. Submitted on-line through: http://www.wishful-project.eu/open-calls
2. Submitted in English

Feasibility check: A technical feasibility check is required before submission. This feasibility check will be carried out by the WiSHFUL members responsible for the facilities, radio hardware platforms, and software platforms involved. As a result of this, an additional concise section is added to the proposal (section D of the Proposal Template) and is provided in collaboration with the WiSHFUL project consortium members. This section also identifies the Patron of the Experiment, who is the lead contact person within the project who will be responsible for the follow up of this Experiment (see section 7 of this document).

Annex A: Proposal Template

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

Open Call 5

Fifth WiSHFUL Competitive Call for Experiments

Full Title of your proposal

Acronym of your proposal (optional)

Call[3] - Identifier[4] - Category[5]	WiSHFUL-OC5-EXP- category
Date of preparation of your proposal:	xx/yy/2017
Version number (optional):	
Your organisation name:	name
Name of the coordinating person:	First name Last name
Coordinator telephone number:	number
Coordinator email: [This is the email address to which the Acknowledgment of receipt will be sent]	Email address

Note: Grey highlighted areas need to be filled. Word template can be downloaded from WiSHFUL project website (see http://www.wishful-project.eu/open-calls)

[3] This call: WiSHFUL-OC5

[4] 'Experiments (EXP)'

[5] 'Scientific Excellence (EXC)' or 'Innovation by Industry (IND)'

Section A Project Summary

(Maximum 300 words – summary of the proposed work)

Remark: The information in this section may be used in public documents and reports by the WiSHFUL consortium.

This section needs to be completed in the draft proposal and will be used for the feasibility check (cf. Section D)

Section B Detailed description and expected results

(minimum 4 pages, and maximum 6 pages)

This section describes the details on the planned Experiment (what does the proposer hope to obtain?, how?, why is it relevant?). This section should also include all information with respect to the State-of-the-Art, or a comparison to competing commercial wireless solutions in case of Experiments of category 'Innovation by Industry' to show the innovative character of the Experiment and the expected scientific or business impact.

This section needs to be completed in the draft proposal and will be used for the feasibility check (cf. Section D)

B.1 Concept and objectives

Describe the specific objectives of the proposed Experiment, which should be clear, measurable, realistic and achievable within the duration of the Experiment (not through subsequent development). Show how they relate to the topic(s) addressed by the competitive call and how and why WiSHFUL is needed for realizing them.

Describe and explain the overall concept that forms the basis for your Experiment. Describe the main ideas, models or assumptions involved.

B.2 Impact

For Experiments of category "Scientific Excellence": *Describe how this Experiment fits in your internal research roadmap, and to which extent the broader research community can benefit from the results of the Experiment.*

For Experiments of category "Innovation by Industry": *Describe how this Experiment fits in your activities, and how this Experiment may strengthen the competitiveness of your business and the growth of your company. Having close contacts with possible end-users during this Experimental phase might be used to illustrate the business impact of the Experiment.*

For any Experiment*: Show that the proposed Experiment has sufficient sustainable benefits for the WiSHFUL project, meaning that there should be an added value for the WiSHFUL project, after the proposer has finished his Experiment.*

B.3 Description of State-of-the-Art

For Experiments of category "Scientific Excellence": *Describe the advances the proposed Experiment would provide beyond the state-of-the-art, and the extent the Experiment is ambitious.*

Is this Experiment expected to lead to groundbreaking results or rather incremental results compared to existing work?

For Experiments of category "Innovation by Industry": *Describe in detail how the proposed solution compares with existing solutions in the field covered by the Experiment. Are there similar Experiments, products, services, etc. on the market? Is this Experiment incremental to existing work?*

B.4 Methodology and associated work plan

Provide a work plan. Provide clear goals and verifiable results, and also a clear timing.

The work plan involves at least the following phases:

1. *Design of Experiment*
2. *Executing the Experiment*
3. *Analysis & feedback*
    - *Analysis of the results of the Experiment*
    - *Feedback on user experience*
    - *Recommendations for improvements and/or future extensions of WiSHFUL software platforms, UPIs and testbeds*
4. *Showcase: Set up of a showcase (demonstration) to be used for the evaluation of the Experiment at the review meeting with the EC, and for further promotion of WiSHFUL*
5. *Dissemination: Regular dissemination actions (journal publications, conferences, workshops, exhibitions, FIRE events, advertising of results at WiSHFUL website, etc.)*
6. *Final report, code and documentation*

NOTE: there is NO need to define work packages or deliverables. All results need to be reported in the final report at the end of the Experiment. Of course, a good communication plan with the Patron is required to exchange progress within different phases.

Section C Requested WiSHFUL software platforms, UPI interfaces, radio hardware platforms and testbeds

Please check the WiSHFUL software platforms, UPI interfaces, radio hardware platforms and testbeds that will be required for your Experiment.

Please visit the following websites to get details on the specific testbeds, hardware platforms, software platforms and UPIs:

- http://www.wishful-project.eu/testbeds
- http://www.wishful-project.eu/software
- https://wishful-project.github.io/wishful_upis/
- https://github.com/wishful-project

This section needs to be completed in the draft proposal and will be used for the feasibility check (cf. Section D). Especially the usage the UPI interfaces must be clearly defined (with identification of specific functions and parameters).

TESTBEDS	**Required (Yes/No)**
w.iLab.t (Heterogeneous wireless testbed @ imec, Ghent, Belgium)	
IRIS (Software Defined Radio testbed @ TCD, Dublin, Ireland)	
TWIST (Sensor testbed and openWRT router testbed @ TU Berlin, Berlin, Germany)	
ORBIT (20 x 20 radio grid testbed @ Rutgers University, New Jersey, US)	
FIBRE@UFRJ (OMF testbed @ UFRJ, Rio de Janeiro, Brazil)	
WiSHFUL portable testbed	
NITOS Testbed (network implementation testbed using open source platforms @ University of Thessaly, Volos, Greece)	
LOG-a-TEC testbed (Josef Stefan Institute @Ljubljana, Slovenia)	
KU Leuven testbed (KU Leuven @Leuven, Belgium)	
ARNO testbed (SSSA @Pisa, Italy)	

HARDWARE PLATFORMS			
Hardware	**Type**	**Technology**	**Number of nodes required**
wireless Wi-Fi card	Atheros athxk,	IEEE 802.11 a/b/g/n	
	Broadcom b43	IEEE 802.11 b/g	
Wireless sensor node	RM090	IEEE 802.15.4	
	Zolertia Z1	IEEE 802.15.4	
	Zolertia RE-Mote	IEEE 802.15.4	

	Jennic JN516X	IEEE 802.15.4	
	VESNA	IEEE 802.15.4	
		IEEE 802.15.4a (UWB)	
		Clean slate non-IEEE 802.15.4	
	Sigfox	LPWAN UNB 868 MHz	
Software Defined Radio (SDR)	WARPv3	IEEE 802.11 b/g	
	USRP2-N210	2.4 – 2.5 GHz	
		4.9 – 5.85 GHz	
		50 – 860 MHz (RX only)	
		800 – 1000 MHz	
		1.5 – 2.1 GHz	
		2.3 – 2.9 GHz	
		50 MHz – 2.2 GHz	
		400 MHz – 4.4 GHz	
	USRP2-N210 w/ beamforming	400 MHz – 4.4 GHz	
	USRP-B200mini	70 MHz - 6 GHz	
	USRP X310	10 MHz – 6 Ghz	
	USRP B210	70 MHz - 6 GHz	
LTE	Airspan	2.59 GHz TDD	
	ip.access (+ SIRRAN EPC SW core)	2500-2570 MHZ (indoor uplink) 2620-2690 MHZ (indoor downlink) 2.53-2.63 GHz (outdoor)	
	srsLTE	USRP based, 2.4-5 GHz	
	OpenAir Interface	Virtual eNB, EPC	
TVWS	SNE-ESHTER	470-862 MHz	
Full Duplex Radio	NI USRP-2943R NI USRP-2952R	1.2 - 6 GHz 0.4 - 4.4 GHz	
Antenna	RAS (Reconfigurable Antenna System)	2.4 GHz 5 GHz	

SOFTWARE	
OPERATING SYSTEMS	**Required (Yes/No)**
Linux	
Contiki	
TinyOS	
PLATFORMS	**Required (Yes/No)**
Wireless MAC Processor (WMP)	
Time-Annotated Instruction Set Computer (TAISC)	
Generic Internet-of-Things ARchitecture (GITAR)	
IRIS Software Radio	
GNU Radio	
Full Duplex	

UPI Interfaces *Please list the UPI functions that are needed to support your Experiment together with the parameters of interest. Try to be as specific as possible.*
Unified Programming Interface – Radio (UPI_R)
[Example: UPI function: wishful_upis.radio.get_measurements Parameters: RSSI, SNR, BER, TX_ACIVITY, NUM_TX_SUCCESS
[Another example: wishful_upis.wifi.radio.set_modulation_rate
Unified Programming Interface – Network (UPI_N)
[Example: UPI function: wishful_upis.net.set_parameters Parameter: ROUTING_MAX_TTL
[Another example: wishful_upis.net.inject_frame(iface, frame, is_layer_2_packet, tx_count=1, pkt_interval=1)
Unified Programming Interface – Global (UPI_G)
[mention here the functions that will be called remotely together with the parameters that will set/controlled remotely)

Unified Programming Interface – Hierarchical (UPI_{HC})
[describe what kind of information will be exchanged in a hierarchical way] [Example: the global control program sends control policies to local control programs, to be executed locally when the connectivity between them is not more available]

Intelligence Components	**Required (Yes/No)**
WiSHFUL UPI exec component	
Measurement collection component	
Feature generation component	
WECA based model training component	
Interference classification component	
Surrogate model creation and optimization	
802.15.4 MAC layer performance data set	
Technology classification dataset	

Please provide a short motivation on why specific testbeds, hardware platforms, software platforms, intelligence components, and/or UPIs will be required for the proposed Experiment. (maximum ½ page)

Section D Compliance check

(maximum 1 page)

This section contains the feedback from the WiSHFUL partner acting as Patron on this Experiment. Each proposing party must contact the WiSHFUL consortium regarding its submission to identify a possible Patron. This Patron can be the WiSHFUL partner responsible for the testbed, hardware or software platform the proposer will use during its Experiment. The proposing party must submit its draft proposal to this Patron by Monday 25 September 2017 at 17:00. The feedback by the Patron is copied into this section of the proposal.

Section E Background and qualifications

(maximum 2 pages)

This section describes the proposer and includes an overview of the activities, the proposer's qualifications, technical expertise and other information to allow the reviewers to judge the proposer's ability to carry out the Experiment.

Section F Expected feedback to the WiSHFUL Consortium

(maximum 2 pages)

This section contains valuable information for the WiSHFUL consortium and should indicate the expected feedback the WiSHFUL consortium can expect from the use of its software platforms, hardware platforms and/or testbeds after carrying out the Experiment. This information is essential in view of the further improving the WiSHFUL software platforms and UPIs, and the testbeds. Note that providing this feedback is one of the key motivations for the existence of the WiSHFUL open calls.

Section G Requested funding

(maximum 1 page)

This section provides an overview of the budgeted costs and the requested funding. A split is made in personnel costs, other direct costs (travel, consumables, etc.) and indirect costs.

Besides the table below, extra information can be provided to support the requested funding and which may help to judge the cost to the WiSHFUL project.

Please show your figures in euros (not thousands of euros).

	Total PM	**Cost (€)**
(1) Direct personnel costs		
(2) Other direct costs, of which:		
Travel		
Equipment		
Other goods and services		
(3) Indirect costs		
(4) Total costs (Sum of 1, 2 and 3)		

In row (1), insert your direct personnel costs for the work involved.

In row (2), insert any other costs, for example travel or equipment costs. Please allocate sufficient budget for participation at the final review meeting, and visit(s) to WiSHFUL partners, in case this is required in view of advanced support by the Patron.

In row (3), calculate the indirect costs (for personnel and other direct costs)

In row (4), calculate the sum of your personnel, other direct costs and indirect costs.

The maximum funding which is allowed in this call is set at 50 000 € for an Experiment of the category 'Scientific excellence', and 40 000 € for an Experiment of the category 'Innovation by Industry',

In view of the review of your proposal it is best to list the costs related to the proposed Experiment as would be done for any European Project.

Section H Use of proposal information

In this section the proposing party is asked to include some statements related to sharing information of his proposal within the WiSHFUL consortium.

Proposals are treated in a confidential way, meaning that only successful proposals must be disclosed to the WiSHFUL consortium. Open calls previously organized by other FIRE projects were very successful and have revealed that many submitted non-granted proposals also contain very interesting and valuable information that could be used for setting up collaborations or to extract ideas for further improving the federated test infrastructures. Therefore the WiSHFUL project would like to have the opportunity to collect more detailed information and further use this information, also if the proposal is not selected for funding. In any case, the WiSHFUL consortium will treat all information of a proposal confidentially.

Two types of information usage are envisaged:

- *Information which is part of the Sections A, C, D and F will be used within the WiSHFUL project as input for tasks related to testbed and software platform optimizations, sustainability studies, etc. The same information can also be used in an anonymous way to create statistics and reports about this first open call. All proposals submitted to this competitive open call are obliged to allow this form of information access and usage.*
- *Other information belonging to this proposal might also be accessed by the WiSHFUL consortium, if allowed by the corresponding proposer. Any use of such information will be discussed and agreed upon with the proposers. Proposers have the freedom to select if they wish to support this kind of information usage.*

I allow that the material provided in Sections A, C, D and F of this proposal may be accessed by the WiSHFUL consortium, also if the proposal is not selected for funding. In any case, the WiSHFUL consortium will treat all this information confidentially. It will be used within the WiSHFUL project as input for tasks related to testbed and software platform optimizations, sustainability studies, etc. The same information can also be used in an anonymous way to create statistics and reports about this first open call.	Yes ☐	
Furthermore, I allow that the other parts of this proposal may be accessed by the WiSHFUL consortium, also if the proposal is not selected for funding. In any case, the WiSHFUL consortium will treat all information of this proposal confidentially. Any use of this information will be discussed and agreed upon with the proposers.	Yes ☐	No ☐

Section I Involvement in FIRE-projects

In this section proposers need to list their involvement in FIRE-projects, either as full partner or as successful proposer in Open Calls from FIRE-projects.

Proposals originating from new players in the FIRE community will be positively discriminated and will receive a higher score.

Annex B

Agreement for the Use of the WiSHFUL Platform for Experimentation

This Agreement for the Use of the WiSHFUL Platform for Experimentation (hereinafter the "Agreement") is entered into by and between:

[*Organization 1*], with its registered office situated at *[Address]* and duly represented by *[Name and Title of legal representative*], hereafter referred to as "the Experimenter".

Interuniversitair Micro-Electronica Centrum vzw, a non-profit organisation duly organized under the laws of Belgium, Register of Legal Entities Leuven VAT BE 0425.260.668, with its registered office situated at Kapeldreef 75, 3001 Leuven, Belgium and hereby duly represented by Luc Van den hove, President and CEO, hereinafter referred to as "the Coordinator" or "IMEC".

IMEC has received from the other members of the consortium for the execution of the H2020 project "Wireless Software and Hardware platforms for Flexible and Unified radio and network controL" – Acronym "WiSHFUL" (hereinafter the "Project") the right to represent them by signing this Agreement with the third parties selected in the Open Calls for Experiments.

1. Objectives and scope

The scope of this Agreement is to stipulate the terms and conditions under which Experimenters can make use of the WiSHFUL facilities for experimental validation of their wireless solution(s). The WiSHFUL facilities and supported software platforms for radio and network control as a whole are further referred to as the Platform. The experimentation activity that is performed by the Experimenter is further referred to as "the Experiment".

In addition to offering the WiSHFUL facilities and software platforms, the Project also provides essential training and support to the Experimenter in order to enable the Experimenter to successfully execute its Experiment. The specific members of the WiSHFUL consortium and its

personnel that provide the WiSHFUL facilities and software platforms and give support to the Experimenter for executing its Experiment are further referred to as “Providers”.

Details of the Experiment entitled *[TO BE COMPLETED]* can be found in the application form submitted by the Experimenter for the fifth WiSHFUL Open Call. The Experiment has been selected for support by the Project as a result of an evaluation process that is approved by the European Commission.

The specific content of the Experiment, the specific WiSHFUL facilities and software platforms used and the Providers involved in the Experiment are further defined in the Experimenter’s proposal as approved by the Project.

2. Terms and conditions

2.1 Applicability

These Terms and Conditions apply to every Experimenter using the Platform. Next to these Terms and Conditions contained in this Agreement, specific regulations of the Provider may apply as well as applicable software and data licenses. These are available at http://www.wishful-project.eu/testbeds and http://www.wishful-project.eu/software and links therein. The Experimenter hereby expressly confirms to have read and to accept these specific regulations and licenses. It is the Experimenter’s responsibility to remain aware of all applicable regulations and of any changes made to them.

The Terms and Conditions apply to the use of all equipment connected to the Platform. This includes wireless components, servers, network(s) residing in the Platform.

These Terms and Conditions apply to use of all software and data within the Platform.

These Terms and Conditions apply to third parties, if accepted by the Project, using the Platform through services the Experimenter has made available through the Platform as part of an Experiment whereby the Experimenter remains liable for this use by third parties.

2.2 Liability

IMEC and the partners of the consortium WiSHFUL assume no liability in regards to interruption, corruption, loss or disclosure of the services, processes and data hosted on the Platform.

The Experimenter shall fully and exclusively bear the risks in connection with the Experiment, including without limitation to any risk arising from the use of the Platform.

The Experimenter is and shall be liable for actions performed on the Platform. In case of misuse, Experimenter is responsible for making good all damages to the Testbed(s) and is responsible for any loss or damage incurred.

The Experimenter is granted account(s) to the Platform for own and personal use. The Experimenter should take appropriate measures to protect its credentials and prevent its use by third parties. The information the Experimenter provides when requesting an account should be correct. Experimenter shall be responsible for all and any loss or damages incurred by the Experimenter and/or the WiSHFUL consortium as a result of any unauthorized transfer by them of their password. No warranty whatsoever is given with respect to the Platform, support and all information provided hereunder including, but not limited to, any express or implied warranty for use, availability, reliability, quality, fitness for a particular purpose or non-infringement of third party intellectual property rights. They are provided “AS IS”.

Experimenter must respect the regulations of the various Platform resources the Experimenter uses in its Experiment.

Experimenter must not interfere with others' work or attempt to invade their privacy. Experimenter must not attempt modify any element of the Platform nor to disrupt the working of the Platform or any other system.

If there is evidence that the actions of Experimenter is adversely impacting the quality offered by the Platform, Providers are empowered to take reasonable measures to terminate or reprioritize usage in order to protect the overall operation of their services. Implicated Experimenters will be contacted by the Providers as early as is reasonable.

Copyright, other intellectual property and data protection legislations apply to software and data and Experimenters must respect them. The terms of applicable software and data licenses must be respected.

In order to keep the Platform operating correctly both technically and legally, it may become necessary to investigate network traffic (for example, wireless traffic) as well as examine information held on systems that are, or have been, connected to the Platform. Experimenter is deemed to have agreed to this and to provide the required access.

In connection with this Agreement, each Party will comply with all applicable export control laws and regulations, including the European Council regulations n°428/2009 of May 5th, 2009 setting up the community regime for the control of export of dual use items and technology. The Experimenter will not use any item or technical data including software and source code (herein referred to as “Item”) received under this Agreement in the design, development, production, stockpiling or use of weapons of mass destruction, such as nuclear, chemical or biological weapons.

The Experimenter assures that it will not directly or indirectly Export any Item to any destination, person, entity or end use prohibited or restricted under such export control regulations, without obtaining prior authorization from the applicable government authorities to the extent required by those laws.

Further, additional national regulations from the government of the Provider(s) must be observed.

2.3 Enforcement

Whenever Experimenter uses the Platform the Experimenter is bound by all the above regulations and the legislation in force at the time.

The regulations and legislation that applies to Experimenter will be enforced by IMEC, as coordinator of the WiSHFUL consortium, or/and by the affected Testbed Providers, even if a breach of either has been evidenced from elsewhere.

Experimenter agrees that the Providers involved may monitor the systems and traffic for vulnerabilities and conformance to the acceptable uses, and Experimenter will collaborate with IMEC and the WiSHFUL consortium and any third party involved should any violations or breaches be noticed. The Providers involved may immediately suspend or stop systems without notice if such violations are found or suspected, or suspend network connectivity. To fulfill legal and contractual requirements, they may communicate to authorized third parties the owner and user of any resource provisioned and connected to the Internet.

2.4 Research use of Platform resources

The Platform has been constructed for experiment-driven research activities, where experiment-driven research is defined as any activity that furthers the Experimenter’s knowledge and/or

understanding of concepts, algorithms, protocols of wireless solutions (more specifically related to control of wireless networks), provided that this activity is legal.

All other use of the Platform by the Experimenter than the use explicitly contained in the Experiment is not permitted.

The use of the Platform to host commercial activities is explicitly disallowed.

2.5 Dissemination of Experiment results

The results achieved during the implementation of the Experiment by the Experimenter will be owned by the Experimenter.

The Experimenter will have to deliver a final report describing the results of the Experiment and the experience gained in using the Platform.

The final report can be made public the WiSHFUL consortium for further promotion of the Platform unless the Experimenter invokes commercial interests to limit the publication thereof.

Publications/demonstrations that are made based on the results of the Experiment should clearly mention the usage of the Platform and Provider also if the publication/demonstration occurs after the end date of the Experiment.

3. WiSHFUL support policy

The Experimenter will receive the support as described in the WiSHFUL Open Call. The support to the Experiment is provided on a reasonable-effort basis. Support should first be sought in the user documentation, which is a living online resource (see http://www.wishful-project.eu/testbeds for documentation on the testbeds, and http://www.wishful-project.eu/software for documentation on the Platform, and links therein) that has a 'getting started' guide and a FAQ section to deal with common questions and problems. It is expected that the Experimenter will go through this to master the basics of managing resources for performing the Experiment on the Platform.

4. Period of the Agreement

The start date of the Experiment is [*start date*] and the end date is [*end date*].

The Experimenter's right to use the Platform and the Agreement are automatically and without notice from the Coordinator terminated if the Experimenter fails to comply with any of the obligations detailed in the Agreement.

Upon termination of the Agreement, the Experimenter shall, unless otherwise agreed upon, immediately discontinue all use of the Platform.

5. Resources and Financial provisions

5.1. By signing this Agreement, the relevant parties of the WiSHFUL consortium commits to provide the necessary facility resources and manpower resources to the Experimenter, free of charge on a reasonable efforts basis.

By signing this Agreement, the Experimenter confirms that it has the necessary manpower resources to timely execute the Experiment.

5.2. For the performance of the Experiments in accordance with the terms and conditions of the Agreement, the following maximum financial support for the Experimenter is foreseen: *[Approved funding]*. Further financial rules and details are given in Open Call information and approved proposal.

The Experimenter will invoice IMEC for the total amount of this financial support after approval by the WiSHFUL consortium of the final report defined in article 2.5 hereof. The final report, code and documentation and the declared costs will be evaluated by the WiSHFUL consortium including the Provider(s) that have given support. Based on this evaluation, a payment of up to 75% of the requested financial support will be carried out by the Coordinator. The remaining 25% will be paid following a formal approval of the report and the work at a technical project review by the European Commission. Payment of the financial support is subject to receipt of the funding from the European Commission.

5.3. The Experimenter hereby agrees to be bound by the obligations as set forth in the articles 22, 23, 35, 36, 38 and 46 of the Grant Agreement. These articles are detailed in Appendix 1.

6. Miscellaneous

The parties may sign and deliver this Agreement by electronic transmission. Each Party agrees that the delivery of this Agreement by electronic transmission shall have the same force and effect as delivery of original signatures and that each party may use such electronic or facsimile signatures as evidence of the execution and delivery of this Agreement by the parties to the same extent that an original signature could be used.

7. Signatures

IMEC, on behalf of the WiSHFUL consortium By: Name: Title: Phone: Email:
Experimenter By: Name: Title: Phone: Email:

Appendix 1

Relevant articles of the Grant Agreement

http://ec.europa.eu/research/participants/data/ref/h2020/mga/gga/h2020-mga-gga-multi_en.pdf