WiSHFUL

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

European Commission

Open Call 3

Third WiSHFUL Open Call for Experiments and Extensions

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1. General call objectives

The WiSHFUL project hereby announces its third Open Call for Experiments and Extensions, which includes 2 tracks:

- ***Track 1 – Call for experiments***: this track targets 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.
- ***Track 2 – Call for extensions:*** this track targets (1) development of new software functionality for the currently supported WiSHFUL software and hardware platforms, (2) adding new hardware that is compliant with the WiSHFUL software platforms, at least supports the WiSHFUL unified programming interfaces, or (3) integration of new Fed4FIRE compliant testbeds that are compliant with the WiSHFUL software platforms and its unified programming interfaces (UPIs).

More information on the scope of this second 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-OC3
Call title:	Third WiSHFUL Open Call for Experiments and Extensions
Submission deadline:	28 October 2016, at 17:00 Brussels local time
Feasibility check deadline:	21 October 2016, 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 federation 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 Friday 21 October 2016, 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 Wednesday 26 October 2016 at 17:00, and must be copied into section D of the proposal template.

Financial information:

Call	Category / identifier	Call budget	Max. budget per exp. or ext.	Minimum no. of exp./ ext. to be funded	Guaranteed support[1]
Experiments	Scientific Excellence WiSHFUL-OC3-EXP-EXC	€ 100 000	€ 50 000	2	€ 10 000
	Innovation by SMEs WiSHFUL-OC3-EXP-SME	€ 115 000	€ 40 000	3	€ 15 000
Extensions	WiSHFUL-OC3-EXT	€ 480 000	€ 100 000	5	€ 40 000
Total funding of this call		€ 695 000, of which € 215 000 for Experiments and € 480 000 for Extensions			€ 65 000

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 SMEs', only proposals from small and medium-size enterprises, including unipersonal companies and individuals, will be accepted.
- 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, even if in different categories. In that case, the proposer might be given the opportunity to chose 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 11 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 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 € 5 000 per Experiment and € 7 000 per Extension (with an upper limit of € 10 000 per Experiment/Extension) will be allocated to the WiSHFUL consortium partner acting as Patron for guaranteed support.

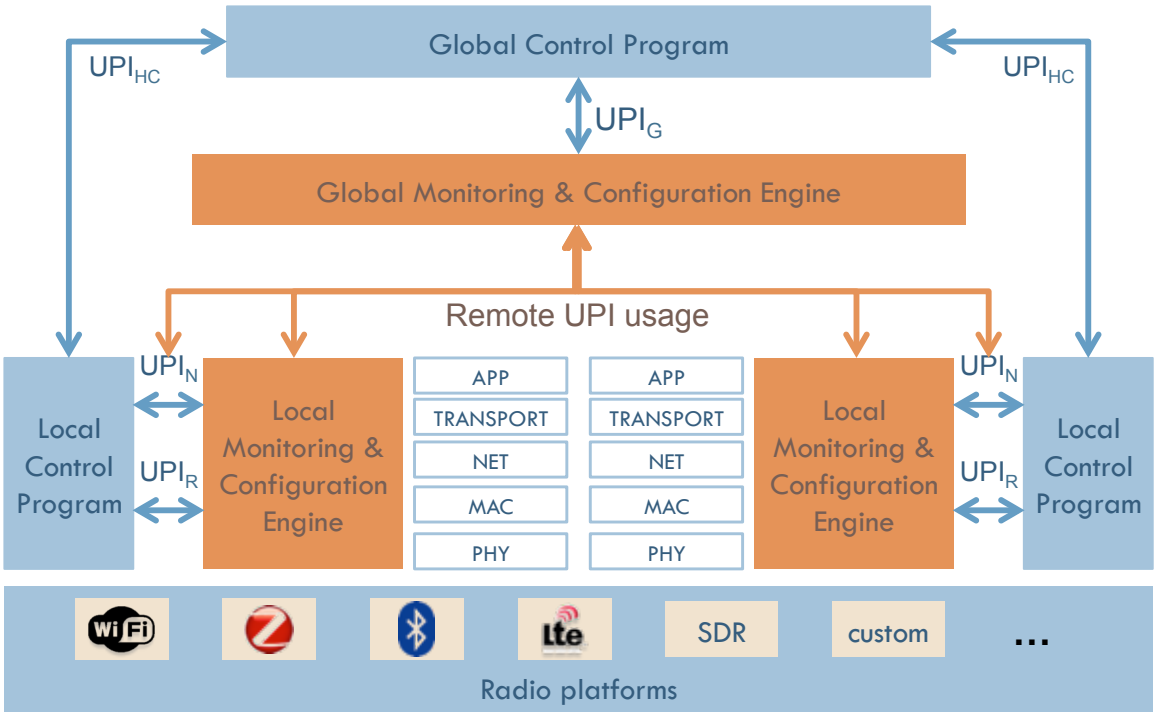
[2] Please note that the submission portal for WiSHFUL Open Call proposals is NOT the H2020 portal.

3. Background information on the WiSHFUL project

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 unified radio and network control interfaces for off-the-shelf as well as advanced SDR equipment that allow customizing wireless access solutions for specific networking and traffic contexts. The proposed unified radio control abstracts hardware specific instructions and thus enables full, vendor-independent radio control, while the unified network control allows rapid prototyping and adaptations of network protocol stacks in a heterogeneous, multi-vendor environment. The unified control interfaces allow rapid prototyping of innovative end-to-end wireless solutions and systems in different vertical markets (manufacturing, smart cities, home, office, healthcare, transportation, logistics, environmental monitoring...) without the need for deep knowledge of the specifics of the radio hardware platform, network protocols and software architectures.

The **WiSHFUL software architecture** (see figure) 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 logics 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***

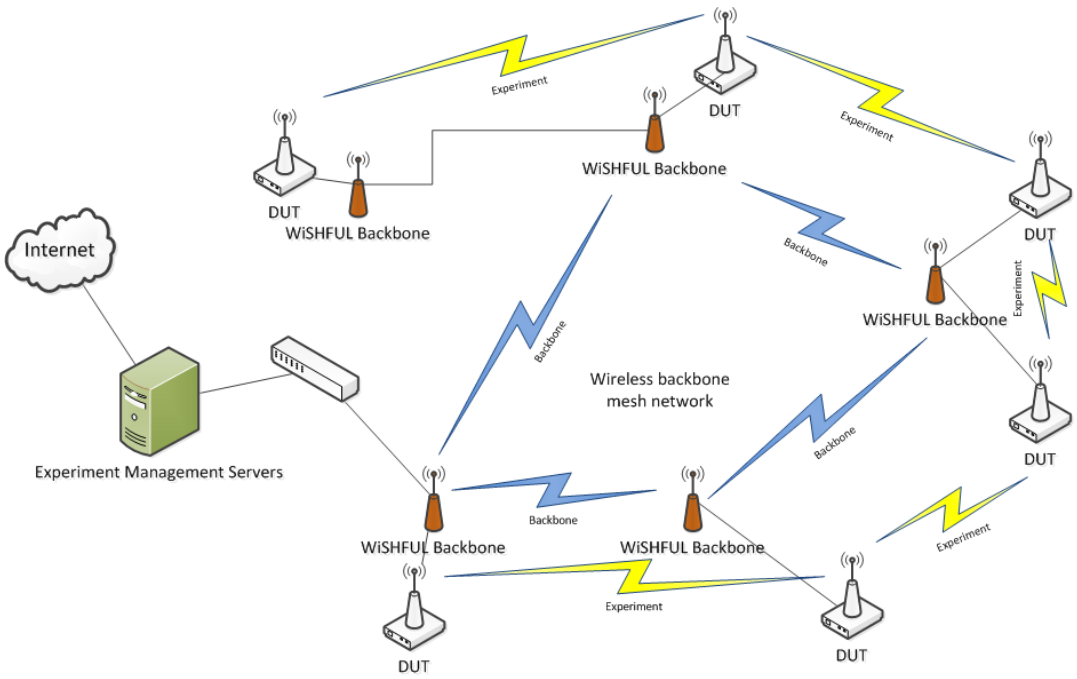
heterogeneous devices. The functions forming the interface are ***generic***, their implementation is hardware and platform specific and is provided by the Local Monitoring and Configuration engine.

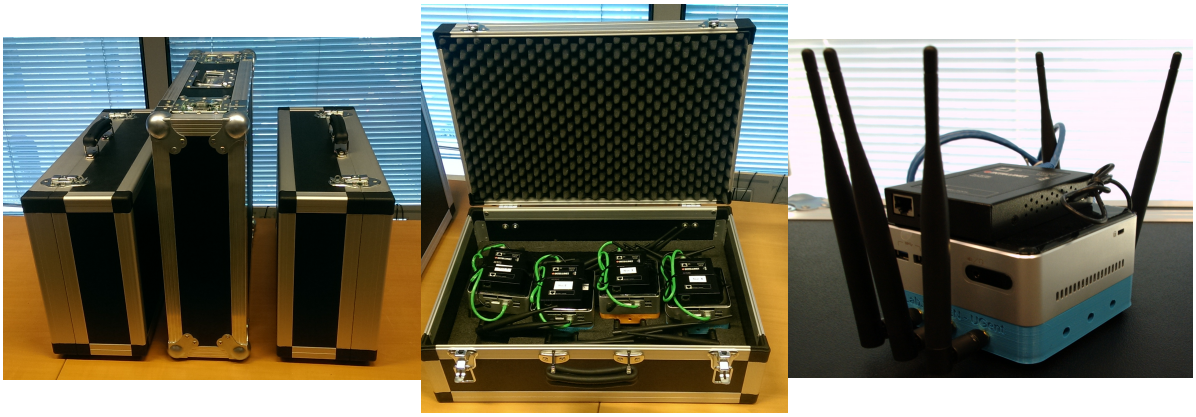
- **Unified Programming Interface – Network (UPI_N)**: this is a software interface consisting of a ***set of functions*** that ensures ***uniform control*** of the upper MAC and higher layer protocol behaviour on ***heterogeneous devices***. The functions forming the interface are generic, their implementation 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 hierarchical control between control programs that are structured in a hierarchical way.
- **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. 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 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 several 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.
- **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).

- **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.

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 access to several **wireless testbeds**, such as TWIST (TU Berlin), w-iLab.t (iMinds), IRIS (TCD), Orbit (Rutgers University) and a FIBRE Island at UFRJ. 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.





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 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 (see below).
- 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. 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.

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)	Contiki, TAISC, GITAR	w.iLab.t, Portable testbed
	Jennic JN516X	IEEE 802.15.4	TinyOS	TWIST, Portable 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
	USRP-B200mini	70 MHz - 6 GHz	IRIS software radio GNU radio IRIS software radio	w.iLab.t, portable testebd
	USRP X310	10 MHz – 6 Ghz	GNU radio	ORBIT
	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)
Antenna	RAS (Reconfigurable Antenna System)	2.4 Hz 5 GHz	Linux, Wireless Mac Processor (WMP)	w.iLab.t , Portable testbed

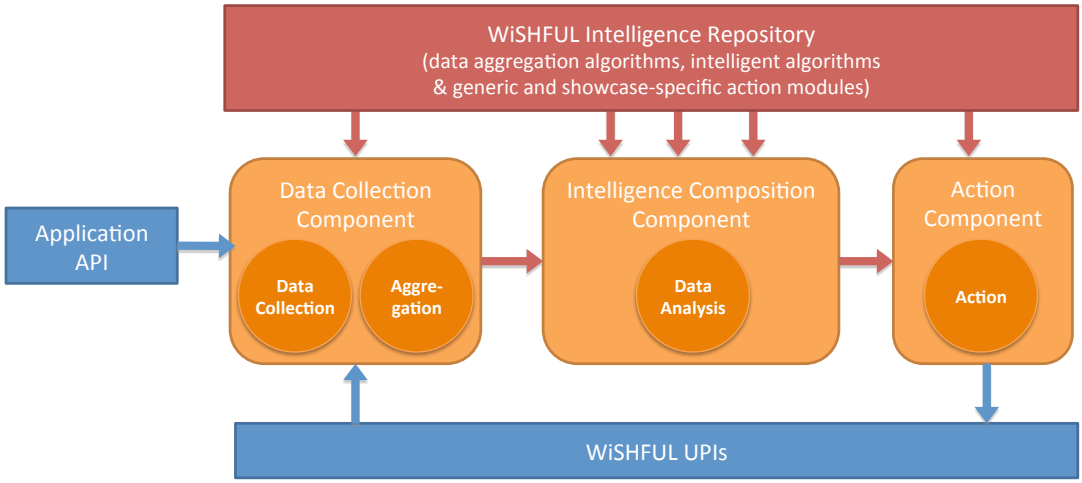
More detailed information on the supported software platforms can be found at http://www.wishful-project.eu/software.

More detailed information on implemented UPIs can be found on the Wireless Testbeds Academy Github (http://wirelesstestbedsacademy.github.io/wishful_upis/index.html).

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

This Open Call will also offer the WiSHFUL Intelligence framework enabling intelligent network and radio control. 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 that are currently being implemented using the Node-RED tool (http://nodered.org):

- 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. With respect to the application requirements, a new interface (Application API) is added to feed the application requirements to the intelligence framework.
- 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.



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).

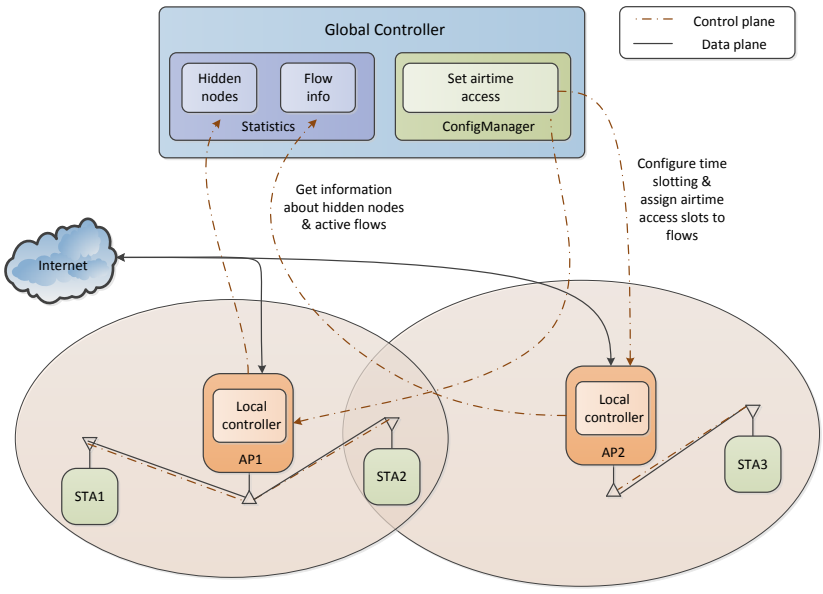
4. Scope of the present call

4.1. Experiments

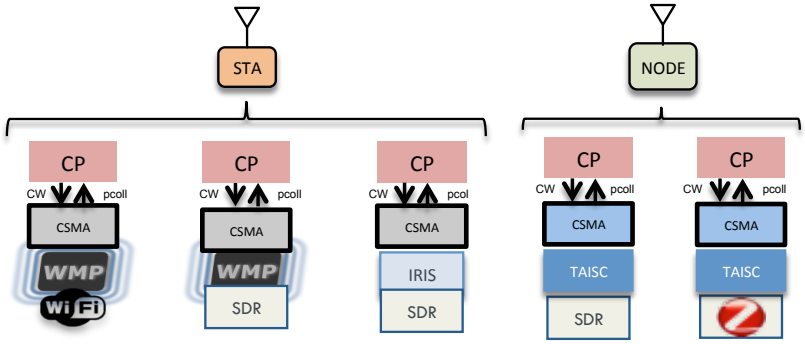
This call solicits for Experiments to validate advanced solutions for controlling wireless networks using the WiSHFUL software platforms and unified programming interfaces (UPIs), and using the facilities and hardware supported by the WiSHFUL Consortium.

These Experiments should be of a short duration (maximum 6 months). Experiments can be inspired by, but not limited to, the example showcases below, currently implemented or being implemented by the WiSHFUL consortium:

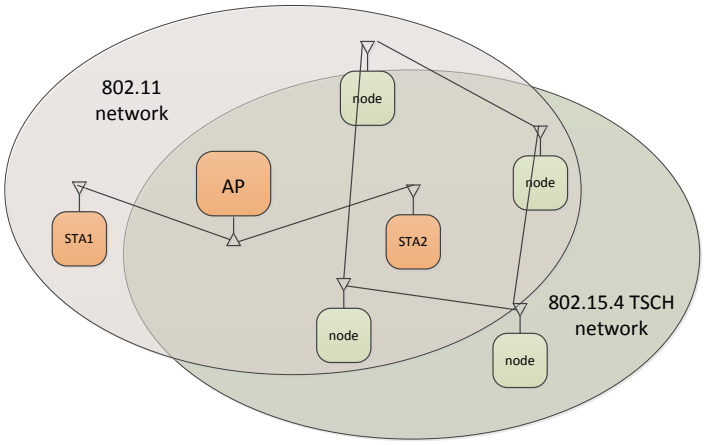
- ***Intra-technology airtime management***: IEEE 802.11 uses a random access scheme called Distributed Coordination Function (DCF) to access and share the wireless medium. The advantage of DCF is its distributed and asynchronous nature making it suitable for unplanned ad-hoc networks, which have no infrastructure. The main disadvantage is its inefficiency in congested networks. Moreover, it suffers from performance issues due to hidden and exposed node problem, which is a severe problem in high-density enterprise networks. In contrast to DCF, in TDMA the channel access is scheduled in a synchronized and centralized manner, and hence is able to provide the required high QoS/QoE requirements of enterprise environments. WiSHFUL allows building hybrid TDMA on top of today’s off-the-shelf WiFi hardware by providing a flexible and extensible software solution. Following the Software-defined networking (SDN) paradigm we separate the control plane from the data plane and provide an API to allow local or global control programs to configure the channel access function. In particular, it allows configuring the TDMA downlink channel access by defining the number and size of time slots in the TDMA superframe. Moreover, for each time slot a medium access policy can be assigned which allows restricting the medium access for particular stations (identified by their MAC address) and traffic identification (e.g. VoIP or video). The latter can be used to program flow-level medium access. The data plane itself resides in each AP and is controlled by the WiSHFUL runtime system. Currently, the showcase is focusing on the downlink, whereas in the future also the uplink will be considered.

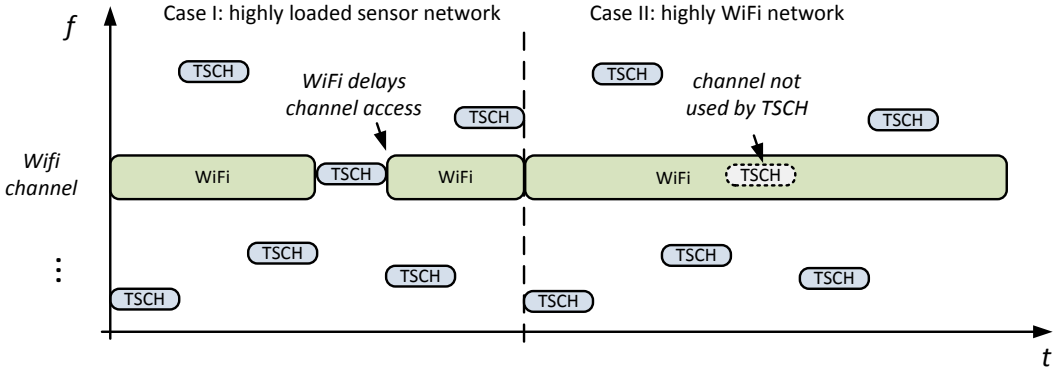


- ***Load-aware & platform-independent MAC adaptation***: It is well known that contention-based protocols work between than scheduled-based protocols in case of intermittent and unpredictable traffic flows, while scheduled-based protocols work better than contention-based ones when strict delay requirements have to be guaranteed. Therefore, the selection of CSMA or TDMA access protocols should depend on network load and application requirements, rather than being defined one-for-all. WiSHFUL UPIs allow to easily collect low-level channel measurements (e.g. link quality indicators, number of successful or failed transmissions, number of contending nodes, etc.) to estimate the network operating conditions, select the best possible access protocol and optimize its performance (e.g. by tuning the CSMA contention window as a function of the collision probability), regardless of the specific radio access technology and PHY-layer parameters. Such a possibility is demonstrated in an exemplary radio control program able to work on both IEEE 802.11 and IEEE 802.15.4 devices. Rather than working on the card-specific drivers and configuration parameters, the experimenter can work on the WiSHFUL abstractions for defining a platform-independent MAC adaptation logic.



- ***Co-existence of IEEE 802.11 and IEEE 802.15e***: In dense wireless networks, the co-existence of heterogeneous technologies using the same wireless resources is challenging. Consider the example IEEE-802.11 (Wi-Fi in 2.4 GHz band) and IEEE-802.15.4e (TSCH) networks. The simultaneous operation of both networks in close proximity will inevitably lead to performance degradation due to interference. This is because of contention-free explicit scheduling of radio resources in TSCH (time-slotted channel hopping) and the unreliability of carrier-sensing (listen-before-talk) mechanism used in Wi-Fi, are unable to sense any wireless transmission of the other technology. The WiSHFUL UPIs can facilitate efficient spectrum management of co-existing heterogeneous technologies by making them aware of each other. This enhances the performance in both networks and makes QoS (throughput, latency, reliability) more predictable. This showcase implements a traffic-aware interference avoidance scheme where, depending on the network load in both networks, other decisions are made. Two possible cases have been considered. In the first case the sensor network is highly loaded. Here it is more efficient to perform any interference avoidance in the WiFi network, reducing the overhead on the more loaded network. To accomplish this, the sensor network provides the scheduling information to allow the WiFi network to delay transmissions to points in time where no collision will occur. In the second case the network load in the WiFi is high, suggesting that excluding the spectrum used by WiFI from the hopping scheme of the sensor network is a more promising approach to co-existence. Yet another approach is to use a cross-technology TDMA protocol to coordinate the transmission between both types of nodes and reduce interference to a minimum. The system runs a TDMA radio program on the WiFi nodes, adapts time slots to traffic requirements, and keeps free some slots that are implicitly reserved to TSCH.





- ***Load and topology aware networking***:
  - ***Routing adaptation:*** In dynamic wireless networks the application requirements vary over time. Moreover, networks can shrink or increase due to node mobility. Routing protocols designed for wireless networks (RPL, OLSR) have built-in support for fine-tuning the protocol behaviour via configuration parameters. Currently, however, in many cases the code needs to be re-deployed for the reconfiguration to have effect. Via the WiSHFUL UPIs it is possible to (*i*) dynamically monitor the network performance and neighbourhood; (*ii*) change routing protocol configuration or change routing modules. This showcase demonstrates that a control program can increase the overall network performance by dynamically selecting the optimal link estimation algorithm (ETX, 4BIT, fuzzy LQE), which drives the routing decisions, by monitoring the achieved performance and node density. The UPIs enable to create an adaptive routing strategy based on the measured QoS and topology information.
  - ***Modulation and Coding Scheme (MCS) selection***: As it is widely known the physical environment of a wireless link changes dynamically and rapidly over time. Hence the quality of communication is affected and selecting a lower MCS index might be more efficient when the channel condition deteriorates. This showcase aims to provide dynamic and adaptive selection of the MCS in the physical layer based on the monitored quality of the wireless links towards neighboring wireless nodes. The closed loop controlling the MCS selection will be local, meaning each node will decide its MCS when he is attempting to communicate with a specific neighboring node based on past monitored statistics of the specific wireless link.
  - ***Dynamic Link estimator selection***: In most routing protocols used today for multi-hop wireless connectivity there is the notion of link quality estimation. Various approaches have been proposed to calculate this metric that is used when routing algorithms try to

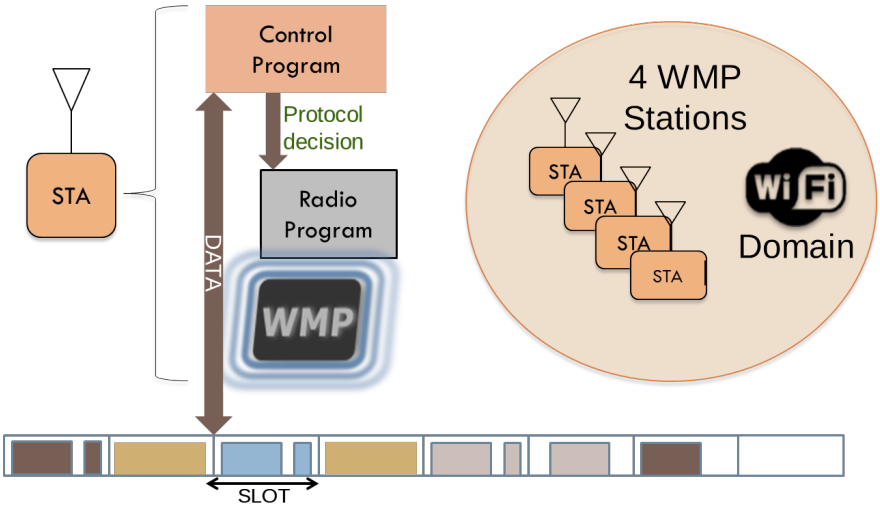
establish the best route towards the destination node based on specific application requirements (best effort for latency, low power operation, least hops travel etc). This showcases aims to provide dynamic link estimator selection based on a per packet strategy enforced from the user of the routing layer (supporting this functionality possibly all the way to the application layer and the running applications). The ability to dynamically in real time alter the link estimator algorithm will provide multi objective capabilities to any routing protocol operating in the system in real time

- ***Prioritization in wireless mesh networks:*** Wireless mesh networks are generally deployed in dynamic wireless environments and further have to carry different types of traffic: (1) control traffic for monitoring of the link qualities, load, etc. in the mesh network, and updating the settings of the mesh nodes, and (2) data traffic with different requirements in terms of latency and throughput. In order to deal with the well-known performance limits of wireless mesh networks, WiSHFUL UPIs can be used for implementing prioritization mechanisms (traffic shaping, flow marking, flow steering) that can differentiate the channel resources allocated to different traffic classes.

- ***Multi-hop load aware MAC adaptations***: In recent years, it has clearly emerged that WiFi network performance can dramatically degrade in multi-hop connected topologies and in high-density node scenarios. These conditions are likely to occur when multiple networks coexist or large access infrastructure is deployed. The main reasons for the degradation include the starvation, hidden nodes, and unfairness phenomena of CSMA-based protocols due to a mismatch in the local views of the wireless medium among the nodes. In this showcase we present a solution for mitigating these problems based on distributed allocations of 'airtimes', i.e. a channel utilization metric based on the computation of the channel holding time of each station. We use the WiSHFUL architecture in order to implement a distributed protocol, based on an auction scheme, for negotiating airtime allocations among the nodes on the basis of the specific traffic requirements and local views of the network. The negotiation protocol also allows reservation of channel resources for control and management operations. In order to prevent each node from holding the channel for more than its allocated airtime, we also define a mechanism for dynamically tuning the contention windows of each node. We use the WiSHFUL UPIs for gathering information on channel collision rates and busy times observed by the stations (i.e. the local views of the channel), as well as for enforcing the desired value of the contention windows. The distributed protocol is implemented in terms of a control program running on each node: the program triggers the sending of customized control messages for notifying offers and claims to other nodes and computes the local airtime allocations and relevant configuration of the contention window.

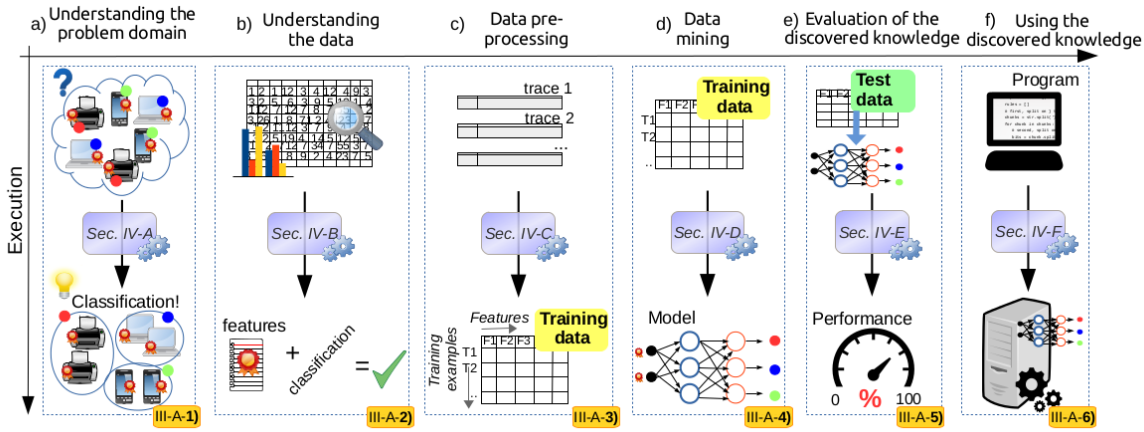
- ***MetaMAC*** : In order to cope with network dynamic conditions, arising from changes in the traffic load or topology, most MAC protocols include some form of adaptations working on a set of configurable parameters. An alternative approach, proposed in this showcase, is providing adaptations by selecting dynamically a MAC protocol among a list of available ones (called MAC components), which may include completely different protocols or multiple instantiations of the same protocol with different configuration parameters. The selection can be performed in run-time as a function of the network context and is transparent to network applications. The approach, called Meta-MAC, has been implemented and validated on the WiSHFUL architecture. Specifically, the list of available protocols has been implemented in terms of abstract Radio Programs and Radio binaries, while the decision logic has been implemented in a local control program. The control program is able to virtually execute the Radio Programs, which are not running on the node, on the basis of a channel trace gathered by exploiting the WiSHFUL UPIs. By comparing the performance results of virtually executed protocols and running protocols, the control program updates the weights

of each protocol component and decides about protocol switching when needed. In particular, we validate the solution in a scenario in which, starting from a slotted ALOHA protocol, the nodes switch to TDMA protocols with non-conflicting assignments as the source rates increase to saturated network conditions.



- ***MAC adaptation in presence of legacy stations***: One of the key aspects of contention access mechanisms is the dynamic adaptation of the contention windows to achieve stability. Several optimization mechanisms have been proposed so far for overcoming the limits of exponential backoff, both in terms of efficiency and in terms of short-term fairness. However, using heterogeneous adaptation mechanisms among the stations may cause heterogeneous throughput performance. In this showcase we demonstrate how customized tuning of the contention window (for example, implementing the recently proposed moderated backoff scheme or the optimal window as a function of the number of stations) can coexist with legacy 802.11 exponential backoff, by guaranteeing that legacy stations achieve the same performance that they would achieve when all the stations employ exponential backoff. We exploit the WiSHFUL UPIs for performing the non-standard tuning of the contention window and estimating the network congestion level (in terms of low-level channel access performance) and a control program to implement the adaptation logic as a function of the number of legacy stations.
- ***Cognitive MAC protocol selection:*** this showcase aims to demonstrate how to increase network performance by adding intelligent mechanisms for deciding on the selection of the most suitable MAC protocol for the current network conditions (for example, number of nodes, density of nodes, interference conditions), while taking into account the application requirements (for example data rate, latency, reliability). To this end, general MAC models are being built for predicting the performance based on the monitoring of the current network conditions and application demands. The intelligent models will be created by following the six steps of the KDP (Knowledge Discovery Process) starting from raw data that is collected via WiSHFUL UPIs. 3 MAC protocols are being investigated: CSMA/CA, TDMA, and TSCH. All data processing steps are integrated in the Node-RED framework that runs on top of WiSHFUL UPIs. As such data collection, aggregation and data analysis components can be easily re-used by other experimenters. Also the data set with raw data will be made

available.



- ***Intelligent interference mitigation in dense networks***: dense wireless networks have a large number of wireless devices (APs and STAs) in a limited area, therefore several wireless nodes belonging to different networks and to different administrative domains interfere each other. Well-known issues such as hidden and exposed nodes as well as flows in the middle are exaggerated by high-density and cause horrible performance for few nodes and result in deep unfairness among BSSs. Centralized knowledge about such pathological interference conditions is beneficial for improving performance but, alone, it is not enough to solve such problems. In facts, intelligence is required to recognize and distinguish such specific interference conditions from those due to scarce link quality or extremely crowded channels. The WiSHFUL architecture for intelligence helps to face such topology-dependent adverse scenarios. A dedicated intelligent module receives customized low-level statistics about local channel utilization (e.g. distributions of busy-idle times, the number of retransmissions, etc.) and feeds a classification algorithm to recognize the reason of unfairness among pre-defined possible sources. In this showcase, the output of the classification algorithm is passed to the global controller that applies BSS-specific access policies. The most straightforward solution is a per-BSS TDMA that makes OBSSs orthogonal to each other. However, this can result in a suboptimal channel usage because of heterogeneous traffic demands of BSSs. Again, the intelligent modules come in handy and the analysis of busy time intervals permits also to reveal unused slots and therefore can be used for the optimal tuning of TDMA parameters.

- ***Multiple Radio Access Technologies sharing the same antenna:*** The vision for future 5G networks involves a converged heterogeneous network environment, integrating Multiple Radio Access Technologies (Multi-RATs) to provide connectivity for mobile subscribers. In this context, the GNU Radio platform provides the necessary functionality to virtualize multiple heterogeneous RATs. The basic idea is to deploy a wide-band RF front-end to receive wireless signals from all wireless standards, and use software basebands to separate and demodulate information streams for each coexisting wireless standard. WiSHFUL UPIs can be used to (*i*) provide seamless interface to configure the different characteristics of multiple virtualized base station, (*ii*) implement mechanisms at the Hypervisor layer to manage the RF Front-End resource portioning (for example, the spectrum allocated to each virtualized base station), and (*iii*) manage the lifecycle of virtualized base station.

- ***Intelligent MCS selection:*** Current wireless access technologies select the MCS index based on local communication characteristics (SINR, bit error rate, etc.). Recently, there have been some studies on more advanced MCS algorithms, such as MCS selection to minimize the total transmission power in a single-cell OFDMA system; and MCS selection to maximize the system throughput of a two-tier macrocell-femtocell network via joint power and bandwidth allocation. However, these solutions are NP-hard optimization algorithms that have two major drawbacks: (*i*) the MCS selection is based only on local information observed by the

wireless node, and (*ii*) several limitations are imposed to reduce the complexity of the optimization problem. In the light of the NP-hardness of such solutions, developing MCS algorithms based on Machine Learning can eliminate these drawbacks. WiSHFUL UPIs can assist the development of Intelligent MCS selection algorithms by (*i*) providing the means to quickly gather any information from the wireless medium, build data-driven learning algorithms based on the observations from the wireless medium, (*iii*) providing the framework to design local or centralized MCS algorithms

More details on the showcases and the results obtained can be found in the WiSHFUL deliverables (http://www.wishful-project.eu/deliverables) and the booklet with Year 1 showcase results (http://www.wishful-project.eu/sites/default/files/images/WiSHFUL_Year1_results.pdf).

Experiments can build further on top of these example showcases by adding more advanced wireless monitoring and control. Experiments can on focus 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 SMEs*** 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 11). It is required that the Experiments are performed by a single organization. In the category 'Innovation by SMEs', 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;
- Easy access to all the required wireless devices and wireless software platforms 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 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 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 from 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 SMEs'. In parallel, an extra budget (on average 5 k€ / Experiment) can be assigned to a WiSHFUL consortium partner acting as the Patron in charge of dedicated (advanced) support of the Experiment.

4.2. Extensions

This call solicits for the following extensions

- development of new ***software*** functionality for the currently supported WiSHFUL software and hardware platforms, such as the porting other/novel programmable radio architectures on WiSHFUL nodes, the design of novel functional splits between local and remote radio functions in the emerging cloud-based approach. Moreover, while the current functionalities are more focused on node radio and network abstractions, it could be relevant to consider network abstractions, such as the definition of network links and topologies, the localization of mobile nodes, etc.

Proposal for Categories [feedback needed from ALL partners]

- ***Category 1 - Network & MAC functionality*** [max. 2 extensions]
  - Routing support: expose advanced routing capabilities and configuration options through UPIs for various platforms (IEEE 802.11, IEEE 802.15.4, etc.)
  - MAC/network platform extensions: either advanced functionality of the flexible MAC platforms already supported by WiSHFUL (like WMP, TAISC and GITAR), or bring in new platforms and enable control through WiSHFUL UPIs.
  - SDN-like extensions, for example Open Flow support through UPIs
- ***Category 2 - Context-awareness through UPIs*** [max. 2 extensions]
  - UPI extensions for supporting ranging and positioning help experimenters and their applications to have deeper understanding about the physical and topological context, support location-aware MAC solutions and test localization algorithms. Ranging and positioning extensions should exploit WiSHFUL sensing capabilities offered by its monitoring UPIs. The new software platform should at least extend WiSHFUL unified programming interfaces by adding functions to estimate the distance between couples of nodes, taking care of propagation and multipath effects. Extreme multipath conditions should be eventually signalled in order to neglect results with poor accuracy.
  - Add functionality to check compliance with local regulations with respect spectrum usage and power settings, duty cycle, etc., and to give warnings if regulations are violated.
  - Enhanced monitoring functionality through UPI, for example distributed spectrum sensing: support for network wide performance monitoring and pinpointing of arising performance drop in some part of the network that could indicate a problem of interference (of cross-technology, hidden node, exposed node or other nature) or high data load in the network. The ability to be able to distinct the problem among would offer extensive abilities to the network controller to react accordingly.
- ***Category 3 - Hardware/testbed extensions*** [max. 2 extensions]
  - Development of WiSHFUL compliant software platforms for new ***radio hardware*** not yet supported by WiSHFUL, such as new wireless technologies (Bluetooth, LPWAN, mmWave, Full Duplex, MIMO, etc). The new software platforms should at least support WiSHFUL

unified programming interfaces. It should further be possible to integrate the new radio hardware in one of the already supported testbeds in the WiSHFUL project (either one of the fixed testbeds, or the portable testbed).

- Integration of new ***testbeds*** IoT, 5G, outdoor infrastructure…). These testbeds should be compliant with Fed4FIRE tools and interfaces for testbed access and experiment control[3], and should offer WiSHFUL compliant software platforms at least exposing unified programming interfaces. New testbeds should be sufficiently different from the ones already available in WiSHFUL, in terms of new hardware types (e.g. card brands, different technologies, etc.) as well as controllable sources of noise including microwave ovens, cordless phones, fluorescent lights, etc.). Extra scenarios that are not natively present in WiSHFUL (e.g. long links) or reconfigurable topologies (e.g. with mobile obstacles) can proficiently extend available testbeds.

- ***Category 4 - Integration with simulator environment*** [max. 1 extension]: enable the use of the WiSHFUL framework in simulator environments like NS3 or other open source simulators. The idea is to be able to control and monitor the simulated nodes in real time using the WiSHFUL framework as it is already done with real nodes. In case of simulators that also support the integration of virtual network simulated by them to communicate and interact with real network topologies, the use of WiSHFUL to control all nodes, physical and virtual would be highly desired.
- ***Category 5 - Other***: topics that are not covered by the previous 4 categories [max. 2 extensions]

Any Extension should be made available to the WiSHFUL consortium and to future external experimenters (either through subsequent (funded) open calls or (non-funded) open access use of the WiSHFUL testbeds and software platforms), under the terms and conditions stipulated in the contract template for Extensions (see Annex C).

Independent evaluations of the submitted proposals will be performed, in order to select the experiments that will be supported by the project. It is required that the extensions are performed by a single organization.

Benefits to participate in this open call are:

- Possibility to gain detailed knowledge on the software platforms supported by WiSHFUL and to extend these platforms with more advanced control functionalities and richer unified program interfaces.
- Possibility to extend your wireless hardware with one of the flexible software platforms supported by WiSHFUL, or with the unified programming interfaces defined in WiSHFUL.
- Possibility to federate your testbed with other advanced wireless testbeds that not only support wireless hardware, but also flexible software platforms with clearly defined control interfaces (UPIs). The availability of a wireless testbed with software platform support will increase the usage of your testbed by external experimenters.
- The simplified application 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 from 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 extension.

[3] The WiSHFUL Open Call does not support costs for making testbeds Fed4FIRE compliant.

Per proposal a budget can be made available up to a maximum of 100 k€ for an extension. Next to this, an extra budget (on average 7 k€ / extension) can be assigned to a WiSHFUL consortium partner acting as the Patron in charge of dedicated (advanced) support of the extension.

5. Inclusion into the consortium

Once a proposer is selected to perform the proposed Experiment, he/she will become a Third Party using Cascade Funding, and to this end he will be contracted by the project coordinator (iMinds) as 'Subcontractor'. In the remainder of this document a 'Third Party using Cascade Funding' is referred to as 'Subcontractor'.

This implies that the administrative load for the Subcontractor will be minimal as only an invoice needs to be submitted to iMinds at the end of the Experiment 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, code and documentation. 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 iMinds 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 iMinds 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 for an Experiment and maximum 8 pages for an Extension)

This section describes the details on the planned Experiment or Extension (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 SMEs' to show the innovative character of the Experiment or Extension 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 or Extension. 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 or Extension. 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 21 October 2016. 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 or Extension.

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 or Extension. 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, both as partner or as 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.

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**.

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 SMEs): 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 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
iMinds	Spilios Giannoulis Spilios.giannoulis@intec.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 • LTE: ip.access

		SW: • IEEE 802.11: Linux • IEEE 802.15.4: Contiki, TAISC, GITAR
TCD	Maicon Kist kistm@tcd.ie	Testbed: IRIS
		HW: • SDR: USRP2-N210
		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

The proposing party must submit its draft proposal to his Patron by 21 October 2016. 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 Subcontractor to iMinds, specific arrangements exist with respect to financial costs and payment schemes:

1. As a Subcontractor, 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 Subcontractor 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 Subcontractor. 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 SME'. The maximum requested funding for an Extension in this Call is set at 100 k€ for an extension.
3. The maximum requested funding for the WiSHFUL partner acting as the Patron for an Experiment is limited to 5 k€ euro on average for an Experiment and 7 k€ euro on average for an Extension. Costs in this case are related to the provision of dedicated (advanced) support.
4. As a Subcontractor, the selected parties for Experiments need to submit a report at the end of the Experiment or Extension (for this call this will be end of June 2017 for an Experiment or end of September 2017 for an Extension, under the assumption that the Experiment starts on 1 January 2017). This report (see section 10), must include an overview of the costs incurred and will be accompanied by an invoice to the project coordinator, in this case iMinds.
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% of the requested 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).
8. For Open Call 3 review meetings with the EC are planned near the end of August 2017 for Experiments and end of October 2017 for Extensions. The exact date will be fixed at the start of the Experiment or Extension. The review meeting will be held in Ghent at iMinds or in Brussels at the EC. At the review meeting the results of the Experiment or Extension need to be presented, preferably through a real-life (remote) demo running in one the WiSHFUL testbeds or in the new testbed (in case of a testbed Extension). Either the Subcontractor 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. Foreground rights

As indicated by the EC Guidelines, a Subcontractor is paid in full for its contribution made to a project by the beneficiary with whom it has a subcontract. As a consequence Subcontractors do not have any IPR rights on the foreground of the project.

10. Reporting

As the selected proposers will be linked to the WiSHFUL consortium as Subcontractor to iMinds, 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 Subcontractor only has to submit a final report after completion of the Experiment or Extesnion. 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 [Only for Experiments]
- B.3 Extension Functionality Validation [only for extensions]
- B.4 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 for SME'. In case of an Extension, section B.4 should focus on the use of the implemented Extension to conduct experiments as a next stage, or use the new functionality/feature in upcoming new activities.

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

This section contains valuable information for the WiSHFUL consortium and describes the Subcontractor's experiences while performing the Experiment or implementing the Extension 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/using the testbeds offered in WiSHFUL
- C.3 Feedback on getting acquainted/using/extending[4] the WiSHFUL framework 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?

[4] 'extending only applies to the category 'Extensions', and not to the categories 'Experiments'

- 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/Extension for promotional purposes

This report will not only serve as an evaluation tool to judge payment of the Subcontractor, 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.

In case of an Extension, the code of the extension, together with the documentation on the use of the Extension, must be posted on the WiSHFUL project webiste and/or Wireless Testbeds Academy Github (http://wirelesstestbedsacademy.github.io/wishful_upis/).

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

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

11. Criteria for evaluation of Experiments and Extensions

Proposals can only be submitted by:

- Parties eligible for participation in the EC Horizon 2020 Programme
- SMEs according to the definition used by the EC (for Experiments in the category 'Innovation by SMEs')
- 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:

1. Criteria for evaluation of Experiments

Specific criteria:

- Experiments, category 'Scientific Excellence':

  1. ***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.

2. ***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.

3. ***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.

- Experiments, category 'Innovation by SMEs':

1. ***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.

2. ***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 SME through product development.

3. ***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.

General criteria (applicable to both categories of Experiments)

4. ***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.

5. ***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.

6. ***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

7. ***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.

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

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

9. ***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.

The weight of criteria 3, 4, 5, 6 and 8 is 5, while criteria 1, 2 and 7 have a double weight of 10 resulting in a maximum score of 55 points. 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 on their total score (with a maximum score of 55). This measure is introduced to positively discriminate such new players and open the FIRE testbeds to a wider community.

2. Criteria for evaluation of Extensions

1. ***Usefulness***: the degree of expected future use of the Extension (Cf. Section B of the Proposal Template)

   The score should reflect the potential of the Extension to be used by future wireless experimenters in subsequent (funded) WiSHFUL open calls or by (non-funded) open access of WiSHFUL facilities and software platforms.

2. ***complementarity***: the degree the Extension will add new software functionality, hardware platforms and testbeds (Cf. Section B of the Proposal Template)

   Similar software functionality, hardware or testbeds as the ones already available in WiSHFUL will obtain a lower score.

3. ***Fed4FIRE compliance*** (only for integration of new testbeds): the degree of interoperability with Fed4FIRE tools for testbed access and experimentation (Cf. Section B of the Proposal Template)

   When the Extension involves the integration of a new testbed, the proposer should indicate that the new testbed can be accessed and used through Fed4FIRE compliant tools. Fed4FIRE compliant testbeds are expected to have an SFA client (e.g. Flack, jFed, Omni or SFI) to select and provision resources, an FRCP client (e.g. OMF or NEPI) for experiment control, and OML for collecting results. More information on Fed4FIRE tools can be found at http://www.fed4fire.eu/tools/. Testbeds that are not Fed4FIRE compliant will get a low score.

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

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

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

   The proposer should exhibit prior technological experience and the necessary qualifications to implement the Extension.

6. ***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 extended use of software platforms, UPIs, and testbeds will be provided, will get a higher score.

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

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

8. ***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.

The weight of criteria 3, 4, and 5 and 7 is 5, while criteria 1, 2 and 6 have a double weight of 10 resulting in a maximum score of 50 points. 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 on their total score (with a maximum score of 55). This measure is introduced to positively discriminate such new players and open the FIRE testbeds to a wider community.

For the final selection of proposals for Extensions, the following rules will be followed:

- Step 1: select the highest ranked proposal (that exceeds the threshold criteria) in each category.
- Step 2: if budget is still available, select the highest ranked proposals (that exceed the threshold criteria) for categories that have a limit of 2 proposals.
- Step 3: if after step 1 and step 2, there is still budget left, then the highest ranked proposal(s) not selected so far in step 1 and step 2, will be selected, disregarding the limitation with respect to the maximum number of proposals.

12. Timing of the evaluation and Experiments and Extensions

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 30 November 2016.

Experiments and Extensions can start at the earliest on 1 December 2016, but no later than 1 January 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 June 2017. The deadline for the final report of an Extension is expected 9 months after the start of the Extension, and no later than the end of September 2017.

The final evaluation of the Experiments and Extensions will happen at a review meeting with the EC. The review meeting for Experiments is currently scheduled for end of August 2017 either in Ghent at iMinds or in Brussels at the EC. The review meeting for Extensions is scheduled for end of October 2017 either in Ghent at iMinds or in Brussels at the EC. The exact date will be fixed at the start of the Experiment or Extension.

13. Submission

Submission deadline of draft proposal to WiSHFUL partner acting as Patron for feasibility check:	21 October 2016, at 17:00 Brussels local time
Submission deadline:	28 October 2016, 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 3

Third WiSHFUL Competitive Call for Experiments and Extensions

Full Title of your proposal

Acronym of your proposal (optional)

Call[5] / category[6]/ Identifier[7]	Call / category / identifier
Date of preparation of your proposal:	xx/yy/2016
Version number (optional):	
Your organisation name:	Your organisation name
Name of the coordinating person:	Name of the coordinating person
Coordinator telephone number:	Coordinator telephone number
Coordinator email: [This is the email address to which the Acknowledgment of receipt will be sent]	Coordinator email

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)

[5] 'Experiments' or 'Extensions'

[6] 'Scientific Excellence' or 'Innovation by SMEs' [only for Experiments]

[7] 'WiSHFUL-OC3-EXP-EXC', 'WiSHFUL-OC3-EXP-SME', or 'WiSHFUL-OC3-EXT'

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 for an Experiment and maximum 8 pages for an Extension)

This section describes the details on the planned Experiment or Extension (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 SMEs' to show the innovative character of the Experiment or Extension 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 or Extension, which should be clear, measurable, realistic and achievable within the duration of the Experiment or Extension (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 or Extension. 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 SMEs": *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 Extensions: *Describe the potential that the Extension will be used by future wireless experimenters from the broader scientific community as well as developers from industry, in particular individuals and SMEs, in subsequent (funded) WiSHFUL open calls or by (non-funded) open access of WiSHFUL facilities and software platforms.*

For any Experiment or Extension*: Show that the proposed Experiment or Extension 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 or Extension.*

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 SMEs": *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?*

For Extensions: *Describe in detail how the Extension will advance existing software, hardware and/or experimental platforms, and to which extent the functionality added by the proposed Extension is different from the functionality that is already available in 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 or Extension*
2. *Executing the Experiment or Extension*
3. *Analysis & feedback*
    - *Analysis of the results of the Experiment or Extension*
    - *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 or Extension 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 or Extension. 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
- http://wirelesstestbedsacademy.github.io/wishful_upis/

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 @ iMinds, 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)	

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	
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	
	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)	

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	

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)
Unified Programming Interface – Network (UPI_N)
Unified Programming Interface – Global (UPI_G)
Unified Programming Interface – Hierarchical (UPI_{HC})

Please provide a short motivation on why specific testbeds, hardware platforms, software platforms 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 or Extension. 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 or Extension. The proposing party must submit its draft proposal to this Patron by 21 October 2016. 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 or Extension.

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 or Extension. 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', 40 000 € for an Experiment of the category 'Innovation by SMEs', and 100 000 € for an extension.

In view of the review of your proposal it is best to list the costs related to the proposed Experiment or Extension 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 is entered into between the H2020 project consortium WiSHFUL, hereinafter referred to as the Project, and [*Organization 1*] hereafter referred to as the Experimenter.

iMinds VZW iMinds VZW, established in iGent Tower, Technologiepark 15, 9052 Gent (Zwijnaarde), Belgium, BE 866386380, is the Coordinator of the Project and has received from the other members of the consortium for the execution of the Project a mandate to represent them by signing the agreements 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 its Experimental facilities and software platforms, the Project also provides the essential training and support to the experimenter in order to enable them to successfully execute their Experiment. The specific members of the WISHFUL consortium and its personnel that provide the facilities and software platforms and give support to the experimenters for executing their Experiment are further referred to as Providers.

Details of the Experiment can be found in the application form submitted by the experimenters for the first 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 EC.

The specific content of the Experiment, the specific WISHFUL facilities and software platforms used, the Providers involved in the Experiment and the related budget and financial support granted by the Project 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. These will be available at http://www.wishful-project.eu/testbeds and http://www.wishful-project.eu/software and links therein. 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 Experimenters have made available through the Platform as part of an Experiment whereby the Experimenters remain liable for this use by third parties.

2.2 Liability

The Project assumes no liability in regards to interruption, corruption, loss or disclosure of the services, processes and data hosted on the Platform.

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

Experimenters are granted account(s) to the Platform, for own and personal use. Experimenters should take appropriate measures to protect their credentials and prevent their use by third parties. The information Experimenters provide when requesting an account should be correct. Experimenters shall be responsible for all and any loss or damages incurred by them and/or the Project as a result of any unauthorized transfer by them of their password.

Experimenters must respect the regulations of the various Platform resources they use in their Experiment.

Experimenters must not interfere with others' work or attempt to invade their privacy. Experimenters 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 Experimenters are 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 the 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. Experimenters are deemed to have agreed to this and to provide the required access.

Resources provided by the Project are under the jurisdiction of the Wassenaar Arrangement. Therefore certain nationalities will not be allowed to get access to the Platform and according Testbeds. According to the Wassenaar Arrangement, the following nationalities are restricted from accessing the Platform and according Testbeds: Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria.

Should Experimenters' usage imply giving access to the Platform to third parties, Experimenters understand they will need to gather explicit consent from the relevant Providers and they agree to enforce any restrictions imposed by this Provider and accept to fulfill their legal obligations as a service provider regarding data protection and retention laws.

This implies also respecting the Wassenaar Arrangement.

The following Experiments are explicitly forbidden on the Platform:

- The development and production of weapons of mass destruction or any military usage. This includes but is not limited to:
  - Nuclear weapons
  - Biological weapons

- Chemical weapons
- Missiles
- Conventional weapons
- Any activity resulting in compromising the security or integrity of any sites or networks connected to the Platform or parts thereof.
- Distribution of documents or materials containing:
- Insults or defamation
- Racial hatred or revisionism
- Advertising for commercial products
- Distribution of material in a way that infringes the copyright of another person

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

2.3 Enforcement

Whenever Experimenters use the Platform they are bound by all the above regulations and the legislation in force at the time.

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

Experimenters agree that the Providers involved may monitor the systems and traffic for vulnerabilities and conformance to the acceptable uses, and Experimenters will collaborate with the Project and any third party involved should any violations or breaches be noticed. The Providers involved may 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 WISHFUL Platform has been constructed for Experiment-driven research activities, where Experiment-driven research is defined as any activity that furthers the Experimenters' 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 WISHFUL Platform to host commercial activities is explicitly disallowed.

2.5 Dissemination of Experiment results

The results achieved will be owned by the Experimenter.

The Experimenters 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 by the Project for further promotion of the WISHFUL 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 WISHFUL Platform and Provider also if the publication/demonstration occurs after the end date of the Experiment.

3. WISHFUL support policy

Subcontractors will receive the support as described in the WISHFUL Open Call. All support to Experiments 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 supported by WiSHFUL, and http://www.wishful-project.eu/software for documentation on the WiSHFUL software platforms, and links therein) that has a 'getting started' guide and a FAQ section to deal with common questions and problems. It is expected that Experimenters will go through this to master the basics of managing resources for Experimentation on the Platform.

4. Period for this collaboration

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

5. Resources and Financial provisions

By signing this agreement, the Project commits to provide the necessary facility resources and manpower resources to the Experimenters, free of charge on a reasonable efforts basis.

By signing this agreement, the Experimenter confirms that they have the necessary manpower resources to execute the Experiment.

The Project will support the Experimenter by granting the support as approved by the Project.

Experiment will invoice iMinds for the total amount of this support after approval by the Project of the Final Report defined in 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 funding will be carried out by the project coordinator. The remaining 25% will be paid following a formal approval of the report and the work at a technical project review by the EC.

6. Signatures

iMinds, on behalf of the H2020 WISHFUL project consortium By: Name: Title: Phone: Email:
Subcontractor By: Name: Title: Phone: Email:

Annex C: Agreement for the Implementation of Extensions to the WISHFUL Platform

This Agreement is entered into between the H2020 project consortium WiSHFUL, hereinafter referred to as the Project, and [*Organization 1*] hereafter referred to as the Subcontractor.

iMinds VZW iMinds VZW, established in Gaston Crommenlaan 8/102, 9050 Gent, Belgium, BE 866386380, is the Coordinator of the Project and has received from the other members of the consortium for the execution of the Project a mandate to represent them by signing the agreements with the third parties selected in the open calls for experimentation and/or extension.

1. Objectives and scope

The scope of this agreement is to stipulate the terms and conditions under which Subcontractors can implement extensions to the WISHFUL facilities. The WISHFUL facilities and supported software platforms for radio and network control as a whole are further referred to as the Platform. The extension that is to be implemented by the Subcontractor is further referred to as the Extension..

The specific members of the WISHFUL consortium and its personnel that provide the facilities and software platforms to the Subcontractors for executing this Agreement are further referred to as Provider(s)

Details of the Extension can be found in the application form submitted by the Subcontractors for the first WISHFUL Open Call. The Extension has been selected for support by the Project as a result of an evaluation process that is approved by the EC.

The specific content of the Extension, the specific WISHFUL facilities and software platforms used, the Providers involved in the implementation of the Extension and the related budget and financial support granted by the Project are further defined in the Subcontractor's proposal as approved by the Project.

2. Terms and conditions

2.1 Applicability

These Terms and Conditions apply to every Subcontractor using the Platform. Next to these Terms and Conditions contained in this Agreement, specific regulations of the Provider may apply. These will be available at http://www.wishful-project.eu/testbeds and http://www.wishful-project.eu/software and links therein. It is the Subcontractor'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 and software connected to the Platform. This includes wireless components, servers, network(s) residing in the Platform and Subcontractor's equipment or facilities (whether institutionally or privately owned) connected to 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 Subcontractors whereby the Subcontractors remain liable for this use by third parties.

2.2 Liability

The Project assumes no liability in regards to interruption, corruption, loss or disclosure of the services, processes and data hosted on the Platform.

Subcontractors shall be liable for actions performed on the Platform. In case of misuse, Subcontractors are responsible for making good all damages to the Platform and are responsible for any loss or damage incurred.

Subcontractors are granted account(s) to the Platform, for own and personal use. Subcontractors should take appropriate measures to protect their credentials and prevent their use by third parties. The information Subcontractors provide when requesting an account should be correct. Subcontractors shall be responsible for all and any loss or damages incurred by them and/or the Project as a result of any unauthorized transfer by them of their password.

Subcontractors must not interfere with others' work or attempt to invade their privacy. Subcontractors 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 Subcontractors are 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 Subcontractors 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 Subcontractors must respect them. The terms of applicable software and data licenses must be respected.

In order to keep the Platform operating correctly both the 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. Subcontractors are deemed to have agreed to this and to provide the required access.

Resources provided by the Project are under the jurisdiction of the Wassenaar Arrangement. Therefore certain nationalities will not be allowed to get access to the Platform and according Testbeds. According to the Wassenaar Arrangement, the following nationalities are restricted from accessing the Platform and according Testbeds: Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria.

Should Subcontractors' usage imply giving access to the Platform to third parties, Subcontractors understand they will need to gather explicit consent from the relevant Providers and they agree to enforce any restrictions imposed by this Provider and accept to fulfill their legal obligations as a service provider regarding data protection and retention laws.

This implies also respecting the Wassenaar Arrangement.

The following use is explicitly forbidden on the Platform:

- The development and production of weapons of mass destruction or any military usage. This includes but is not limited to:
  - Nuclear weapons
  - Biological weapons
  - Chemical weapons
  - Missiles

- Conventional weapons
- Any activity resulting in compromising the security or integrity of any sites or networks connected to the Platform or parts thereof.
- Distribution of documents or materials containing:
- Insults or defamation
- Racial hatred or revisionism
- Advertising for commercial products
- Distribution of material in a way that infringes the copyright of another person

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

2.3 Enforcement

Whenever Subcontractors use the Platform they are bound by all the above regulations and the legislation in force at the time.

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

Subcontractors agree that the Providers involved may monitor the systems and traffic for vulnerabilities and conformance to the acceptable uses, and Subcontractors will collaborate with the Project and any third party involved should any violations or breaches be noticed. The Providers involved may 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 WISHFUL Platform has been constructed for experiment-driven research activities, where experiment-driven research is defined as any activity that furthers the Subcontractors' 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 Subcontractor than the use explicitly permitted under this Agreement is not permitted.

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

2.5 Dissemination of the results / Use of the Extension

The results achieved will be owned by the Subcontractor.

The Subcontractors will have to deliver a final report describing the Extension and all other results achieved during the execution of this Agreement as well as the experience gained in using the Platform. The subcontractors further have to post the code of their Extension, together with the documentation on the use of the Extension, on the Wireless Tesbeds Academy Github (https://github.com/WirelessTestbedsAcademy).

The final report can be made public by the Project for further promotion of the WISHFUL Platform.

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

As laid down in the WISHFUL Open Call the Subcontractor will make the Extension available and will provide support for third parties that have been selected by the Project for the execution of their experiment on the WISHFUL Platform.

3. WISHFUL support policy

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

4. Period for this collaboration

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

5. Resources and Financial provisions

By signing this agreement, the Project commits to provide the necessary facility resources and manpower resources to the Subcontractors, free of charge on a reasonable efforts basis.

By signing this agreement, the Subcontractor confirms that they have the necessary manpower resources to execute the Agreement.

The Project will support the Subcontractor by granting the support as approved by the Project.

Subcontractor will invoice iMinds for the total amount of this support after approval by the Project of the Final Report, and after posting of the code and after approval of the documentation of the code, as defined in 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 funding will be carried out by the project coordinator. The remaining 25% will be paid following a formal approval of the report and the work at a technical project review by the EC.

6. Signatures

iMinds, on behalf of the H2020 WISHFUL project consortium By: Name: Title: Phone: Email:
Organization 1   By: Name: Title: Phone: Email: