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

Project Deliverable D8.1

Support of Third Party experiments of Year 2

Contractual date of delivery:	31-12-2016
Actual date of delivery:	23-12-2016
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Work package:	WP8 – Wireless Innovation Experiments
Estimated person months:	4.5
Nature:	R
Dissemination level:	PU
Version:	1.0

Abstract:

This deliverable reports on the nature and the volume of the support being given to open call participants during the first 2 years of the project. It also briefly presents the focus and scope of the experiments in order to present clearly why the given support was important for the third party experimenters.

Keywords:

Wireless Experiments, Open Calls, support

Executive Summary

This deliverable summarizes the actions taken by the WiSHFUL consortium in order to support third party experiments within the Open Calls context. **SMEs, research institutes and universities have used the WiSHFUL offered tools and framework to conduct highly complex and beyond the standards experiments** in order to acquire insights regarding new products, algorithms or architectures for wireless networks. Patrons were selected for each proposal to guide and manage the experimenter while also acting as a communication point between the consortium and the experimenters. **The focus of this document is to report on the support given from the consortium partners to experimenters** and to provide the overall picture of the Open Call overhead to the consortium as far as support is concerned. Support given was spread across every stage of the experiments from initial contact with the testbeds and the tools provided until the preparation and presentation of results during the OC review meeting. The nature of the support ranges from testbed access and use support, WiSHFUL framework and UPIs related support, extension of WiSHFUL framework and UPIs according to requirements from experimenters up to tutorial and howto's preparation upon request. The time investment that consortium members spent for tutoring and support activities is also detailed quantitatively by the mean of timetables.

List of Acronyms and Abbreviations

Device under test	DUT
Open Call	OC
ORBIT measurements framework	OMF
ORBIT measurements library	OML
Power Spectral Density	PSD
Quality of Experience	QoE
Radio Environment Map	REM
Radio Resource Management	RRM
Software Defined Networking	SDN
Unified Programming Interface	UPI

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1 Introduction

Experimentation using Fed4FIRE testbeds and their related software tools is easier than setting up and maintaining proprietary testbeds for experimentally validating ideas and product enhancements. However, the experimenter is required to have knowledge of several tools and software platforms to handle hardware reservations, experiment setup and execution as well as measurement handling and storing. The WiSHFUL framework adds a layer of complexity to the experiments and the use of sophisticated and complex software platforms may appear difficult for a newcomer in the world of federated testbeds. To fill this gap, all consortium members were available to offer their support to experimenters, making it easier for them to grasp at once all the notions and use correctly the offered software and hardware platforms. In this document the support given by the WiSHFUL consortium is reported and specifically for the Open Call 1 experiments that have been selected, which were:

- ***WiFi-Dense*** (Experimental assessment of WiFi coordination strategies in dense wireless scenarios) conducted by Allbesmart (Portugal)
- ***Agile*** (Enabling Agile Spectrum Adaptation in Commercial WLAN Deployments) conducted by Gridnet SA (Greece)
- ***Quest*** (Quality-of-Experience of video streaming in wireless network) conducted by StreamOwl (Greece)
- ***Senseful*** (SDN driven Joint Access Backhaul coordination for next generation dense Wi-Fi Small Cell networks via WiSHFUL APIs) conducted by I2CAT (Spain)

2 OC1 experiments presentation and support given

The experiments presented in this document are the outcome of Open Call 1. These experiments have been concluded by the time of writing this deliverable, whereas Open Call 2 experiments are still underway and thus the support given to them will be reported in year 3 after their completion. The AUTOKEY experiment had a delayed start because of managerial reasons, so its time plan is no longer aligned with the rest of the OC1 proposals. As a consequence it is not included in this report, since its experimental activities are not yet concluded. We further note that the results of the Open Call 1 experiments are not public, and hence we can only report the information that can be made pubic.

2.1 Wi-Fi Dense - Allbesmart

2.1.1 Short description of the experiment

The rapidly increasing popularity of WiFi has created unprecedented levels of congestion in the unlicensed frequency bands, especially in densely populated urban areas. The main objective of this experiment is to assess the benefits of a RRM approach in dense WiFi networks for 2.4 GHz and 5 GHz bands that make use of realistic Radio Environment Maps. The main challenge of this experiment is to assess the benefit of a coordinate management of radio resources in dense WiFi indoor and outdoor scenarios.

The generic setup of the experiment is based on the WiSHFUL software architecture (blue and orange blocks) and uses the $UPI_{N,R}$ and UPI_{Hc} interfaces. The Global Control Program is the piece of software that implements the RRM algorithm/strategy that adapts the WiFi devices based on the local observed REM, which is built based on the spectrum sensors.

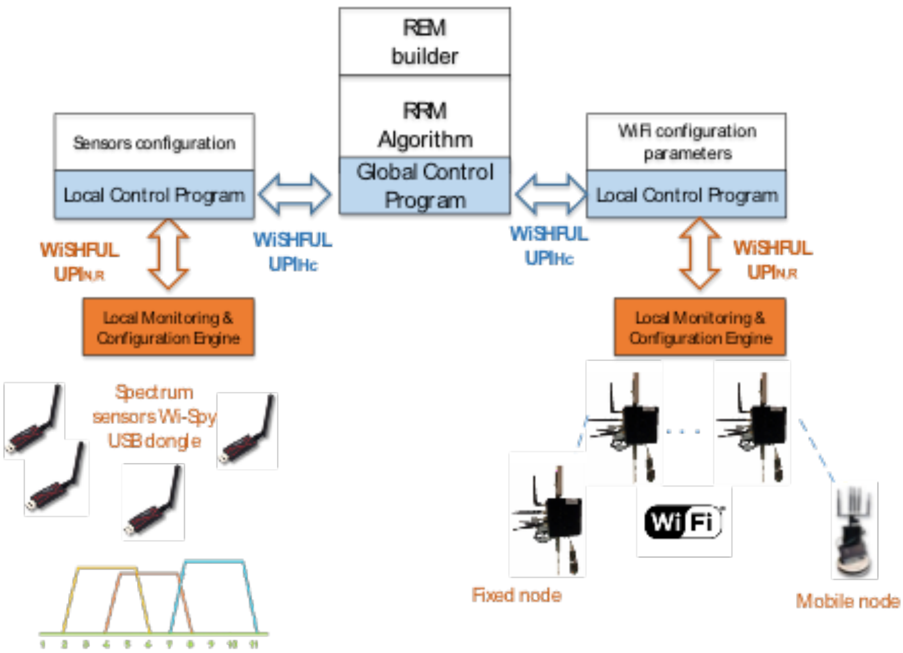

Figure 1. WiFi-Dense experiment architecture presentation

2.1.2 Support given to the experimenters

In the following table the support given to this experiment is presented in detail. This tabular approach will be used throughout the document in order to present uniformly the support given to experimenters. Tables include the description of supporting activities and the responsible partner that provided them.

Table 1 - Time sheet of the support dedicated to the WiFi Dense proposal

Partner	Description of support	Dedicated Time [hour]
IMEC	preparation of tests	22
IMEC	support for script	12
IMEC	implementation of tests scripts	18
IMEC	update OMF-OML tutorial	10
IMEC	general UPI usage support	12
IMEC	add missing UPI functionalities	34
IMEC	add hostapd_cli functionality to UPIs	4
IMEC	portable testbed support on site in Allbesmart	32
TUB	Wi-Fi UPI implementation support	10
	TOTAL	**154**

2.2 AGILE – GRIDNET SA

2.2.1 Short description of the experiment

The goal of this experiment is to conduct a systematic evaluation of a spectrum adaptive 802.11 based system (AGILE) under a vast variety of experimental configurations, in order to characterize its ability to improve spectrum efficiency and network performance of 802.11 links under spectrum congestion and interference conditions.

The main challenges of deploying the experiment include:

- Increased heterogeneity and wide range of required hardware platforms
- Complexity in establishing wireless links with specific channel conditions (topologies, signal strengths, etc.)
- Difficulty in configuring multiple complex experimental scenarios including heterogeneous devices that need to be centrally managed

The AGILE system was deployed and tested to characterize its ability to improve spectrum efficiency and network performance of 802.11 links under varying spectrum congestion and interference conditions, caused by a wide range of interference sources.

Figure 2. AGILE experiment setup

2.2.2 Support given to the experimenters

In the following table the support given to this experiment is presented in detail, indicating the supportive partner, the supportive activity and the time spent.

Table 2 - Time sheet of the support dedicated to the AGILE proposal

Partner	Description of support	Dedicated Time [hour]
IMEC	conference call for WiSHFUL framework support	4
IMEC	IEEE 802.15.4 bridge support	12
IMEC	Support for example with IEEE 802.15.4 nodes	6
IMEC	USRP scripts creation to imitate a Microwave	14
IMEC	general UPI usage support	14
	TOTAL	**50**

2.3 QUEST – STREAMOWL

2.3.1 Short description of the experiment

The QUEST experiment spreads across a broad range of aspects including multimedia communication, video transmission, network architecture and control, Wi-Fi networks, and QoE in video streaming services. This multidisciplinary approach is motivated by the adopted cross-layer optimization approach, which performs optimizations of the network functions and resource allocation based on the overall network topology, the network conditions of individual users, and the individual QoE requirements of the specific application at the end-user. Thus, the experiment involved aspects both at the network layer (i.e. routing, packet forwarding) and at the application layer (i.e. the DASH video client), while taking into account the special characteristics of wireless networks (e.g. link failures, variable throughput, etc.).

The experiment topology is depicted in Figure 3: the Devices Under Test, running Linux OS, host a video client (e.g VLC player, mplayer, or an HTML5 player embedded in a webpage) which is scheduled to consume a video stream originating from YouTube. The experiment management server is used to emulate different network conditions, while the Unified Programming Interface - Network (UPI_N) and the Unified Programming Interface - Global (UPI_G) of the WiSHFUL software architecture are configured to optimize video QoE by controlling the network protocol stack. A subset of the video sequences that are streamed to the DUTs are further used in a subjective test with real users to investigate the impact on the actual subjective user opinion and train the objective models for accurate prediction based on objective parameters of the video stream.

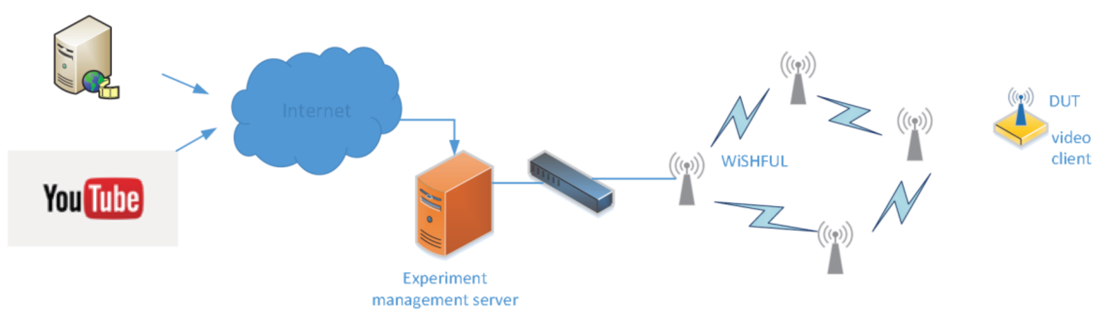

Figure 3. Quest experiment topology setup

2.3.2 Support given to the experimenters

In the following table the support given to this experiment is presented according to 2.1.1.b presented structure.

Table 3 - Time sheet of the support dedicated to the WiFi Dense proposal

Partner	Description of support	Dedicated Time [hour]
IMEC	Conference call for WiSHFUL framework support	3
IMEC	UPIs usage support	4
IMEC	wilab-t testbed support	5
	TOTAL	**12**

2.4 SENSEFUL – I2CAT

2.4.1 Short description of the experiment

Dense Small Cell networks are considered the most effective way to cope with the exponential increase in mobile traffic demand forecasted for the upcoming years. However, novel architectures are required to enable cost-efficient deployments of very dense outdoor Small Cell networks, complementing the coverage layer provided by macro-cells. In this regard, two important challenges need to be solved to make this vision a reality: i) increased traffic dynamics, which are translated into more frequent handovers, and ii) cost-efficient deployment of large numbers of Small Cells.

SENSEFUL aimed to evaluate an SDN-based architecture addressing the two problems highlighted above: SDN as the key technology to promote adaptability to a varying environment and provide efficient mobility solutions in the dense access layer, and ii) novel wireless backhauling technologies where traditional wired connectivity does not meet cost/efficiency restrictions.

Using the same radio resources for access and backhaul, on the other hand, introduces a new challenge that is tackled in SENSEFUL by introducing a cooperative management between both segments of the network. This architecture features separate SDN controllers for the wireless access and the wireless backhaul, which are coordinated through a novel interface defined throughout the project. The proposed architecture benefits from the hierarchical WiSHFUL control architecture and is based on the use of various radio, network and global WiSHFUL UPIs.

Thus, the set of experiments run within SENSEFUL were designed to assess the potential of such architecture, highlighting the benefits of the coordinated management of access and backhaul networks in a Wi-Fi-based small cell testbed. More precisely, the new capabilities of this joint access/backhaul control that have been evaluated are the following:

- Backhaul-aware access network control
- Access/Backhaul resource management

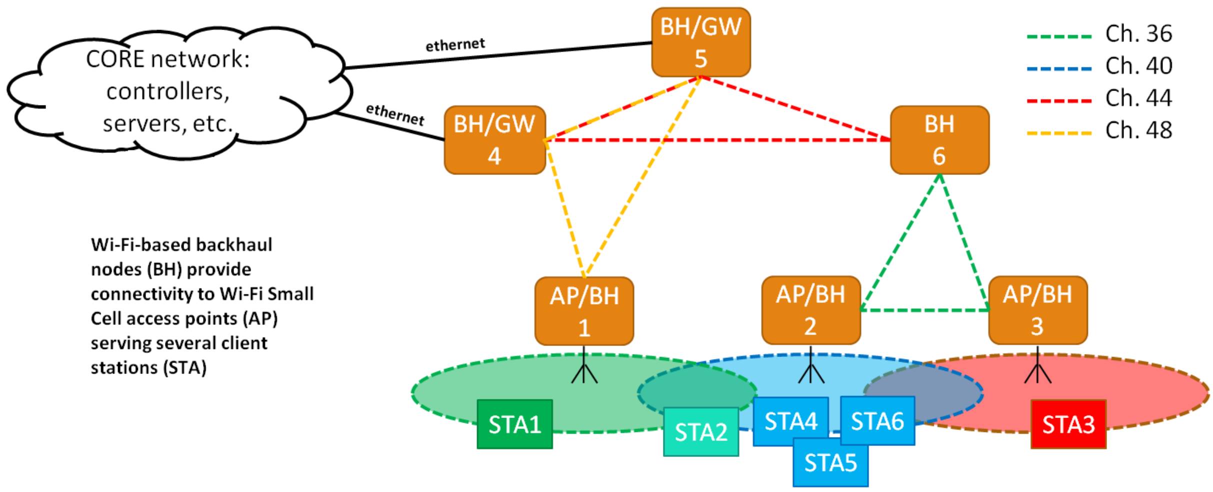

Figure 4. SENSEFUL experiment architecture

2.4.2 Support given to the experimenters

In the following table the support given to this experiment is presented according to the structure defined in 2.1.1.b.

Table 4 - Time sheet of the support dedicated to the WiFi Dense proposal

Partner	Description of support	Dedicated Time [hour]
TUB	porting support	20
TUB	testbed specific support	5
TUB	general support	13
TUB	introduction to WiSHFUL	10
	TOTAL	**48**

3 Conclusions

In this deliverable the support given to Open Call 1 experiments was presented. The support given was spread across all stages of a wireless experiment and was given mostly from the patron of the experiment. This was not imposed, but it was resulted due to careful selection of partners to act as patrons for specific experiments based on their expertise and on the selected testbed to be used in the experiment. In that way, the overhead to identify the right supporting partner was minimized. The support given for solving specific issues, and the establishment of communication points with the Consortium were effective and demonstrated that, despite of the heterogeneity of functionalities and hardware platforms included in the WiSHFUL testbed, the experimenters easily familiarized with the WiSHFUL control framework, taking advantage of the simplification and unification of the offered programming models.