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

Project Deliverable D9.2

Second Dissemination Report

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Abstract:
This public deliverable reports on dissemination activities within the second year of the project.

Keywords:
Dissemination, communication, promotion, publications, demonstrations, presentations

Executive Summary

This document compiles all dissemination activities for the second year of the WiSHFUL project. We include a list of evidence, both pictorial and web based, where available/applicable. Activities are organized into the following categories:

- ***Scientific publications***: this category includes a list of publications in peer-reviewed international conferences (12 papers) and scientific journals (4 papers). Entries in this category include a citation, publication type, and abstract.
- ***White Papers***: this category presents a list of published white papers contributed to by consortium members in 2016.
- ***Presentations***: highlights a set of presentations presented by WiSHFUL partners.
- ***Keynotes***: outlines details of keynote speeches presented in Wroclaw in Poland by Professor Luiz Da Silva, and University of Zaragoza in Spain by Dr. Johann M. Marquez-Barja.
- ***Demonstrations***: this category presents a list of WiSHFUL project demonstrations at conferences.
- ***Meetings***: Presents a list of FIRE Board and DWG Telco meetings and presentations organized and attended by consortium members.
- ***Tutorials and Training***: outlines a training event about Game Theory and Dynamic Spectrum Access presented in EURECOM, Sophia Antipolis, France, and a tutorial presentation on the WiSHFUL project at a consortium meeting in Paris, France, of the H2020 eWINE project.
- ***Conferences and Exhibitions***: presents a summary of the participated conferences and exhibitions attended to by consortium members, which include EuCNC, NetFutures, and 5GPPP.
- ***Newsletter, Website, and Videos***: details are presented with statistics (where available) about the WiSHFUL Newsletter, Website and Tutorial Videos distributed.
- ***Standardisation activities***: a summary of the interactions with ETSI are reported. More details on these activities are reported in D9.3.
- ***Open Calls***: Summary and results of the first three WiSHFUL open calls are presented. The open calls have attracted attention from a wide range of researchers and engineers coming from more than 29 Universities and Research Institutes and also from 27 SMEs and 1 large company.
- ***Year 3 Dissemination Plan***: outlines the dissemination strategy including targeted conferences and meetings, and so forth for Year 3 of the project.

List of Acronyms and Abbreviations

AFI	Autonomic Future Internet
BSS	Basic Service Set
CPU	Central Processing Unit
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
DCF	Distributed Coordination Function
DOA	Description of Action
DSC	Dynamic Sensitivity Control
FPGA	Field Programmable Gate Array
GITAR	Generic extension for Internet-of-Things Architectures
IoE	Internet of Everything
IoT	Internet of Things
M2M	Machine to Machine
MAC	Medium Access Control
MB	Moderated Backoff
NGI	Next Generation Internet
NTECH	Network Technologies
OS	Operating System
RAN	Radio Access Network
RFNoC	RF Network on-Chip
RRM	Radio Resource Management
SDN	Software-Defined Networking
SDR	Software Defined Radio
TAISC	Time Annotated Instruction Set Computer
TDMA	Time Division Multiple Access
ToR	Terms of Reference
UPI	Unified Programming Interface
WiFi	Wireless Fidelity
WLAN	Wireless Local Area Network
WMP	Wireless MAC Processor

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1 Introduction

1.1 Scope

This deliverable reports on the dissemination activities taking place during the second year of the project. Its aim is to disseminate WiSHFUL project results, promote partner test facilities, and WiSHFUL's open, flexible software platforms via the website, regular newsletters, social networks, training events, tutorial videos, keynote presentations, conferences, demonstrations, publications, and so forth. It also aims to create awareness of WiSHFUL among standardization and regulation bodies and policy makers. Furthermore, the dissemination goals of the project serve to develop an exploitation strategy for maintaining the WiSHFUL test facilities and software platforms after the project's completion. Where available, we have presented evidence of events taking place, along with estimates of the number of attendees reached.

We start this deliverable by listing the KPIs for year 2 of the project as outlined in the Description of Action (DoA). Section 2 presents overview of all published and accepted Scientific Publications during M12 to M24. Section 3 lists the White Papers contributed to by consortium members. Sections 4, 5, 6, 7, and 8 list Presentations, Keynotes, Demonstrations, Meetings, Tutorials and Training events attended and presented by project partners during Year 2. Section 9 summarizes Exhibitions undertaken by WiSHFUL partners during 2016. Section 10, 11, and 12 present the dissemination activity of the WiSHFUL project Website, Tutorial Videos, the first project and Newsletter distributed. This is followed by a summary of the open calls completed in year 3 in Section 13. Section 14 outlines the tentative Dissemination plan for year 3. Finally, we conclude this deliverable in Section 15.

1.2 KPIs

The following KPIs were defined in the DoA and were continuously monitored throughout the lifetime of the project. Table 1 presents the KPIs stated in the DoA for year 2 and the total accomplished at month 24 of the project.

	Year 2 (Target)	Year 2 (Achieved)
Number of peer-reviewed publications at high quality conferences	10	12
Number of peer-reviewed publications in well-established international scientific journals	4	4
Number of invitation as keynote speakers at renown international conferences	2	2
Number of exhibitions	2	3
Number of participants at trainings	15	20

Table 1: KPI metrics for the dissemination work package

2 Scientific Publications

In this section we give an overview of all published and accepted scientific publications. Publications that are being prepared or are still under review are not listed.

1. I. Tinnirello, M. Wentink, D. Garlisi, F. Giuliano, and G. Bianchi, "MAC Design on real 802.11 Devices: from Exponential to Moderated Backoff", IEEE WoWMOM 2016

Publication Type: Conference

Abstract: Abstract—In this paper we describe how a novel backoff mechanism called Moderated Backoff (MB), recently proposed as a standard extension for 802.11 networks, has been prototyped and experimentally validated on a commercial 802.11 card before being ratified. Indeed, for performance reasons, the time critical operations of MAC protocols, such as the backoff mechanism, are implemented into the card hardware/firmware and cannot be arbitrarily changed by third parties or by manufacturers only for experimental reasons. Our validation has been possible thanks to the availability of the so called Wireless MAC Processor (WMP), a prototype of a novel wireless card architecture in which MAC protocols can be programmed by using proper abstractions and a state-machine formal language, which enable easy modifications of legacy operations. Experimental results are in agreement with simulations and prove the effectiveness of Moderated Backoff, as well as the potentialities of the WMP platform.

2. N. Flick, D. Garlisi, V. R. Syrotiuk, and I. Tinnirello, "Testbed Implementation of the Meta-MAC Protocol", CNERT INFOCOM Workshop 2016 (paper soon available)

Publication Type: Conference Workshop

Abstract: The meta-MAC protocol is a systematic and automatic method to dynamically combine any set of existing MAC protocols into a single higher layer MAC protocol. We present a proof-of-concept implementation of the meta-MAC protocol by utilizing a programmable *wireless MAC processor* (WMP) on top of a commodity wireless card in combination with a host-level software module. The implementation allows us to combine, with certain constraints, a number of protocols each represented as an extended finite state machine. To illustrate the combination principle, we combine protocols of the same type but with varying parameters in a wireless mesh network. Specifically, we combine TDMA protocols with all possible slot assignments. We demonstrate that an implementation of the meta-MAC protocol over the WMP rapidly converges to non-conflicting TDMA slot assignments for the nodes.

3. P. Ruckebusch et al., "A Unified Radio Control Architecture for Prototyping Adaptive Wireless Protocols," 2016 European Conference on Networks and Communications (EuCNC), Athens, 2016, pp. 58-63.doi: 10.1109/EuCNC.2016.7561005

Publication Type: Conference

Abstract: Experimental optimization of wireless protocols and validation of novel solutions is often problematic, due to limited configuration space present in commercial wireless interfaces as well as complexity of monolithic driver implementation on SDR-based experimentation platforms. To overcome these limitations a novel software architecture is proposed, called WiSHFUL, devised to allow: i) maximal exploitation of radio functionalities available in current radio chips, and ii) clean separation between the logic for optimizing the radio protocols (i.e. radio control) and the definition of these protocols.

4. P. Gallo, K. Kosek-Szott, S. Szott and I. Tinnirello, "SDN@home: A Method for Controlling Future Wireless Home Networks," in IEEE Communications Magazine, vol. 54, no. 5, pp. 123-131, May 2016. doi: 10.1109/MCOM.2016.7470946

Publication Type: Journal

Abstract: Recent advances in wireless networking technologies are leading toward the proliferation of novel home network applications. However, the landscape of emerging scenarios is fragmented due to their varying technological requirements and the heterogeneity of current wireless technologies. We argue that the development of flexible software-defined wireless architectures, including such efforts as the wireless MAC processor, coupled with SDN concepts, will enable the support of both emerging and future home applications. In this article, we first identify problems with managing current home networks composed of separate network segments governed by different technologies. Second, we point out the flaws of current approaches to provide interoperability of these technologies. Third, we present a vision of a software-defined multi-technology network architecture (SDN@home) and demonstrate how a future home gateway (SDN controller) can directly and dynamically program network devices. Finally, we define a new type of flexibility enabled by SDN@home. Wireless protocols and features are no longer tied to specific technologies but can be used by general-purpose wireless SDN devices. This permits satisfaction of the requirements demanded by home owners and service providers under heterogeneous network conditions.

5. M. Kulin, C. Fortuna, E. De Poorter, D. Deschrijver, I. Moerman, "Data-Driven Design of Intelligent Wireless Networks: An Overview and Tutorial", Sensors 2016, 16(6), 790, doi: 10.3390/s16060790

Publication Type: Journal

Abstract: Data science or "data-driven research" is a research approach that uses real-life data to gain insight about the behavior of systems. It enables the analysis of small, simple as well as large and more complex systems in order to assess whether they function according to the intended design and as seen in simulation. Data science approaches have been successfully applied to analyze networked interactions in several research areas such as large-scale social networks, advanced business and healthcare processes. Wireless networks can exhibit unpredictable interactions between algorithms from multiple protocol layers, interactions between multiple devices, and hardware specific influences. These interactions can lead to a difference between real-world functioning and design time functioning. Data science methods can help to detect the actual behavior and possibly help to correct it. Data science is increasingly used in wireless research. To support data-driven research in wireless networks, this paper illustrates the step-by-step methodology that has to be applied to extract knowledge from raw data traces. To this end, the paper (i) clarifies when, why and how to use data science in wireless network research; (ii) provides a generic framework for applying data science in wireless networks; (iii) gives an overview of existing research papers that utilized data science approaches in wireless networks; (iv) illustrates the overall knowledge discovery process through an extensive example in which device types are identified based on their traffic patterns; (v) provides the reader the necessary datasets and scripts to go through the tutorial steps themselves.

6. P. Ruckebusch, J. Bauwens, B. Jooris, S. D. Giannoulis, E. De Poorter, I. Moerman, D. Garlisi, I. Tinnirello and P. Gallo, "Cross-Technology Wireless Experimentation: Improving 802.11 and 802.15.4e coexistence", 2016 17th IEEE International Symposium on "A World of Wireless, Mobile and Multimedia Networks" (WoWMoM), June 21-24, Coimbra, Portugal

Publication Type: Conference Demo Paper

Abstract: In this demo we demonstrate the functionalities of a novel experimentation framework, called WiSHFUL that facilitates the prototyping and experimental validation of innovative solutions for heterogeneous wireless networks, including cross-technology coordination mechanisms. The framework supports a clean separation between the definition of the logic for optimizing the behaviours of wireless devices and the underlying device capabilities, by means of a unifying platform-independent control interface and programming model. The use of the framework is demonstrated through two representative use cases, where medium access is coordinated between IEEE-802.11 and IEEE-802.15.4 networks.

7. S. Zehl, A. Zubow and A. Wolisz, "hMAC: Enabling Hybrid TDMA/CSMA on IEEE 802.11 Hardware", arXiv, 2016.

Publication Type: arXiv

Abstract: We present our current work-in-progress on the design and implementation of a hybrid TDMA/CSMA medium access architecture, hereafter referred to as hMAC, which can be used on top of commercial IEEE 802.11 off-the-shelf hardware. The software only solution is based on the popular Linux ATH9K softMAC driver and hence can be used with standard Linux systems using Atheros based wireless network devices. The proposed hMAC exploits the standard 802.11 power saving functionality present in the ATH9K device driver to enable control of the software packet queues. This allows the assignment of TDMA time slots on wireless link and traffic class basis. While the solution is placed only in the device driver, the CSMA/CA functionality on hardware level is still active. This enables inter-working with standard unmodified 802.11 devices. We tested our prototypical hMAC implementation in a small test-bed. Therefore, we implemented a centralized interference management scheme in which pairs of links suffering from a hidden node problem are assigned to TDMA time slots on a per-link basis. To show the benefits of the proposed hMAC approach we compared the results with standard 802.11 DCF and classical, i.e. per-node, TDMA. Finally, to enable collaboration with the research community, the hMAC source code is provided as open-source.

8. S. Zehl, A. Zubow, M. Döring and A. Wolisz, "ResFi: A Secure Framework for Self Organized Radio Resource Management in Residential WiFi Networks," 2016 IEEE 17th International Symposium on A World of Wireless, Mobile and Multimedia Networks (WoWMoM), Coimbra, 2016, pp. 1-11, doi: 10.1109/WoWMoM.2016.7523511

Publication Type: Conference

Abstract: In dense deployments of residential WiFi networks individual users suffer performance degradation due to both contention and interference. While Radio Resource Management (RRM) is known to mitigate this effects its application in residential WiFi networks being by nature unplanned and individually managed creates a big challenge. We propose ResFi - a framework supporting creation of RRM functionality in legacy deployments. The radio interfaces are used for efficient discovery of adjacent APs and as a side-channel to establish a secure communication among the individual Access Point Management Applications within a neighborhood over the wired Internet backbone. We have implemented a prototype of ResFi and studied its performance in our testbed. As a showcase we have implemented various RRM applications among others a distributed channel assignment algorithm using ResFi. ResFi is provided to the community as open source.

9. B. Jooris, J. Bauwens, P. Ruckebusch, P.D. Valck, C.V. Praet, I. Moerman, E. De Poorter, "TAISC: A cross-platform MAC protocol compiler and execution engine", Computer Networks, Volume 107, Part 2, 9 October 2016, Pages 315–326, doi:10.1016/j.comnet.2016.03.027 (2016)

Publication Type: Journal

Abstract: MAC protocols significantly impact wireless performance metrics such as throughput, energy consumption and reliability. Although the choice of the optimal MAC protocol depends on time-varying criteria such as the current application requirements and the current environmental conditions, MAC protocols cannot be upgraded after deployment since their implementations are typically written in low level, hardware specific code which is hard to reuse on other hardware platforms. To remedy this shortcoming, this paper introduces TAISC, Time Annotated Instruction Set Computer, a framework for hardware independent MAC protocol development and management. The solution presented in this paper allows describing MAC protocols in a platform independent language, followed by a straightforward compilation step, yielding dedicated binary code, optimized for specific radio chips. The compiled code is as efficient in terms of memory footprint as custom-written protocols for specific devices. To enable time-critical operation, the TAISC compiler adds exact time annotations to every instruction of the optimized binary code. As a result, the TAISC approach can be used for energy-efficient cross-platform MAC protocol design, while achieving up to 97% of the theoretical throughput at an overhead of only 20 µs per instruction.

10. T. Kazaz, C.V. Praet, M. Kulin, P. Willemen, and I. Moerman, "Hardware Accelerated SDR Platform for Adaptive Air Interfaces", ETSI Workshop on Future Radio Technologies - Air Interfaces, 27-28 January 2016, Sophia Antipolis, France

Publication Type: Conference Workshop

Abstract: Advanced 5G wireless infrastructure should support any-to-any connectivity between densely arranged smart objects that form the emerging paradigm known as the Internet of Everything (IoE). While traditional wireless networks enable communication between devices using a single technology, 5G networks will need to support seamless connectivity between heterogeneous wireless objects, and consequently enable the proliferation of IoE networks. To tackle the complexity and versatility of the future IoE networks, 5G has to guarantee optimal usage of both spectrum and energy resources and further support technology-agnostic connectivity between objects. This can be realized by combining intelligent network control with adaptive software-defined air interfaces. In order to achieve this, current radio technology paradigms like Cloud RAN and Software Defined Radio (SDR) utilize centralized baseband signal processing mainly performed in software. With traditional SDR platforms, composed of separate radio and host commodity computer units, computationally-intensive signal processing algorithms and high-throughput connectivity between processing units are hard to realize. In addition, significant power consumption and large form factor may preclude any real-life deployment of such systems. On the other hand, modern hybrid FPGA technology tightly couples a FPGA fabric with hard core CPU on a single chip. This provides opportunities for implementing air interfaces based on hardware/software co- processing, resulting in increased processing throughput, reduced form factor and power consumption, while at the same time preserving flexibility. This paper examines how hybrid FPGAs can be combined with novel ideas such as RF Network- on-Chip (RFNoC) and partial reconfiguration, to form a flexible and compact platform for implementing low-power adaptive air interfaces. The proposed platform merges software and hardware processing units of SDR systems on a single chip. Therefore, it can provide interfaces for on-the-fly composition and reconfiguration of software and hardware radio modules. The resulting system enables the abstraction of air interfaces, where each access technology is composed of a structured sequence of modular radio processing units.

11. N. Kaminski, I. Moerman, S. Giannoulis, P. Gallo, A. Zubow, R. Leblon, I. Seskar, S. Choi, and J. de Rezende, "Unified Radio and Network Control Across Heterogeneous Hardware Platforms", ETSI

Workshop on Future Radio Technologies - Air Interfaces, 27-28 January 2016, Sophia Antipolis, France.

Publication Type: Conference Workshop

Abstract: Experimentation is an important step in the investigation of techniques for handling spectrum scarcity or the development of new waveforms in future wireless networks. However, it is impractical and not cost effective to construct custom platforms for each future network scenario to be investigated. This problem is addressed by defining Unified Programming Interfaces that allow common access to several platforms for experimentation-based prototyping, research, and development purposes. The design of these interfaces is driven by a diverse set of scenarios that capture the functionality relevant to future network implementations while trying to keep them as generic as possible. Herein, the definition of this set of scenarios is presented as well as the architecture for supporting experimentation-based wireless research over multiple hardware platforms. The proposed architecture for experimentation incorporates both local and global unified interfaces to control any aspect of a wireless system while being completely agnostic to the actual technology incorporated. Control is feasible from the low-level features of individual radios to the entire network stack, including hierarchical control combinations. A testbed to enable the use of the above architecture is utilized that uses a backbone network in order to be able to extract measurements and observe the overall behaviour of the system under test without imposing further communication overhead to the actual experiment. Based on the aforementioned architecture, a system is proposed that is able to support the advancement of intelligent techniques for future networks through experimentation while decoupling promising algorithms and techniques from the capabilities of a specific hardware platform.

12. J. Bauwens, B. Jooris, E. De Poorter, P. Ruckebusch, and I. Moerman, "Towards a MAC Protocol App Store", demo abstract paper accepted for the International Conference on Embedded Wireless Systems and Networks, EWSN 2016, Graz, Austria, February 15-17, 2016

Publication Type: Conference Demo

Abstract: In recent years there has been a growing interest in the Internet-of-Things (IoT), leading to an expanding number of wireless environment and application domains in which IoT deployments are realized. Over the course of its lifetime, an IoT device will be exposed to different environments and varying demands in terms of network throughput, latency, power consumption, etc. For instance, consider the case of transportation and logistics where sensors will be attached to goods, pallets and containers, monitoring their respective state. These nodes need to work optimally every step of the supply chain: from frequent monitoring in densely packed warehouses to infrequent monitoring during overseas transit. The Medium Access Control (MAC) plays a major role in how a device handles the (changing) application requirements and environment. Unfortunately today there is no one-size-fits-all MAC protocol that works well in all cases. This causes an ever increasing number of MAC protocols that are each optimized for a certain application [1]. There have also been some hybrid or adaptive protocols developed to cope with different environments [2], but even they have limitations in reconfiguring the parameters or changing the behaviour of MAC protocols.

13. P. Ruckebusch, E. De Poorter, C. Fortuna, & I. Moerman, (2016). GITAR: Generic extension for Internet-of-Things ARchitectures enabling dynamic updates of network and application modules. Ad Hoc Networks, Volume 36, Part 1, January 2016, Pages 127–151

Publication Type: Journal

Abstract: The Internet-of-Things (IoT) represents the third wave of computing innovation and relies on small, cheap and/or energy efficient devices densely deployed in various spaces. Automatically managing, updating and upgrading the software on these devices, particularly the network stacks, with new, improved functionality is currently a major challenge. In this paper we propose GITAR, a generic extension for Internet-of-Things architectures, that enables dynamic application and network level upgrades in an efficient way. GITAR consists of four design concepts which can be applied to any operating system running on IoT/M2M devices. The proof of concept implementation in this paper uses the Contiki OS and the evaluation, based on analytical and experimental methods, shows that GITAR i) is up to 14% more efficient in terms of memory usage and ii) has less or similar run-time CPU overhead as state of the art solutions while offering upgrade functionality down to the network level and iii) can reuse existing Contiki network protocols for dynamic updates without requiring modifications to the code.

14. E. Khorov, A. Kiryanov, A. Krotov, P. Gallo, D. Garlisi, I. Tinnirello. Joint Usage of Dynamic Sensitivity Control and Time Division Multiple Access in Dense 802.11ax Networks. In Lecture Notes in Computer Science, Springer, Nov. 2016

Publication Type: Conference Paper

Abstract: It is well known that in case of high-density deployments, Wi-Fi networks suffer from serious performance impairments due to hidden and exposed nodes. The problem is explicitly considered by the IEEE 802.11ax developers in order to improve spectrum efficiency. In this pa- per, we propose and evaluate the joint usage of dynamic sensitivity control (DSC) and time division multiple access (TDMA) for improving the spectrum allocation among overlapping 802.11ax BSSs. To validate the solution, apart from simulation, we used a testbed based on the Wireless MAC Processor (WMP), a prototype of a programmable wireless card.

15. I. Tinnirello, D. Garlisi, F. Giuliano, V. R. Syrotiuk, and G. Bianchi. 2016. MAC learning: enabling automatic combination of elementary protocol components: demo. In Proceedings of the Tenth ACM International Workshop on Wireless Network Testbeds, Experimental Evaluation, and Characterization (WiNTECH '16). ACM, New York, NY, USA, 89-90. DOI: http://dx.doi.org/10.1145/2980159.2980174

Publication Type: Conference Demo

Abstract: Cognition as a way to deal with the challenges of future wireless networks has been largely considered by the recent literature, with a main focus on physical layer adaptability and dynamic spectrum access. In this demo, we show how a simple cognition mechanism can be also applied at the MAC layer, by exploiting the emerging paradigm of programmable wireless cards. The idea is using the formal definition of simple MAC protocol components and platform-independent representation of channel events gathered from the wireless node, for emulating the behaviour of protocols which are not currently running on the network, learning about their expected performance, and dynamically reconfiguring the wireless node. We demonstrate that programmable nodes, employing our cognition scheme, can find in a distributed way a con-conflicting schedule with other neighbour nodes and can switch from contention-based to scheduled-based protocols as a function of the network load.

16. A. Zubow, S. Zehl, A. Wolisz, “BIG AP - Seamless Handover in High Performance Enterprise IEEE 802.11 Networks", IEEE Network Operations and Management Symposium (NOMS), full paper, local, 2016

Publication Type: Conference Paper

Abstract: Enterprise IEEE 802.11 networks need to provide high network performance to operate a large number of diverse clients like laptops, smartphones and tablets as well as capacity hungry and delay sensitive novel applications like mobile HD video & cloud storage efficiently. Moreover, such devices and applications require much better mobility support and higher QoS/QoE. Existing solutions can either provide high network performance or seamless mobility but not both. We present BIGAP, a novel architecture achieving both of the above goals. The former is achieved by assigning different channels to co-located APs in order to fully utilize the available radio spectrum. The latter is achieved by providing a mechanism for below MAC-layer handover through exploiting the Dynamic Frequency Selection capability in 802.11. In essence BIGAP forces clients to change AP whilst they 'believe' they are simply changing channel. BIGAP is fully compatible with 802.11 and requires no modifications to the wireless clients. Testbed results demonstrate a significant improvement in terms of network outage duration (which is 32x smaller as compared to state-of-the-art solutions) and negligible throughput degradation during handover operation. In this way frequent and seamless handover operations can take place thus supporting both seamless mobility and efficient load balancing.

17. P. Gawłowicz, S. Zehl, A. Zubow and A. Wolisz, " NxWLAN: Neighborhood eXtensible WLAN", arXiv, 2016.

Publication Type: arXiv

Abstract: The increased usage of IEEE 802.11 Wireless LAN (WLAN) in residential environments by unexperienced users leads to dense, unplanned and chaotic residential WLAN deployments. Often WLAN Access Points (APs) are deployed unprofitable in terms of radio coverage and interference conditions. In many cases the usage of the neighbor's AP would be beneficial as it would provide better radio coverage in some parts of the residential user's apartment. Moreover, the network performance can be dramatically improved by balancing the network load over spatially co-located APs. We address this problem by presenting Neighborhood extensible WLAN (NxWLAN) which enables the secure extension of user's home WLANs through usage of neighboring APs in residential environments with zero configuration efforts and without revealing WPA2 encryption keys to untrusted neighbor APs. NxWLAN makes use of virtualization techniques utilizing neighboring AP by deploying on-demand a Wireless Termination Point (WTP) on the neighboring AP and by tunneling encrypted 802.11 traffic to the Virtual Access Point (VAP) residing on the home AP. This allows the client devices to always authenticate against the home AP using the WPA2-PSK passphrase already stored in the device without any additional registration process. We implemented NxWLAN prototypically using off-the-shelf hardware and open source software. As the OpenFlow is not suited for forwarding native 802.11 frames, we built software switch using P4 language. The performance evaluation in a small 802.11 indoor testbed showed the feasibility of our approach. NxWLAN is provided to the community as open source.

18. S. Zehl, A. Zubow, A. Wolisz, "BIG AP - A Seamless Handover Scheme for High Performance Enterprise IEEE 802.11 Networks", IEEE Network Operations and Management Symposium (NOMS),

Publication Type: Conference Demo

Abstract: We demonstrate BIGAP, a novel architecture providing both high network performance as well as seamless handover in Enterprise IEEE 802.11 networks. The former is achieved by assigning different channels to co-located APs to fully utilize the available radio spectrum. The latter is achieved by providing a mechanism for below MAC-layer handover through exploiting the Dynamic Frequency Selection (DFS) capability in IEEE 802.11. In essence BigAP forces clients to change AP whilst they 'believe' they are simply changing channel. BIGAP is fully compatible with 802.11 and

requires no modifications to the wireless clients.

3 White Papers

During Year 2 of the WiSHFUL project, several partners were involved in the creation of a white paper. In summary, one white paper was produced between M12 and M24 of the project, which was created for a public audience.

1. Alexander Willner, Chiara Petrioli, Federico M. Facca, Ingrid Moerman, Johann M. Marquez-Barja, Josep Martrat, Levent Gurgen, Sebastien Ziegler, Serafim Kotrotsos, Sergi Figuerola Fernandez, Stathes Hadjiefthymiades, Susanne Kuehrer, Thanasis Korakis, Tim Wauters, Timur Friedman. "Next Generation Internet Experimentation: Drivers Transforming Next Generation Internet Research and Experimentation." (June, 2016).

Publication Type: White Paper

Website: https://www.ict-fire.eu/wp-content/uploads/Drivers-Transforming-NGI-Experimentation-Whitepaper-V1.0-Release.pdf

Abstract: In a world where competitive economies are increasingly dependent on innovative application of information and communication technologies and where changes in technology and culture are happening rapidly, Europe must remain at the forefront of the Next Generation Internet (NGI). User-driven experimentation is now driving the evolution of the Internet. Europe's public investment policy must foster the creation of vibrant experimentation ecosystems that are supported by the research and development of open experimentation platforms that engage citizens and companies in finding solutions, activating business markets, and addressing important societal challenges.

4 Presentations

4.1 Wireless experimentation & benchmarking

WiSHFUL presented at NetFutures'16 in the *Interoperability, Benchmarking & Experimentation* session by Ingrid Moerman from IMEC, Ghent University, an invited session speaker[1]. She presented the current state of the art in wireless experimentation & benchmarking based on research carried out by the WiSHFUL project.

Presentation Title:	Wireless experimentation & benchmarking
Dates:	20th April 2016
Presenter:	Ingrid Moerman (IMEC - Ghent University)
Location:	Brussels, Belgium
Evidence 1:	http://netfutures2016.eu/programme/interoperability-benchmaking-experimentation
Evidence 2 (Presentation):	http://netfutures2016.eu/wp-content/uploads/2016/05/NetFutures2016_IngridMoerman_Benchmarking.pdf

4.2 FIRE testbeds enabling 5G experimentation, by Ingrid Moerman

Figure 1: Participants at the FIRE Forum 2016 on 27th September

The FIRE STUDY organised the FIRE Forum 2016 on 27th September, which was collocated with the ICT Proposers Day in Bratislava. Ingrid Moerman presented a presentation entitled: *FIRE testbeds enabling 5G experimentation* - Figure 1.

1 Benchmarking Session at NetFutures http://netfutures2016.eu/programme/interoperability-benchmaking-experimentation/

Presentation Title:	FIRE testbeds enabling 5G experimentation
Dates:	27th September 2016
Presenter:	Ingrid Moerman (IMEC - Ghent University)
Audience:	50 representatives from 42 different projects or organizations, including the EC.
Location:	Bratislava, Slovakia
Evidence 1:	https://www.ict-fire.eu/mc-events/fire-forum-2016/
Presentation:	https://www.ict-fire.eu/wp-content/uploads/Ingrid-Moerman.pdf

4.3 WiSHFUL Open Call Presentation

Ingrid Moerman from IMEC made a presentation to encourage participation in the 3rd WiSHFUL open call process to participants and FI project leaders at the FIRE Forum meeting held in Bratislava, Slovakia, see Figure 2.

Presentation Title:	WiSFHUL Open Call Presentation
Dates:	27th September 2016
Presenter:	Ingrid Moerman (IMEC - Ghent University)
Audience:	50 representatives from 42 different projects or organizations, including the EC.
Location:	Bratislava, Slovakia
Evidence 1:	https://www.ict-fire.eu/mc-events/fire-forum-2016/

Figure 2: WiSHFUL Open Call Presentation

5 Keynote

Trends in Spectrum Sharing for Future Wireless Networks

Keynote Title:	Trends in Spectrum Sharing for Future Wireless Networks
Dates:	Thursday 8th September 2016
Presenter:	Luiz Da Silva
Location:	Wroclaw, Poland
	EMC EUROPE 2016 WROCLAW
Evidence 1:	http://www.emceurope.org/2016/files/EMCEurope2016_final_programme.pdf

Enabling 5G Future Networks

Presentation Title:	Enabling 5G Future Networks
Dates:	21st December 2016
Presenter:	Dr. Johann M. Marquez-Barja (CONNECT Centre for Future Networks and Communications, Trinity College Dublin, Ireland)
Location:	iNIT Jornadas 2016 (Intelligent Networks and Information Technology Workshop) held in University of Zaragoza, Campus Teruel, Spain
Evidence 1:	http://init.unizar.es/jornadas_init_2016/
Abstract:	Abstract: 5G Future Networks base their evolution on the coexistence of the heterogeneous network technologies, enabling dynamic solutions to fulfill the assorted connectivity requirements of the end-users. Future Networks rely on two main pillars: access and architecture. There are new radio technologies that will provide an enhanced access network, these new radio technologies will make use new waveforms and PHY techniques, such as mmwave or massive MIMO techniques. Regarding the network architecture, the current wireless and optical networks will converge providing a seamless end-to-end architecture, through network slicing and virtualization techniques, which is capable to orchestrate and to tailor a network to the requested services. This talk will provide an overview of the current trends of 5G Future Networks from both perspectives: radio access and network architecture, including standardization matters. Moreover, during this talk current research on future networks will be discussed, in particular, the research being carried out under the H2020 WiSHFUL, and the H2020 FUTEBOL projects funded by the European Commission.

6 Demonstrations

6.1 Towards a MAC Protocol App Store

Abstract: In recent years there has been a growing interest in the Internet-of-Things (IoT), leading to an expanding number of wireless environment and application domains in which IoT deployments are realized. Over the course of its lifetime, an IoT device will be exposed to different environments and varying demands in terms of network throughput, latency, power consumption, etc. For instance, consider the case of transportation and logistics where sensors will be attached to goods, pallets and containers, monitoring their respective state. These nodes need to work optimally every step of the supply chain: from frequent monitoring in densely packed warehouses to infrequent monitoring during overseas transit. The Medium Access Control (MAC) plays a major role in how a device handles the (changing) application requirements and environment. Unfortunately today there is no one- size-fits-all MAC protocol that works well in all cases. This causes an ever-increasing number of MAC protocols that are each optimized for a certain application [1]. There have also been some hybrid or adaptive protocols developed to cope with different environments [2], but even they have limitations in reconfiguring the parameters or changing the behaviour of MAC protocols.

Title:	Towards a MAC Protocol App Store
Dates:	15th – 17th February 2016
Presenter:	Jan Bauwens, Bart Jooris, Eli De Poorter, Peter Ruckebusch and Ingrid Moerman
Location:	Graz, Austria
Evidence 1:	http://www.wishful-project.eu/sites/default/files/EWSN2016_TAISC_demo.pdf
Conference:	Demo at the *International Conference on Embedded Wireless Systems and Networks*, EWSN 2016

6.2 Demonstration of collaborative coexistence between IEEE 802.15.4e (TSCH) and IEEE 802.11 technologies

ETSI organised a workshop entitled “From Research To Standardization” on 10-11 May 2016 in ETSI Headquarters in Sophia Antipolis. It was organised in the context of the H2020 program of the European Commission. The WiSHFUL team provided a demonstration of the collaborative coexistence between IEEE 802.15.4e (TSCH) and IEEE 802.11 technologies.

Title:	Demonstration of collaborative coexistence between IEEE 802.15.4e (TSCH) and IEEE 802.11 technologies
Dates:	10th – 11th May 2016
Presenter:	Ingrid Moerman, Pieter Becue & Peter Ruckebusch (IMEC – Gent University)
Audience:	Unknown
Evidence 1:	http://www.etsi.org/news-events/events/1016-2016-05-ws-from-research-to-standardization

6.3 Demo - MAC Learning: Enabling Automatic Combination of Elementary Protocol Components

Abstract: Cognition as a way to deal with the challenges of future wireless networks has been largely considered by the recent literature, with a main focus on physical layer adaptability and dynamic spectrum access. In this demo, we show how a simple cognition mechanism can be also applied at the MAC layer, by exploiting the emerging paradigm of programmable wireless cards. The idea is using the formal definition of simple MAC protocol components and platform-independent representation of channel events gathered from the wireless node, for emulating the behaviour of protocols which are not currently running on the network, learning about their expected performance, and dynamically reconfiguring the wireless node. We demonstrate that programmable nodes, employing our cognition scheme, can find in a distributed way a con-conflicting schedule with other neighbour nodes and can switch from contention-based to scheduled-based protocols as a function of the network load.

Title:	MAC Learning: Enabling Automatic Combination of Elementary Protocol Components
Dates:	3rd – 7th October 2016
Presenter:	Ilenia Tinnirello, Violet R. Syrotiuk, & Giuseppe Bianchi
Location:	New York City, NY, USA
Evidence 1:	http://dx.doi.org/10.1145/2980159.2980174
Conference:	In Proceedings of the Tenth ACM International Workshop on Wireless Network Testbeds, Experimental Evaluation, and Characterization (WiNTECH '16).

7 Meetings

7.1 FIRE Board Meetings

WiSHFUL partners were present at the FIRE Board meetings co-located with Net Futures, 2016.

FIRE Board Meeting Co-Located with @NetFutures 2016

Dates:	21st April 2016
Presenter:	Ingrid Moerman and IMEC Team (IMEC – Gent University)
Audience:	No. FI Projects Reached (Estimate 27)
Evidence 1:	FIRE Board Meeting EventBrite NetFutures 2016: http://www.eventbrite.com/e/fire-board-meeting-2142016-registration-23227475003

FIRE Board Meeting, Bratislava, Slovakia

Dates:	21st April 2016
Presenter:	Ingrid Moerman and IMEC Team (IMEC – Gent University)
Location:	Bratislava, Slovakia
Audience:	No. FI Projects Reached (Estimate 30+)
Evidence 1:	FIRE Board Meeting Bratislava, Slovakia, on 28th of September 2016 https://www.ict-fire.eu/mc-events/fire-board-meeting-by-invitation/

7.2 FIRE DWG Telco meetings

WiSHFUL members have attended the monthly DWG Telco meetings held throughout 2016. These meetings allow WiSHFUL partners to promote WiSHFUL initiates such as the Open calls and reach a number of different FI projects creating project awareness. Moreover, these meetings support networking opportunities among other FI projects. Some evidence to support attendance at these meetings is available in the meeting minutes[2] [3] [4].

[2] DWG Telco meeting June 13th 2016 Meeting Minutes https://docs.google.com/document/d/1vdeWwlRnNT5bIqxaUaybYjcCotXenrIg5j2a9mNLb7c/edit#heading=h.3xmwah2qarnc

[3] DWG Telco meeting 24th November 2016 Meeting Minutes: https://docs.google.com/document/d/1n44dS3Kjhcd-ozwEXv75RiLJglORxRtlL59jP9ikDOo/edit

[4] DWG Telco meeting 11th May 2016 Meeting Minutes: https://docs.google.com/document/d/1FkGeb-PnipXeAn8xOR60tWz0KBs1OctVhOcY3hoHSOg/edit?usp=sharing

8 Tutorials and Training

8.1 Tutorial: Introduction to Game Theory applied to Dynamic Spectrum Access

Professor Luiz da Silva (Trinity College Dublin) presented a lecture on "Introduction to Game Theory applied to Dynamic Spectrum Access"[5]. The Lecture took place at the Summer School on Spectrum Aggregation and Sharing for 5G Networks[6], at EURECOM, Sophia Antipolis, France. It was organized by the ADEL and Speed5G H2020 projects.

Dates:	17th -19th October 2016
Presenter:	Luiz DaSilva
Audience:	Approximately 20 people
Evidence 1:	http://www.euracon.org/images/sampledata/DaSilva_SSSAS5G.pdf
Evidence 2:	http://www.euracon.org/index.php/2013-02-12-09-41-49/sssas5g

8.2 Tutorial: Overview of the WiSHFUL project

Ingrid Moerman (IMEC) has given a tutorial presentation on the WiSHFUL project". The presentation took place at the H2020 eWINE plenary meeting at Thales Communication & Security in Paris.

Dates:	6th September 2016
Presenter:	Ingrid Moerman
Audience:	Approximately 15 people

[5] Introduction to Game Theory Applied to Spectrum Sharing – available at http://www.euracon.org/images/sampledata/DaSilva_SSSAS5G.pdf

[6] (Indian) Summer School on Spectrum Aggregation and Sharing for 5G Networks – available at http://www.euracon.org/index.php/2013-02-12-09-41-49/sssas5g

9 Conferences and Exhibitions

In this section, we present a summary of participated conferences and exhibitions attended by WiSHFUL partners during year 2 of the project.

9.1 NetFutures 2016 Brussels

WiSHFUL participated at the NetFutures 2016 conference in April. Capabilities of the Portable Testbed were demonstrated for the first time to the general public through several use cases. These included improving coexistence of heterogeneous wireless technologies that share the same spectrum such as IEEE 802.11 and IEEE 802.15.4e. The WiSHFUL software architecture enables real-time reconfiguration of wireless networks using unified control interfaces, cross-technology control, and management. The project was promoted on the NetFutures conference website[7] and the FIRE 2016 leaflet[8]. Photographic evidence of the booth and presentations to key individuals are available in Table 2, Table 3, and Table 4.

Dates:	20^{th} – 21^{st} April 2016
Presenter:	Ingrid Moerman and IMEC Team (IMEC – Gent University)
Audience:	No. Participants Reached (Estimate 200) based on leaflets distributed, demos presented, poster views, etc. No. FI Projects Reached (Estimate 30)
Evidence 1:	http://netfutures2016.eu
Evidence 2:	https://www.ict-fire.eu/wp-content/uploads/FIRE_Brochure2016-web.pdf

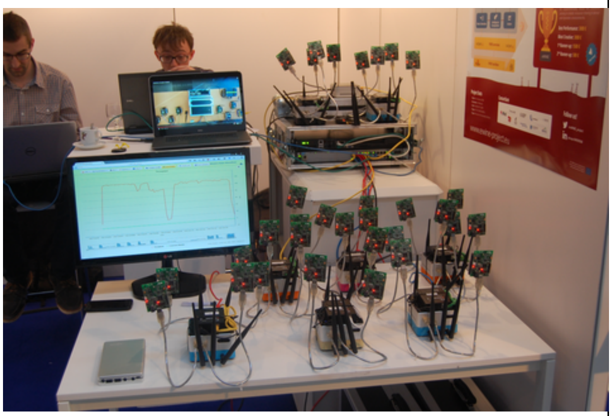
	

Table 2: Pictures of WiSHFUL booth and posters at NetFutures 2016

[7] http://netfutures2016.eu

[8] https://www.ict-fire.eu/wp-content/uploads/FIRE_Brochure2016-web.pdf

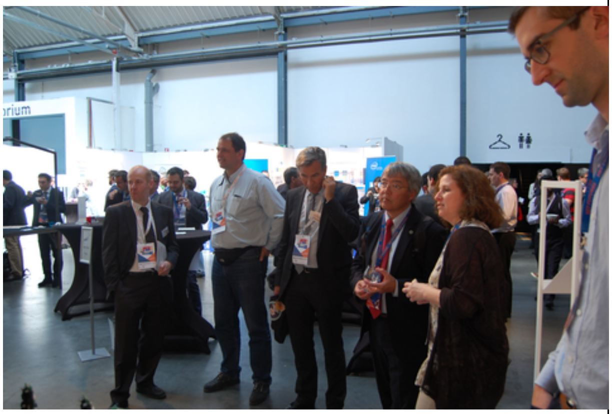
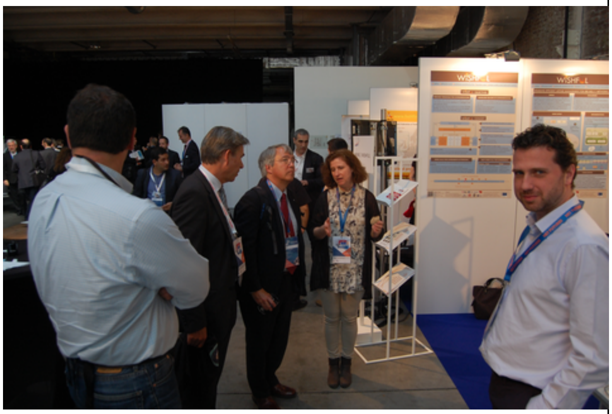



Table 3: Dr. Jim Kurose, Assistant Director of the National Science Foundation (NSF) for the Computer and Information Science and Engineering (CISE), visiting the WiSHFUL Booth at NetFutures'16

Table 4: Mr. Andrus Ansip Vice President for the Digital Single Market on the European Commission from the European Commission, visiting the WiSHFUL Booth at NetFutures'16.

9.2 EuCNC 2016 Athens

EuCNC'2016 is the 25th edition of a successful series of technical conferences in the field of telecommunications, sponsored by the European Commission. The conference showcases the status of research in advanced networks and associated topics is presented in sessions, workshops, exhibitions, and demonstrations. The WiSHFUL project team participated with a booth and demonstration (see Table 5) showcasing the use of the first release of the portable testbed at this exhibition. The portable testbed offers identical functionality (in terms of testbed access, provisioning of resources, experiment control, monitoring, etc.) to researchers and wireless developers as if they would run their experiments in one of the advanced wireless testbeds in a fixed physical environment.

Dates:	27th – 30th June 2016

Location:	Athens, Greece
Presenter:	Ingrid Moerman and IMEC Team (IMEC – Gent University)
Evidence 1:	http://eucnc.eu/2016/
Evidence 2:	http://www.eucnc.eu/2016/www.eucnc.eu/indexe637.html?q=node/134

Table 5: WiSHFUL Booth with portable testbed at EuCNC 2016, Athens, Greece.

9.3 Second Global 5G Event on 9th-10th November 2016, Rome (Italy)

The WiSHFUL team attended the 5G Infrastructure Public Private Partnership (5G PPP) conference in Rome, Italy, which was initiated by the EU Commission and industry manufacturers, telecommunications operators, service providers, SMEs and researchers. The aim of this initiative is to deliver solutions, architectures, technologies and standards for the ubiquitous next generation communication infrastructures of the coming decade. The WiSHFUL team had a booth at this exhibition and demonstrated the portable testbed – see Table 6.

Dates:	9th – 10th November 2016
Location:	Rome, Italy.
Presenter:	Ingrid Moerman and IMEC Team (IMEC – Gent University)
Evidence 1:	https://5g-ppp.eu/

Table 6: Pictures from the Second Global 5G Event on 9th-10th November 2016, Rome (Italy)

10 Newsletter

The WiSHFUL project published its first newsletter in October 2016. It is planned to release a newsletter every three months until the project's completion. The first newsletter includes announcement about recently opened Open Call 2 funding for experiments and extension from both academia and industry. The newsletter also contains a description of the biggest events WiSHFUL has participated in 2016 as well as a summary of the latest Plenary Meeting of WiSHFUL that took place in Gent, Belgium. Several screenshots of the October newsletter[9] are available in Table 7.

WiSHFUL

Newsletter #1, October 2016

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

WIRELESS SOLUTION DEVELOPMENT

The WiSHFUL project aims to reduce the threshold for experimental validation of innovative wireless solutions in several ways. First, it offers open and free of charge access to a number of advanced wireless testbeds offering different wireless technologies such as IEEE 802.11, IEEE 802.15.4, LTE, DVB-T and SDR. It also guarantees support from skilled people. Next, it offers several software platforms that comprise data plane and control plane functionality for advanced and intelligent radio and network control. However, different wireless technologies and platforms can be very heterogeneous in terms of memory, processing capabilities, and supported operating systems and software. The software platforms offered by the WiSHFUL project come with a unified, technology-agonistic interface called a UPI or Unified Programming Interface. This UPI provides a uniform control interface that allows experimenters to focus on the network optimisation without the need to dig into complex hardware and software specifications for different technologies and platforms. Finally, WiSHFUL offers a portable testbed that can be deployed at any location allowing validation in the real world involving real users. The portable testbed offers the same functionality to experimenters as if they were running their experiments on a fixed testbed.

Wireless developers are very welcome to validate their innovative wireless solutions on one (or multiple) testbeds supported by WiSHFUL using the very flexible software platforms accessible through a unified interface. They can also receive funding via one of the Open Calls. Additionally, WiSHFUL has dedicated Open Calls for small and medium-size enterprises (SMEs), including unipersonal companies and individuals.

Ingrid MOERMAN Imec

OPEN CALL 3

Open Call for Experiments and Extensions is NOW open!

Calls for experiments

Jan 15 Dec 15 Dec 16 Dec 17

Calls for extension

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.

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 supporting the WiSHFUL unified programming interfaces, or (3) integration of new Fed4FIRE compliant testbeds that offer WiSHFUL software platforms that are compliant with the WiSHFUL software platforms and its unified programming interfaces (UPIs).

PROPOSALS ARE DUE ON 28/10/2016

For more information check the http://www.wishful-project.eu/OpenCall3

Please visit http://www.wishful-project.eu/ or email contact@wishful-project.eu for further information

WiSHFUL

Newsletter #1, October 2016

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

EuCNC 2016 Athens

EuCNC'2016 is the 25th edition of a successful series of a technical conferences in the field of telecommunications, sponsored by the European Commission. The WiSHFUL Project participated with a booth at this exhibition.

NetFutures 2016 Brussels

WiSHFUL participated at the NetFutures 2016 conference in April. Capabilities of the Portable Testbed were demonstrated for the first time to the general public through several use cases. These included improving coexistence of heterogeneous wireless technologies that share the same spectrum such as IEEE 802.11 and IEEE 802.15.4e. The WiSHFUL software architecture enables real-time reconfiguration of wireless networks using unified control interfaces, cross-technology control, and management.

Plenary Meeting # 5

The 5th WiSHFUL plenary meeting took place from 10th to 12th of October 2016 in Gent, Belgium. It was attended by over 20 people from the Consortium. Several project-related items were discussed including: progress of showcases, the status and results from OC1 and OC2, future showcase planning, structure of deliverables, and partner work related responsibilities.

Several points about the WiSHFUL 2.0 Framework were also discussed including: status of implementation, stability and validation tests, examples, tutorials, documentation status online, future plans, and the intelligence framework. We also explored extending software and hardware that we can support based on the results of Extension Calls and consortium activities for the OC4 Experiments. The next plenary meeting is scheduled to be in Berlin from 23rd-25th of January 2017.

Consortium

Acknowledgment

The research leading to these results has received funding from the European Horizon 2020 Programme under grant agreement n°645274 (WiSHFUL project).

Please visit http://www.wishful-project.eu/ or email contact@wishful-project.eu for further information

Table 7: Screenshots of the 1st WiSHFUL Newsletter released in October 2016.

Metric	Year 1	Year 2
Visitors:	323	3,363
Sessions:	581	7,406
Pages Views	1,422	20,703
Avg. Session Duration:	01:51	03:03
Top 5 Countries:	Belgium Greece, USA, Italy, Ireland	Belgium, Greece, Italy, Spain, USA

Table 8: User Statistics collected from Google Analytics for the www.wishful-project.eu website

9 WiSHFUL October 2016 Newsletter - available at: http://www.wishful-project.eu/sites/default/files/images/Newsletter-WiSHFUL.pdf

11 Website

As stated in the first dissemination report[10], the main WiSHFUL website is www.wishful-project.eu. Analytic information associated with this site, was captured using Google Analytics, see Figure 3. Typically, we notice an increase in visitor traffic to these websites during events such as Net Futures '16 (April), EuCNC '16 (June), 5G-PPP '16 (November), FIRE Board Forums and Meetings (April and September 2016), and so forth. During Year 2 of the project, www.wishful-project.eu recorded an enormous increase in user traffic. Google Analytics captured the following statistics (see Table 8 and Figure 3).

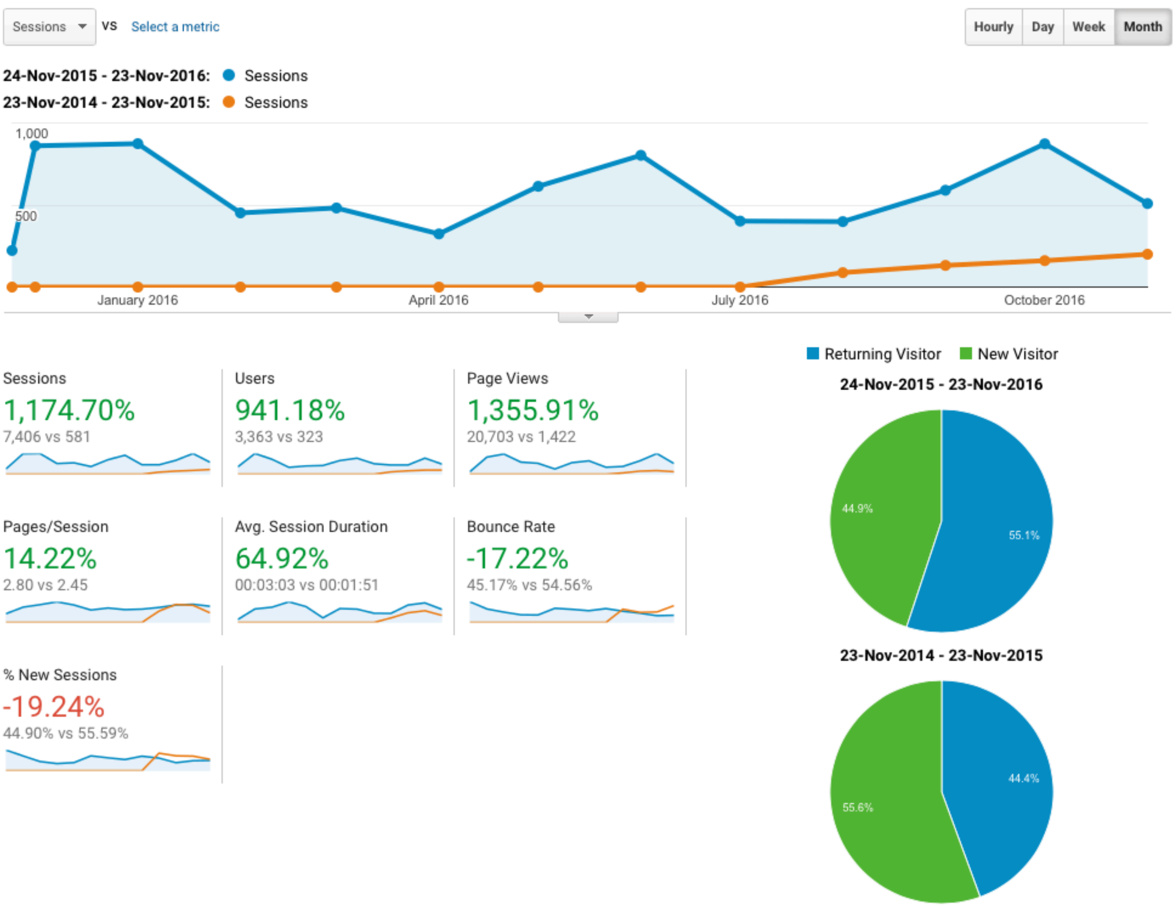


Figure 3: www.wishful-project.eu website Year1 vs Year2 user traffic comparison

[10] http://www.wishful-project.eu/sites/default/files/images/review/WiSHFUL_D9.1_Lead_TCD_R_PU_2015-12-23_Final.pdf

12 Videos

Two WiSHFUL video tutorials have been release in Year 2 of the project. These include the IRIS Video tutorial and the Infrastructure-Initiated Handover for IEEE 802.11 Networks tutorial.

12.1 Iris Video

Video Title:	Iris showcase of WiSHFUL integration
Description:	Tutorial showing the use of the Iris WiSHFUL UPIs
Release Date:	December 2nd 2016
URL:	http://www.wishful-project.eu/sites/default/files/Short-Final-WebSite.mp4

12.2 WiSHFUL Showcase Infrastructure-Initiated Handover for IEEE 802.11 Networks

Video Title:	WiSHFUL Showcase Infrastructure-Initiated Handover for IEEE 802.11 Networks
Description:	Description of Infrastructure-Initiated Handover for IEEE 802.11 Networks
Release Date:	2016 November
URL:	https://www.youtube.com/watch?v=FtA91tZ9cCk

13 Interaction with ETSI

The **WiSHFUL project supplied ETSI with different types of contributions** along several directions and addressing heterogeneous task groups. In 2016 two **papers** were presented at the Workshop on Future Radio Technologies – Air Interfaces [1, 2], one **demonstration** on inter-technology coexistence [3] and one **presentation** at the NTECH task group for Autonomic network engineering for the self-managing Future Internet (AFI) [4]. These activities and the consequent relations permitted to establish **multiple contacts between WiSHFUL and ETSI**. The WiSHFUL control framework emerged as a potential enabler for the Generic Autonomic Network Architecture (GANA) proposed by ETSI NETCH and further investigations will be run to check if WiSHFUL can be used to set a Proof of Concept (PoC) of the GANA architecture. Relationship between WiSHFUL and ETSI is also demonstrated by the reference of the ETSI standard architecture to the WiSHFUL project [5]. Further details on ETSI initiatives can be found in D9.3, which describes standardization and pre-standardization activities.

14 Open Calls

Over the lifetime of the project, WiSHFUL will organise 5 Open Calls for wireless innovation experiments and 2 open calls for extending the WiSHFUL hardware and software platforms. The first Open Call for Experiments and Extensions was launched on 9th of December 2015, the second Open Call for Experiments was launched on 13th of May 2016, and the Third Open Call was launched on 16th of September 2016 – see Figure 4. Currently, all Open Calls for Experiments and Extensions are NOW CLOSED. However, the Next Call for Experiments (Open Call 4) is expected to be in early January 2017 (date of announcement).

To date, three open calls have been launched and closed providing funding for experimentation of SMEs and large companies as well as research institutes and universities. Two Open calls included in parallel funding for extensions in terms of software modules but also of hardware platforms supported as well as new testbeds to be added to the WiSHFUL ecosystem. The funding used already for Open Calls is more than €1,560,000 from a total of almost €2,000,000. Our open calls have attracted attention from a wide range of researchers and engineers coming from more than 29 Universities and Research Institutes and also from 27 SMEs and 1 large company.

The remainder of this section summarises the first three Open Calls and promotion mechanisms completed in Year 2 of the project.

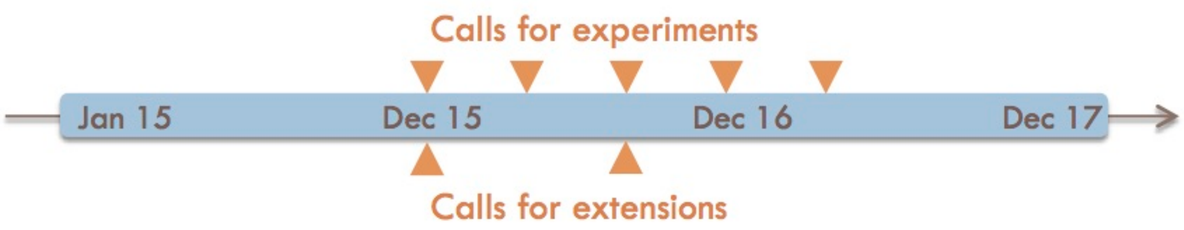


Figure 4: WiSHFUL Open Calls taking place in Year 2 of the project.

14.1 First Open Call – Launched 9th of December 2015

The **first Open Call** includes 2 tracks, which was launched on December 9th, 2015, at FIRE Forum in Brussels:

- **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 supporting the WiSHFUL unified programming interfaces, or (3) integration of new Fed4FIRE compliant testbeds that offer WiSHFUL software platforms that are compliant with the WiSHFUL software platforms and its unified programming interfaces (UPIs).

14.2 First Open Call: Results (Deadline 29th of January 2016)

The first open call closed on January 29th, 2016 at 17:00 Brussels time. The WiSHFUL project received 26 proposals, of which:

- 5 proposals for Experiments, category 'Innovation by SME'
- 7 proposals for Experiments, category 'Scientific Excellence'
- 14 proposals for Extensions

Among the proposers are 13 universities, 3 research institutes, 9 SMEs, and 1 large enterprise.

The proposals originate from the following countries (in no particular order): Belgium, Germany, Greece, Italy, Macedonia, The Netherlands, Portugal, Slovenia, Spain and Switzerland.

Some statistics on the budget:

Total request for funding: EUR 1,679,375 (oversubscription factor: 4)

- average requested funding for proposals for Experiments, category 'Innovation by SME': EUR 39,494
- average requested funding for proposals for Experiments, category 'Scientific Excellence': EUR 42,768
- average requested funding for proposals for Extensions: EUR 84,430

After a thorough review process by external independent reviewers, it was found that the quality of most proposals was good to very good. Due to budget limitations, only 8 proposals can receive funding as a result of the first open call:

- Experiments, category 'Innovation by SME':
    - Albesmart (PT): Experimental assessment of WiFi coordination strategies in dense wireless scenarios [Patron: IMEC]
    - Gridnet SA (GR): Enabling Agile Spectrum Adaptation in Commercial WLAN Deployments [Patron: IMEC]
    - StreamOwl (GR): Quality-of-Experience of video streaming in wireless networks [Patron: IMEC]
- Experiments, category 'Scientific Excellence':
    - Freie Universität Berlin (DE): Wireless Channel-based Autonomous Key Management for the IoT [Patron: TU Berlin]
    - I2CAT (ES): SDN driven Joint Access Backhaul coordination for next generation dense Wi-Fi Small Cell networks via WiSHFUL APIs [Patron: TU Berlin]
- Extensions:
    - Adant Technologies (IT): Reconfigurable Antenna System for WLAN platforms [Patron: CNIT]
    - Univeristy of Thessaly (GR): FIRE LTE EXperimentation using WiSHFUL [Patron: IMEC]
    - University of Perugia (IT): DVB-T software radio transmitter eXtension for IRIS [Patron: TCD]

14.3 Second Open Call – Launched 13th of May 2016

The WiSHFUL project announced its second Open Call for Experiments on 13th of May 2016, targeting advanced solutions for controlling wireless networks using the WiSHFUL software platform and unified programming interfaces (UPIs), and using the facilities and hardware supported by the WiSHFUL Consortium.

14.4 Second Open Call: Results (Deadline 28th of Oct 2016)

The second open call closed on June 24th, 2016 at 17:00 Brussels time. The WiSHFUL project received 13 (eligible) proposals, of which:

- 6 proposals for Experiments, category 'Innovation by SMEs'
- 7 proposals for Experiments, category 'Scientific Excellence'

Among the proposers are 6 universities, 6 SMEs, and 1 large enterprise.

The proposals originate from the following countries (in no particular order): Belgium, France, Greece, Italy, The Netherlands, Serbia, and Spain.

Some statistics on the budget:

Total request for funding: EUR 548,605 (oversubscription factor: 2.6)

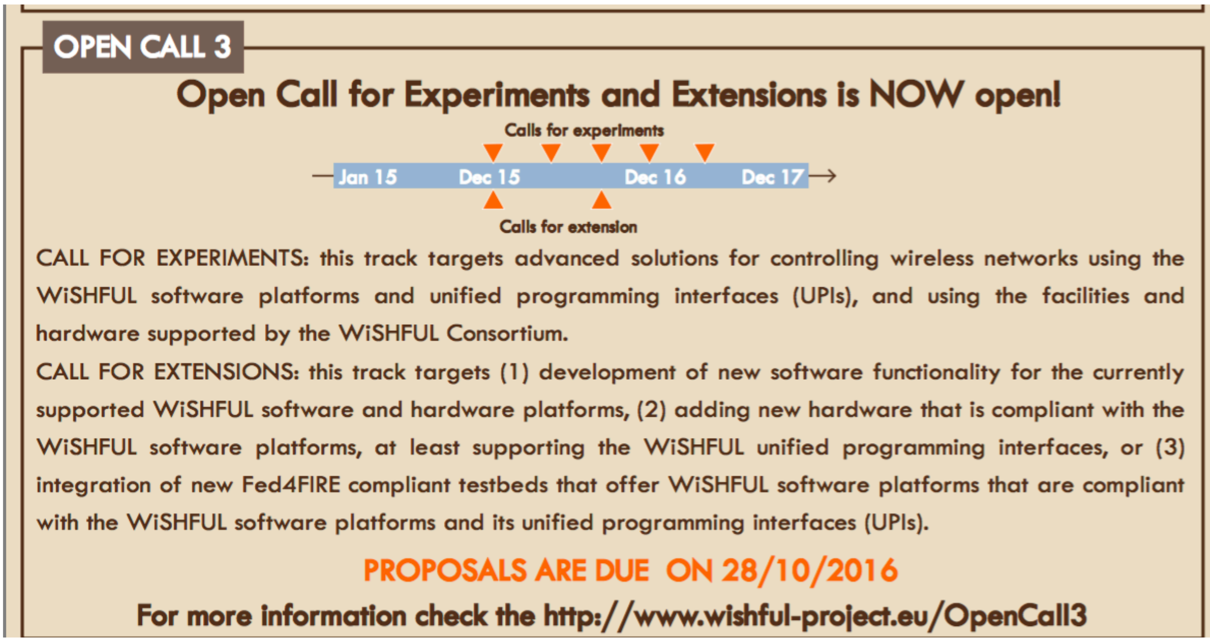
- average requested funding for proposals for Experiments, category 'Innovation by SMEs': EUR 38,661
- average requested funding for proposals for Experiments, category 'Scientific Excellence': EUR 45,234

After a thorough review process by external independent reviewers, it was found that the quality of most proposals was good to very good. Due to budget limitations, only 5 proposals can receive funding as a result of the second open call:

- Experiments, category 'Innovation by SMEs':
  - Incelligent (GR): Experiments for the validation of predictive wireless network management [Patron: IMEC]
  - Level7 S.r.l.u (IT): PROviding Mobile Enviroments To End Users [Patron: IMEC]
  - Modio Computing (GR): Machine-learning assisted control of wireless sensor networks [Patron: IMEC]
- Experiments, category 'Scientific Excellence':
  - Delft University of Technology (NL): Energy-harvesting Low-power Wireless Bus for WSNs [Patron: IMEC]
  - University of Macedonia (GR): Controlling Radio-Aware data Flows [Patron: IMEC]

14.5 Third Open Call – Launched 16th of September 2016

The WiSHFUL project announced its third Open Call for Experiments and Extensions on 16th September 2016, targeting advanced solutions for controlling wireless networks using the WiSHFUL software platform and unified programming interfaces (UPIs), and using the facilities and hardware supported by the WiSHFUL Consortium.



OPEN CALL 3

Open Call for Experiments and Extensions is NOW open!

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.

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 supporting the WiSHFUL unified programming interfaces, or (3) integration of new Fed4FIRE compliant testbeds that offer WiSHFUL software platforms that are compliant with the WiSHFUL software platforms and its unified programming interfaces (UPIs).

PROPOSALS ARE DUE ON 28/10/2016

For more information check the http://www.wishful-project.eu/OpenCall3

Figure 5: Screenshot of the Open Call from the first WiSHFUL Newsletter

14.6 Third Open Call: Results (Deadline 28th of Oct 2016)

On the day of writing this document, the results from the third open call are not available.

14.7 Open Calls Promotion

Archival information about the last three WiSHFUL Open Calls can be found at: http://www.wishful-project.eu/open-calls

Open Call announcements have been promoted via various communication channels, including:

- The WiSHFUL website
- The WiSHFUL newsletter
- Promotion at relevant conference and exhibitions such as NetFutures, EuCNC and 5G-PPP with demos at the exhibition booth.
- Promotion via the FIRE Network
    - FIRE website - https://www.ict-fire.eu and https://www.ict-fire.eu/open-calls/
    - Monthly FIRE Communication at Dissemination and Communication Working Group (DWG) telco meetings,
    - FIRE Forum
- Announcement to other relevant European & national projects via the WiSHFUL partners
- Dissemination via national research and industrial networks (e.g. IMEC communication letter)

15 Year 3 Dissemination Plan

The following section outlines the dissemination strategy for Year 3 of the WiSHFUL project. First, we identify the Year 3 KPIs identified in the DOA. Next, we identify conferences, open calls, events, social networks, and so forth targeted to reach help us reach these dissemination goals.

15.1 Year 3 KPIs

The dissemination goals for year three, specified in the DOA, are outlined in Table 9.

Goal	Year 3 (Target)
Number of peer-reviewed publications at high quality conferences	10
Number of peer-reviewed publications well established International scientific journals	5
Number of invitation as keynote speakers at renown international conferences	1
Number of exhibitions	2
Number of participants at trainings	20

Table 9: Year 3 KPI metrics

15.2 Dissemination Conferences

WiSHFUL Consortium members plan to participate in the following conferences in 2017. Some conferences such as INFOCOM, DYSPAN, and EuCNC require demo paper publications to be submitted. Other conferences such as NetFutures do not.

Conference	Date	Website	Presentation
DYSPAN 2017	6th-9th March 2017, Baltimore, USA.	http://dyspan2017.ieee-dyspan.org	Demo (Paper)
INFOCOM 2017	1st to 4th of May 2017, Atlanta, GA, USA	http://infocom2017.ieee-infocom.org	Demo (Paper)
TNC 2017	29th of May to 2nd of June, Linz, Austria	https://tnc17.geant.org/	Stand/Demo
IoT week 2017	6th to 9th June, in Geneva, Switzerland.	http://iot-week.eu/iot-week-2017	Stand/Demo
EuCNC 2017	12th to 15th June, in Oulu, Finland	http://www.eucnc.eu/	Demo (Paper)
NetFutures 2017	28th to 29th of June, The Egg in Brussels	Details to be announced	Stand/Demo

15.3 Keynotes Planned in Year 3

The following is a definitive of Keynote conferences planned in Year 3 of the project.

Keynote Title:	**Trends in Future Wireless Networks (Tentative Title)**
Dates:	June 18 to 21, 2017.
Conference	The 2017 IEEE 18th International Conference on High Performance Switching and Routing
Presenter:	Luiz Da Silva
Location:	Unicamp Convention Center, Campinas, São Paulo, Brazil
Evidence 1:	http://hpsr2017.ieee-hpsr.org/

15.4 Year 3 Newsletters

WiSHFUL partners intend to publish four project newsletters in 2017. We have also been invited to publish in the IEEE SDN Newsletter.

Project Newsletters

Dates:	Throughout 2017, Starting in January
Author:	Trinity College Dublin
Audience:	FIRE Network
Publication:	Available on Website: http://www.wishful-project.eu
Details:	Four WiSHFUL newsletters are planned for 2017 starting in January. They will be distributed on the FIRE dissemination group network.

Softwarisation of radios and wireless networks

Dates:	To appear: January 2017
Author:	Ingrid Moerman, Spilios Giannoulis, Eli De Poorter and Xianjun Jiao (Ghent University)
Audience:	IEEE Community
Publication:	Invited paper: IEEE Software Defined Networks - Softwarization eNewsletter
Details:	While SDR and SDN initially were parallel evolutions happening in isolated research communities, several European projects, more specifically the H2020 projects WiSHFUL, eWINE and ORCA are currently developing enablers to bridge the gap between SDR and SDN. These projects offer advanced software and hardware platforms in open state-of-the-art large-scale wireless test facilities that can be used and further extended by academic researchers and wireless developers.

15.5 Training

Dates:	18th to 20th September 2017
Location:	CNIT, Palermo, Italy.
Conference General Chair:	Ilenia Tinnirello (CNIT)

Audience:	Tutorial for PhD Students – how to use Wishful

15.6 Social Networking

Site:	SMARTUS – Social Networking site
Audience:	Statup companies distributed around Europe.
Goal:	Distribute Open calls announcements on this network.

15.7 Open Calls

As discussed in section 0, the WiSHFUL consortium will organize 5 Open Calls for wireless innovation experiments and 2 open calls for extending the WiSHFUL hardware and software platforms. Partners will organize the outstanding open calls in 2017.

16 Conclusions

The objective of this deliverable was to report on the dissemination activities taking place during Year 2 of the WiSHFUL project. This was achieved by disseminating project results and promoting partner facilities and the WiSHFUL framework by writing high quality scientific publications, dissemination on the website and social networks, attending conferences, presenting keynotes, training end-users, and so forth. Highlights from Year 2 of the project include presenting 10 papers at internationally recognised conference venues, publishing 4 papers in well-established internationally recognised scientific journals, and disseminating our work via keynote presentations at high profile academic and industry meetings and events. Moreover, the WiSHFUL Open Call process is highlighting the ease with which academia and industry partners can access and utilise WiSHFUL testbed facilities. Our research and work has also reached key policy and decision making individuals such as Dr. Jim Kurose, Assistant Director of the National Science Foundation in the USA and Mr. Andrus Ansip, Vice President for the Digital Single Market on the European Commission at events such as NetFutures 2016. Furthermore, we have presented our work to individuals and bodies involved in academia, industry, conferences, meetings, plenaries, training events, and so forth, which will help ensure the long-term exploitation and sustainability of WiSHFUL project research, resources and results. Finally, we have outlined the dissemination strategy for Year 3 of the project by identifying key conferences, events, meetings and so forth to promote the work completed by WiSHFUL project partners.

17 References

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