imec

TRINITY COLLEGE DUBLIN

cmit

berlin

nCENTRIC

RUTGERS

UFRJ

SEOUL NATIONAL UNIVERSITY

WiSHFUL

OPEN CALL 5 - WEBINAR

Ingrid Moerman & Spilios Giannoulis – IMEC

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

Outline

- WiSHFUL Project Overview
  - Why?
  - Objectives
  - Showcases
  - Architecture
- How to
  - use UPIs
  - intelligence framework
- Open Call 5 info
- Some testimonies

WiSHFUL project Overview

- **Wi**reless **S**oftware and **H**ardware platforms for **F**lexible and **U**nified radio and network contro**L**
- Call: H2020-ICT-2014-1
- Topic: ICT-11-2014 (FIRE+)
- Type of action: RIA
- Budget: 5.171 M€ (of which 1.99 M€ for Open Calls)
- Duration: 40 M
- Partners

imec, Trinity College Dublin, cnit, TU berlin, nCENTRIC, Rutgers, UFRJ Universidade Federal do Rio de Janeiro, Seoul National University

WiSHFUL

WiSHFUL - WHY?

Barriers for wireless innovation

Why this radio parameter cannot be configured? According to the specs, it should be possible…

Interesting platform, unfortunately documentation is very poor…

Tweaking a radio driver is cumbersome! Chipset manufacturers refuse to give any support…

Experimental validation is extremely useful, but learning curve is slow…

A one-size-fits-all solution is not suited for my wireless innovation. More flexibility & adaptability is highly desired, but how to implement?

Real-life prototyping is hard!

Working with heterogeneous devices is painful: specifications, HW/SW platforms and APIs are so different!

WiSHFUL OBJECTIVES

OBJECTIVES

1 TO REDUCE THRESHOLD FOR EXPERIMENTATION in view of stimulating wireless innovation

- by building open, flexible & adaptive **software platforms** with unified programming **interfaces (UPIs)** for **intelligent radio and network control**
- by offering these software platforms in wireless Fed4FIRE compliant **test facilities**

2 TO INCREASE THE REALISM OF EXPERIMENTATION

- to offer **portable testbeds** that can be deployed at any location allowing validation in the real world and involving real users

OBJECTIVES

3 TO ATTRACT 3RD PARTIES FOR EXPERIMENTATION

- validating innovative wireless solutions
- using WiSHFUL software platforms and interfaces
- using (portable) facilities and hardware supported by WiSHFUL

4 TO ATTRACT 3RD PARTIES FOR EXTENSIONS

- new **software** functionality for the WiSHFUL software platforms
- new **hardware**
  - compliant with WiSHFUL software platforms
  - at least supporting the WiSHFUL UPIs
- new **testbeds**
  - Fed4FIRE compliant
  - offering WiSHFUL software platforms / UPIs

OBJECTIVES

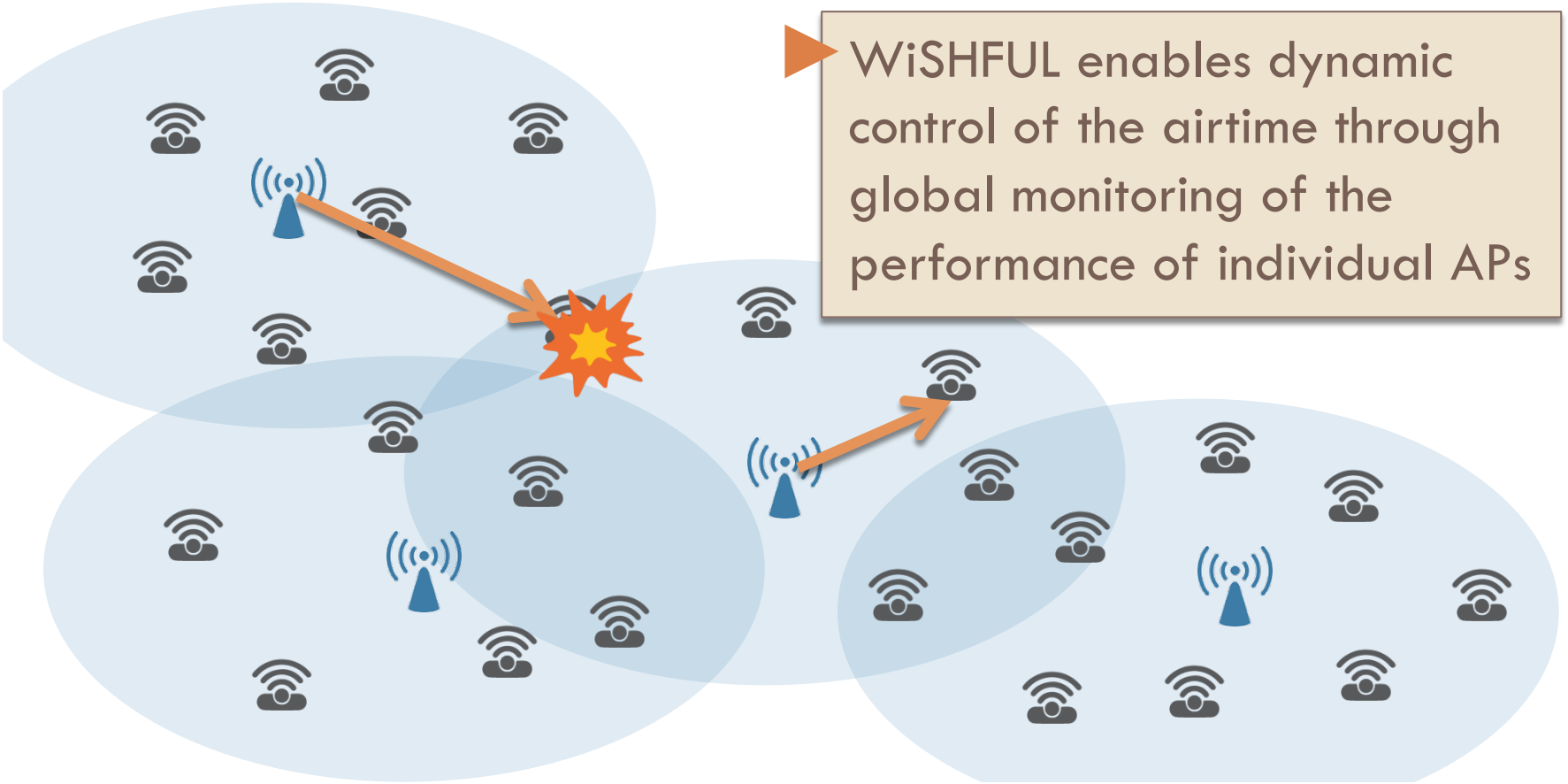
3 TO ATTRACT 3RD PARTIES FOR EXPERIMENTATION

- validating innovative wireless solutions
- using WiSHFUL software platforms and interfaces
- using (portable) facilities and hardware supported by WiSHFUL

WiSHFUL DRIVING SHOWCASES

Some examples

How to avoid co-channel interference caused by hidden nodes in dense Wi-Fi networks?



WiSHFUL enables dynamic control of the airtime through global monitoring of the performance of individual APs

Some examples

How to adapt MAC parameters and MAC strategy depending on the load and interference?

- WiSHFUL offers cognitive MAC adaptation strategies that
  - support runtime parameter tuning and on the fly switching of MAC protocols
  - are independent on technology and software platform
- WiSHFUL offers intelligent techniques to learn the behaviour and predict the performance of MAC protocols

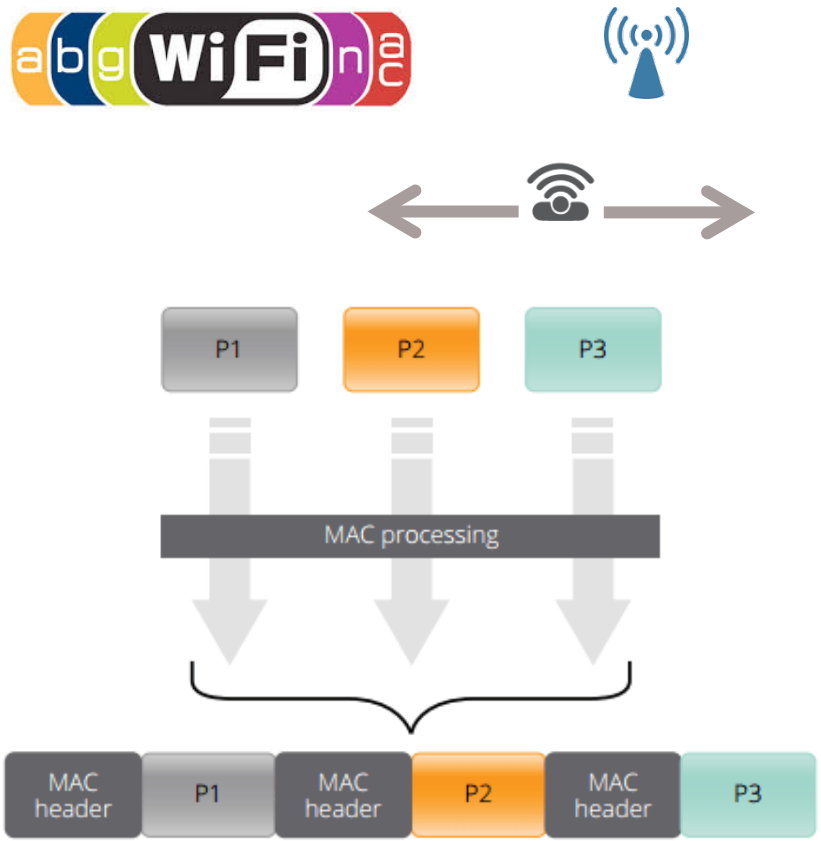
Some examples

How to avoid interference between heterogeneous technologies?

- WiSHFUL offers interference mitigation techniques that adapt to traffic load through
  - sharing of information between technologies
  - learning the behaviour of interfering networks

Some examples

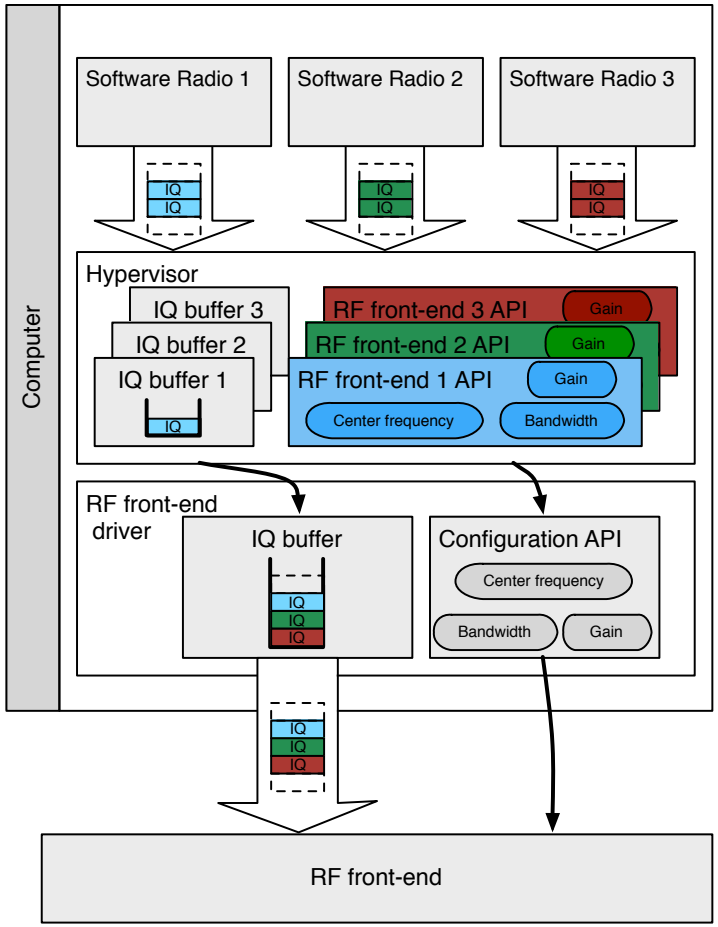
How to maximally exploit IEEE802.11 settings to achieve high throughput?



- WiSHFUL allows
  - to analyse aggregation schemes over a wide range of PHY features under different channel conditions and mobility scenarios
  - to validate mobility-aware algorithms which adapt PHY rate and frame aggregation length in real-time

Some examples

How to design and implement radio virtualization as an enabler for multi-radio access technology in future wireless networks?

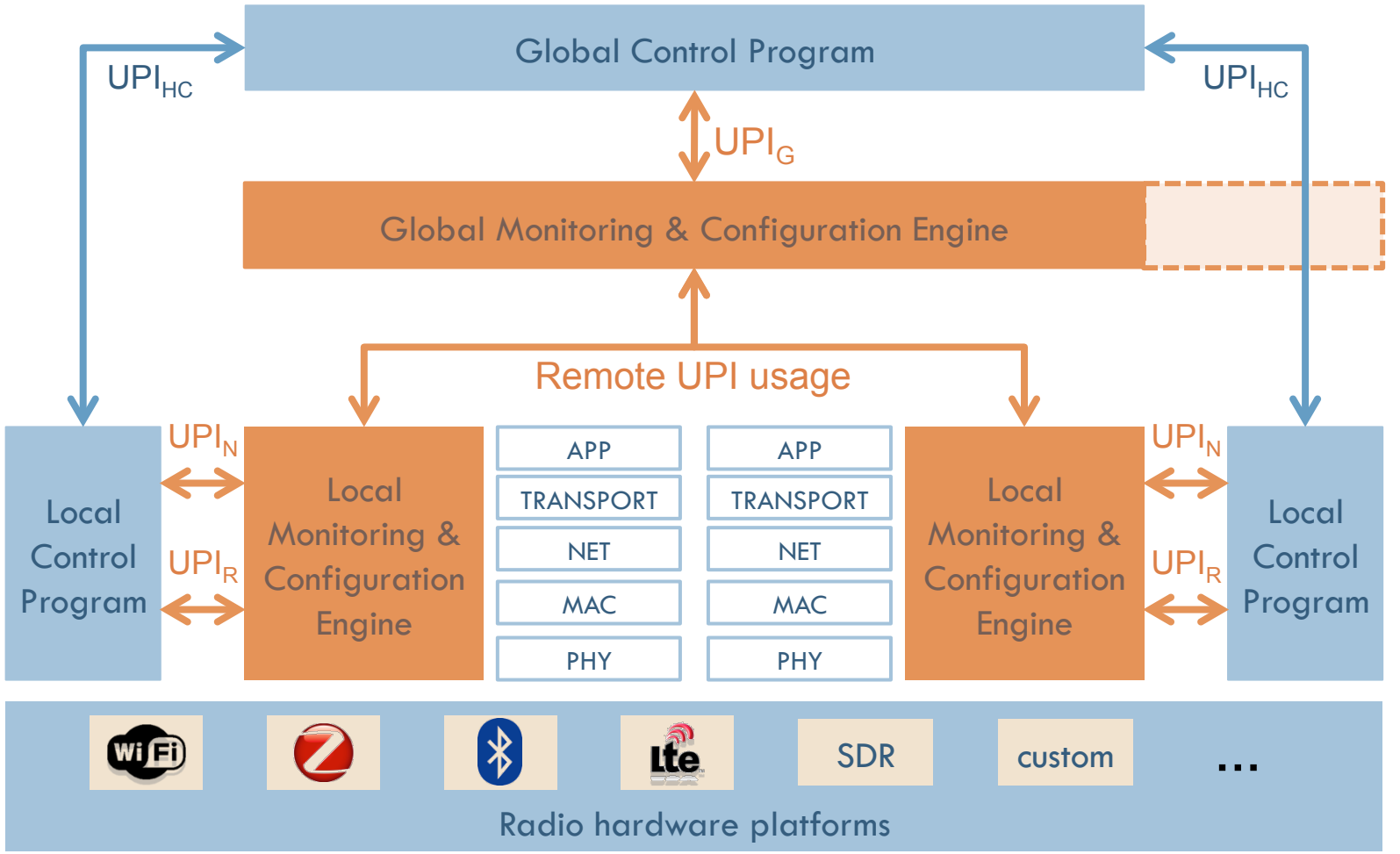


- WiSHFUL enables instantiation of multiple virtual RF front-ends in a single SDR hardware platform

WiSHFUL

GENERAL ARCHITECTURE FOR RADIO AND NETWORK CONTROL

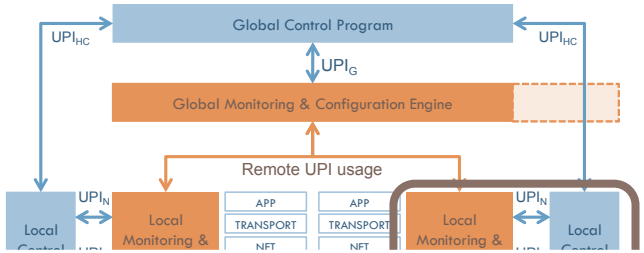
WiSHFUL Software Architecture



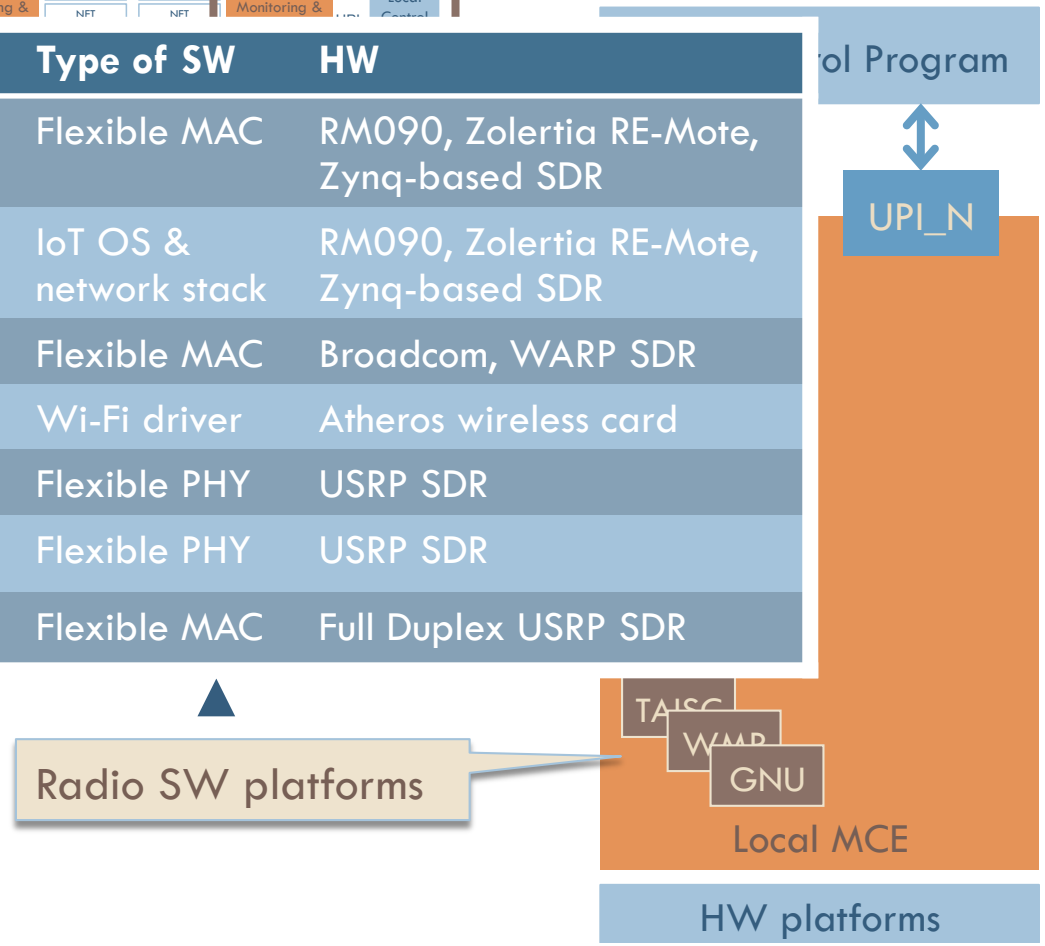
Device specific (HW & SW platform), implemented by WiSHFUL

Device independent (within device class), implemented by experimenter

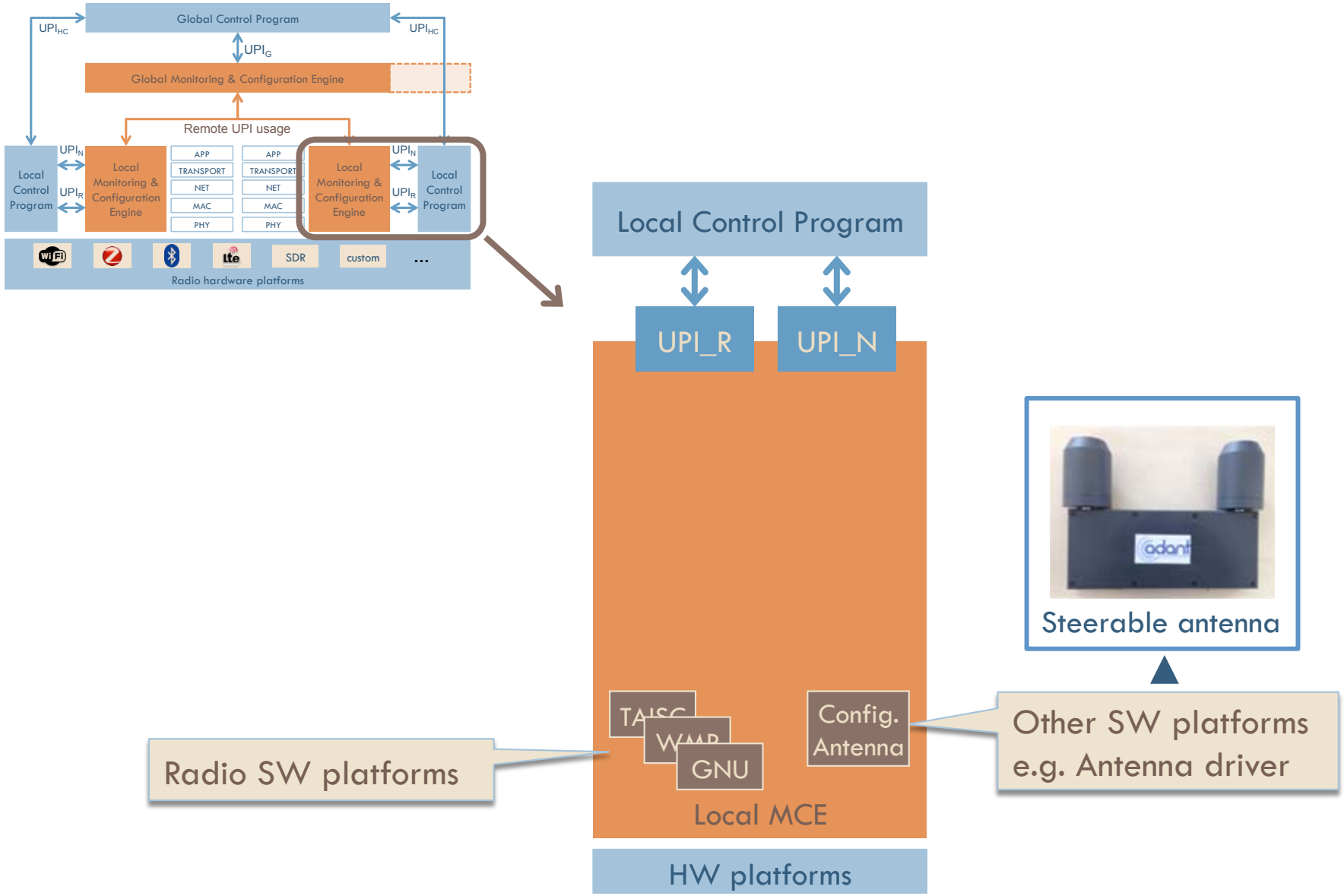
WiSHFUL SW Architecture demystified



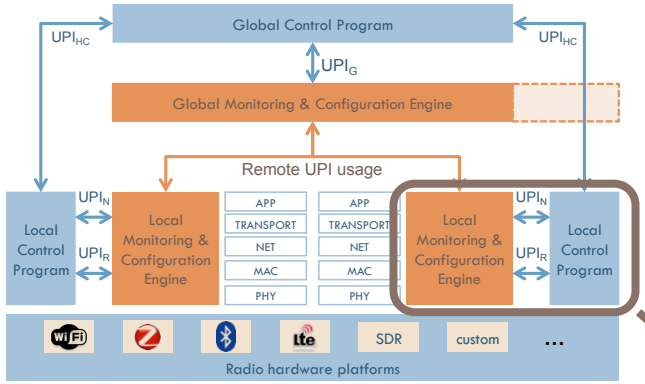
SW platform	Type of SW	HW
TAISC	Flexible MAC	RM090, Zolertia RE-Mote, Zynq-based SDR
Contiki	IoT OS & network stack	RM090, Zolertia RE-Mote, Zynq-based SDR
WMP	Flexible MAC	Broadcom, WARP SDR
Linux	Wi-Fi driver	Atheros wireless card
IRIS	Flexible PHY	USRP SDR
GNU	Flexible PHY	USRP SDR
Labview	Flexible MAC	Full Duplex USRP SDR

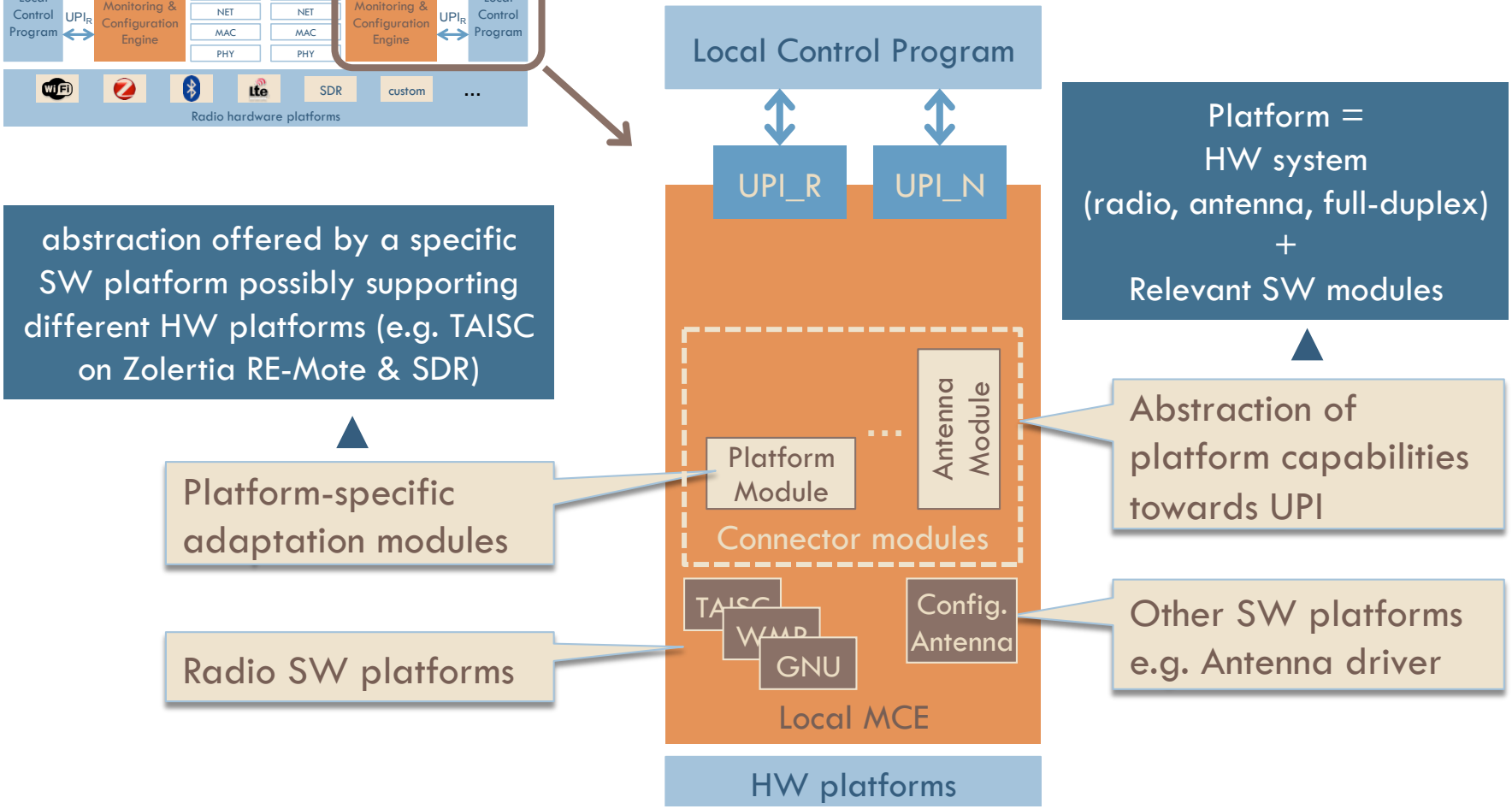


WiSHFUL SW Architecture demystified

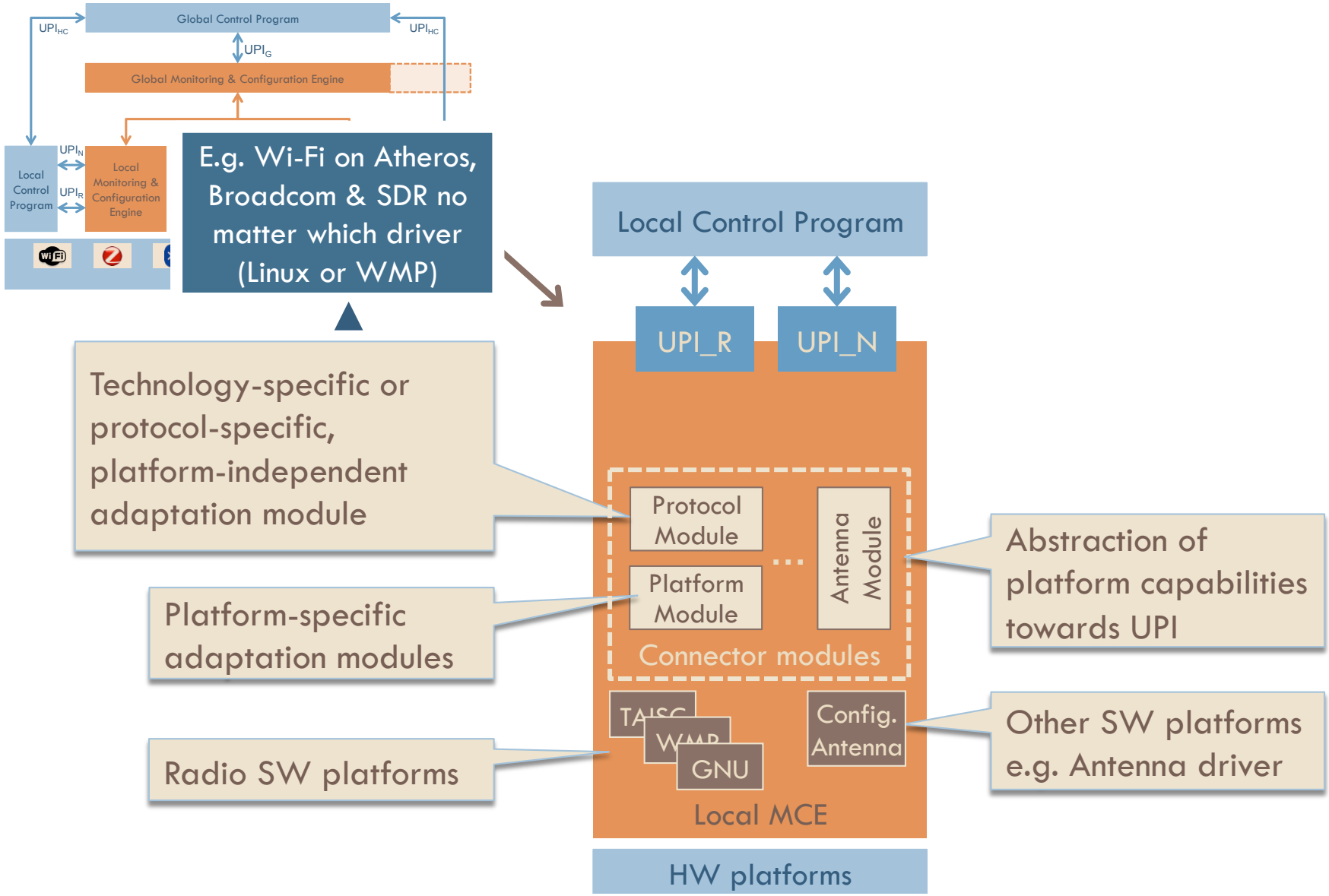


WiSHFUL SW Architecture demystified

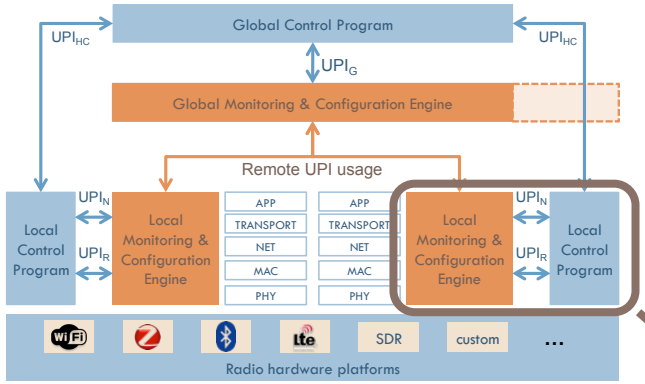


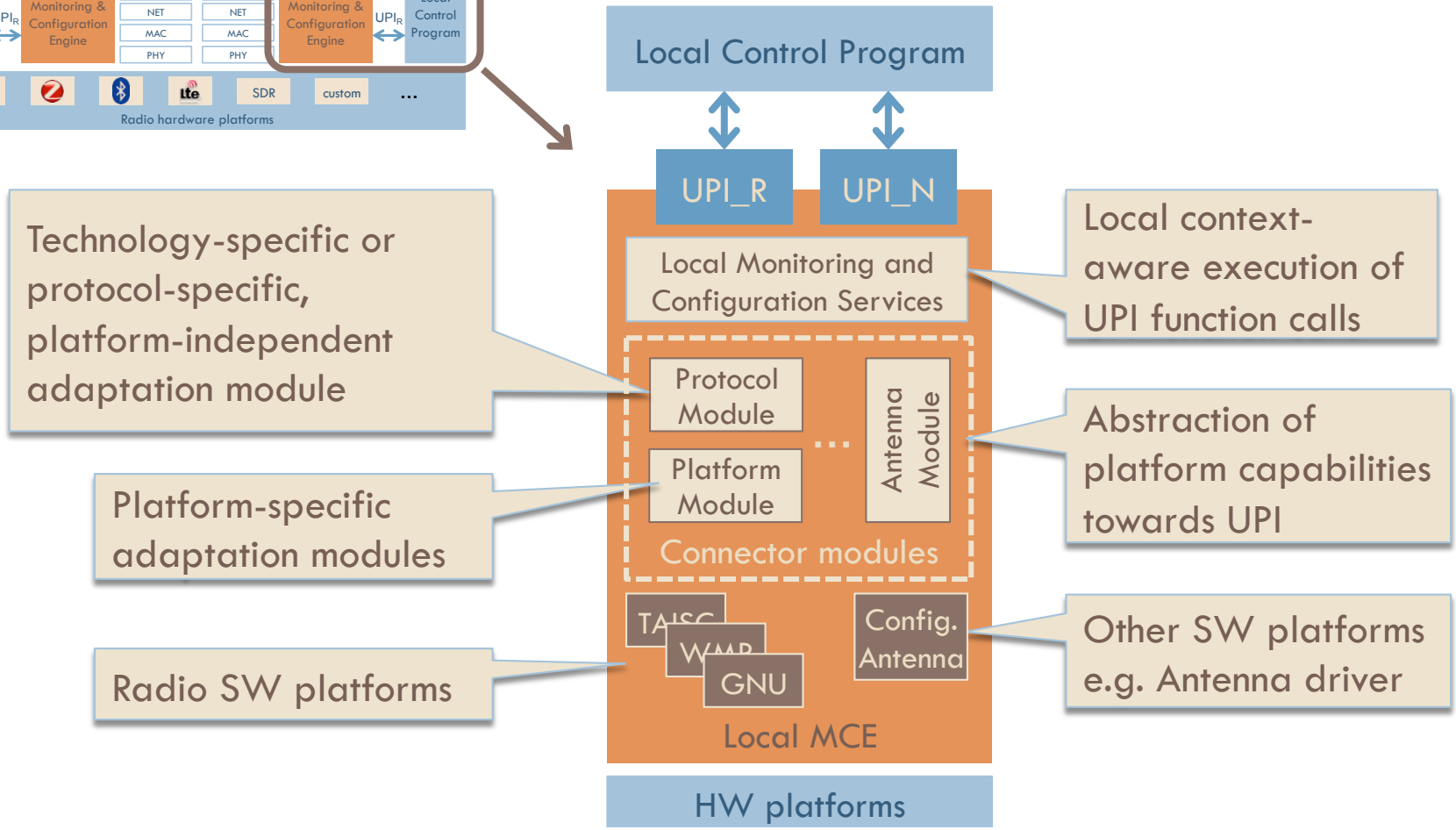


WiSHFUL SW Architecture demystified

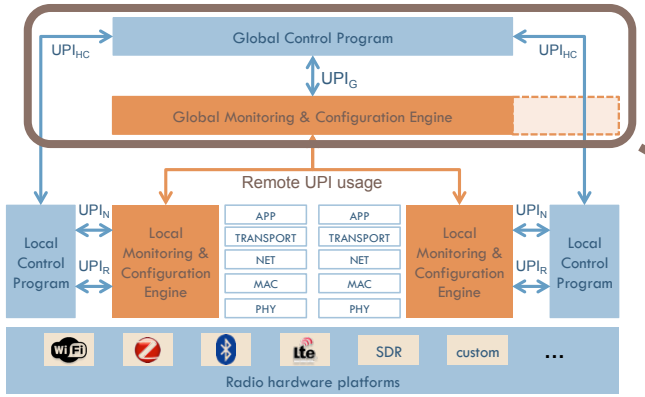


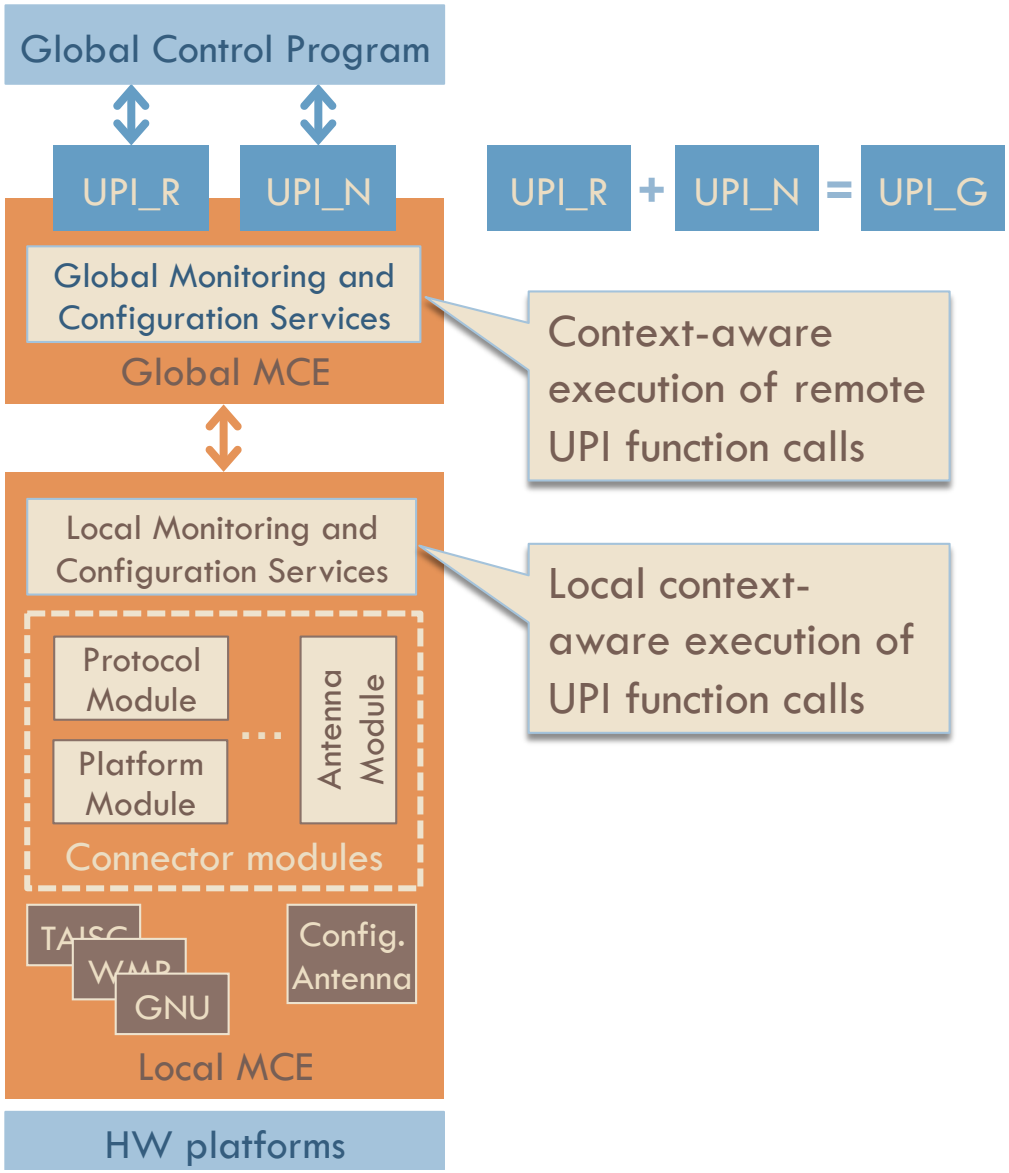
WiSHFUL SW Architecture demystified





WiSHFUL SW Architecture demystified





UPI_R + UPI_N = UPI_G

CONTEXT =

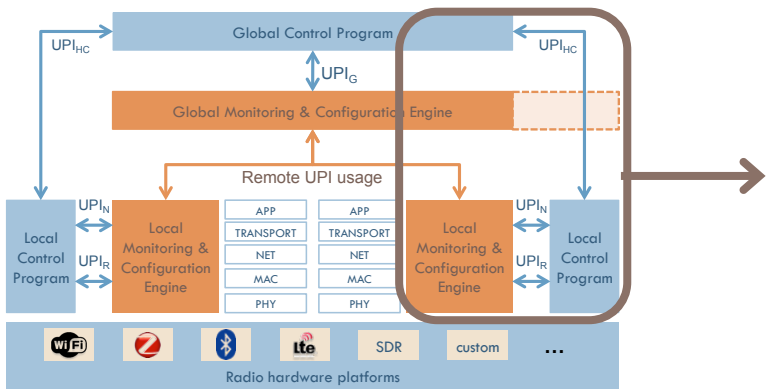
WHAT?
which UPI call(s)

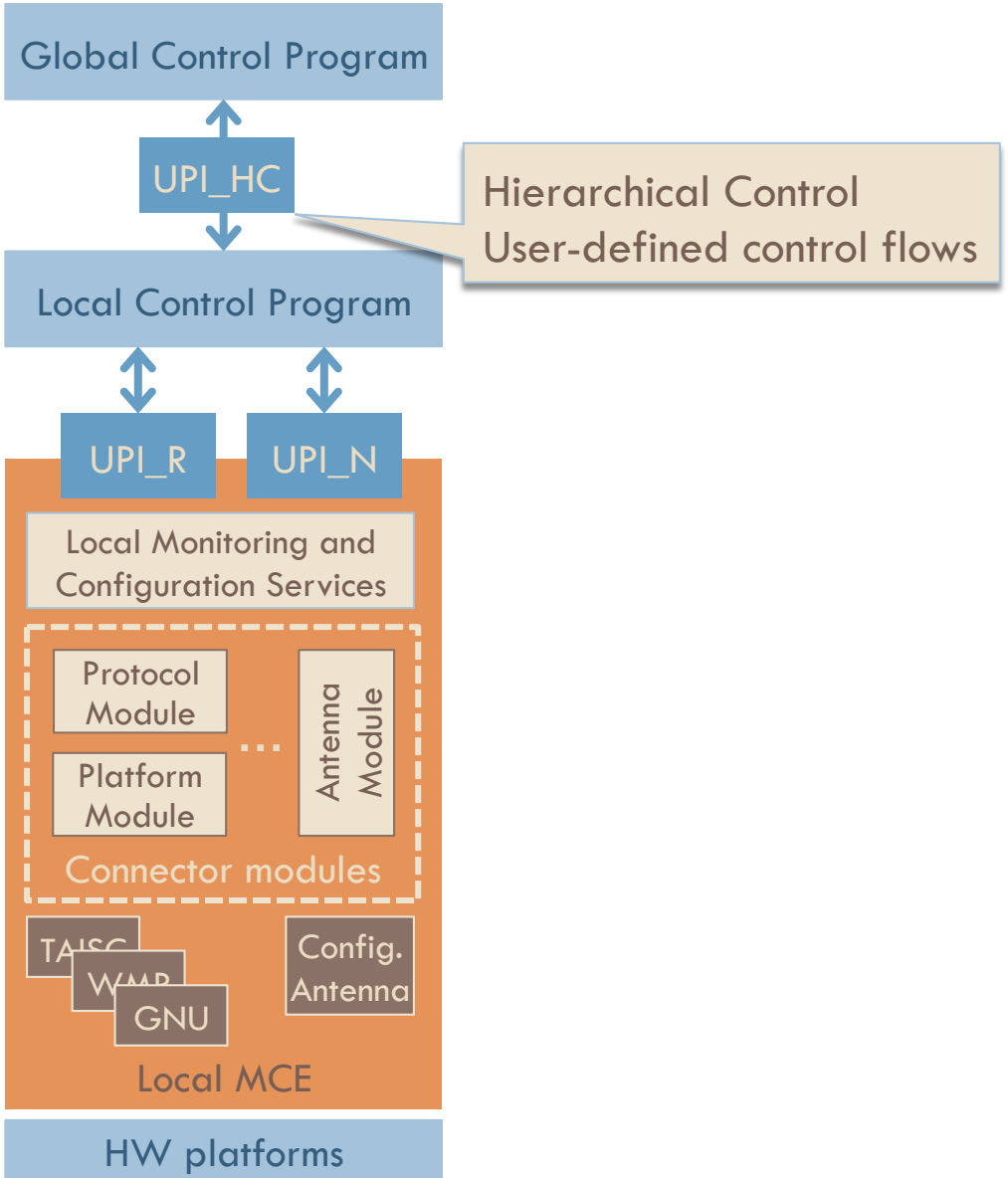
WHERE?
which nodes & interfaces

WHEN?
time-scheduled, delayed

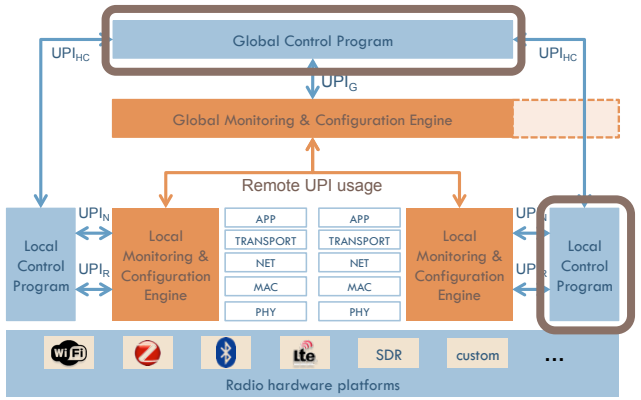
HOW?
blocking, non-blocking

WiSHFUL SW Architecture demystified





WiSHFUL SW Architecture demystified



Take decisions on network and radio settings

Global/Local Control Program

Decision

State

Action

Build up view on radio environment and network state by collecting monitoring information

Execute decisions

UPI_R

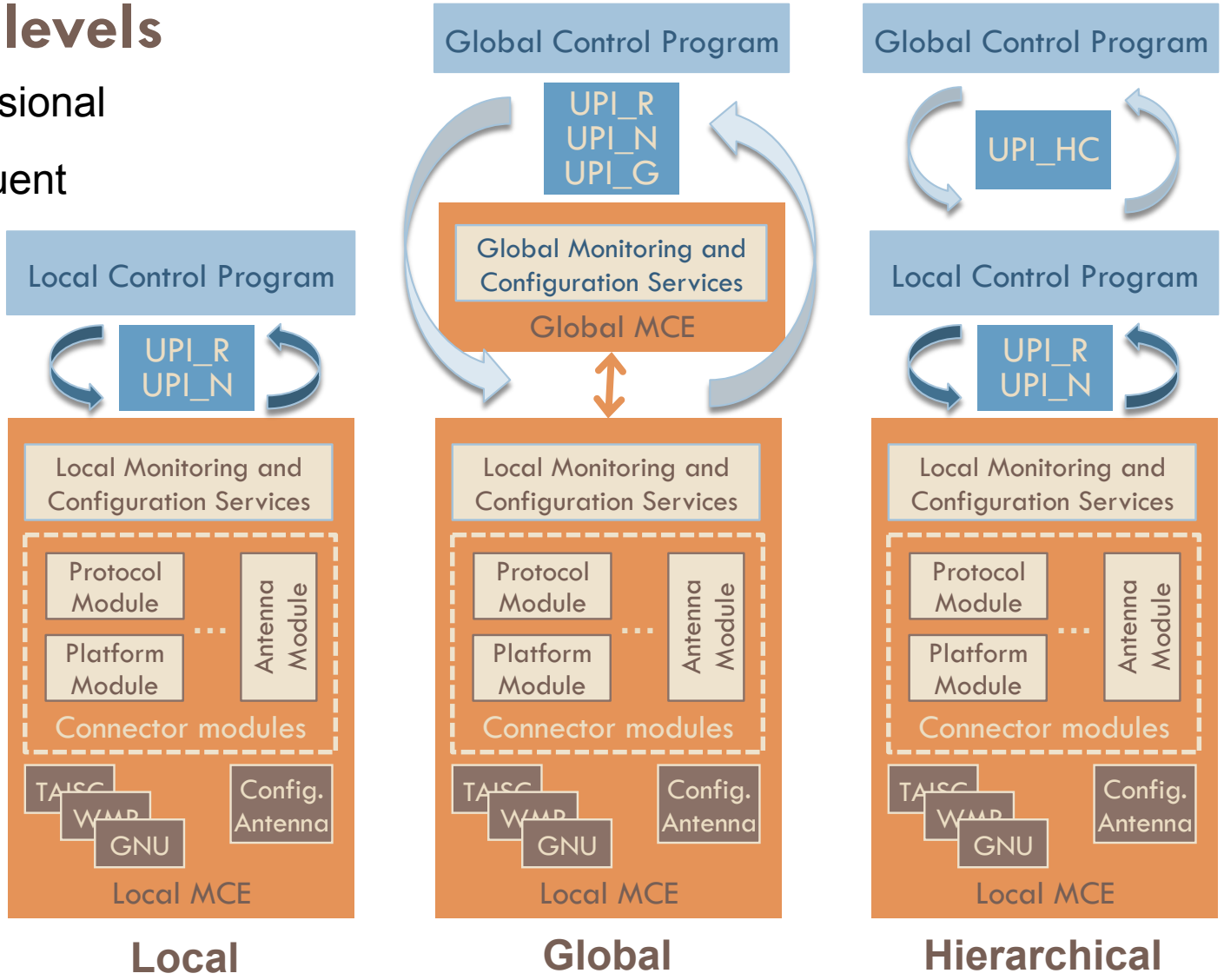
UPI_N

WiSHFUL SW Architecture demystified

Control levels

Occasional

Frequent

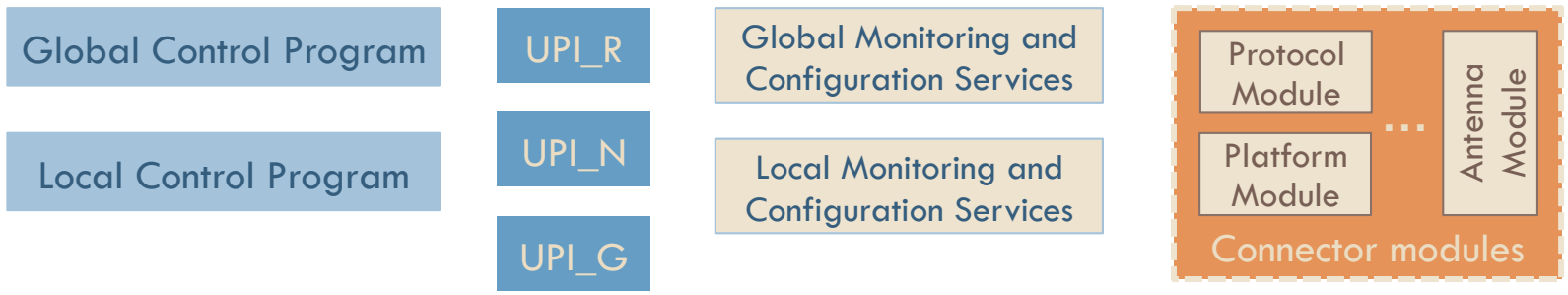


WiSHFUL SW Architecture demystified

WiSHFUL CONTROL FRAMEWORK

=

Control Program(s) + UPIs + M&C services + connector modules



Supported platforms by WiSHFUL

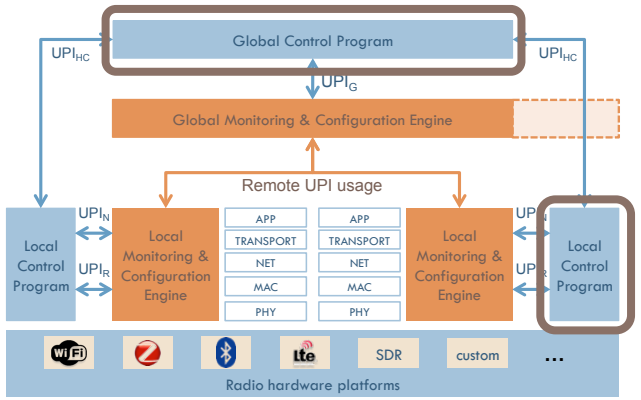
[platform = hardware system + software platform]

TAISC | WMP | Atheros 9K | GNU | IRIS | Config. Antenna | Full-Duplex MAC

WISHFUL

ARCHITECTURE FOR INTELLIGENT RADIO AND NETWORK CONTROL

WiSHFUL SW Architecture + Intelligence



Smart data analysis
= intelligent optimisation + machine learning techniques

Global/Local Control Program

Application API

Decision

State

Action

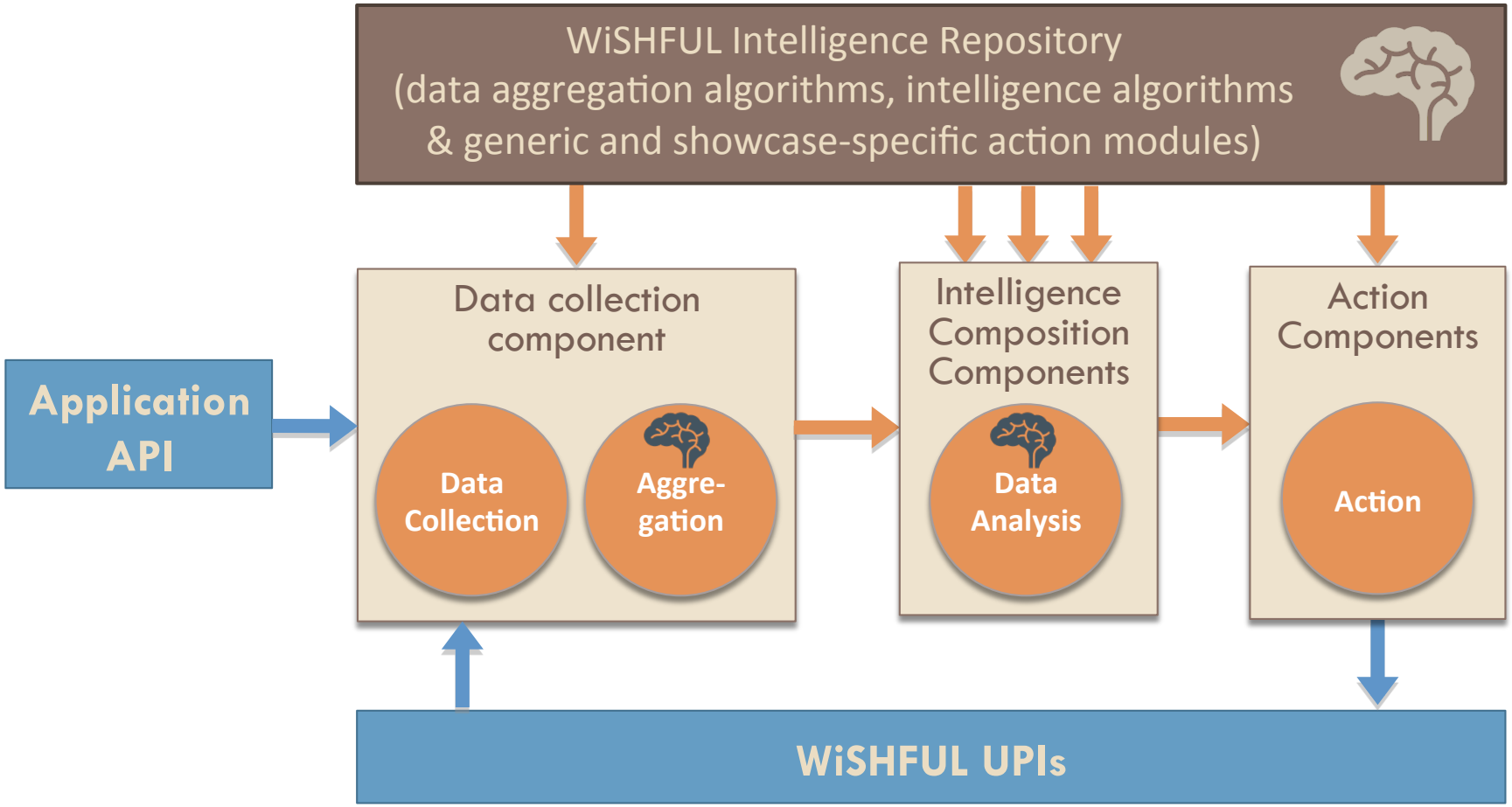
Execution of intelligent decisions using UPI function calls

Collect data about radio & network operation via UPIs, and application requirements
+
Smart data aggregation

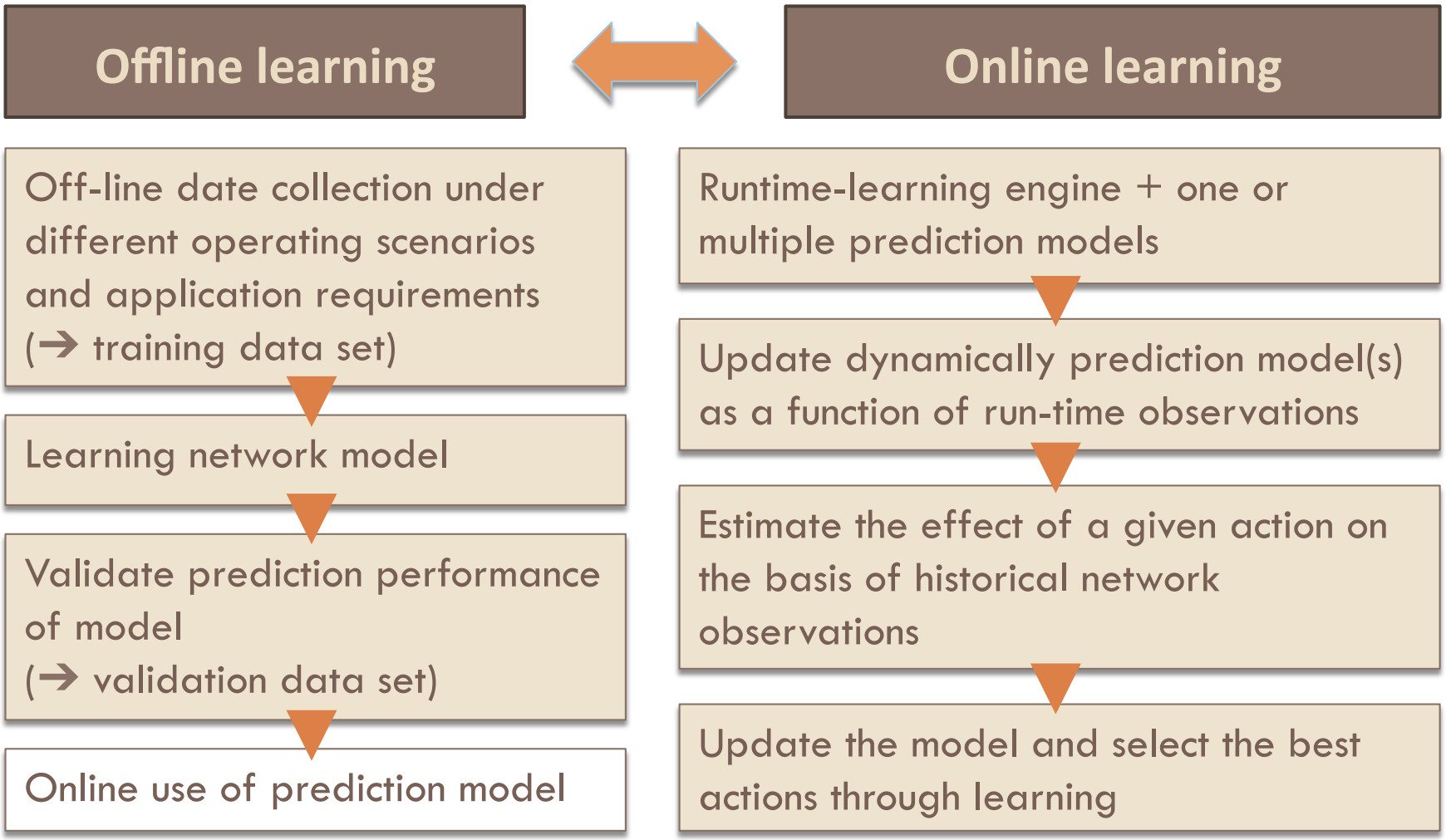
UPI_R

UPI_N

Intelligence Framework

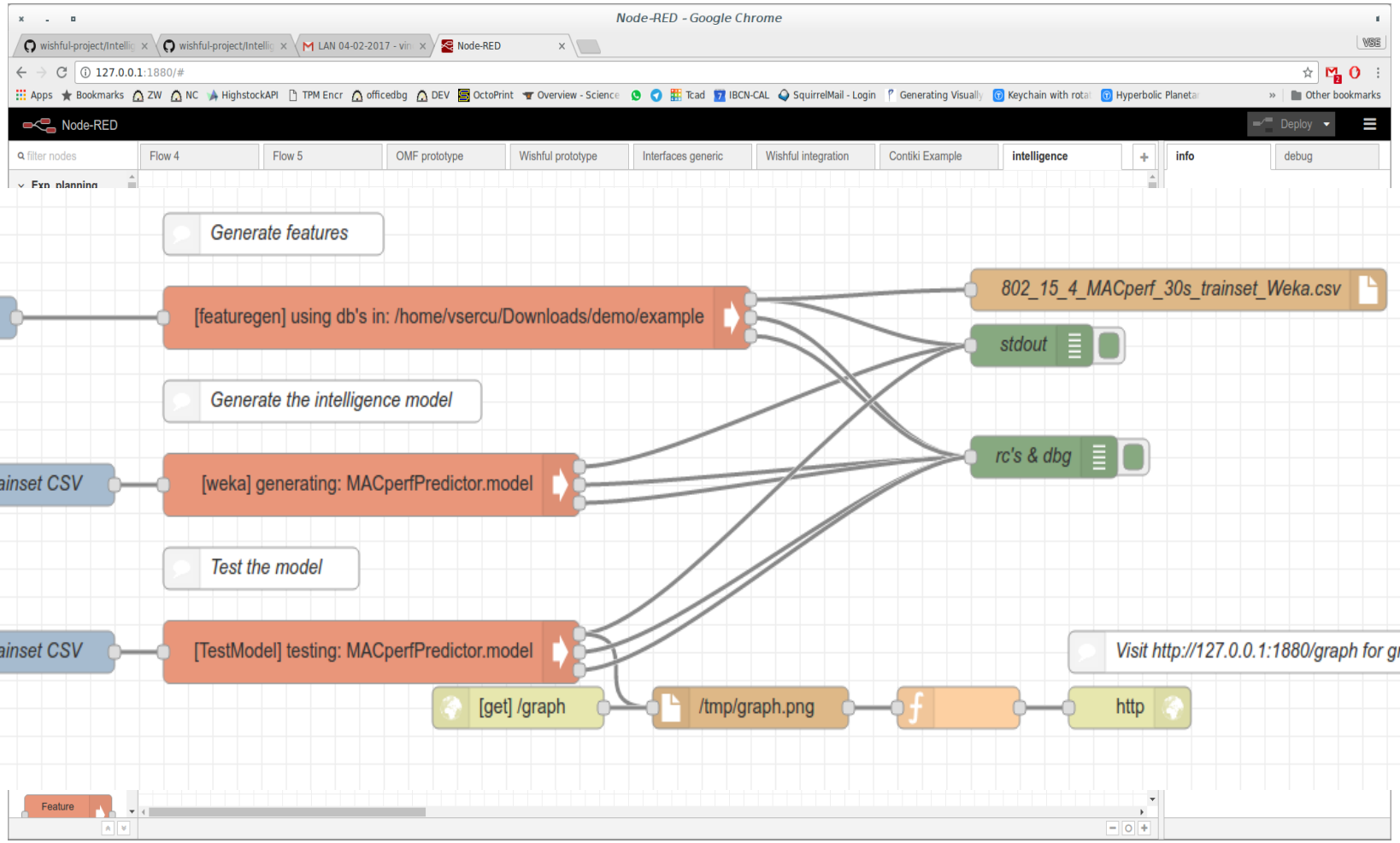


Intelligence approaches



Intelligence framework

Process flow in intuitive Node-RED front-end

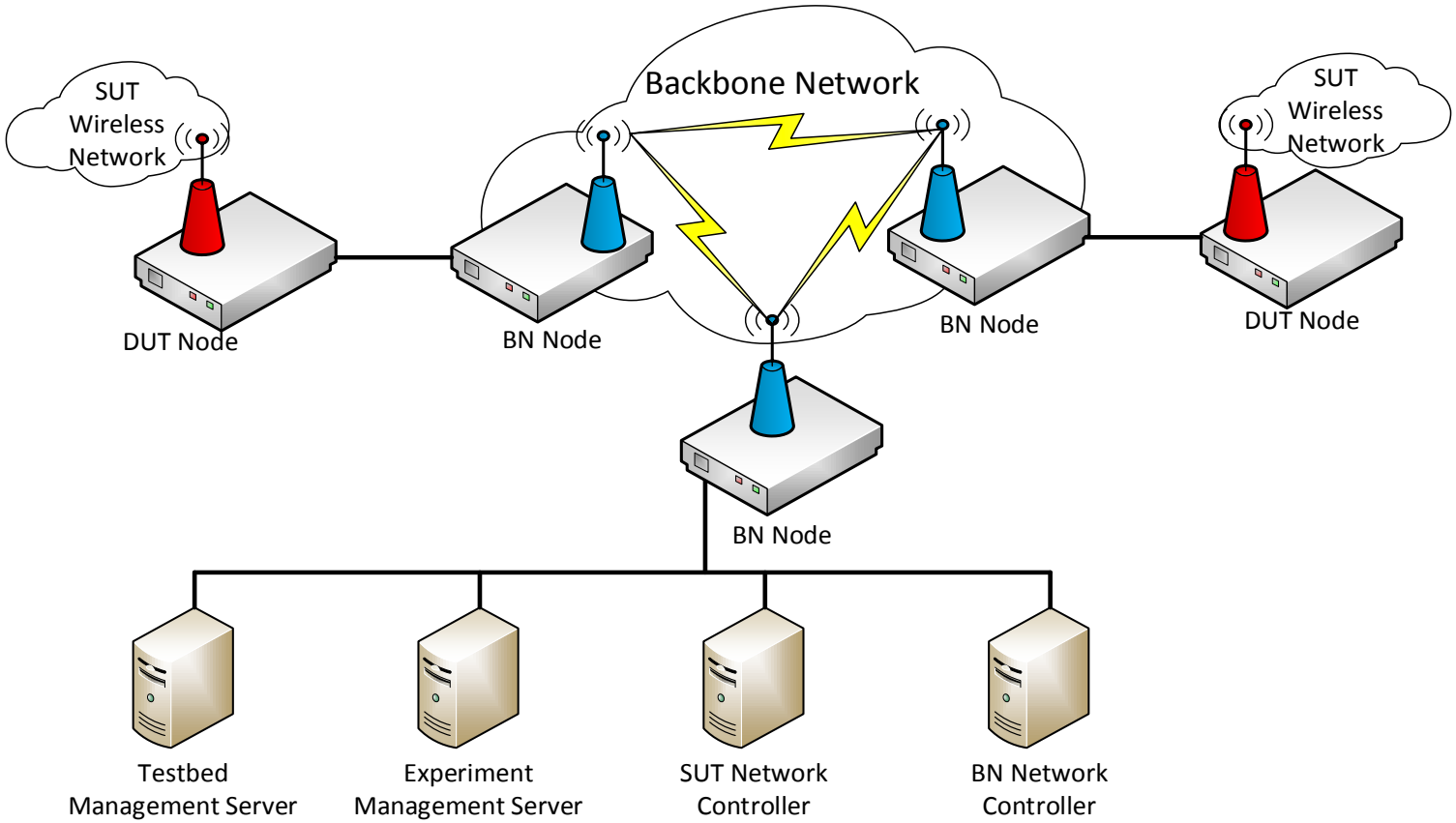


WISHFUL

PORTABLE TESTBED

Portable testbed architecture

- deploy compact testbed at any location
- replace wired backbone by wireless backbone
- same experiment control features as fixed FIRE test facilities



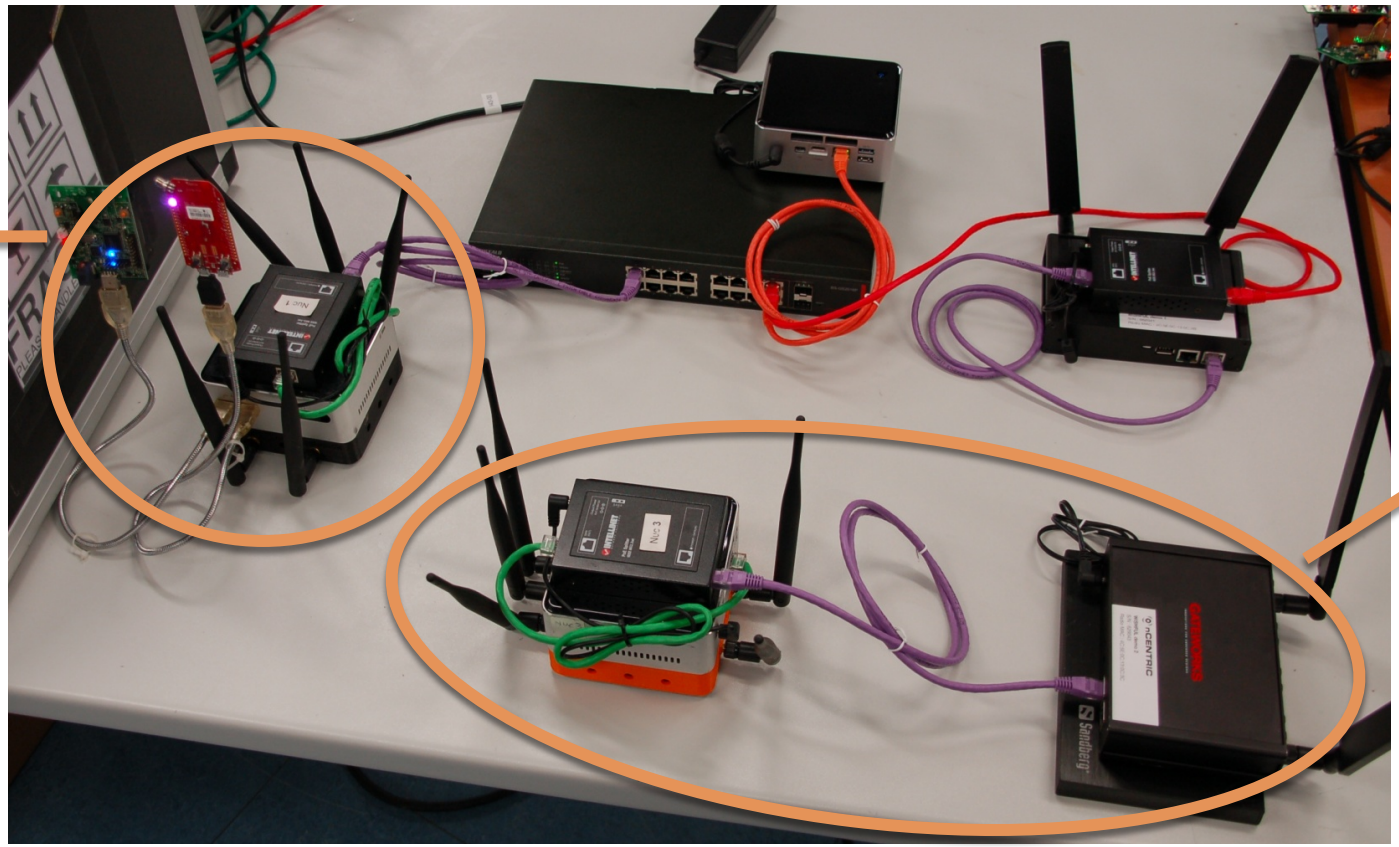
Portable testbed – Release 1

- First release

Portable Testbed - Release 2

WiSHFUL

- Integrated solution
  - Multiple power options: AC / PoE / Battery
  - Backbone: wired / wireless



WISHFUL

How to use UPIs?

How to use UPIs

- See https://wishful-project.github.io/wishful_upis/

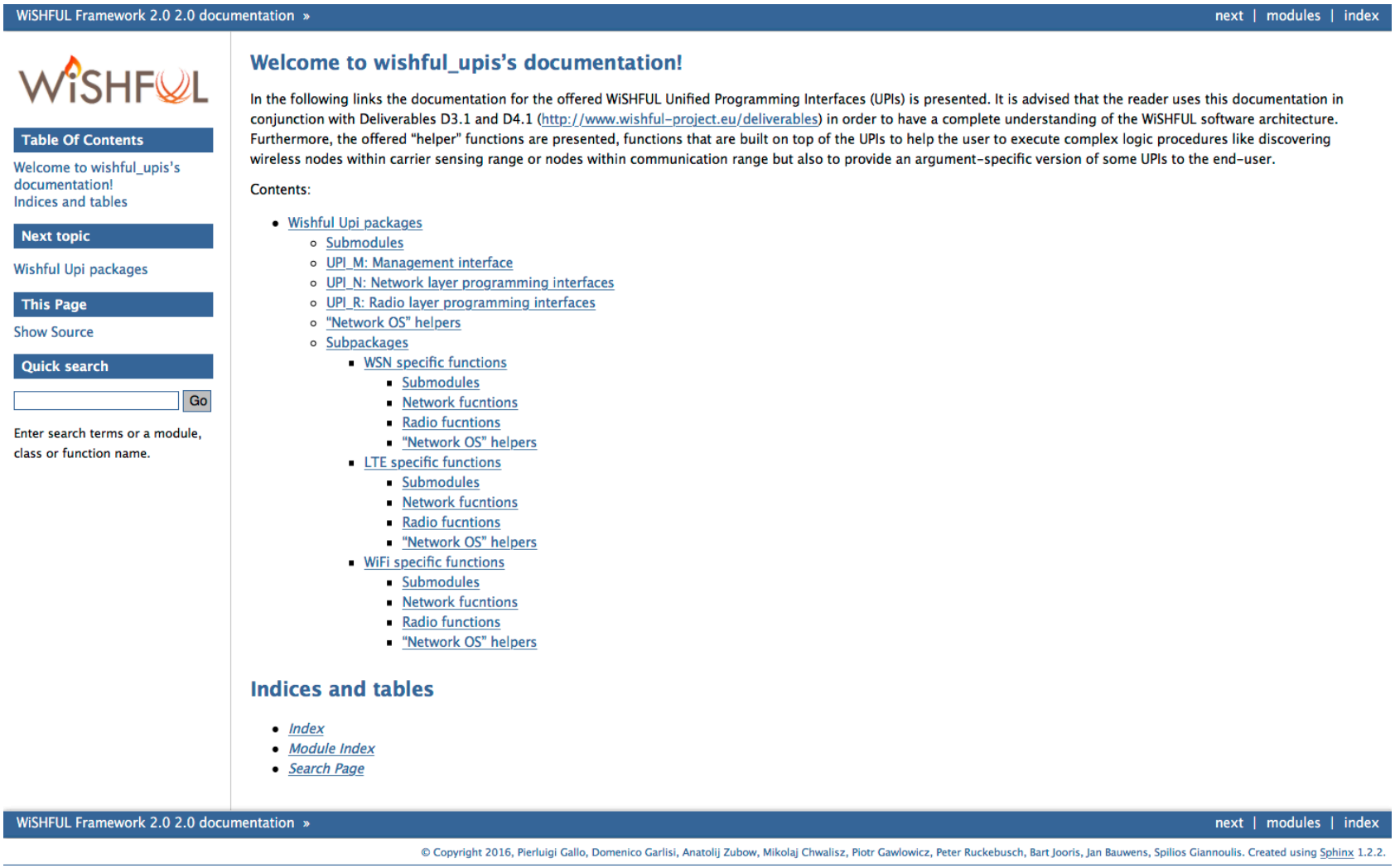


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Table Of Contents

Welcome to wishful_upis's documentation!
Indices and tables

Next topic

Wishful Upi packages

This Page

Show Source

Quick search

Go

Enter search terms or a module, class or function name.

Welcome to wishful_upis's documentation!

In the following links the documentation for the offered WiSHFUL Unified Programming Interfaces (UPIs) is presented. It is advised that the reader uses this documentation in conjunction with Deliverables D3.1 and D4.1 (http://www.wishful-project.eu/deliverables) in order to have a complete understanding of the WiSHFUL software architecture. Furthermore, the offered "helper" functions are presented, functions that are built on top of the UPIs to help the user to execute complex logic procedures like discovering wireless nodes within carrier sensing range or nodes within communication range but also to provide an argument-specific version of some UPIs to the end-user.

Contents:

- Wishful Upi packages
  - Submodules
  - UPI_M: Management interface
  - UPI_N: Network layer programming interfaces
  - UPI_R: Radio layer programming interfaces
  - "Network OS" helpers
  - Subpackages
    - WSN specific functions
      - Submodules
      - Network fucntions
      - Radio fucntions
      - "Network OS" helpers
    - LTE specific functions
      - Submodules
      - Network fucntions
      - Radio fucntions
      - "Network OS" helpers
    - WiFi specific functions
      - Submodules
      - Network fucntions
      - Radio functions
      - "Network OS" helpers

Indices and tables

- *Index*
- *Module Index*
- *Search Page*

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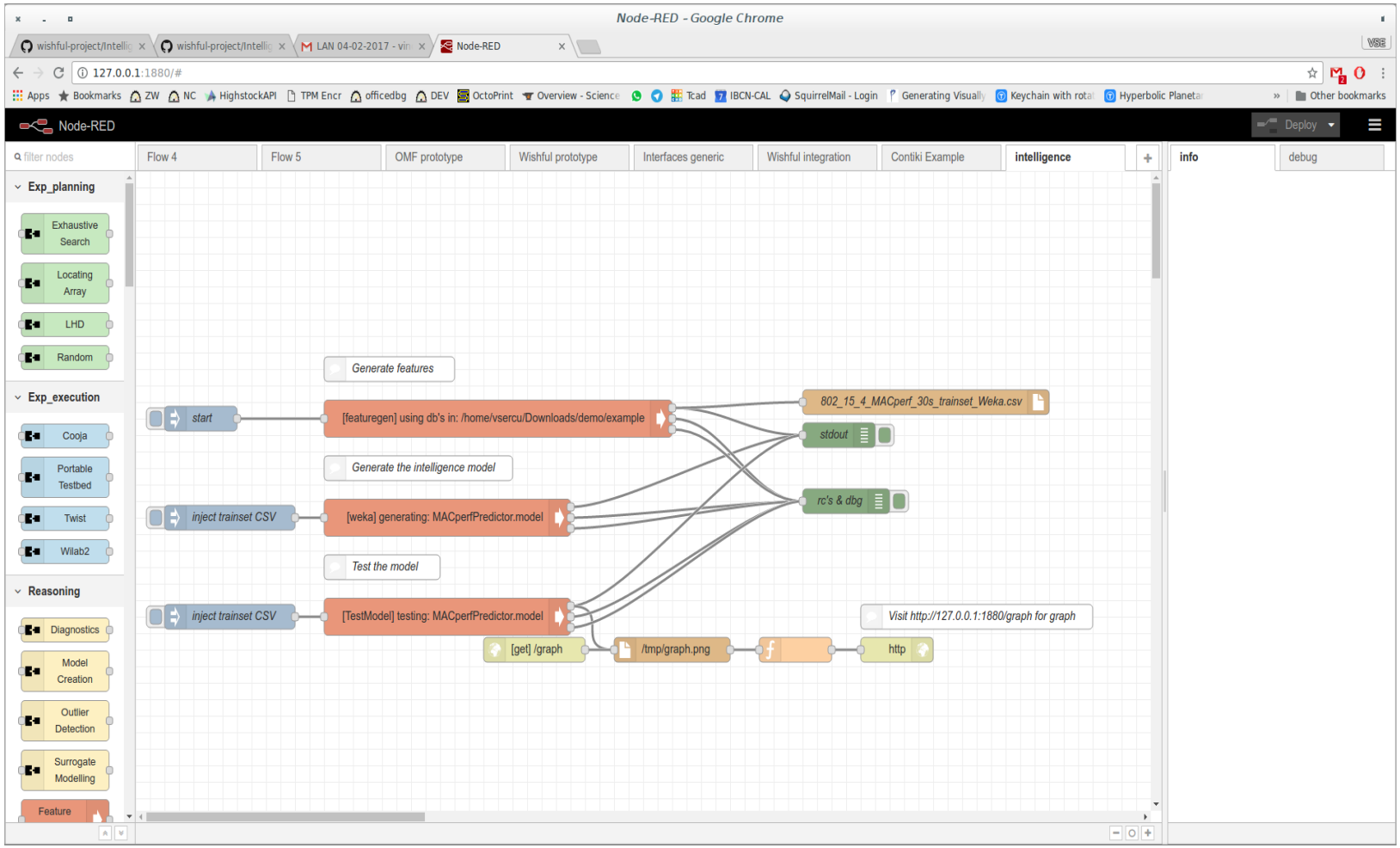
WISHFUL

How to use intelligence framework

How to use intelligence framework

Process flow in intuitive Node-RED front-end



WISHFUL

OPEN CALLS 5
FOR EXPERIMENTS

General Call Info

Project full name	WiSHFUL - Wireless Software and Hardware platforms for Flexible and Unified radio and network controL
Project grant agreement No.	645274
Call identifier	WiSHFUL-OC5
Call title	Fifth WiSHFUL Open Call for Experiments
Submission deadline	Monday 2 October 2017, at 17:00 Brussels local time
Feasibility check deadline	Monday 25 September 2017, at 17:00 Brussels local time

- Feasibility check
  - Discuss feasibility of experiment related specific requirements within the WiSHFUL supported test facilities
- Patron
  - Main contact person
  - Main WiSHFUL partner in charge of the testbed(s) or software platform(s) used in Experiment
  - Responsible for basic and advanced support to Experiment
  - Writes feedback on feasibility to be included in proposal

Financial information

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

- Funding mechanism: Third Party receiving financial support using Cascade Funding
- Inclusion to consortium via sub-agreement between WiSHFUL coordinator and Third Party (see Annex B)
- Simple payment process based on 2 invoices
  - 75% payment based on evaluation of final report
  - 25% payment after successful review by the European Commission (EC)

Requirements related to proposer

- Proposers must be eligible for participation in EC H2020 projects (according to standard EC H2020 guidelines)
- Proposals will only be accepted from a single party.
- 'Innovation by Industry'
  - only for small, medium and large size enterprises, including unipersonal companies and individuals
  - participation of SMEs and unipersonal companies is encouraged
- Only one proposal can be selected from the same proposer
  - In case of multiple highly-ranked proposals the proposer can choose the one to be retained for funding
  - Parties having been selected in previous WiSHFUL Open Calls cannot participate again
- The WiSHFUL project especially welcomes and stimulates the participation of new players

Scope of Open Call 5 (1)

- To validate advanced solutions for controlling wireless networks using the WiSHFUL software platforms and unified programming interfaces (UPIs), and using the test facilities and hardware supported by the WiSHFUL Consortium
- Software platforms:
  - see OC document
  - http://www.wishful-project.eu/software
- Facilities and hardware
  - see OC document
  - http://www.wishful-project.eu/testbeds

Scope of Open Call 5 (2)

- Focus on control of
  - radio
  - lower network layers
  - higher network layers
- Own showcases or build on top of existing showcases
  - See this presentation
  - http://www.wishful-project.eu/documents (results)
- Small extensions to UPIs or WiSHFUL platforms are possible
  - to be supported by Patron
  - NOTE: Extensions to WiSHFUL supported software platforms and UPIs are WiSHFUL foreground. Experimenters have no rights on WiSHFUL foreground.

Benefits for Experimenters

- **No need for deep technical knowledge** on radio hardware platforms or network protocol implementations, allowing the Experimenter to focus on advanced/intelligent control strategies for optimizing wireless network solutions
- **Easy access** to all the required wireless devices, wireless software platforms and intelligence components in different testbeds with a single account and unified Experimentation tools (cf. FED4FIRE/FED4FIREplus project)
- **Dedicated support** by skilled WiSHFUL members (through Patron)
- **Simplified application** (and reporting) **process** compared to standard H2020 calls
- **Rapid review process** (< 1 month) by independent external evaluators

Proposal template

Section	Title	Page limit
Section A	Summary (public)	max. 300 words
Section B	Detailed description and expected results	4-6 pages
Section C	Requested WiSHFUL software platforms, UPI interfaces, radio hardware platforms, testbeds	1 page (in addition to mandatory tables)
Section D	Compliance check	max. 1 page
Section E	Background and qualifications	max. 2 pages
Section F	Expected feedback to the WiSHFUL Consortium	max. 2 pages
Section G	Requested funding (1 page)	1 page
Section H	Use of proposal information	1 page
Section I	Involvement in FIRE-projects	

Evaluation criteria

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

EXC: criteria 7, 8, 9

IND: criteria 10, 11, 12

Reporting template

Part	Section	Title
Part A		Summary (public)
Part B		Detailed description
	B.1	B.1 Concept, Objectives, Set-up and Background
	B.2	B.2 Technical Results and Lessons learned
	B.3	B.3 Impact
Part C		Feedback to WiSHFUL
	C.1	Testbeds/Hardware/Software Resources & UPIs used
	C.2	Feedback on getting acquainted and using the testbeds offered in WiSHFUL
	C.3	Feedback on getting acquainted and using the WiSHFUL software frameworks and UPIs
	C.4	Feedback on the administration process of your proposal, Patron communication, and support received from the consortium
	C.5	Why WiSHFUL was useful?
	C.6	Other feedback
	C.7	Quote (public)
Part D		Leaflet (public)

Do's and Don'ts

- Select Patron and discuss initial idea
- Interact with Patron and, if needed, other WiSHFUL members
- Don't ask Patron to review proposal, only ask technical questions and questions related to feasibility
- Section B (Description of experiment)
  - be concise and to the point
  - no need to define WPs and separate deliverables
- Section C (Testbeds & SW/HW Platforms);
  - be specific on HW/SW platform requirements & UPIs (and parameters!) to be employed in your experiment
- Section D (Compliance check)
  - include feedback from Patron without any modification
  - if needed, response to feedback can be added
- Don't underestimate importance of section F (Feedback)
- Give clear answers to evaluation criteria
- All proposals must be submitted via submission portal

WISHFUL

TESTIMONIES

SENSEFUL: *"Wishful helped us execute a complex R&D project, integrating novel wireless technologies, in less than 6 months"*

- **SENSEFUL: *"SDN driven Joint Access Backhaul coordination for next generation dense Wi-Fi Small Cell networks via WiSHFUL APIs "***

- **Problem Statement:**
  - Dense deployment of low cost Small Cells based on Wi-Fi technology using wireless backhauling.
  - Coordination of access and backhaul resources

- **Used Wishful testbed and UPIs**
  - TWIST testbed at TU Berlin / UPIs: H-TDMA and AP initiated client handover

- **Main Benefits**
  - Speed-up deployment of our technology at scale
  - Easy integration of existing Wishful functions (Big AP from TU Berlin)

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CORAL
Cross-Layer Control of Data Flows

Coordinator: Lefteris Mamatas | Team: Tryfon Theodorou, George Violettas, Sofia Petridou, Polychronis Valsamas, Antonios Tsioukas

Softwarized & Wireless Networks Research Group

Experimentation of SDN-inspired capabilities aiming at improved QoE of users and QoS of applications over Internet of Things (IoT) devices

WiSHFUL enabling technologies for CORAL:

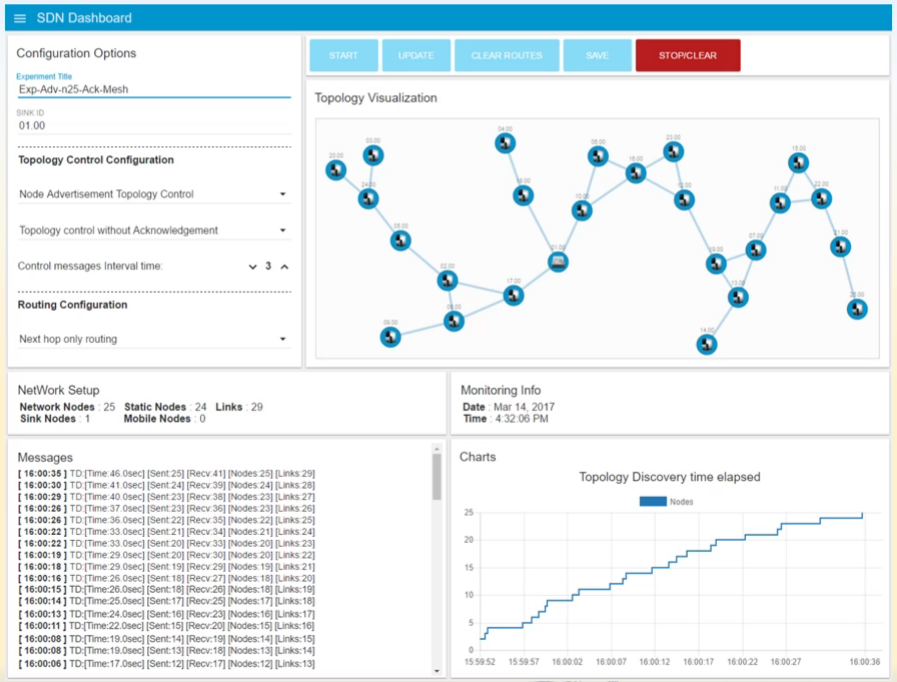
- radio- and network-control abstractions
- novel experimentation facilities
- heterogeneous wireless environments

CORAL novel features:

- bespoke protocol configurations per node
- efficient SDN-inspired communication strategies
- novel heterogeneity handling

Publications:

- "An Experimentation Facility Enabling Flexible Network Control for the Internet of Things," in *2017 IEEE Conference on Computer Communications (INFOCOM)*, Atlanta, 2017
- "Intelligent Network Control for the Internet of Things INTER-IOT", eWINE Grand Challenge 1st runner up award 2017



URL: http://swn.uom.gr

European Commission | Horizon 2020 European Union funding for Research & Innovation

WiSHFUL

Modio Computing SP

Expertise

Streaming analytics | Cloud provisioning | Machine learning

Customers

Rackspace | Rambus | Amadeus | Fortify | InternetQ

Experiment

Machine-learning assisted control of Wireless Sensor Networks

Why WiSHFUL?

Benefits

Reduced development effort by at least **2x**

Experiment portable to **multiple** wireless hardware

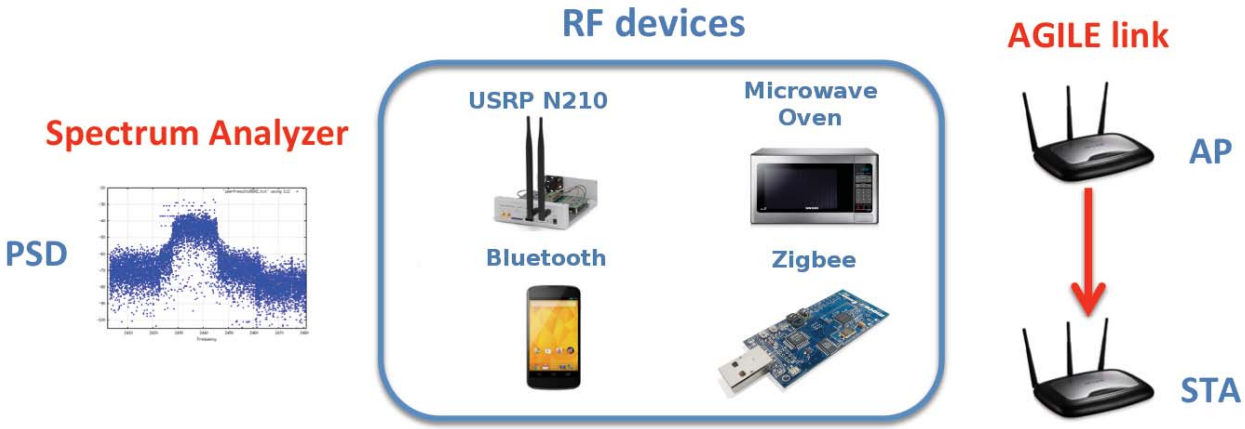
Potential

Speedup of IoT experimentation

Promotion of **hardware conformance** tests

Dr. Efstratios Keranidis

Enabling Agile Spectrum Adaptation in Commercial WLAN Deployments



Direct interaction between highly-expertised academic and industrial partners on top of the WiSHFUL platform enabled us to collect valuable feedback and ideas for improving our wireless networking solutions.

time for questions
WISHFUL