SEVENTH FRAMEWORK PROGRAMME

CREW WinnComm tutorial

1: Overview of the CREW project

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WinnComm 2012, Brussels

ibbt imec ctvr TU berlin TECHNISCHE UNIVERSITÄT DRESDEN THALES EADS IJS

Durham University TECHNISCHE UNIVERSITÄT ILMENAU tecnalia

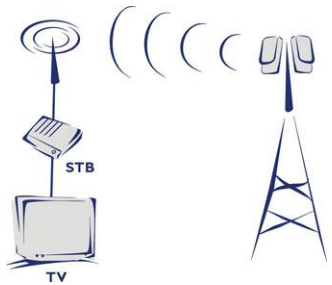
European Commission

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 258301 (CREW project).

Wireless developer's questions

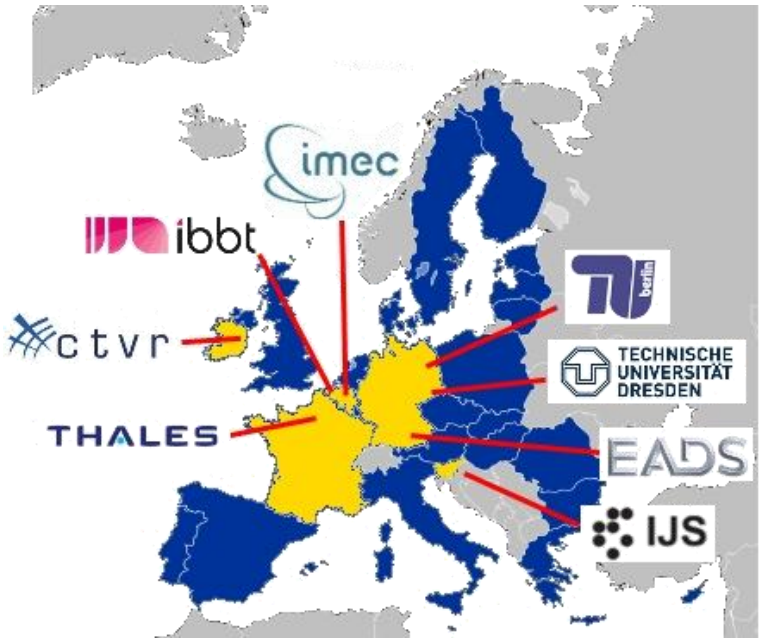
- **How to evaluate cognitive radio / cognitive networking solutions?**
  - … in a configurable environment
  - … in a repeatable way
  - … allowing fair comparison of results

- **Should/can I build my own testing environment?**



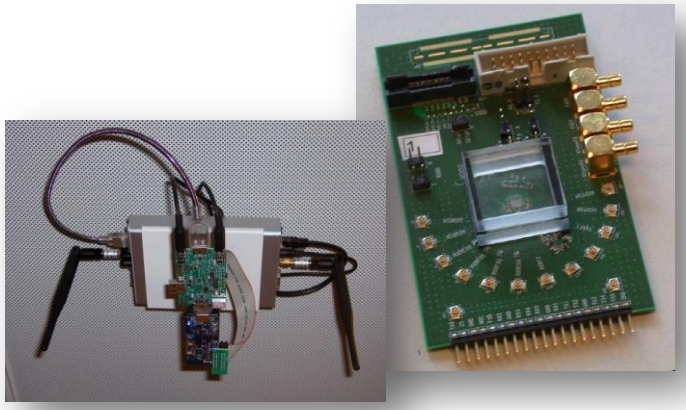
Answer: CREW

- **Cognitive Radio Experimentation World**
  - FP7 call 5
  - Project started October 2010
  - 8 core partners
  - 3 experimentation partners
  - www.crew-project.eu



Target: to establish an **open federated test platform**, facilitating experimentally-driven research on

- advanced spectrum sensing
- cognitive radio
- cognitive networking
- spectrum sharing
  in licensed and unlicensed bands



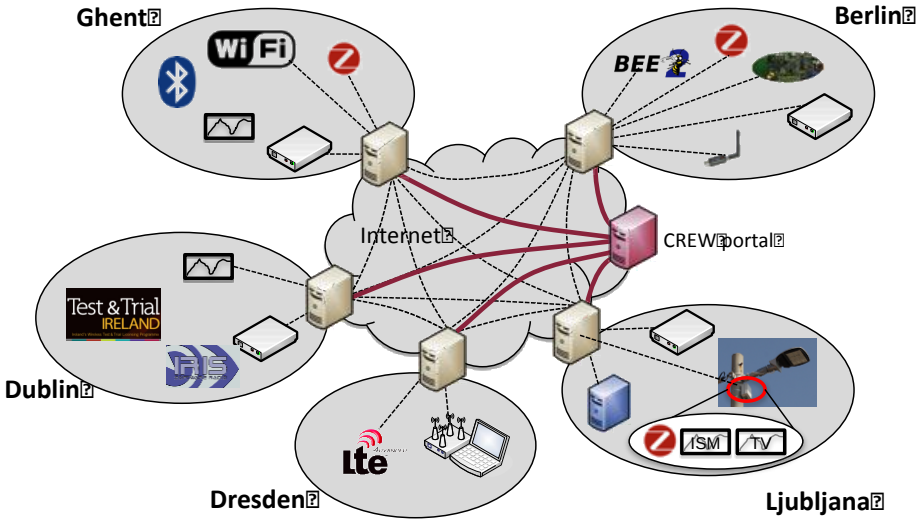
IP CREW: Target

- **CREW is …**
  - Bringing together test facilities for supporting research on spectrum, cognitive radio & cognitive networking
  - Augment facilities with novel cognitive components
  - Bringing together expertise on experimentation
  - Facilitating access to heterogeneous test facilities
  - Offering better methodologies for experimentation (repeatability, reproducibility, comparability)

- **CREW is NOT …**
  - Doing research on spectrum sensing, cognitive radio & cognitive networking
  - Design new algorithms

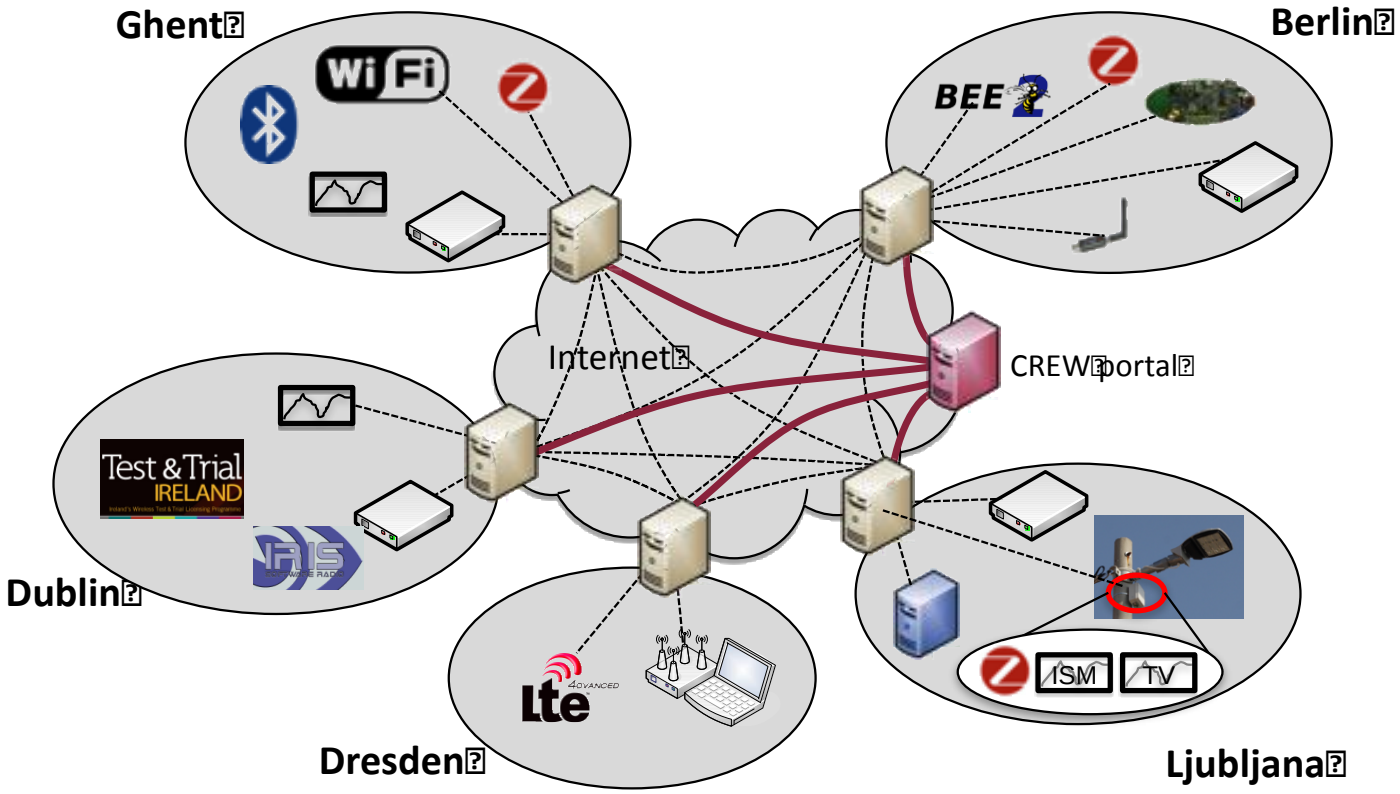
CREW platform

- Starting from **5** operational **wireless testbeds**
  - heterogeneous ISM
  - heterogeneous licensed
  - cellular
  - wireless sensor
  - outdoor heterogeneous ISM/TVWS
- augmented with State-of-the-Art cognitive sensing platforms



IEEE 802.11
IEEE 802.15.1
IEEE 802.15.4
LTE-advanced
EyesIFX nodes
CR database
IRIS GPP-based software radio platform
Comreg spectrum licenses
BEE2 FPGA platform
USRP software radio
Versatile Sensor Node on Light pole
imec Sensing Agent
UHF/VHF TV sensing
ISM bands sensing
THALES advanced sensing platform
WiSpy Spectrum analyzer
Interconnection of portals
Interconn. between testbed elements

CREW platform



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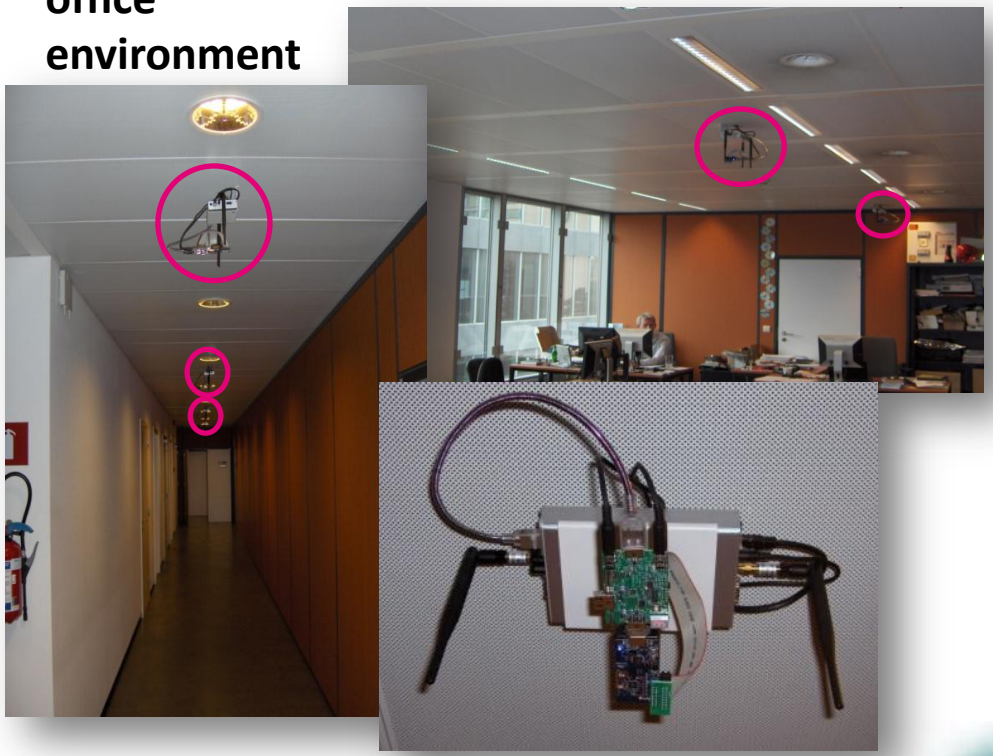
IBBT w-iLab.t

ibbt

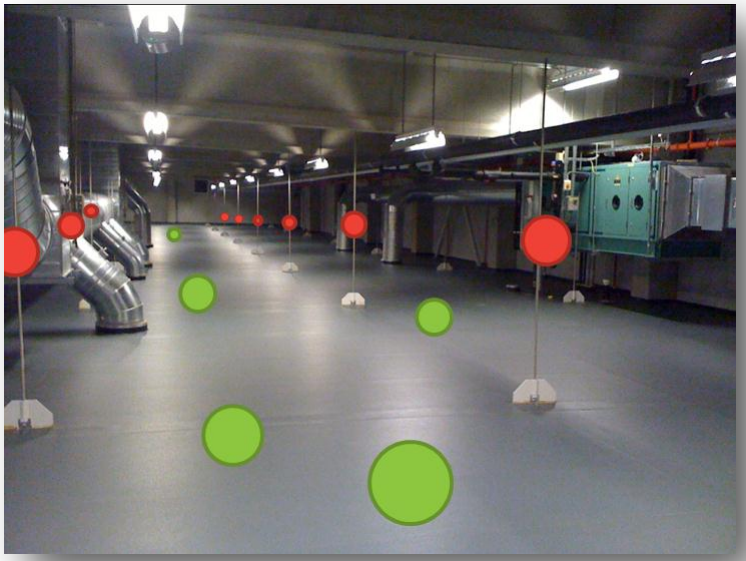
200 + 60 wireless nodes (WiFi/Zigbee/Bluetooth)

cognitive components: USRP, AirMagnet, imec sensing agent

office environment

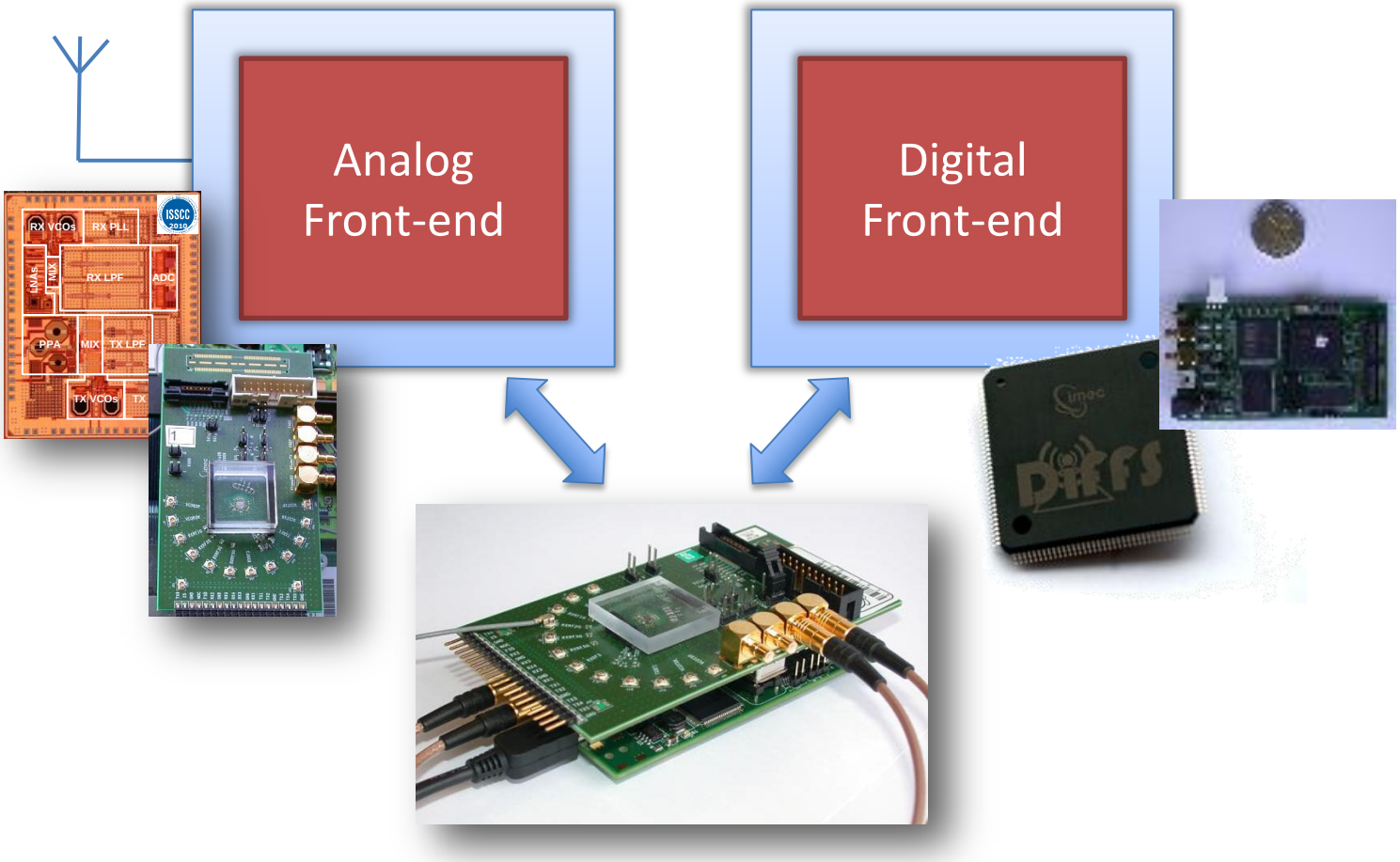


Pseudo-shielded environment



imec sensing agent

imec advanced spectrum sensing



Advanced spectrum sensing

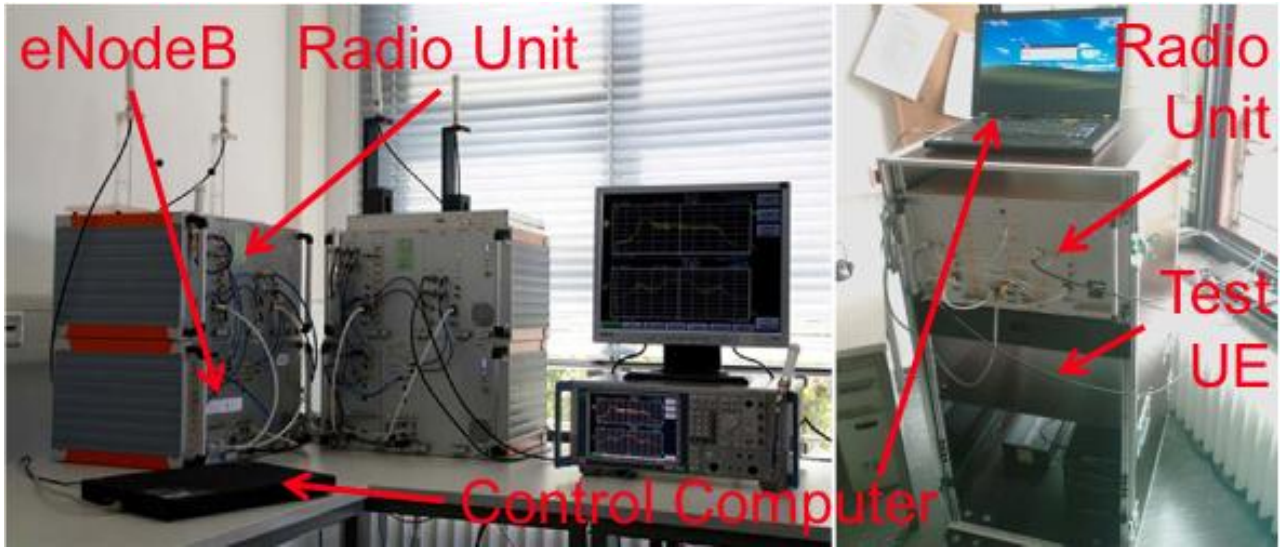
Combination of analog & digital FE in compact device

TU Berlin TWIST testbed

204 +16 wireless sensor nodes (Tmote Sky/EyesIFXv2/Shimmer2)
cognitive components: Wi-Spy, BEE 2 FPGA platform

TU Dresden - LTE advanced testbed

TECHNISCHE UNIVERSITÄT DRESDEN



Signalion SORBAS (3 eNodeB + 3 UE)
Signalion HALO 430 SDR equipment
Indoor & outdoor
LTE license

IRIS reconfigurable radio - Dublin

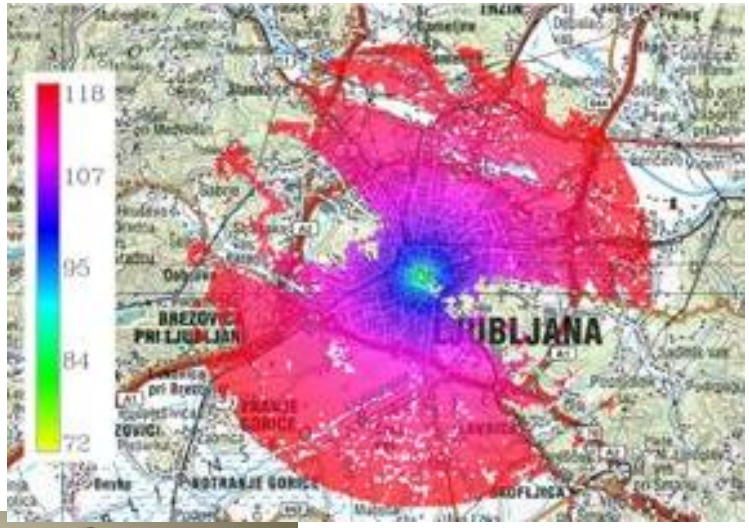
ctvr

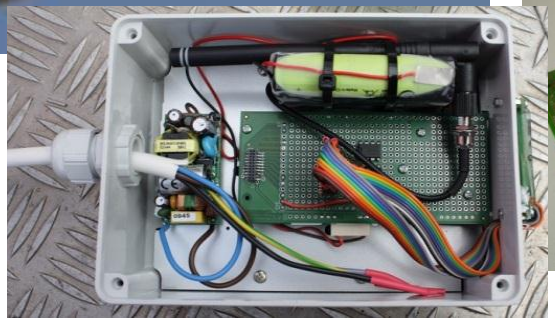
4 IRIS reconfigurable cognitive radio platforms + 4 USRP

TV-bands license

Outdoor VSN - testbed

IJS



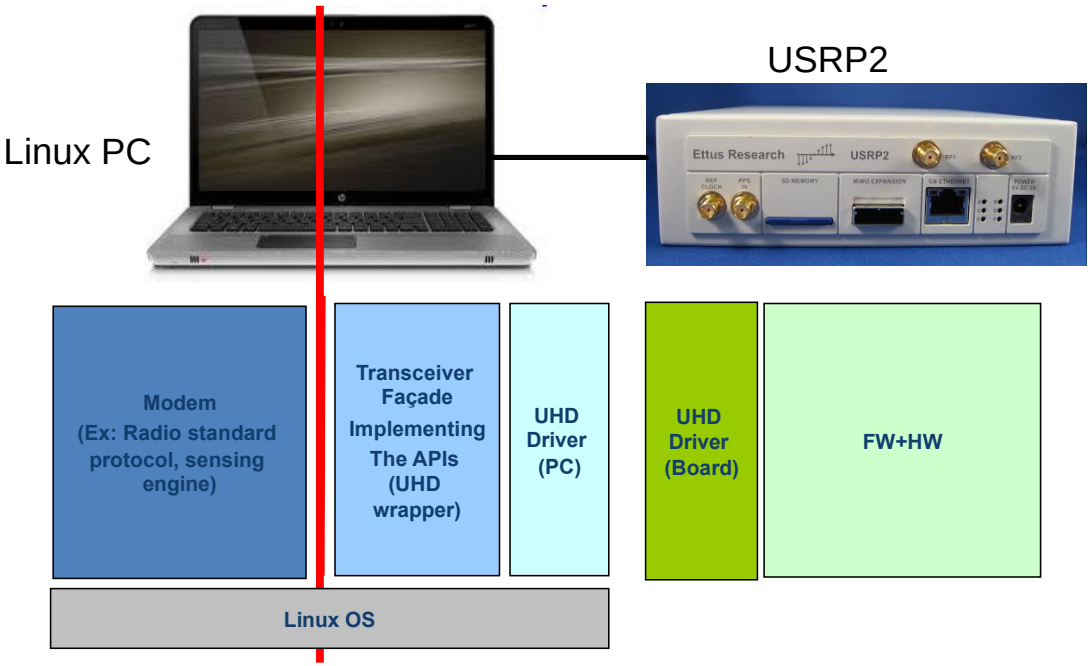


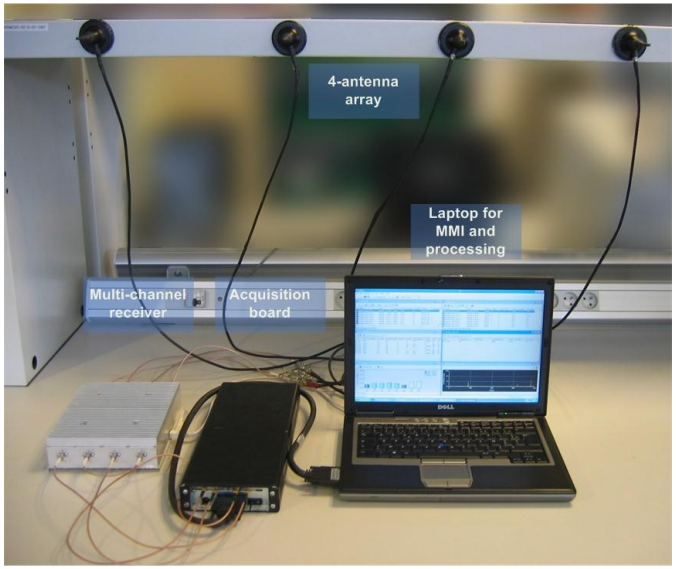
25 outdoor versatile sensor nodes

GRASS RaPlaT open source radio-planning tool

CREW federated platform: key aspects

THALES





Transceiver API for SDR architecture (compliant to WINNF)

Multi-antenna LTE detection

Industrial partners

EADS

EADS is a global leader in aerospace, defense and related services and will implement an aeronautics use case.

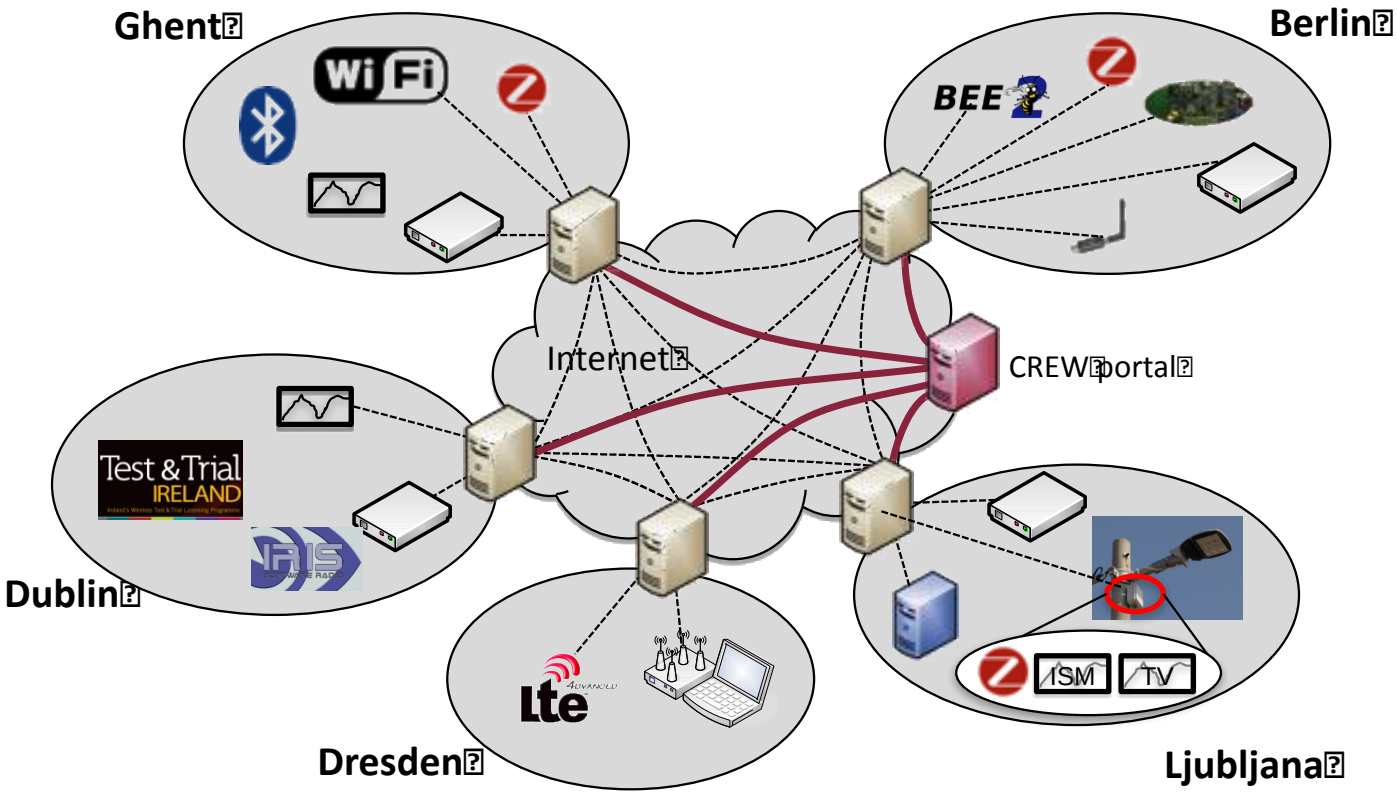
CREW Federated platform: key aspects

- **common portal**
  - comprehensive **description** of the individual testbeds
  - **guidelines** on how to access and use the federated testbed
- **novel cognitive components**
  - **relocation** of components
  - **linking together** software and hardware **entities** from the different partners
  - **standardized API** for SDR architectures (developed within WINNF)
- **creation of open data sets**

  a **common data structure** enables the emulation of CREW components in other experimental environments or in a simulator
- **benchmarking framework**
  - enabling experiments under controlled and **reproducible test conditions**
  - offering **automated procedures** for experiments and performance evaluation
  - allowing **fair comparison**
- **2 open calls**
  - More info: http://www.crew-project.eu/opencallinfo

CREW federated platform: key aspects

- **common portal comprehensive description of the individual testbeds**
  - **guidelines** on how to access and use the federated testbed



CREW federated platform: key aspects

- **common portal comprehensive description of the individual testbeds**
  - **guidelines** on how to access and use the federated testbed

CREW federated platform: key aspects

- **common portal comprehensive description of the individual testbeds**

Home

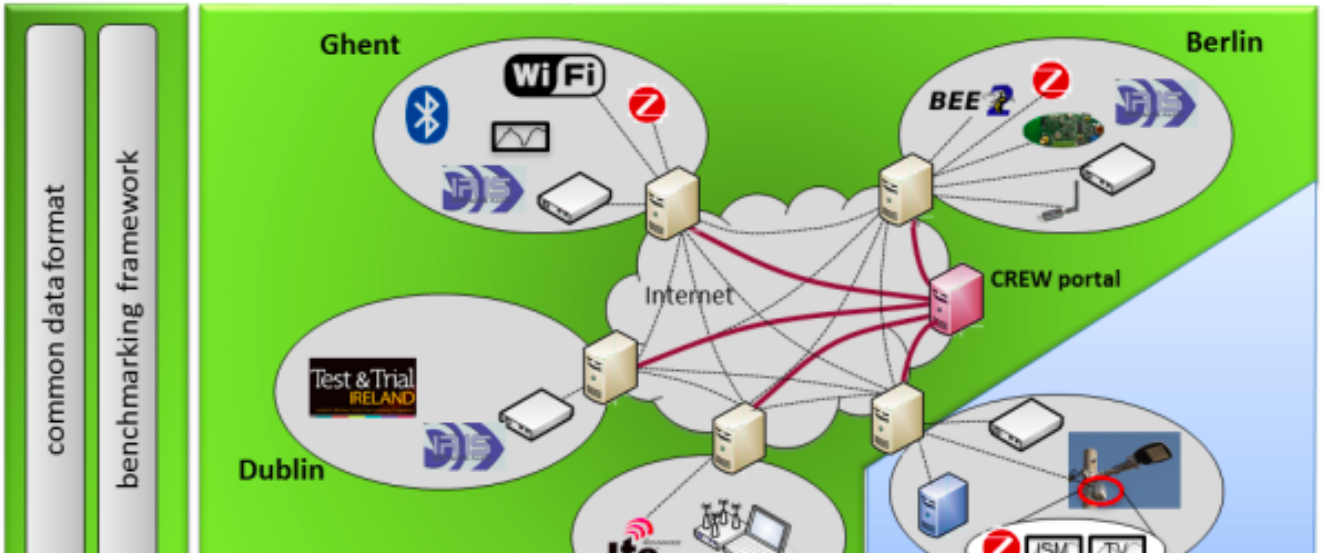
Portal: getting started

View | Edit | Outline

Not sure which facility to use? Start by accessing the graphical overview of the CREW facilities, or consult the list of testbeds and cognitive components for a concise description of the different components. This list can be filtered based on technology, application, and frequency range, to find the component that is most suitable to you.

Once you know which testbed(s) or component(s) to use and for detailed information, consult the advanced information section.

For **information on the benchmarking platform**, please consult the section of the w-iLab.t testbed on benchmarking. For **information on the CREW common data format**, please consult the page on the common data format.You can use the menu on the left of this website to navigate through the portal.



CREW federated platform: key aspects

- **common portal comprehensive description of the individual testbeds**

Filter on frequency range: ISM 2.4GHz | Filter on OSI layer: MAC | Filter on radio type: IEEE802.11 bg | Apply

Testbed or cognitive component	Short description
TWIST	The TKN Wireless Indoor Sensor Network Testbed (TWIST) is a multi-platform, hierarchical sensornetwork testbed architecture developed at the Technische Universität Berlin. One instance is currently deployed at TUB campus: a total of 204 sensor nodes (102 eyesIFX and 102 Tmote Sky nodes) are distributed in a 3D grid spanning 3 floors of an office building, resulting in more than 1500 m² of instrumented office space. Two nodes of each platform are deployed, while the larger ones (~28 m²) have four nodes. This setup results in a fairly regular grid deployment pattern with intra node distance of 3m. Within the rooms the sensor nodes are attached to the ceiling. The TWIST architecture introduces a layer of "super-nodes" (previous figure, right) between the sensor nodes and the testbed server, which manages sensor node reprogramming, configuration or accessing debug information over the serial connection. TWIST relies on COTS hardware and fully leverages the features of the USB 2.0 standard. The sensor nodes are connected to the super-nodes via USB hubs, which act as concentrators and also provide a power supply management capability. This enables active topology control and node fault injection modelling through selective powering on and off of nodes. TWIST is currently being extended by mobile robots which can be used for experiments that involve controlled mobility. At the end of CREW Year 1 (at the time of the first open call) one mobile robot can be used for local experiments.
w-iLab.t	The w-iLab.t allows flexible testing of the functionality and performance of wireless networking protocols and systems in a time-effective way, by providing hardware and the means to install and configure firmware and software on (a selection of) nodes, schedule automated experiments, and collect, visualize and process results. Thanks to an in-house designed hardware control device, unique features of the testbed include the triggering of repeatable digital or analog I/O events at the sensor nodes, real-time monitoring of the power consumption, and battery capacity emulation. At a first location, the "w-iLab.t Office" consists of a wireless Wi-Fi (IEEE 802.11a/b/g) and sensor network (IEEE 802.15.4) testbed infrastructure, deployed across three 90 m x 18 m floors of the IBBT office building in Ghent, Belgium. At 200 places throughout the office spaces, meeting rooms and corridors, wireless hardware is mounted to the ceiling.

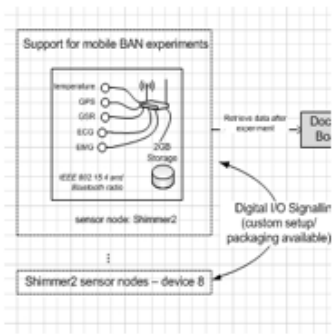
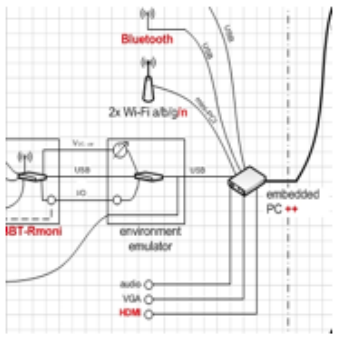
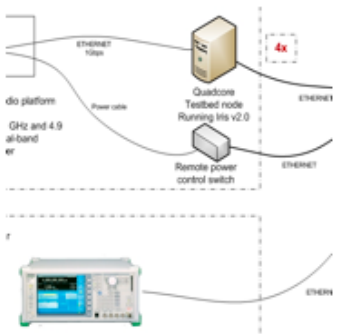
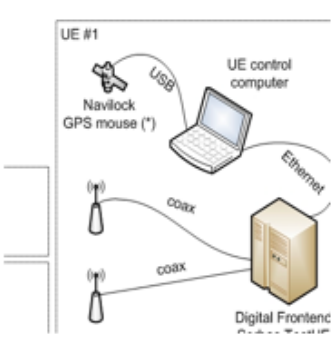
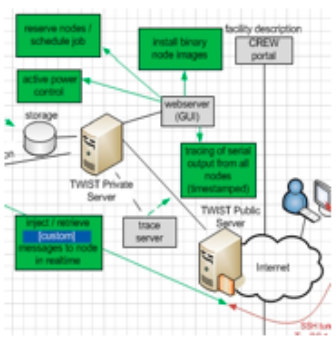
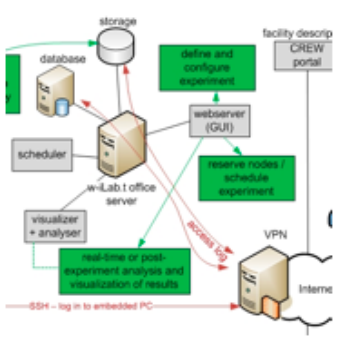
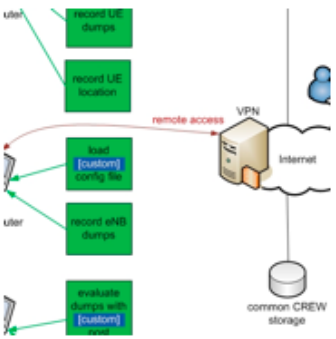
CREW federated platform: key aspects

- **common portal comprehensive description of the individual testbeds**

Schematic overview

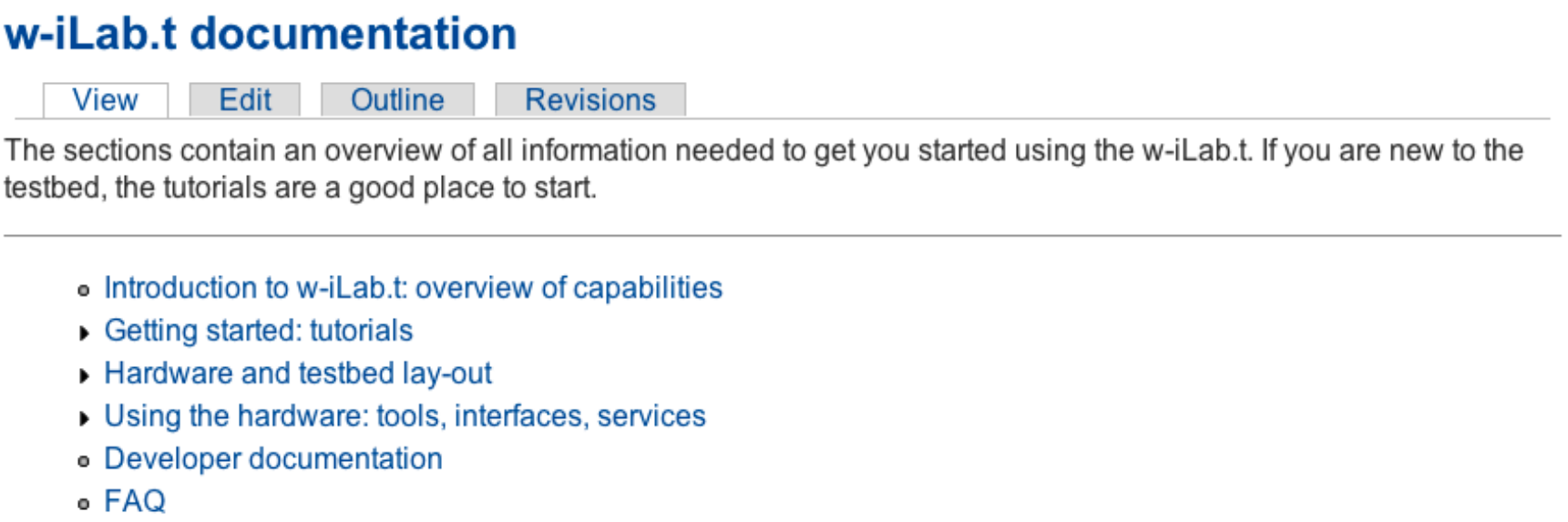
View | Edit | Outline | Revisions

Please click the thumbnail extracts below to get a full screen view of the different infrastructures. After clicking the thumbnails, click to zoom in. The images may also be downloaded on the bottom of this page.

TWIST - Berlin	w-iLab.t - Gent	Iris - Dublin	LTE-Advanced - Dresden
			
Hardware overview	Hardware overview	Hardware overview	Hardware overview
			
Usage overview	Usage overview	Usage overview	Usage overview
Access documentation	Access documentation	Access documentation	Access documentation

CREW federated platform: key aspects

- **common portal comprehensive description of the individual testbeds**



w-iLab.t documentation

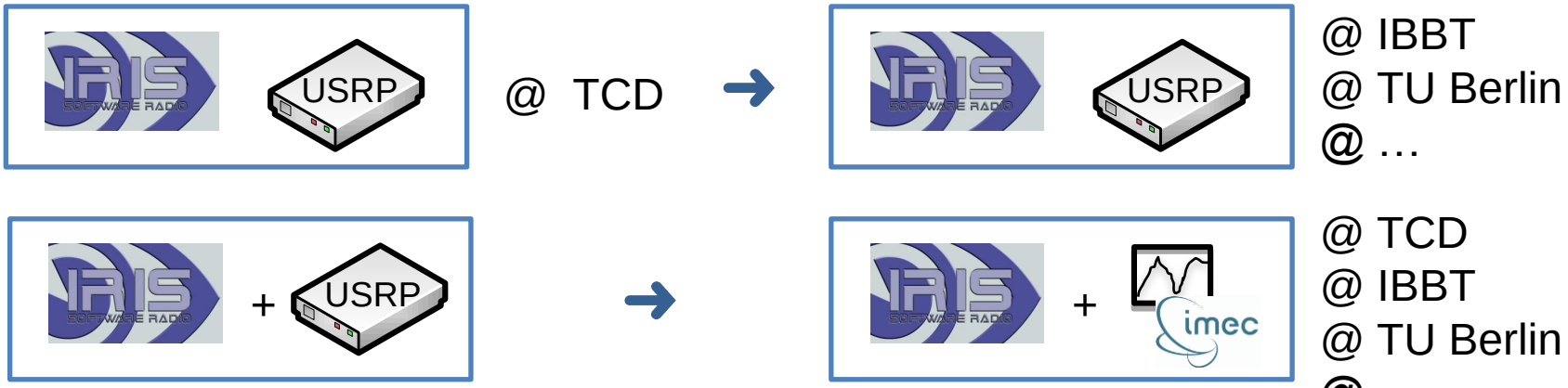
View | Edit | Outline | Revisions

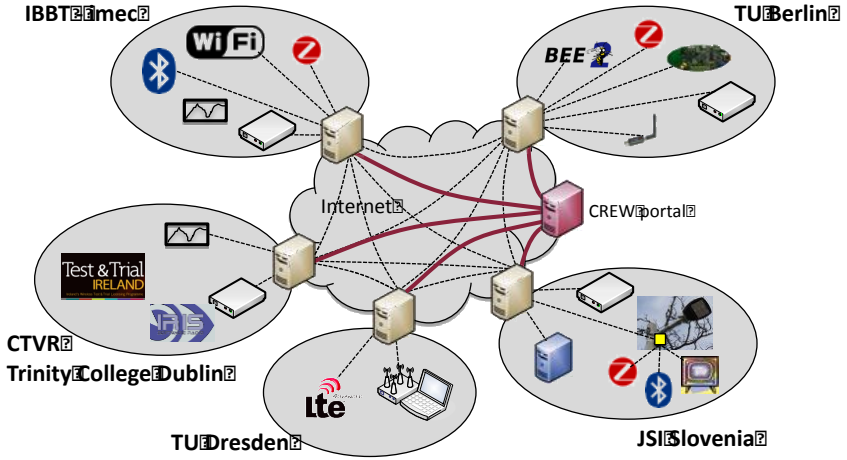
The sections contain an overview of all information needed to get you started using the w-iLab.t. If you are new to the testbed, the tutorials are a good place to start.

- Introduction to w-iLab.t: overview of capabilities
- Getting started: tutorials
- Hardware and testbed lay-out
- Using the hardware: tools, interfaces, services
- Developer documentation
- FAQ

CREW federated platform: key aspects

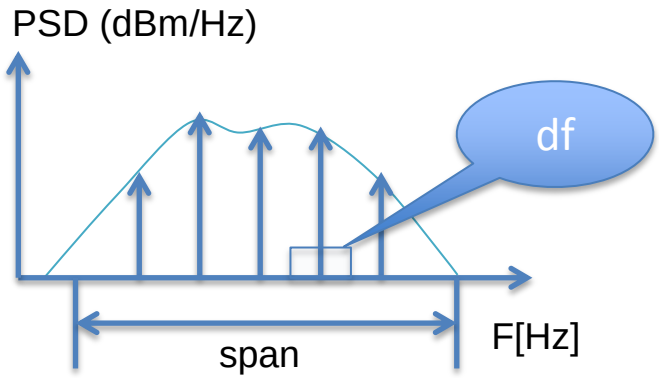
- **novel cognitive components**
  - **relocation** of components
  - **linking together** software and hardware **entities** from the different partners





CREW federated platform: key aspects

- **creation of open data sets**
  - a **common data structure** enables the emulation of CREW components in other experimental environments or in a simulator
  - Extension of IEEE 1900.6 standard
    - **Experiment abstract**: structured description of experiment
    - **Meta information**: info fordescribing, understanding, and evaluating information
      - devices, location, time, radio frequency, variable parameters, trace description, signal generation…
    - **Experiment traces:** e.g. sensing data

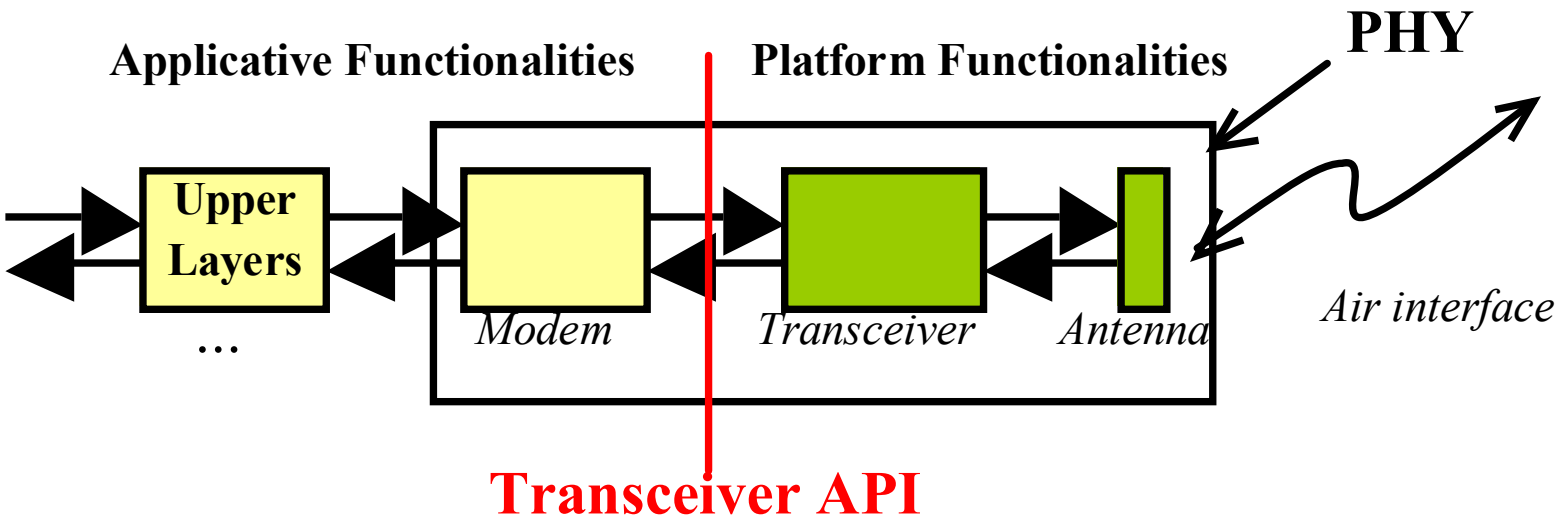


0	-101	-90	-82	-94	-91	-91	-89
T1	-98	-90	-90	-93	-95	-94	-92
T2	-76	-75	-92	-72	-92	-96	-92
⋮			⋮				

➜ See CREW deliverable D3.1

CREW federated platform: key aspects

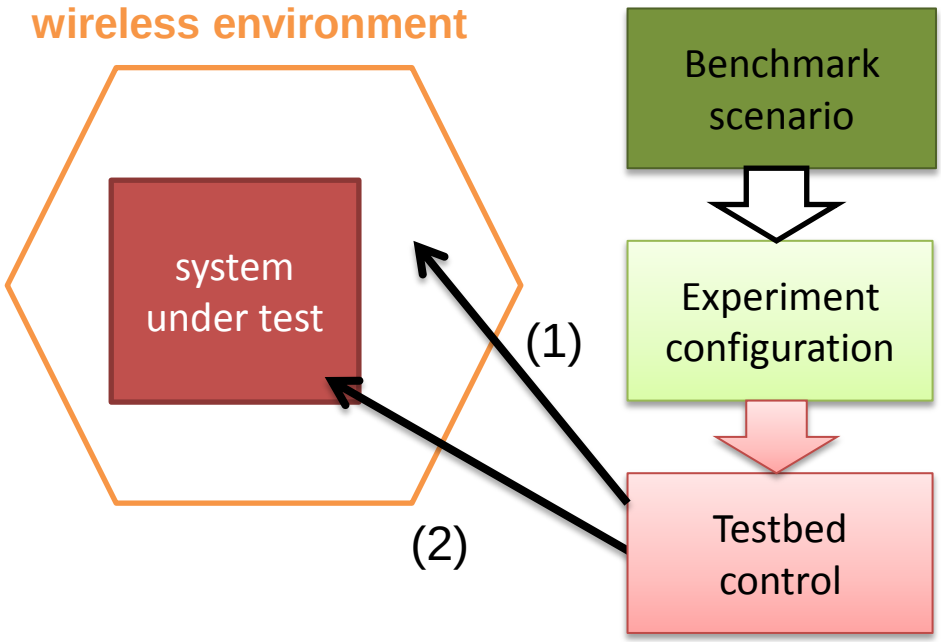
- **transceiver API**
  - **standardized API** for SDR architectures (developed within WINNF)
  - functional specification for RF hardware platforms command and control

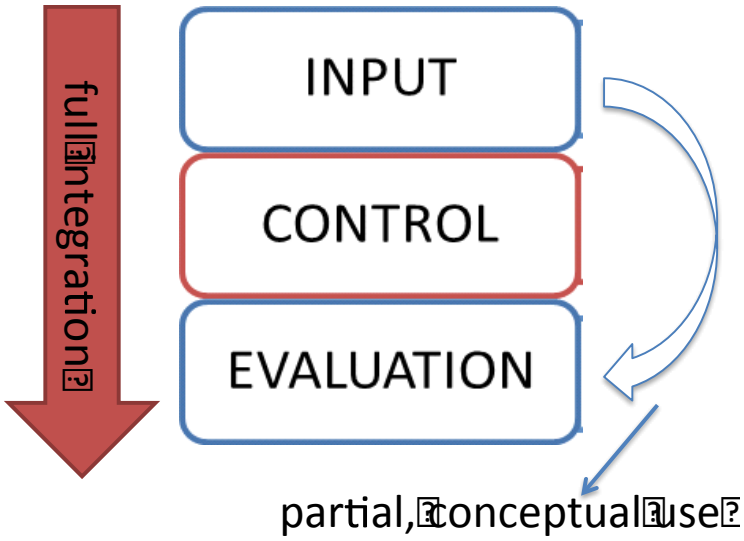


➜ See CREW deliverable D3.1

CREW federated platform: key aspects

- **benchmarking framework**
  - enabling experiments under controlled and **reproducible test conditions**
  - offering **automated procedures** for experiments and performance evaluation
  - allowing **fair comparison**





➜ See CREW deliverable D4.1

CREW federated platform: key aspects

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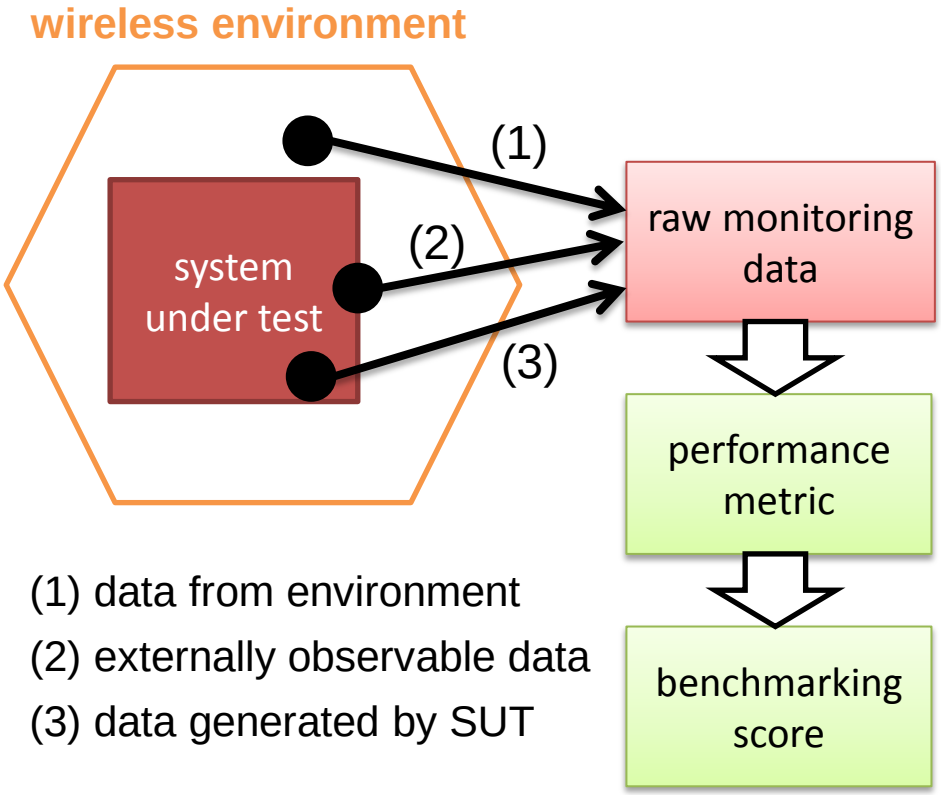
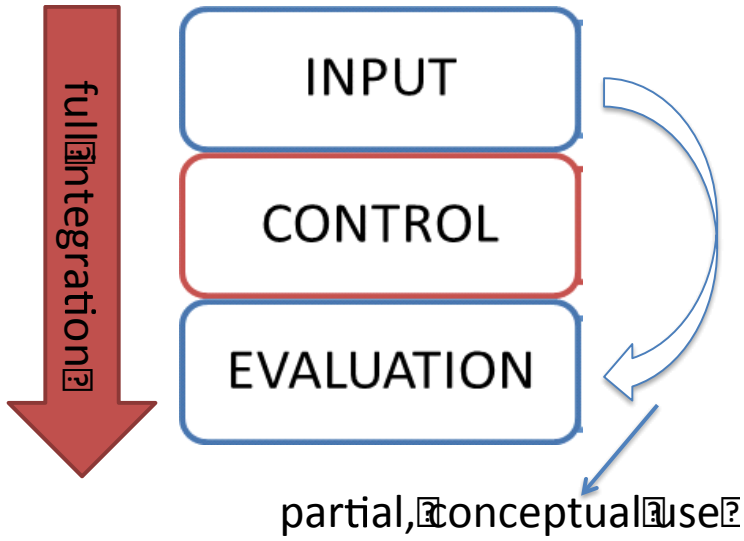
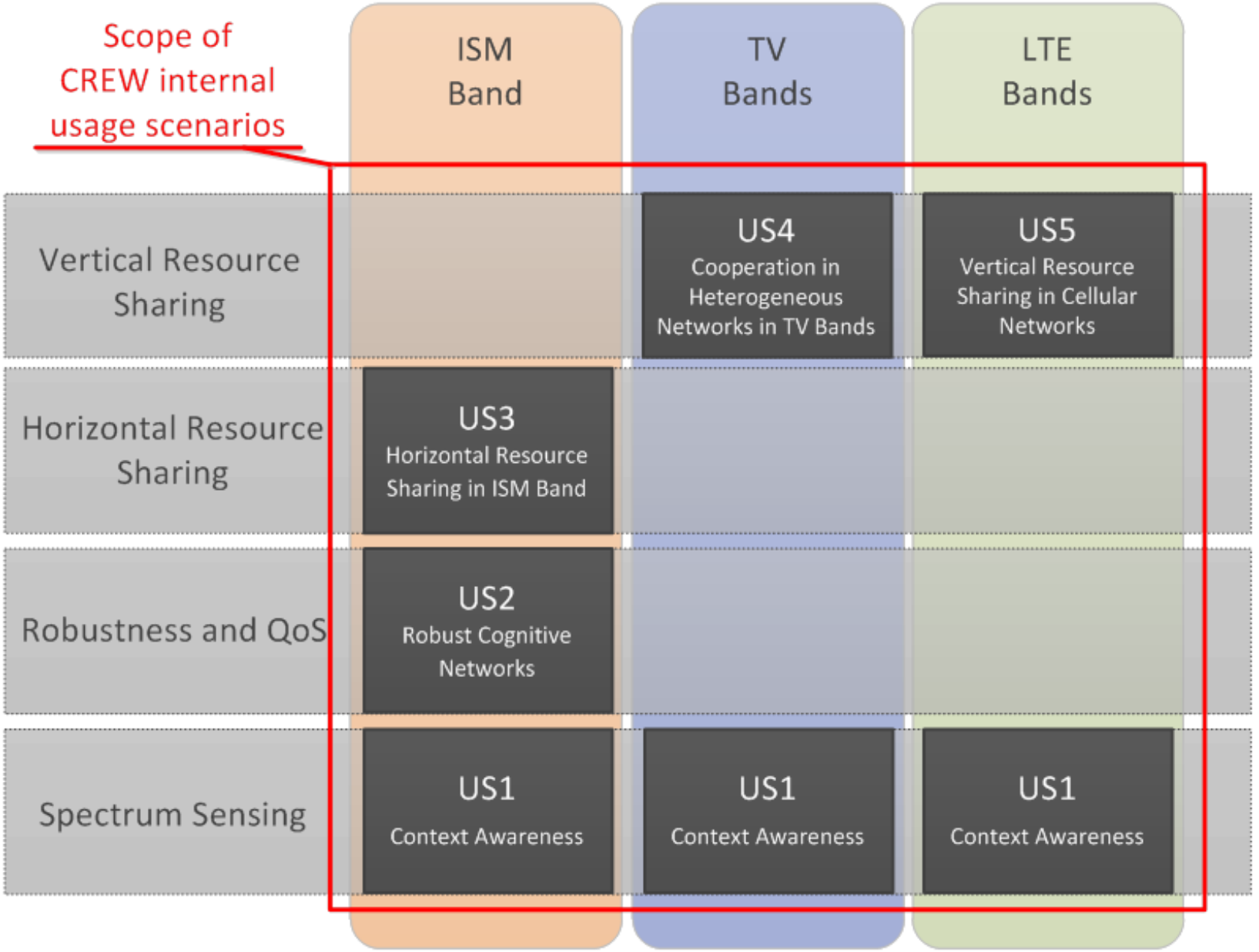




CREW usage scenarios



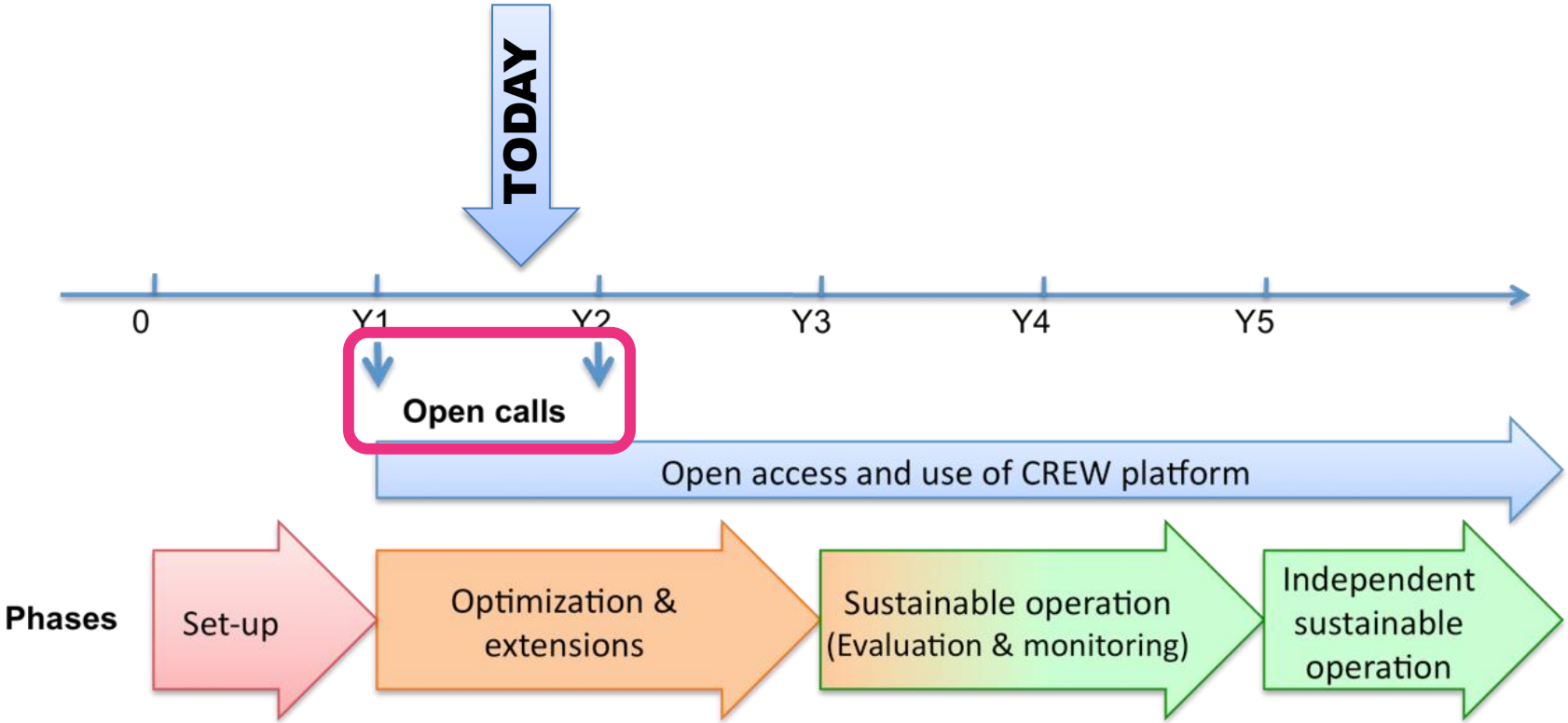
CREW internal usage scenarios

- **US1 - Context awareness for cognitive networking**
  - spectrum sensing in unlicensed (ISM) and licensed bands (TV white spaces, cellular systems)
- **US2 - Robust cognitive networks**
  - applications that require robust communications though avoiding harmful interference and using frequency agility to improve communication quality
- **US3 - Horizontal resource sharing in the ISM band**
  - algorithms, protocols and networking architectures for coexistence of and cooperation between independent heterogeneous network technologies
- **US4 - Cooperation in heterogeneous networks in TV bands**
  - new ideas for opportunistic spectrum access to underutilized licensed TV bands
- **US5 - Cognitive Systems and Cellular Networks**
  - the impact of dynamic spectrum access by secondary users on LTE cellular primary systems.

➜ **See CREW deliverable D2.1**

CREW roadmap

- **Start**
  - October 2010
  - Duration 5 years



Q & A

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The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 258301 (CREW project).