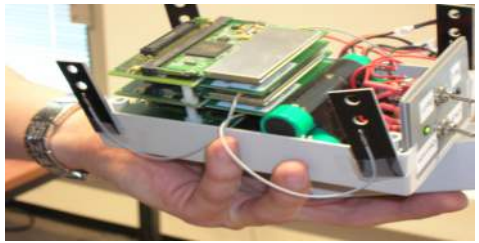
WIRELESS TESTBEDS AND TUTORIAL

A GENERIC TESTING ENVIRONMENT OVERCOMES THE DRAWBACKS OF INDIVIDUAL SET-UPS

- Individual set-ups: difficult to reproduce and to compare results
- The benefit of scale
  - testbed size
  - re-use and professionalization of tools

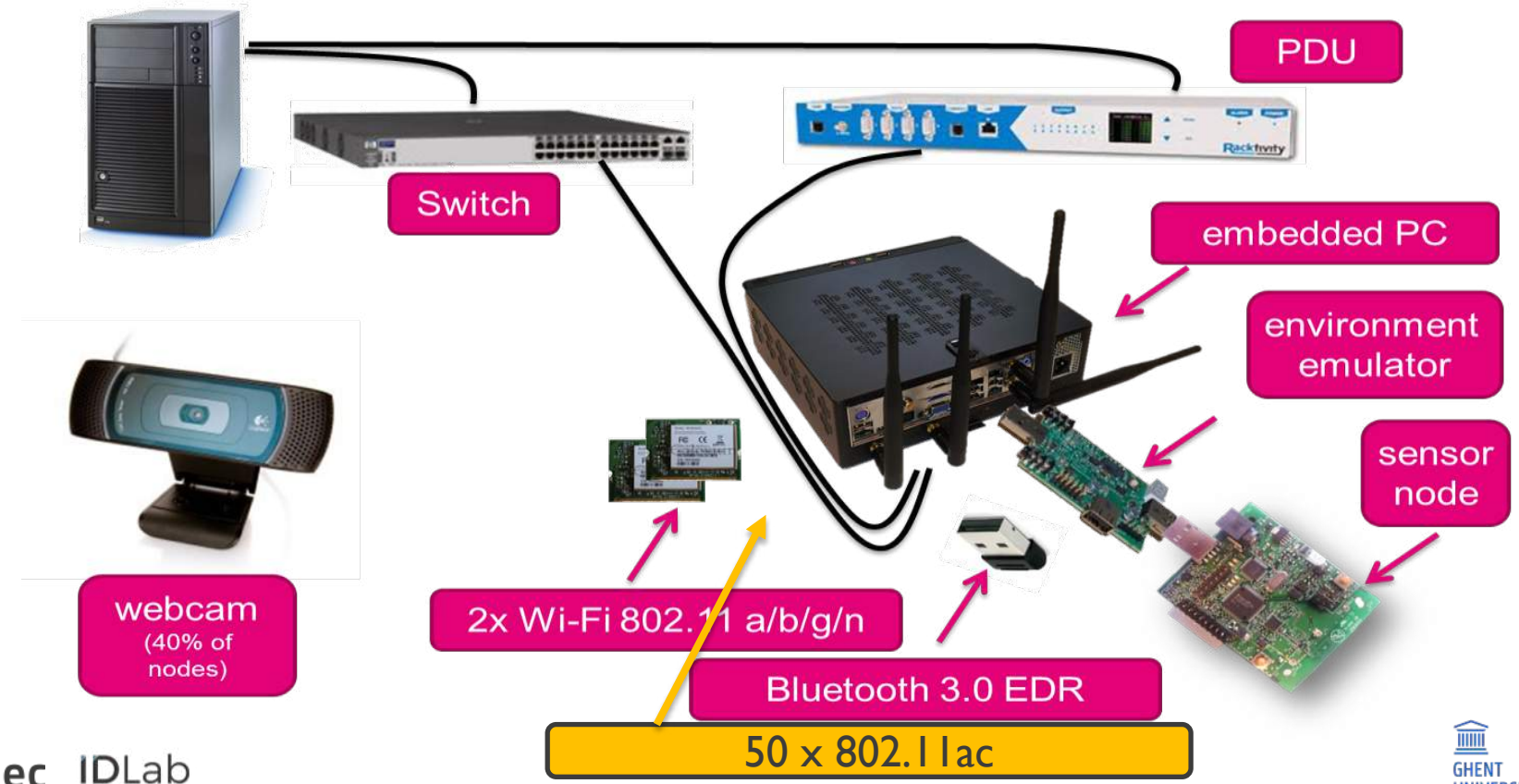


Some of the nodes in our test set-ups, before 2007

GENERIC WIRELESS TESTING ENVIRONMENTS
OVERVIEW

- w-iLab.t
  - w-iLab.1 (officelab)
  - w-iLab.2 (industrial lab)
- Portable testbed
- Industrial-IoT lab
- Homelab

W-ILAB TESTBED ARCHITECTURE (ALL TESTBEDS)

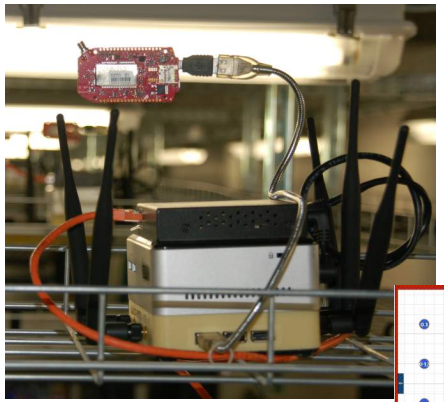


W-ILAB.T TESTBED

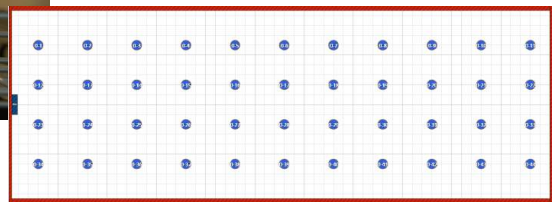
2 testbed locations:

- w-iLab.1: datacenter with 44 embedded PCs (WiFi and sensor nodes)
- w-iLab.2: industrial room with 100 fixed +15 mobile nodes (WiFi, sensor, LTE, SDR)

Use cases: wireless, sensor, mobile, networking, SDR, 3rd party hardware



4 RF-shielded boxes



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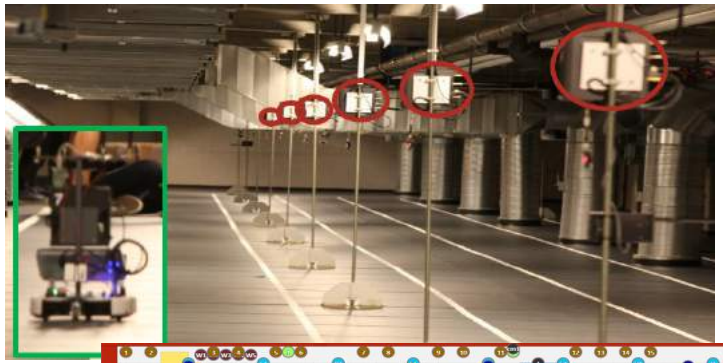

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W-ILAB.T – SOFTWARE DEFINED RADIO

USRP x310 (x2)
10Gbps fiber to switch
10 Gbps Ethernet to server

USRP B210 (x4)
USRP B200 (x4)
USB3.0 to Intel NUC

ZC706 with Zync-7000 SoC (x3)
1Gbps Ethernet to APU
2 x USB (UART + JTAG)

APU
AMD G-series (1GHz)
Only for programming & debugging

Xilinx ZedBoard Zync-7000 SoC (x1)
2 x USB (UART + JTAG)

SERVER
Intel Xeon
Only for programming & debugging

SERVER (x7)
Intel Xeon Processor D-1541
(2.1GHz, 8 cores, 16 threads)
16GB DDR4 RAM

NUC (x8)
Intel Core i5-4250U
(3M Cache, up to 2.60 GHz)
8GB DDR3 RAM

RFNoC Ettus Research

GNURadio THE FREE & OPEN SOFTWARE RADIO ECOSYSTEM

SRS LTE open-source 4G from handset to core

Openwifi First FREE open source full stack real-time Wi-Fi

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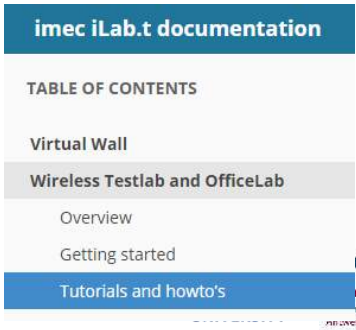


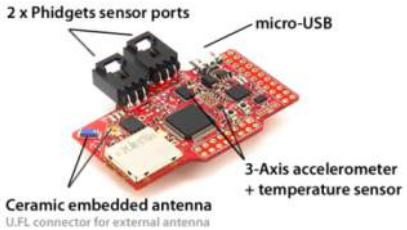
IOT-OFFICELAB

Office environment with 110 embedded PCs spread over 3 office floors

Use cases: wireless, sensor, networking, 3rd party hardware, indoor localization (UWB)

CONSTRAINED IOT DEVICES

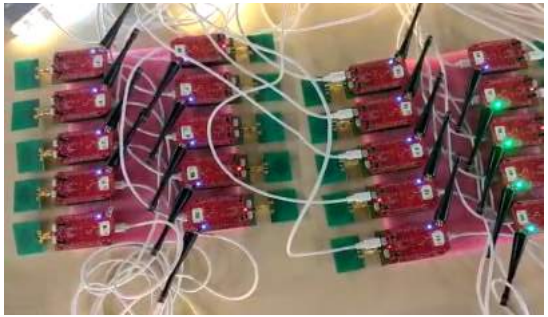
- Zolertia Re-Mote
  - 2.4GHz / 868MHz
  - UWB-shield (in-house developed)
- Currently deployed:
  - Temperature sensors
  - Many other sensors possible



- Zolertia Z1
  - 2.4GHz

- RM090
  - 2.4GHz

- Environment Emulator
  - Battery emulation
  - 6KHz sample rate
  - Generate I/O events on DUT
    - RM090/Re-Mote



- UWB shield
  - UWB radio, sub-cm accuracy

- Nordic Semiconductor nRF52 DK
  - BLE development kit

- Sparklan WPEA-251N(BT)
  - 802.11a/b/g/n
  - Bluetooth 4.0 LE/ 3.0 HS/ 2.1 EDR standard

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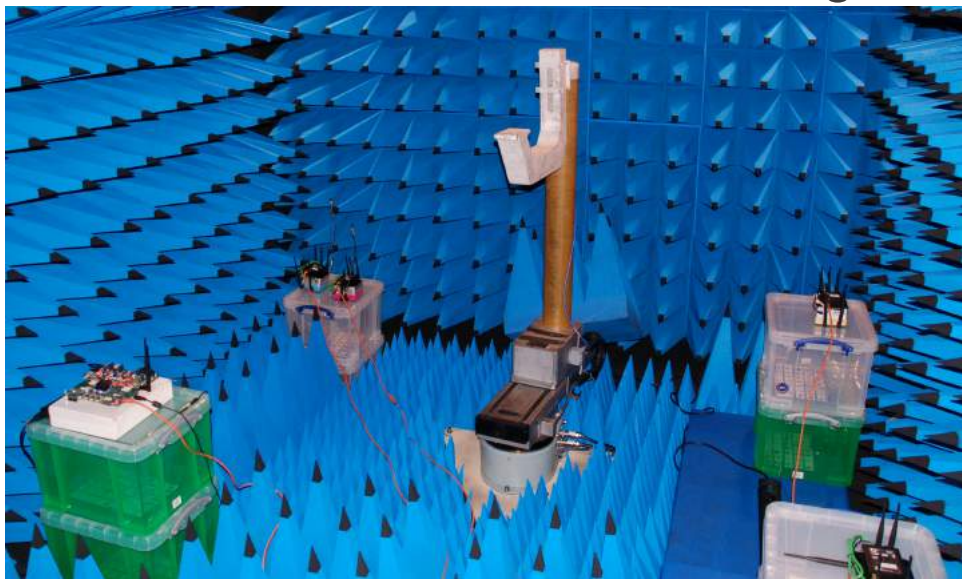
PORTABLE TESTBED

Portable wireless test infrastructure with 15 embedded PCs (WiFi/sensor) & SDR equipment. Easily extendable with 3rd party hardware.

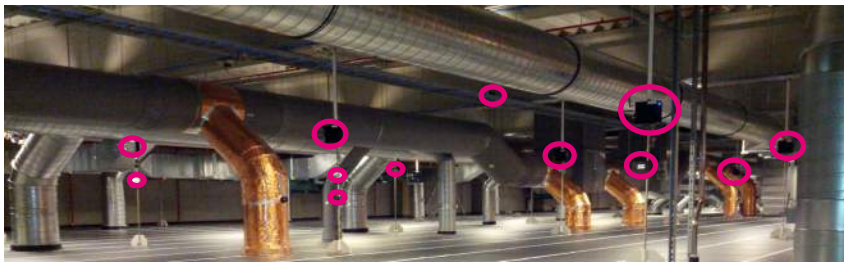
Use cases: wireless, sensor, networking, on-site testing, rapid deployment



W-ILAB.T WIRELESS TESTING: FACTS AND FIGURES

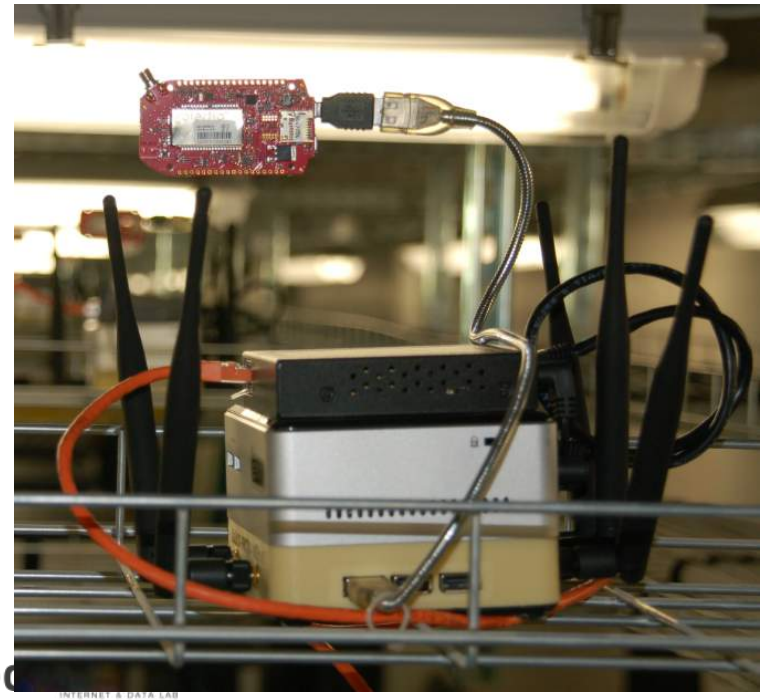
- generic testbed for wireless networks
  - implementing and testing protocols, applications, complete products,…
  - using the installed equipment and technologies and/or by integrating *3rd party products or technologies*

- 2 testbed locations
  - w-iLab.1
    - iGent datacenter: 40+ locations + 4 shielded boxes
    - iGent offices: 100+ locations
  - w-iLab.2 Plenum cleanroom
    - 70m x 22m
    - 150 fixed + 20 mobile node locations + SDR



W-ILAB.1 IGENT DATACENTER

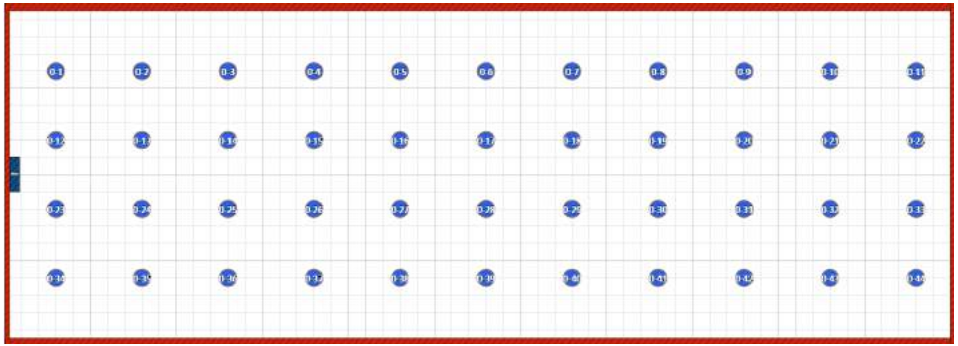
- Limited wireless interference
- (almost) no human presence



44 Intel NUC

i5 / 8GB RAM / 320GB HDD
802.11a/b/g/n + BT 4.0
802.11ac (3x3)

2x Zolertia Remote



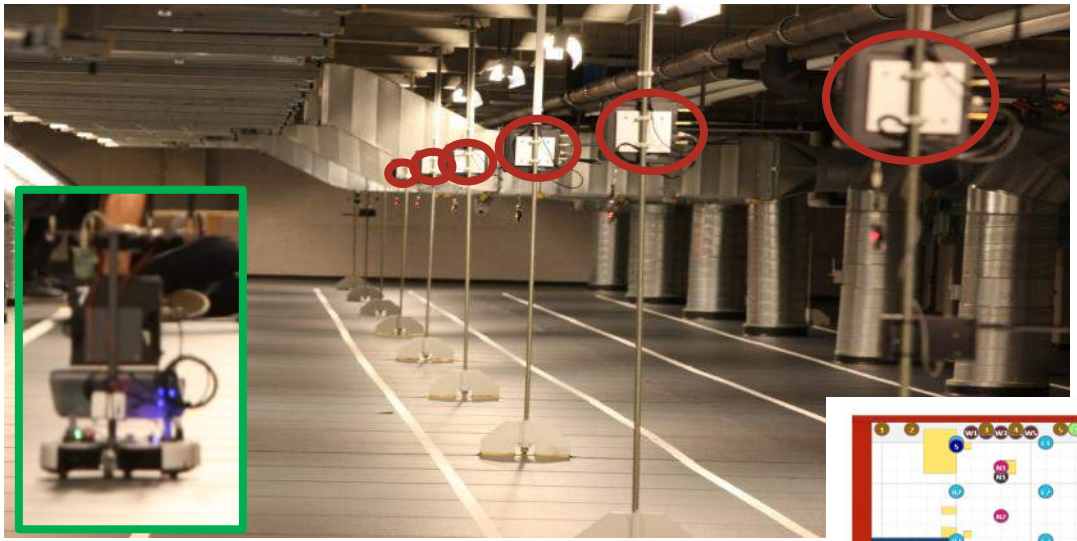
https://wilab1.ilabt.iminds.be/inventory

W-ILAB.I IGENT OFFICES

100+ NUCS with 1x Zolertia Remote

W-ILAB.2 PLENUM CLEANROOM

- external interference limited compared to office environment
- (almost) no human presence



150 fixed nodes

20 mobile nodes

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W-ILAB.2 PLENUM CLEANROOM SPECIAL NODES AND PROXY USE

- some embedded nodes are used as proxy to connect to specialized hardware
- more powerful servers available for special purposes (16x 10Gbit interfaces)

2 x femtocell (ip.access)

+emulated core (SiRRAN)

lte

USRP, WARP, IMEC SE SDR/cognitive

sensor nodes (RM090 with MSP430), environment emulator,...

+20 UE (Huawei) lte

?

your custom hardware (e.g via USB, PoE, 220V, ethernet)

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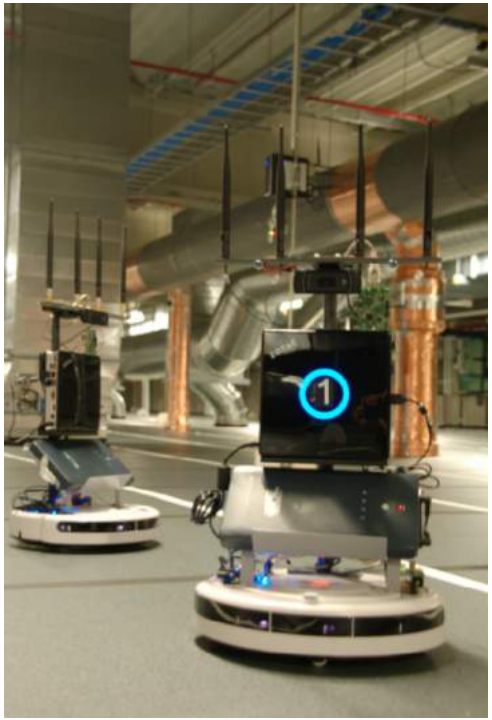
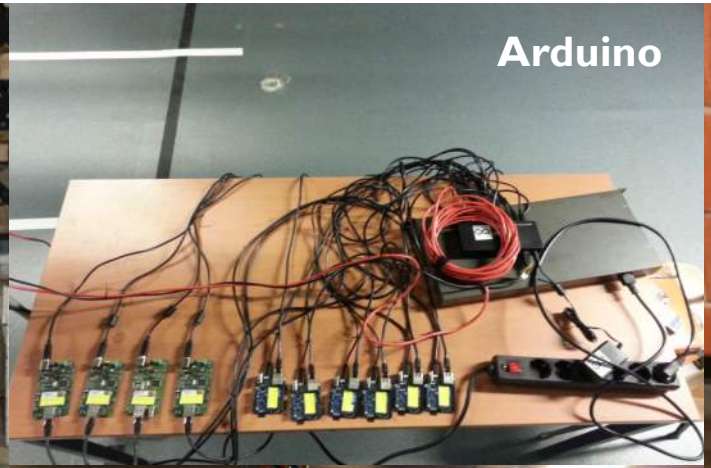
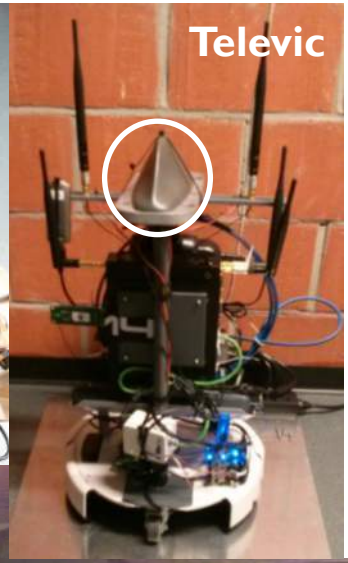
MOBILE NODES INTRODUCE REPRODUCIBLE MOBILITY IN EXPERIMENTS

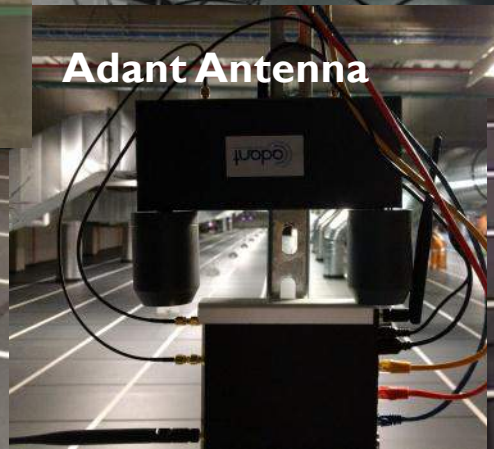


- Remote controllable
- 5cm accuracy => Repeatability
- Automated charging
- PTZ-camera system
- Possible to add extra IoT devices (USB)

THIRDPARTY HARDWARE INTEGRATION & TESTS







PORTABLE TESTBED

IoT extensions possible over USB

PORTABLE TESTBED

- https://www.youtube.com/watch?v=dkiTrK7zlpU

INDUSTRIAL IOT LAB

- 30x10m
- 3 areas:
  - Flexible production area with industrial robotic arms
  - Open space 6mx10m (e.g. for drone flying)
  - Warehouse area (17m x 10m)
- UWB localisation (IDLab development)
- mocap for drone localisation verification (5x5m, 8x Qualisys Miqus)

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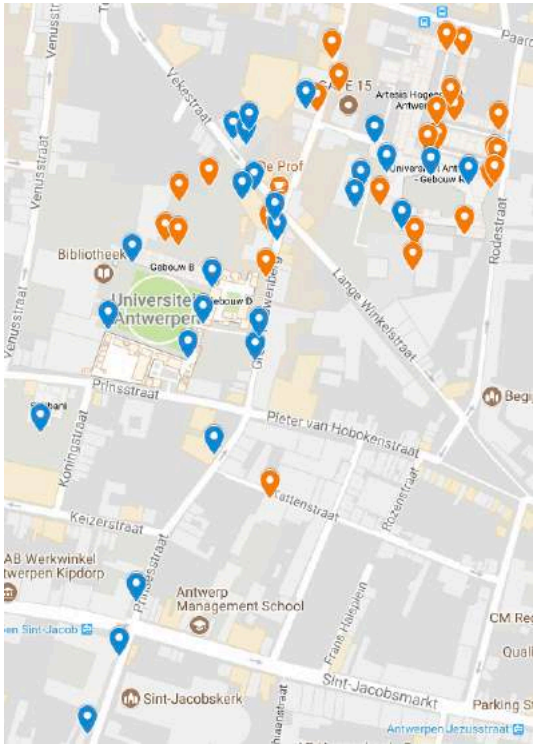
CITYLAB TODAY: A CONNECTIVITY INFRASTRUCTURE

MULTI-TECHNOLOGY CONNECTIVITY

- Large deployment operational outdoor
  - 35 CityLab gateways in City Campus
  - 15 additional gateways pending
  - 15 in Smart Zone for connectivity services
- Focus on coexistence testing in unlicensed spectrum and edge computing
  - Outdoor edge computing
  - Supporting WiFi, 802.15.4, Bluetooth and sub-GHz
  - Backed up by commercial LPWAN backends (LoRa, SigFox, NB-IoT)



HOMELAB

- Flexible home environment
  - Integration of technologies
  - User experiences
  - E-health / home automation / localization …

WHAT DOES THE TESTBED DO?

The testbed does not do anything by its own, but all devices/interfaces/… in the testbed can be used "as if a set-up was on your desktop"…

Yet with tools that help you to

- Discover and reserve
- Provision, install and configure
- Experiment with / control / monitor / measure nodes easily, at scale

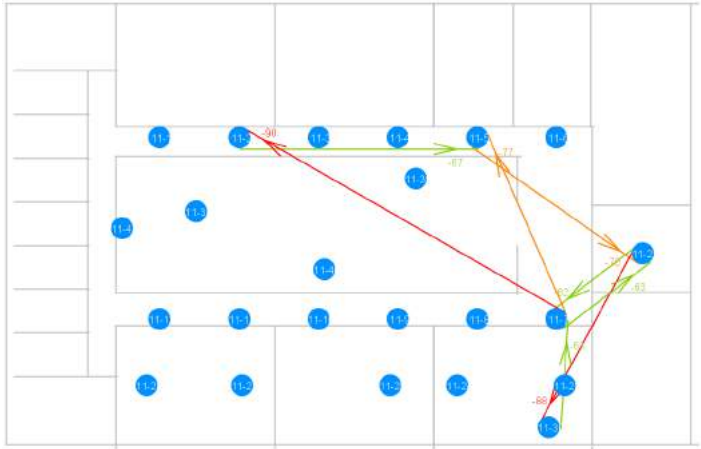
Obtain more reliable developments and results, in a faster and more easy way.

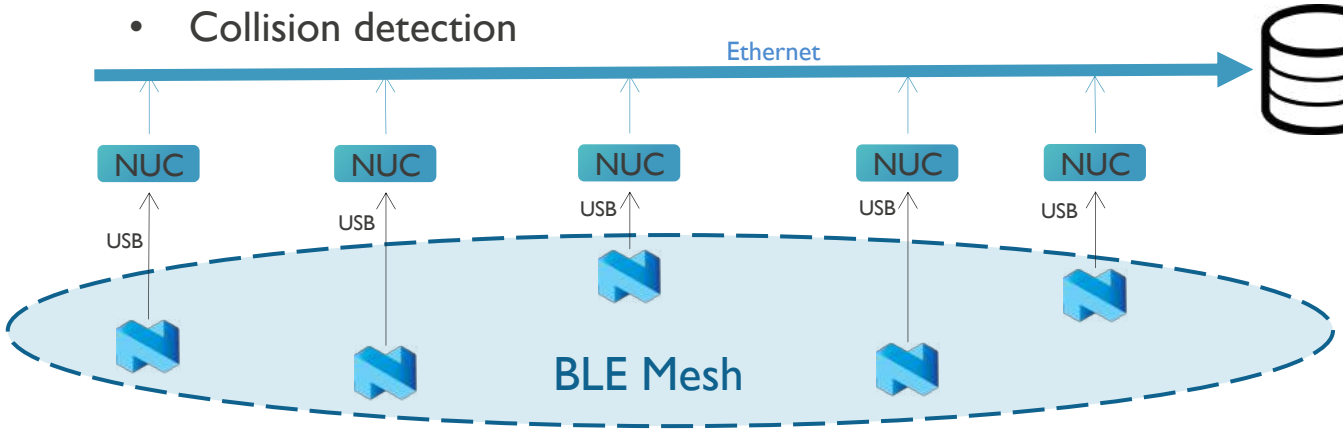
HOW TO OPERATE THE TESTBED?

- Can be operated fully remotely: jFed
- Typical way of working:
  - 1/ reserve a slot for testing [+ indicate what hardware will be used]
  - 2/ "swap in" test/experiment after reservation slot starts
    - i.e. configure all nodes according to experiment description
  - 3/ during experiment, trigger certain manual or automated events (e.g. "imitate traffic", "generate interference", switch on/off node, change config. parameters…) and log relevant data
  - 4/ after experiment ends, "swap out" experiment
  - 5/ process data

BLE MESH EXPERIMENTS

- 22 nodes
- All nodes equipped with:
  - nRF52 development boards
  - Bluetooth 5.0 support
  - Long range support (nRF52840)
- All nodes are synchronized for logging purposes
- BLE Mesh topology experiments
  - Round-trip time validation
  - Scalability tests
  - Collision detection





Data analysis + visualisation

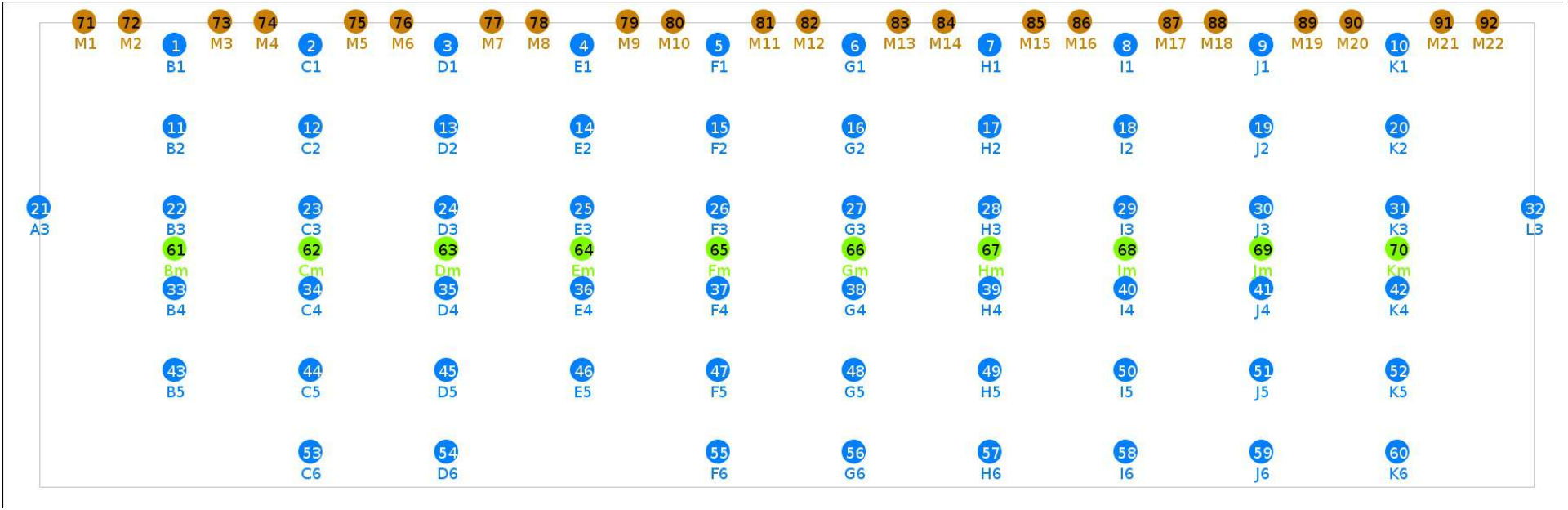
SOUNDS INTERESTING?

IMEC iLab.t technical testing offers hardware and tools, and all necessary knowledge and support to answer your technical (testing) needs

https://doc.fed4fire.eu
https://doc.ilabt.imec.be

helpdesk@ilabt.imec.be

W-ILAB.2 DEMO & HANDS ON


71 M1
72 M2
1 B1
73 M3
74 M4
2 C1
75 M5
76 M6
3 D1
77 M7
78 M8
4 E1
79 M9
80 M10
5 F1
81 M11
82 M12
6 G1
83 M13
84 M14
7 H1
85 M15
86 M16
8 I1
87 M17
88 M18
9 J1
89 M19
90 M20
10 K1
91 M21
92 M22
11 B2
12 C2
13 D2
14 E2
15 F2
16 G2
17 H2
18 I2
19 J2
20 K2
21 A3
22 B3
23 C3
24 D3
25 E3
26 F3
27 G3
28 H3
29 I3
30 J3
31 K3
32 L3
61 Bm
62 Cm
63 Dm
64 Em
65 Fm
66 Gm
67 Hm
68 Im
69 Jm
70 Km
33 B4
34 C4
35 D4
36 E4
37 F4
38 G4
39 H4
40 I4
41 J4
42 K4
43 B5
44 C5
45 D5
46 E5
47 F5
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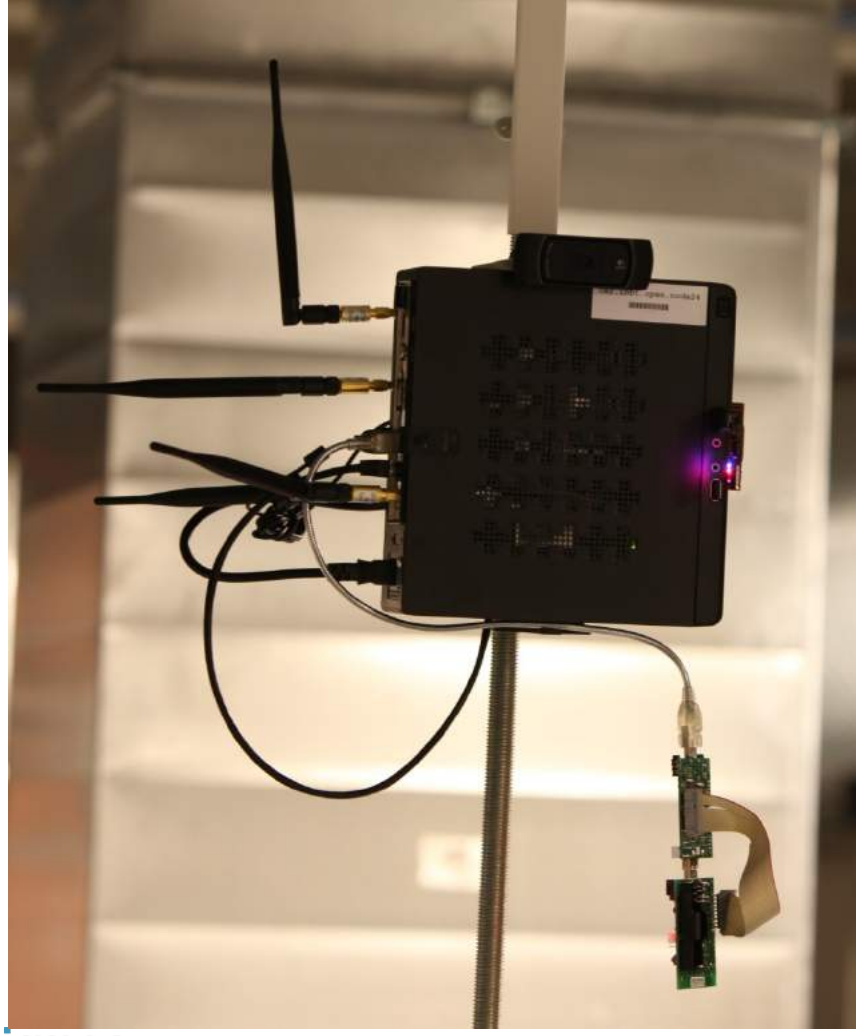


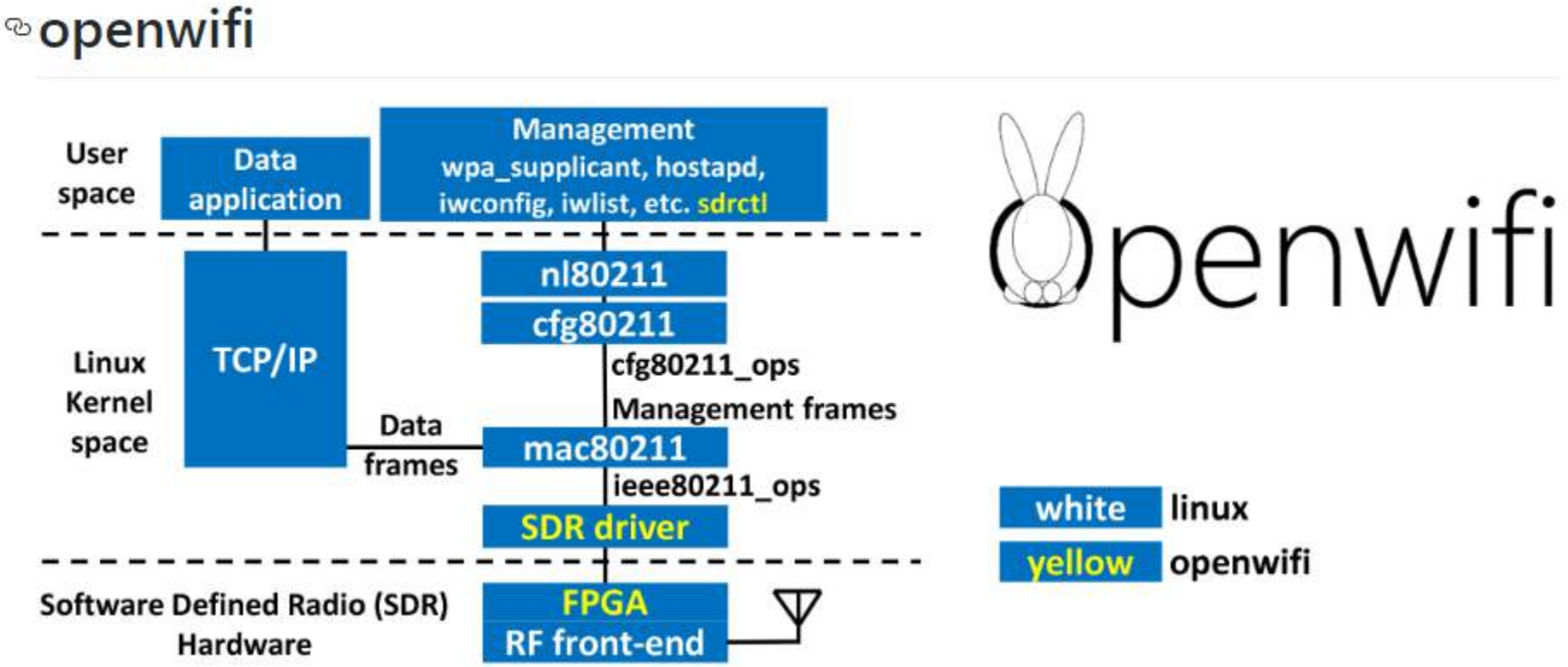
- Embedded PC (Zotac)
  - 2x WiFi 802.11 a/b/g/n
  - 802.15.4 sensor node
  - Bluetooth 3.0 EDR

TUTORIAL

- https://doc.ilabt.imec.be/ilabt/wilab/tutorials/index.html
- http://inventory.wilab2.ilabt.iminds.be/ : reservation
- https://doc.ilabt.imec.be/ilabt/wilab/tutorials/ap_client_tut.html

MORE ADVANCED: OPENWIFI

https://github.com/open-sdr/openwifi



DEMO MOBILE NODE

- https://doc.ilabt.imec.be/ilabt/wilab/tutorials/mobile_tut.html