

# EOSystem

## Energy Optimized drone-based healthcare delivery System



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Smart Anything Everywhere Area 2

[www.smart4all-project.eu](http://www.smart4all-project.eu)  
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Focused Technology Transfer Experiments  
(FTTE) 2<sup>nd</sup> Call  
Financial Support to Third Parties



**Saves  
lives**



**Unpredictable  
needs**

Emergencies  
difficult to plan

**h24**

**Daily  
needs**



**Long awaiting  
times**

Means not always  
available



**Easily  
perishable**



**High  
costs**

Staff active  
24/7

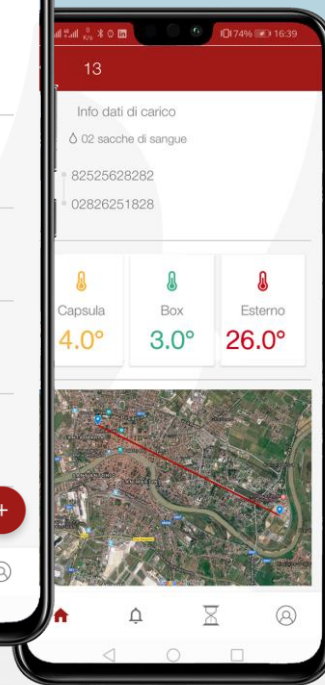


**donor unevenly  
distributed**



**Transport  
not compliant**

SLA  
unrespected

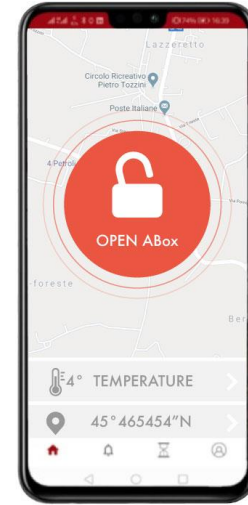




# The ABzero system



# The Smart Capsule and Spoke platform



APP.

Temperature management

Door lock release

Flight monitoring

# The blood and blood components UN3373 box

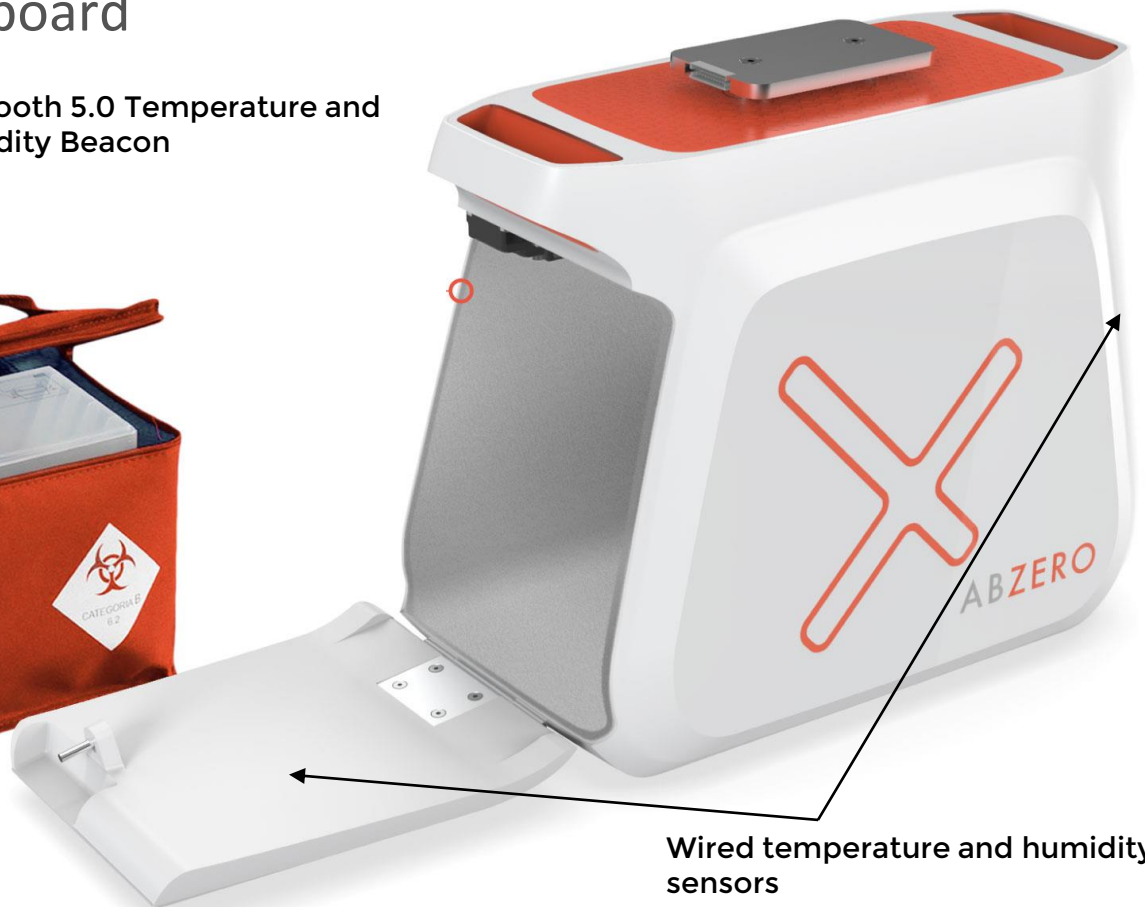




## Current sensors onboard



Bluetooth 5.0 Temperature and Humidity Beacon



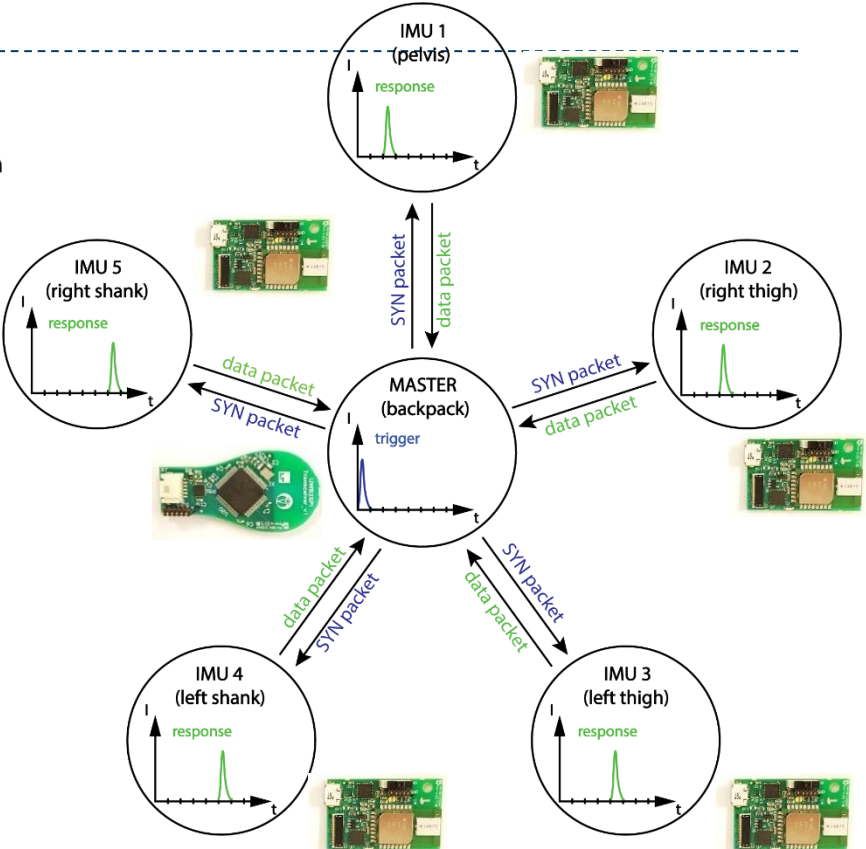
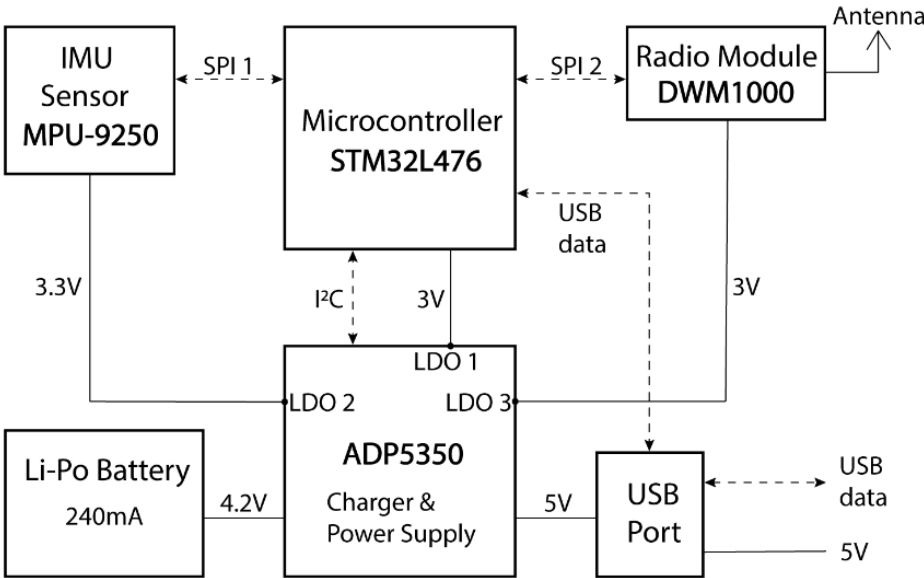
Wired temperature and humidity sensors



# Bluetooth 5.0 Temperature and Humidity Beacon

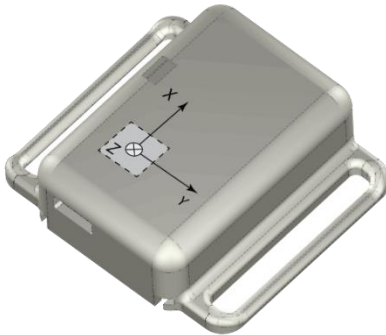
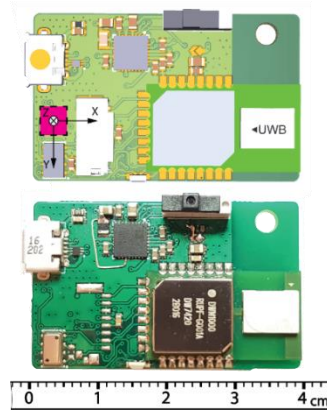
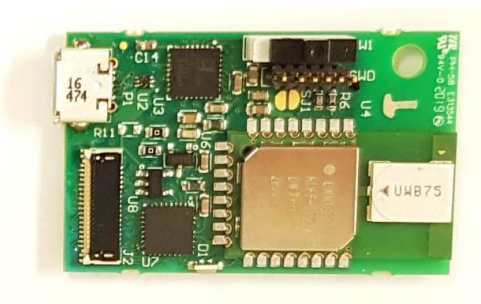
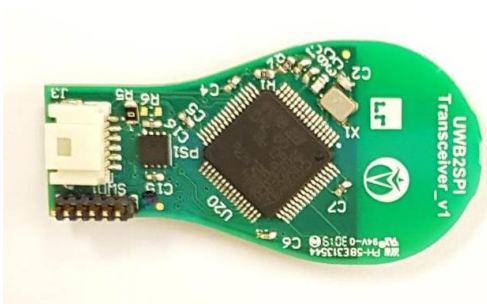
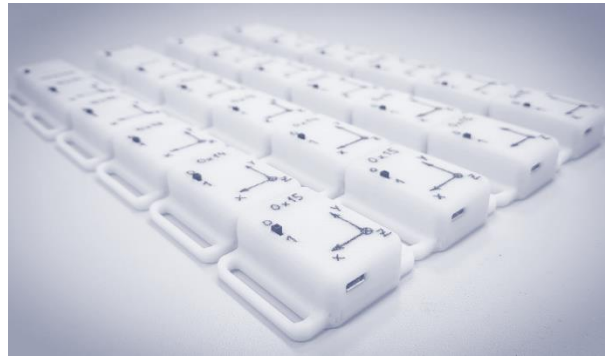


# Inertial Measurement Units (IMU)



# IMU rev. E

- ▶ Produced 60 UWB IMU devices (rev. E – last version)
- ▶ Produced CTRBv2 and UWB2SPI
- ▶ Custom synchronization interval
- ▶ Optimized battery consumption: autonomy from 2,5 h to around 6 h
- ▶ Configuration software tool



# IMU fw&hw development

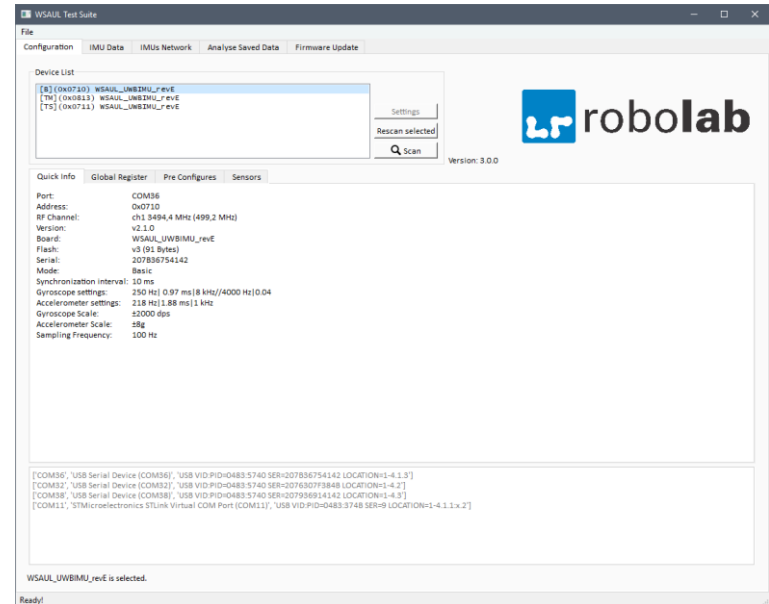
- ▶ functions and USB instructions to set **digital low pass filter** (DLPF) for accelerometer and gyroscope.
- ▶ functions and USB instructions to set available full **scale ranges** for accelerometer and gyroscope
- ▶ functions to set internal IMU output rate **divider** ( $f_s = 1 \text{ kHz}$ , DLPF: on)
- ▶ functions to set predefined MCU's timer **sampling** frequency:
  - ▶ {1, 10, 20, 50, 100, 200, 250, 400, 500, 800, 1000} Hz
- ▶ UWB IMU rev. E devices **produced**
- ▶ straps for wearing devices
- ▶ plastic IMU cases 3D-printed



# Software Application - WSA Test Suite

**WSA Test Suite:** *configure, test, measure:*

- ▶ device configuration
- ▶ reading IMU data from single device over USB
- ▶ network of IMUs
  - ▶ master device in network with 6 remote devices
  - ▶ 9-DOF IMU (MPU-9250) and temperature data
  - ▶ pressure sensor (MS5611-01BA03) + temperature data
  - ▶ radio (DWM1000) received signal strength data
  - ▶ packet counters (master + remote devices)
  - ▶ packet loss calculation
  - ▶ battery level indicator
  - ▶ raw ADC or SI units display of output data
- ▶ option to save data to file for later inspection (up to 30 min)
- ▶ upgrade firmware over USB
- ▶ Mount SD Card, File open, Data display



# Software Application - WSA Test Suite

**Command Menu**

Connect to IMU com36

Select .bin file

Burn Firmware

**Firmware upload guide**

1. Connect IMU on which you want to update firmware to USB port To start, enter com port number of device you want to update (e.q. COM3) and click 'Connect to IMU' button.
2. Click 'Select .bin file' button and select .bin firmware file. Confirm file selection with OK.
3. When above things are completed press 'Burn Firmware' button and wait until program finishes its task!

**Progress**

```
(12:57:01) To start connect to IMU!
(13:39:30) None port entered!
(13:39:53) Serial port com36 connection established successfully!
(13:40:03) Bin file C:/Users/zorani/Documents/CL+++/Software/GIT-repositories/WSAUL_UWBIMU_revE/MDK-ARM/WSAUL_UWBIMU_revE.bin selected
(13:40:17) Command "BL_FLASH_BANK2_ERASE" SENT!
(13:40:18) Erase finished successfully!
(13:40:18) Command "BL_FLASH_WRITE" SENT!
(13:40:33) Progress: 32032/67748
```

**Firmware update**

47%

Ready!

**Configuration – Preset**

robolab

Version: v3.0.0

**Device List**

- [B] (0x0710) WSAUL\_UWBIMU\_revE
- [TS] (0x0711) WSAUL\_UWBIMU\_revE
- [TM] (0x0813) WSAUL\_UWBIMU\_revE

**Quick Info** | **Global Register** | **Pre Configures** | **Sensors**

CL++ pre-configured settings

- WSAUL\_XCTRB\_0701
- WSAUL\_XCTRB\_0702
- WSAUL\_UWBIMU\_0711
- WSAUL\_UWBIMU\_0712
- WSAUL\_UWBIMU\_0713
- WSAUL\_UWBIMU\_0714

Test IMU pre-configures

- WSAUL\_BASIC\_CONFIGURATION\_0710
- WSAUL\_TEST\_IMU\_0711
- WSAUL\_TEST\_IMU\_0712
- WSAUL\_TEST\_IMU\_0713
- WSAUL\_TEST\_IMU\_0714
- WSAUL\_TEST\_IMU\_0715

[[COM36], 'USB Serial Device (COM36)', 'USB VID:PID=0483:5740 SER=207836754142 LOCATION=1-4.1.3']  
 [[COM56], 'USB Serial Device (COM56)', 'USB VID:PID=0483:5740 SER=2078379C394E LOCATION=1-4.3']  
 [[COM32], 'USB Serial Device (COM32)', 'USB VID:PID=0483:5740 SER=2076307F384B LOCATION=1-4.2']  
 [[COM11], 'STMicroelectronics STLink Virtual COM Port (COM11)', 'USB VID:PID=0483:3748 SER=9 LOCATION=1-4.1.1.x.2']

WSAUL\_UWBIMU\_revE is selected.

Ready!

# Software Application - WSA Test Suite

**IMU sensors configuration**

robotlab laboratory of robotics

Version: v2.1.2 (CL++ 2.1.x)

Configurable internal IMU sampling rate divider (when DLPF is on and internal sampling is 1 kHz) MCU sampling timer easy to set to predefined values:  
 {1, 10, 20, 50, 100, 200, 250, 400, 500, 800, 1000} Hz

Internal sampling divider: Enter value: 0 - 255 | Sample Rate Divider

**Inspect/analyze of saved data**

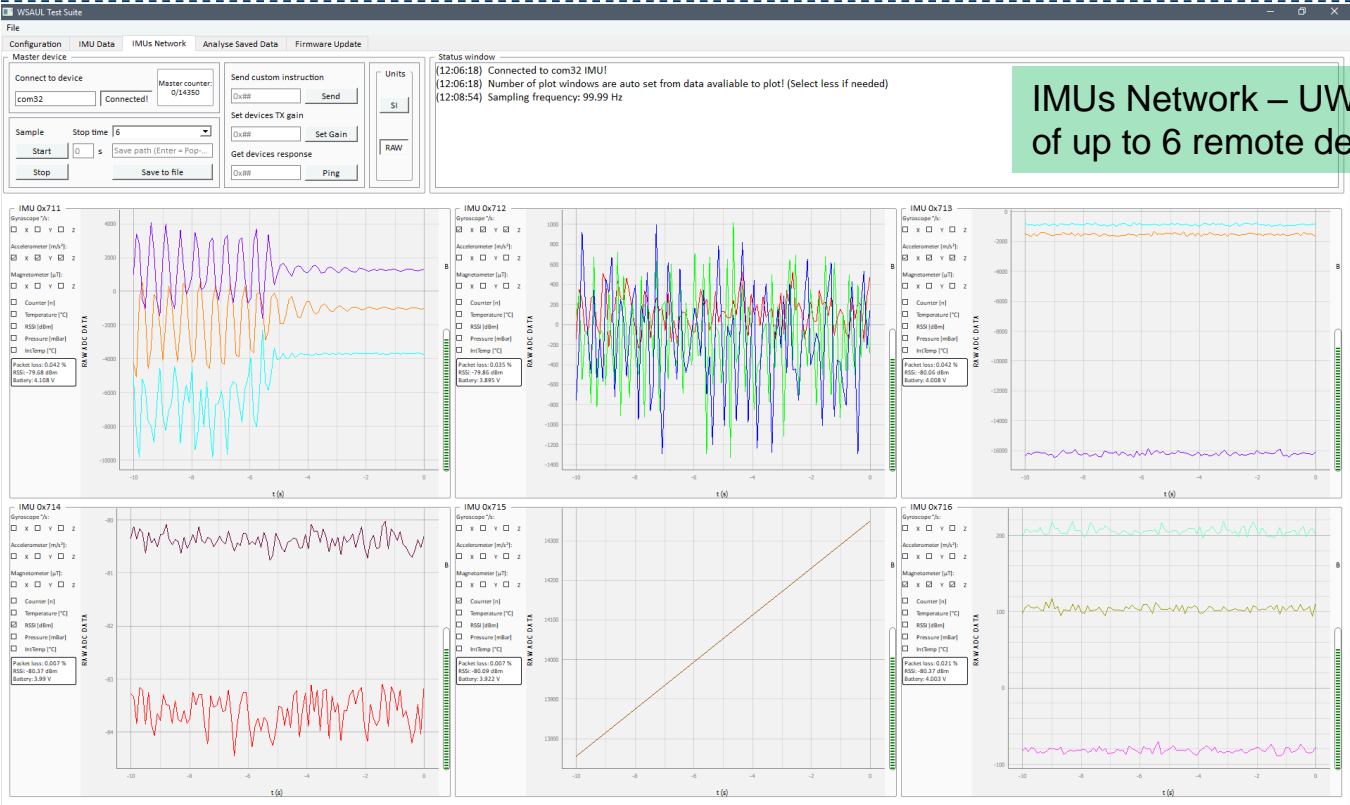
RAW ADC DATA

Sample (In)

Selected file: C:\Users\zorani\Documents\CL++\Software\GIT-repositories\WSAUL\_TEST\_SUITE\09-06-2020\_12\_15\_04.txt



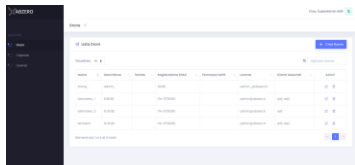
# Software Application - WSA Test Suite



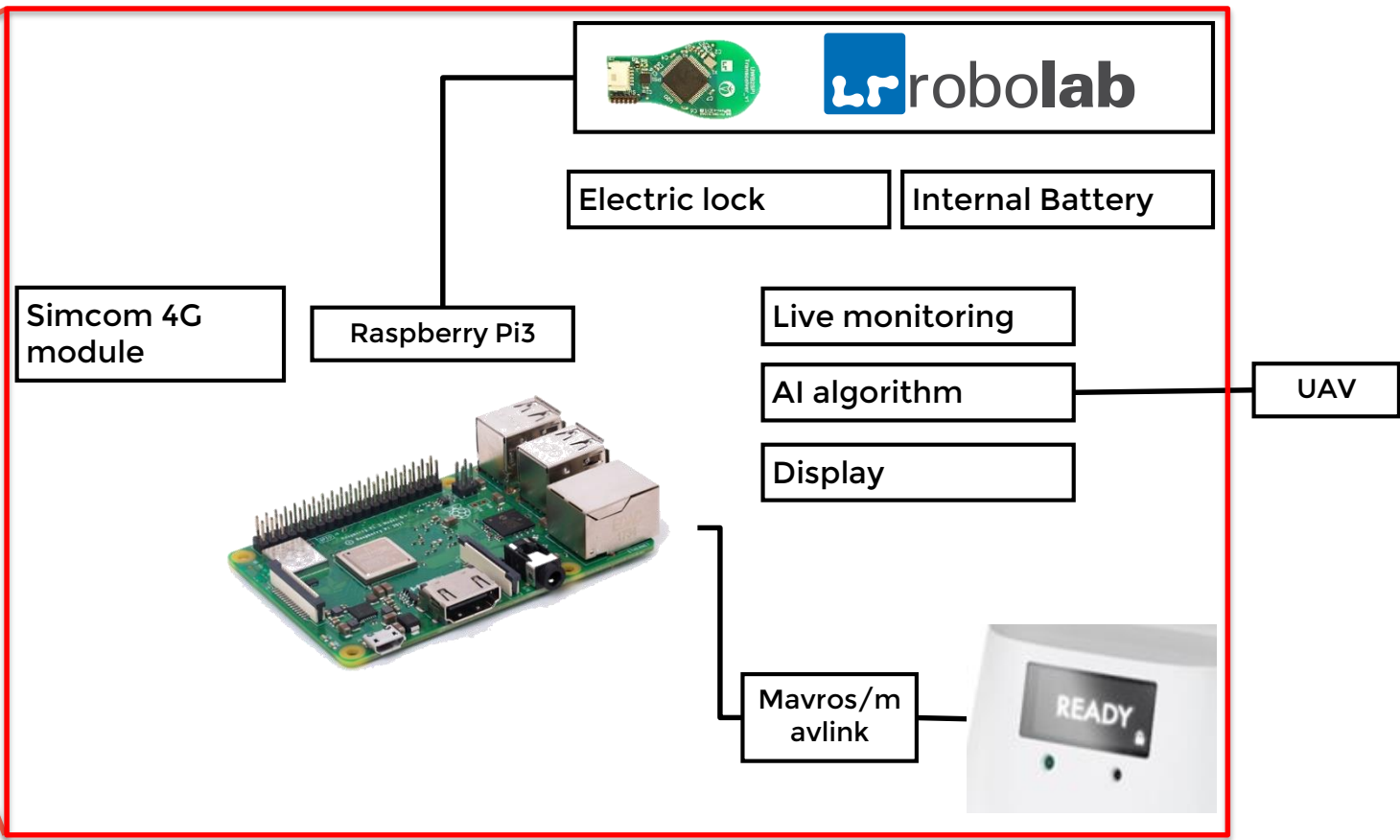
IMUs Network – UWB radio network of up to 6 remote devices (via USB)

Ready.

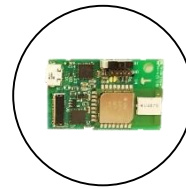
# System architecture detail



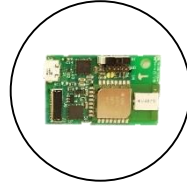
SPOKE



# Sensorizing the Smart Capsule



Slide vibration monitoring



Capsule vibration monitoring



# Timeline (December 1<sup>st</sup> – October 1<sup>st</sup>)

## **WP1: Technology transfer**

- Task 1.1: Analysis of ABZ's sub-systems monitoring requirements [Month1 to M1]
- Task 1.2: Adaption/Implementation of new sensors on the IMU device [M2 to M7]
- Task 1.3: Firmware and hardware integration of the IMU device in the fIAIX system and lab testing [M4 to M7].

Milestone #1: 2.0 version of the ABZ's system integrated

## **WP2: Test and demonstration**

- Task 2.1: Obtainment of flight authorization [M7 to M7]
- Task 2.2: Field tests and demonstration in operating conditions (5 delivery missions) with KPI check [M7 to M9]
- Task 2.3: Fine-tuning and final modifications [M8 to M9]

Milestone #2: 2.1 (final) version of the system integrated (after fine-tuning)

## **WP3: PM, IPR agreement design & Dissemination [M1 to M9]**

- Task 3.1: IPR licensing agreement design and signature [M1 to M1]
- Task 3.2: Preparation and publication of abstracts and presentations (R, PU). [M3 to M9]
- Task 3.3: Elaboration of MP (Mentoring Plan) Initial plan, Intermediate report [M9 to M9]

# Current and past projects



**myGalileoDrone**  
**1st prize**

of 100,000 EUR cash

is awarded to

**NAUTILUS**  
Delivery of medical goods via patented smart capsule  
equipped with Galileo for improved tracking  
**Giuseppe Tortora and ABZERO team**



**myGalileoDrone**  
competition

## IUPITER project



UNIVERSIDAD  
DE MÁLAGA



**Junta de Andalucía**  
Consejería de Salud y Familias  
SERVICIO ANDALUZ DE SALUD

## E-FLIGHT project



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Focused Technology Transfer  
Experiments (FTTE) 2<sup>nd</sup> Call  
Financial Support to Third Parties