

# Aquadrone : geo-tracking and collecting environmental data from an underwater remotely operated vehicle

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AGENCE FRANÇAISE  
POUR LA BIODIVERSITÉ

ÉTABLISSEMENT PUBLIC DE L'ÉTAT

Pôle INSIDE



eaufrance



## The french Biodiversity Agency invests in open source

Since 2002 and the setup of the **French Water Information System**, a strong will promotes open source technologies : in technology choices (QGIS, PostgreSQL, R, JAVA, Python, Drupal CMS...) and in deployment strategies and user support.

## Renewing digital projects and environmental approaches

**Open source software** : AGILE / SCRUM methods, new way to lead developments and contracts, better access for public officials and general audience.

**Open source hardware** : before *Aquadrone*, the AFB invests in sensors (sonars, LIDARs) for GIS. ROVs are mainly not open source and provided at high costs by private companies.

## Partnerships and current projects

The AFB gathers public actors and open source players :

- **online open source tools**
- **public markets** for open development and open data
- professional **training** involving private sector
- **INSIDE cluster** for digital innovation and promotion

## A wide scope of data collected

*Bathymetry, physico-chemistry, hydromorphology, biology, quantity (discharge and low flows), real-time temperatures (...)*

## A great diversity of natural places

Tools need to be fitted to **various conditions** and **natural places** :  
temperature and shock resistance, weight, variable ranges...

A great scientific part : **ready-to-use answers are hard to find.**

## To explore : to be able to go and site sensors everywhere

Because some places are **hard to reach**

Because **safety** and user **welfare** are priorities

And because the use of a drone can be **cheaper.**

➡ A need for survey automation (bathymetry only)

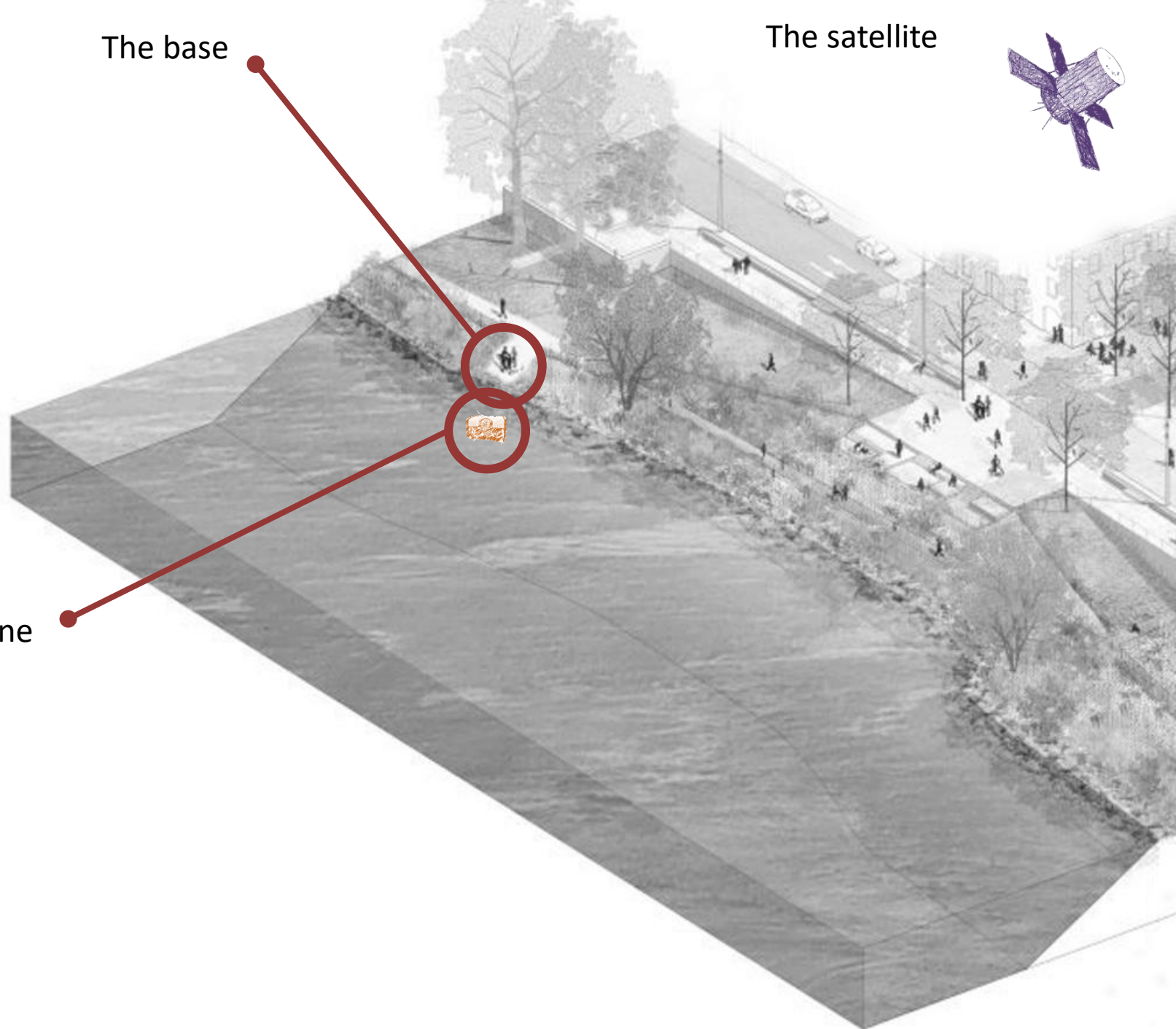
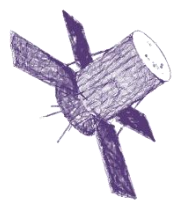
➡ Supporting existing methods and assisting users on site



# Design brief

The base

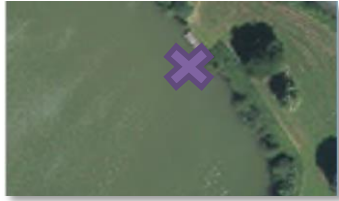
The satellite



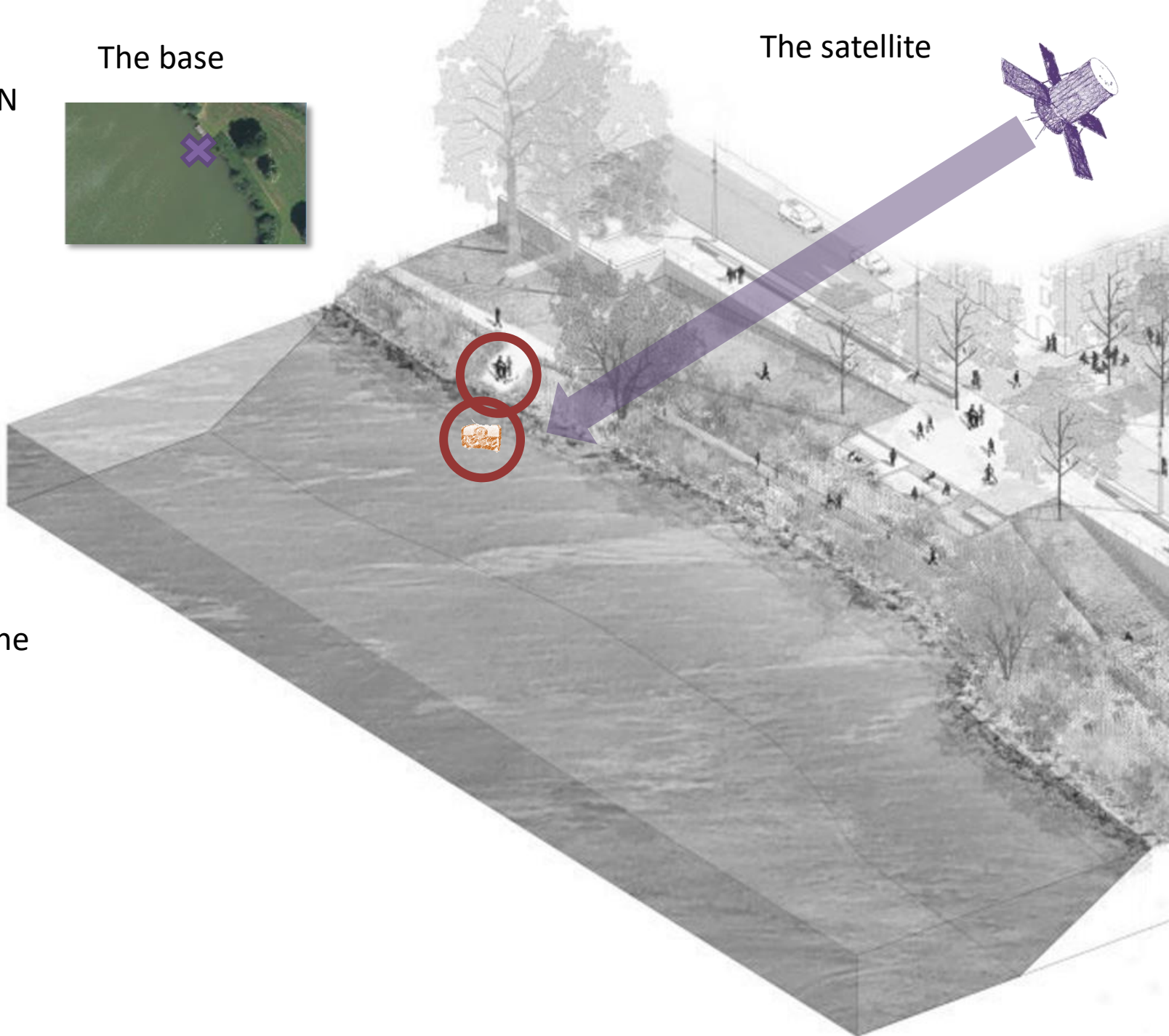
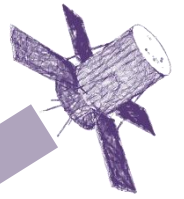
The aquadrone

PHASE 1:  
INITIALIZATION

The base



The satellite



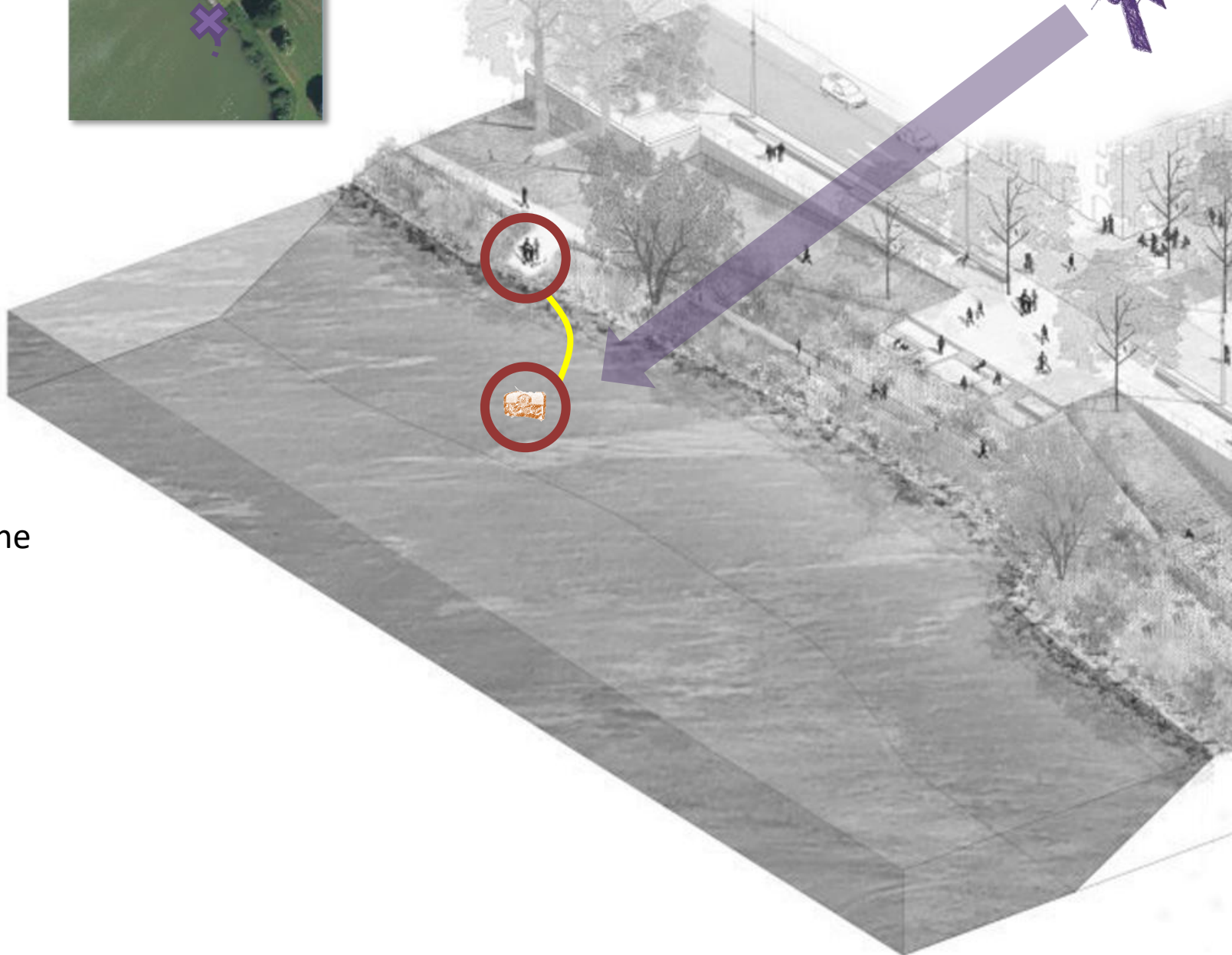
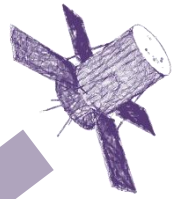
The aquadrone

PHASE 2:  
SURFACE RIDE

The base



The satellite



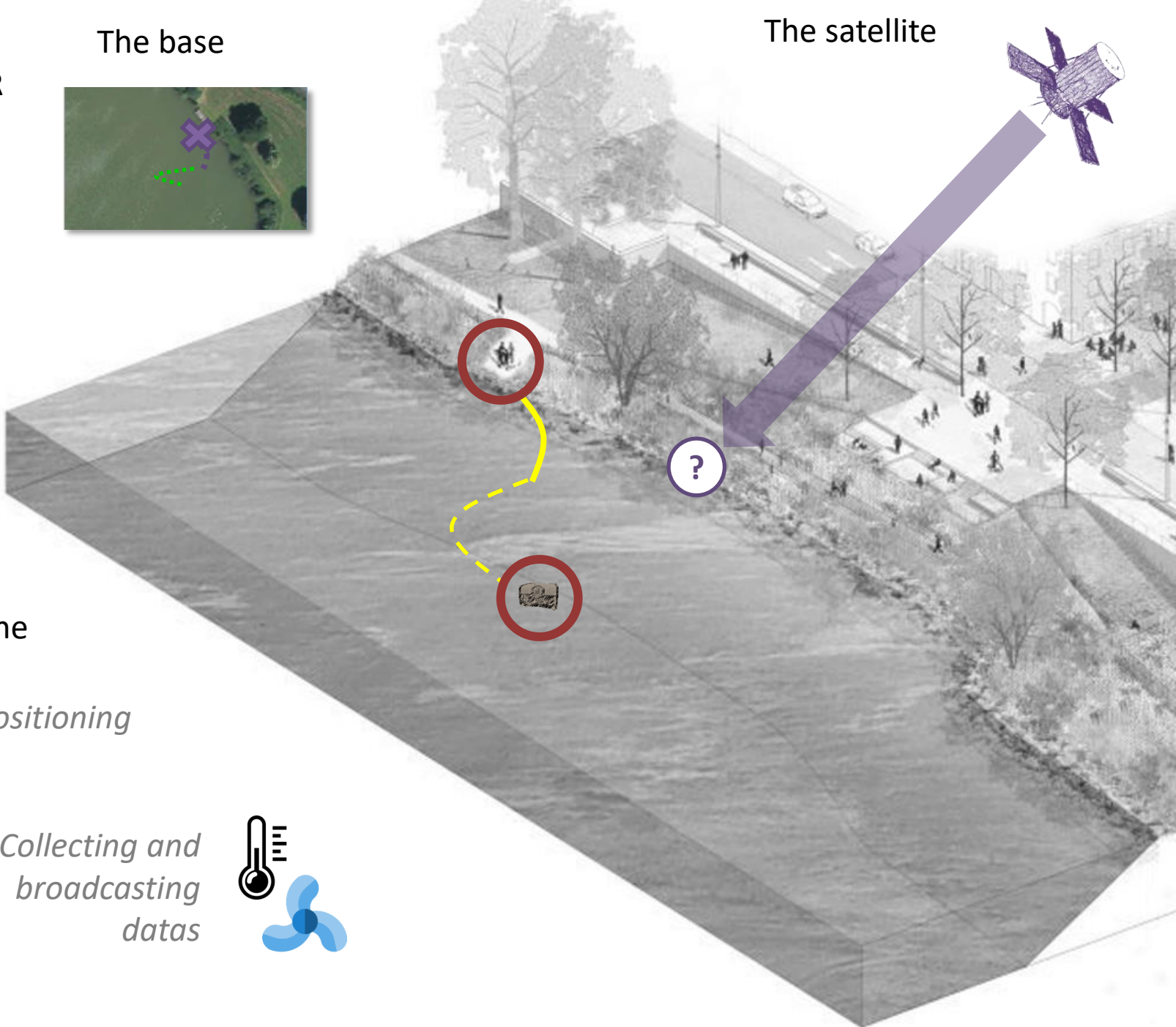
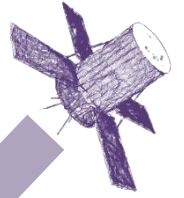
The aquadrone

PHASE 3:  
UNDERWATER  
RIDE

The base



The satellite

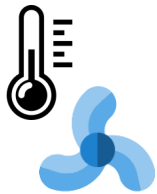


The aquadrone



*IMU positioning*

*Collecting and  
broadcasting  
datas*



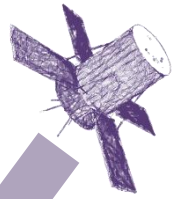


PHASE 4:  
SURFACE  
RECALIBRATION

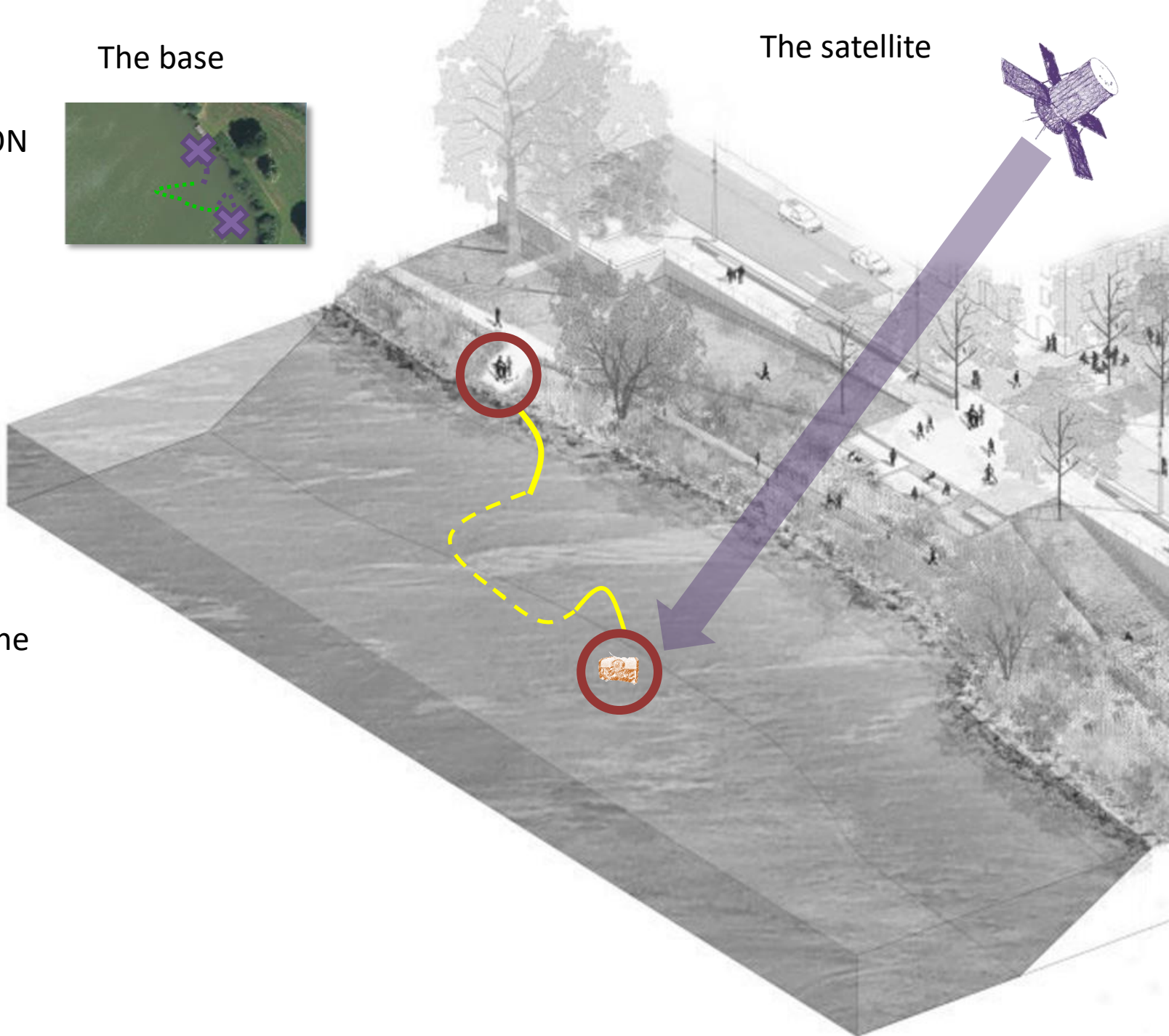
The base



The satellite



The aquadrone



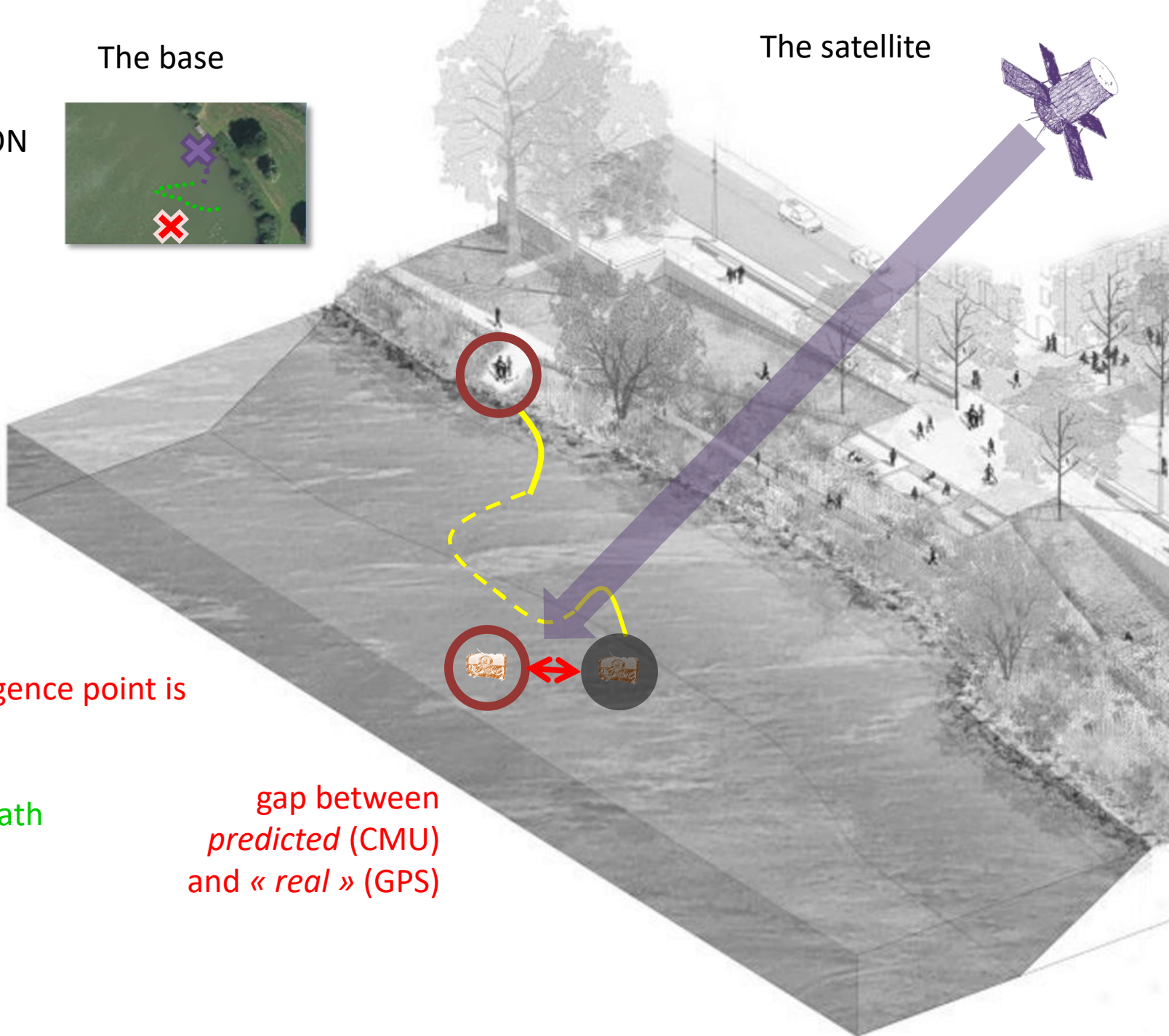
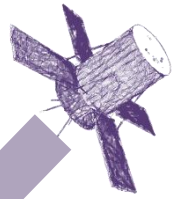
PHASE 4:  
SURFACE  
RECALIBRATION

The base



The path  
we think

The satellite



What if emergence point is  
different ?

The « *real* » path  
is different

gap between  
*predicted* (CMU)  
and « *real* » (GPS)

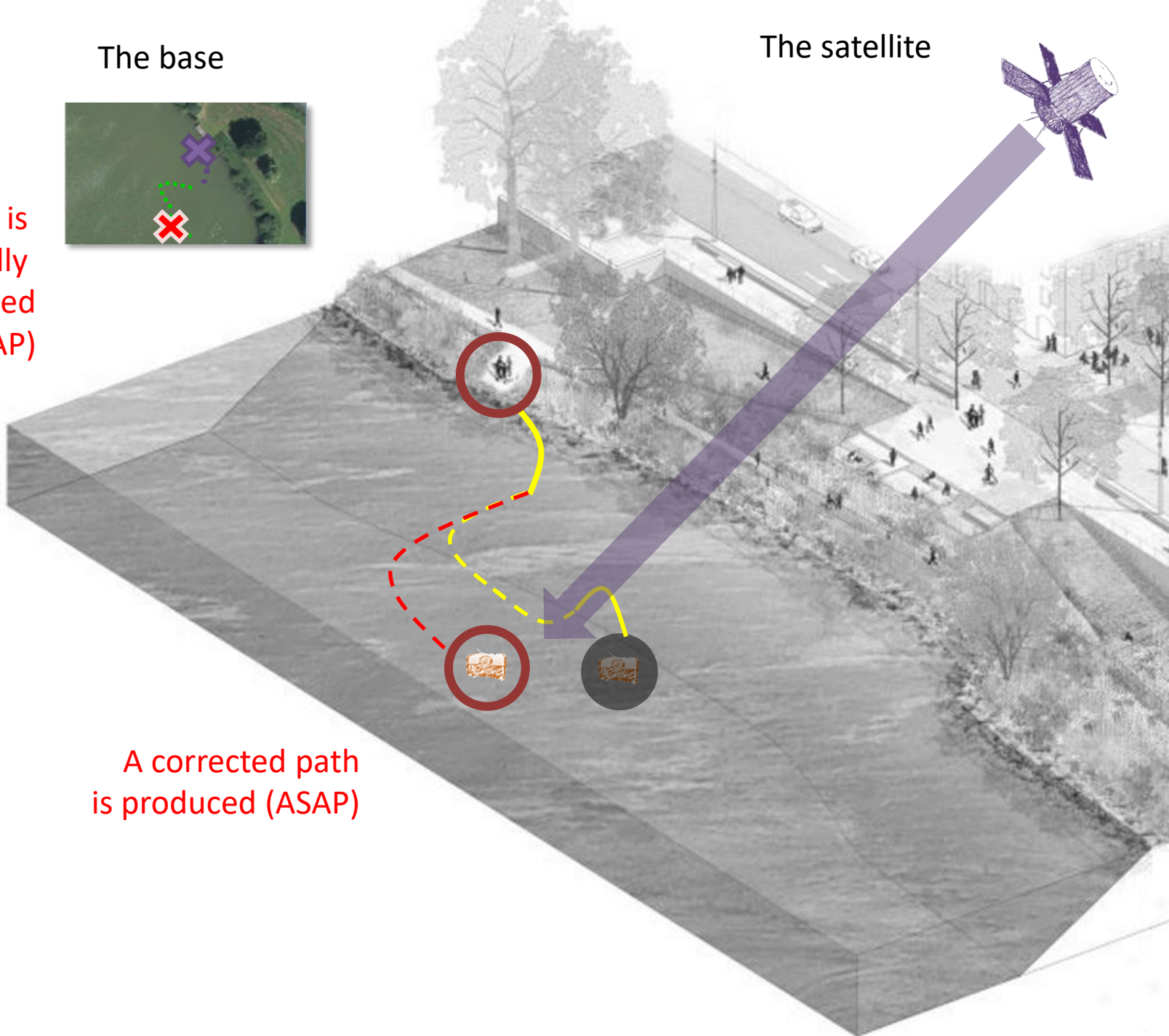
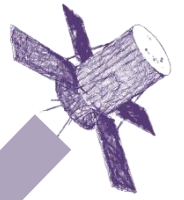
PHASE 5:  
CORRECTING  
DATAS

The base



The map is  
dynamically  
corrected  
(ASAP)

The satellite



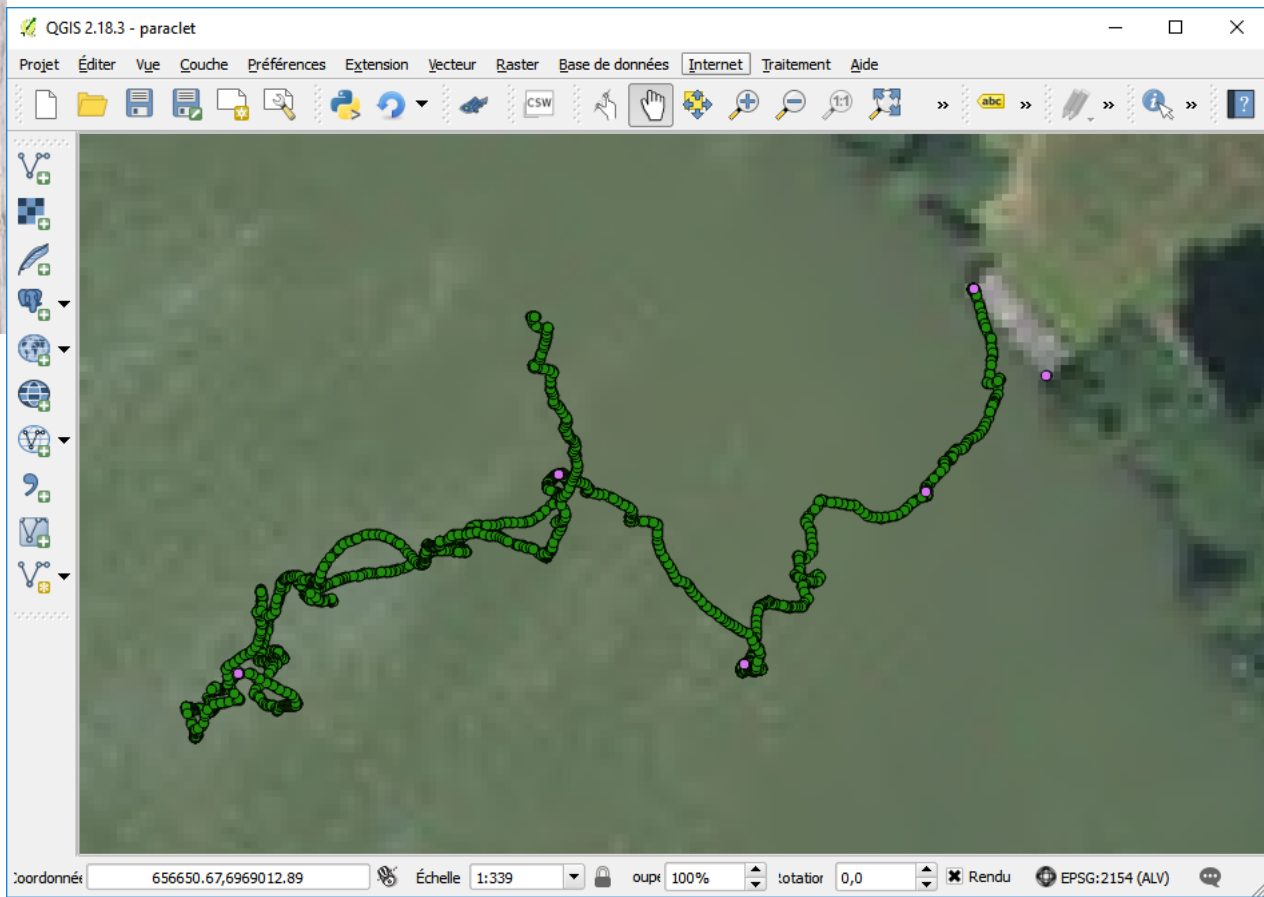
A corrected path  
is produced (ASAP)

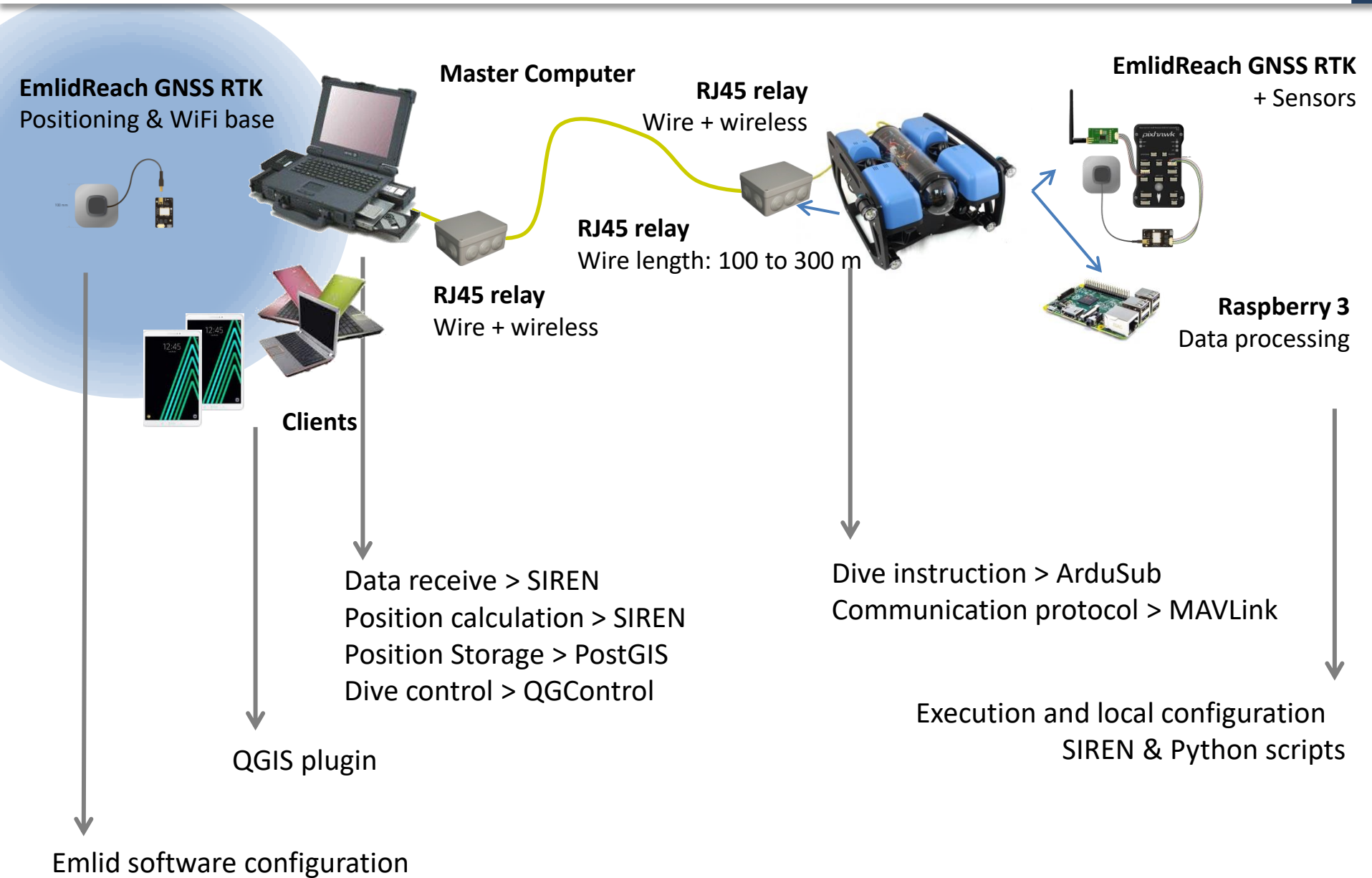
# Technical solution

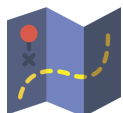
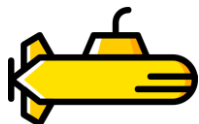


Precision:  
 $\pm 50\text{cm}$

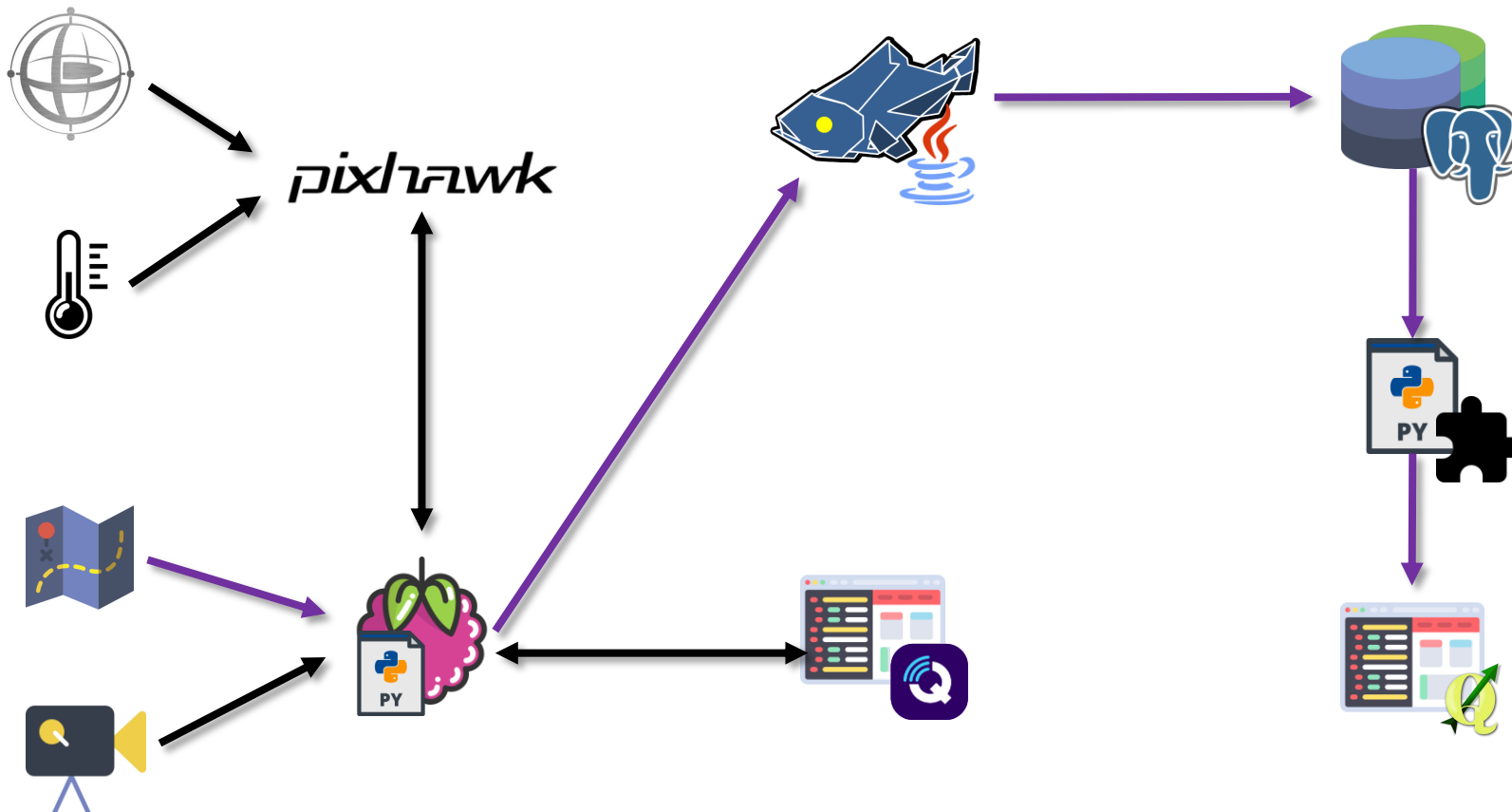
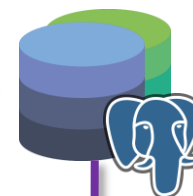
Refresh:  
at least each 1s

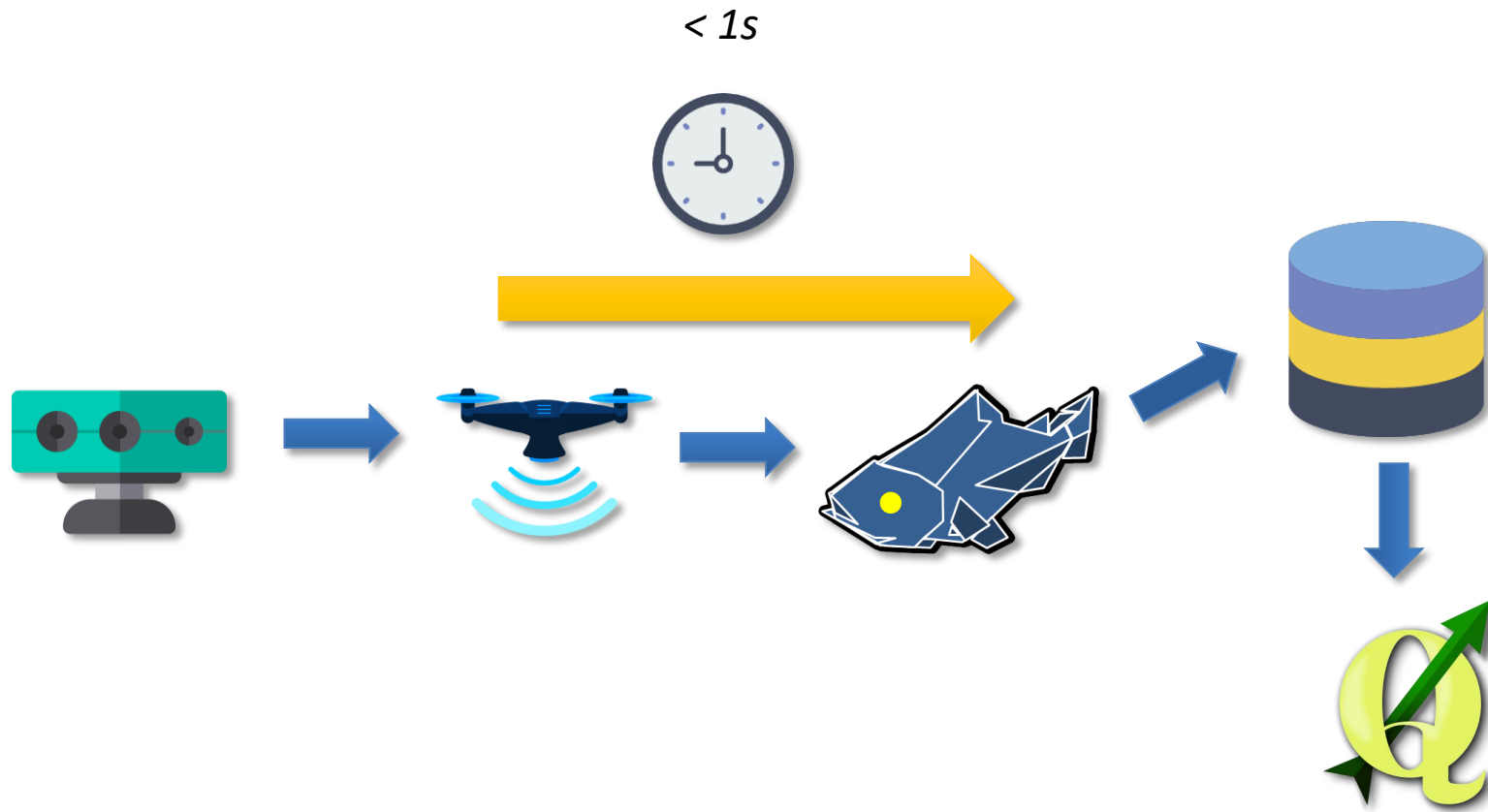






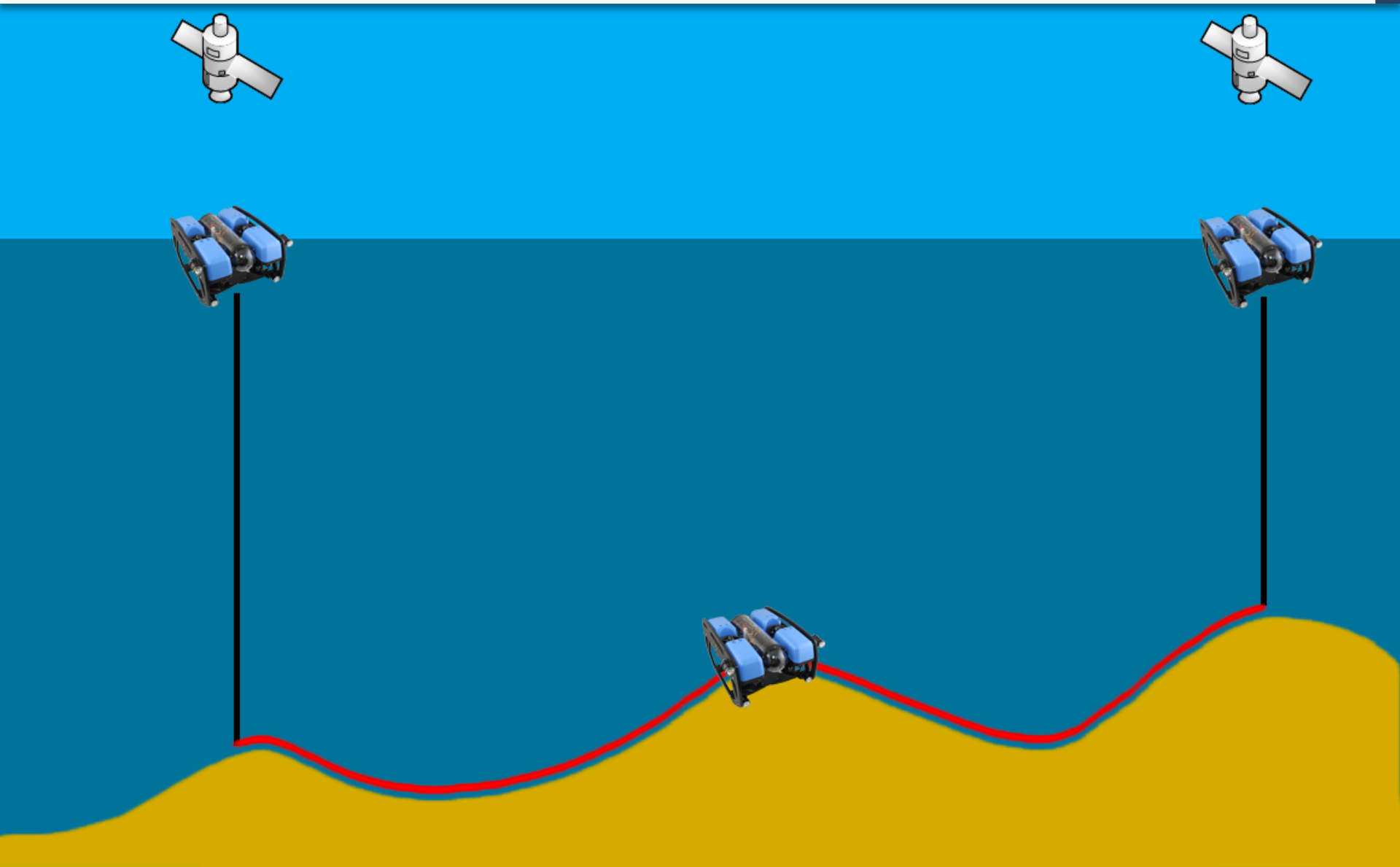
*pixhawk*



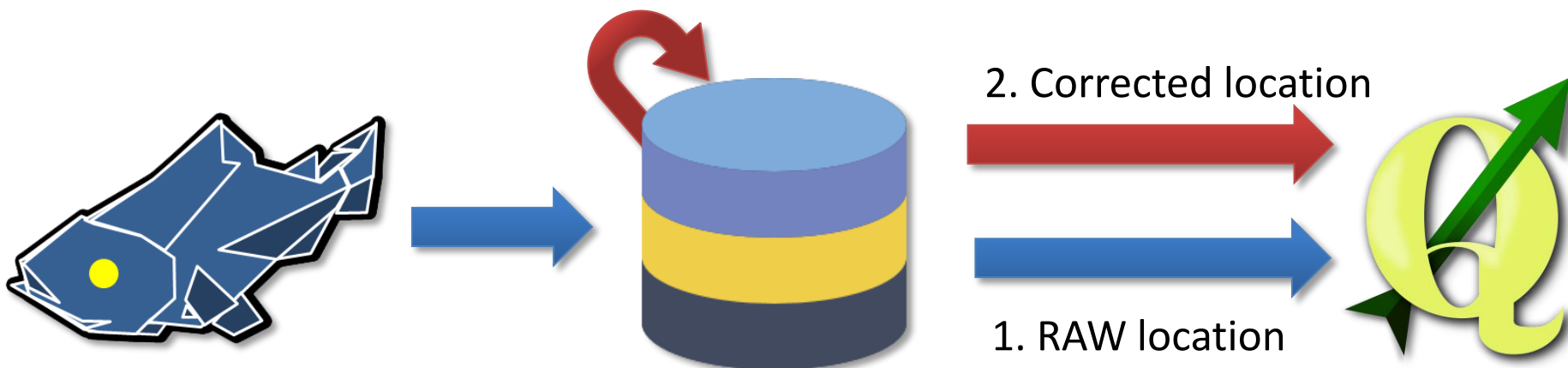




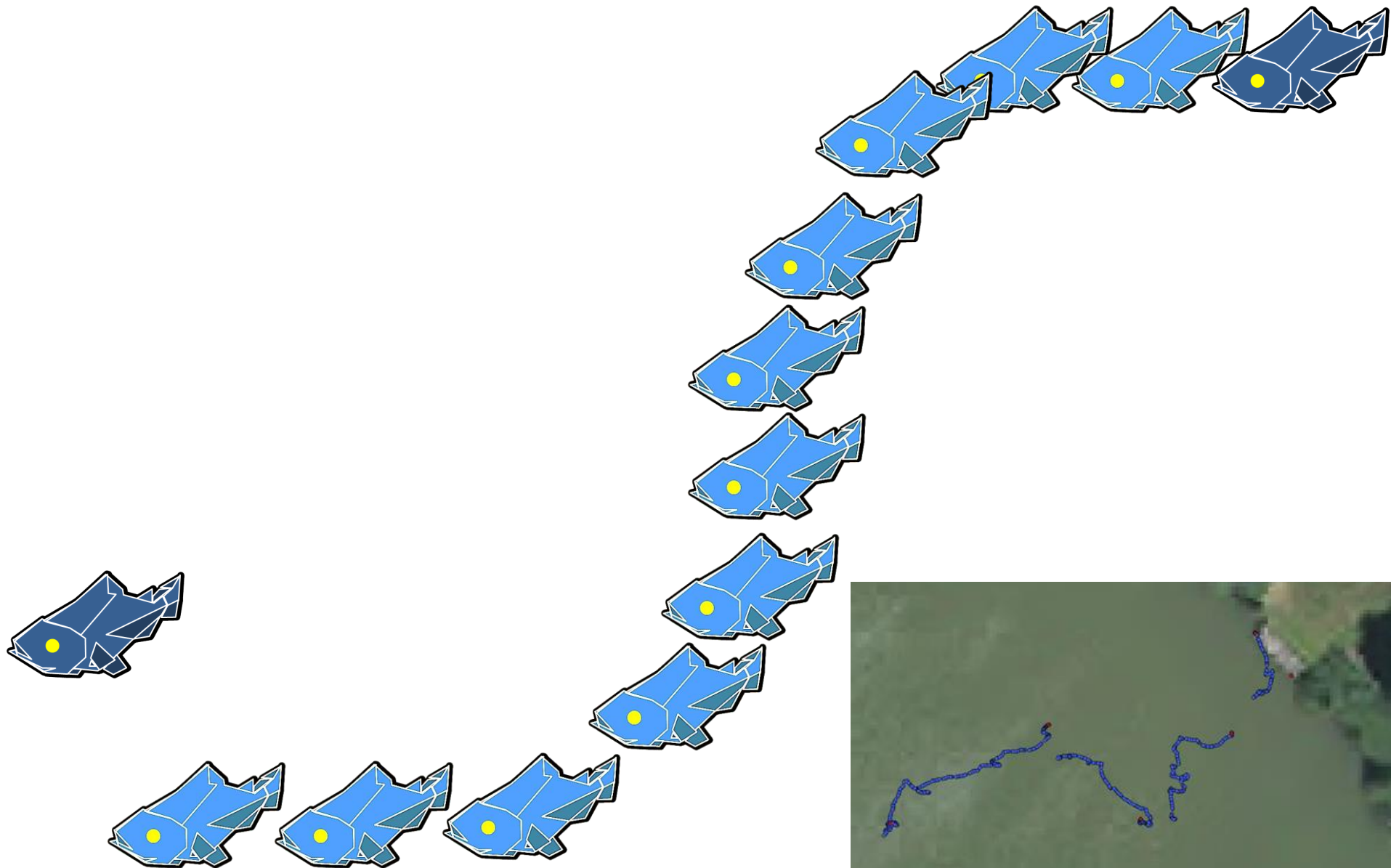
# Solving the positioning issue



# Processing



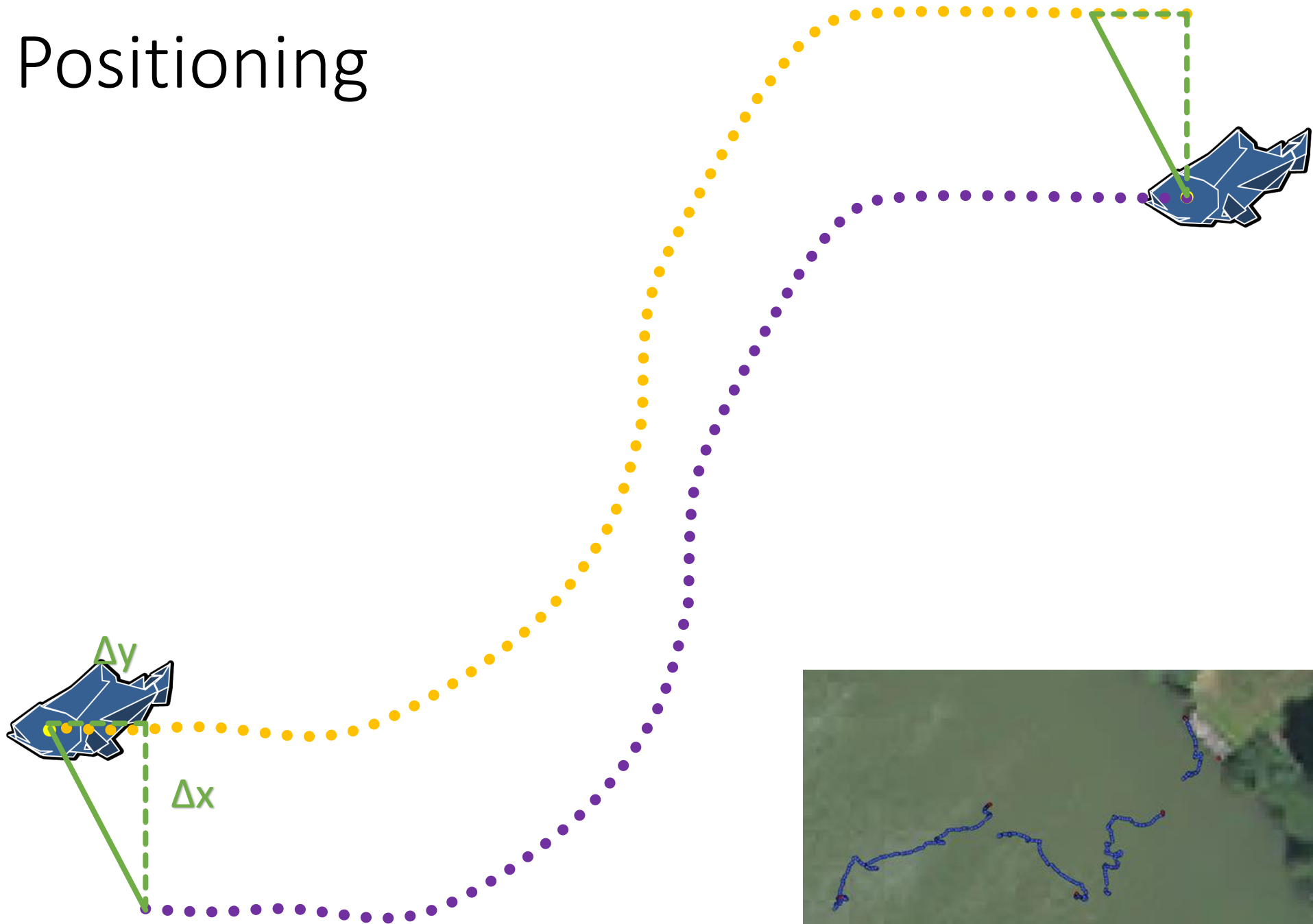
# Positioning



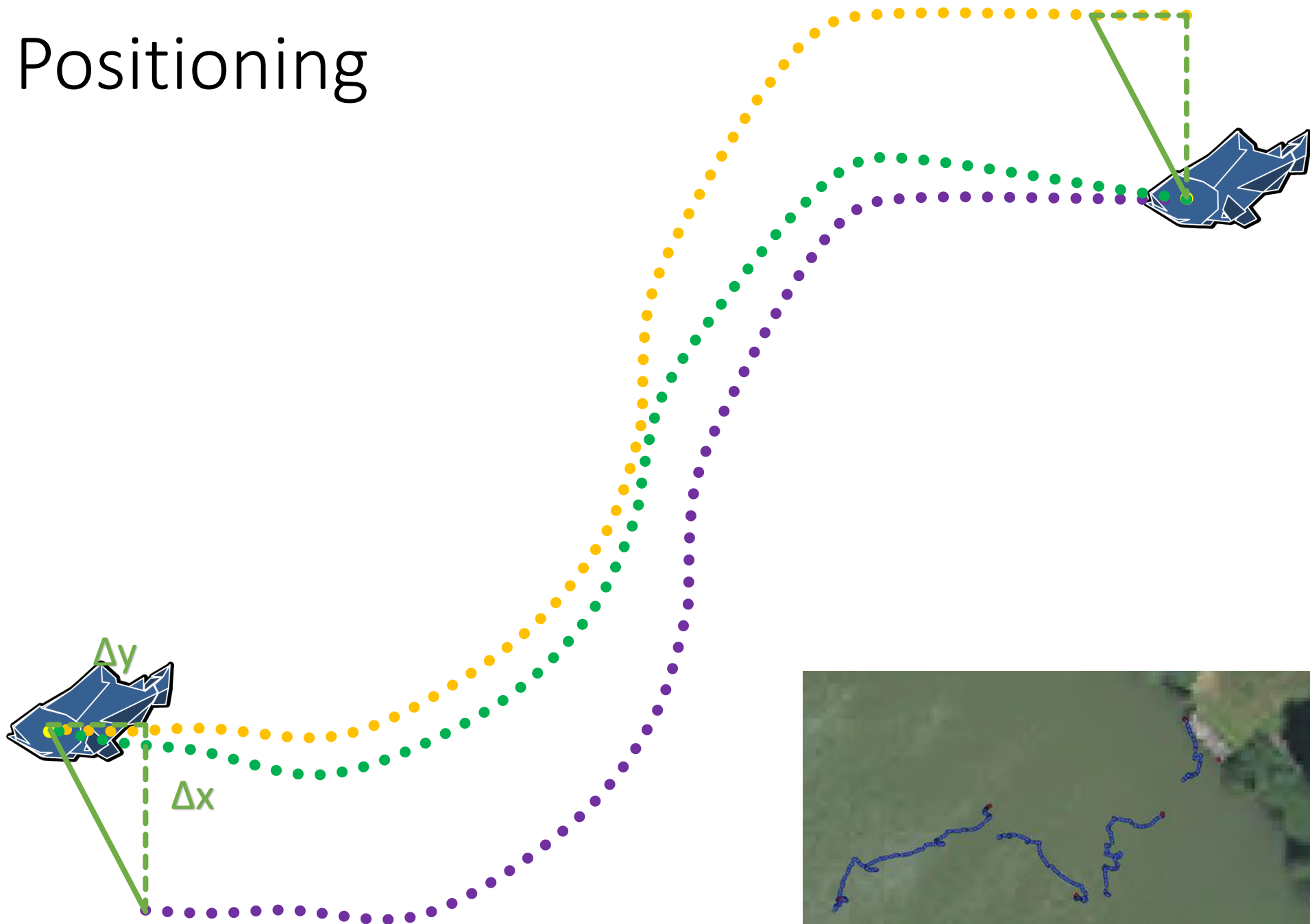
# Positioning



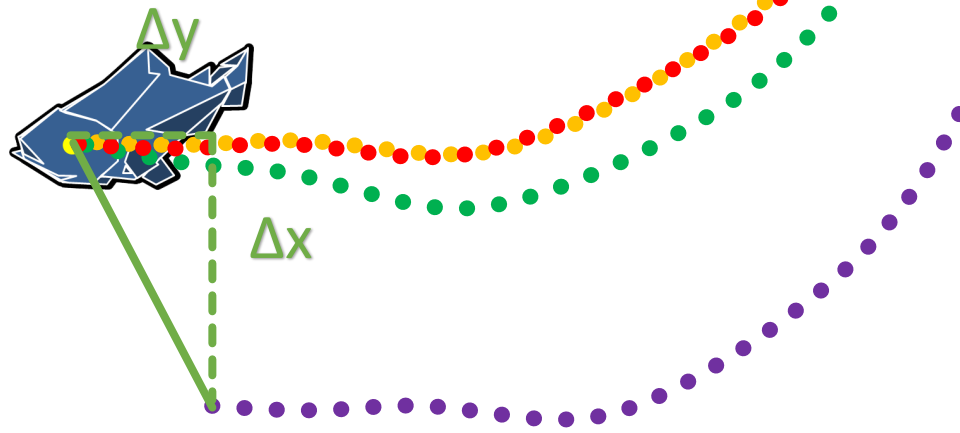
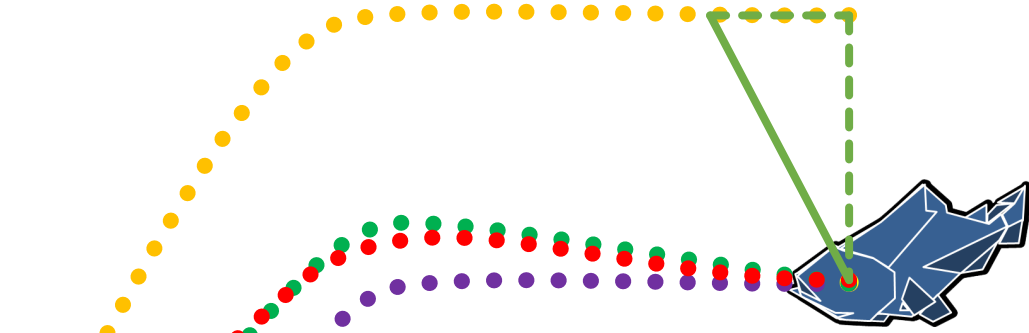
# Positioning

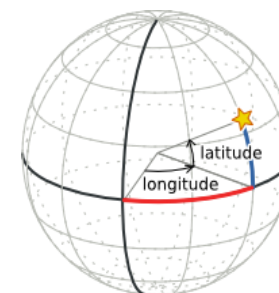
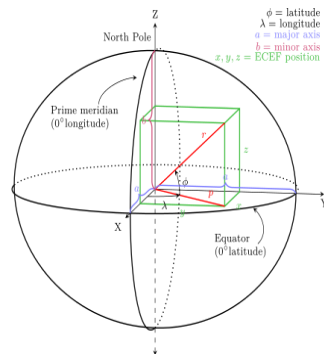
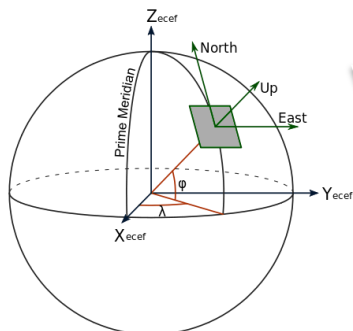
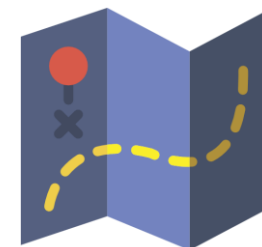


# Positioning



# Positioning





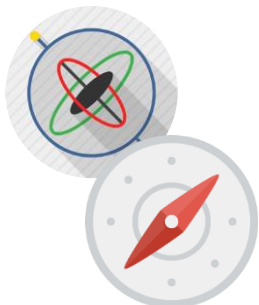
**Drone**  
Reference

**ENU**  
Reference

**ECEF**  
Reference

**GPS**  
Reference  
(WGS84)



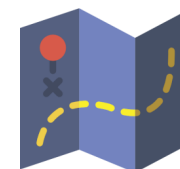


New IMU

Display position on QG Control

Water Linked® Underwater GPS Kit  
*By BlueRobotics*

Separate everything

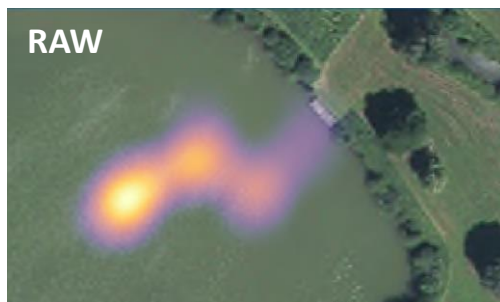


# Outcomes & prospects

## Regarding drone positioning



## Regarding dynamic heat map

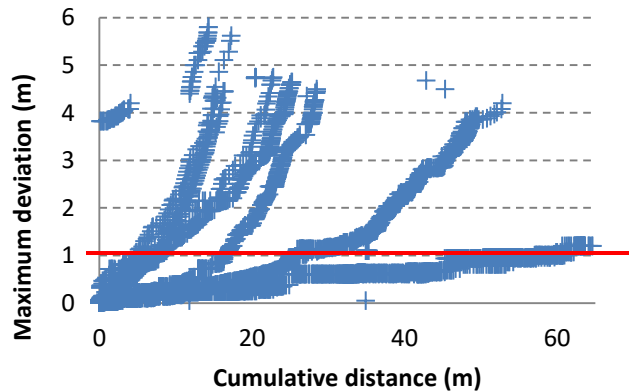


## Characterizing deviation

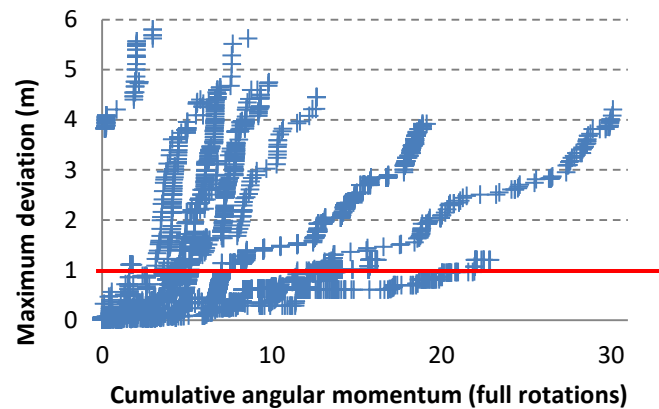
20 to 50 cm accuracy when the trajectory is linear

Underestimate of 1/7 to 1/6 of the curvilinear distance during tight turns.

*Max(gap) following cumulative distance since last GPS reference*



*Max(gap) following cumulative angular momentum since last GPS reference*



## Last project four-days stage for integration tests and life-size tests

**An operational focus** : professional users are requested – *more than 15 days on site with around 30 participants*

Is the drone usable for **surveys** ? For **scientific purposes** ? Is it a **gadget geek** ?

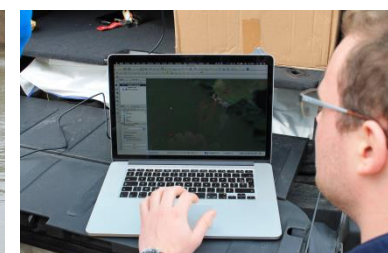
## Advices and recommendations

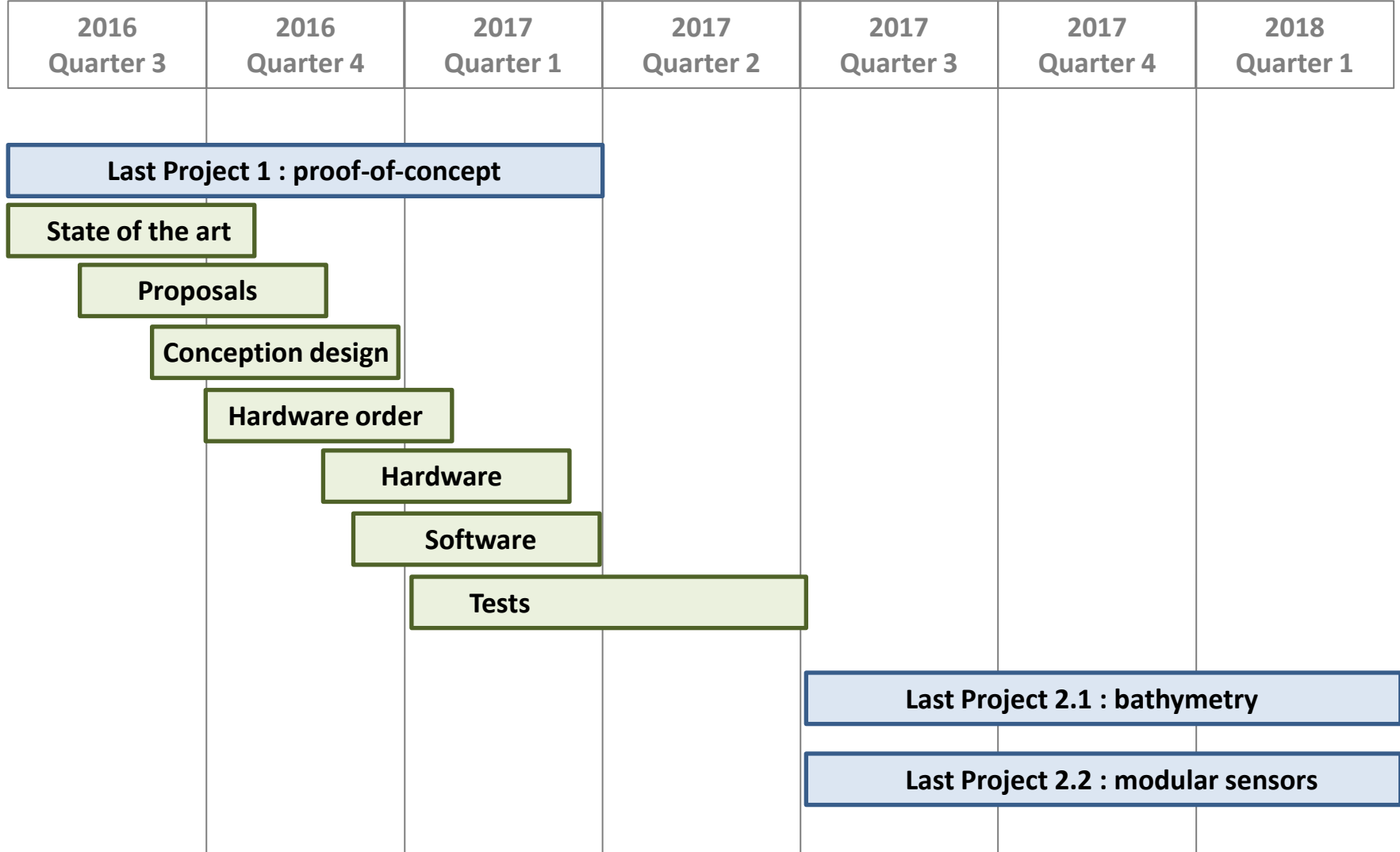
- ➔ **safety** tips and **check** lists
- ➔ different places and natural **conditions** = different **equipment** (*visibility*)
- ➔ **ergonomics** : less cables, less leak tests, less boxes
- ➔ **modularity** : three boxes – the base, the drone, the sensors – each with its own battery

## A new approach of digital tools : user communities

Open source top down / bottom up : need **feedback** on each type of use

Free to think about **other ROVs** (aerial, terrestrial, floating) and **other uses** of hardware





## *Thank you for listening*

- **AFB team :**  
Alexandre Liccardi (DAPP, INSIDE), Laurent Breton (DAPP), Gabriel Melun (DREC)
- **ESIPE *Last Project*, 2016 – 2017 team :**  
Jérémie Collomb, Julien Roussel, Philippe Strock, Loïc Szymanski, Thibault You, Jérôme Goasdoue, Théo Pascoli, François Vanderperre
- **Technical advisors AFB :**  
Yann Galez (SD76), Philippe Rosan (SD62), Baptiste Roussel (DIR Normandie Hauts de France), Caroline Pénil (DAPP), François Hissel (DAPP), Marie Colin (DAPP), Mourthy Tetchana (DSI)  
Geomatic community of the AFB



*Everything (codes, schema, technical specifications, integration tests...) is available at*  
<http://www.pole-inside.fr/aquadrone>