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Monitoring urban chemistry at the street corner: the SMILE startup project

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USERS-2022

Urban Science and Engineering for Resilience and Sustainability

Monitoring urban chemistry at the street corner: the SMILE startup project



Project Leaders

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Outline

- **The SMILE project: context and expected outcomes**
- The SMILE Concept
- Technical implementation: 2D approach
- Technical implementation: 3D approach
- Co-development partners
- Conclusion & Perspectives

Genesis

- **SMILE project begun in 2020 and involved at first 3 partners:**
 - **Dr. Hassen Aziza**, head of the Memory team (MEM) at **IM2NP**, UMR 7334 **IM2NP** (CNRS, AMU).
 - **Dr. Pascal Taranto**, director of a Mixed Research Unit at **CGGG**, UMR 7304 (CNRS, AMU)
 - **Dr. Charles Talbot**, weather scientist and co-founder of the SCOP (cooperative production society) **LICA**, “Collective and Artificial Intelligence Laboratory”.

- **SMILE : Self-calibrating IoT Multi-sensor platform to Leverage citizen’s Empowerment in air pollution.**

Objective & Outcomes

■ Objective

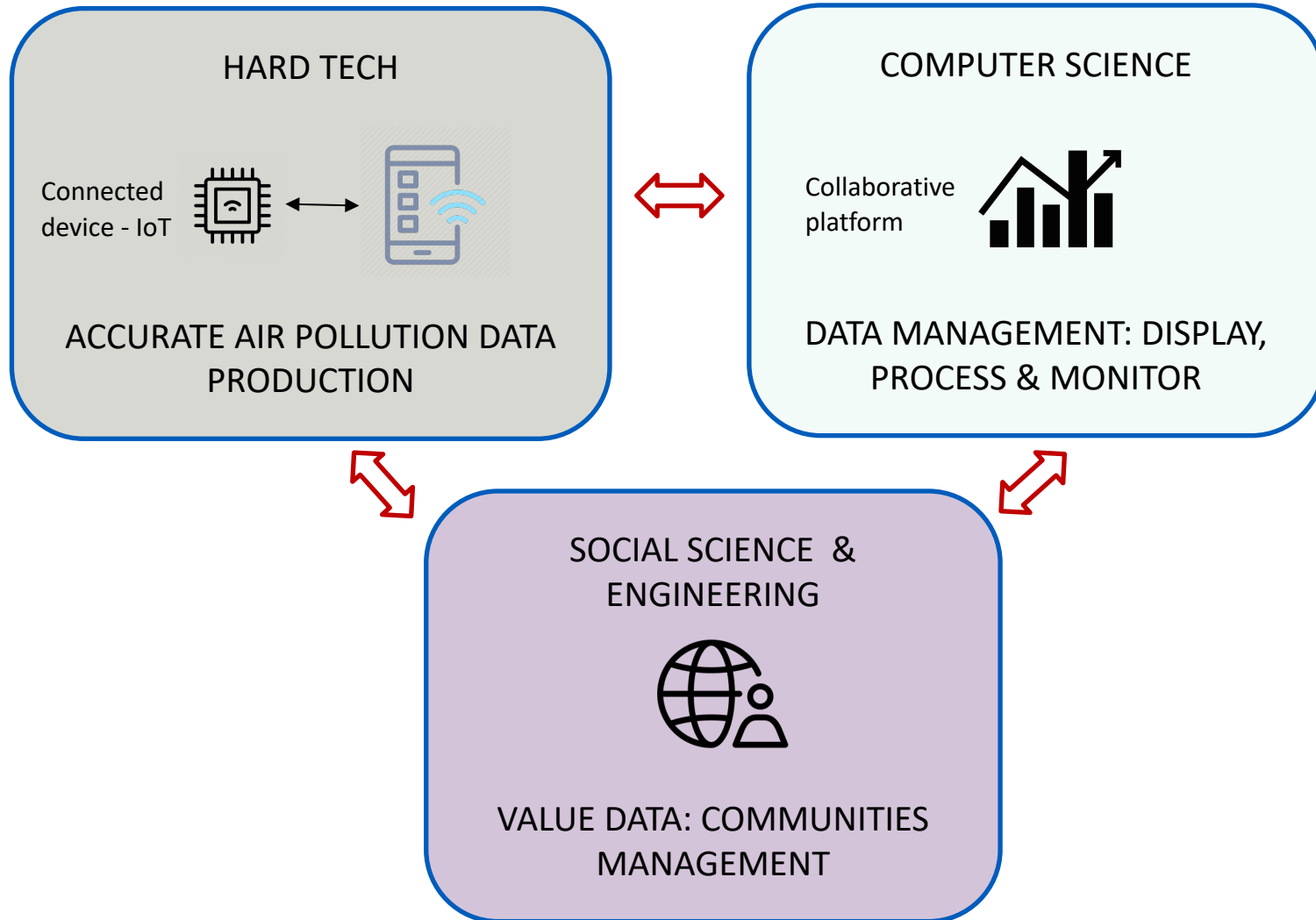
- Tackle the major problem of atmospheric pollution in urban environment

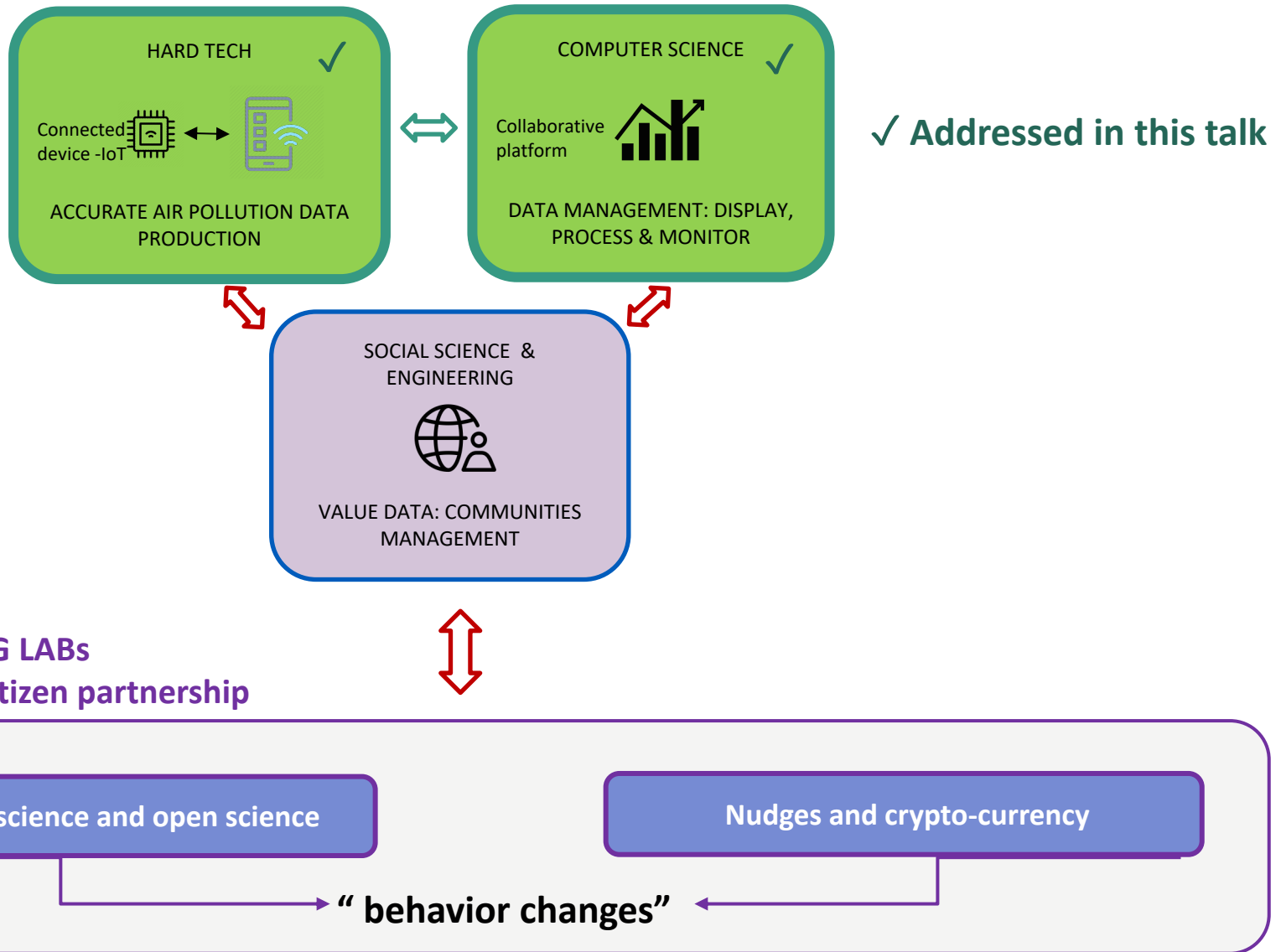
■ Outcomes

- Produce **accurate** environment data and provide groundbreaking solutions for IoT technology in air sensors
- Process data and provide groundbreaking **citizen-oriented interface** for monitoring pollution
- Value data and provide in the follow-up an integrated solution tailored for each city and ready for business, to foster **behaviors changes** on local and global scale

SMILE is a **Social and Human Science-oriented project**. SMILE is based on the concept of “Empowerment”, that is the process that enables individuals to become aware of their capacity to act and to gain access to more power and control over their lives.

SMILE: a multidisciplinary project





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Information related to pollution ?

- Today pollution data providers:
 - Mobile commercial sensor devices
 - Low-cost but not accurate
 - Not connected
 - The "World Before" solution (individualist)
 - Government reference equipment
 - Accurate but Expensive
 - Not mobile
 - Limited in number



The collective solution lies between the two:
It retains the **mobility and the low cost** on the one hand and the **precision** of the measurements on the other hand

Limitations of mobile commercial sensor devices

■ **Problem: *sensor drift***

Significant part of commercial sensor technologies is sold without initial individual calibration to reduce cost. After deployment, calibration done on a regular basis is needed, otherwise the device will be just a **personal gadget drifting over time**.

■ **Solution: “*in situ*” calibration of sensors**

The calibration process will leverage on government or private **reference equipments**. the breakthrough consists of the capacity of the connected sensor to integrate techniques (both software and hardware*) for **calibrating sensors dynamically** to compensate their drift over time.

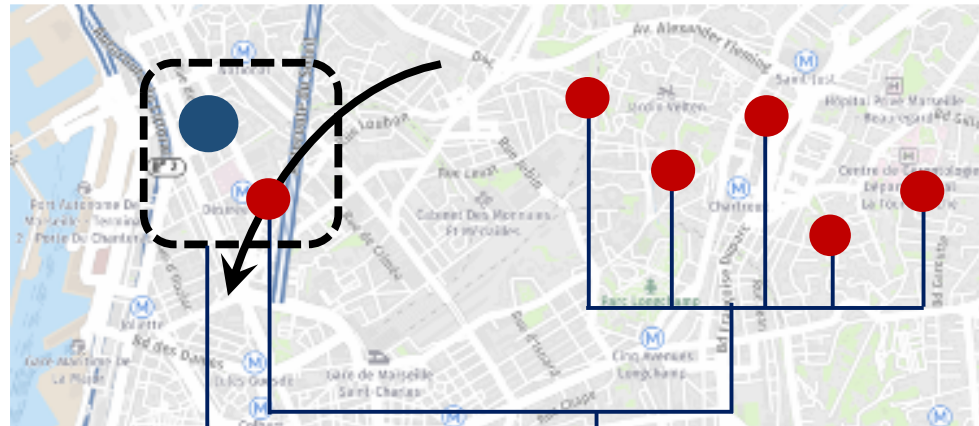
*Patented technique (SATT Sud-Est)

Turning commercial sensor devices accurate !

■ Dynamic calibration of sensors deployed in the field

●
Reference
Equipement

●
Connected
connecté



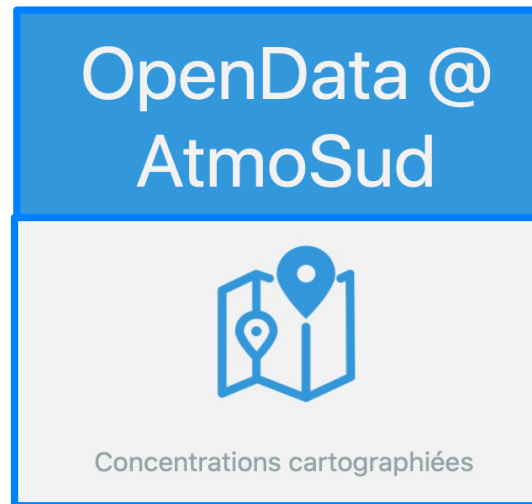
When the low-cost mobile
sensor is co-located with
reference instruments

A drift compensation
is operated in real
time

Sensors remain in the electronic device. No extraction of the sensors from the devices followed by a recalibration in the laboratory is required (prohibitive on the scale of a distributed sensor network)

Reference instruments data access: ATMOSUD

- POC: the drift compensation is achieved by recovering calibration parameters from reference instruments/stations owned by **ATMOSUD***



<https://opendata.atmosud.org>

*Association for reference stations management in the South of France PACA Region

THE SMILE CONCEPT

Extension of the **measurement accuracy** of reference equipments at any point in the urban space, using a dynamic network of :

- ✓ **Interconnected** et **self-calibrating** devices
- ✓ Providing real-time **mapping and analysis** of air quality at the **street level**

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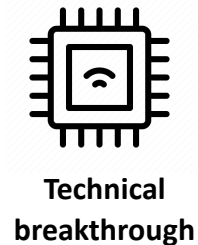
Environment data measurement methodology

A connected devices is used for real-time mapping and analysis of air quality

IoT Device

Cell Phone App

Collaborative Platform



Sensor data



Calibration data



Sensor data



Calibration data

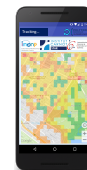


Human science breakthrough
("Empowerment")

Maps



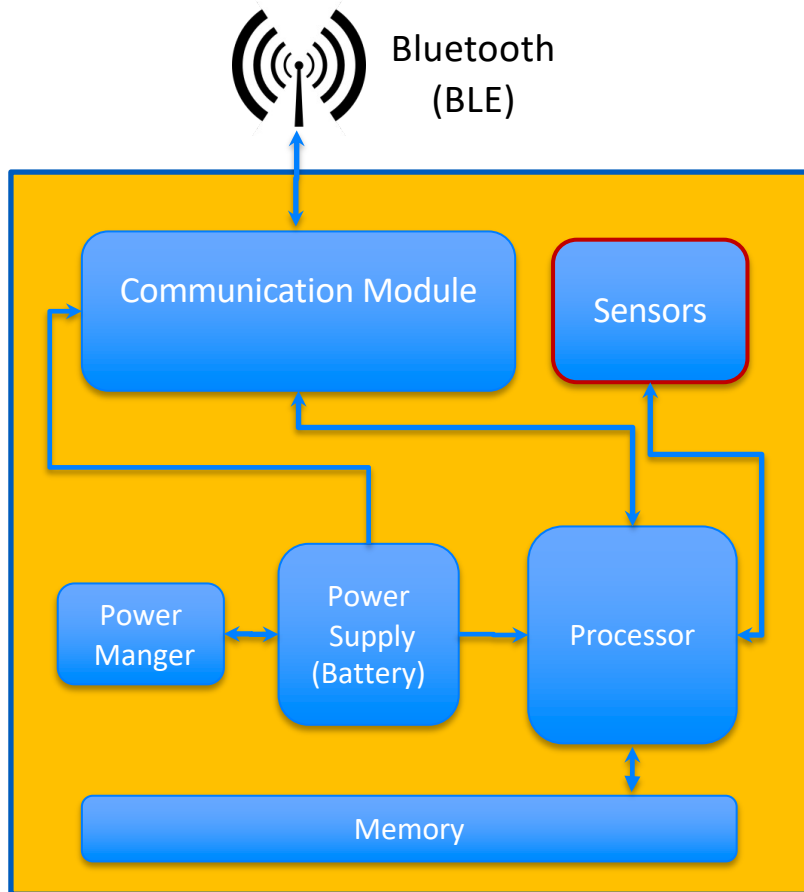
Maps



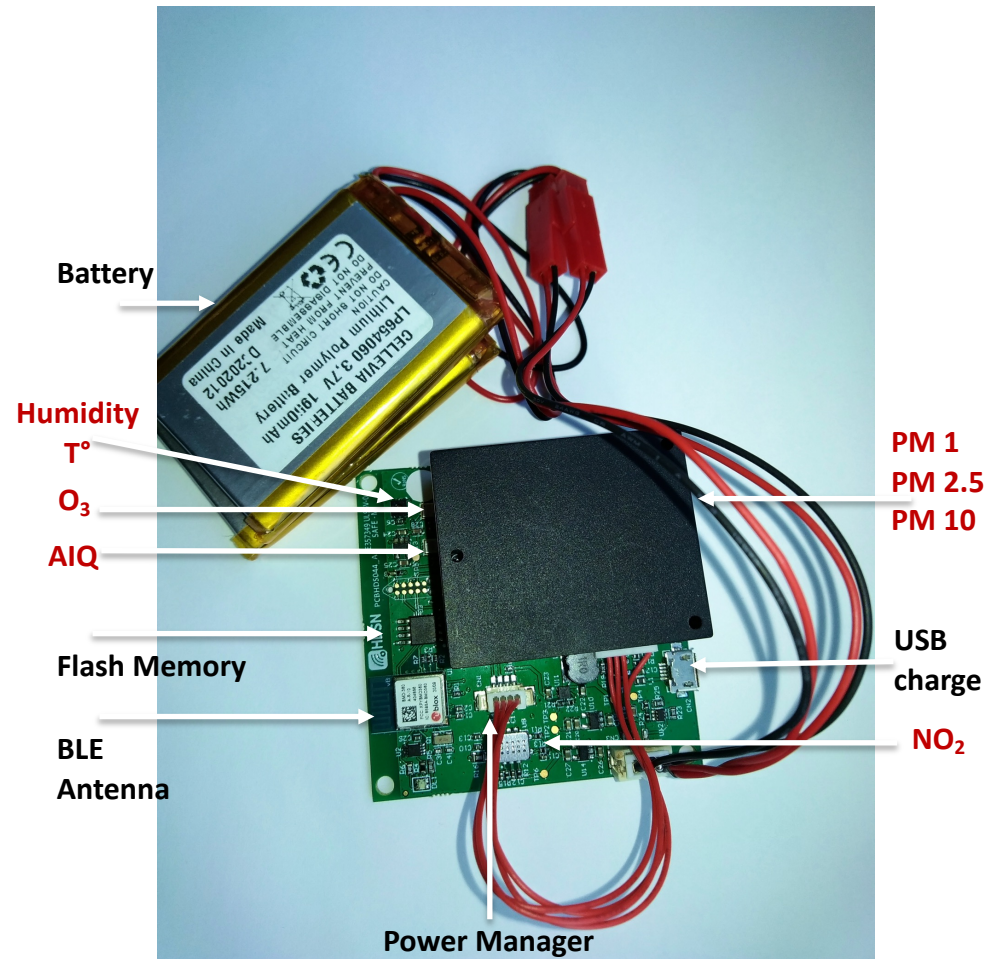
End users
street corner data

IoT Device: electronic

IoT device block diagram

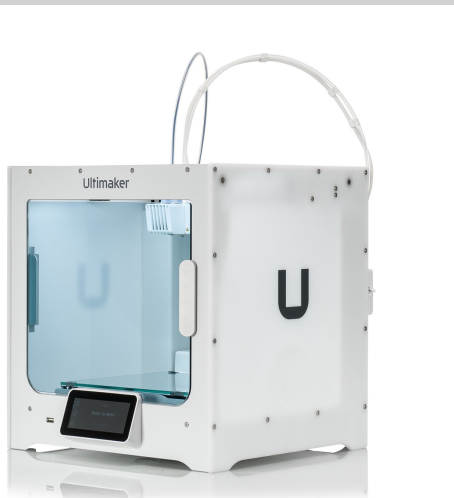
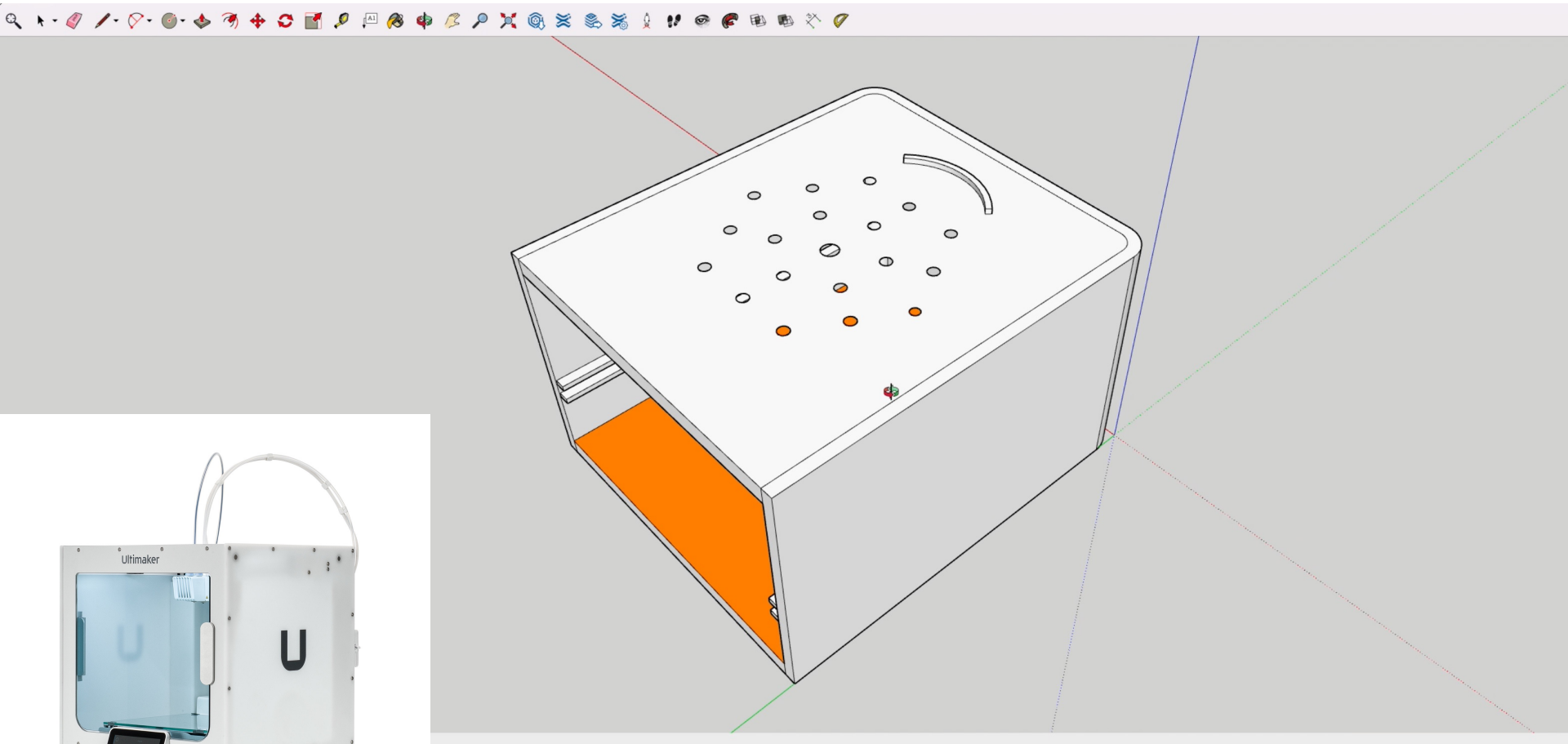


V1 prototype (Size : 60 x 60 mm)



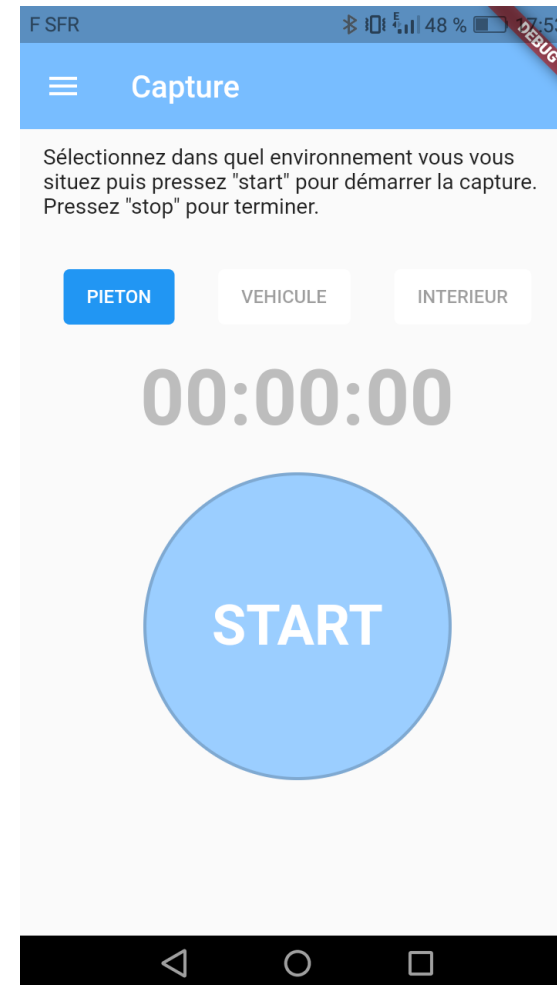
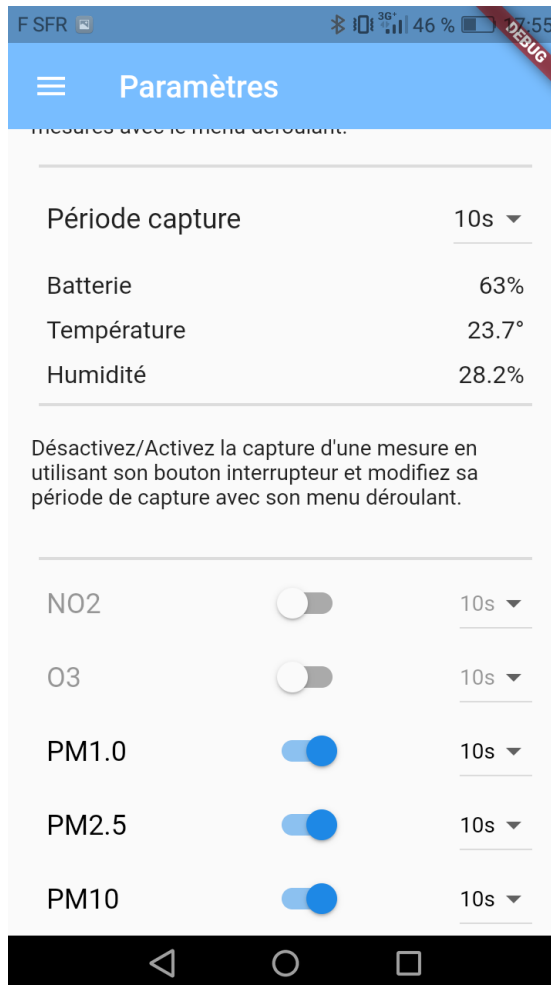
IoT Device: Mechanics

SMILE BOX DESIGN



3D PRINTER

Cell phone App



Collaborative platform (data sharing and analysis)

Smile Air Quality

Hassen.aziza

Se déconnecter

Smile Air Quality

A visualization for air quality values

Visualiser les données brutes

Visualiser la carte interactive

2 raw data

3 geo-localized data

1 Login

Collaborative platform (data sharing and analysis)

Raw data

Smile Air Quality

Visualiser la carte interactive

Hassen.aziza

Se déconnecter

Données sensors

| Date | Device | Sensors | | | | | | | | | Latitude | Longitude | Contexte |
|------------------------|--------------------|---------|-----|-----|-------|--------|--------|-------|----------|------|------------|-----------|------------|
| | | battery | aqi | no2 | ozone | mp 1.0 | mp 2.5 | mp 10 | humidity | temp | | | |
| 19/05/2022 13:07:34 | IM2NP-784A40C30960 | 89 | 0 | 4 | 0 | 3 | 4 | 4 | 39.1 | 28.5 | 48.9102574 | 2.3668089 | pedestrian |
| 19/05/2022 13:07:29 | IM2NP-784A40C30960 | 90 | 0 | 4 | 0 | 3 | 4 | 4 | 39.2 | 28.3 | 48.9102549 | 2.3666979 | pedestrian |
| 19/05/2022 13:07:24 | IM2NP-784A40C30960 | 89 | 0 | 4 | 0 | 3 | 4 | 4 | 39.0 | 28.1 | 48.9102818 | 2.3665679 | pedestrian |
| 19/05/2022 13:07:19 | IM2NP-784A40C30960 | 89 | 0 | 4 | 0 | 3 | 4 | 4 | 38.7 | 28.1 | 48.9103196 | 2.3665586 | pedestrian |
| 19/05/2022 13:07:14 | IM2NP-784A40C30960 | 89 | 0 | 3 | 0 | 3 | 4 | 4 | 38.5 | 28.0 | 48.9103403 | 2.3665629 | pedestrian |
| 19/05/2022 13:07:09 | IM2NP-784A40C30960 | 89 | 0 | 3 | 0 | 3 | 4 | 4 | 38.3 | 27.9 | 48.9103504 | 2.3665579 | pedestrian |
| 19/05/2022 13:07:04 | IM2NP-784A40C30960 | 90 | 0 | 3 | 0 | 3 | 4 | 4 | 38.2 | 27.8 | 48.9103294 | 2.366516 | pedestrian |
| 19/05/2022 13:06:59 | IM2NP-784A40C30960 | 89 | 0 | 3 | 0 | 3 | 4 | 4 | 38.2 | 27.9 | 48.9103245 | 2.3664827 | pedestrian |
| 19/05/2022 13:06:54 | IM2NP-784A40C30960 | 90 | 0 | 3 | 0 | 3 | 4 | 4 | 38.2 | 28.0 | 48.9103384 | 2.3664267 | pedestrian |
| 19/05/2022 13:06:49 | IM2NP-784A40C30960 | 89 | 0 | 3 | 0 | 3 | 4 | 4 | 38.1 | 28.0 | 48.9103502 | 2.3663584 | pedestrian |

Collaborative platform (data sharing and analysis)

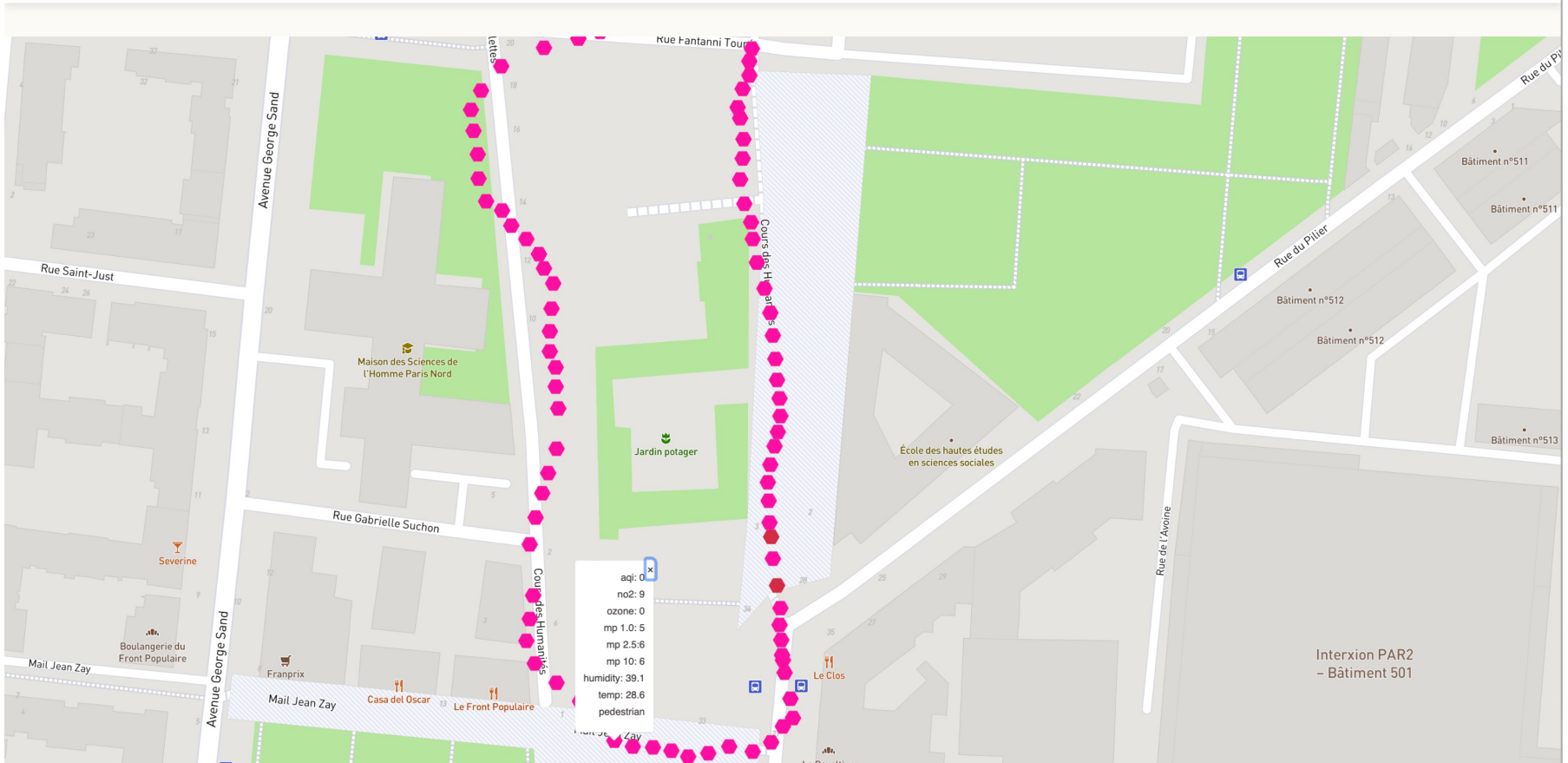
Geo localized data

Smile Air Quality

Visualiser les données brutes

Hassen.aziza

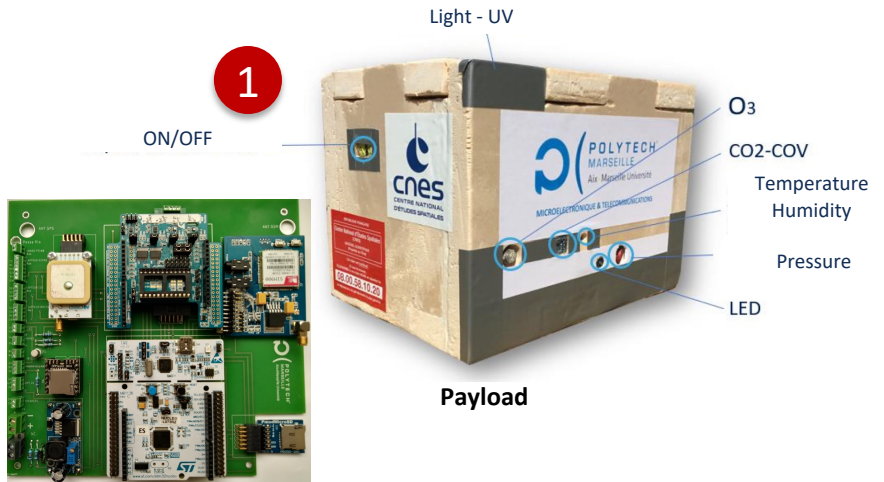
Se déconnecter



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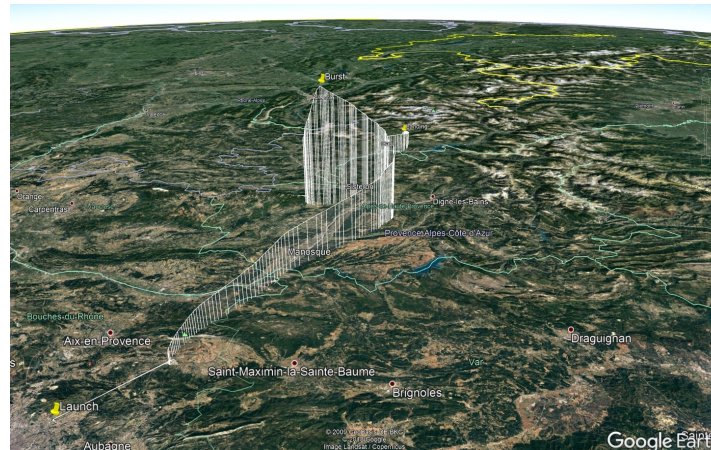
3D - first attempt: High Altitude Balloon (HAB)



Electronic PCB design (LoRa communication)



life.augmented



[Video Link](#)

Real-Time Balloon Tracking

*CNES: French agency for Space policy

3D - second attempt: Drones

■ Matrice 300



Matrice 300



Matrice 300 + sensor

■ Vidéo 2



[Video Link](#)

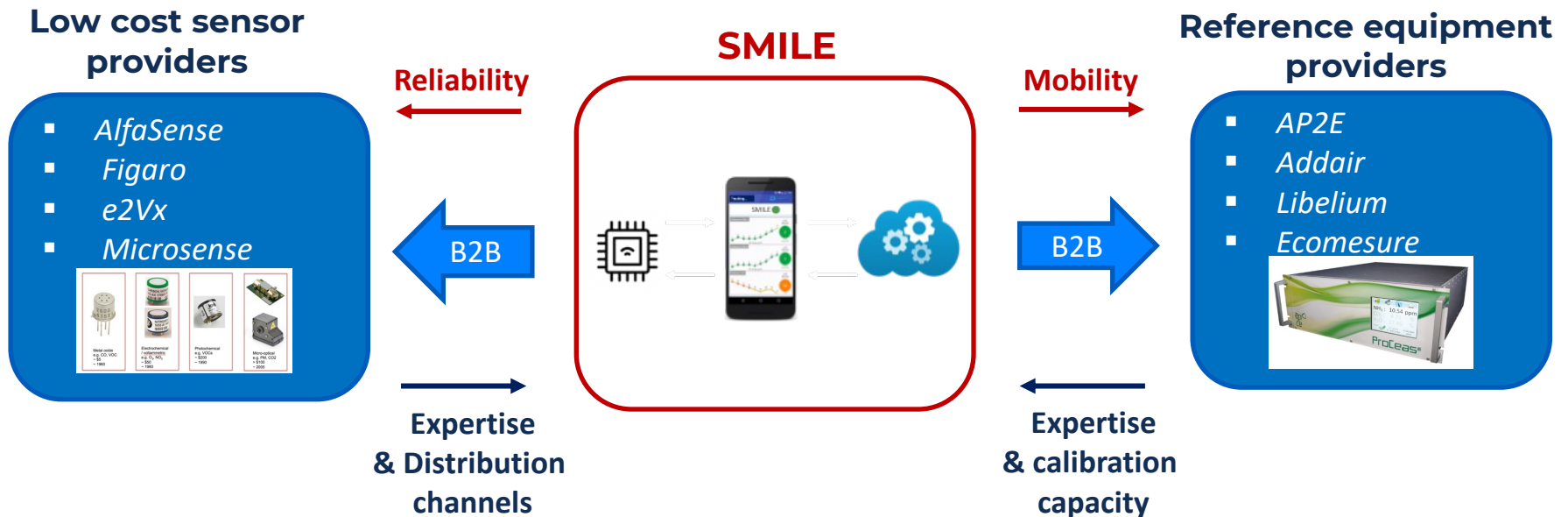
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Co-development partners

■ SMILE development and promotion strategy (1/2)

Short term partners & customers

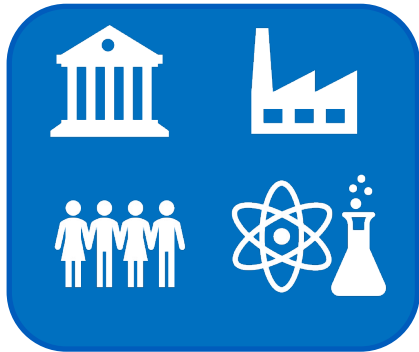


Co-development partners

■ SMILE development and promotion strategy (2/2)

Middle / Long term customers

Industry, academia and
policy makers (cities)



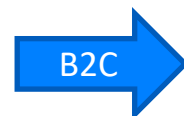
Reliable data



SMILE



Reliable data



Citizen



« Reliable Health Companion »

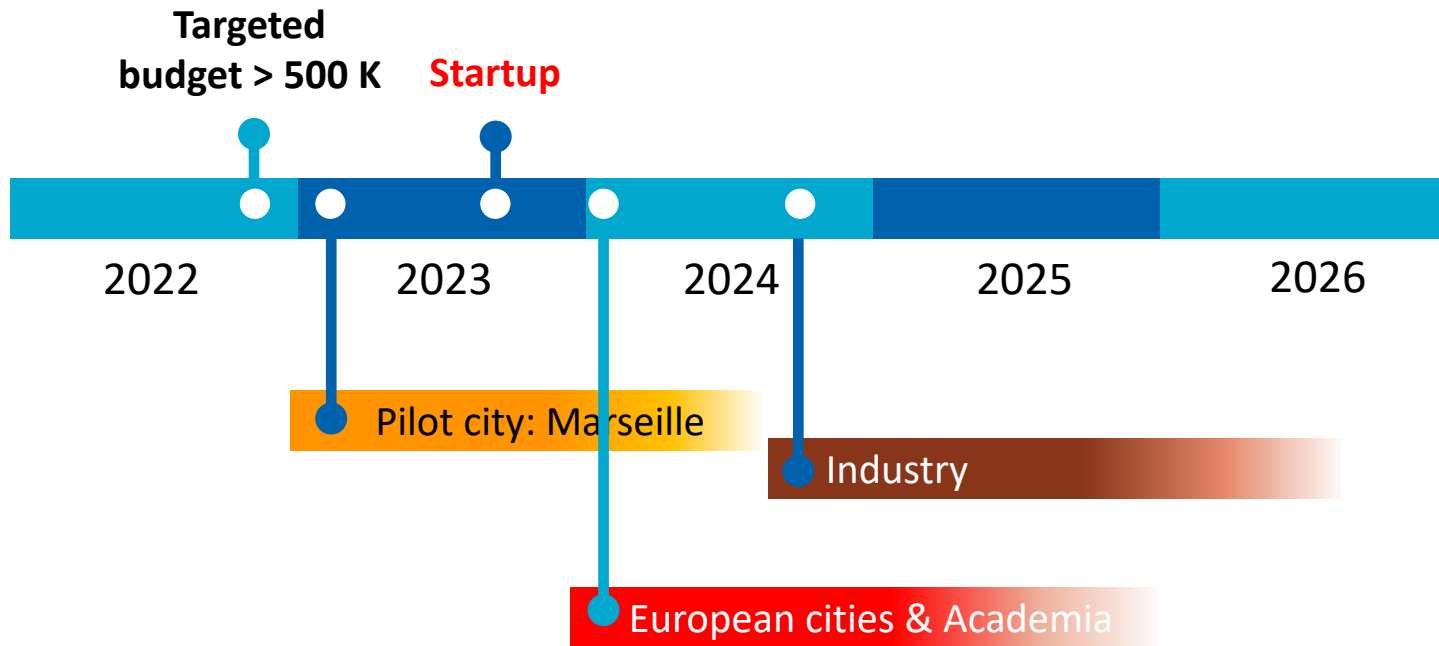
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Deployment

- Deployment of the SMILE solution in a pilot city
 - ✓ **Marseille City and the "Métropole" Aix-Marseille Provence**
- Deployment of the SMILE solution to the creation of a start-up
 - ✓ **SAAT Sud-Est support**
- A route-to-market will be planned to provide European cities with the SMILE solution. A business model will be established to provide European cities with a complete solution tailored to their specific needs.
 - ✓ **5 European municipalities are targeted including the metropolitan city of Milan**

Time Line



Thank you for your attention

*“we have to move fast, before it is too late”
Helsinki Manifesto (2006)*

Plus...

Main parameters

| | | | | | | |
|------------------------|----|-----|--|--|--|--|
| microparticule 1.0 | | | | | | |
| microparticule 2.5 | | | | | | |
| microparticule 10 | | | | | | |
| NO2 | | | | | | |
| AQI | O3 | NO2 | | | | |
| battery level en % | | | | | | |
| Temperature / Humidity | | | | | | |

Outdoor Air Quality Index

| Air Quality Index (AQI) | Level of Concern and Air Quality Condition | NO ₂ Concentration [ppb] | O ₃ Concentration [ppb] | Color Code |
|-------------------------|--|-------------------------------------|------------------------------------|------------|
| 0 to 50 | Good | 0 to 53 | 0 to 62 | Green |
| 51 to 100 | Moderate | 54 to 100 | 63 to 124 | Yellow |
| 101 to 150 | Unhealthy for Sensitive Groups | 101 to 360 | 125 to 164 | Orange |
| 151 to 200 | Unhealthy | 361 to 649 | 165 to 204 | Red |
| 201 to 300 | Very unhealthy | 650 to 1249 | 205 to 404 | Purple |
| 301 to 500 | Hazardous | 1250 to 2050 | 405 to 604 | Maroon |