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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

Hassen AZIZA (IM2NP) - Pascal TARANTO (CGGG)

hassen.aziza@univ-amu.fr



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

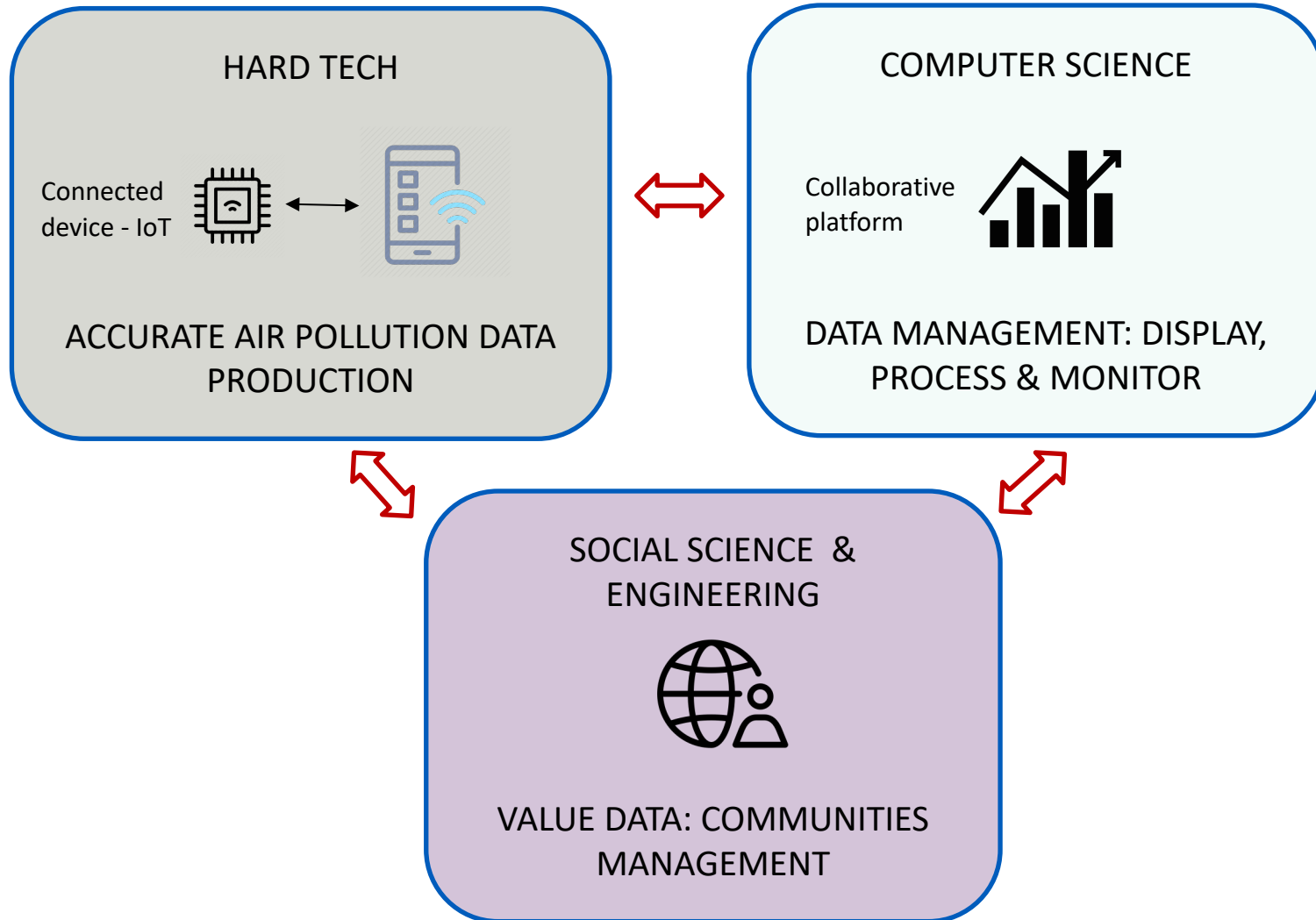
- Tackle the major problem of atmospheric pollution in urban environment

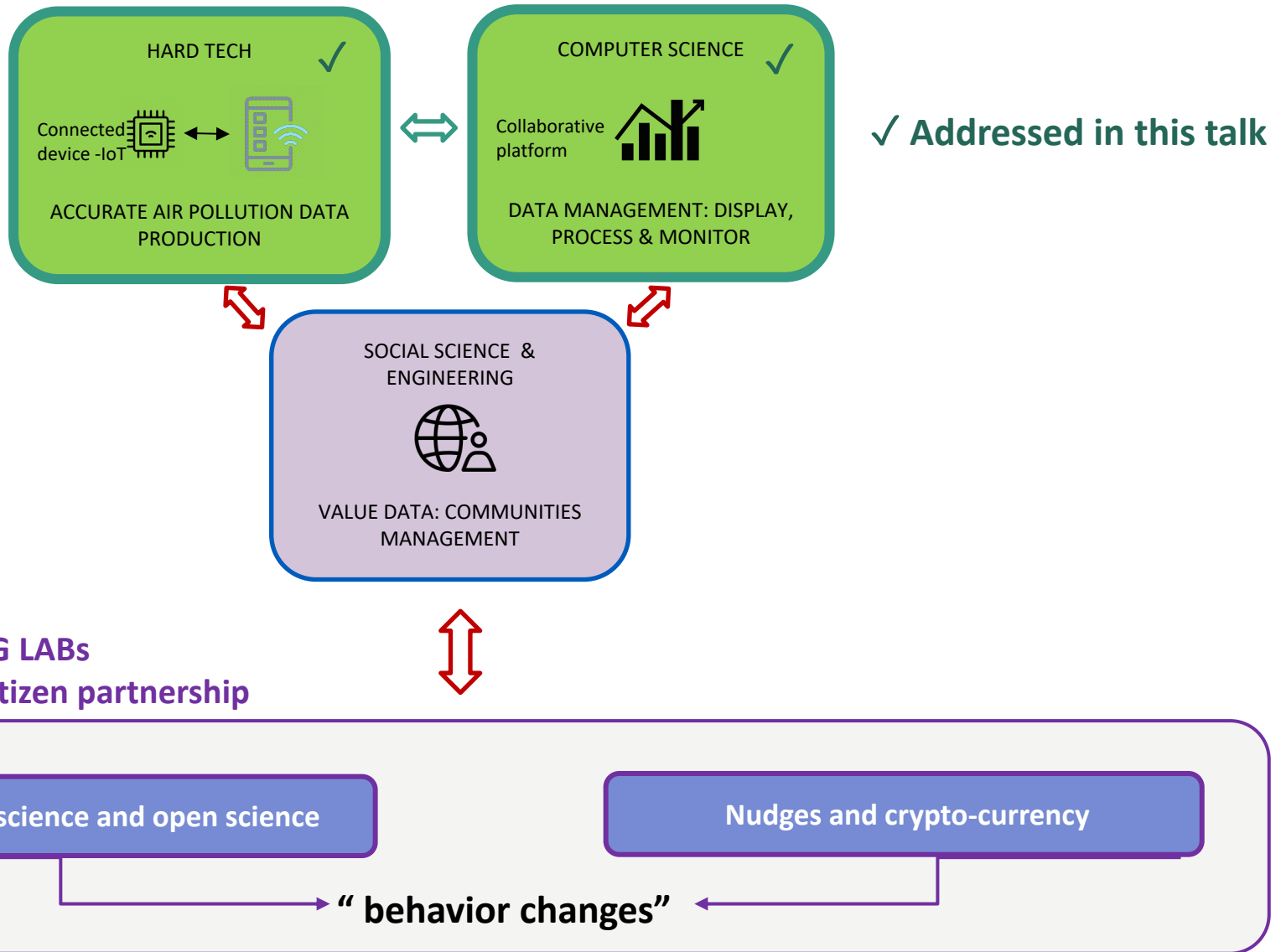
■ Outcomes

- 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**

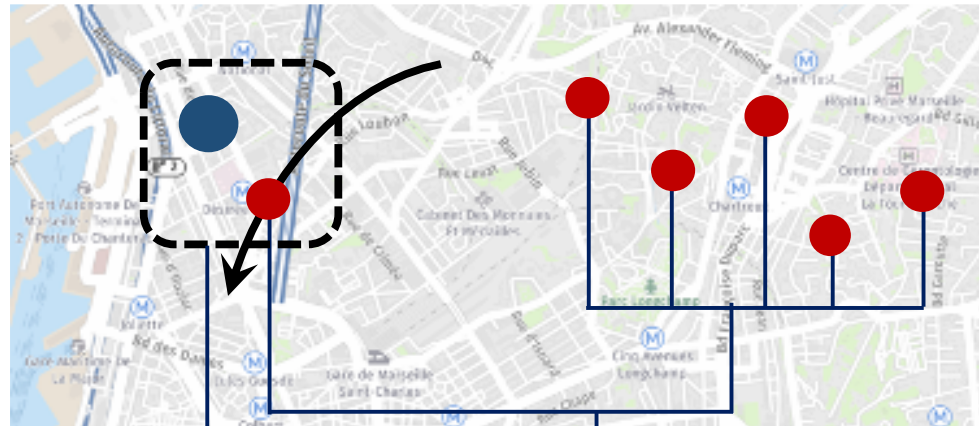
The calibration process will leverage on government or private **reference equipments**. the breakthrough consists of the capacity of the connected sensor to integrate techniques (both software and hardware*) for **calibrating sensors dynamically** to compensate their drift over time.

Turning commercial sensor devices accurate !

■ Dynamic calibration of sensors deployed in the field

●
Reference
Equipement

●
Connected
connecté



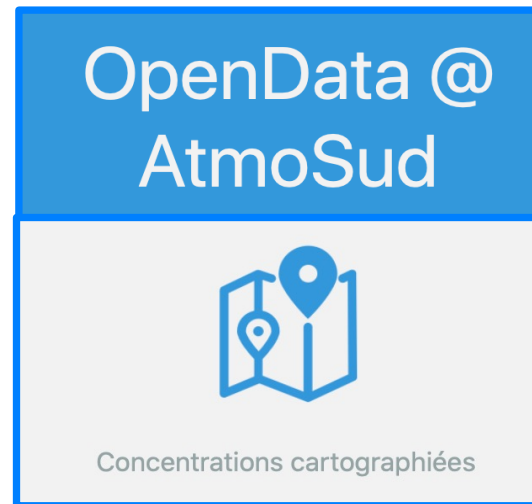
When the low-cost mobile
sensor is co-located with
reference instruments

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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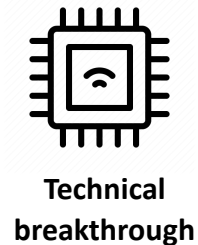
Environment data measurement methodology

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

IoT Device

Cell Phone App

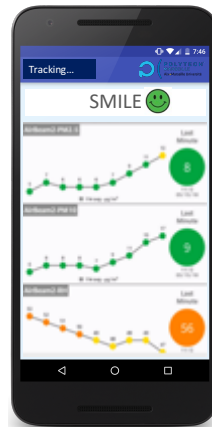
Collaborative Platform



Sensor data



Calibration data



Sensor data



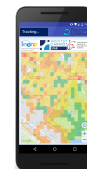
Calibration data



Human science
breakthrough
("Empowerment")

Maps

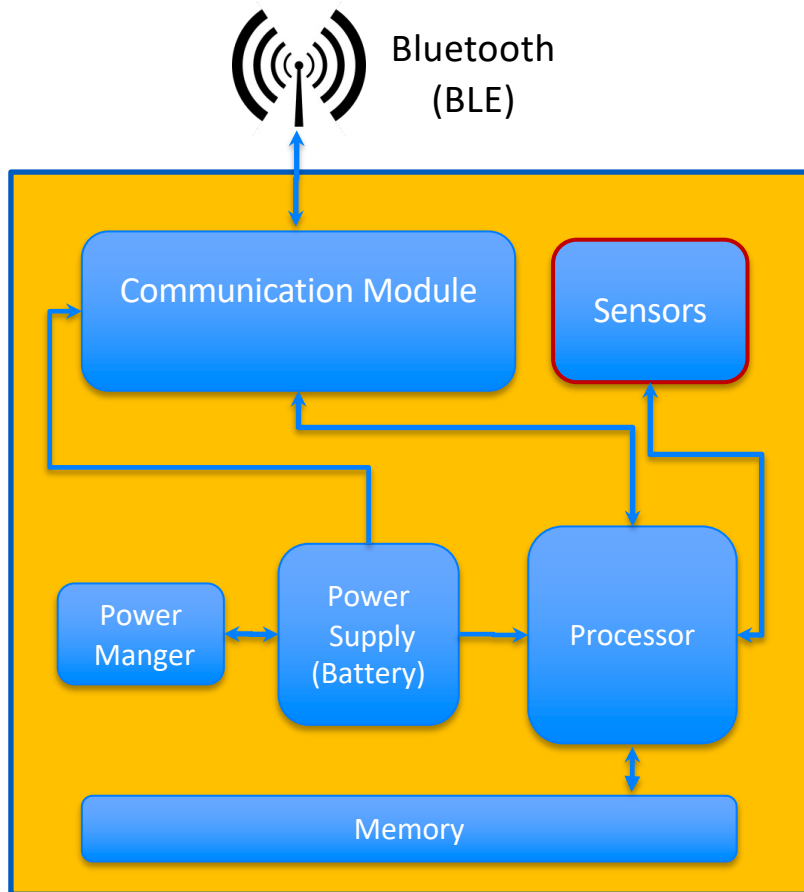
Maps



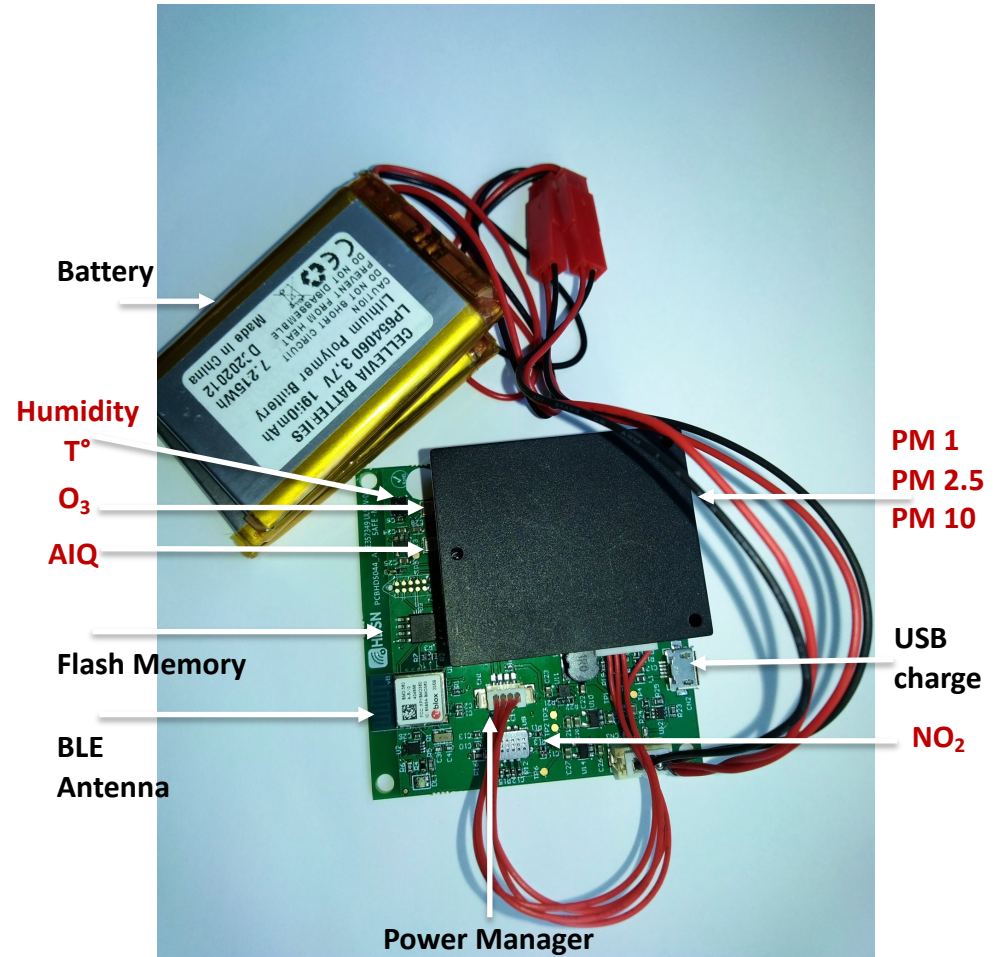
End users
street corner data

IoT Device: electronic

IoT device block diagram

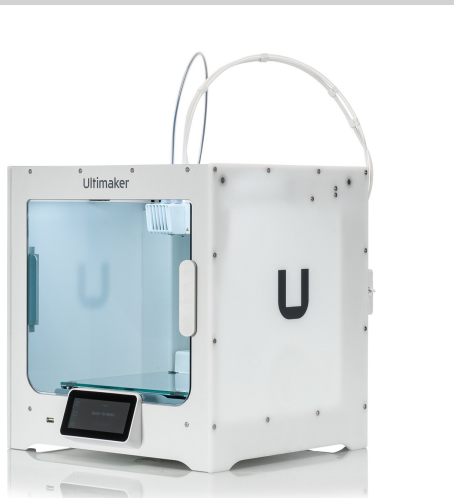
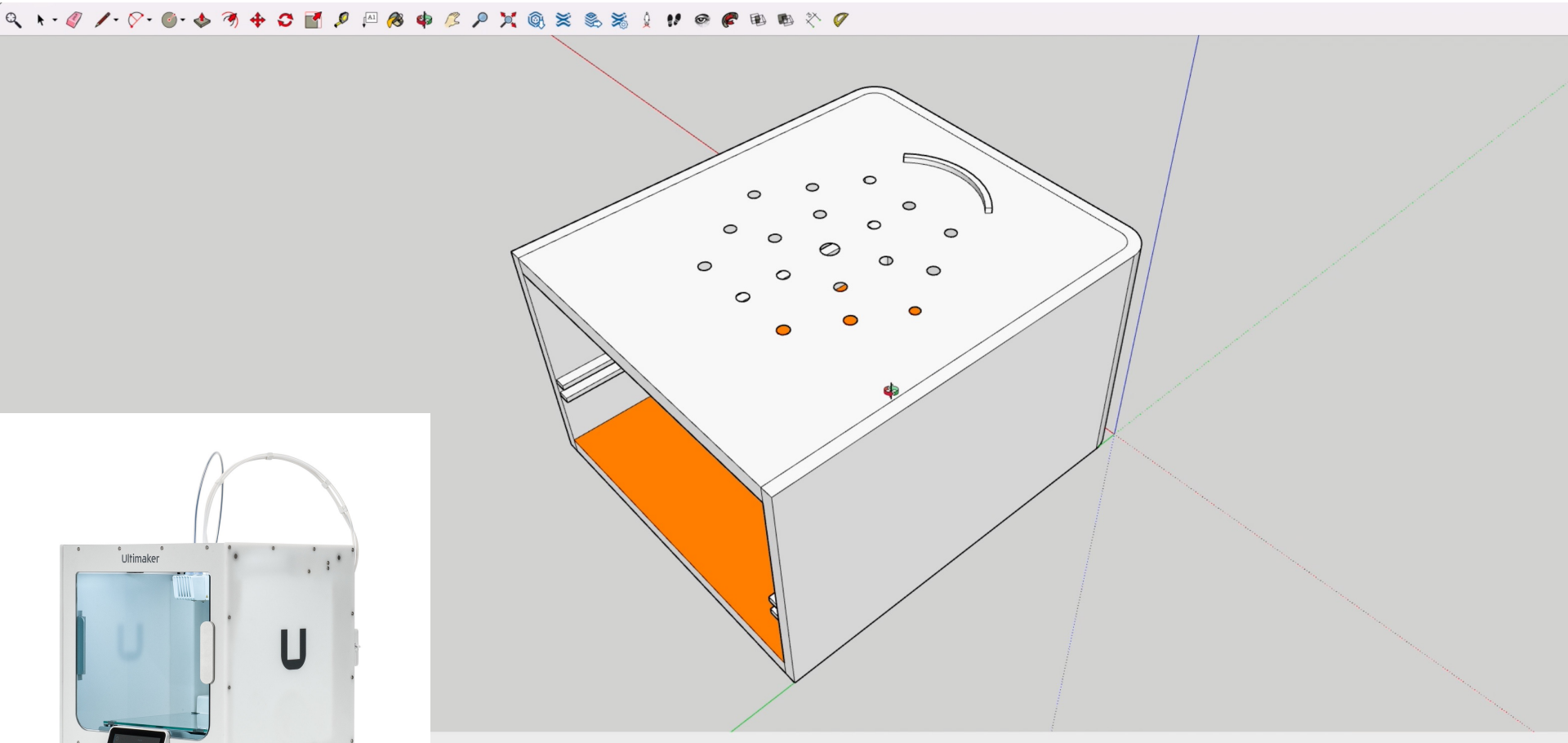


V1 prototype (Size : 60 x 60 mm)



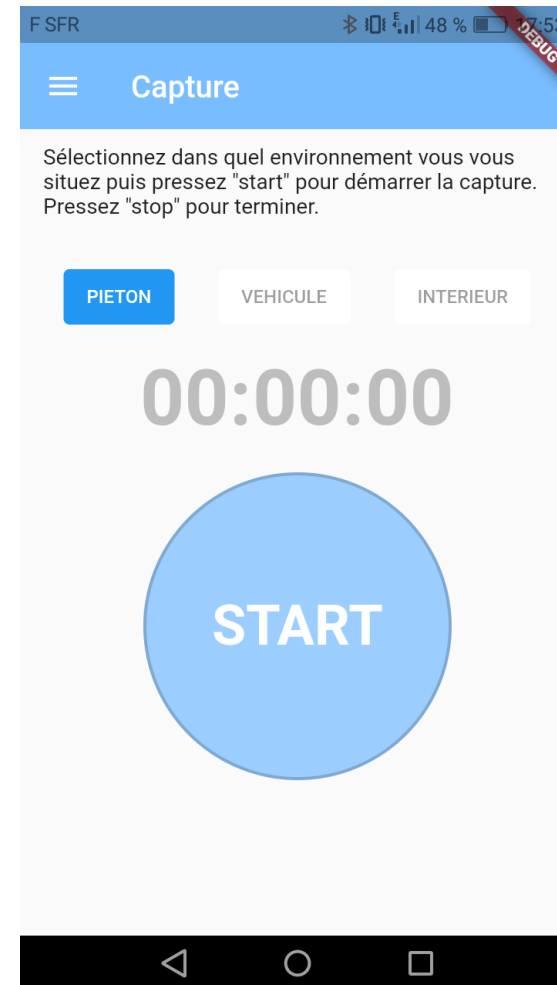
IoT Device: Mechanics

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)

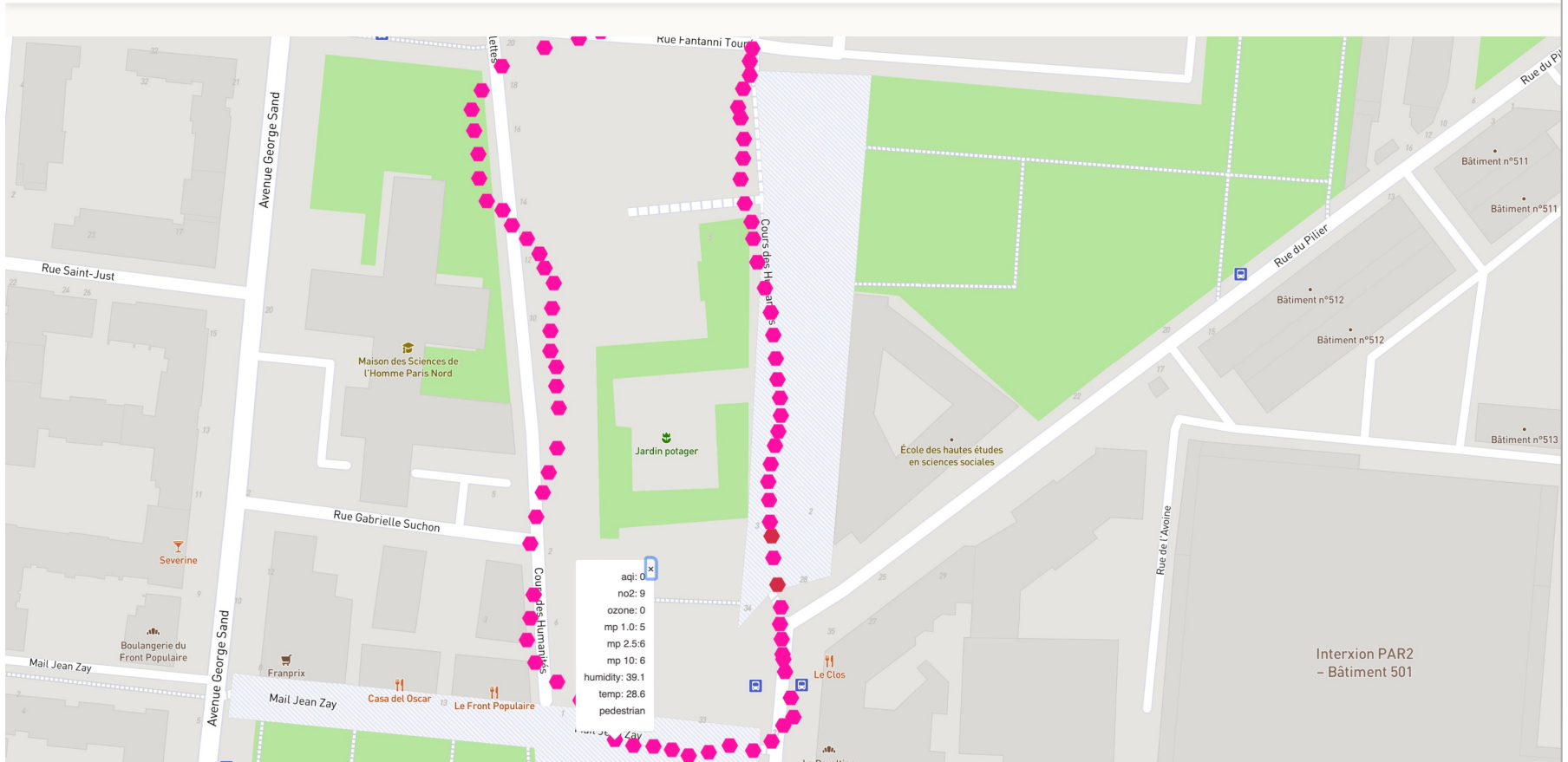
Geo localized data

Smile Air Quality

Visualiser les données brutes

Hassen.aziza

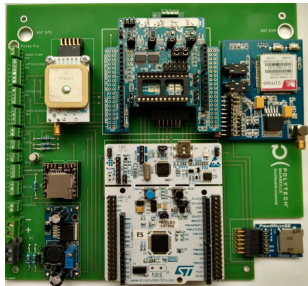
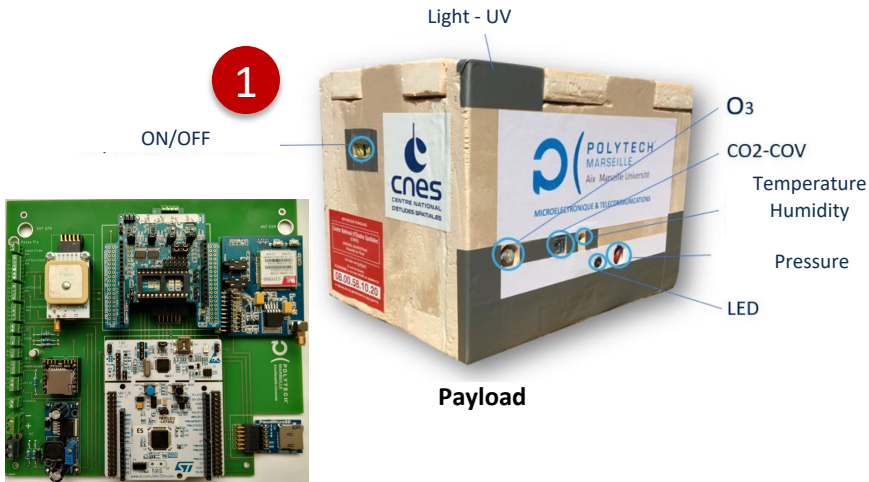
Se déconnecter



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



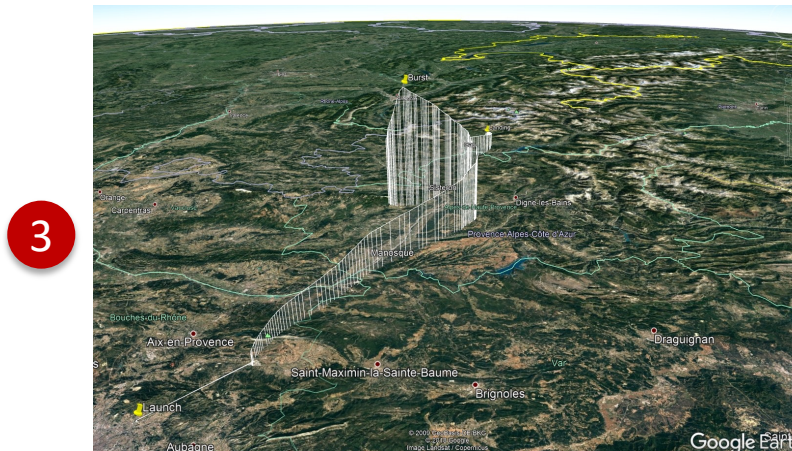
Electronic PCB design (LoRa communication)



life.augmented



Launching



Real-Time Balloon Tracking

[Video Link](#)

*CNES: French agency for Space policy

3D - second attempt: Drones

■ Matrice 300

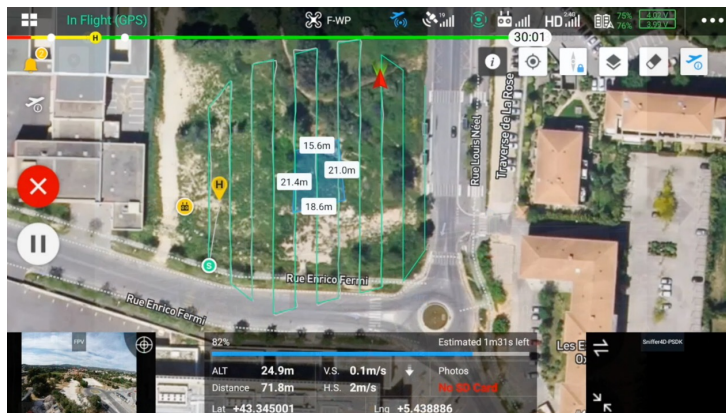


Matrice 300



Matrice 300 + sensor

■ Vidéo 2



[Video Link](#)

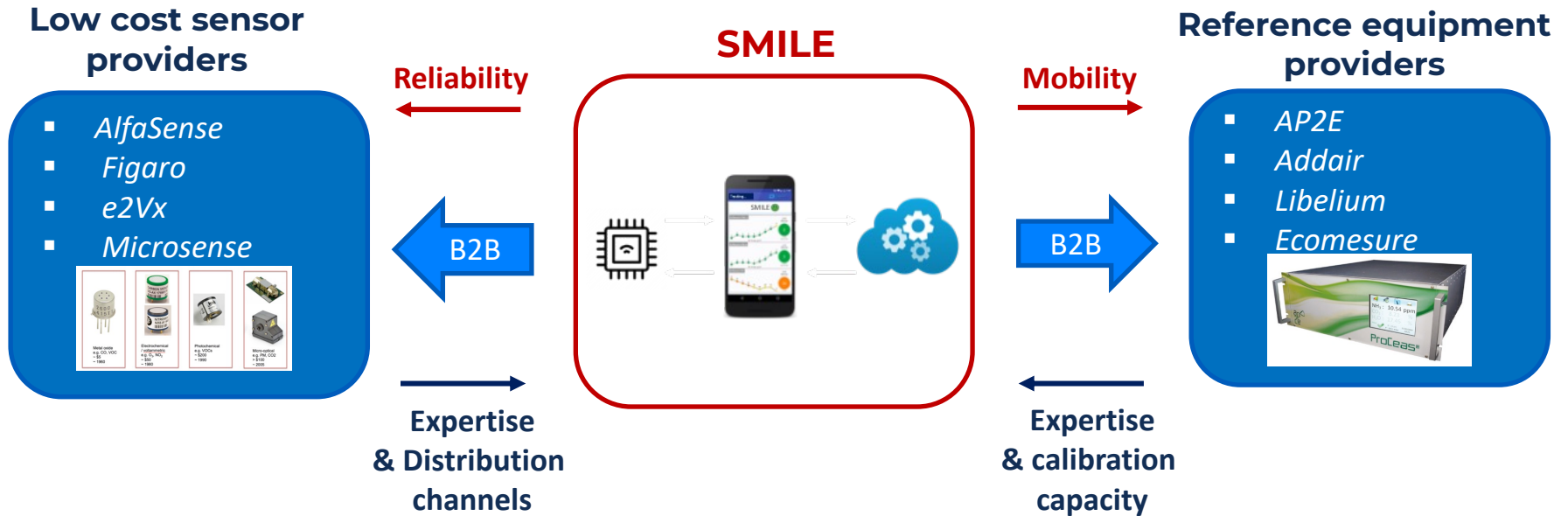
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Co-development partners

■ SMILE development and promotion strategy (1/2)

Short term partners & customers

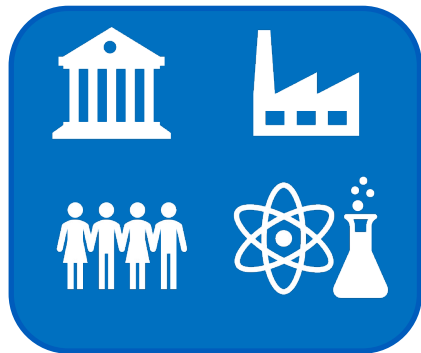


Co-development partners

■ SMILE development and promotion strategy (2/2)

Middle / Long term customers

Industry, academia and
policy makers (cities)



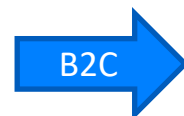
Reliable data



SMILE



Reliable data



Citizen



« Reliable Health Companion »

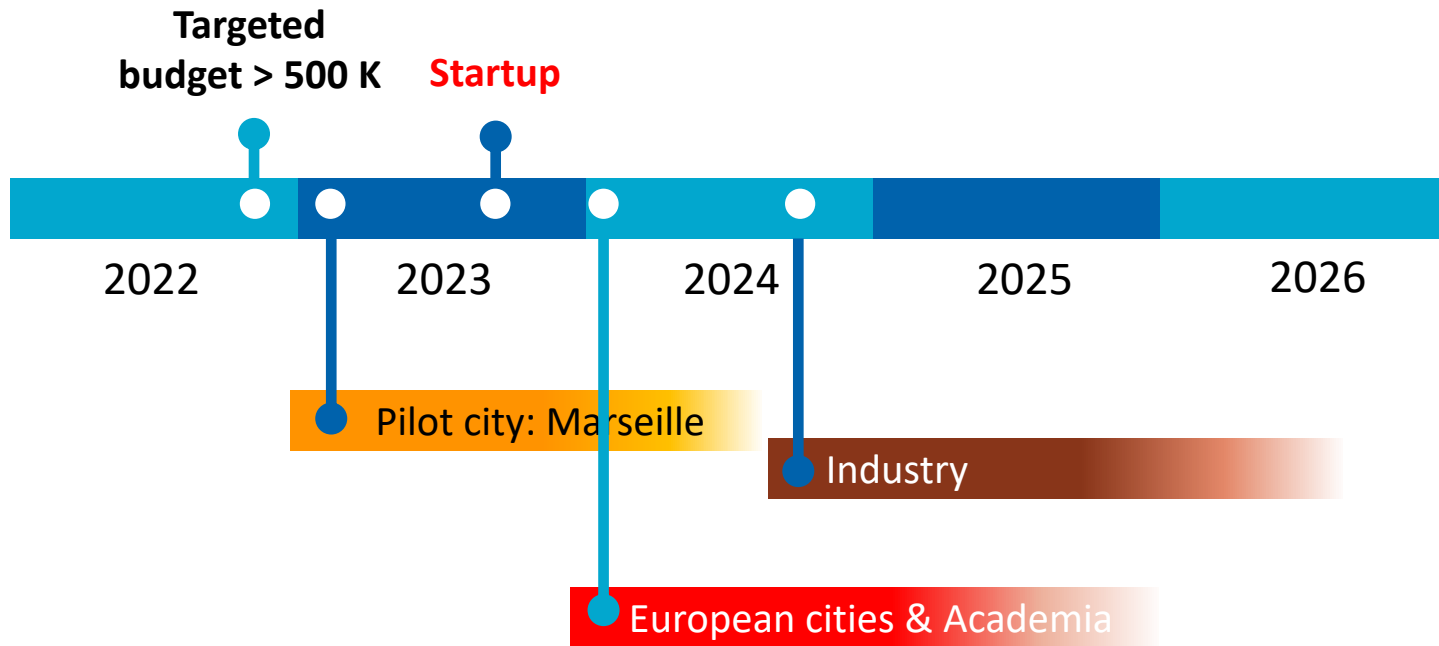
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Deployment

- 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