



# Wearable sensors

Tested in:

- Road construction - highway near Gran Sasso Nord, Italy
- Building construction - Helsinki Metropolitan Area, Finland

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# Wearable devices developed within beeyonders

- **Indoor Localization System:** Provides information on the location of workers inside building apartments. Tested in building construction use-case.
- **Environmental Monitoring Station:** Measures air quality, assessing environmental conditions. Tested in building construction use-case.
- **Wearable device for operators' safety:** Tracks workers' locations in outdoor environments, detect possible man-down situations and provides alerts related to proximity with autonomous vehicles. Tested in road construction use-case.

An IoT infrastructure was established to enable seamless data transmission from the prototypes to a digital twin cloud platform

# Indoor localization system – Final application

The system detects the time instant at which a specific operator has entered/exited a specific apartment



Ranging sensor +  
Bluetooth antenna

Bluetooth  
tag

Battery

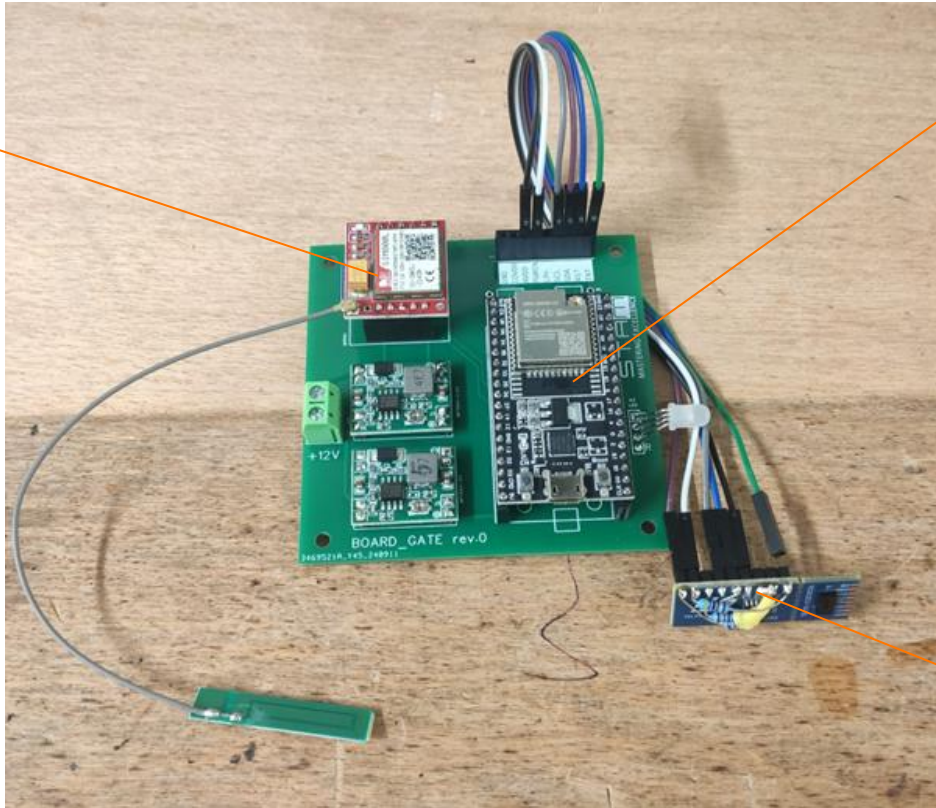
LAB TESTING



Building construction site

# Indoor localization system – System design

Modem for  
2g  
connectivity



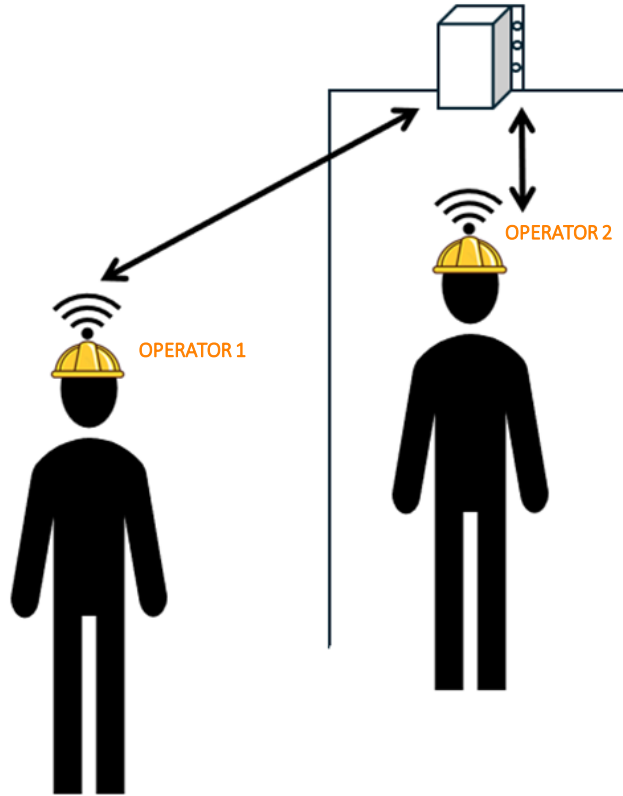
Microcontroller  
with Bluetooth  
antenna

Custom  
copper  
shielding for  
Bluetooth  
antenna

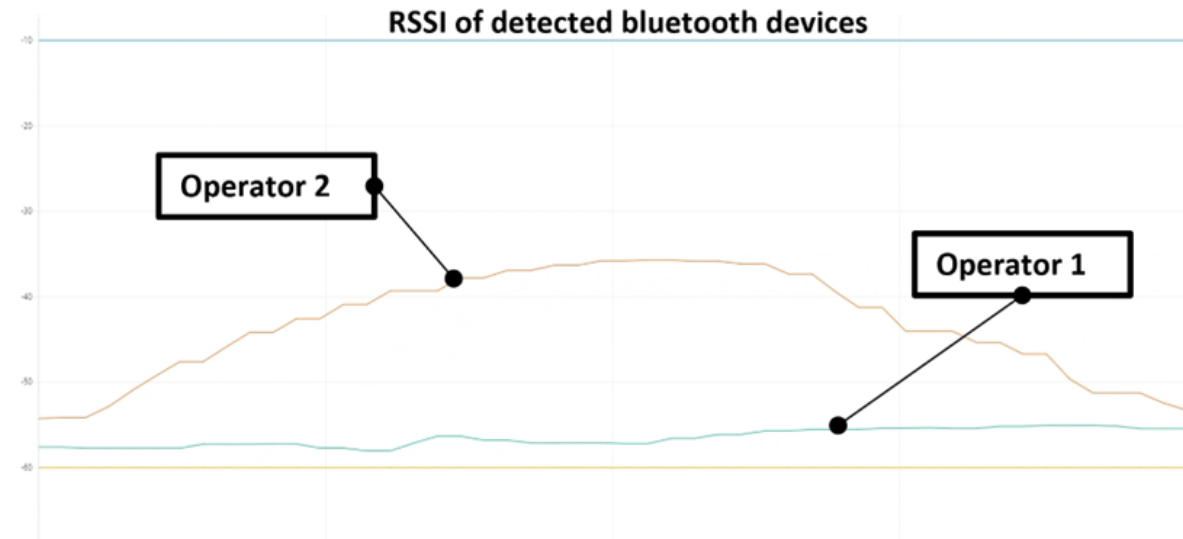
Ranging  
sensor



# Indoor localization system



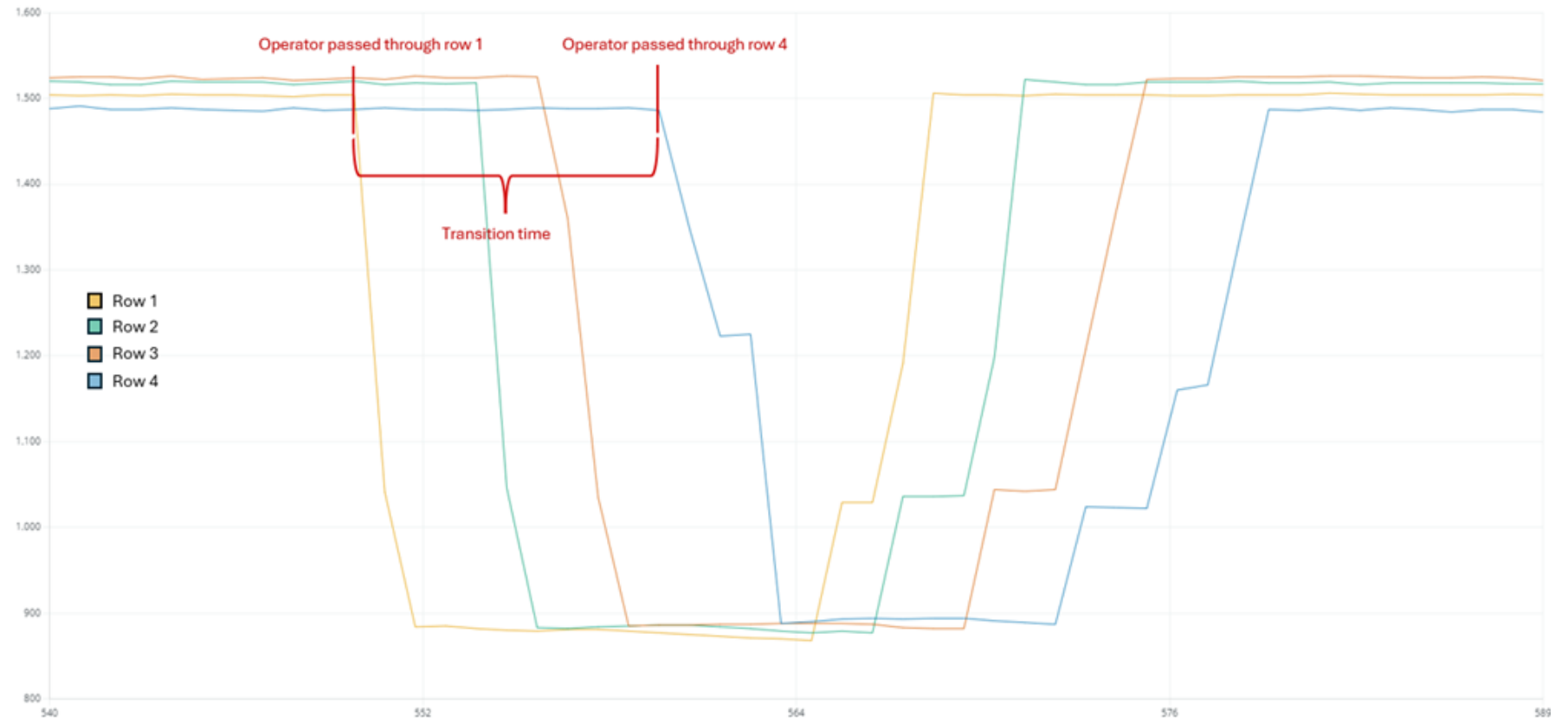
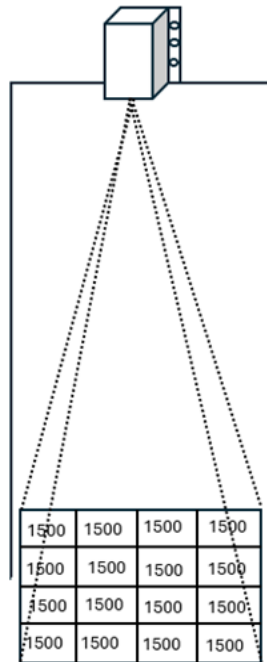
The copper shielding filters out the RSSI of surrounding operators that are not right below the door



Operator 1 is standing still near the door, while Operator 2 is passing through it.

# Indoor localization system

Changes in the values of distances measured by the ranging sensor allow to understand the direction in which the operator is crossing the door



# Environmental station – Final application

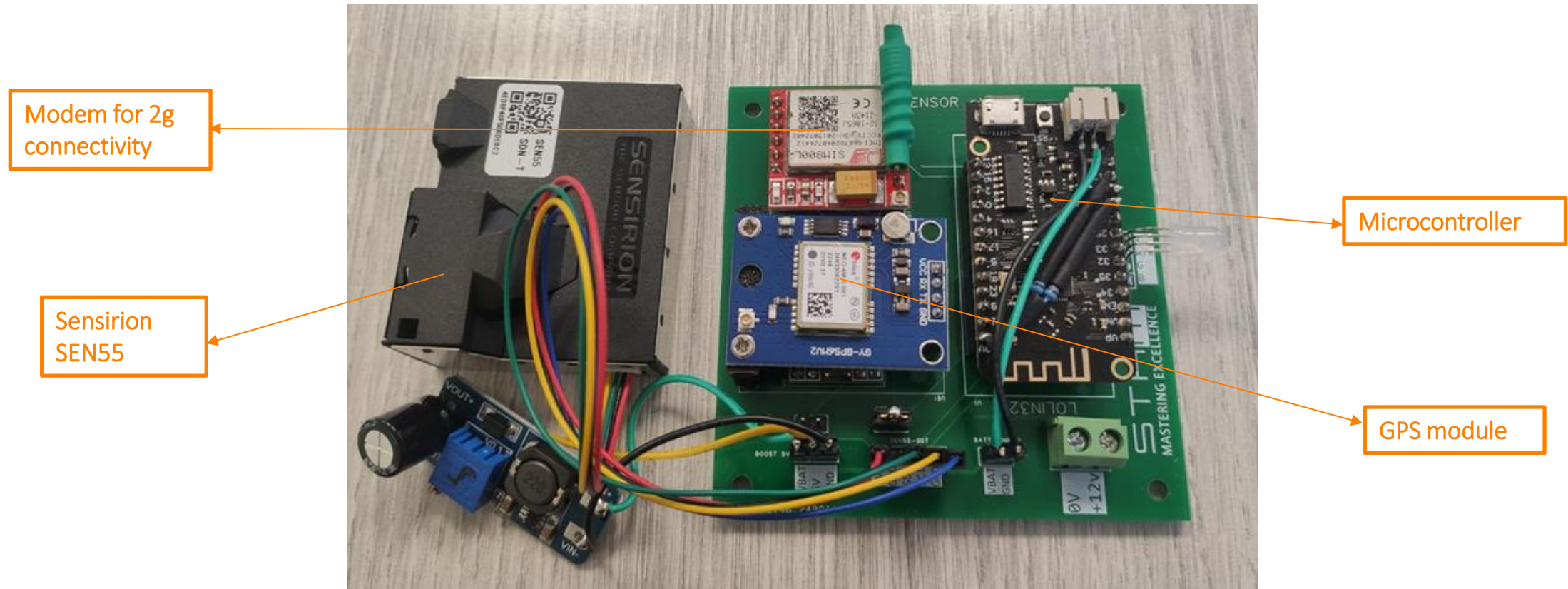
The system measures the quality of the air through 8 different parameters:

- Temperature [°C]
- Humidity [%RH]
- PM1.0, PM2.5, PM4, PM10 [ $\mu\text{g}/\text{m}^3$ ]
- VOC [adimensional index 0-500]
- NOx [adimensional index 0-500]



Building construction site

# Environmental station – System design



# Wearable device for operator's safety – System design

The device enhance the safety of operators monitoring the interactions with autonomous vehicles.

The wearable system consists in:

- An RTK receiver to accurately track the location of workers
- A buzzer to notify workers about the proximity with autonomous vehicles
- An accelerometer to detect possible man-down situations



Road construction site

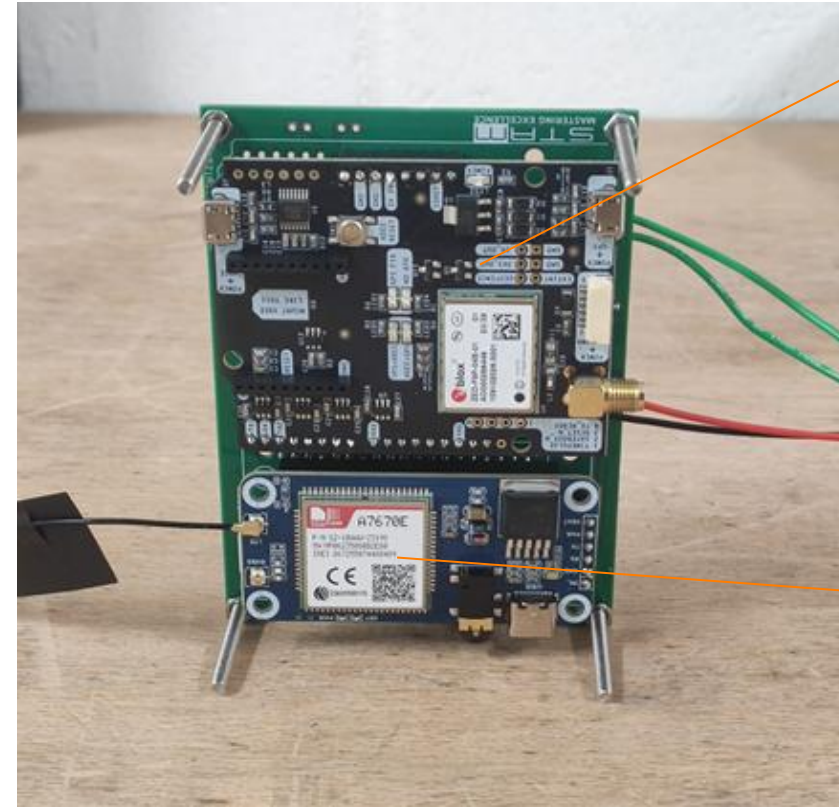
# Wearable device for operator's safety – System design



Buzzer

Accelerometer

Microcontroller



RTK board

Modem for 4g connectivity

# IoT infrastructure

