IOT AT URBAN EDGE FOR AUTOMATED DRIVING

OBUs, Pothole detector, Smart traffic light and Algorithms for pedestrian detection

Autopilot Webinar

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AUTOPILOT

IOT AND AUTOMATED DRIVING

- **IoT** is the base to enable **local awareness**
- **IoT** and **edge/fog computation** can bring valuable benefits to automated manoeuvres
  - Safety related services need very low delays (computation + transmission)
  - Enable others high-value services (local information)
- Others services (non real-time) will benefit of data saved on an **IoT Platform**
  - OneM2M platform

THE IOT OBU ARCHITECTURE

THE IOT RSU ARCHITECTURE

IOT PLATFORM (ONEM2M)

COMMUNICATION SYSTEM

LTE

Precise position and time

CAM DENM

SPAT MAP

CANbus interface

G5

Communication

G5

COMMUNICATION SYSTEM

Precise position and time

CAM DENM

SPAT MAP

CANbus interface

WiFi

IoT FOG COMPUTATION

Filtering relevant data to facilitate AD algorithms

IoT "Virtual pothole sensor" management framework

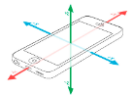
Computation

IoT EDGE COMPUTATION

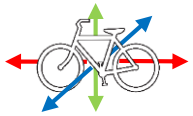
Send notification to vehicles based on camera detection + SPAT (over G5)

IoT pedestrian detection camera management framework

Inertial Sensors 6LowPAN and CAN



Smartphone



Bicycle

IoT devices

Traffic light

Stereocamera

THE ACTORS

IoT In-Vehicle Platform

Smart Traffic light with Pedestrian detection

Connected bicycle

Pothole detector based on a “virtual” sensor

THE IoT IN-VEHICLE PLATFORM

- Manages all the messages

From other IoT devices via G5

Sends info to OneM2M platform via LTE

Collects data from accelerometers

- Performs Fog computation

Filters all the information and sends them to the AD function when **relevant**

Aggregates and analyses accelerometers to create the **virtual sensor** view

  - e.g. SPAT sent to AD only 300 meters before the TL and if the car is traveling directly towards the TL

THE ACTORS

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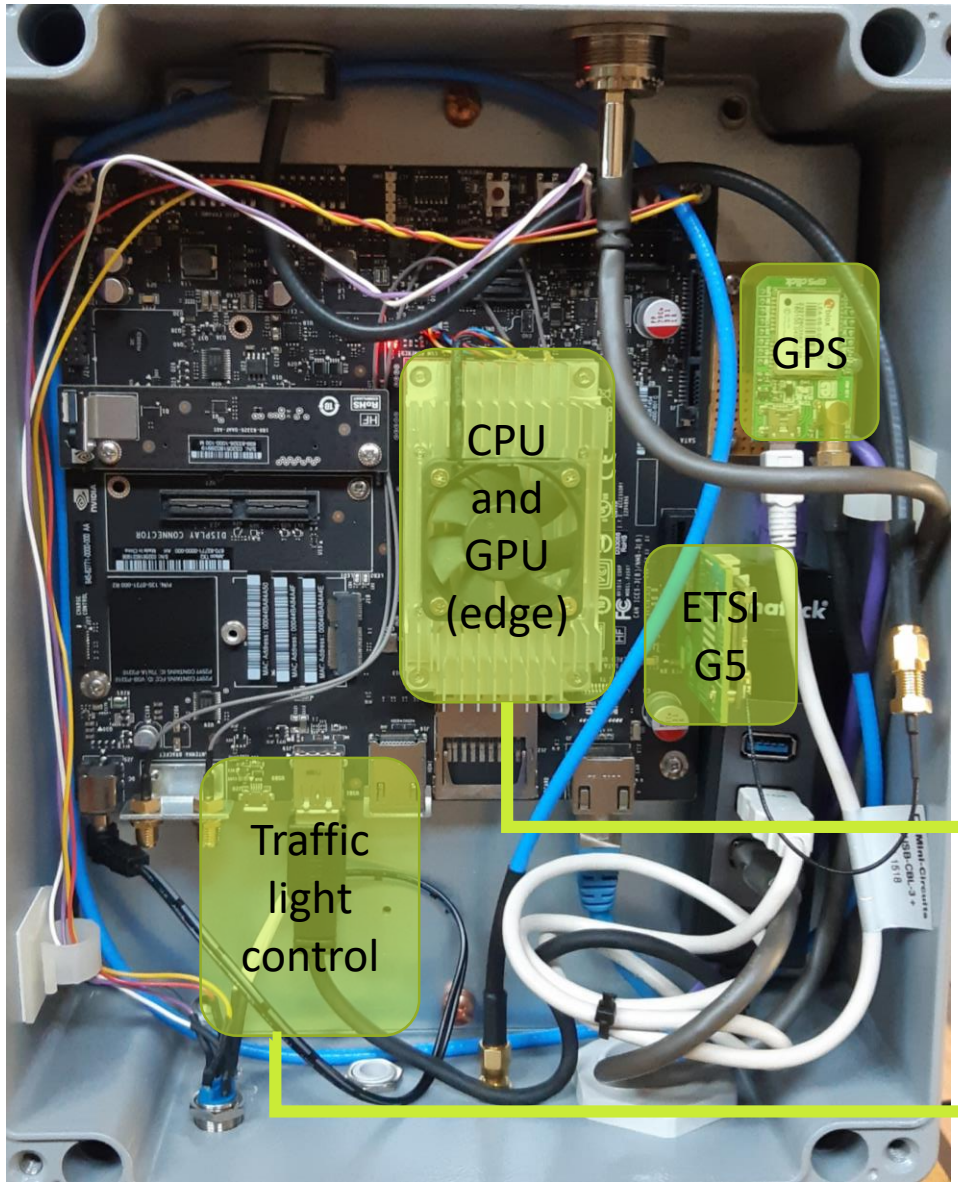
SMART TRAFFIC LIGHT



SMART TRAFFIC LIGHT FUNCTIONS

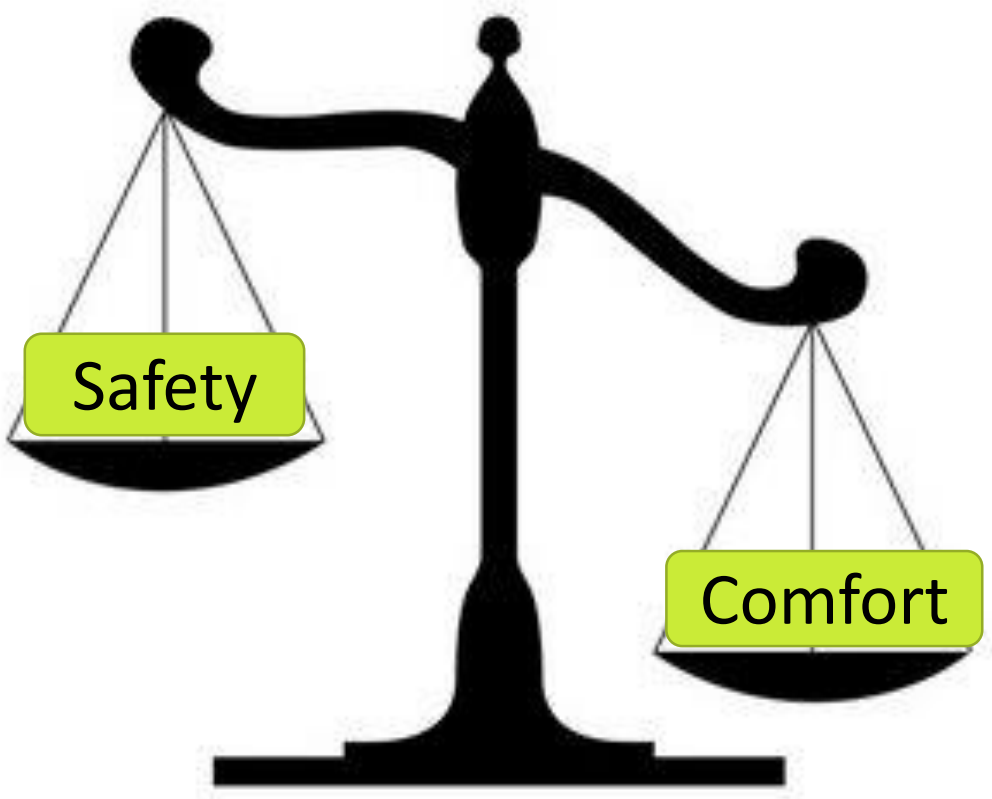
Traffic light management

Communication (ETSI G5 SPAT/MAP + DENM + messages to the OneM2M platform)

Pedestrian detection

- Detection Mechanism with good results
  - Histogram of Oriented gradients (HOG), proposed by Dalal and Triggs 2005 (23000+ citations) - trained by using dataset of 1800+ annotated human images
- Implementations
  - HOG was included in OpenCV (open computer vision library)
- Limitations
  - Computationally expensive (needs a GPU to work in real-time)
  - Many variables that change its performance significantly, cannot be generalized for every situation
  - Obstructions can be a problem – not so easy to find the best “point of view”
  - Trade-off between False positives/False negatives

PEDESTRIAN DETECTION: WHAT ARE THE CONSEQUENCE?



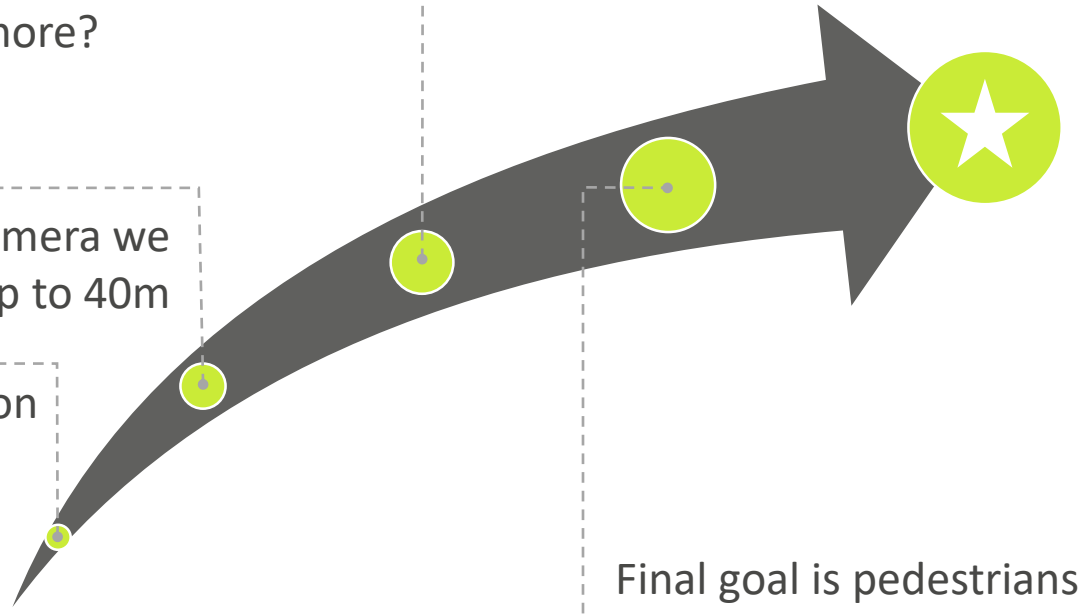
EXTENSIONS UNDER DEVELOPMENT

How much accuracy?

- Lane level or more?

Thanks to the stereo camera we can measure distances up to 40m

New algorithm for detection



Final goal is pedestrians tracking

- What about computation requirements?
- Do we need non-standard messages?

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IoT In-Vehicle Platform

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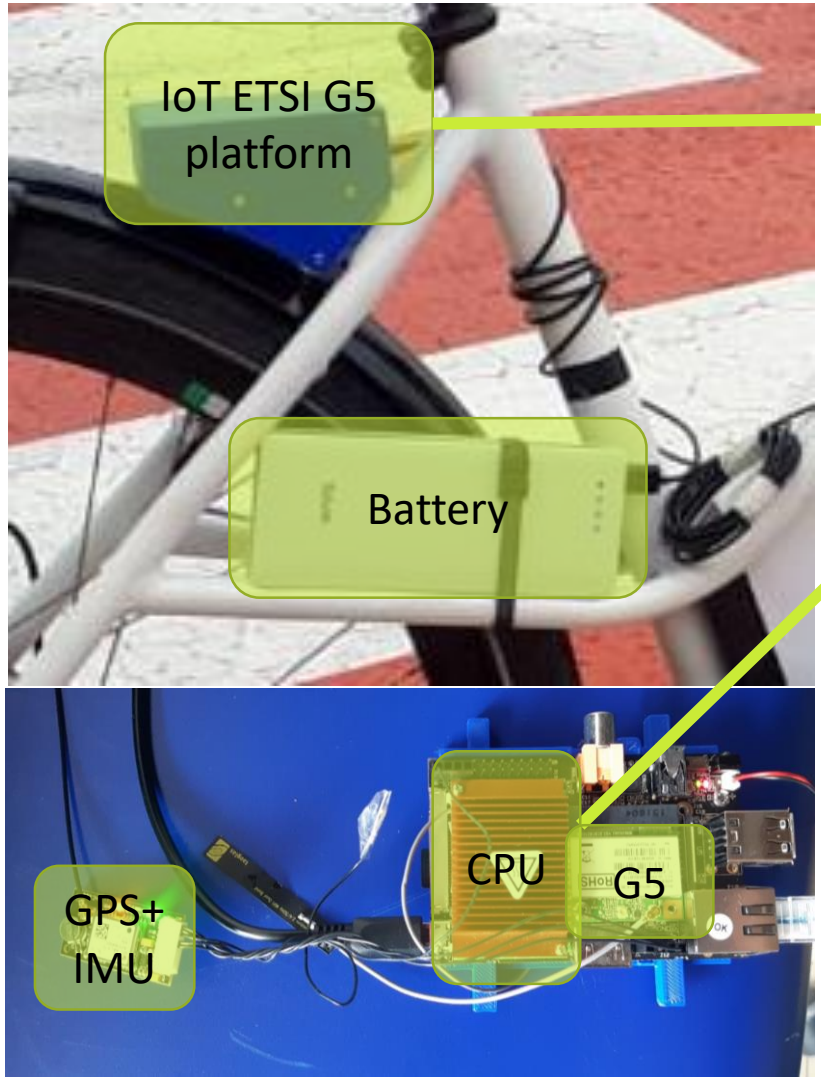
Pothole detector based on a “virtual” sensor

THE FALLEN BICYCLE USE CASE



- GPS with IMU
  - The raw values from IMU accelerometers are used to detect the fall
- A fall detection triggers a DENM
  - Sending and cancellation should be managed
- The bicycle can send CAMs as a vehicle
  - The IMU feeds the fields about bicycle dynamic

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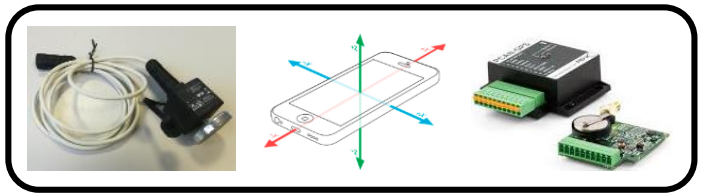
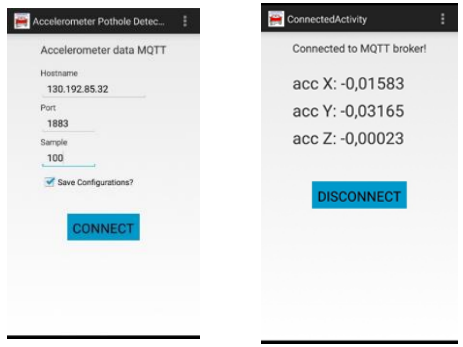
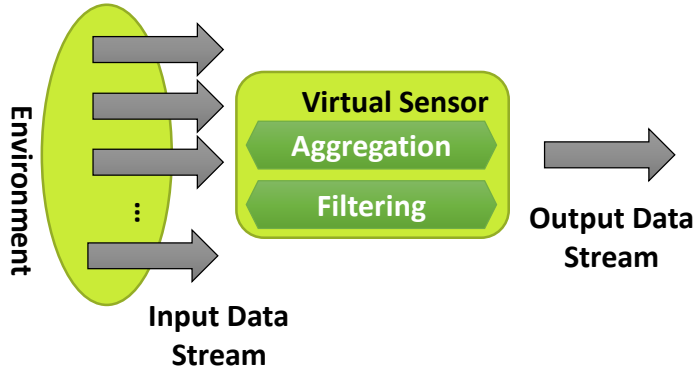




Pothole detector based on a “virtual” sensor

THE «VIRTUAL SENSOR» CONCEPT



- Vehicles are increasingly equipped with different type of sensors
- **Combining** data from cameras, microphones, inertial sensors, beacons (e.g., GPS), etc… or different sensors of the same type, allows to:

improve the **accuracy** and **reliability** of sensor data

create virtual sensors that bridge what can be measured to what developers want to detect, leveraging on **sensor fusion** techniques

- New and highly sophisticated applications become possible

THE “VIRTUAL” POTHOLE SENSOR

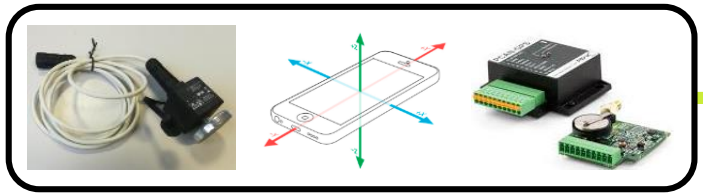
The virtual sensor will be composed by:

- Smartphone connected via Wi-Fi
  - Android with Wi-Fi/Bluetooth, accelerometer, gyroscope, GPS and compass sensors
- 6LoWPAN vibration sensors
  - Configuration of USB stick TI CC2531 (dongle in 6LoWPAN modality, with OS Contiki)
- IMU: PEAK PCAN-GPS

The current implementation of the algorithm is based on smartphone data

POTHOLE DETECTOR AS “VIRTUAL SENSOR”

- Data from different devices are fused together and processed
- Elaborations sent to the cloud OneM2M platform
  - Crowdsourced data can be retrieved via a OneM2M subscription and used by other vehicles

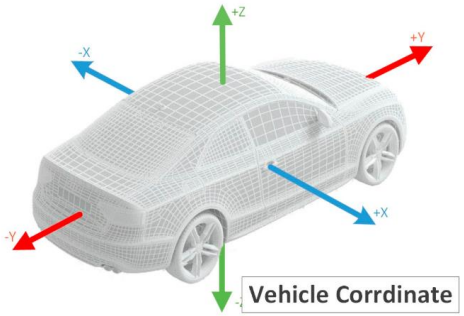


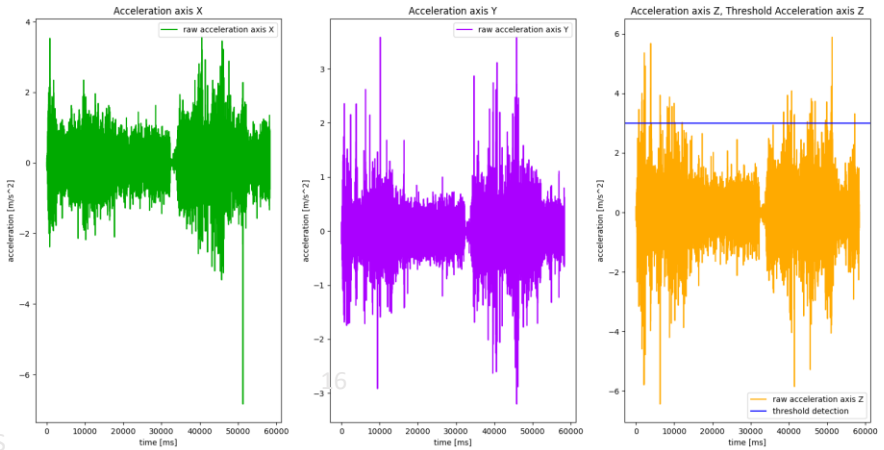
MQTT

OBU
(raw acceleration signal elaboration algorithm)

OneM2M over MQTT

IoT Cloud Platform
(OneM2M)
+ Autopilot Applications





Car picture taken from: https://www.mdpi.com/1424-8220/17/3/633/htm

THE TEAM

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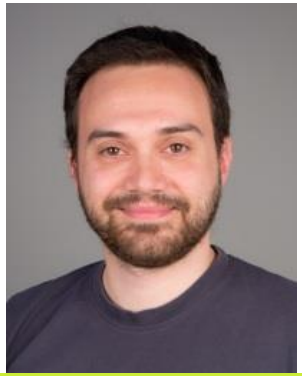

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THANK YOU
FOR YOUR ATTENTION

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