UCLM Universidad de Castilla-La Mancha

Escuela Superior de Informática

A methodology for monitoring traffic flow and air pollution in urban areas

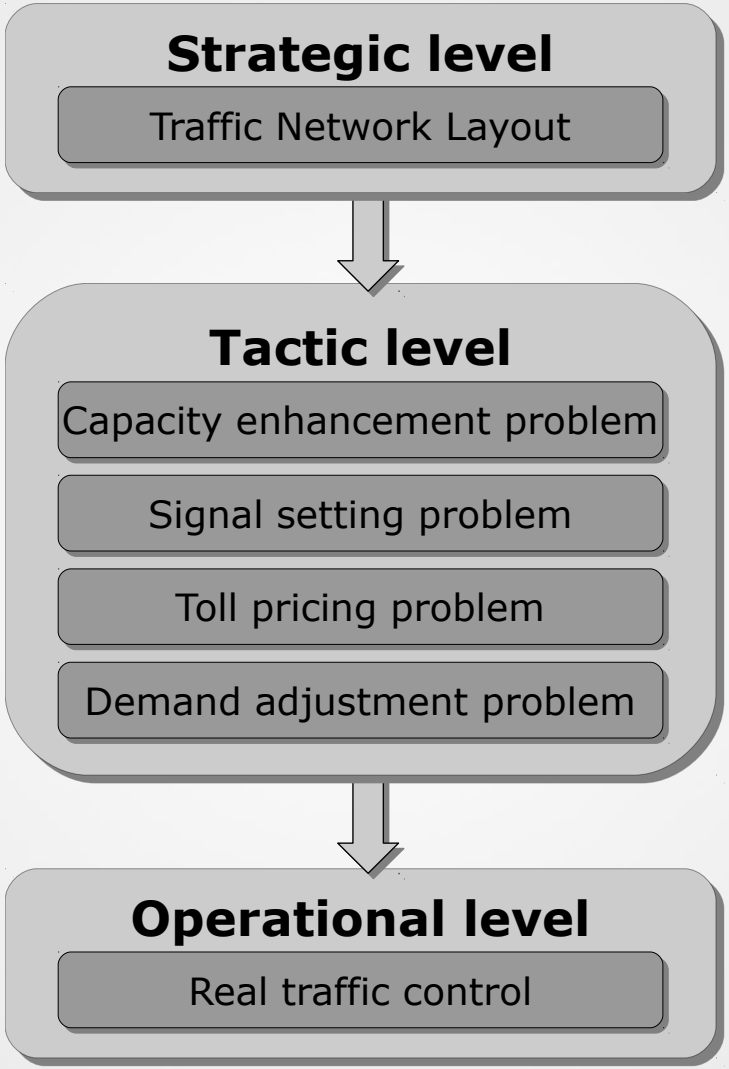
SYSORM 2019
5th June 2019

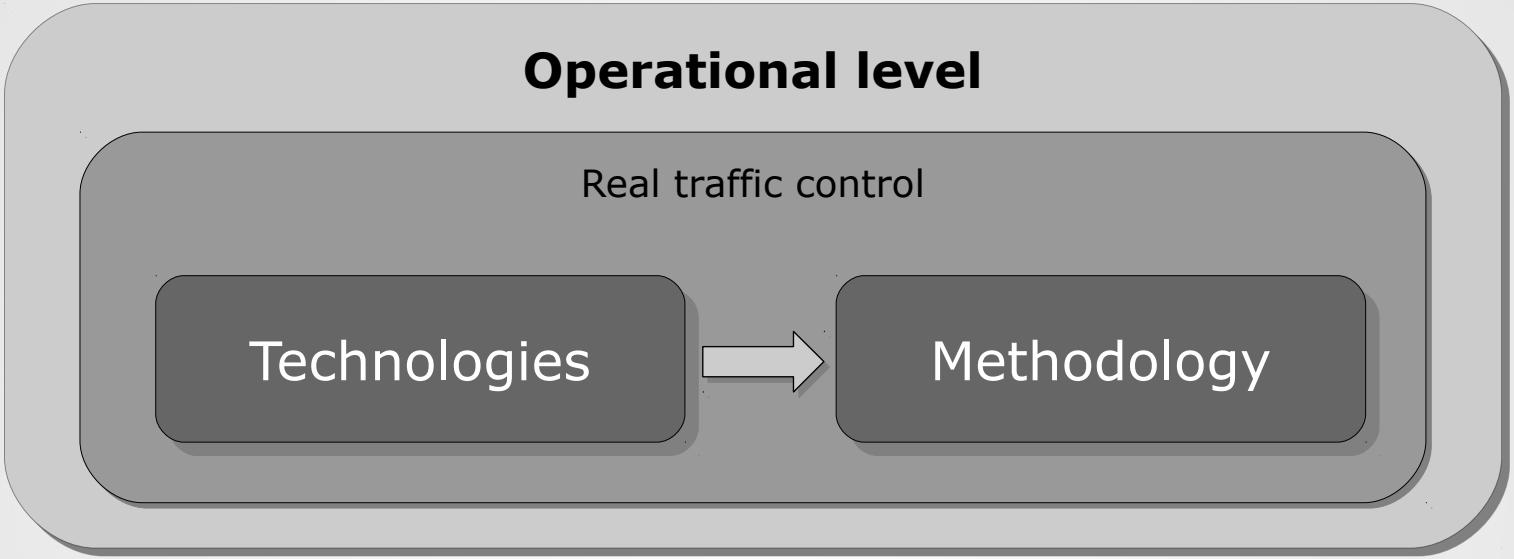
José Ángel Martín-Baos
Ricardo García-Ródenas
Luis Rodríguez-Benitez

Content


Conclusions
05
Results
04
Methodology
03
Research Question
02
Introduction
01

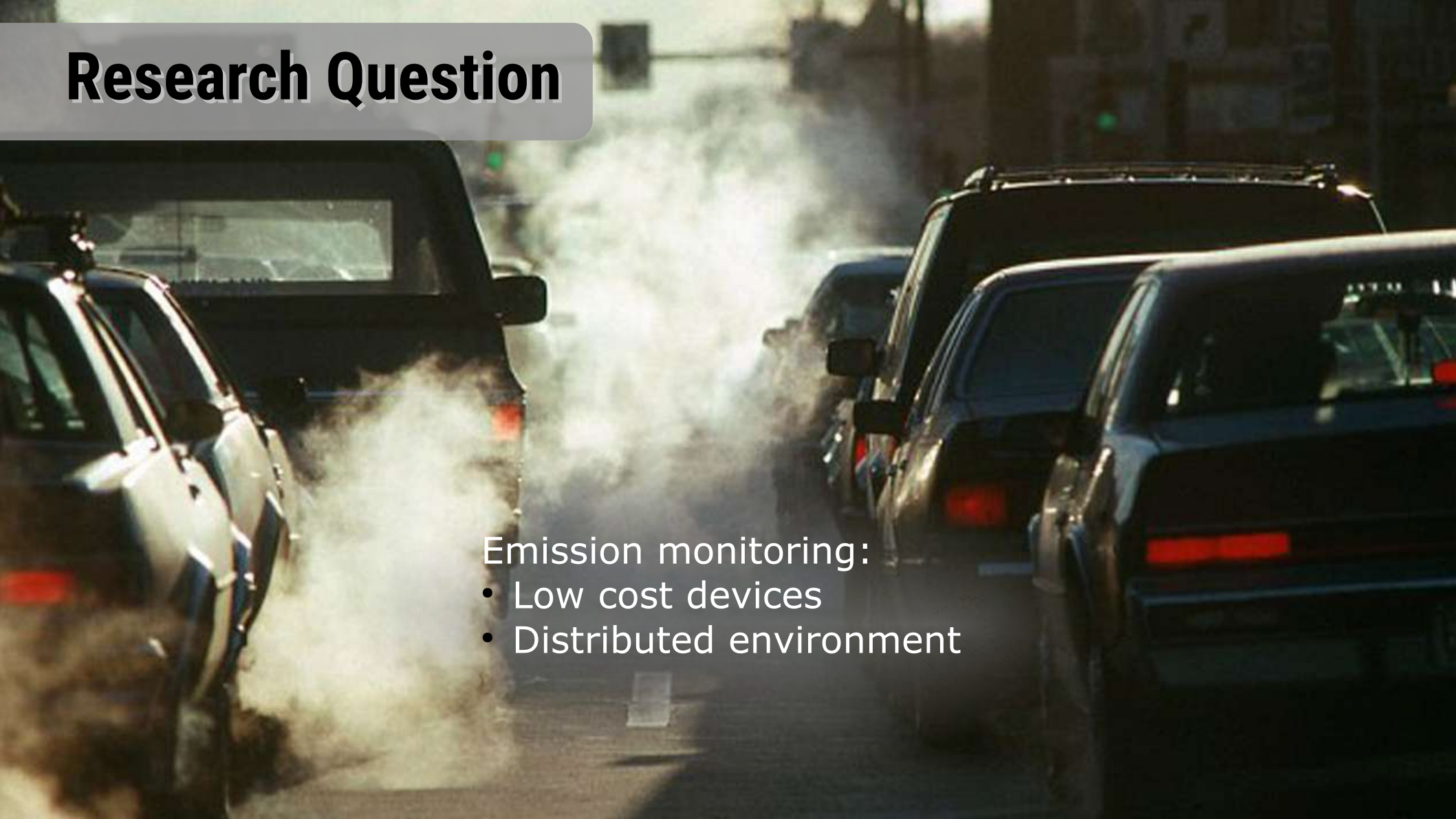
Introduction





Proyect awarded by:

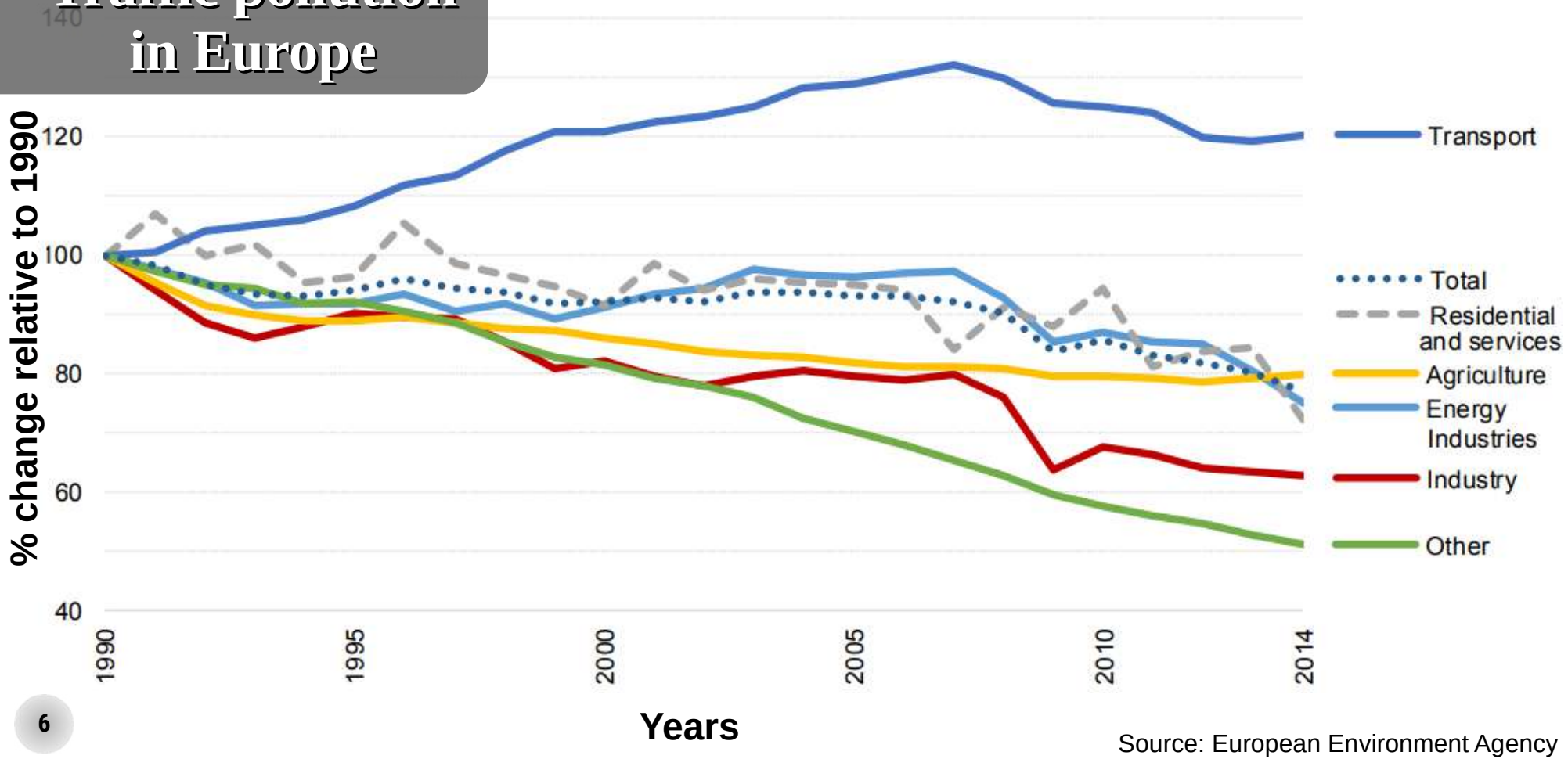
Research Question



Emission monitoring:

- Low cost devices
- Distributed environment

Traffic pollution in Europe

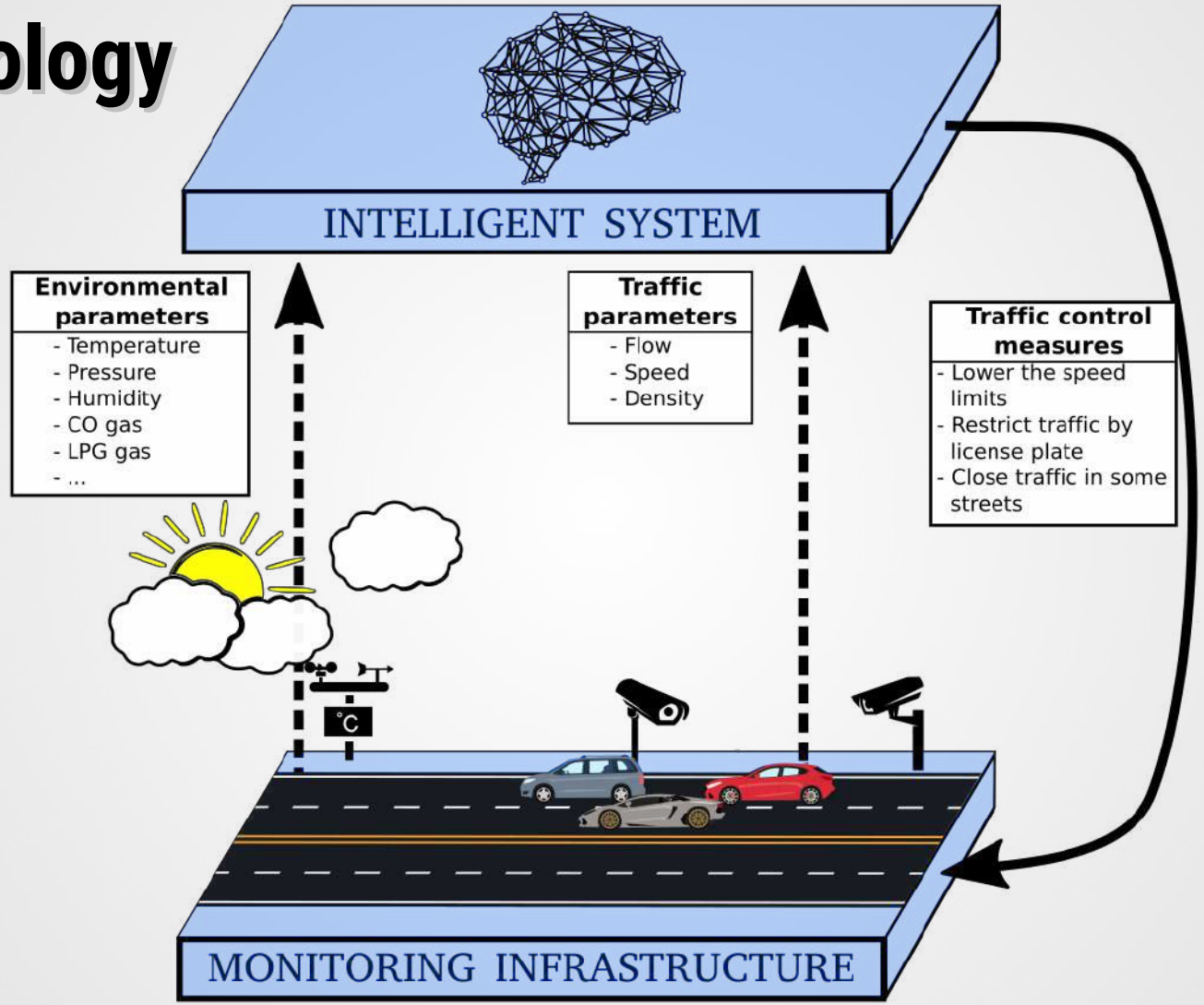


Source: European Environment Agency

Environmental labels in Spain

Source: www.cocheando.es

Methodology

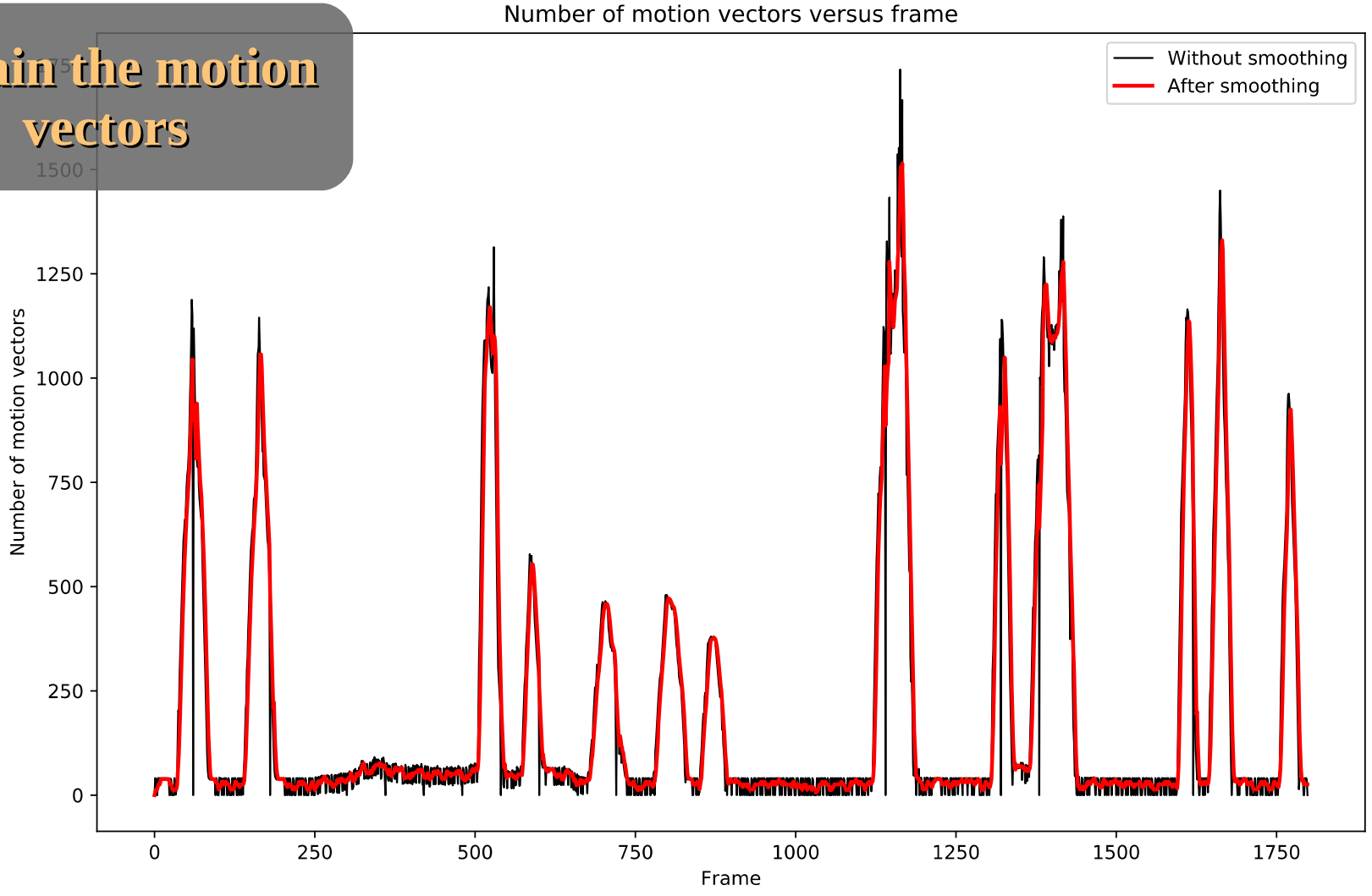


Raspberry Pi

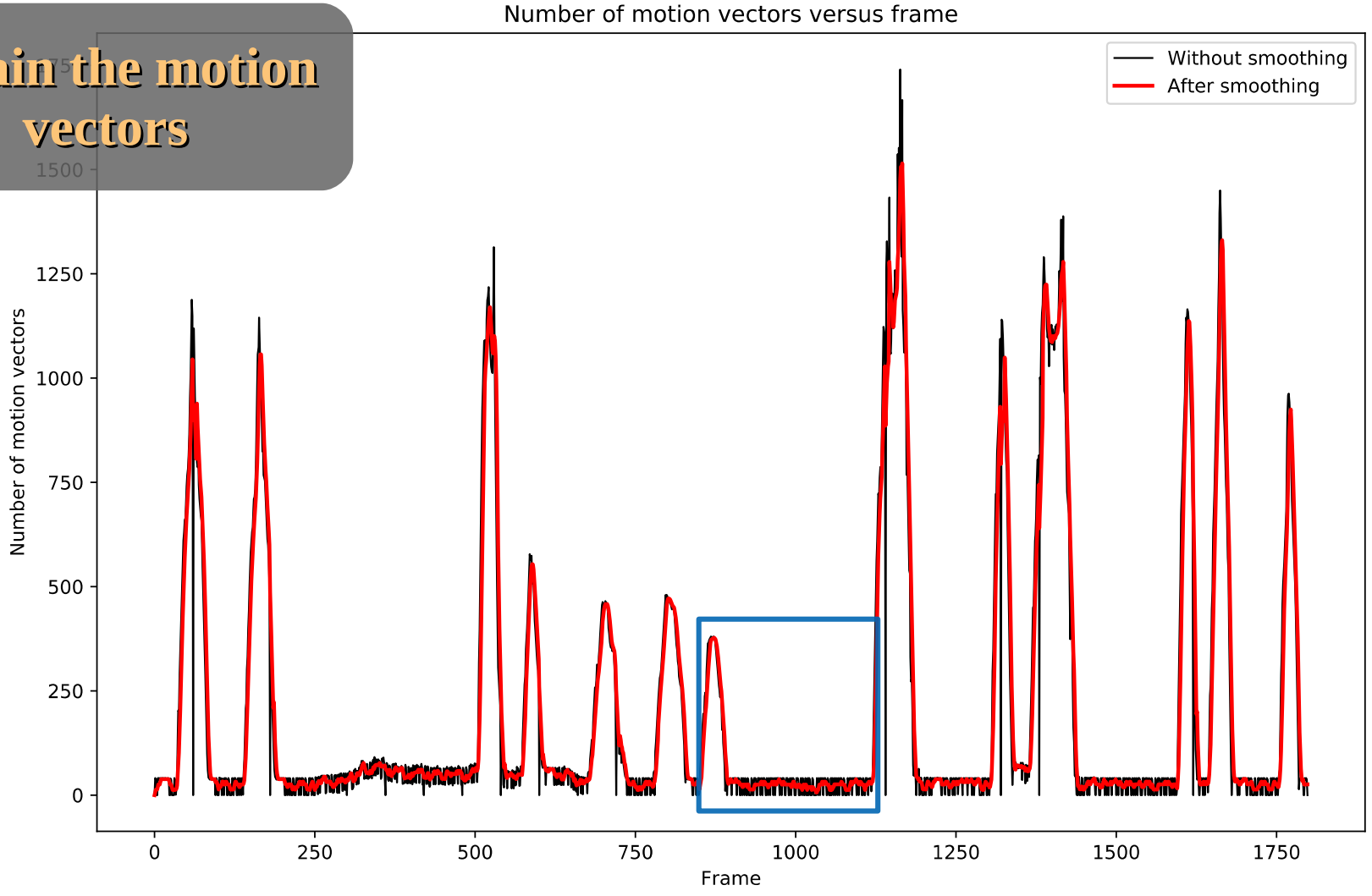
Source: www.raspberrypi.org

Motion Vectors

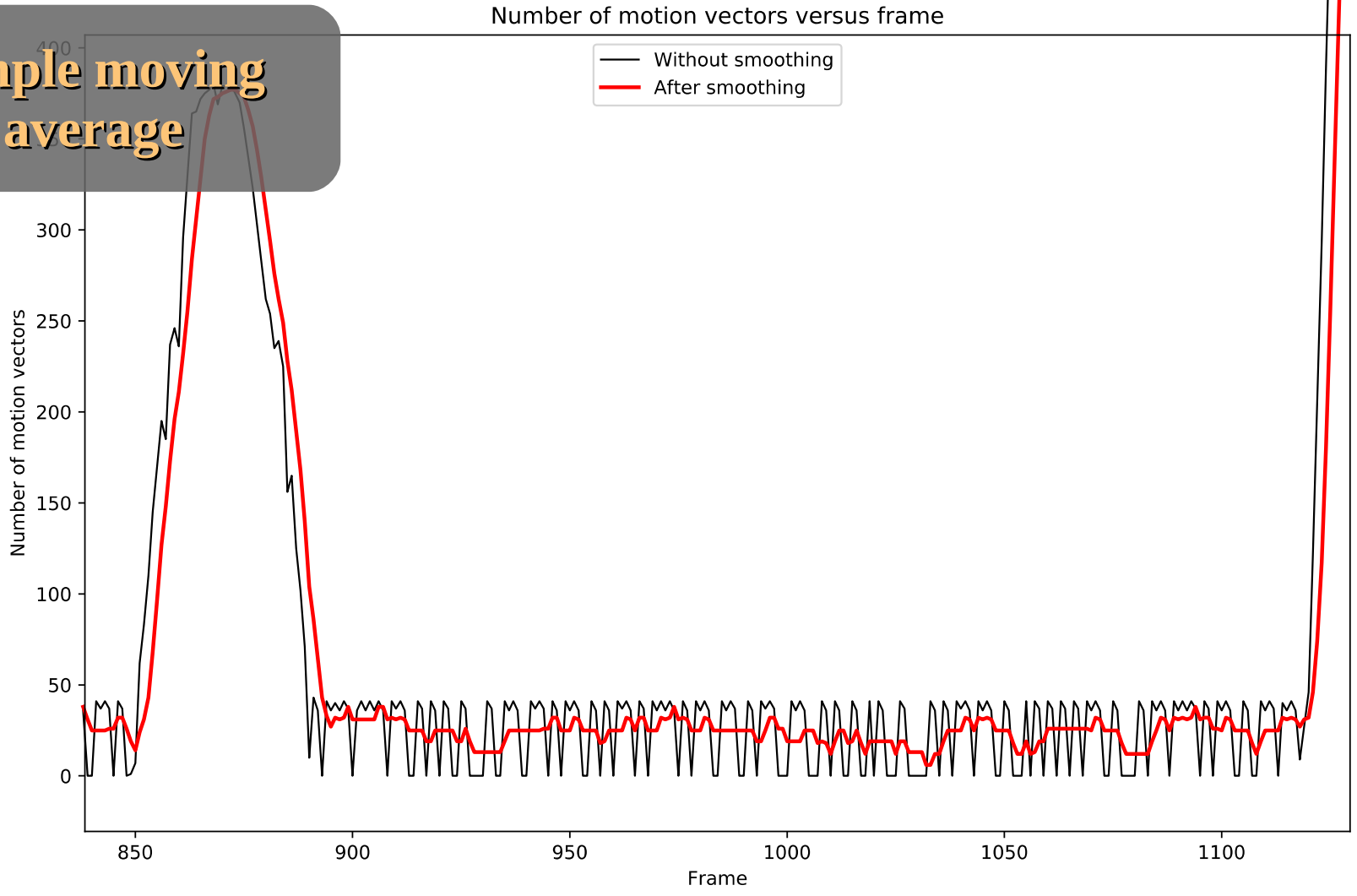
Obtain the motion vectors



Obtain the motion vectors



Simple moving average



Algorithm to count vehicles

```
n_vehicles ← 0
car_detected ← False
growth ← 0

GROWTH_LIMIT ← 5
WIDTH_THRESHOLD ← 10
HEIGHT_THRESHOLD ← 150
SMOOTH_ORDER ← 6

/* Repeat for each frame in the video */

    mv ← smooth(mv, SMOOTH_ORDER)
```

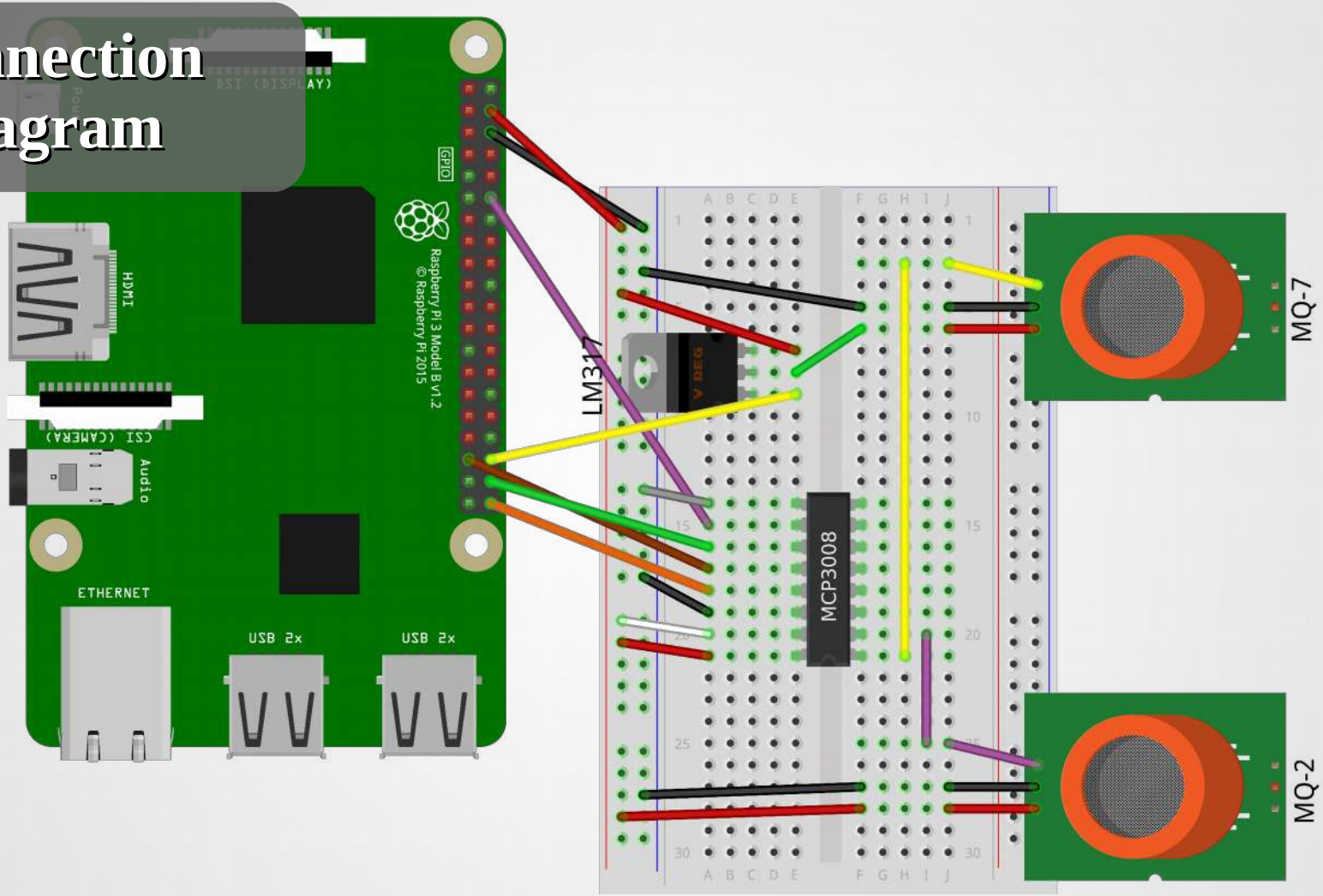
Algorithm to count vehicles

```
/* Repeat for Left and Rigth direction */

if mv[previous frame] < mv and growth < GROWTH_LIMIT then
|   growth ← growth + 1;
else if mv[previous frame] > mv and growth > - GROWTH_LIMIT then
|   growth ← growth - 1;
end

if mv >= HEIGHT_THRESHOLD and growth > 0 then
|   n_positive_frames ← n_positive_frames + 1;
|   if n_positive_frames >= WIDTH_THRESHOLD and car_detected = False then
|   |   car_detected ← True;
|   |   n_vehicles ← n_vehicles + 1;
|   end
else if growth = - GROWTH_LIMIT then
|   car_detected ← False;
|   n_positive_frames ← 0;
end
```

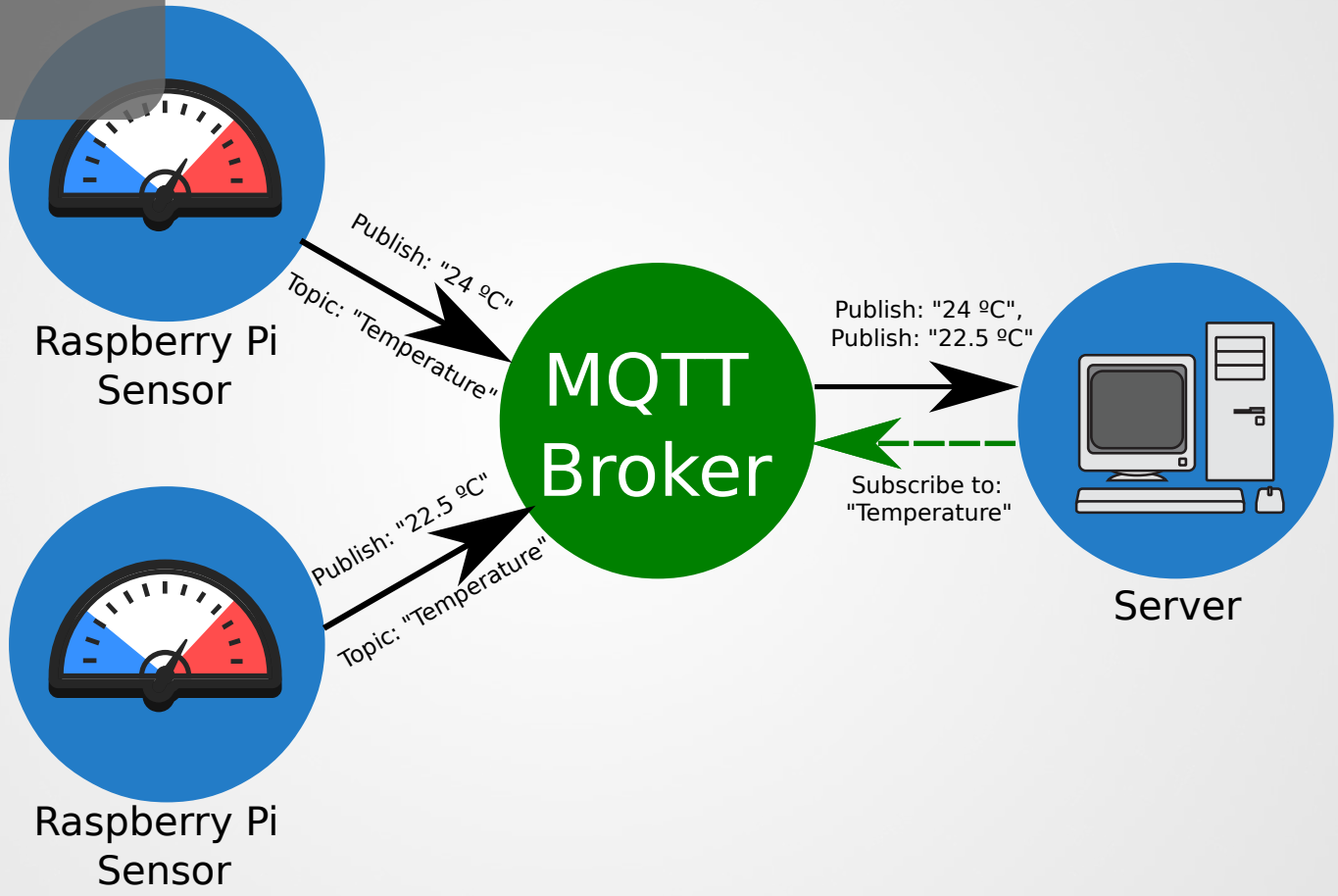
Algorithm to count vehicles

DEMO

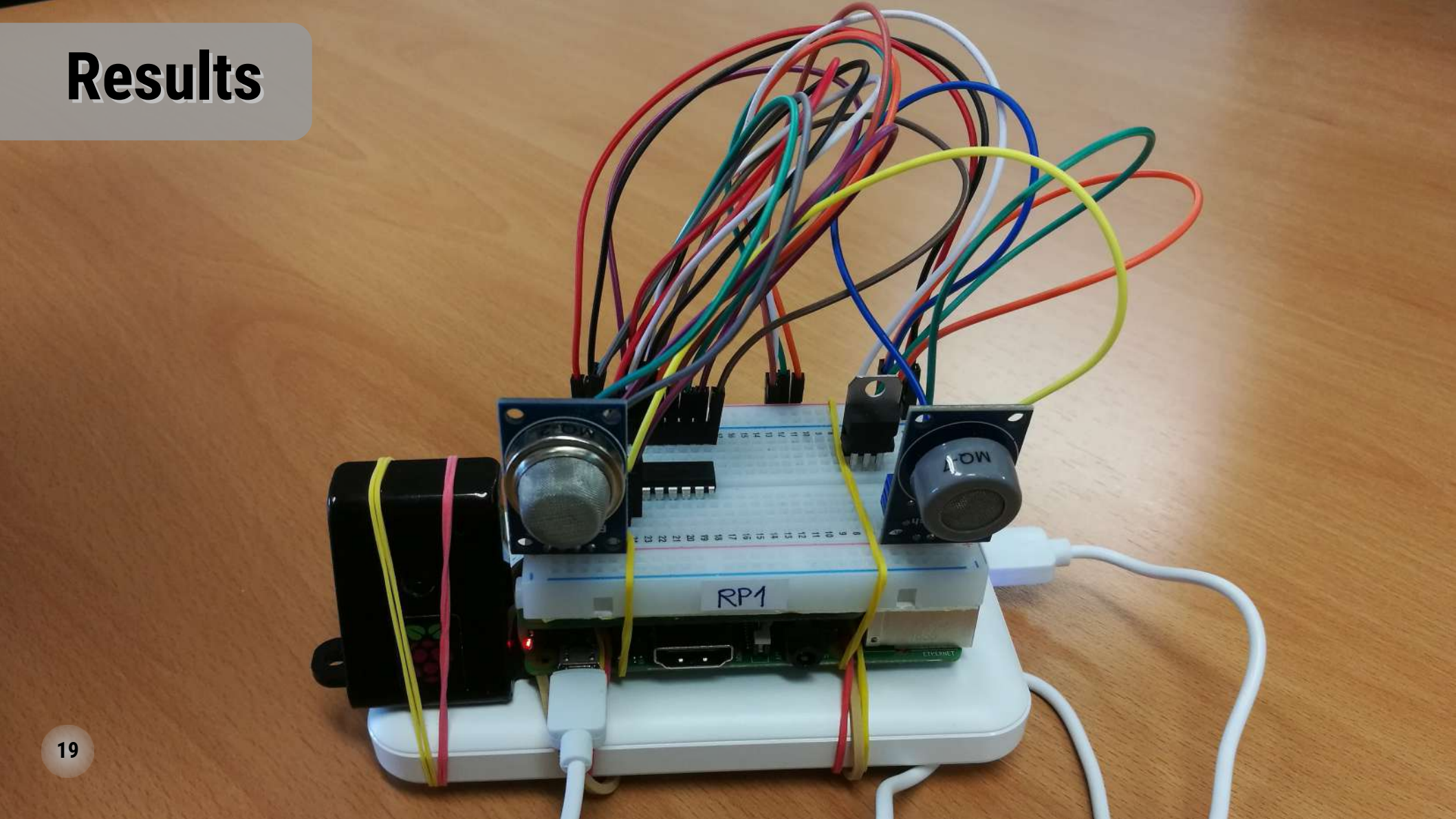
Connection diagram



IBM IoT Platform



Results



~ 90 % average percentage hits
using 23 test videos in a street with
one line in each direction

0,4% of the information used
compared to traditional video
analysis techniques

~ 0,0024 seconds per frame

Web Page

Last data of device 1: Escuela Superior de Informática. Ciudad Real, España.

Environmental parameters

Temperature

Humidity

Pressure

CO gas concentration:

3.14 ppm

LPG concentration:

10.34 ppm

Last updated: 2018-05-30 21:41:52

Traffic parameters

Vehicles per hour:

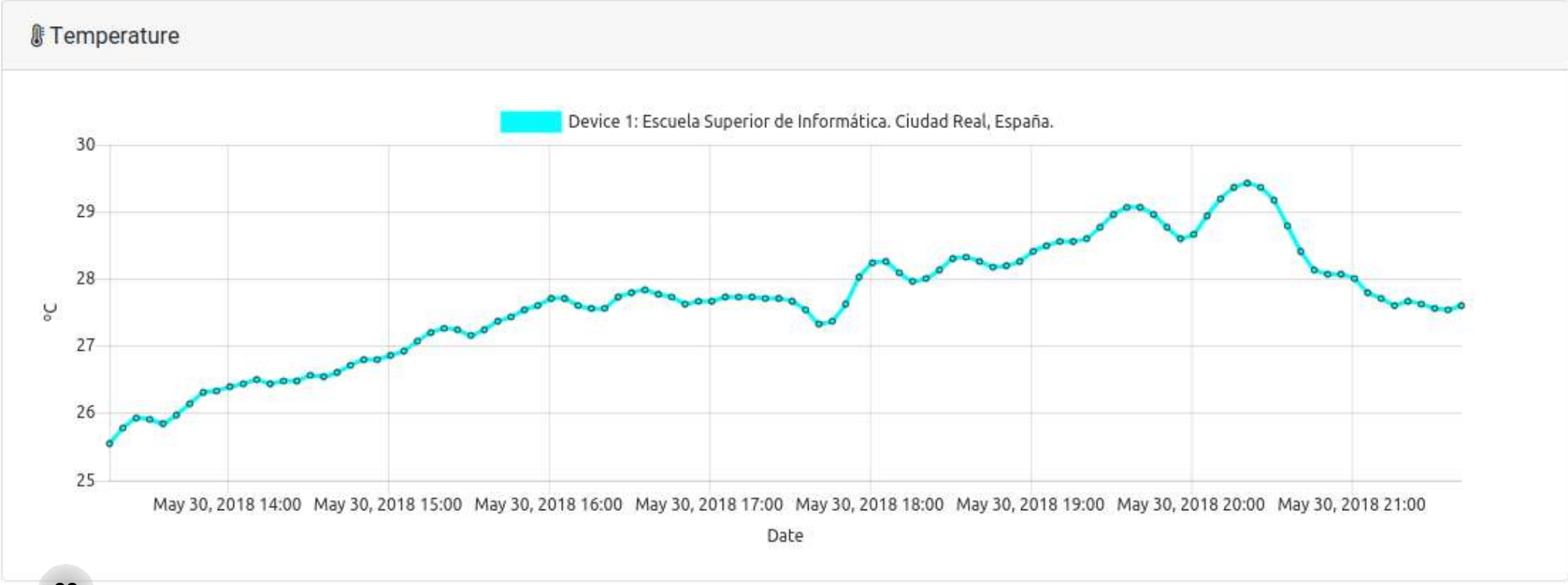
180

Last updated: 2018-05-30 21:41:52

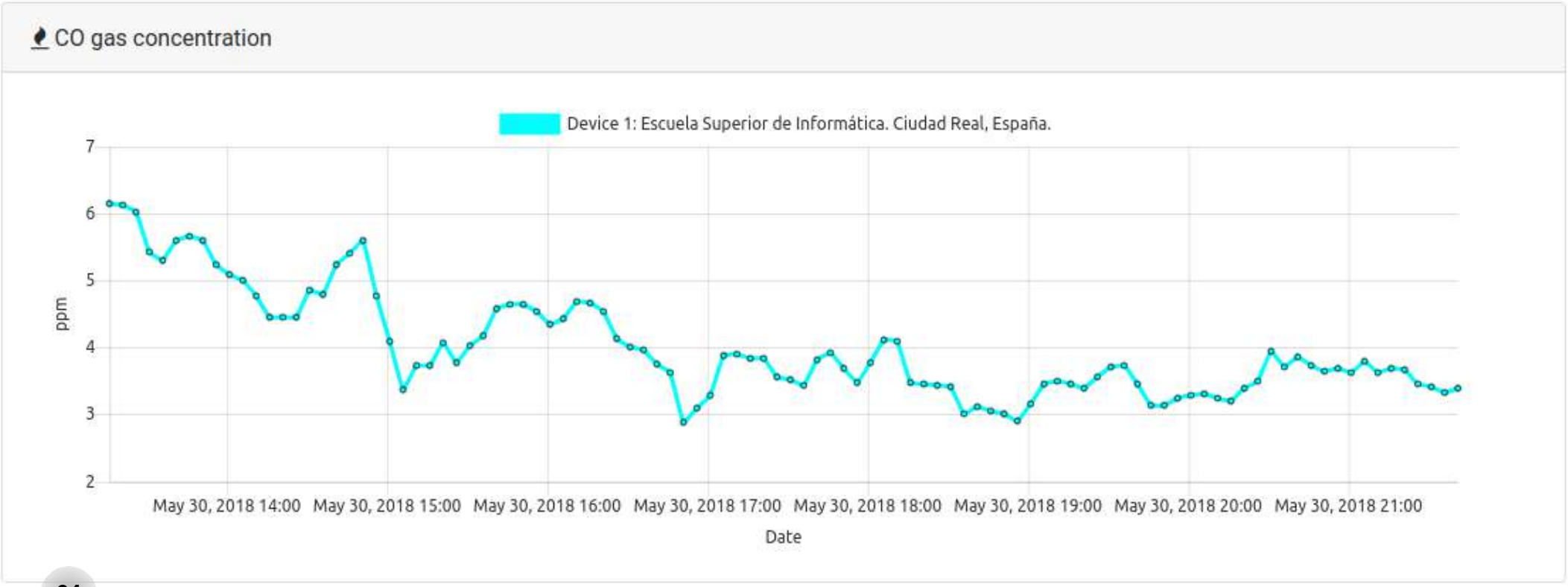
Web Page


Vehicles per hour
Device 1: Escuela Superior de Informática. Ciudad Real, España.
800
700
600
500
400
300
200
Vehicles/hour
May 30, 2018 14:00
May 30, 2018 15:00
May 30, 2018 16:00
May 30, 2018 17:00
May 30, 2018 18:00
May 30, 2018 19:00
May 30, 2018 20:00
May 30, 2018 21:00
Date

Web Page


Temperature
Device 1: Escuela Superior de Informática. Ciudad Real, España.
30
29
28
27
26
25
°C
May 30, 2018 14:00
May 30, 2018 15:00
May 30, 2018 16:00
May 30, 2018 17:00
May 30, 2018 18:00
May 30, 2018 19:00
May 30, 2018 20:00
May 30, 2018 21:00
Date

Web Page


CO gas concentration
Device 1: Escuela Superior de Informática. Ciudad Real, España.
ppm
7
6
5
4
3
2
May 30, 2018 14:00
May 30, 2018 15:00
May 30, 2018 16:00
May 30, 2018 17:00
May 30, 2018 18:00
May 30, 2018 19:00
May 30, 2018 20:00
May 30, 2018 21:00
Date

Conclusion

ALGORITHM

Motion vectors allows to use statistical techniques to detect vehicles without processing the image itself.

~90% of vehicles detected.
Low CPU resources (~10%).
Fast (~0,0024 s/frame)

MONITOR

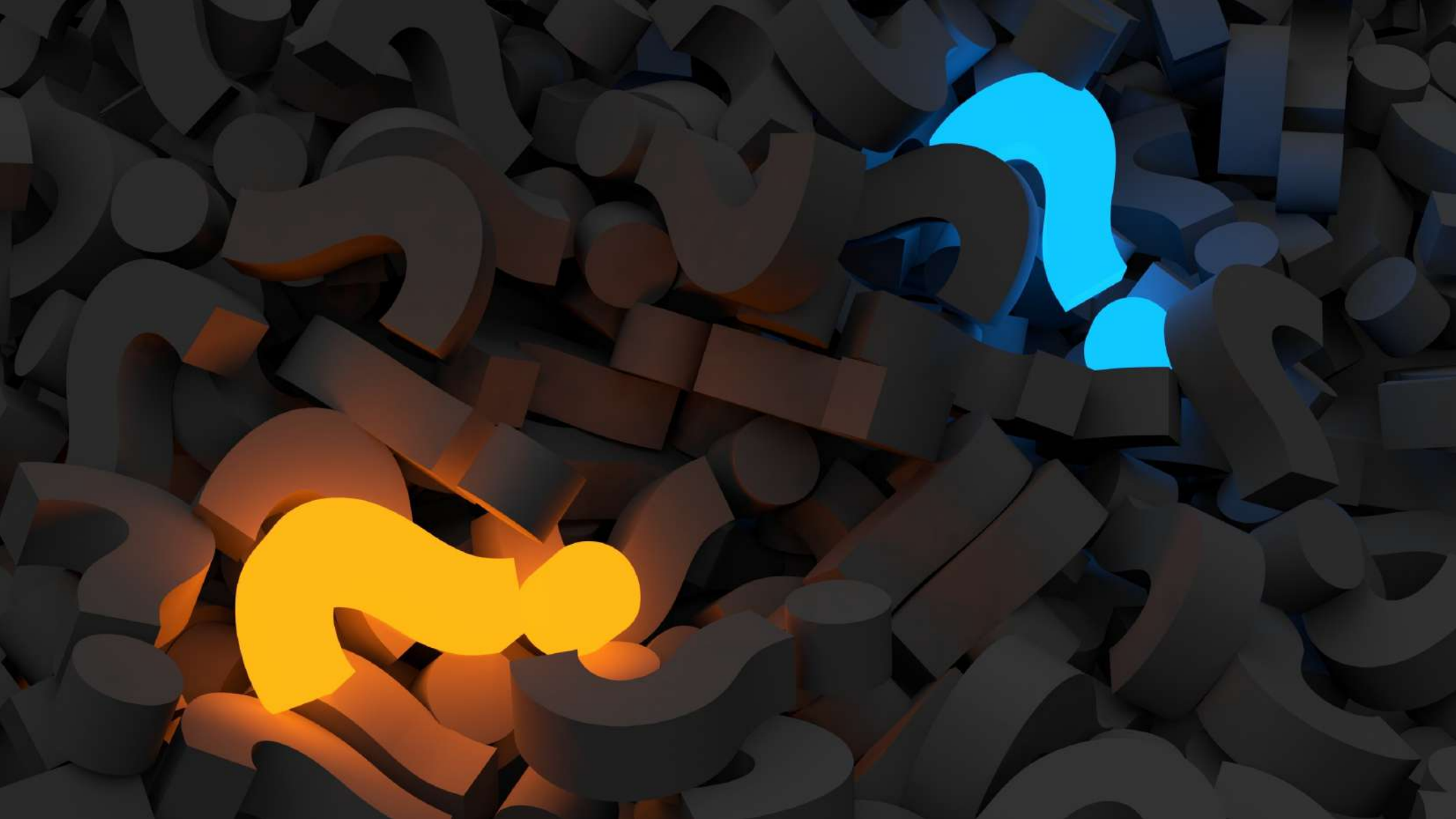
We are able to **monitor** simultaneously **road traffic** and **air pollution** using a low-cost device.

FUTURE WORK

Implement a machine learning based methodology to **estimate** the **air quality evolution** using the data provided by this infrastructure and **recommend** palliative actions.

COMUNICATION

We are able to communicate all the information to the cloud using IBM services, were it can be processed.



Universidad de Castilla-La Mancha

Escuela Superior de Informática

Thank you for your attention

José Ángel Martín Baos

Universidad de Castilla-La Mancha

JoseAngel.Martin@uclm.es

https://linkedin.com/in/joseangelmartinb/