Development of a Tamper-Proof Onboard Weighing System for Road Freight

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The SETO Project

A *Horizons Europe* research project

Traditional WIM gives detailed and accurate weights, but only at one location (using weighbridges or road sensors)

We propose a Tamper-proof weighing approach is an on-board weighing method that uses vehicle axle vibration and road profile to estimate gross vehicle weight.

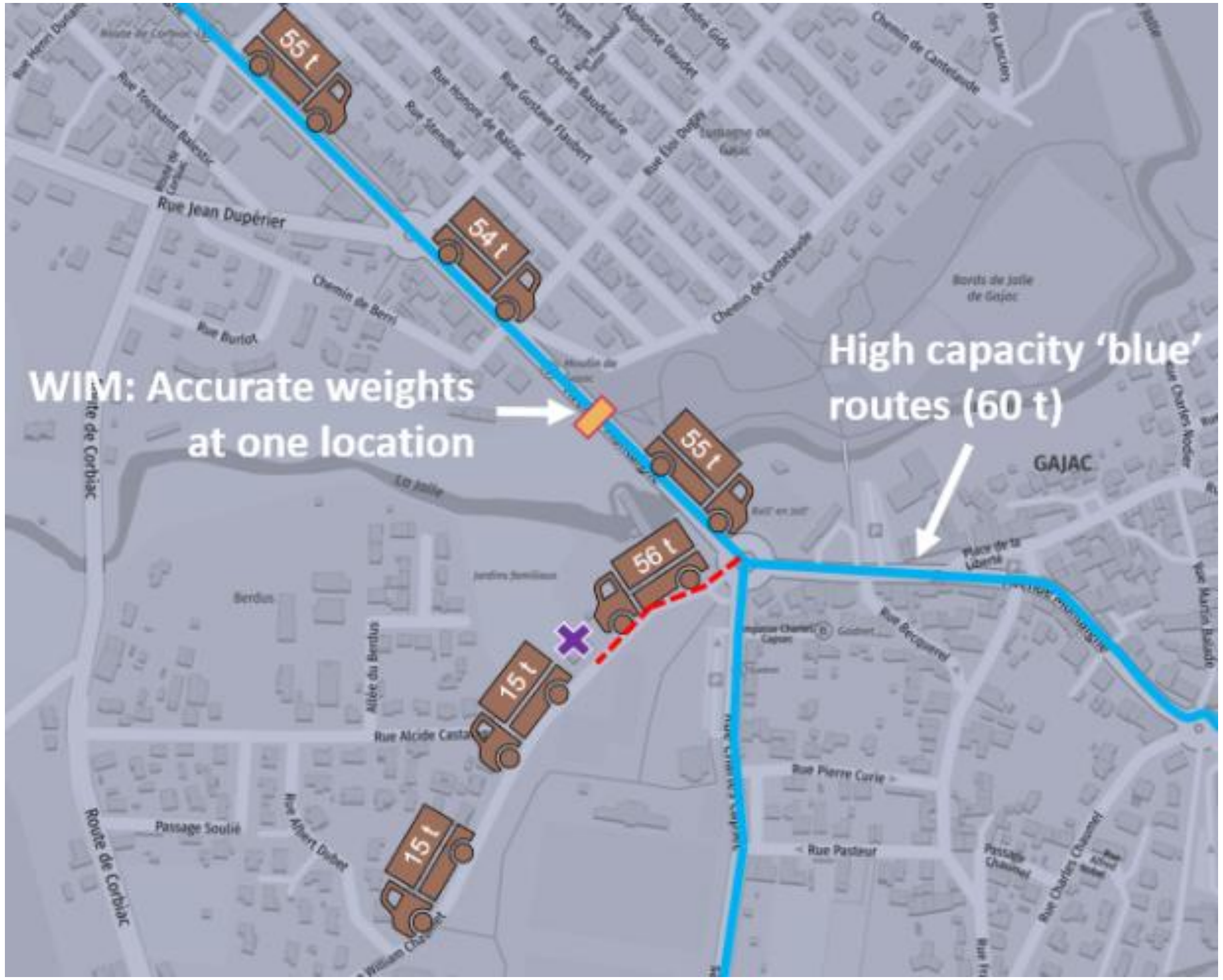
On-board weighing may be less accurate, but it monitors weight everywhere on road.
With better accuracy, this approach can be very beneficial for weight enforcement.

The SETO Project

Tamper proof approach has a practical application in regards to enforcement

For example, here, the general limit is 48 t but 60 t is allowed on the blue route

A violation is detected when the truck leaves the blue route (red dashed)



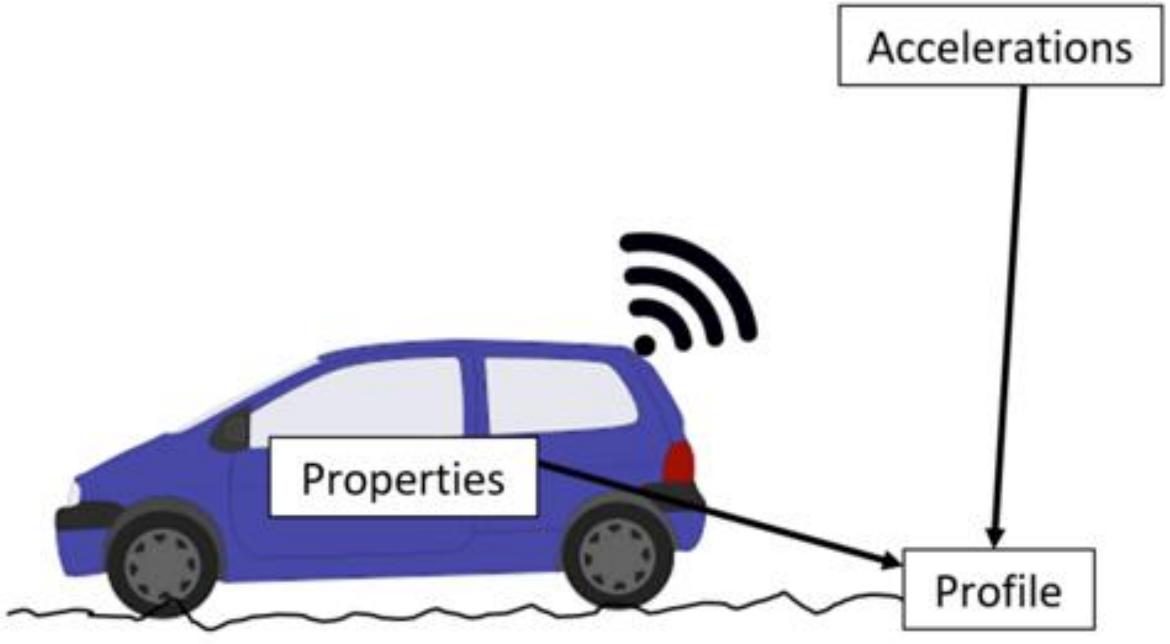
This has the potential to monitor compliance with legal weight limits without disrupting traffic flow.

Tamper Proof Approach – Idea

Inverse Newmark-β problem is a known method to estimate the road profile.

This approach requires a knowledge of all the vehicle properties – spring stiffnesses, masses, etc.

Resulting a calibration problem as we are dealing with many different vehicles that we have no control over.

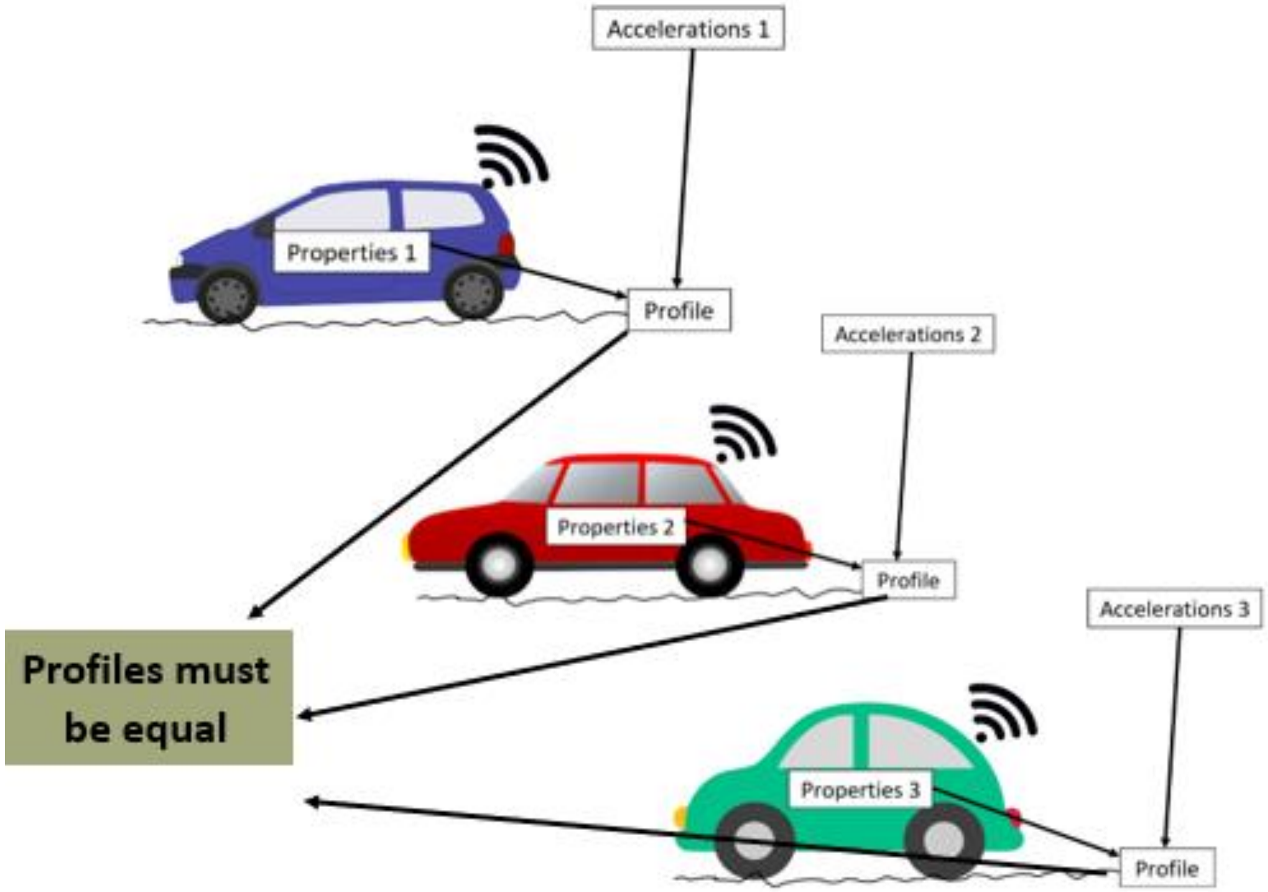


Tamper Proof Approach - IDEA

The calibration problem can be solved using off-bridge data – by applying the fact that all vehicles pass over the same profile

Hence, an optimisation solution can be applied using each vehicle traversing a same profile

Optimisation Solution: Find vehicle properties that minimize the sum of squared differences between all the implied profiles



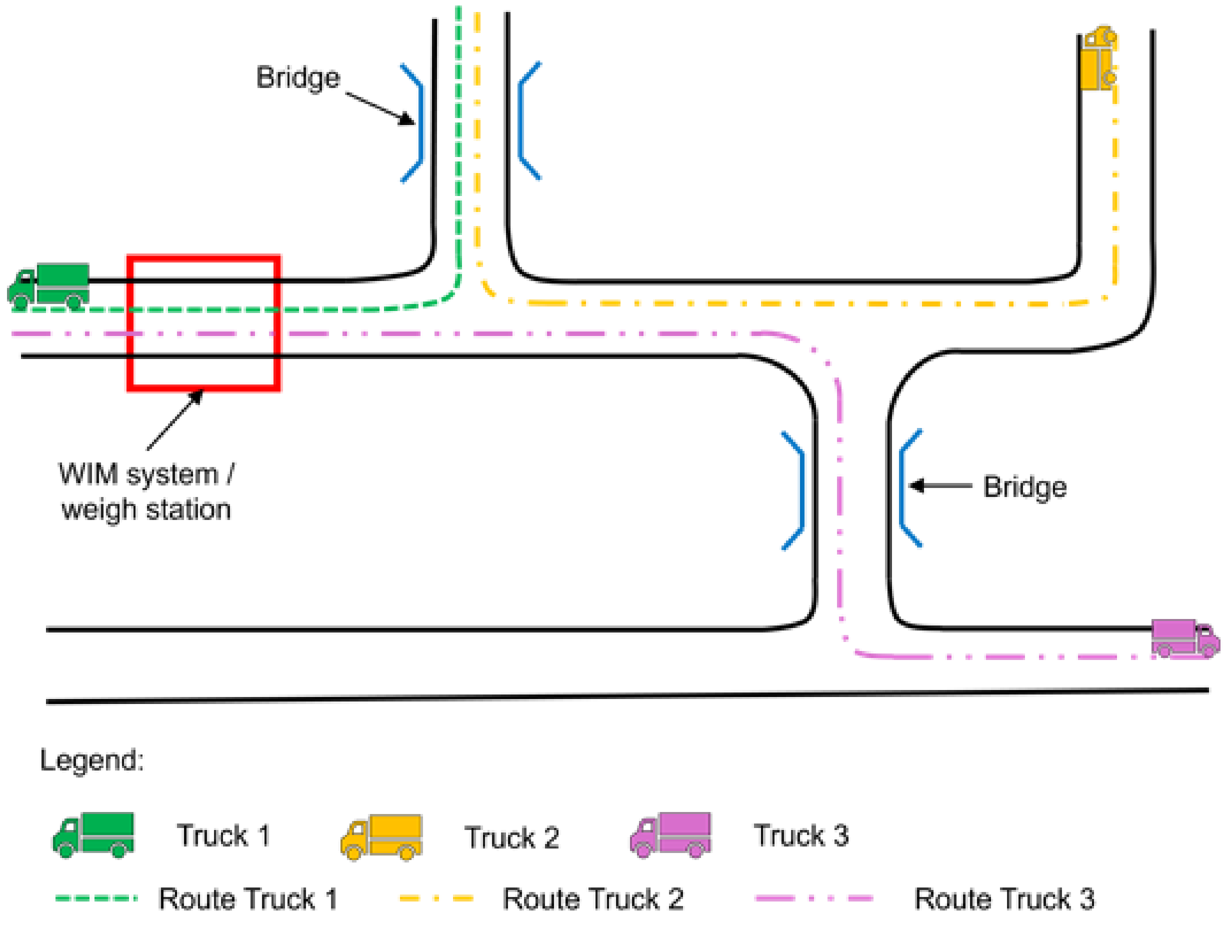
Tamper Proof Approach – Field Feasibility

Measure (uniaxial) acceleration and position (GPS) of at least 10 trucks

Whose routes overlap

And which pass over bridges (optional)

And which pass over the WIM site or can be weighed in another way

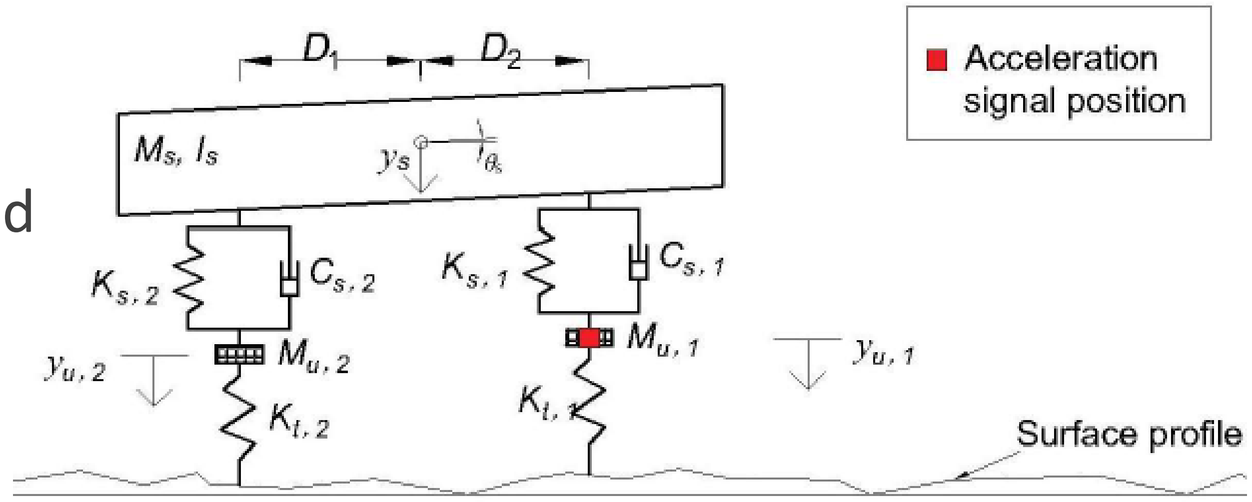


Tamper Proof Approach – Numerical Validation

A half-car model is simulated for the numerical analysis.

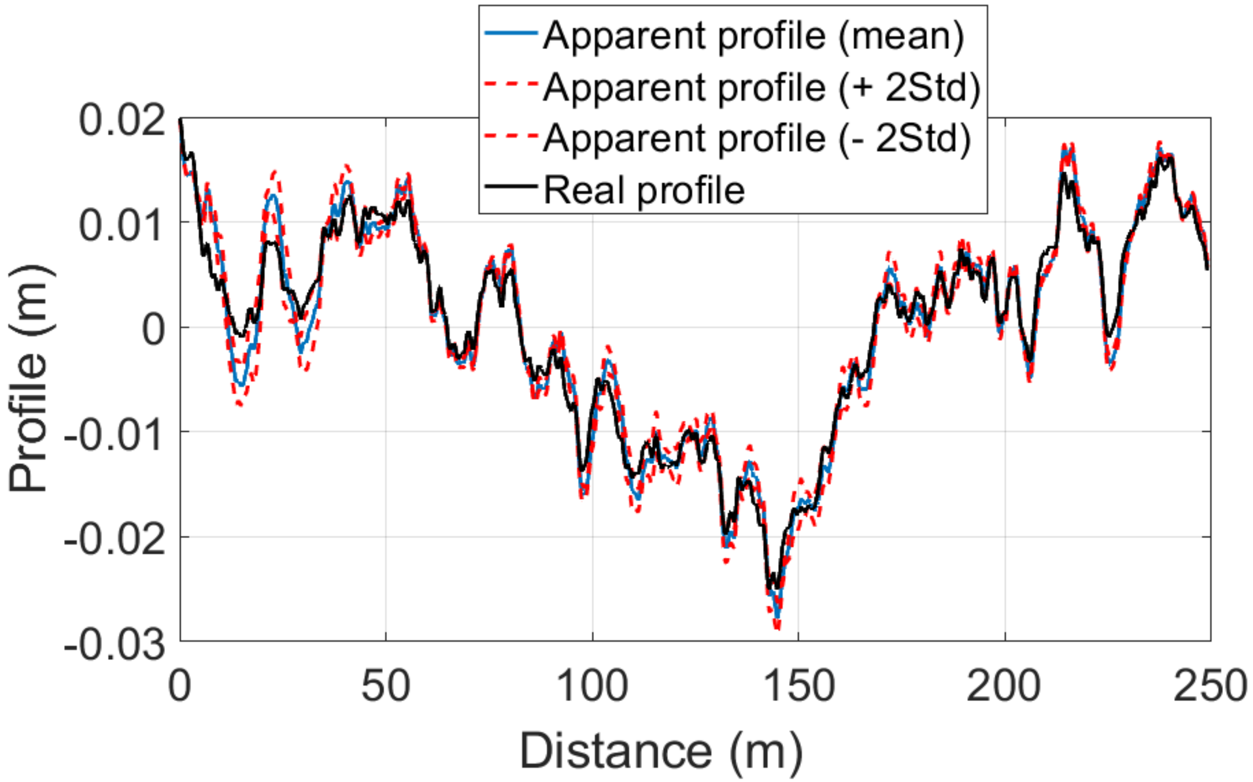
A set of vehicles with different weights and speeds have been simulated to traverse same profiles.

Axle accelerations are measured using dynamic modelling. These accelerations are used to test the proposed approach for tamper proof on-board weighing.



Tamper Proof Approach – Numerical Validation

Acceleration signals from a set of 50 vehicles are used to derive road profiles using inverse Newmark β problem.



Vehicle properties are randomly selected for the derivation of the weights

Tamper Proof Approach – Numerical Validation

With the help of optimisation technique – each derived profile is compared with mean of a statistic of road profiles.

By minimising the sum of squared difference between the derived and mean profiles, GVW has been calculated for each vehicle.

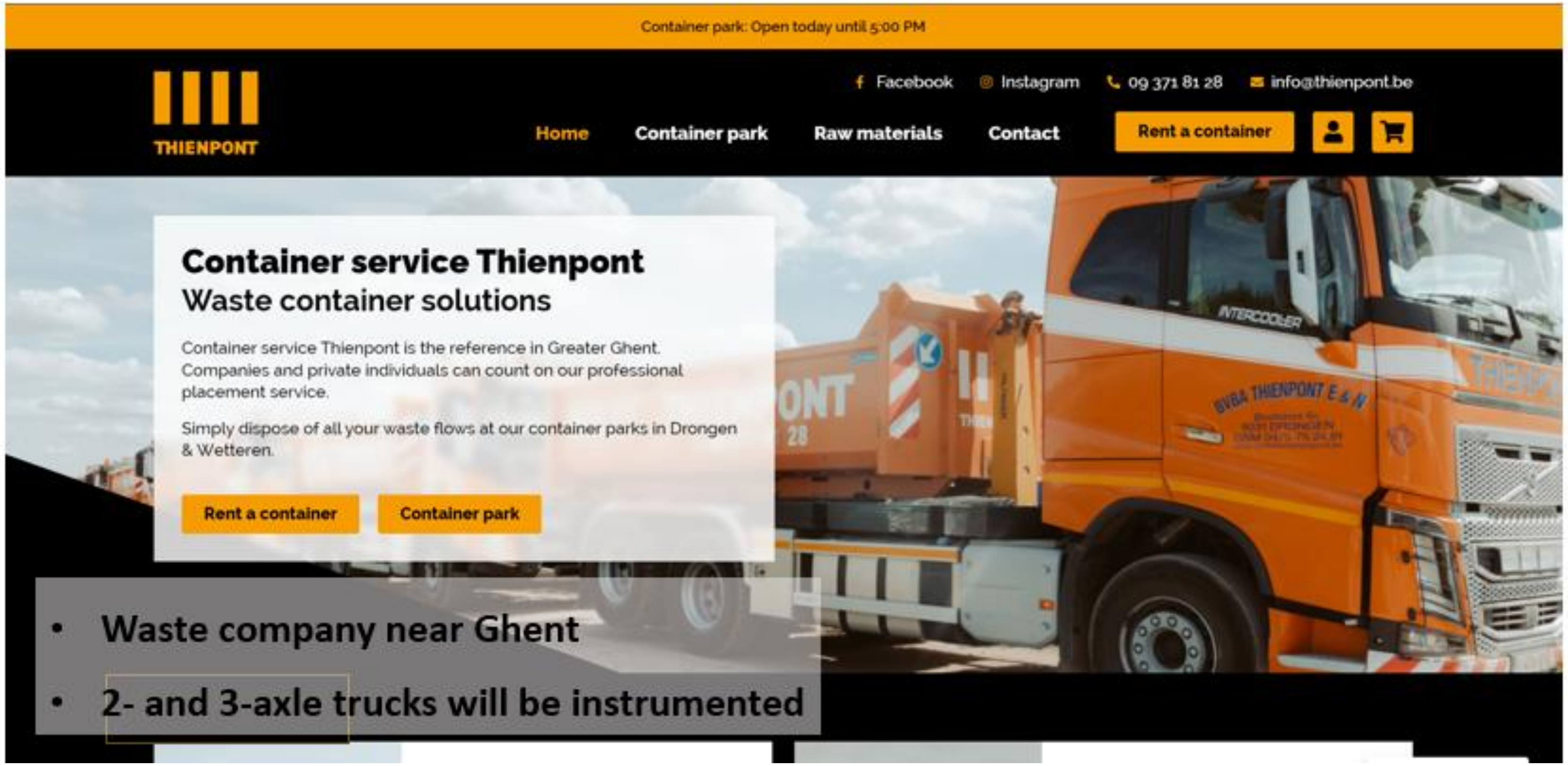
Results showing less than 5% accuracy with noisy and variable vehicle properties conditions (in simulation)

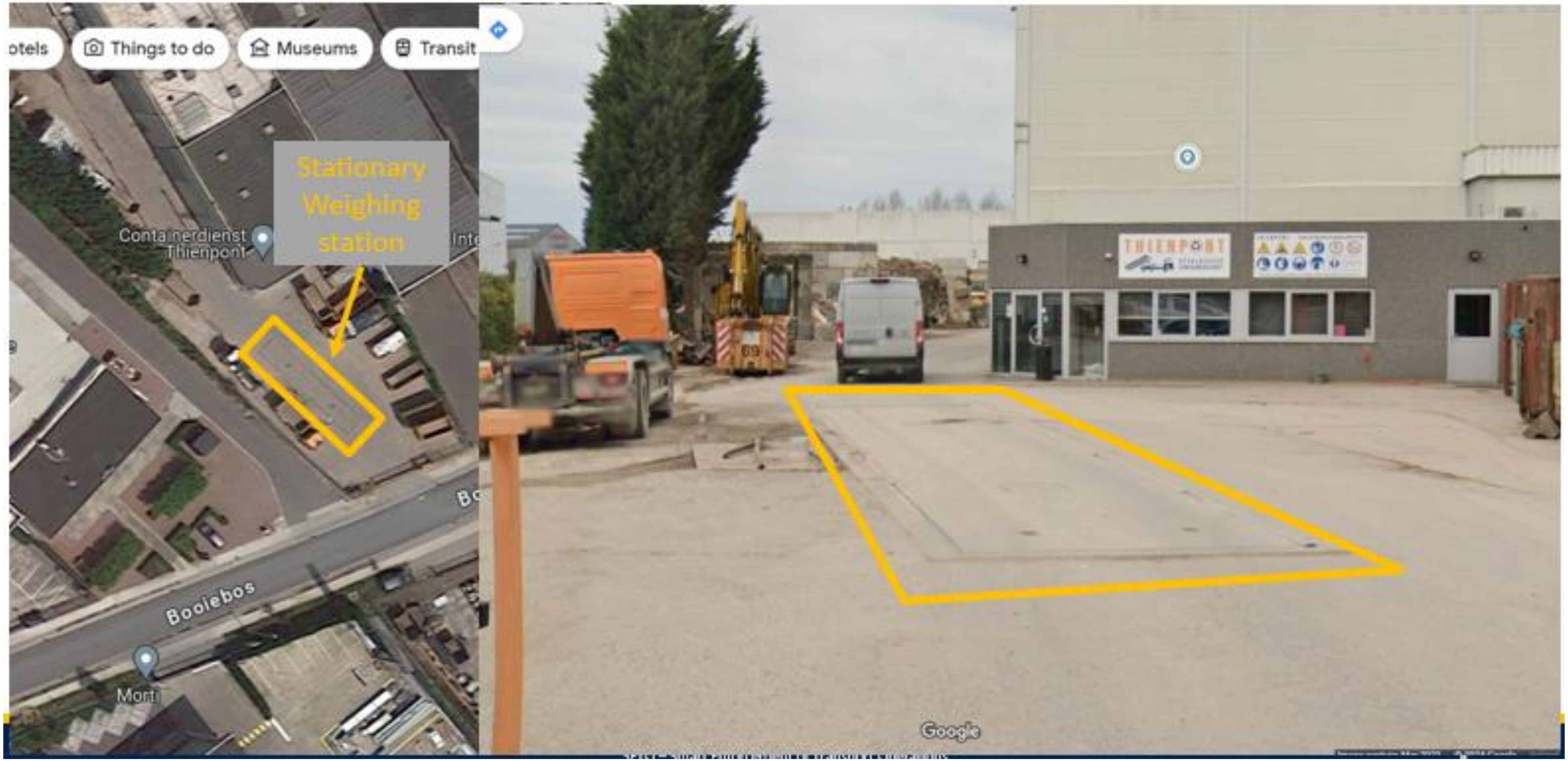
Tamper Proof Approach – FIELD TEST

Working with Theinpont, Belgium, for the approach field test

Next Steps:

1. Instrumentation
2. Field verification and data validation
3. Finalise instrumentation on 10 vehicles

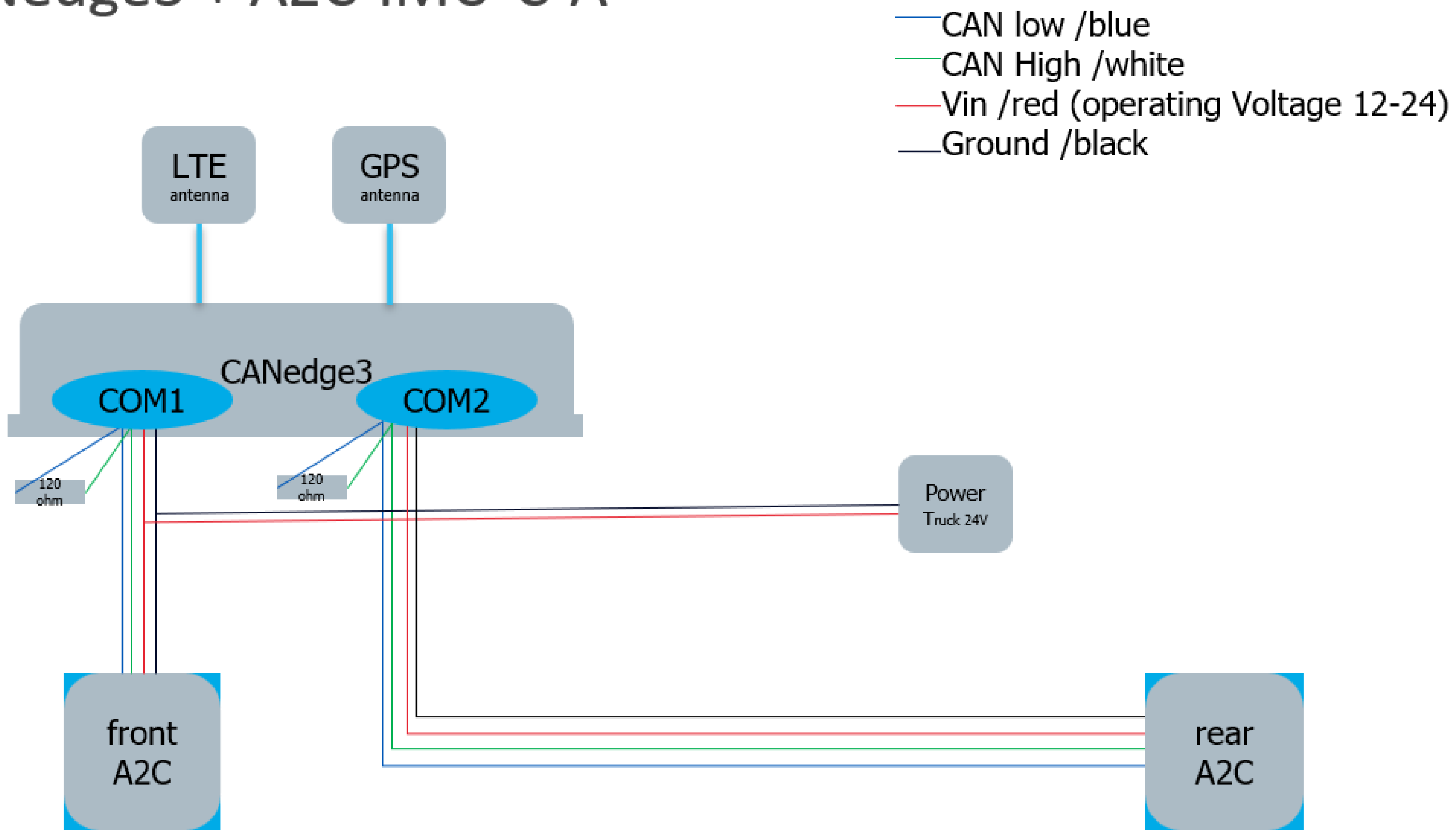



Things to do
Museums
Transit
Stationary Weighing station
Containerdienst Thienpont
Booiebos
Morti
THIENPONT
Google

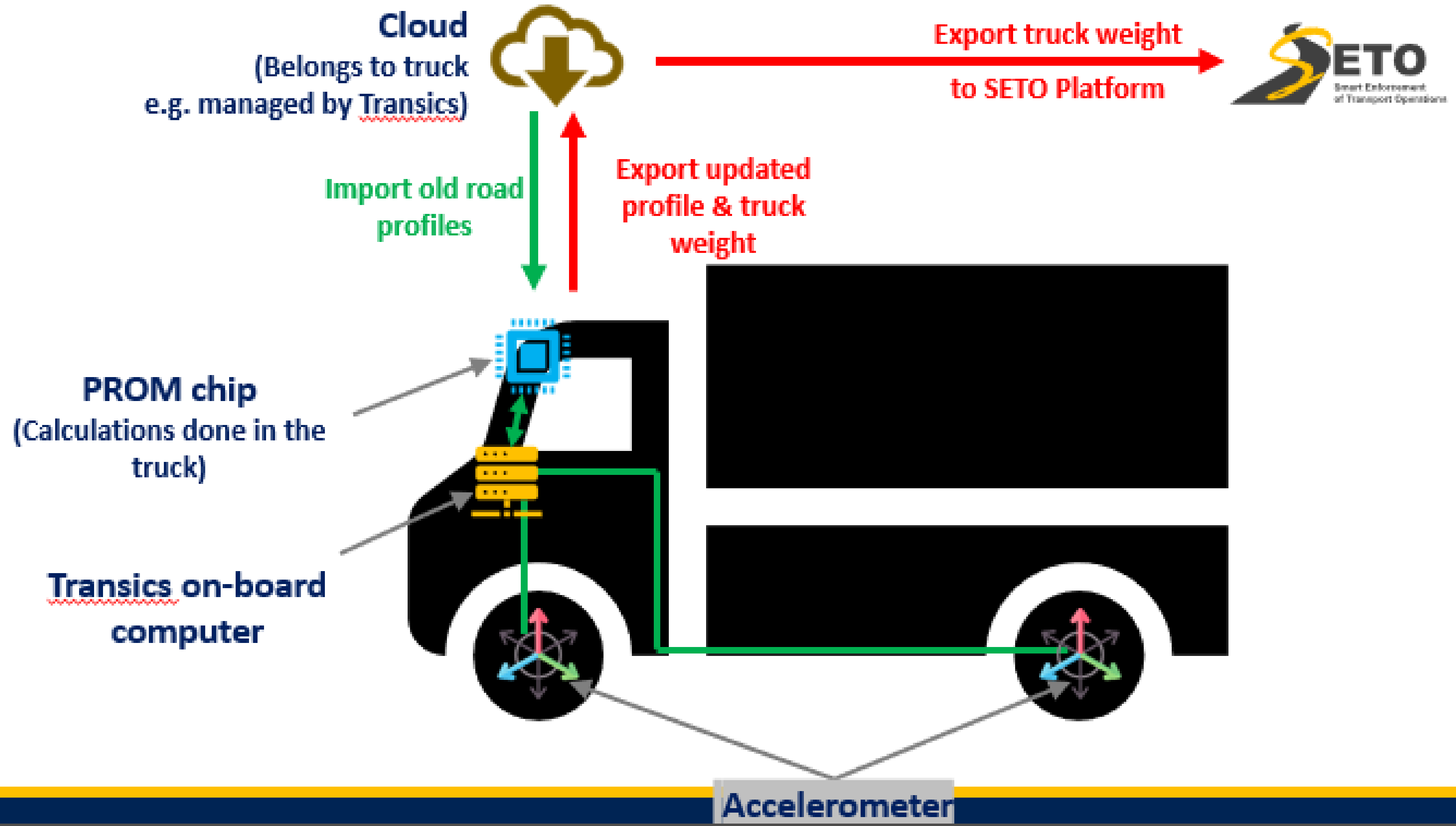
Sensor's setup

Wiring schematic

CANedge3 + A2C-IMU-C-A



Long-term goal



The goal of the SETO project (Smart Enforcement of Transport Operations) is, among other things, to develop technologies to improve and simplify the enforcement process for transport vehicles, particularly those travelling across European borders

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