Panel session: open challenges in verification and control of cyber-physical systems

UnCoVerCPS Workshop - June 6th 2018, Milano

Prof. Sergio M. Savaresi
move.deib.polimi.it

The context - The «mega-trends»

Electric

Autonomous

Large reduction of the number of cars (1:10?)

Large reduction of fossil-fuel usage (-90%?)

Large reduction of fatalities (-99%?)

Shared

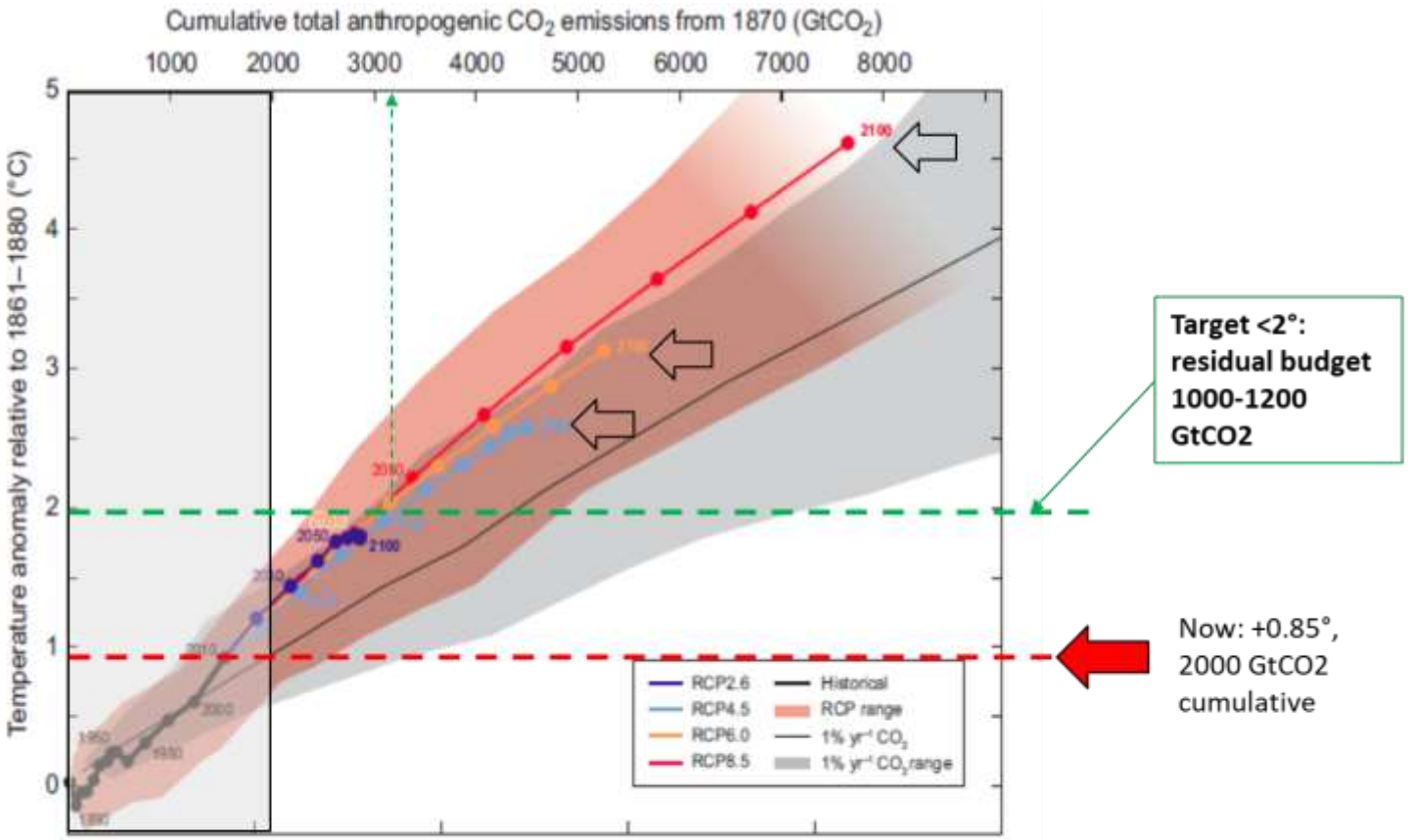
Light (soft-mobility)

The context - A different direction of personal mobility?

ICT technologies are evolving MUCH faster than vehicles and trasport systems

A (near) future without (or just a few) real vehicles?

The context - More than that: is <2° achievable with a classical «people-moving» model?



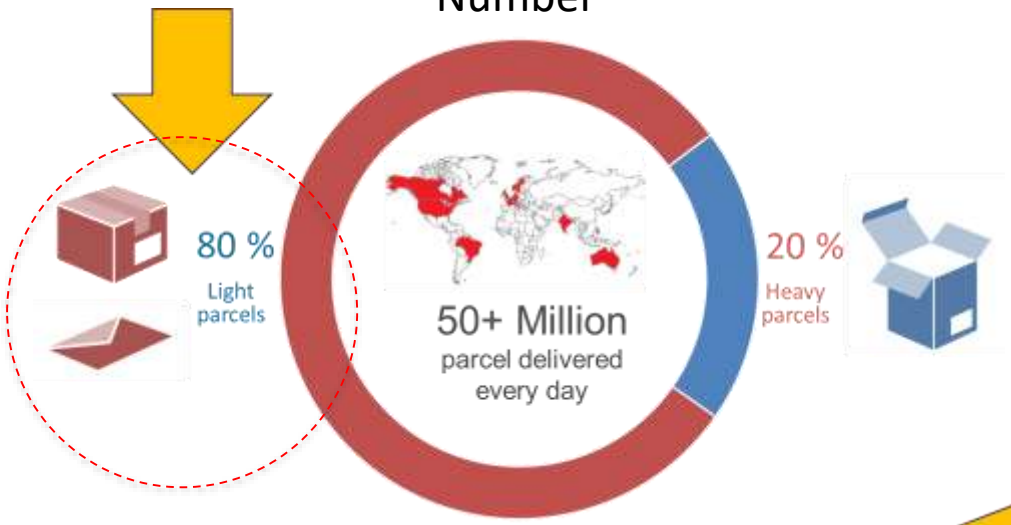
«Google-ization» or «Amazon-ization» of mobility?

Google

amazon

The parcel-delivery main figures

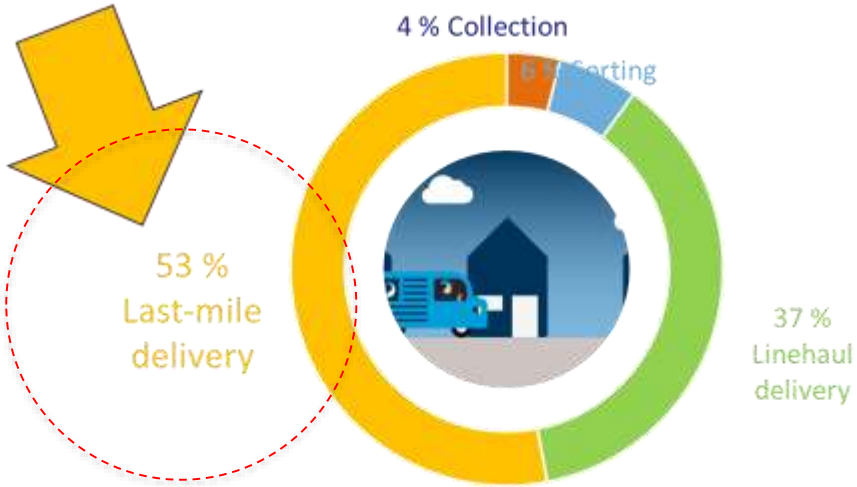
Number



About 40 Billion

of parcels delivered in 2017

Cost



Small-parcels delivery problem: solution

Bike couriers

Couriers employed by the parcel service provider

Point-to-point delivery goods and food delivery

Small number of parcel shipped every day

Currently on the market

Air drone transportation

Autonomous aircraft that carry parcels up to 15 kg

Lot of safety problems

One supervisor every 8 drones

Currently in development phase

Ground drone transportation

Small autonomous vehicle that deliver parcels to the doorstep

Sidewalk and street to reach their destination

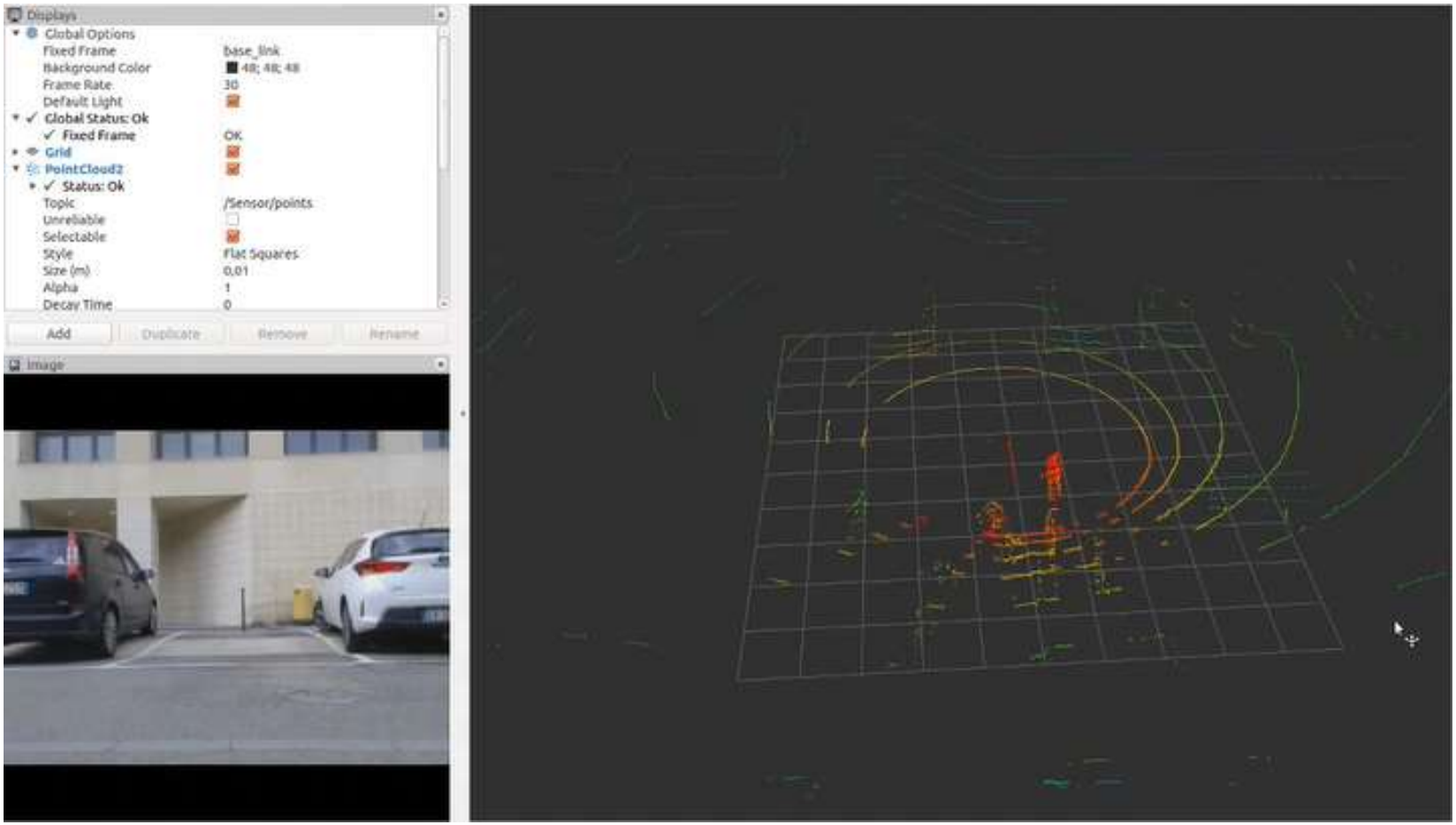
One single supervisor for 50-100 drones

Currenty in development phase

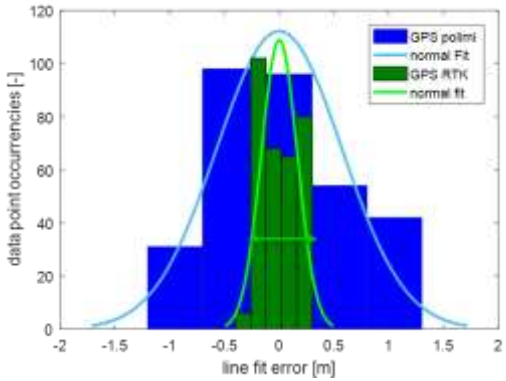
Ground drones for parcels delivery: a booming market

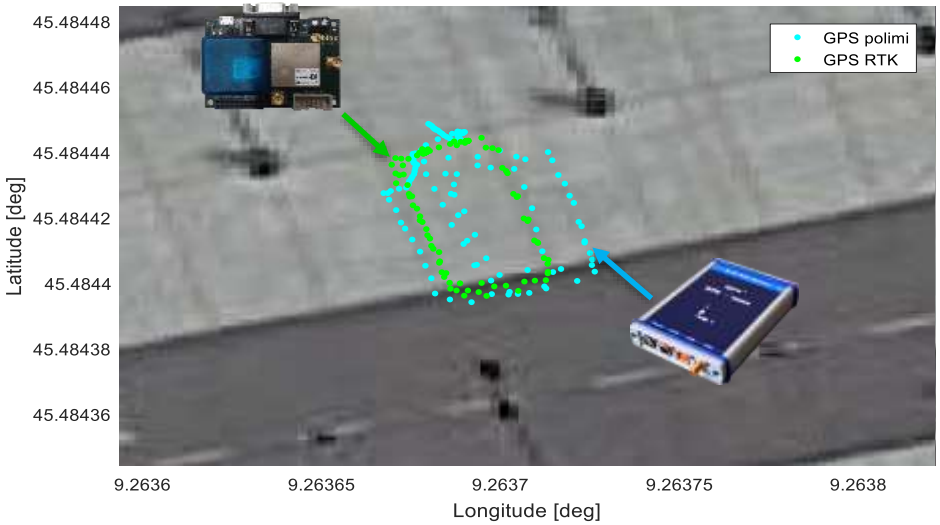
YAPE: an autonomy-level 4 ground drone research project

Sensing – VIDEO and high-resolution LIDARs



Sensing: high-precision GNSS (RTK)

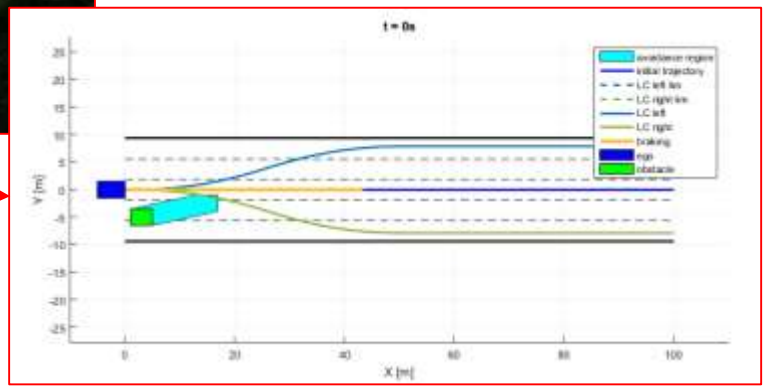




4-layers control problem (similar to a car) – Huge multi-layer control problem

Trajectory tracking (vehicle-dynamics control)

Trajectory planning & optimization (longitudinal/lateral) – Vehicle-dynamics control set-points

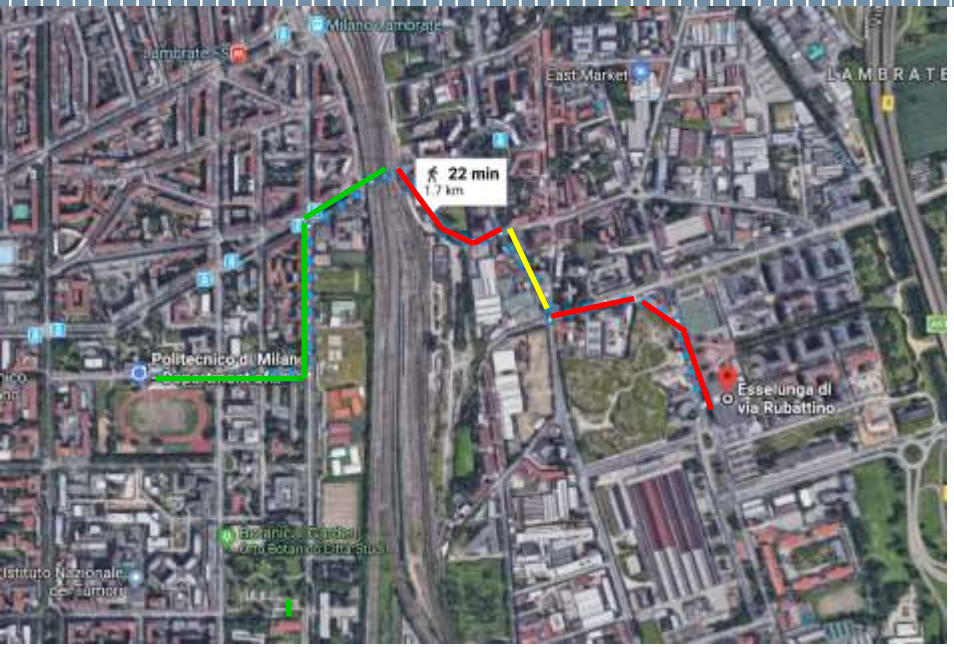


Dynamic-environment perception

Localization/mapping (static)

Driving-environment-related

The “pedestrian path” (working environment) issue

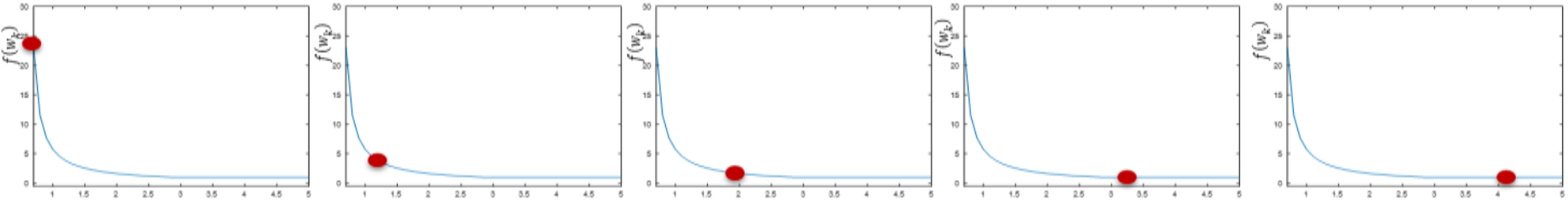


Car-roads are (well) designed and equipped according to formal navigation rules (vertical and ground road signs, traffic-lights, precise navigation rules, etc.)

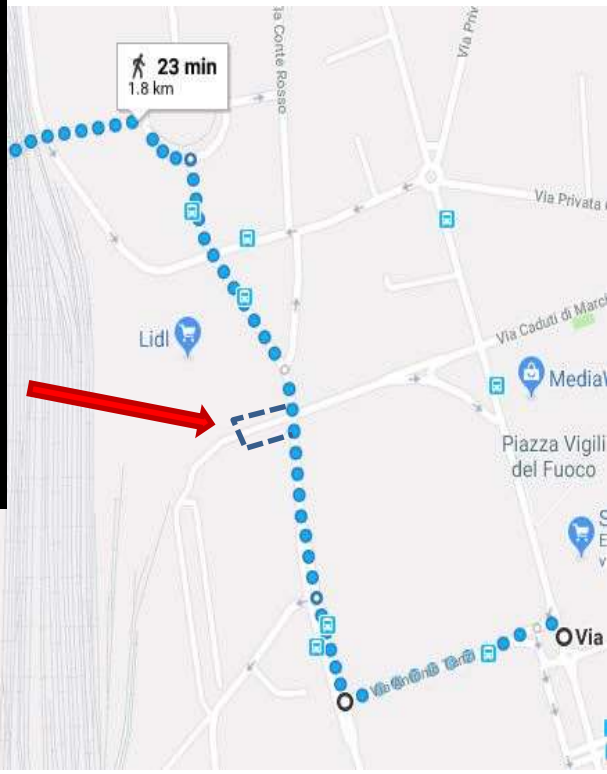
Car-roads are well-mapped (and high-precision mapping is expected soon)

What about side(pedestrian)-walks?

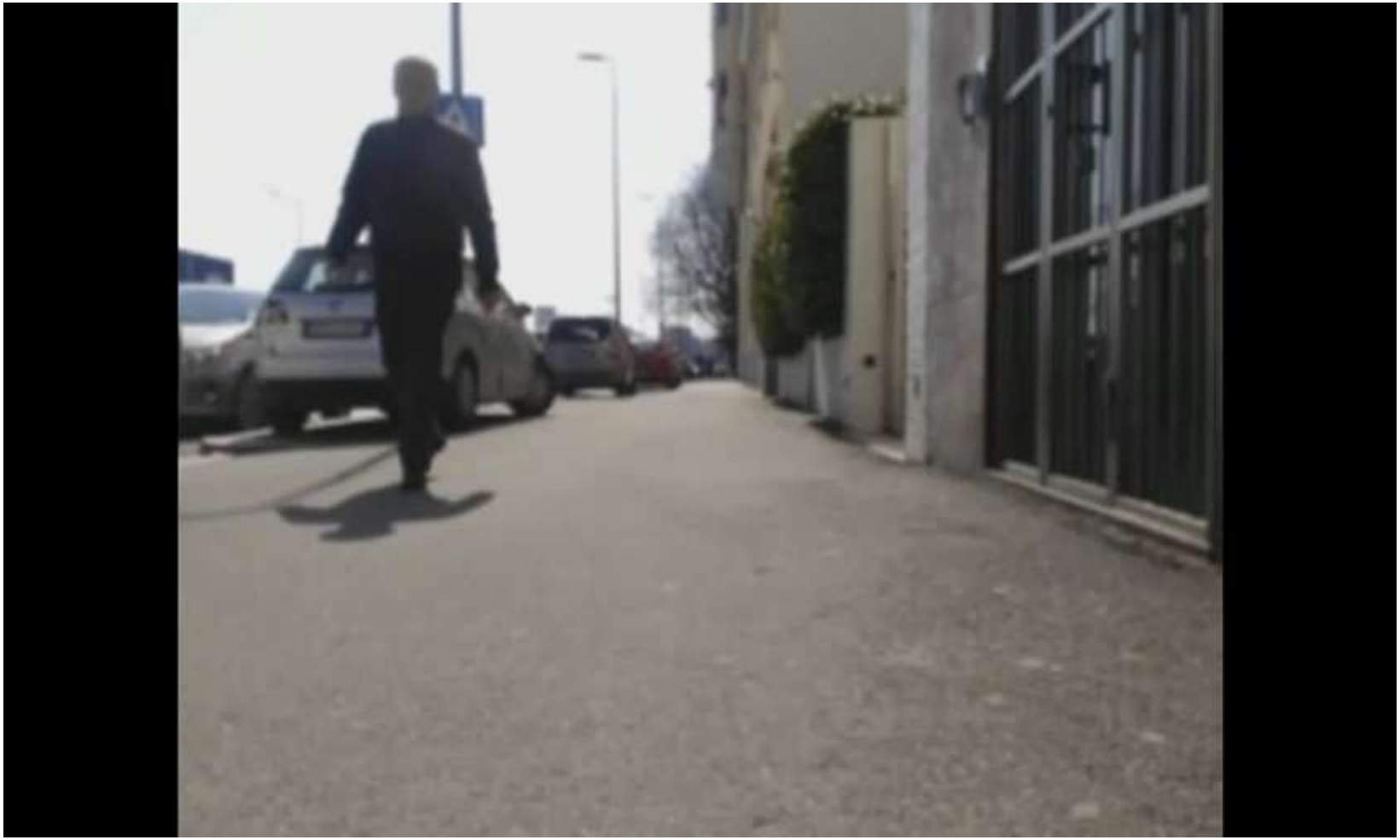
Sub-issue (example): available sidewalk width



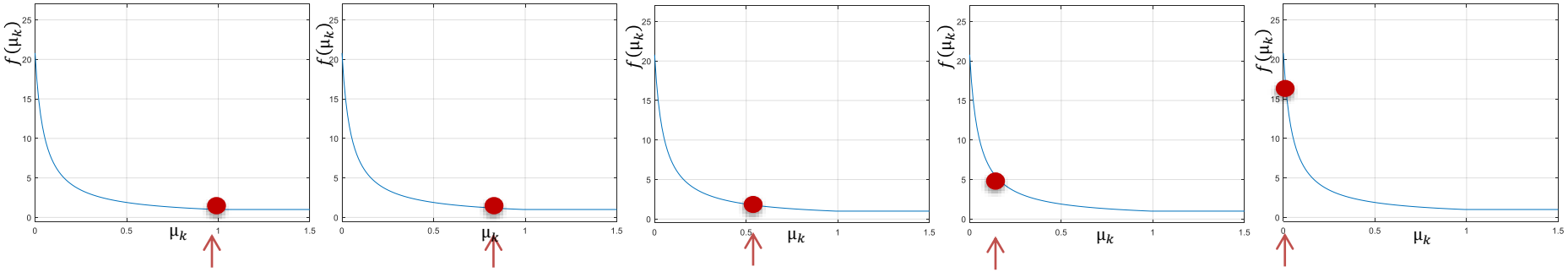
Sub-issue (example): sidewalk stop (dynamic)



Sub-issue (example): sidewalk unexpected crossing of cars

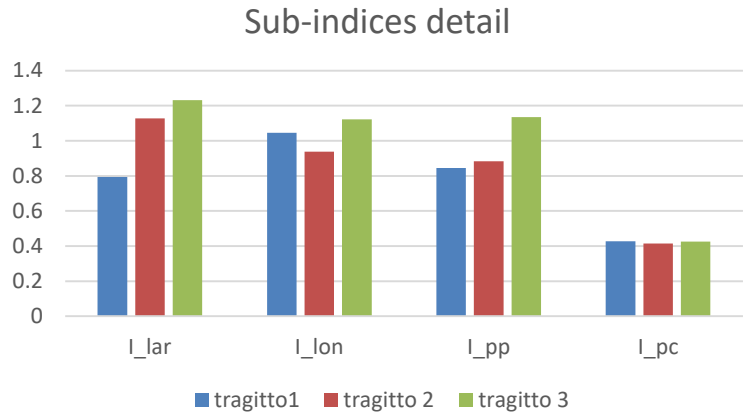


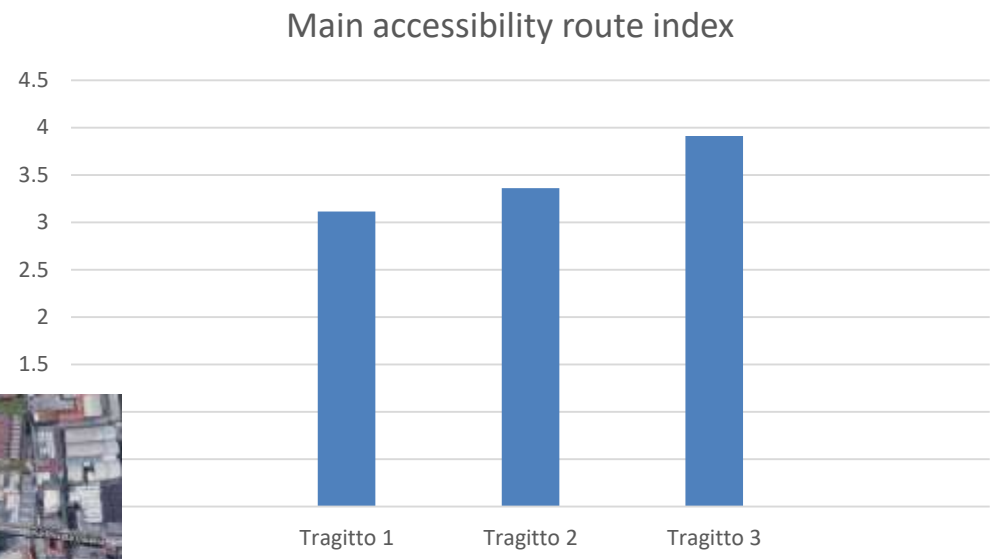
Sub-issue (example): zebra-crossings formats



Sub-issue (example): obstacles, ramps, etc.

Accessibility of a road-path: a formal/numerical assessment





Final remarks and an open-issue

Current autonomous-vehicle technology is focusing on autonomous **CARS** but **autonomous parcel-delivery drones** are expected to grow even more rapidly

Overall they have similar problems in sensing and control

Major difference (in sensing, mapping, localization, control, safety…): **structure of pedestrian routes**:

- **Poorly structured**
- **No signs**
- **No well-defined and clear navigation rules**
- **Poorly maintained**
- **No guarantees of accessibility**
- **Very high (but DIFFERENT) safety issues (pedestrians interactions)**

Do we need specific design and verification methods to address this problem?