Social distancing in public transportation through electromagnetic fingerprinting

Paolo Giaccone

in collaboration with Claudio Casetti, Ali Hojeij,

Marco Rapelli, Riccardo Rusca

Pietro Urso (GTT)

GTTI - Solutions against pandemic

November 5th 2020

COVID restrictions on public transportation

- COVID restrictions on the maximum occupancy on public transportation to keep large social distance
  - DPCM 3/11/2020 “a bordo dei mezzi pubblici del trasporto locale e del trasporto ferroviario regionale, con esclusione del trasporto scolastico dedicato, e' consentito un coefficiente di riempimento non superiore al 50 per cento”
- how to count the onboard passengers?

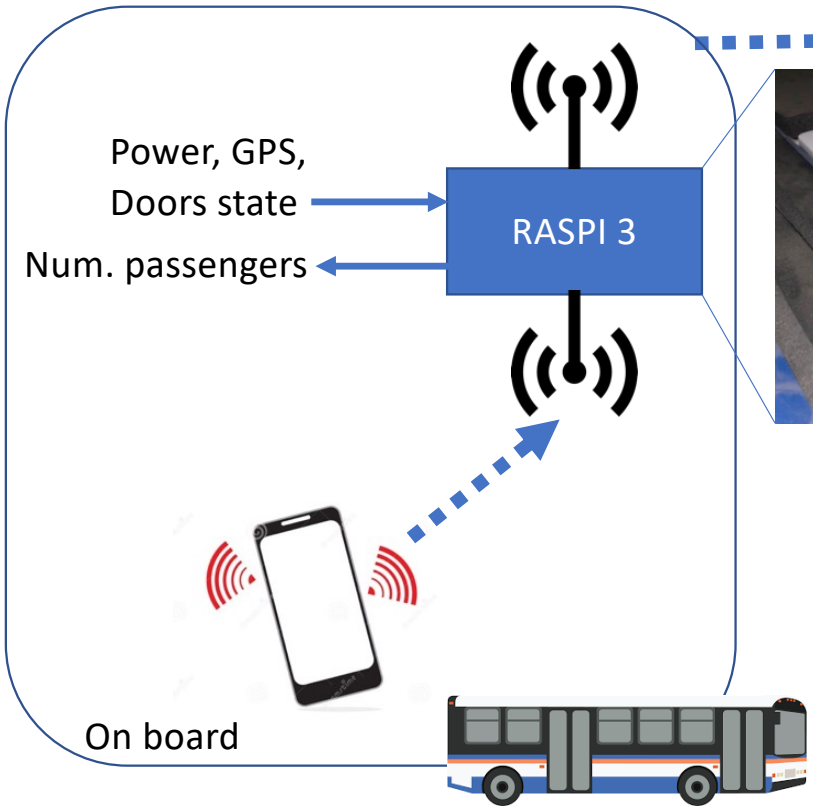
Counting passengers for public transport

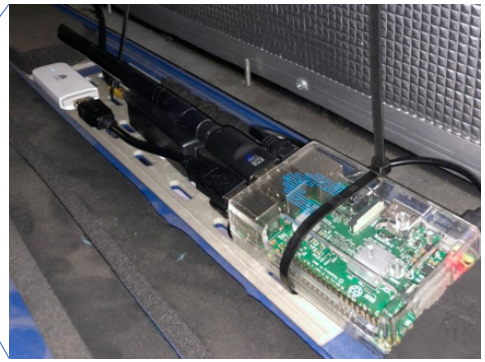
- automatic passengers counting systems
  - ticket counter or counters on the ground
  - load cells on suspensions of the vehicles
  - optical sensors and vision solutions
  - infrared sensors at the doors
  - treadle mat sensors
- often very expensive and time-consuming to install
- not available for most of the bus fleets

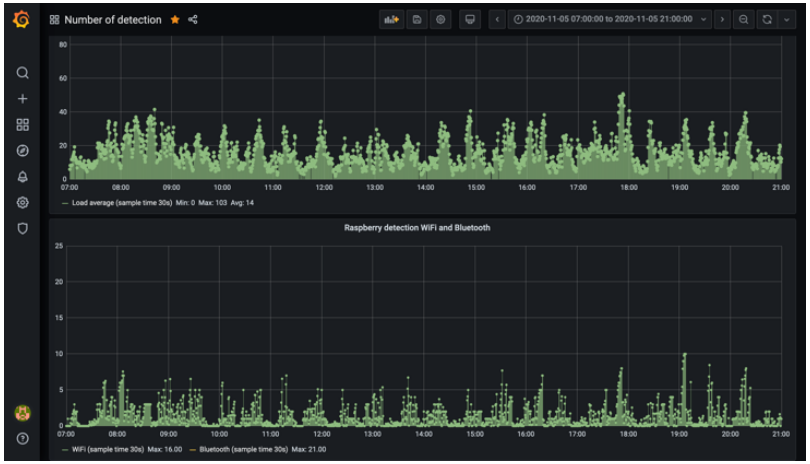
Our solution

- exploit passenger “ELM fingerprint” due to the carried smartphones
- we passively capture the "probe requests" sent periodically from each smartphone to find known APs
  - MAC address is the device fingerprint
- sometimes MAC addresses are randomized to preserve privacy
  - every 10sec /few minutes, depending on the implementation

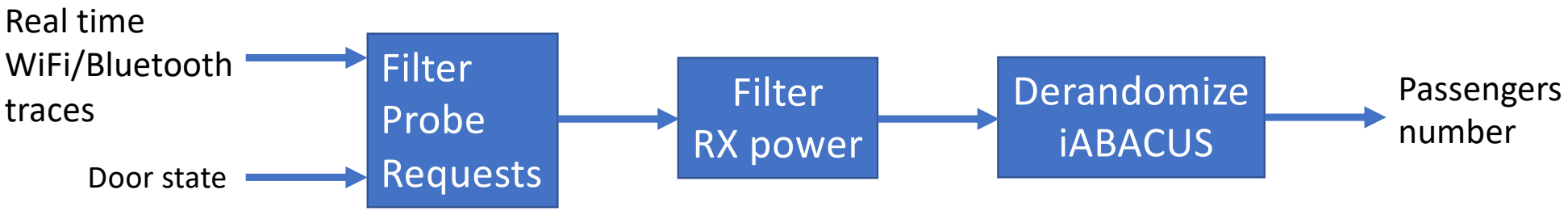
On-board and remote processing







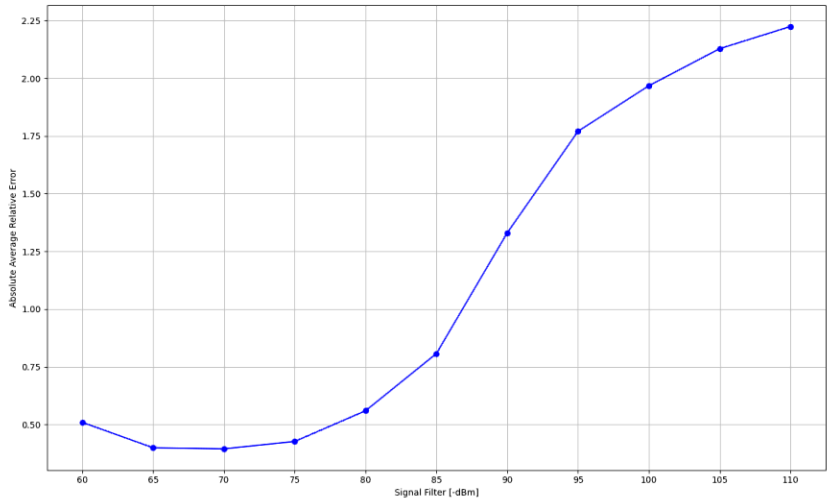
Onboard online processing



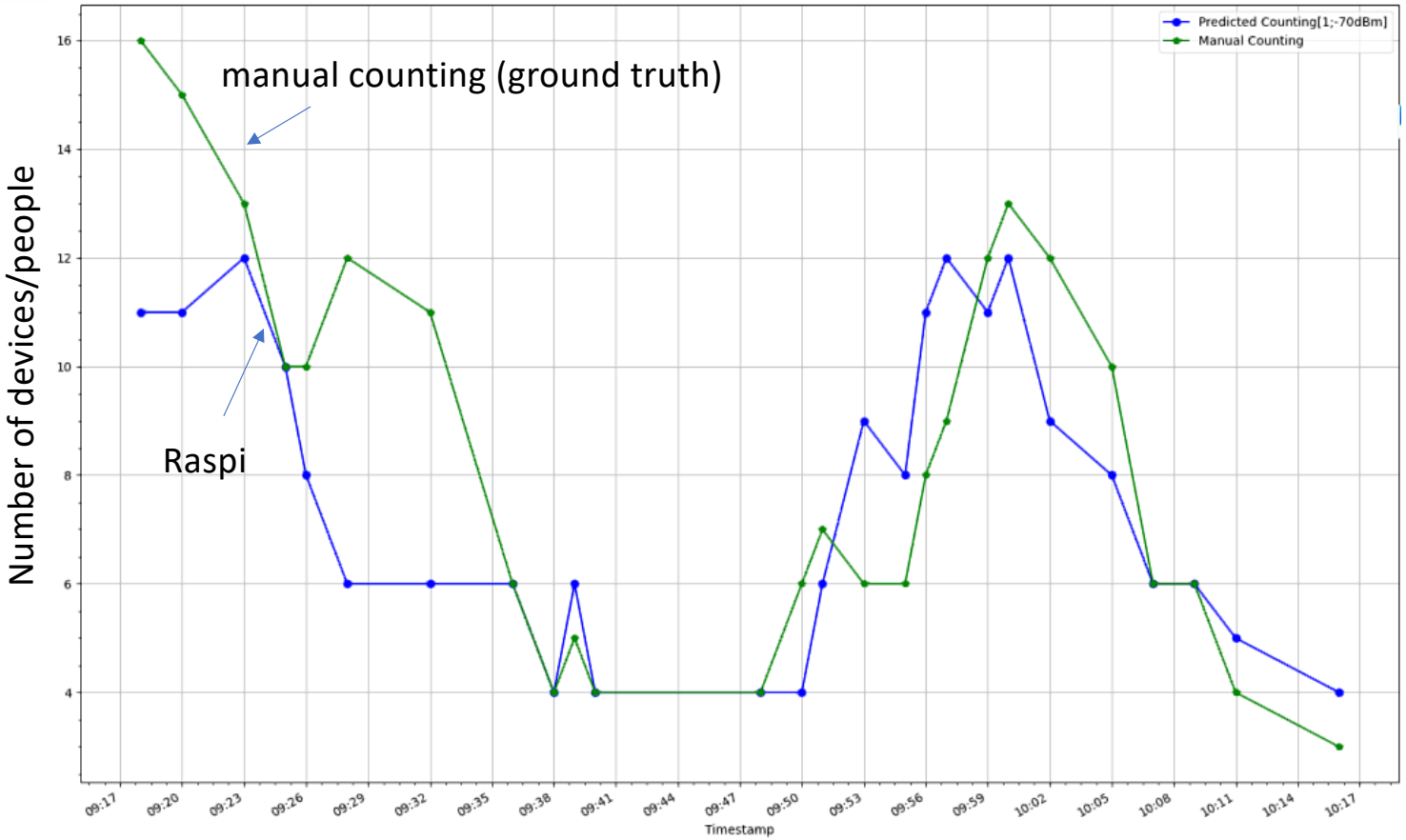
Nitti, M.; Pinna, F.; Pintor, L.; Pilloni, V.; Barabino, B. iABACUS: A Wi-Fi-Based Automatic Bus Passenger Counting System. *Energies* **2020**, *13*, 1446.

Preliminary results

- our solution has been tested during the last months almost daily on a in-operation GTT bus
- tuning of filtering parameters



Preliminary results



Conclusions

- very hard to get high accuracy
  - people may not carry the smartphone
  - the WiFi/Bluetooth interface may not be active
  - a single person may carry many connected devices (sensors, smart watches)
  - interference by external enviroment (e.g., when at bus stop, cars in proximity)
- simpler to get a reasonable accuracy when the number of passengers is high
  - this is exactly when the system is supposed to work to identify “above threshold” events
  - law of large numbers (LLN)
  - using inference technique to estimate a correction factor