Aalto University
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Traffic state estimation in the presence of connected vehicles

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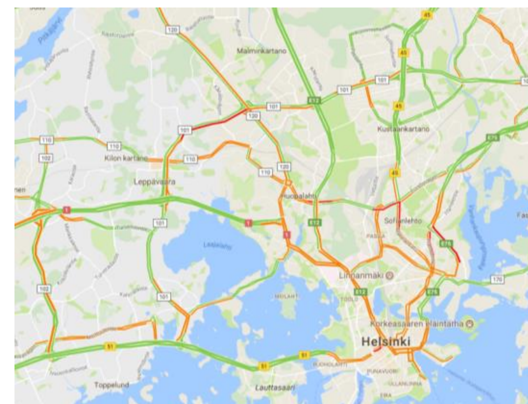
Motivation

Traffic congestion has a strong economical and social impact on our society

Automated and connected vehicles will influence traffic flow, with an uncertain impact (positive or negative)

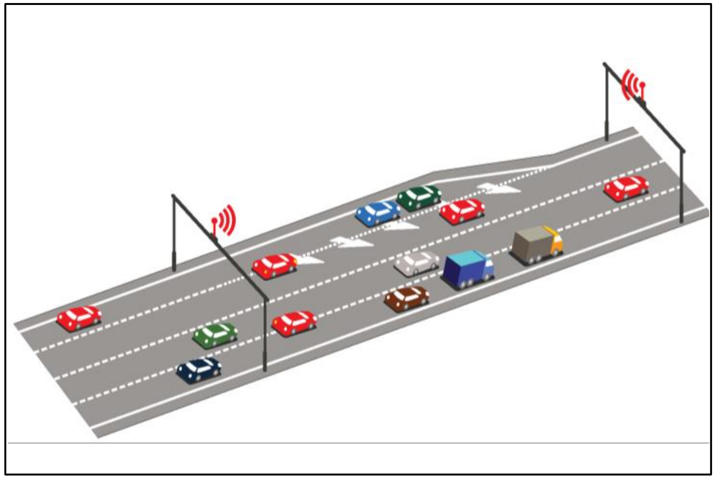
Automated and connected vehicles will actively influence traffic flow, via computing or receiving customised commands

Several traffic management strategies have been proposed for both conventional and novel actuators

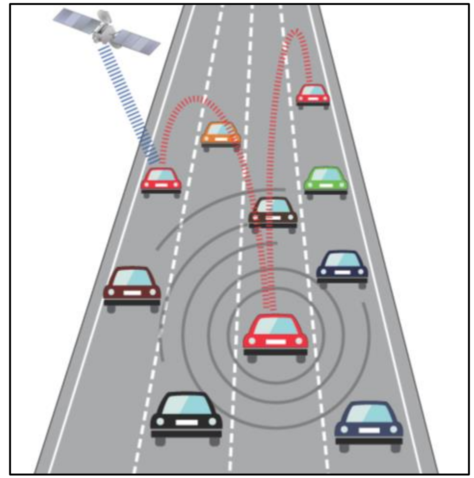


Helsinki area, 23 August 2017, 4:00 pm

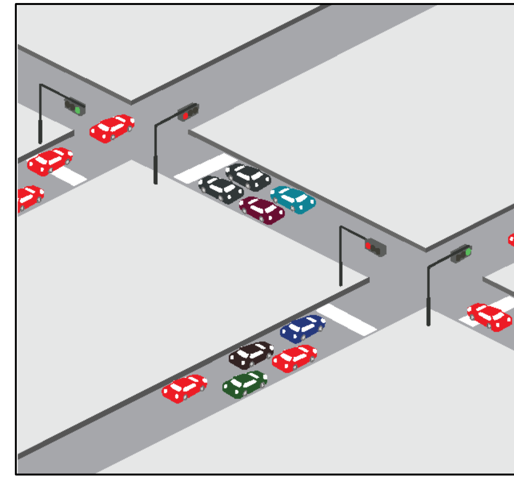
Traffic management strategies



Smart lane-changing strategies



Traffic-adaptive ACC



Smart intersection control and routing in road networks

Need for Traffic State Estimation

A prerequisite for traffic management is that the system (infrastructure-based or vehicle-based) is aware of the current traffic situation in sufficient details

(e.g., number of vehicles for each lane of a 500 m road stretch)

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100% connected vehicles: each vehicle report position, speed, and any other information

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How?

100% connected vehicles: each vehicle report position, speed, and any other information

Less than 100% connected vehicles: we need **Traffic State Estimation (TSE)**!

Namely, using a limited amount of information and some knowledge of the behaviour of our system, we can derive also unmeasured quantities.

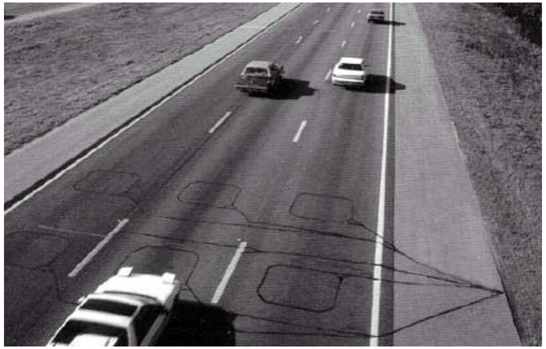
Current measurements for TSE

How do we get such information today?

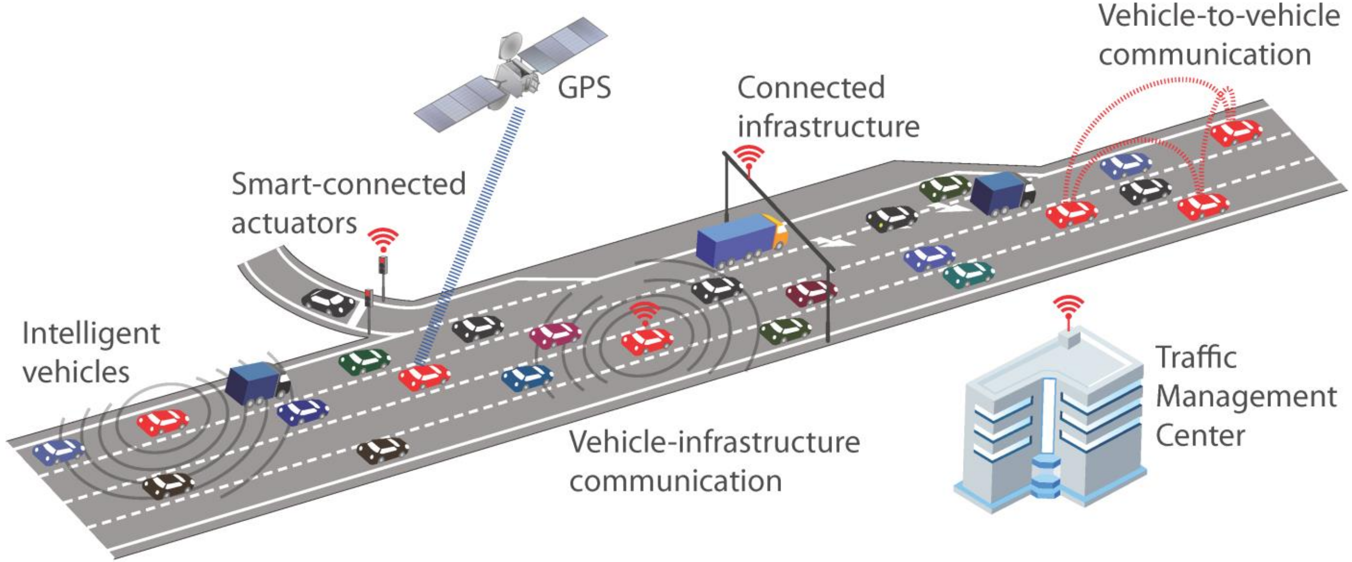
Installation of loop detectors, camera, radars, etc…

For accurate estimation (useful for traffic management), we need detectors every 1500 m – 2500 m (in motorways)

Detectors are expensive to install, expensive to maintain, suffer from systematic bias



Future measurements for TSE



Vehicle connectivity is appearing in various forms in the current traffic and, in the near future, it may enable overcoming several of the previously mentioned issues.

TSE with connected vehicles

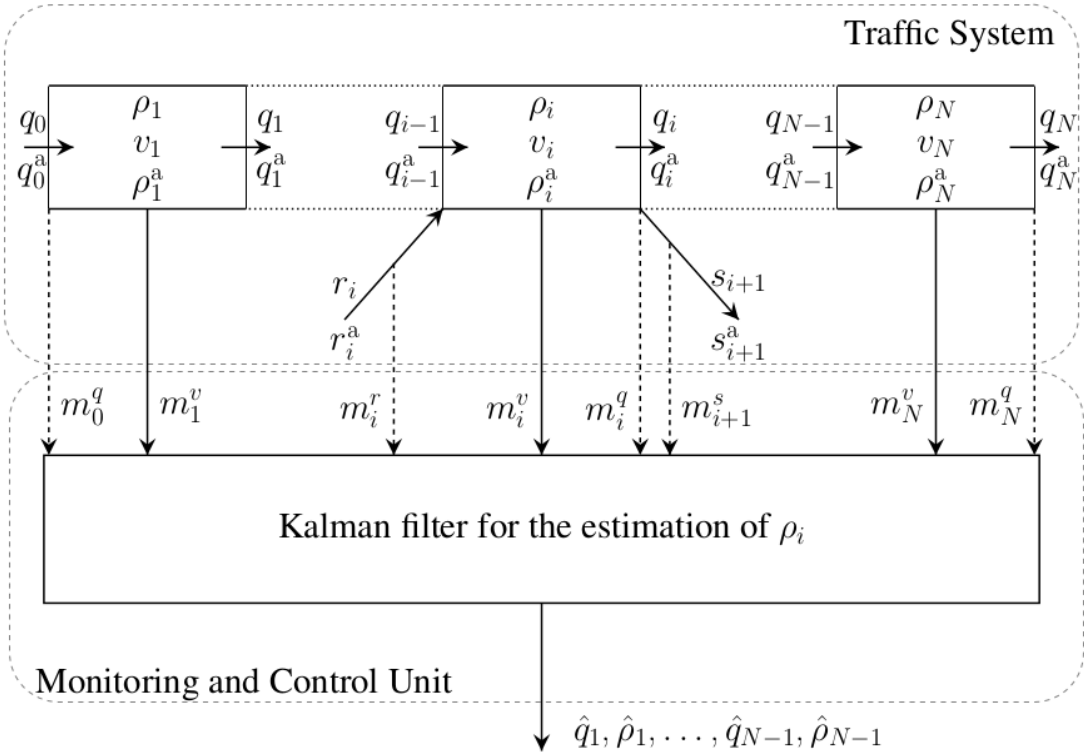
We assume that connected vehicles report their position and speed, as well as any other relevant information (acting as mobile sensors)

Our method aims at obtaining per-lane density and flow, allowing also for lane-based management policies and lane advices

A limited amount of spot detectors, at strategic locations, is still necessary for accurate flow estimation

We assume that a centralised Traffic Management Centre collects and processes the data

TSE framework



Case studies

We tested our method in several experiments

- using real and simulated data
- defining several scenarios involving different penetration rates of connected vehicles

Case study 1: NGSIM I-80 data

Case study 2: microscopic simulation using AIMSUN

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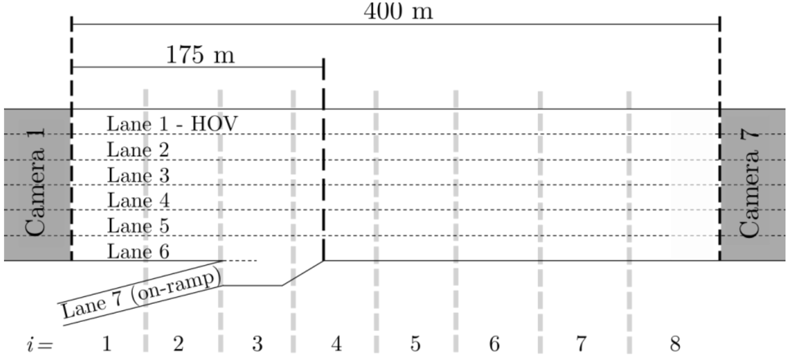
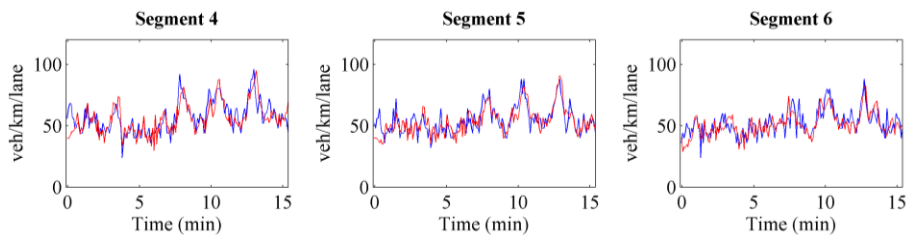
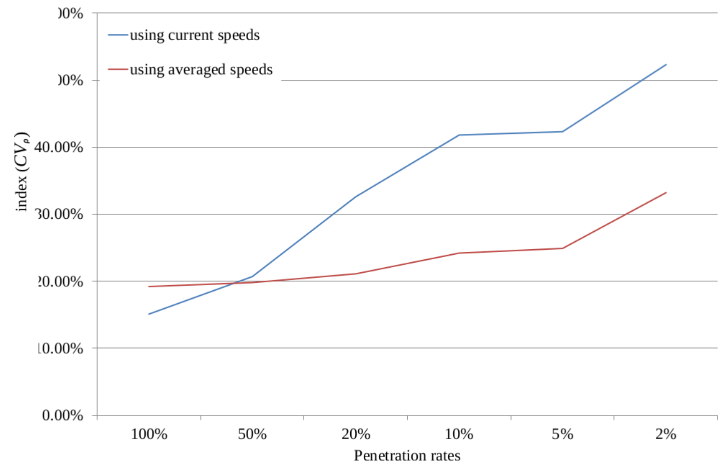
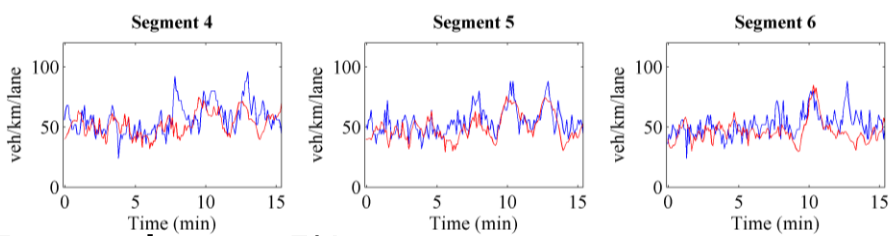




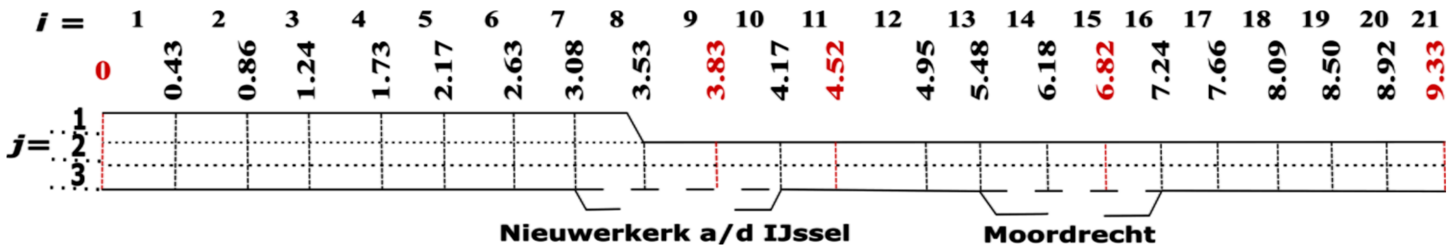
Penetration rate 100%

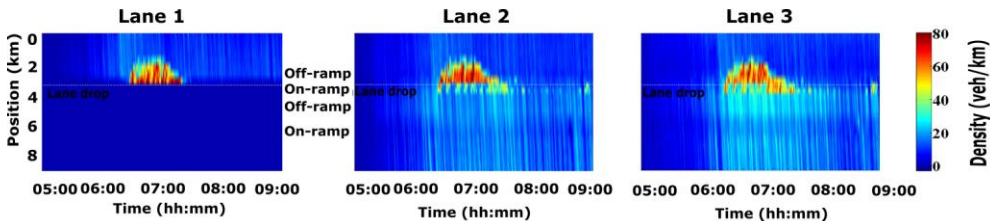




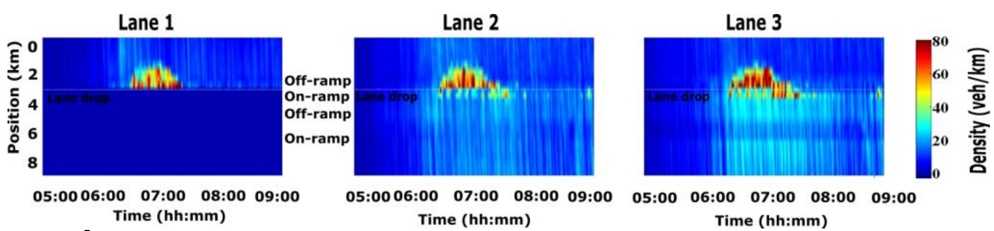
Penetration rate 5%

Case study 2: AIMSUN microsimulation

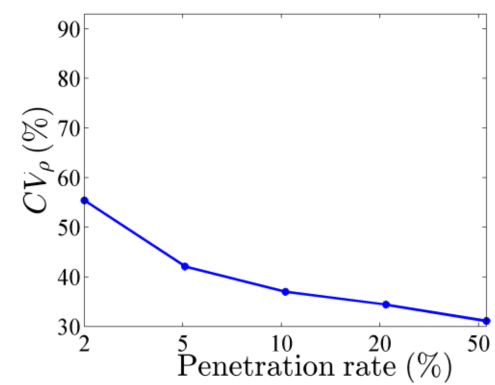




Ground truth



Estimates



Conclusions

We propose a per lane traffic state estimation scheme, showing its capabilities via various experiments

The estimation scheme captures the onset of congestion with accurate timing and reproduces reliably any challenging traffic conditions in space and time

Density estimation is satisfactory even for low penetration rates

Methodologically, we are extending our method by removing need for spot measurements

Currently, we are looking for a possible field implementation

Reference list

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Thank you!

Questions?

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