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Assessing the impact of Connected and Automated Vehicles: A freeway scenario.

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Joint Research Centre

Anticipated impacts from AVs

Less congestion ↓
Shorter travelling time ↓
Less pollution ↓
Less energy consumption ↓
Less accidents ↓
More parking space ↑
Higher mobility (elderly, kids, etc) ↑

So, is AV-technology that really promising?

Anticipated impacts from AVs

Improvement, probably, won't come unconditioned for reasons such as:

- No clear relationship between penetration of AVs and potential gain (congestion, energy etc).
- Future traffic demand cannot be easily estimated
- Electrification is not interwoven with Automation
- New industry business – uncharted waters

Anticipated impacts from AVs

In this work, we study the impact of Connectivity and Automation on a freeway scenario assessing the CACC logic*.

Summarized preliminary results show:

- Less congestion does not necessarily mean less energy consumption.
- Vehicles' coordination might needed to exploit better the potential of the technology.

*Mahmassani HS (2016) 50th Anniversary Invited Article—Autonomous Vehicles and Connected Vehicle Systems: Flow and Operations Considera-tions. Transp Sci 50:1140–1162. doi: 10.1287/trsc.2016.0712
*Gipps PG (1981) A behavioural car-following model for computer simulation. Transp Res Part B Methodol 15:105–111. doi: 10.1016/0191-2615(81)90037-0

Case study – Ring road of Antwerp

The idea is to run simulation experiments based on real data on a real network and study the benefits of CACC on a highway.

Ring road of Antwerp and Network

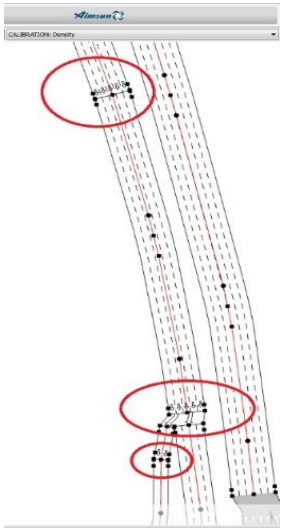
- Connects the 2nd biggest port in Europe with the continent

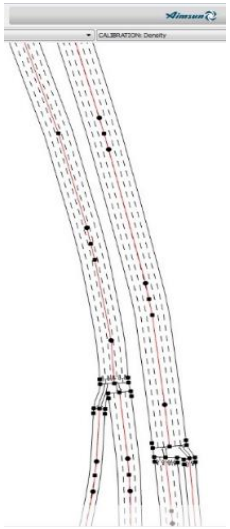
- Is responsible for over half of the overall pollutant emissions generated by road transport in the city

- The final supply model of the network consists of 119km of roads with 27 centroids (origin/destination points) and 117 intersections.

Ring road of Antwerp and Network

- Traffic demand based on real counts during peak hours
- Post-processing of the loaded network





Simulation scenarios

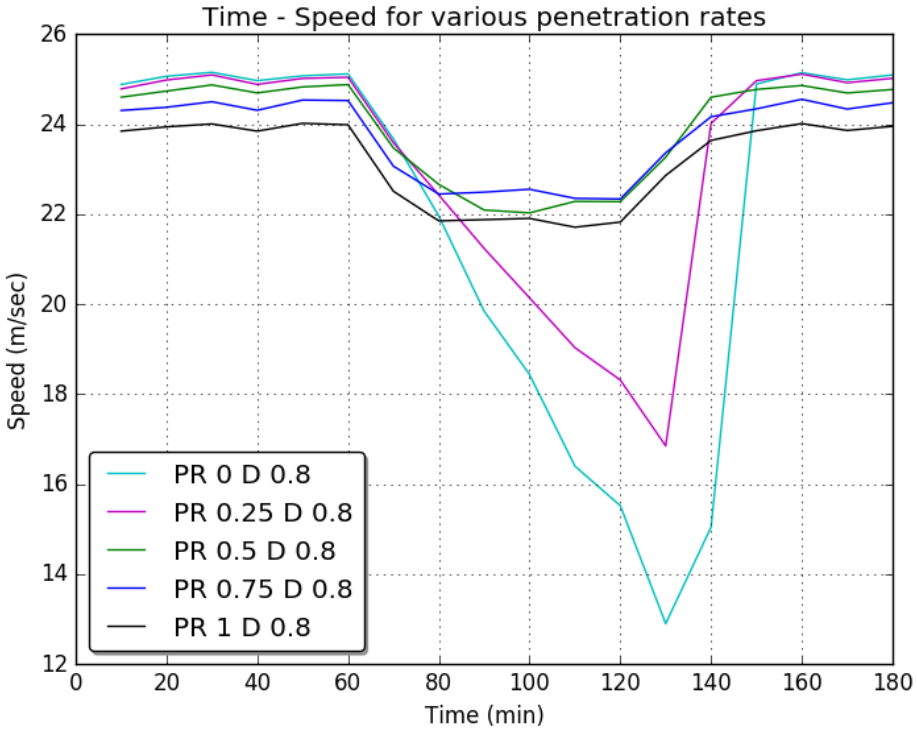
- Variable CACC penetration rates
- Variable traffic demands
- 3 hours of simulation (load – peak – unload)

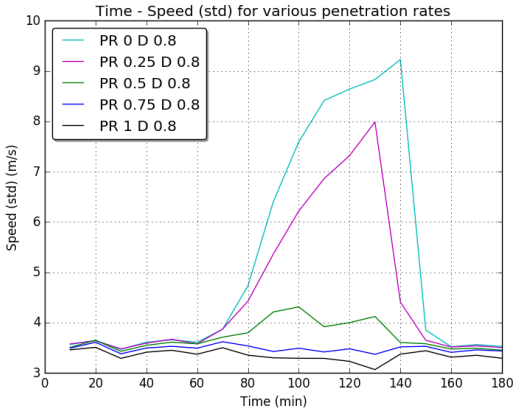
Assessment metrics

- Harmonic average speed
- Standard deviation of the speed
- Average density of the network
- Average flow of the network
- Total energy consumption on wheels*

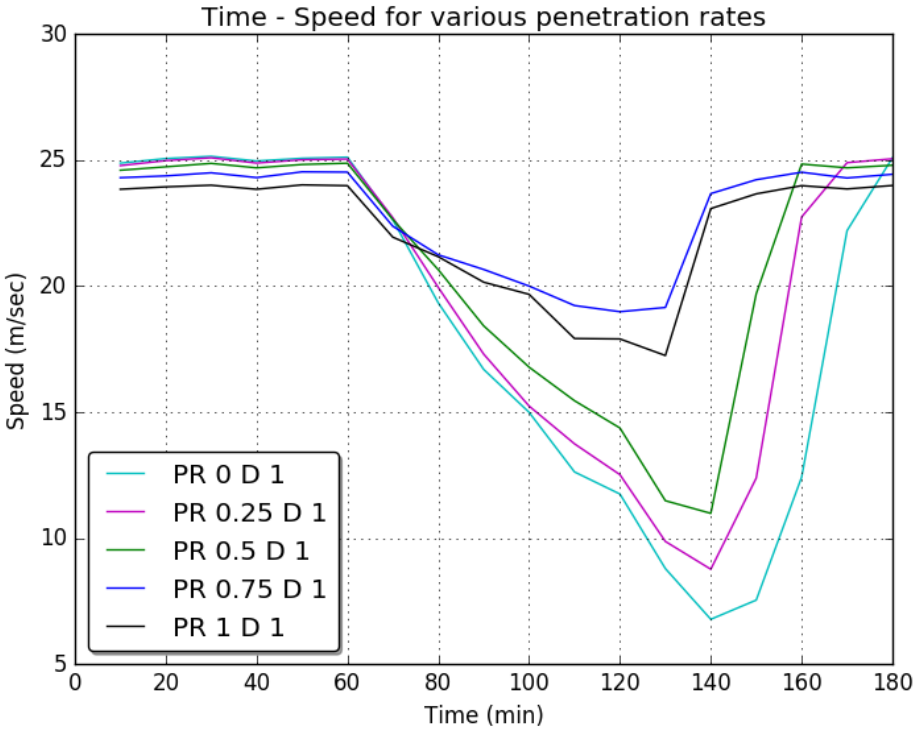
*Pavlovic J, Marotta A, Ciuffo B (2016) CO2 emissions and energy de-mands of vehicles tested under the NEDC and the new WLTP type approv-al test procedures. Appl Energy 177:661–670. doi: 10.1016/j.apenergy.2016.05.110

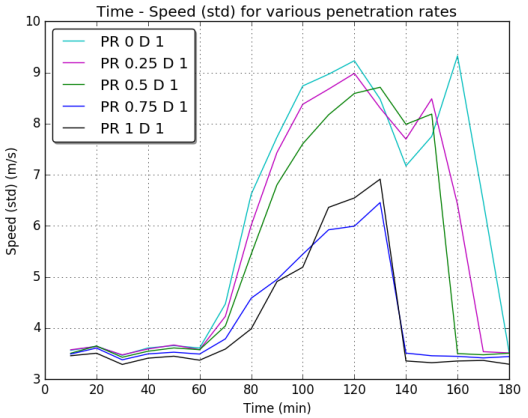
Simulation results - Speed



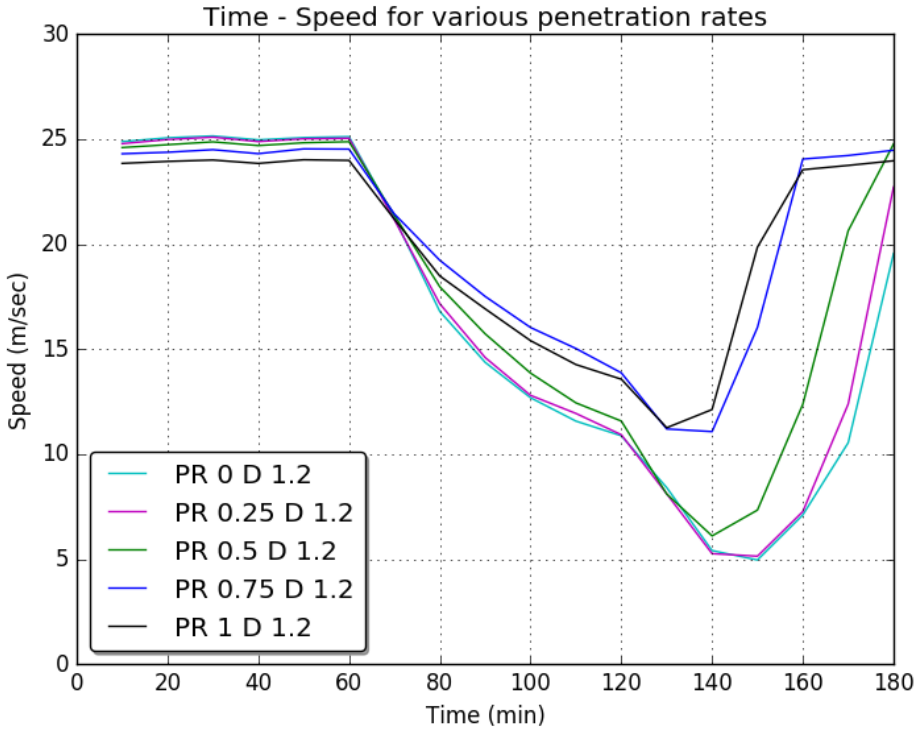


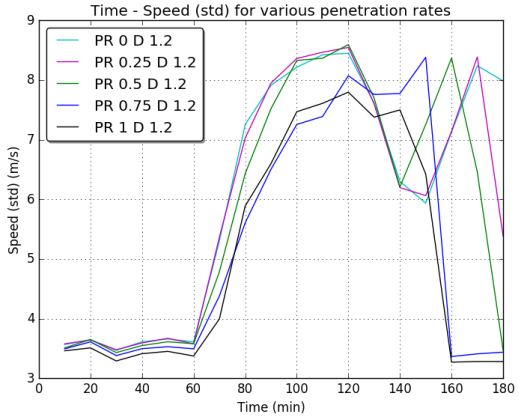
Simulation results - Speed





Simulation results - Speed





Results – Energy consumption

CACC Penetration rate	Traffic Demand D		
	0.8D	**D**	**1.2D**
PR 0	3468.9 kJ	3507.6 kJ	3539.5kJ
PR 0.25	1.60%	2.06%	1.26%
PR 0.5	3.85%	4.98%	4.64%
PR 0.75	5.57%	9.43%	9.95%
PR 1	4.30%	9.36%	15.01%

Conclusions

- CACC, higher demands, higher efficiency
- Penetration rate and CACC efficiency are not linearly correlated
- Particularities of the network need consideration
- Communication with the infrastructure and coordination of AVs could help
- Human behavior (i.e. exceeding speed limit) can potentially facilitate flows

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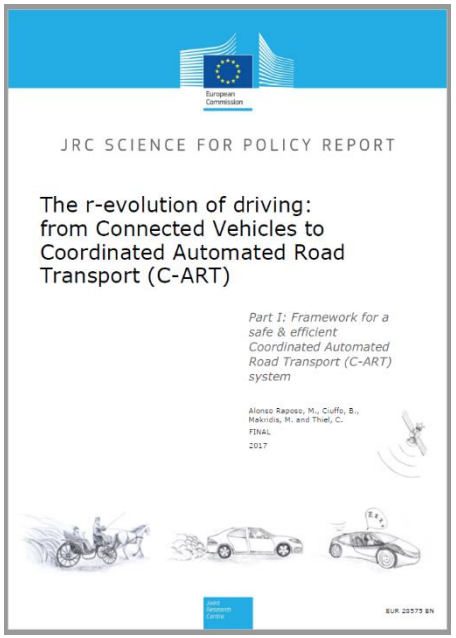
JRC will host the 2nd Symposium on Management of Future Motorway and urban traffic systems

Ispra (IT), 11-12 June 2018



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