

# Using micro-simulation modelling for driver assistance systems assessment

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## The need

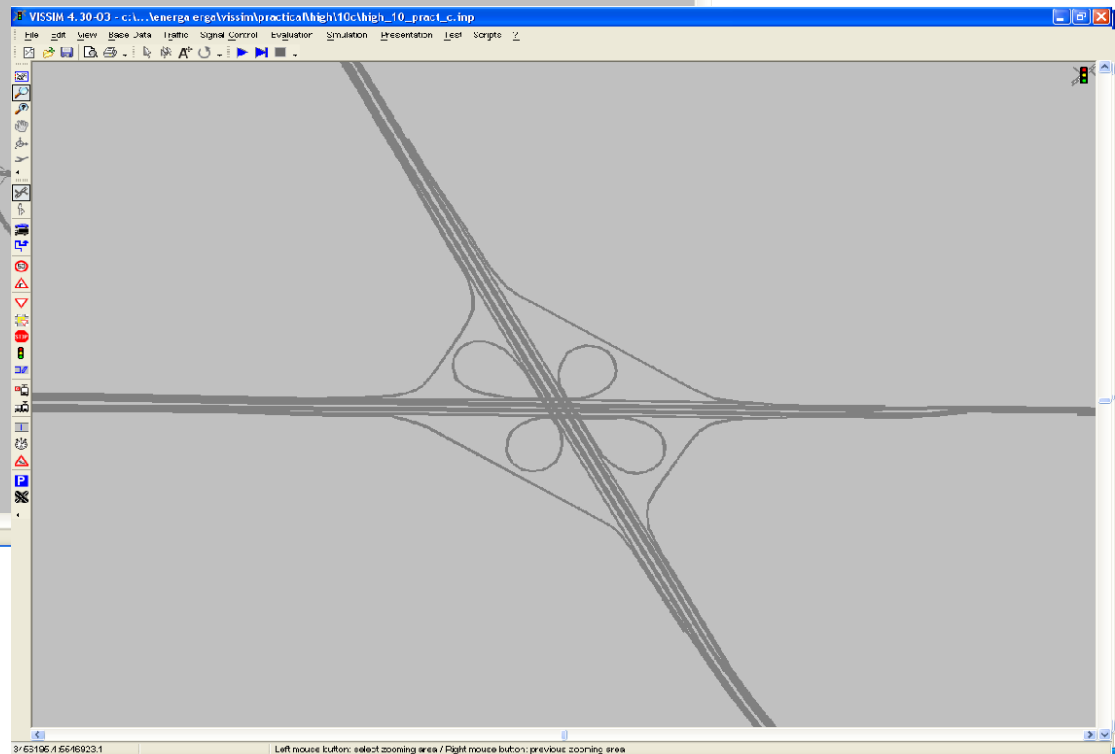
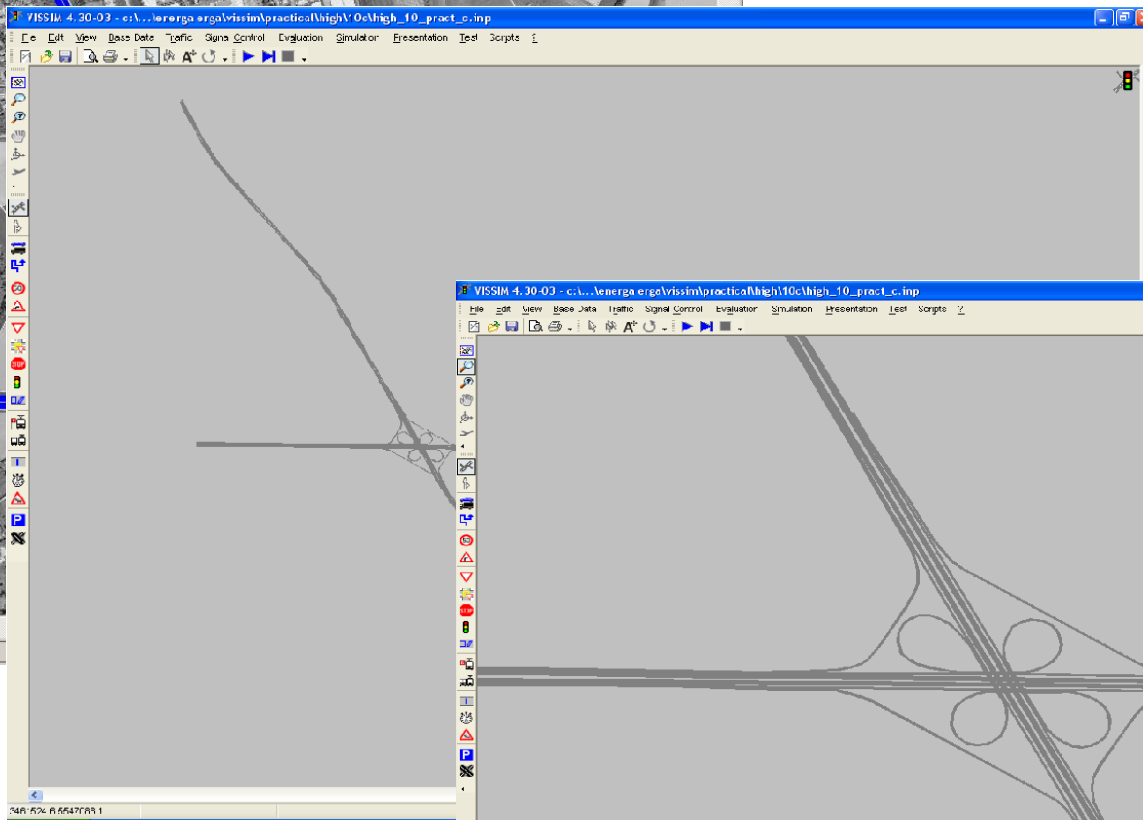
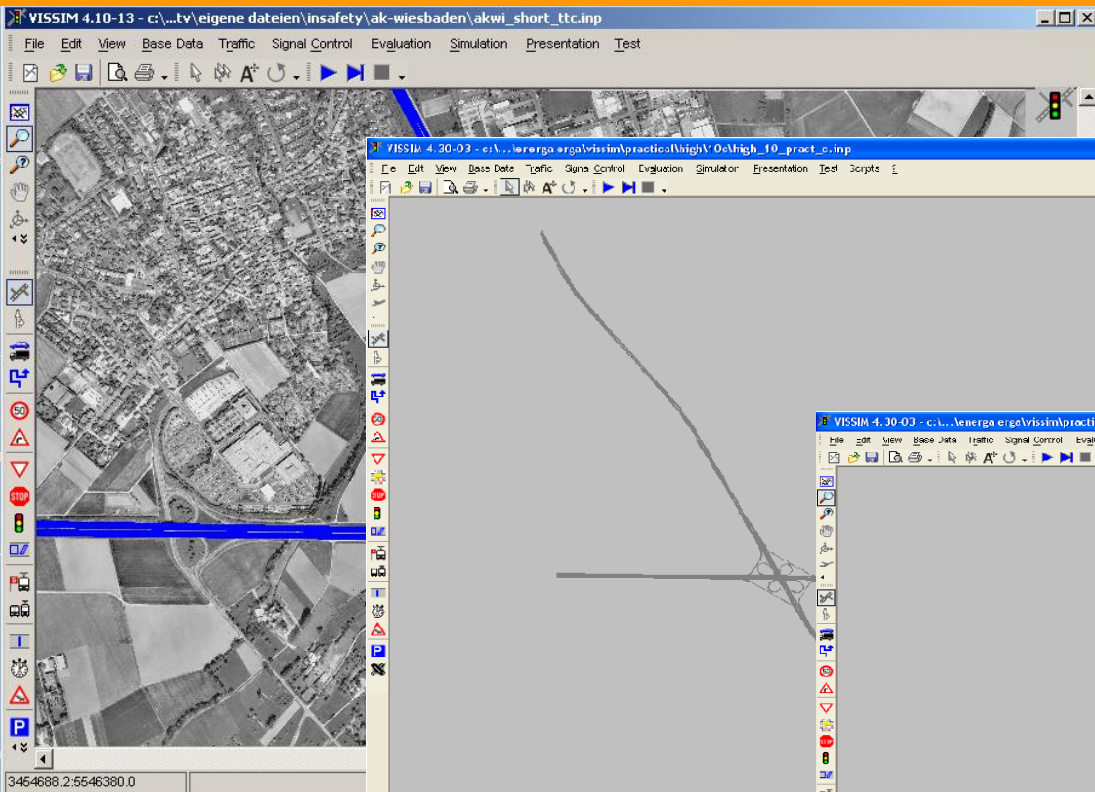
- ADAS – worldwide trend
- Some already in the market – more at research level  
– started becoming standard vehicle equipment;
- Still low penetration rate;
- Need to predict the effects of the increase of the use of these systems;
- Need to suggest measures or modifications of the systems to prevent possible side-effects.
- Micro-simulation traffic models:
  - Able to simulate real traffic situations;
  - Possible to measure certain parameters, indicating the network performance.

## The IN-SAFETY project

- EC co-funded, FP6 STREP, 2005-2008.
- Coordinator: Dr. E. Bekiaris (CERTH/HIT)
- Aim: *to use intelligent, intuitive and cost-effective combinations of new technologies and traditional infrastructure best practice applications, in order to enhance the forgiving and self-explaining nature of roads*
- Developing and testing new simulation models (micro and macro) to pre-estimate and validate the safety and functionality of road environments.
- Micro: VISSIM, S-Paramics, RuTSim
- Macro: Saturn, MtModel
- In this paper: VISSIM

## The application

- Aim: to investigate the safety and traffic efficiency impacts of ADAS-equipped vehicles, in several different penetration rates, on the same road and under the same circumstances.
- Network: highway, including intersection.
- ADAS: Collision Avoidance System (CAS), Lane Change Assistant (LCA)



# Traffic parameters

- Traffic volumes and simulation duration
  - Low: 1800 veh/h (4hours)
  - Medium: 3000 veh/h (2hours)
  - High: 5000 veh /h (1hour)
- Vehicle types and vehicle classes
  - PKW, including passenger cars, not equipped with any ADAS
  - LKW, including trucks, not equipped with any ADAS
  - ADAS<sub>th</sub>, including passenger cars, equipped with the specific ADAS, following the theoretical behaviour parameters that the use of this equipment would imply (i.e. if the CAS warns the driver when  $TTC \ll 2\text{sec}$  then we estimate that all drivers keep a min TTC of 2sec).
  - ADAS<sub>b</sub>, ADAS<sub>c</sub>, including passenger cars equipped with the specific ADAS, following behaviour parameters deriving from previous real tests with the ADAS in question (i.e. we consider different behavioural adaptations of drivers with CAS, such as different min TTC as measured in past tests with real users).
- Equipped vehicles' penetration rates:
  - ADAS<sub>th</sub>, ADAS<sub>b</sub>, ADAS<sub>c</sub>: 0%, 10%, 25%, 50%, 75%, 100% of passenger cars
  - LKW: 10% of total

# Driving behavior parameters

- In VISSIM, there are several default parameters set, both for longitudinal and lane change behavior, whose values determine the behavior of the vehicle and whose differentiation could lead to different effects.
- **Longitudinal:**
  - CC1, defining the headway that the driver allows from the preceding vehicle;
    - 0.9m (PKW, LKW) – default VISSIM value
    - 1.0m (ADASth)
    - 1.2m (ADASb)
    - 0.8m (ADASc)
- **Lane change**
  - Min headway
  - Safety distance reduction factor
  - Max deceleration for cooperative braking

Not possible to come up with a set of values that would create the desired effect (more/less lane changes) to simulate the system's effect to the drivers.

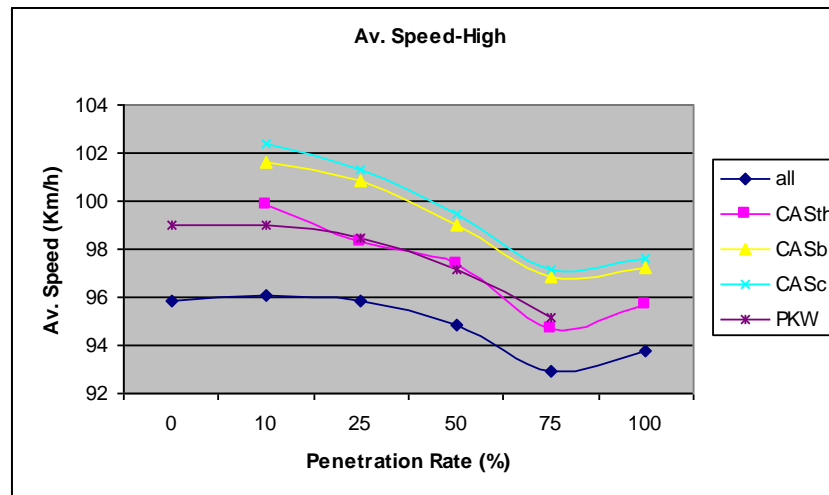
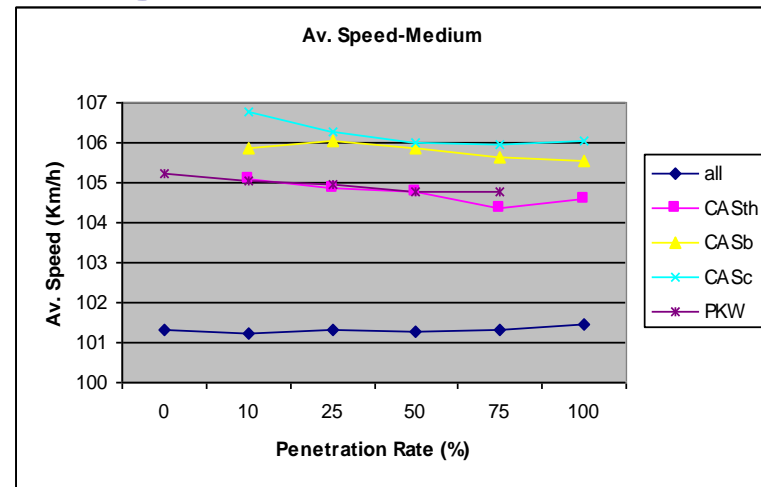
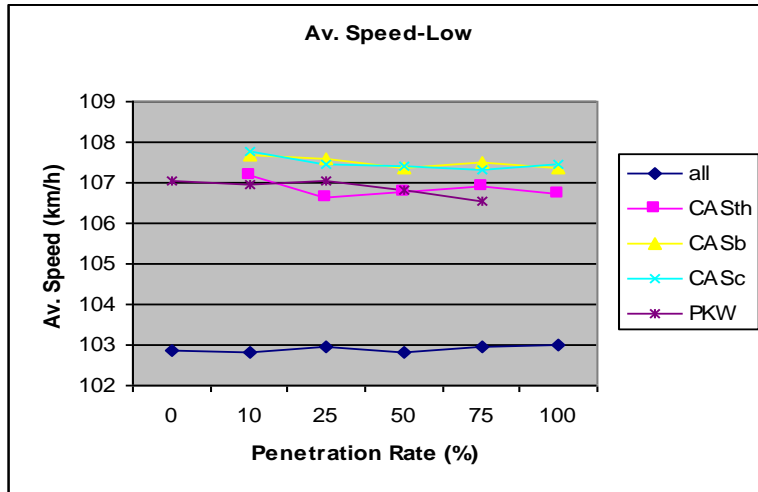


# Scenarios and evaluation parameters

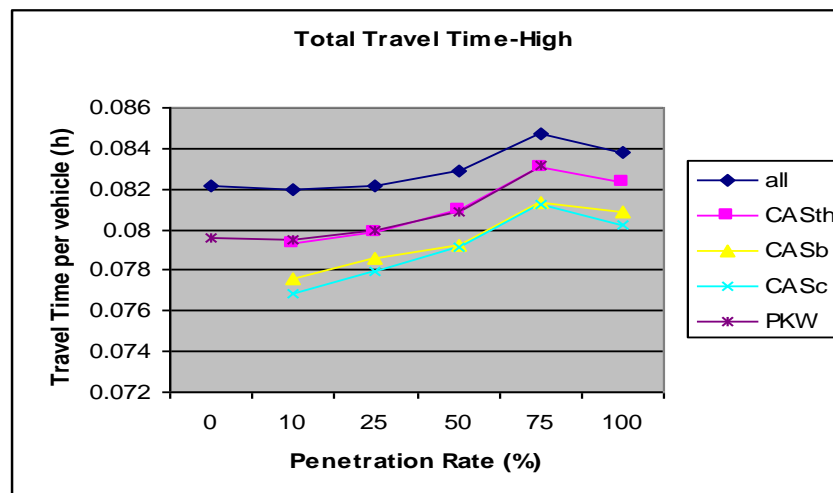
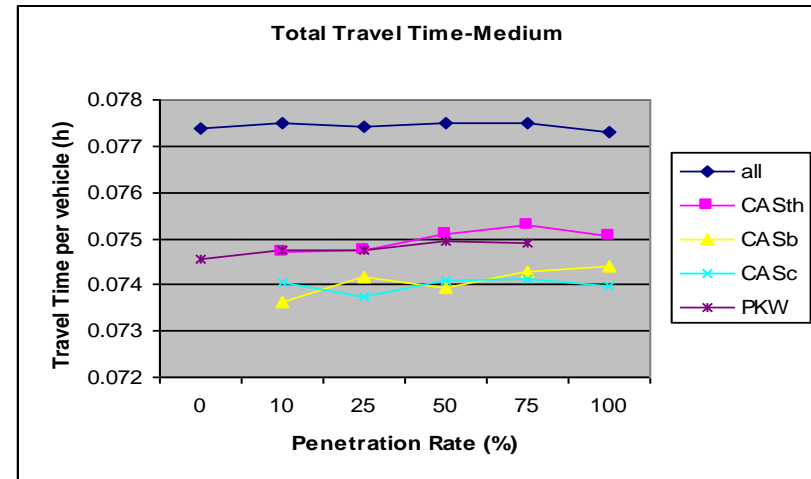
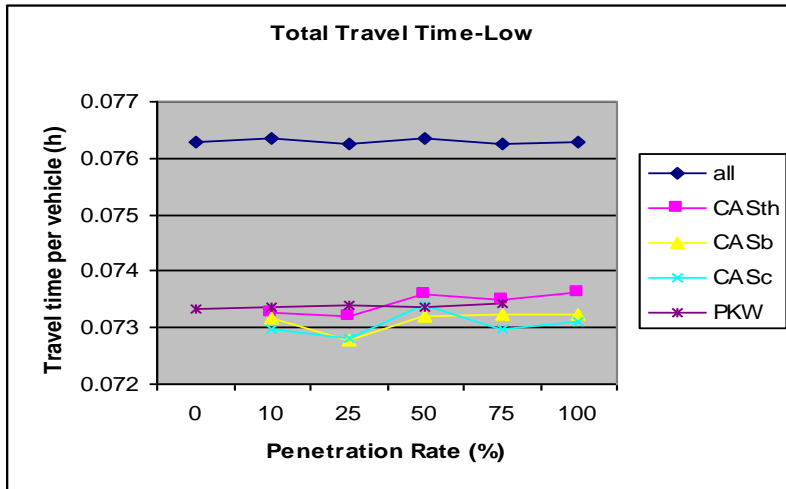
	1	2	3	4	5
<b>Traffic composition</b>	PKW, LKW (without use of ADAS)	PKW, LKW, ADASth (with ADAS theoretical values, mixed traffic)	ADASth, LKW (with ADAS theoretical values, equipped vehicles only)	PKW, LKW, ADASth, ADASb, ADASc (with ADAS theoretical values and values from real tests, mixed traffic)	LKW, ADASth, ADASb, ADASc (with ADAS theoretical values and values from real tests, equipped vehicles only)
<b>Traffic Volume</b>					
<b>Low</b>	0% pen.rate	10%, 25%, 50%, 75%, pen.rate	100% pen.rate	10%, 25%, 50%, 75%, pen.rate	100% pen.rate
<b>Medium</b>	0% pen.rate	10%, 25%, 50%, 75%, pen.rate	100% pen.rate	10%, 25%, 50%, 75%, pen.rate	100% pen.rate
<b>High</b>	0% pen.rate	10%, 25%, 50%, 75%, pen.rate	100% pen.rate	10%, 25%, 50%, 75%, pen.rate	100% pen.rate

- Selected parameters to be evaluated:
  - Average speed (Km/h)
  - Total travel time (h)
  - Fuel consumption (Kg)

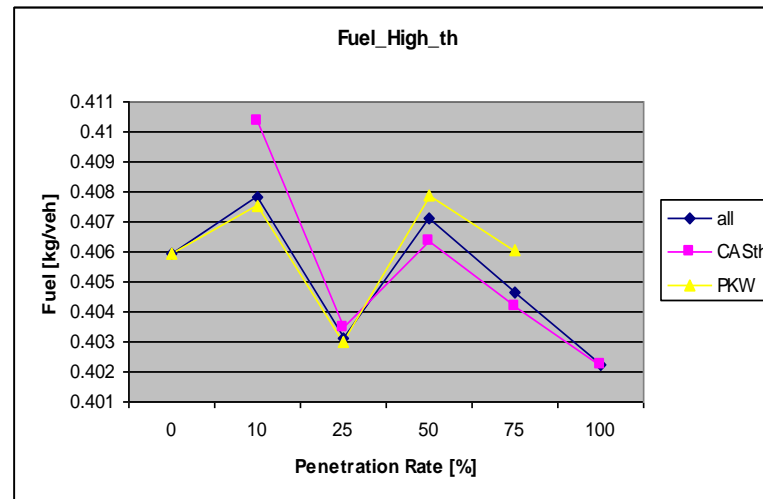
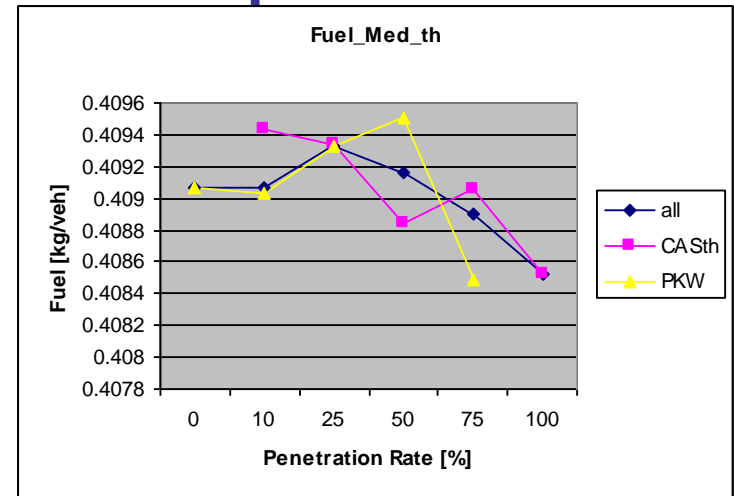
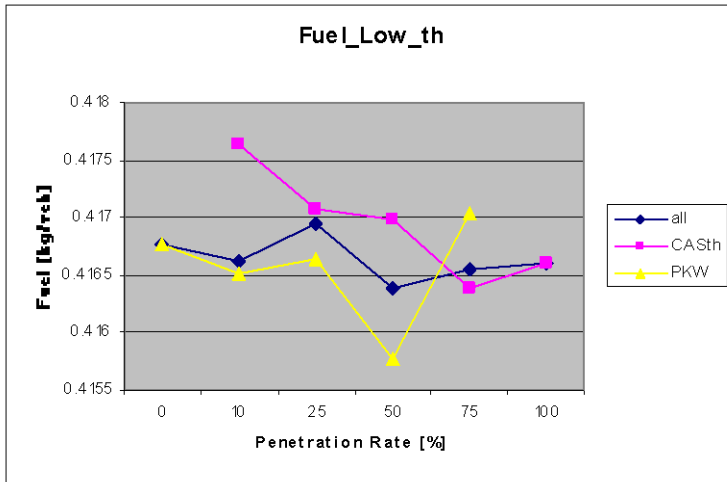
# Results – CAS – Average Speed



# Results – CAS – Total Travel Time



# Results – CAS – Fuel Consumption



## Conclusions (1)

- Micro-simulation models, VISSIM in particular, in their current status can be used for the simulation of networks where ADAS equipped vehicles are included.
- The reliability of results of the model depends highly on the driving behaviour parameters included in the model and the values selected for them by the researcher.

## Conclusions (2)

- CAS – Av.Speed
  - Average speed of vehicles in network scale is slightly decreasing;
  - Decrease is more significant for equipped vehicles;
  - Decrease rises with penetration rate – maximum decrease at 75% pen. rate;
  - As approaching 100% pen. rate the traffic is being normalized;
  - Positive effect in terms of traffic safety enhancement.

## Conclusions (3)

- CAS – Travel time
  - Travel time in the network is slightly increasing, due to lower speed;
  - The increase in travel time should not be considered as a drawback, since the positive effect on road safety imposed by the reduction of speed is definitely more important.

## Conclusions (4)

- CAS – Fuel Consumption
  - Model's results show a reduction in fuel consumption;
  - More significant for higher penetration rates and higher traffic volumes;
- The modification of all the effects does not seem to be significant; however this is mainly due to the fact that the headway values that have been influenced varied at  $\pm 0.2\text{m}$ .



## Conclusions (5)

- LCA
  - The VISSIM model, at its current status, does not seem to provide reliable simulation of the effect of such a system in the lane change behavior.
  - Need for the inclusion of additional parameters that would allow the effective simulation of such behaviors.

*Thank you!*

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