Application of intelligent speed adaptation for connected vehicles

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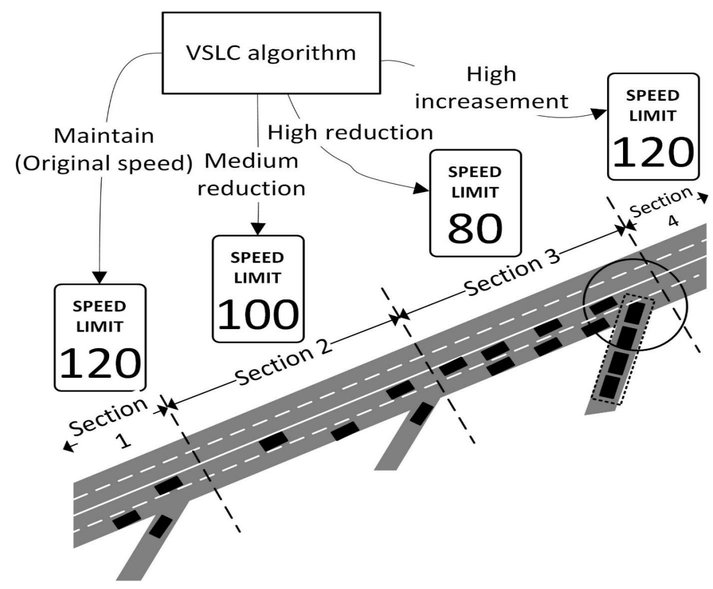
Introduction to Variable Speed Limit Control

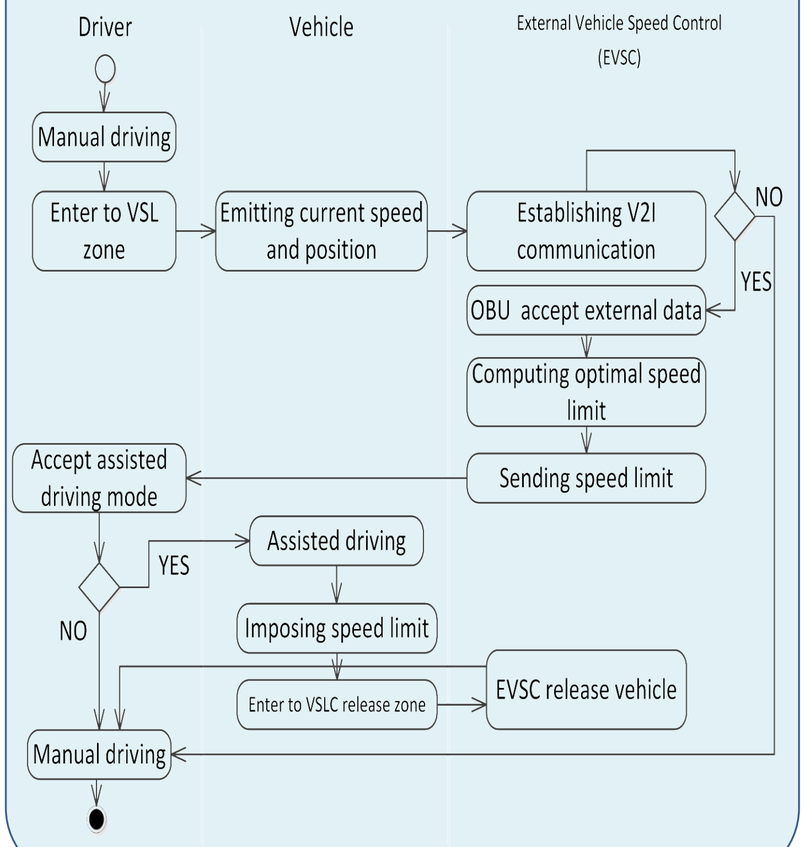
- ***Variable speed limit control (VSLC) presents an efficient way to increase the Level of Service (LoS) and safety of urban motorways***
- ***Main impact of VSLC on traffic flow***
  - Reduction of the mean speed under critical densities („shock-wave suppression")
  - Homogenization of vehicle speeds, i.e. reduction of speed differences among vehicles and mean speed on motorway
  - Increased safety on motorway



Intelligent Speed Adaptation (ISA)

ISA system monitors the location and speed of the vehicle, compares it to a defined set speed, and takes corrective action such as advising the driver and/or governing the top speed of the vehicle.

VSLC infrastructure-to-vehicle communication



Future work on this topic

- ISA penetration rate in the future will be tested on the microscopic level, also
- Development of a cooperative VSLC algorithm which will incorporate other supportive motorway control methods
- Development of a VSLC algorithm with learning capabilities
- Real connected vehicle approach testing

Modeling of ISA in macro-simulation ACTM model

- VSLC is implemented through modification of the cell mean speed equation

$$v_i^c = \min\left(v_i^{VSLC}, \frac{f_{i[k]}/(1-\beta_{i[k]})}{n_{i[k]}+\gamma r_{i[k]}}\left(\frac{L_i}{\Delta t}\right), v_i^{ff}\right)$$

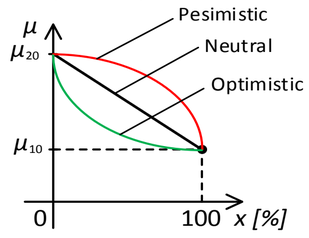
- Penetration coefficient

$$\mu = \frac{1}{n}\sum_{i=0}^{n}\frac{v_i^{AVG}}{v_i^{SLC}}$$

- Coefficient is added to the parameter v_i^{VSLC}

$$v_i^c = min\left(v_i^{SLC}\times\mu,\quad v_i^{ff},\quad v_i^{fd}\right)$$

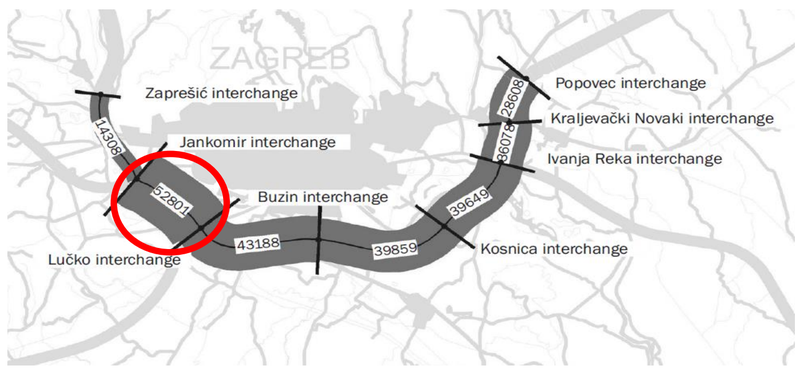
- Estimation of ISA penetration rate impact on actual speed



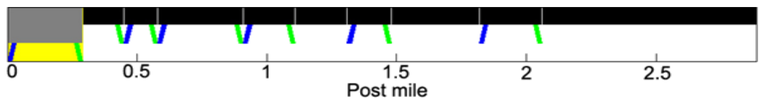
Zagreb bypass use case model

Simulation model is based on Zagreb bypass (section Lučko-Jankomir)

- Realistic traffic demand based on a working day traffic demand change characteristic



ACTM model of Zagreb bypass



Simulation results (neutral prognosis)

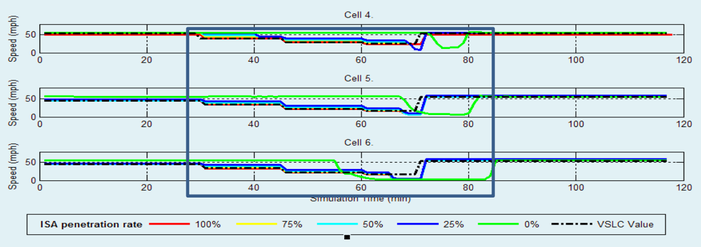
- Different ISA penetration rates (PR) applied on three different traffic scenarios

Table 1. Average **TT** in case of various ISA penetration rates

		ISA penetration rate [%]				
		0	25	50	75	100
Traffic Demand	Low	4.53	3.63	3.56	3.50	3.45
	Medium	5.8	4.67	4.61	4.54	4.49
	High	14.41	10.03	9.05	8.84	8.81

Table 2 Average **Delay** in case of various ISA penetration rates

		ISA penetration rate [%]				
		0	25	50	75	100
Traffic Demand	Low	3.4	1.4	1.32	1.34	1.25
	Medium	6.2	5.26	5.08	4.96	4.74
	High	68.91	61.52	60.01	59.21	58.53



Conclusion

- In macro-simulation environment greatest difference between 0 % and 25 % of ISA PR
- Increase of ISA PR improves overall results
- Simulated ISA prevented complete traffic standstill during congestion

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Research is partially funded by project
Intelligent Cooperative Sensing for Improved traffic efficiency (ICSI)
(FP7-317671), Project web: http://www.ict-icsi.eu/

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