Driving with Automation (PPT)

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Driving with Automation

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COTA International Conference of Transportation Professionals - 7-9th July 2017 Shanghai

http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/intellisafe-autopilot/drive-me/real-life

Level	Name	Narrative definition	DDT		DDT fallback	ODD
			Sustained lateral and longitudinal vehicle motion control	*OEDR*	*DDT fallback*	*ODD*
Driver performs part or all of the *DDT*						
0	No Driving Automation	The performance by the *driver* of the entire *DDT*, even when enhanced by *active safety systems.*	*Driver*	*Driver*	*Driver*	n/a
1	Driver Assistance	The *sustained* and *ODD*-specific execution by a *driving automation system* of either the *lateral* or the *longitudinal vehicle motion control* subtask of the DDT (but not both simultaneously) with the expectation that the *driver* performs the remainder of the *DDT*.	*Driver* and *System*	*Driver*	*Driver*	Limited
2	Partial Driving Automation	The *sustained* and *ODD*-specific execution by a *driving automation system* of both the *lateral* and *longitudinal vehicle motion control* subtasks of the *DDT* with the expectation that the *driver* completes the *OEDR* subtask and *supervises* the *driving automation system*.	*System*	*Driver*	*Driver*	Limited
ADS ("*System*") performs the entire *DDT* (while engaged)						
3	Conditional Driving Automation	The *sustained* and *ODD*-specific performance by an *ADS* of the entire DDT with the expectation that the *DDT fallback-ready user* is receptive to *ADS*-issued *requests to intervene*, as well as to *DDT performance-relevant system failures* in other *vehicle* systems, and will respond appropriately.	*System*	*System*	*Fallback-ready user (becomes the driver during fallback)*	Limited
4	High Driving Automation	The *sustained* and *ODD*-specific performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a *user* will respond to a *request to intervene*.	*System*	*System*	*System*	Limited
5	Full Driving Automation	The *sustained* and unconditional (i.e., not *ODD*-specific) performance by an *ADS* of the entire *DDT* and *DDT fallback* without any expectation that a *user* will respond to a *request to intervene*.	*System*	*System*	*System*	Unlimited

Automated driving

Driver assistance/
Partial automation

Driver needs to be able to intervene at all times

Automated parking, autocruise

Conditional/ High automation

Vehicle in control in special conditions

Taxibots, platooning, automated highways

Comfort, efficiency, safety, costs

Mode choice, location choice, urban and transport planning

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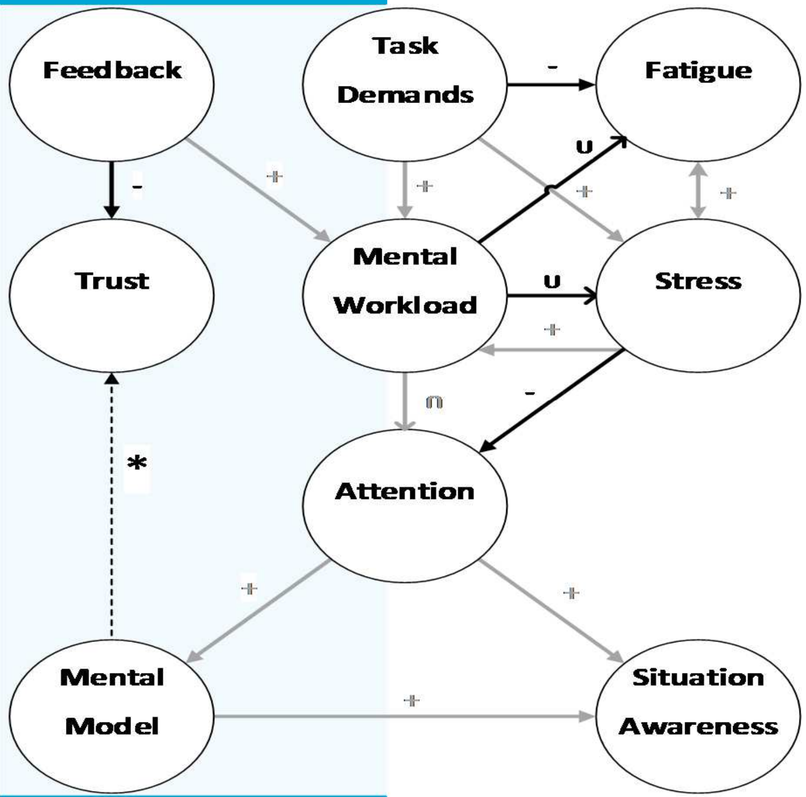
Fundamental changes in driving behaviour

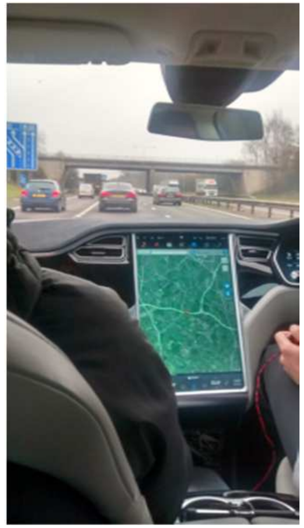
Driver in control

Vehicle in control
Driver
supervision

Workload,
driving performance,
attention,
situation awareness
risk compensation,
Driver Vehicle Interface,
acceptance,
mode transition,
purchase and use

Human behaviour during highly automated platooning

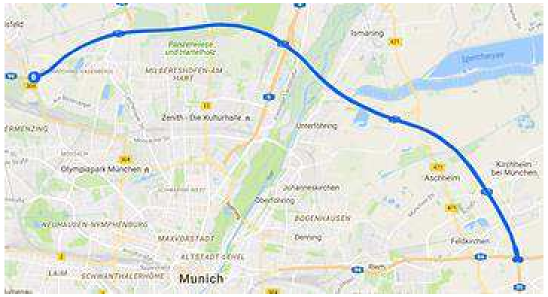




Mental underload
Degraded monitoring

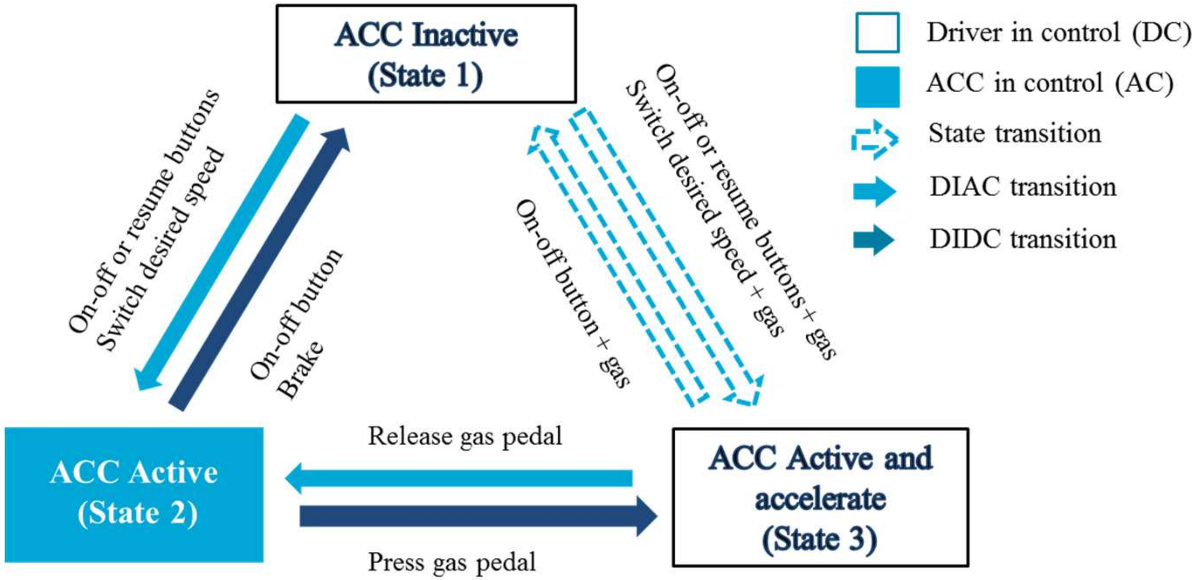
Heikoop et al (2016), Effects of platooning on signal-detection performance, workload, and stress: A driving simulator study, Applied Ergonomics
Heikoop et al (2016) Psychological constructs in driving automation: a consensus model and critical comment on construct proliferation. Theor. Issue Ergon. Sci.

Driving Behaviour in Control Transitions between Adaptive Cruise Control and Manual Driving



35 km motorway

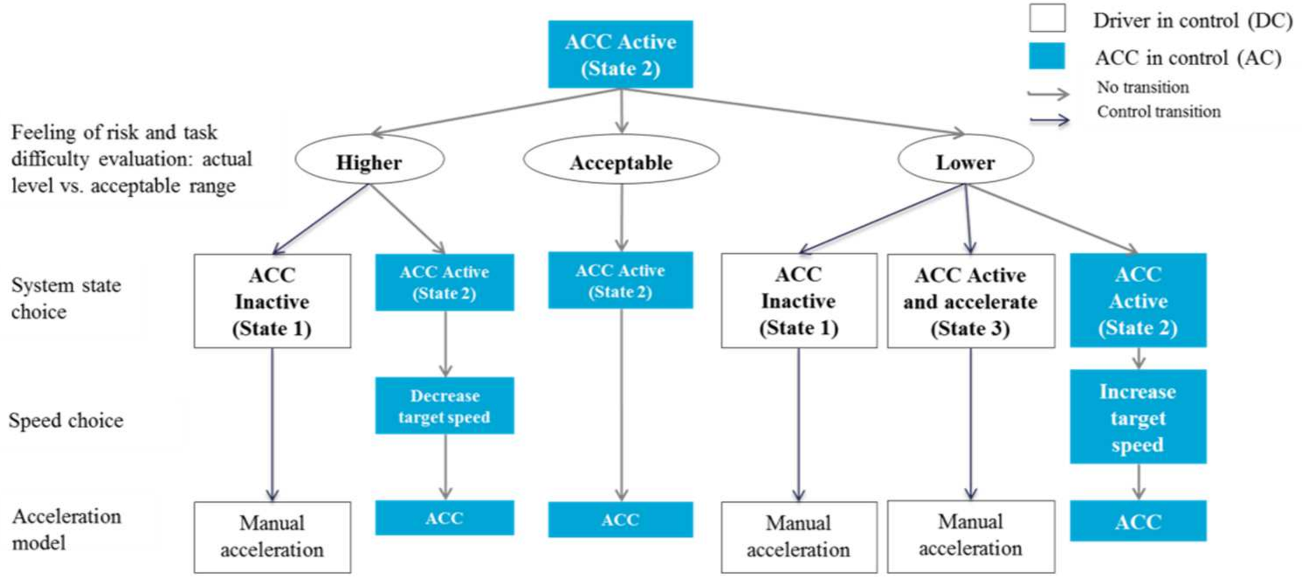
BMW 5 with Full Range ACC
23 participants



observations 10 s before, 10 s after, each authority transition at 1 Hz

Deactivation by brake:
speed drops 10 km/h in 4 s
Distance headway increases 5 m in 2s

Deactivation by gas pedal:
speed increase 6 km/h in 5 s
Distance headway increases 1.5 m in 1 s

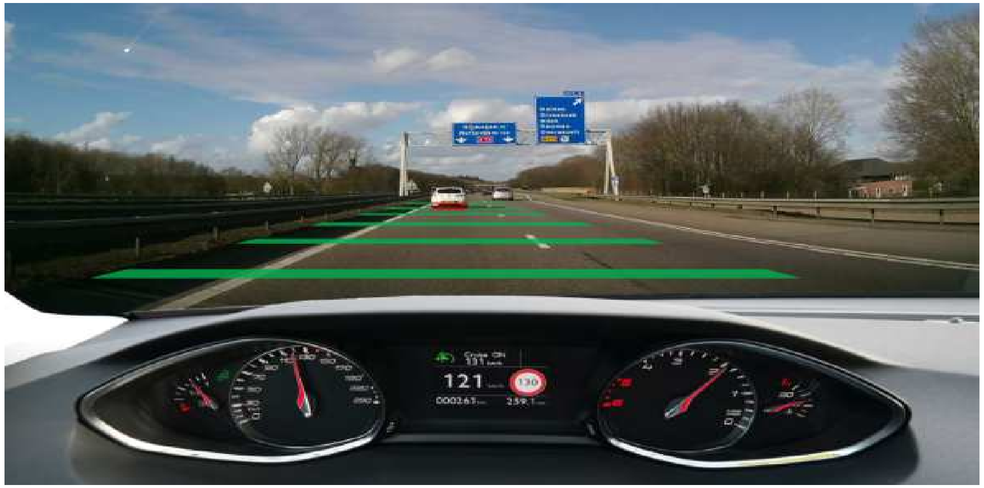


Mixed logit

Factors attributing to deactivation:

On ramps, expected cut-ins, Approaching slower vehicles

Varotto, et al (2017), Resuming manual control or not? Modelling choices of control transition in full-range adaptive cruise control, Transportation Research Record



Driving with ACC

Field study 8 ACC vehicles at RHDHV
Questionnaire in cooperation with ANWB

Current ACC systems maintain longer headways than human drivers

Drivers reduce lane changing when using ACC –staying in left or right most lane

ACC users rate pleasureness at 8 on a 1-10 scale
- Full range ACC scores higher
- Clumsy technology decreases pleasure

ACC more likely to be bought by high-income males

Winter, et al (2017) , Pleasure in using adaptive cruise control, Traffic Injury Prevention
Schakel et al (2017), Driving Characteristics and Adaptive Cruise Control, IEEE ITS Magazine

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Driver aspects

- Automated Vehicles will lead to different vehicle behaviour
- Authority transitions relevant but hardly studied
- Situation awareness decreases with prolonged automated driving
- Current ACC headways larger than human headway
- Decrease in lane change when driving with ACC

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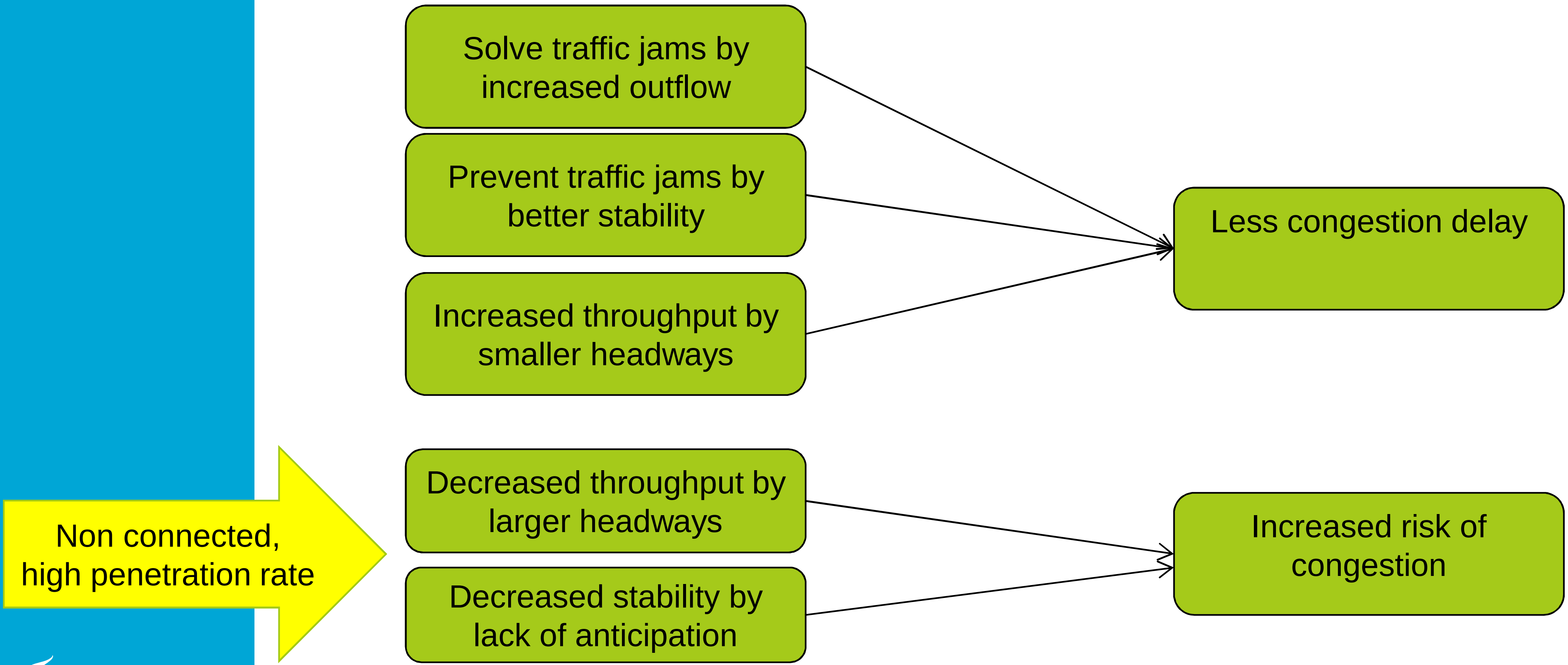
Potential impacts on traffic



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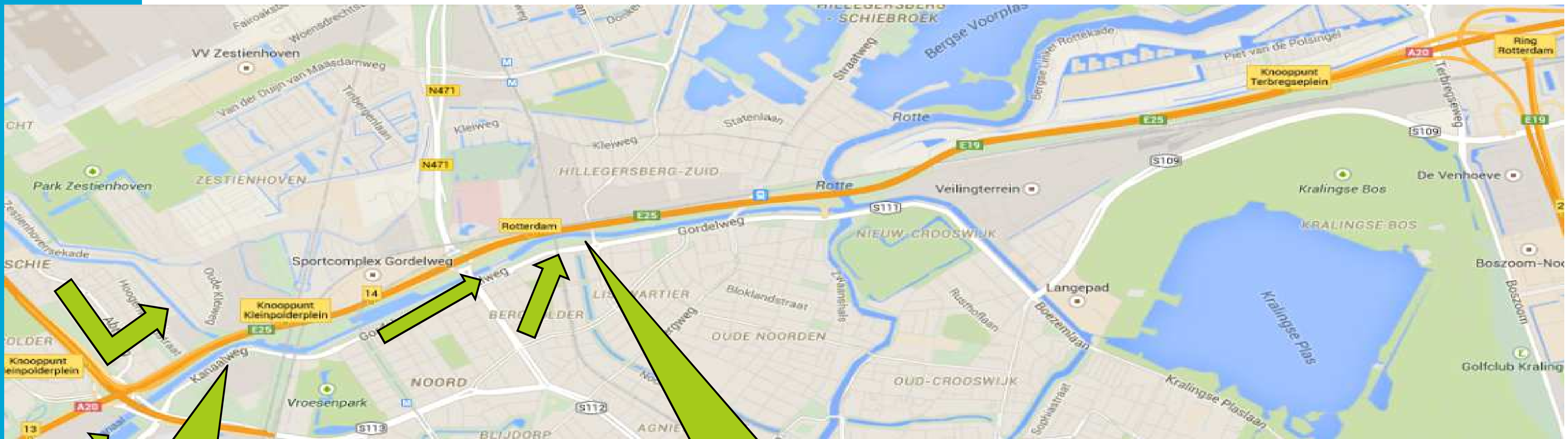
A20: bottleneck motorway, no more space to expand

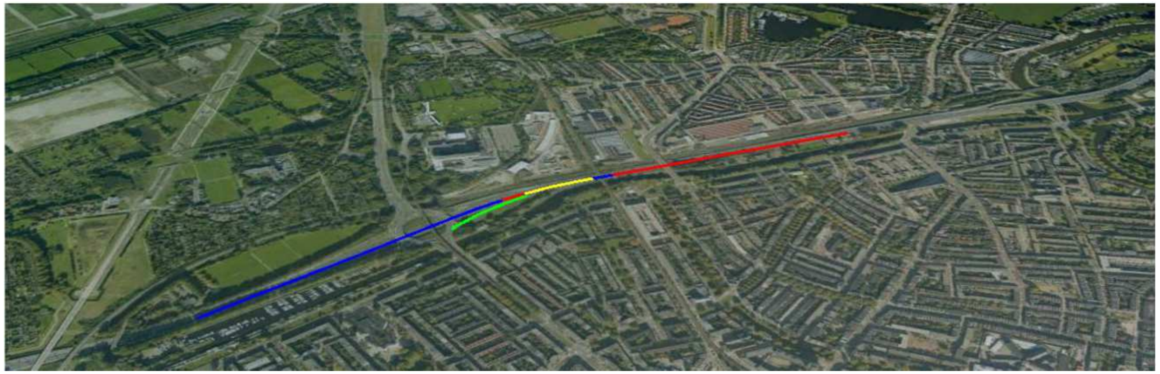


3+2 cross weaving

Short on-ramp

How can AVs relieve congestion here?

A20 congestion S112 on ramp



MOTUS simulation

RSU:
triggers at high flows on right lane;
suggests courtesy yielding and anticipatory lane changing

ACC: more agile response; switched off by RSU

Scenario	(lc)comp (%)	q_{th} (veh/h)	pACC (%)	Avg. TT change (%)	Delay change (%)	Vehicle-kilometres change (%)
Base case	-	-	-	0	0	0
Only-ACC	-	-	40	-4.5	-18.3	+2.7
Only-RSU	80	1200	-	-19.5	-72.6	+2.3
Combined	80	1200	40	-7	-27.5	+2.4

Sideris (2016)

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	Reactietijd [s]	Gemiddelde volgtijd [s]	Gemiddelde maximale versnelling [m/s²]	Gemiddelde normale vertraging [m/s²]	Gemiddelde maximale vertraging [m/s²]
Auto	0.8	- (≈ 1.0)	2.8	-3.5	-7
ACC	0.8	1.6	2.5	-2.5	-6
Nieuwere ACC	0.4	1.6	2.5	-2.5	-6
Verbeterde ACC	0.4	1.2	2.5	-2.5	-6
CACC	0.2	0.8	2.5	-2.5	-6

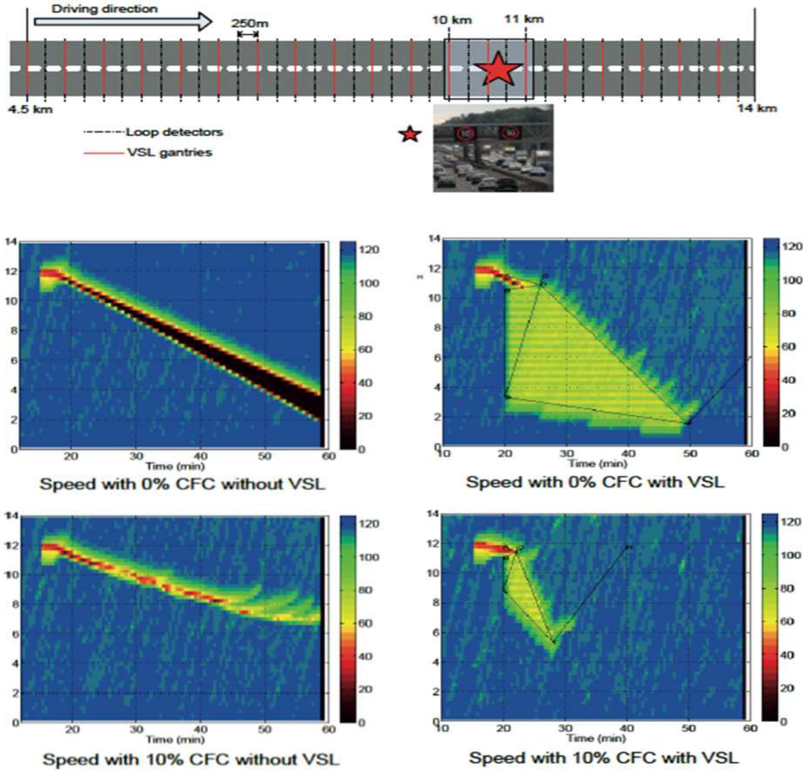
- Current ACC increases congestion
- New/improved ACC start reducing congestion at 10% penetration rate
- CACC strongly reduces congestion

Note: (C)ACC modelled as ‘special’ drivers

Huisman (2016)

AIMSUN

Managing traffic with Connected Variable Speed Limits and ACC



- Traffic control is still necessary with presence of IVs, particularly at low penetration rate;
- Although IV changes traffic flow characteristics, the VSL algorithm works well with presence of IVs;
- Connected traffic control and vehicle control bring extra benefits in improving traffic efficiency;
- Redesign of traffic control systems taking into account the changed flow characteristics may lead to further improvement.

M. Wang, W. Daamen, S.P. Hoogendoorn, and B. van Arem. Connected variable speed limits control and car-following control with vehicle-infrastructure communication to resolve stop-and-go waves. Journal of ITS.

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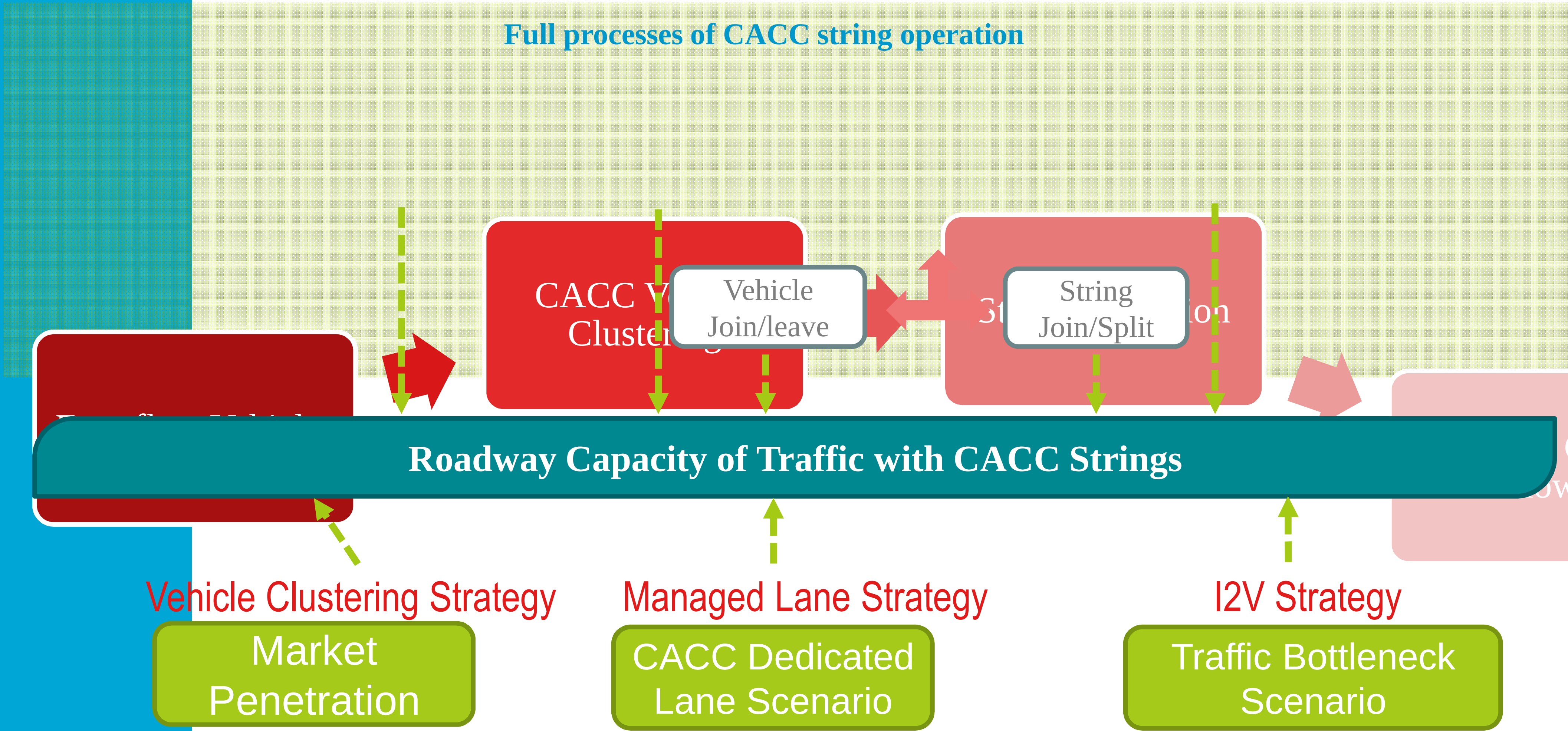
High Performance Vehicle Streams with active CACC string clustering



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Lin Xiao

Cooperative automated driving strategies for efficient traffic operations near on-ramp bottlenecks

Better control algorithms

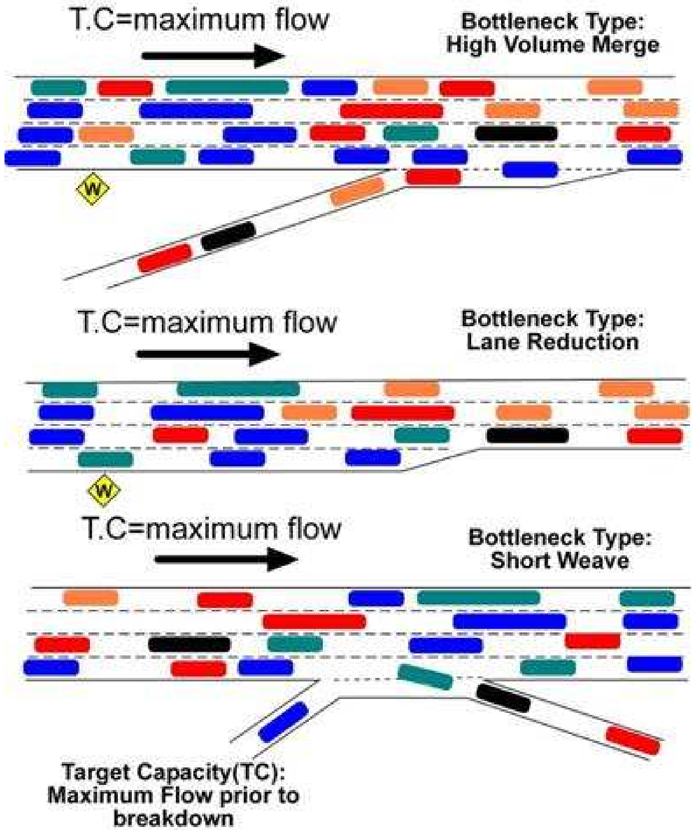
- Relieve traffic congestion,
- improve traffic safety,
- reduce pollution.

Mixed AV and manual traffic.

Different penetration rates

Different traffic scenarios

Traffic flow simulation



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China Scholarship Council www.csc.edu.cn

Rijkswaterstaat
Ministry of Infrastructure and the Environment

Na Chen

Will Automated Driving improve traffic flow efficiency?

- Potential impacts of current ACC systems negative because of long headways
  - Need for more capable ACC
- Cooperative ACC can improve traffic flow efficiency
- Special attention needed for bottlenecks and authority transitions
- Statement about doubling roadway capacity are far from reality

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Driving with automation…

- SAE L1-2 commercially available
  - SAE L3-4 with OEDR at system in R&D stage
- Mental underload, reduced situation awareness
  - More than ever, automation needs to be safer than driver
- Current ACC have longer headways than human drivers
  - Better ACC or CACC needed to avoid increase of congestion
- New focus: lane changing and manoeuvering
  - Especially at roadway bottlenecks
- Simulation models widely available
  - Are authority transitions included
- Public data about driving with automation scarce
  - Data sets to be published in journals