



Delft University of Technology

Are we ready for SAE Level 4 (on) Motorways? (PPT)

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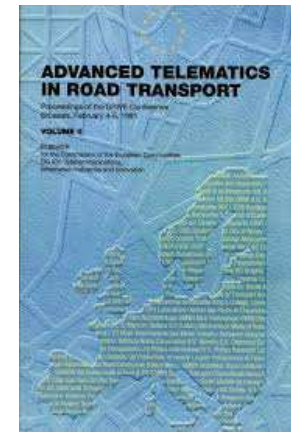
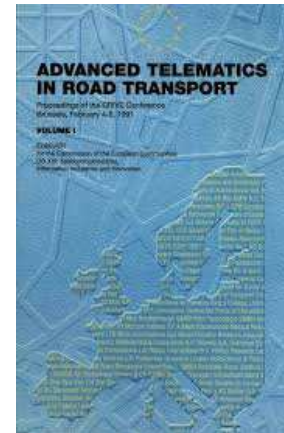
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Are we ready for SAE Level 4 (on) Motorways?

Bart van Arem



How I met Frans...



Get It In On The Road, Get It In the Vehicle.



Declaration of Amsterdam

Cooperation in the field of connected and automated driving

14-15 April 2016

High expectations rest on Automated Driving





Automated cars can improve traffic efficiency and safety

Netherlands to facilitate large scale testing of automated cars

Dealing with 50 shades of automation....

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
Human driver monitors the driving environment						
0	No Automation	the full-time performance by the <i>human driver</i> of all aspects of the <i>dynamic driving task</i> , even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the <i>driving mode</i> -specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the <i>driving mode</i> -specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the <i>human driver</i> perform all remaining aspects of the <i>dynamic driving task</i>	System	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment						
3	Conditional Automation	the <i>driving mode</i> -specific performance by an <i>automated driving system</i> of all aspects of the dynamic driving task with the expectation that the <i>human driver</i> will respond appropriately to a <i>request to intervene</i>	System	System	Human driver	Some driving modes
4	High Automation	the <i>driving mode</i> -specific performance by an automated driving system of all aspects of the <i>dynamic driving task</i> , even if a <i>human driver</i> does not respond appropriately to a <i>request to intervene</i>	System	System	System	Some driving modes
5	Full Automation	the full-time performance by an <i>automated driving system</i> of all aspects of the <i>dynamic driving task</i> under all roadway and environmental conditions that can be managed by a <i>human driver</i>	System	System	System	All driving modes

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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

What is it like to 'drive' in high automation?

**INTRODUCING VOLVO CARS
SEAMLESS INTERFACE FOR SELF-DRIVING CARS**

What does a highly automated road look like?



Call in the experts!



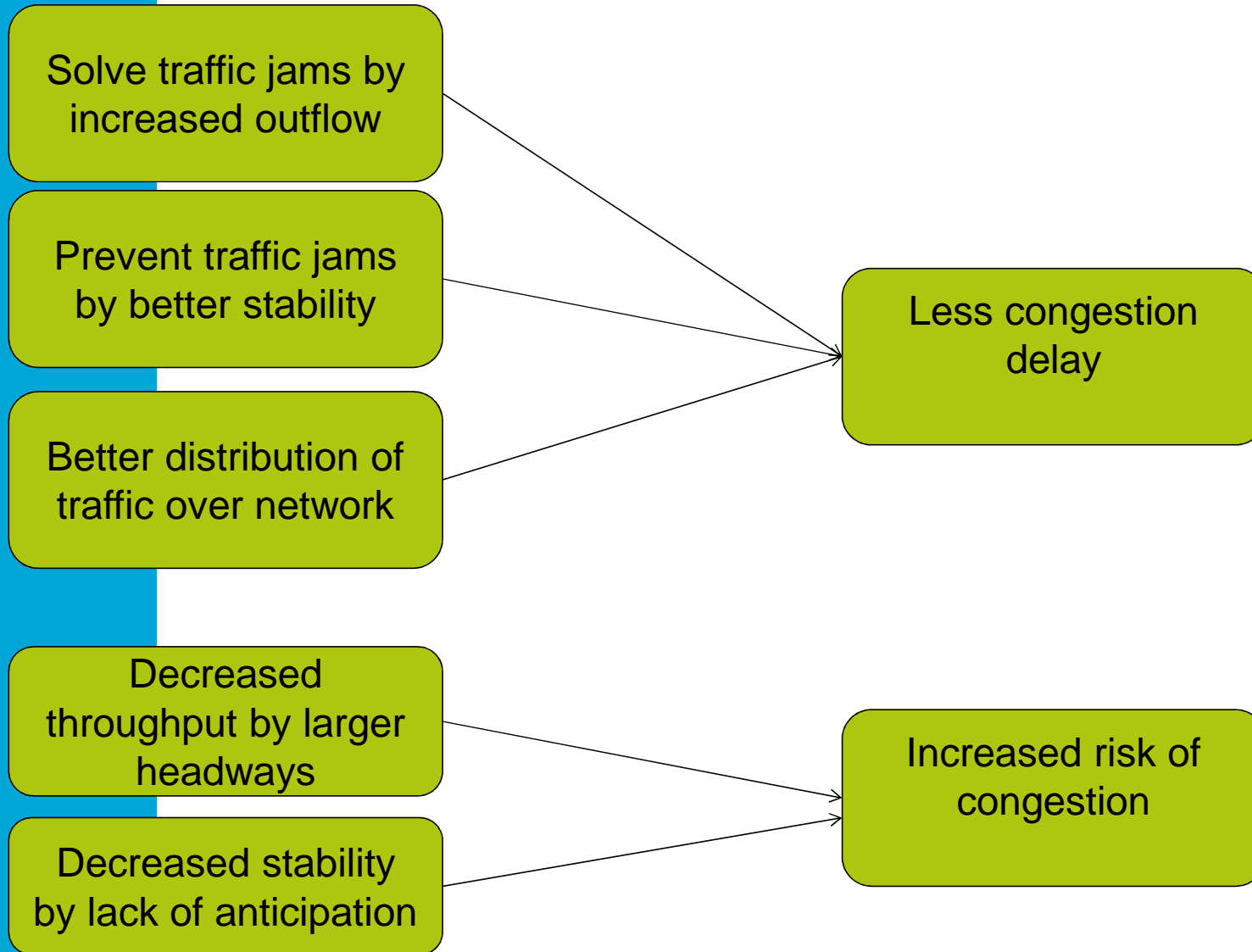
Automated roads?

- Implication of changes in traffic load? Platoons, bridges, rutting?
- Automated driving under adverse roadway and weather conditions?
- Implications for traffic management? Opportunity or thread?
- eHorizon: automated driving cloud for real-time positioning, manoeuvring and safety?
- Level 4 certified roads?
- Geometric design, transition zones?
- Who is responsible?



Potential impacts on traffic

Non connected
Large penetration



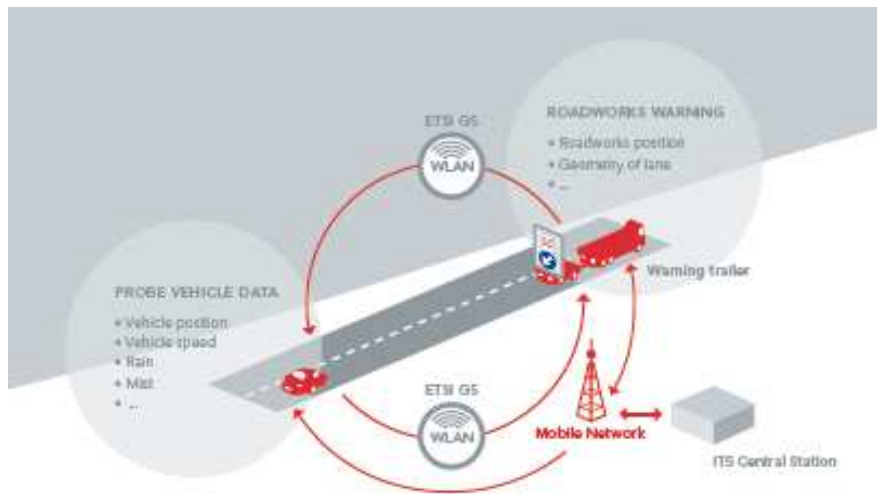
Imagine yourself an automated vehicle!



3+2 cross weaving

Short on-ramp

How can AVs relieve congestion here?



Cooperative ITS Corridor

Joint deployment

V2V	I2V/V2I
Hazardous location warning	Road works warning
Slow vehicle warning	In-vehicle signage
Traffic Jam ahead warning	Signal phase and time
Stationary vehicle warning	Probe Vehicle Data
Emergency Brake light	
Emergency vehicle warning	
Motorcycle approaching indication	

(Very rough) Exploration using LMS

Automated Autonomous

5% capacity decrease on primary road network

	Index km travelled
Train	100.3
Car driver	99.8
Car passenger	99.7
Bus, tram, metro	100.2
Cycling	100.1
Walking	100.1
Total	99.98

Index congestion
115.7

Automated Cooperative

15% capacity increase primary road network
10% capacity increase secondary road network
10% decrease value of time commuting and business car trips

	Index km travelled
Train	98.8
Car driver	100.8
Car passenger	101.4
Bus, tram, metro	99.2
Cycling	99.3
Walking	99.4
Total	100.10

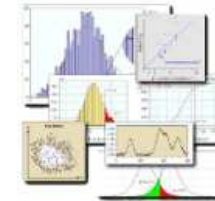
Index congestion
69.1

From demonstration to research and deployment!

Develop efficient and reliable technology



Collect, analyse and publish large scale real-world experience



Study spatial, transport and societal impacts



Regulations, type approval



Awareness, ambitions, expectations, reality checks



What we can learn from Frans

