




SELF-LEARNING ENGINES: FROM ON-LINE OPTIMIZATION TOWARDS FLEX FUEL ENGINES

Prof. Frank Willems
TNO Automotive
Eindhoven University of Technology (TU/e)

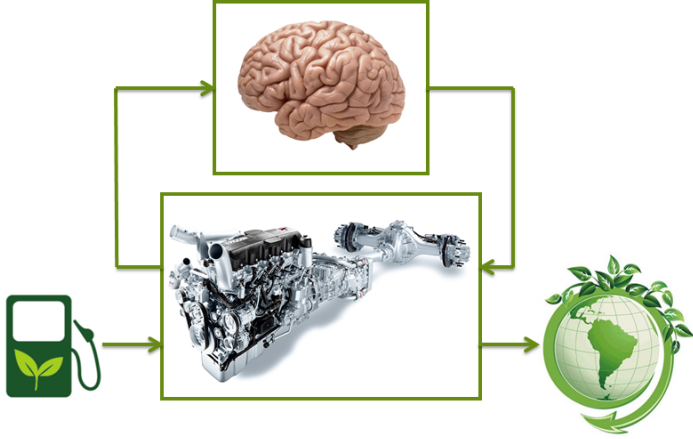
TNO innovation
for life

SAECCE
SAE-CHINA CONGRESS & EXHIBITION

Special Session - Improvement of IC Engine Fuel
Consumption and the New Technology
November 6, 2018, Shanghai, China



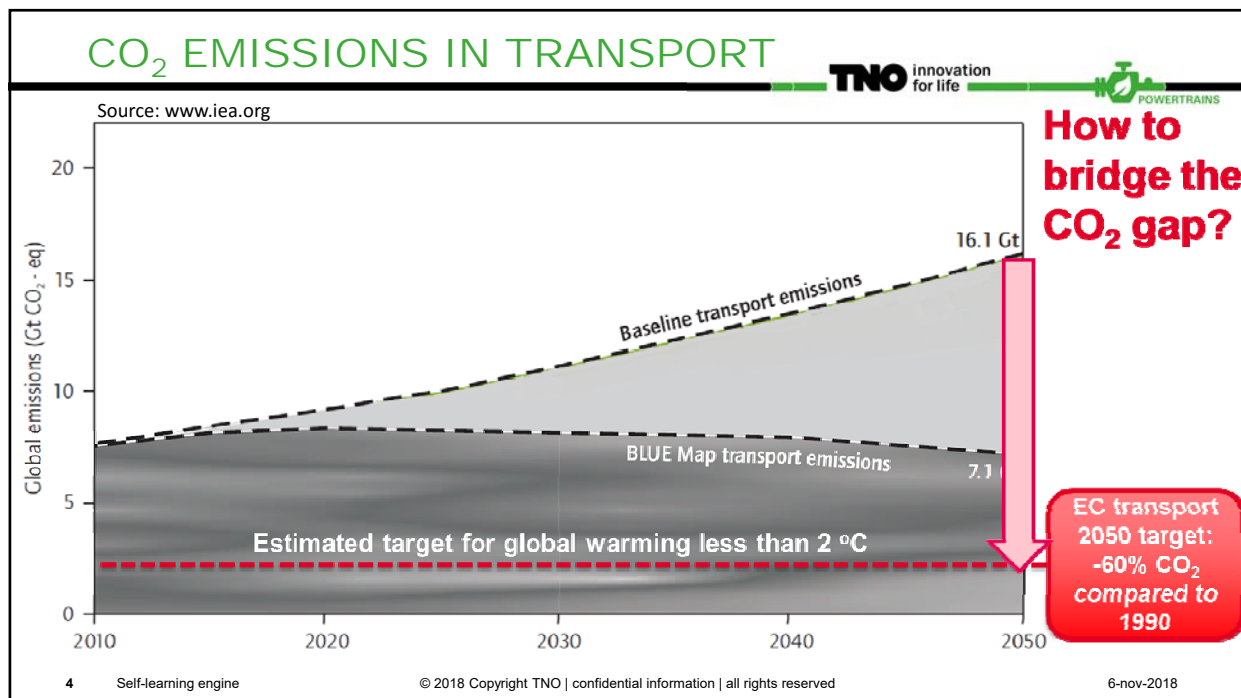
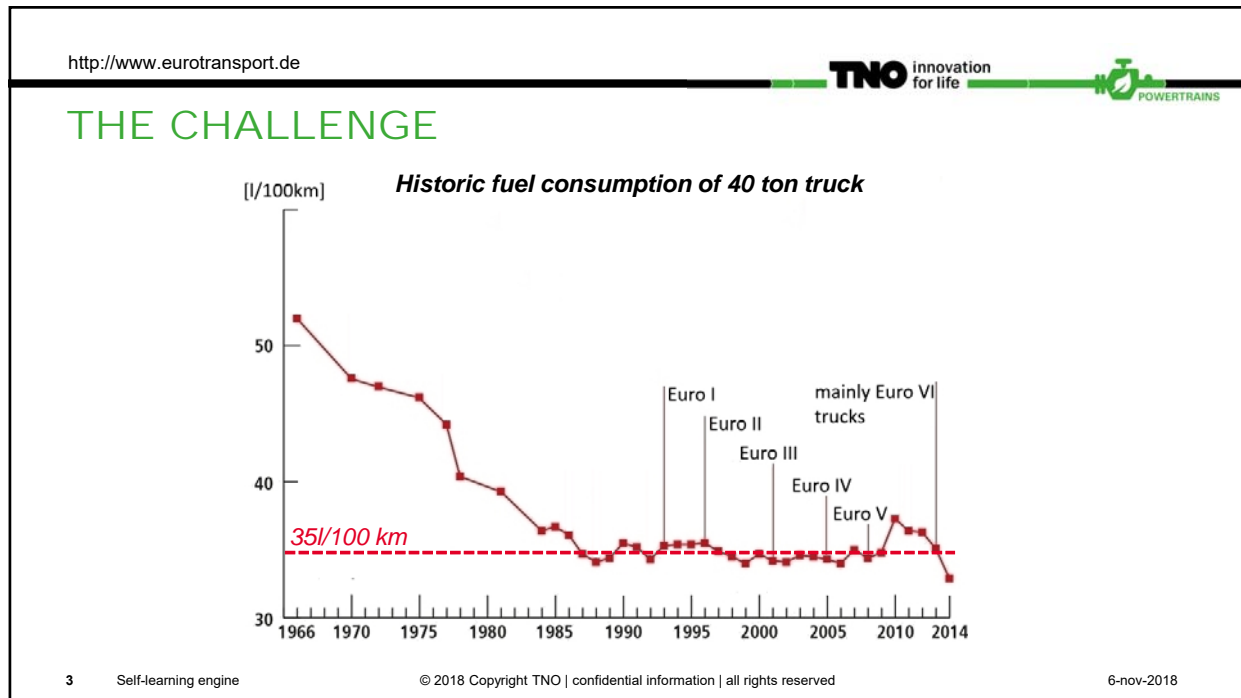
NEW, EXCITING CHAPTER IN ENGINE CONTROL

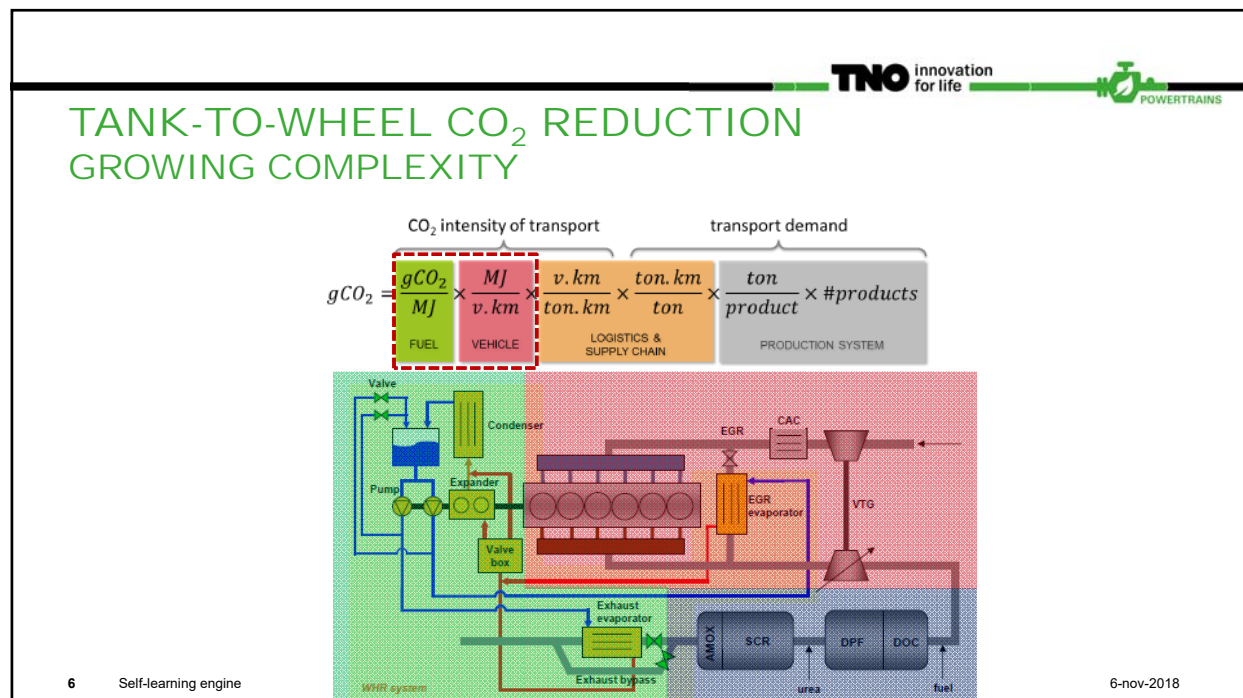
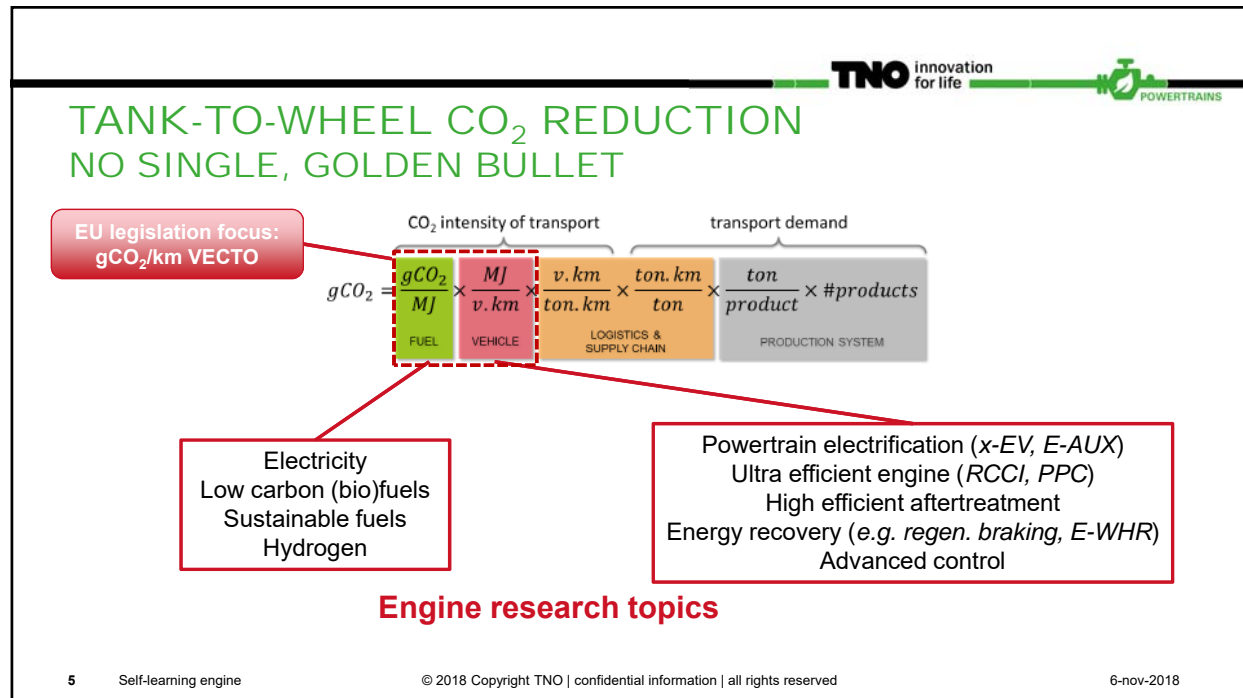


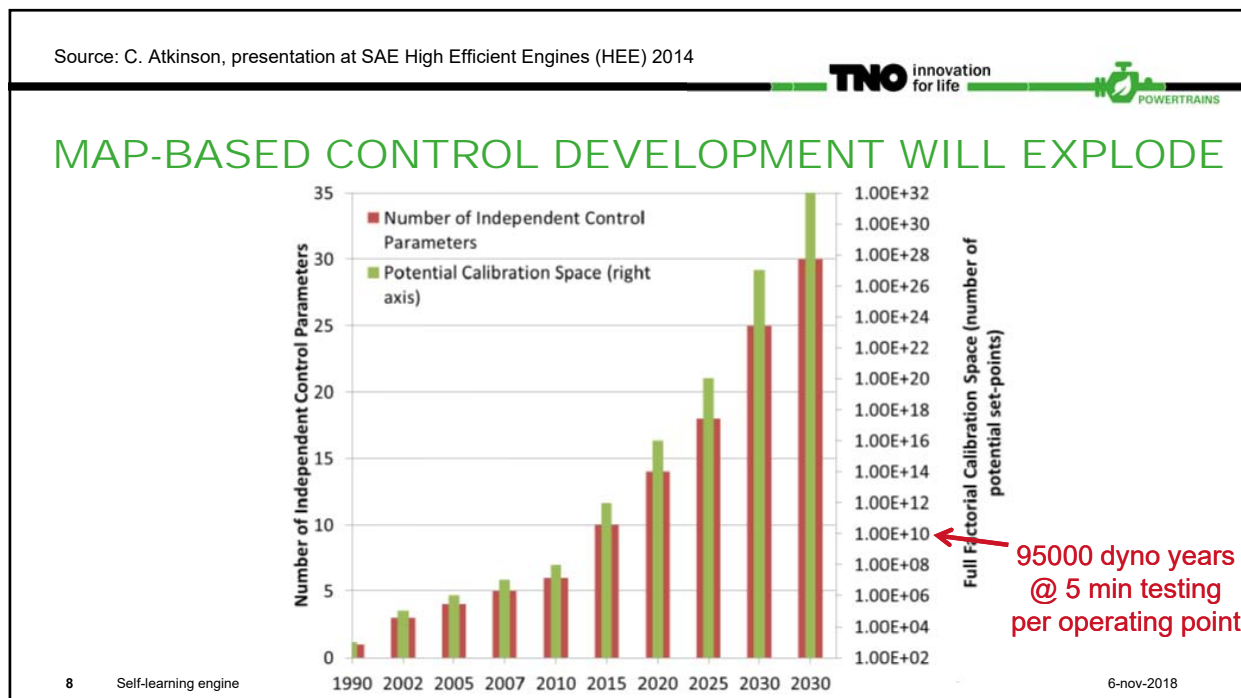
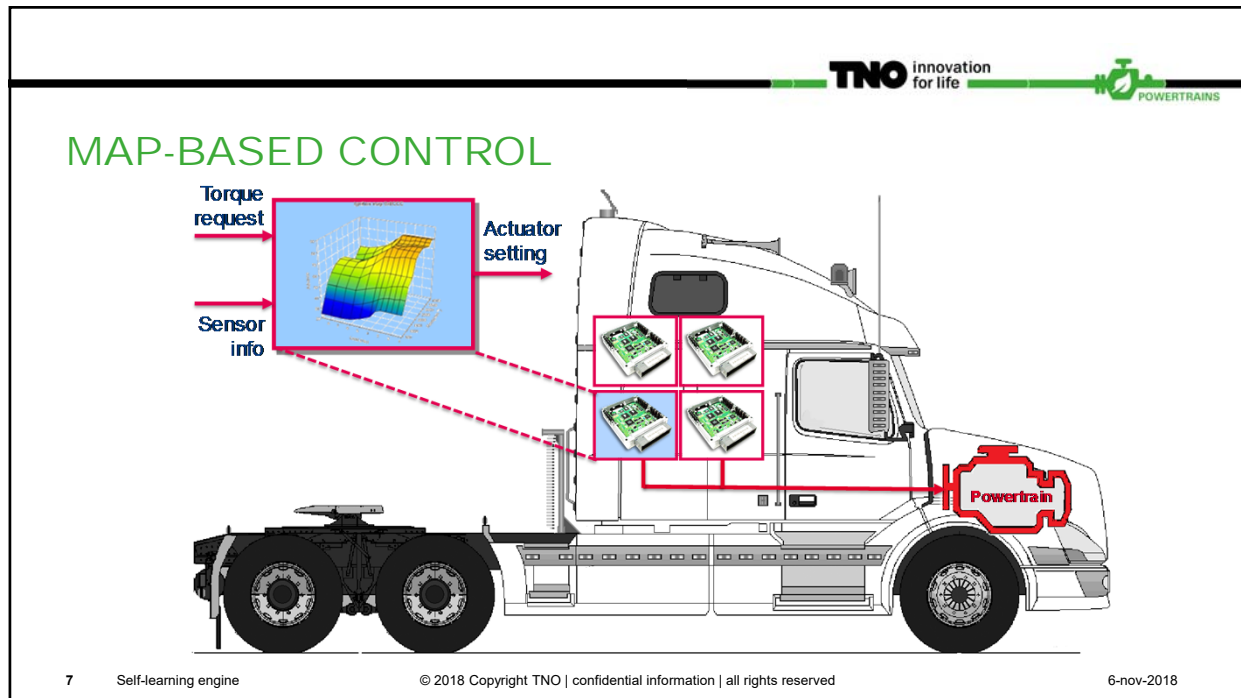
2 Self-learning engine

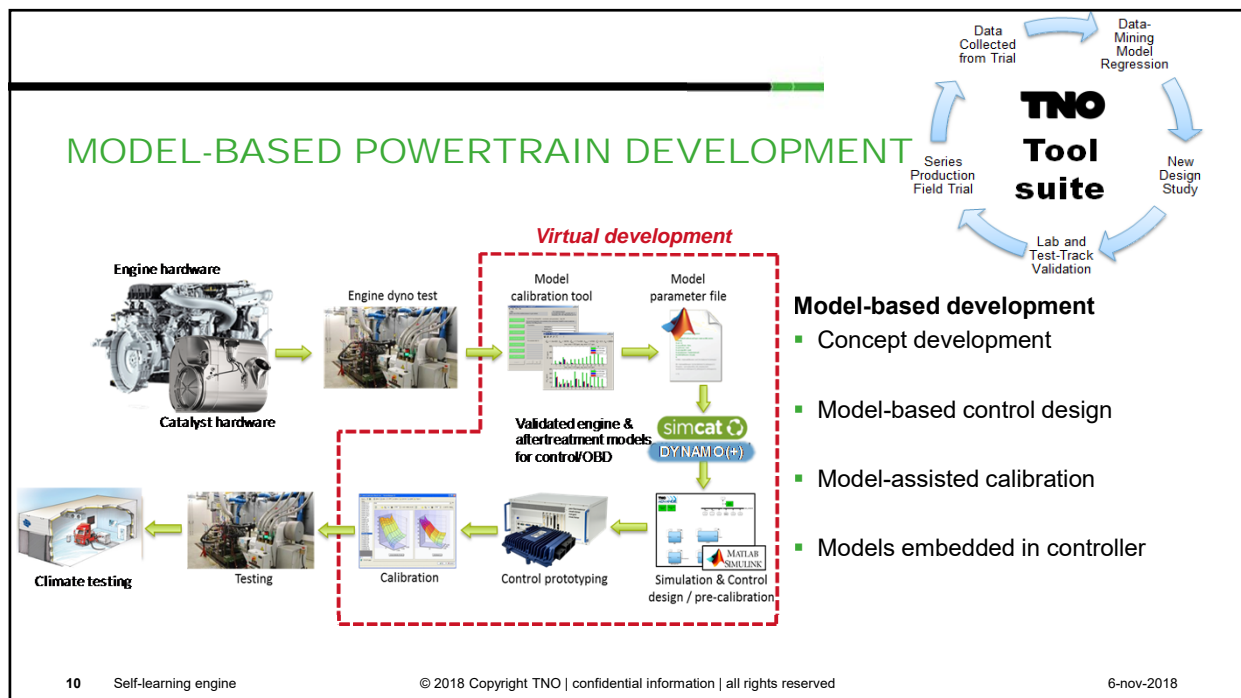
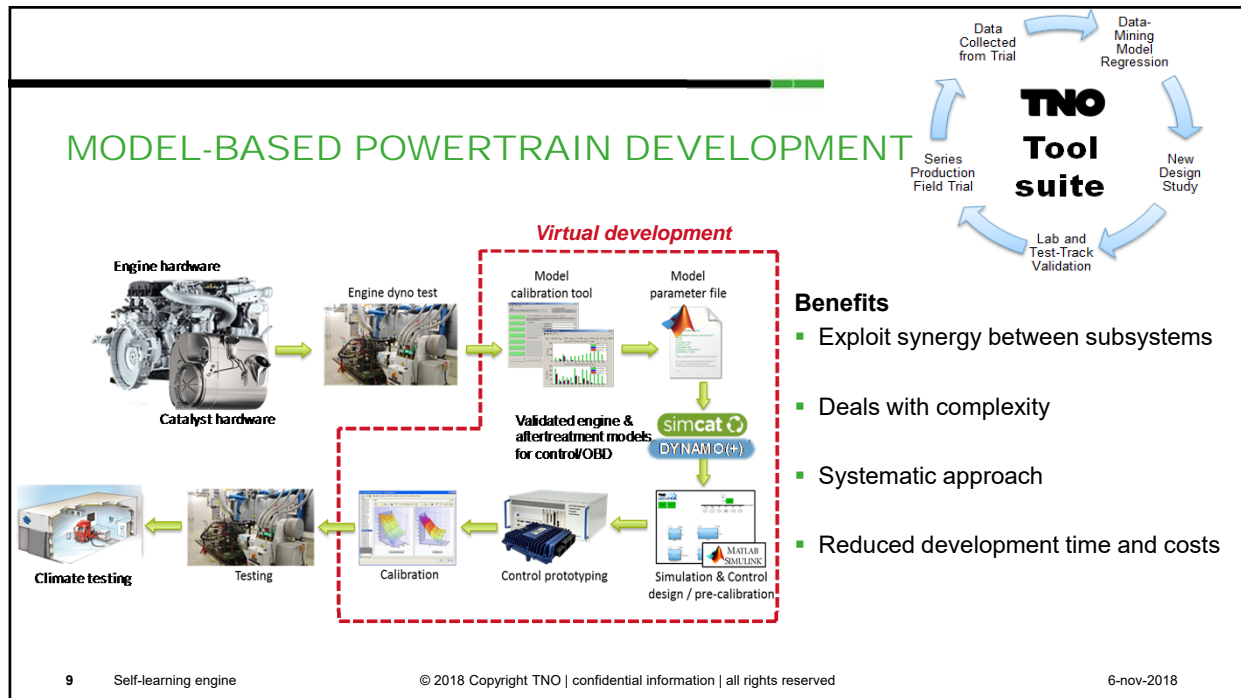
© 2018 Copyright TNO | confidential information | all rights reserved

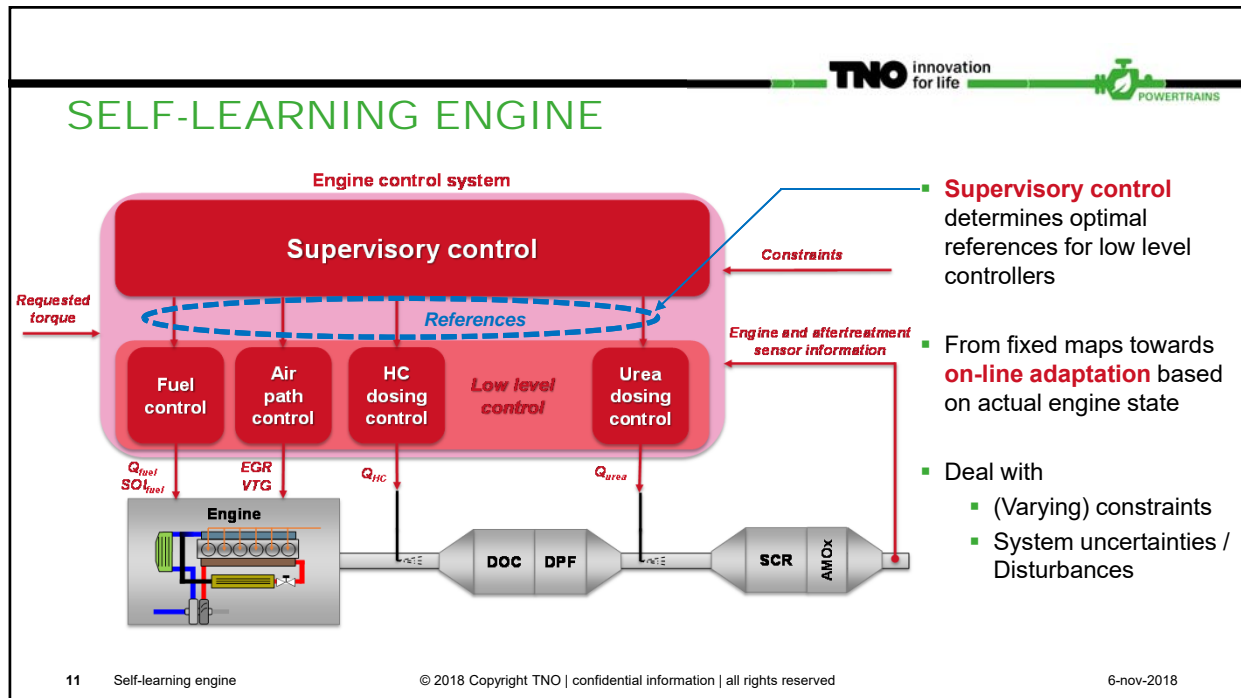
6-nov-2018



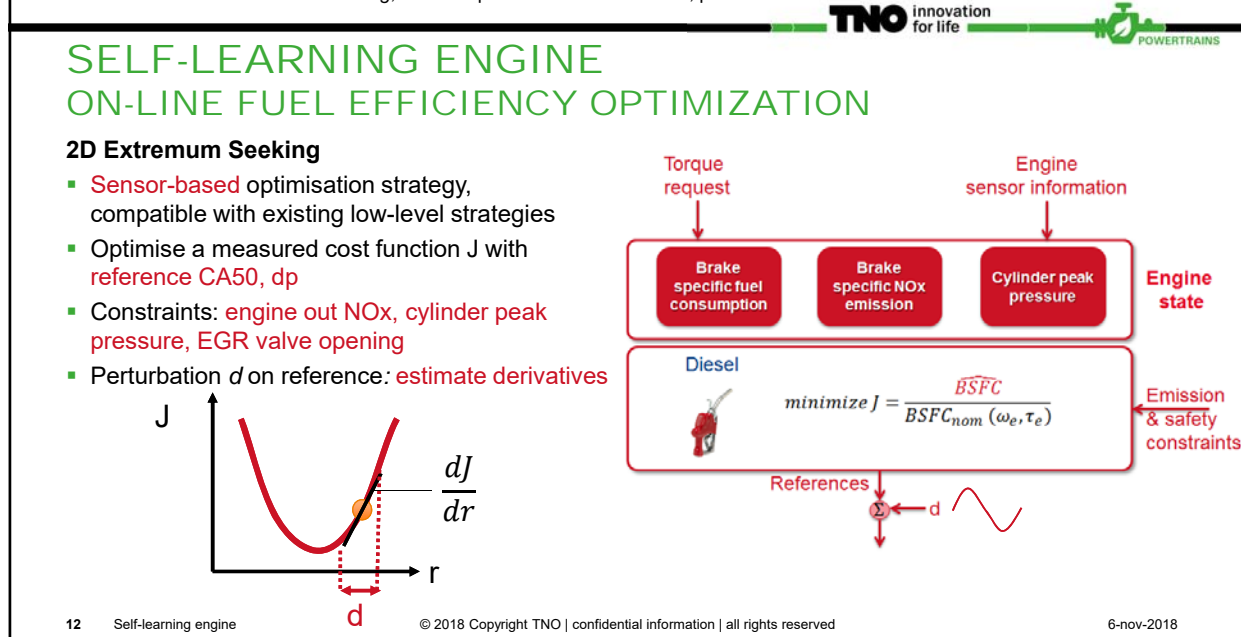


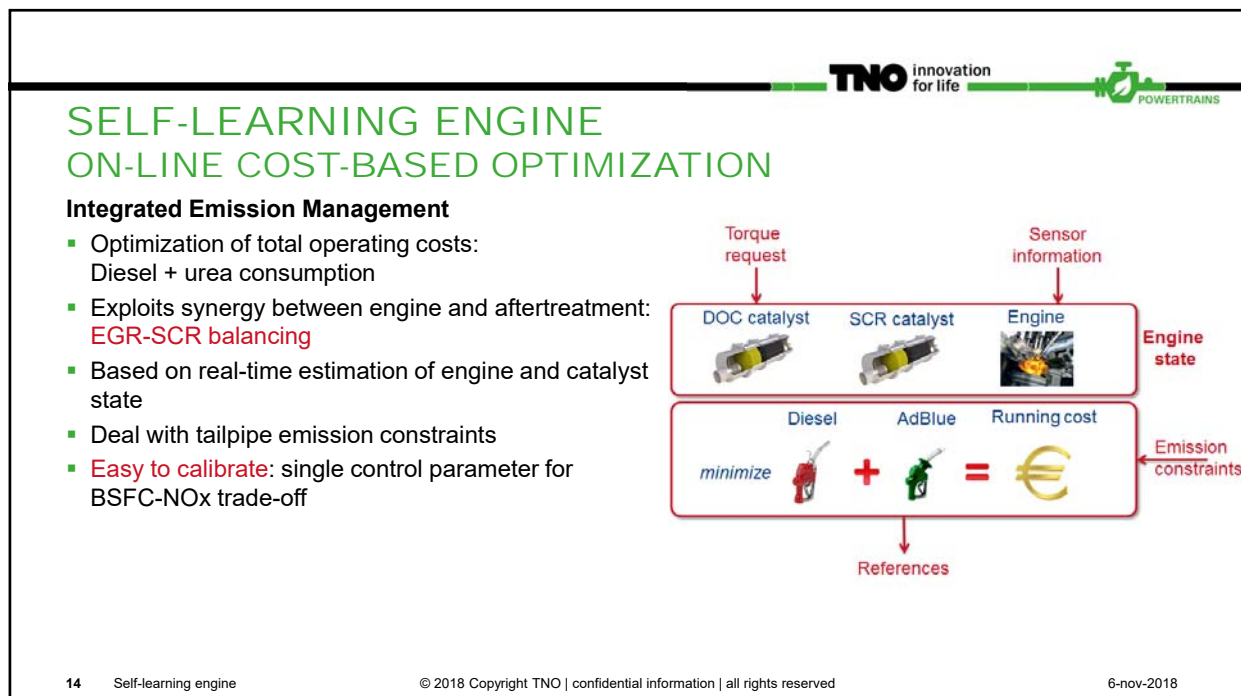
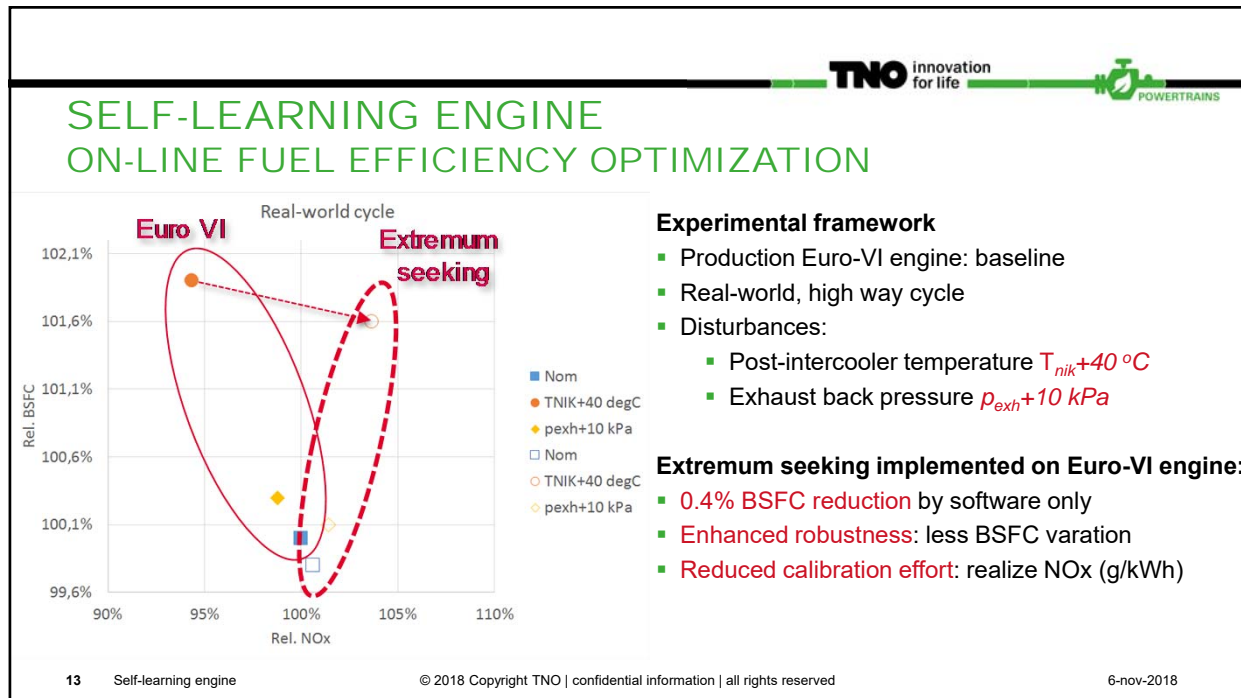






Van der Weijst et al. (2018) *On-line fuel-efficiency optimization of Diesel engines using constrained multivariable extremum-seeking*, 17th European Control Conference, p.213-218



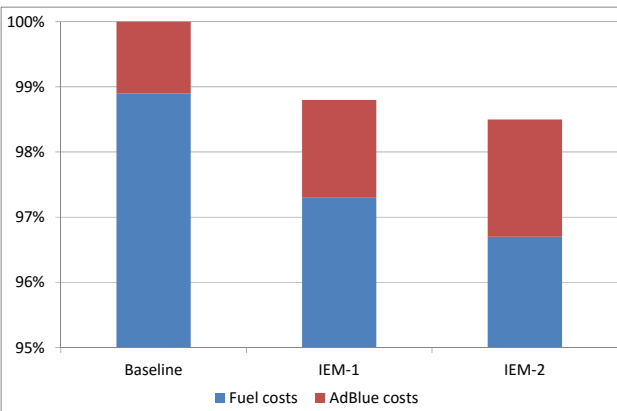


Willems, F., Mentink, P., Kupper, F. & Van den Eijnden, E. (2013). Integrated emission management for cost optimal EGR-SCR balancing in diesels, 7th IFAC Symposium on Advances in Automotive Control, p. 701-706

TNO innovation
for life



SELF-LEARNING ENGINE ON-LINE COST-BASED OPTIMIZATION



Experimental framework

- Production Euro-VI engine: baseline
- Hot World Harmonized Transient Cycle (WHTC)

Integrated Emission Management (IEM) implemented on Euro-VI engine:

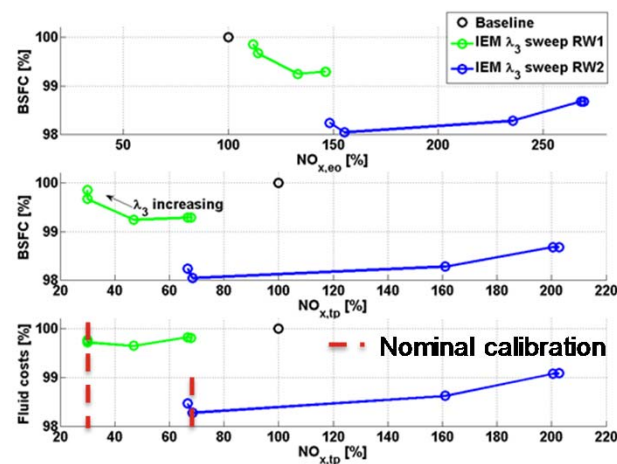
- Two calibrations:
 - IEM-1: Euro-VI NOx
 - IEM-2: low BSFC
- EGR-SCR balancing
- 2.1% BSFC reduction** by software only

Mentink, P., Van den Nieuwenhof, R., Kupper, F., Willems, F. et al., "Robust Emission Management Strategy to Meet Real-World Emission Requirements for HD Diesel Engines," SAE Int. J. Engines 8(3):2015, doi:10.4271/2015-01-0998

TNO innovation
for life



SELF-LEARNING ENGINE ON-LINE COST-BASED OPTIMIZATION



Simulation framework

- Euro-VI engine with IEM strategy
- Baseline calibration: production Euro-VI
- Real-world urban test cycles
- BSFC-NOx trade-off by sweep control parameter λ_3

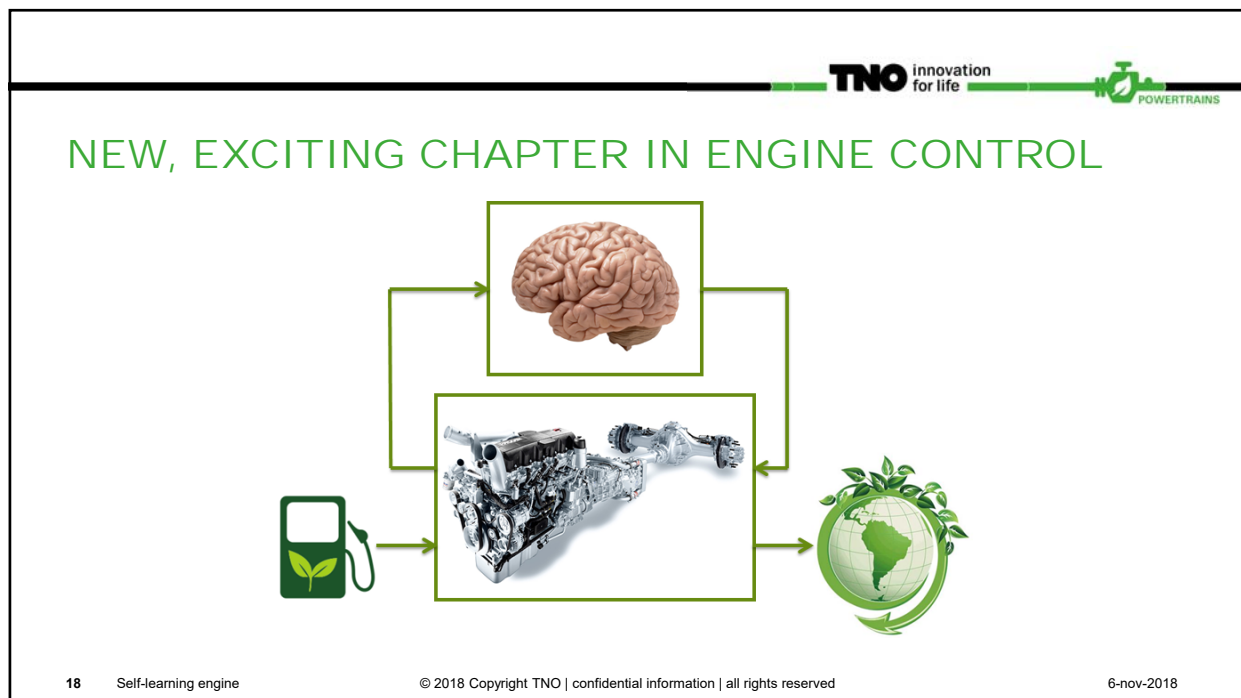
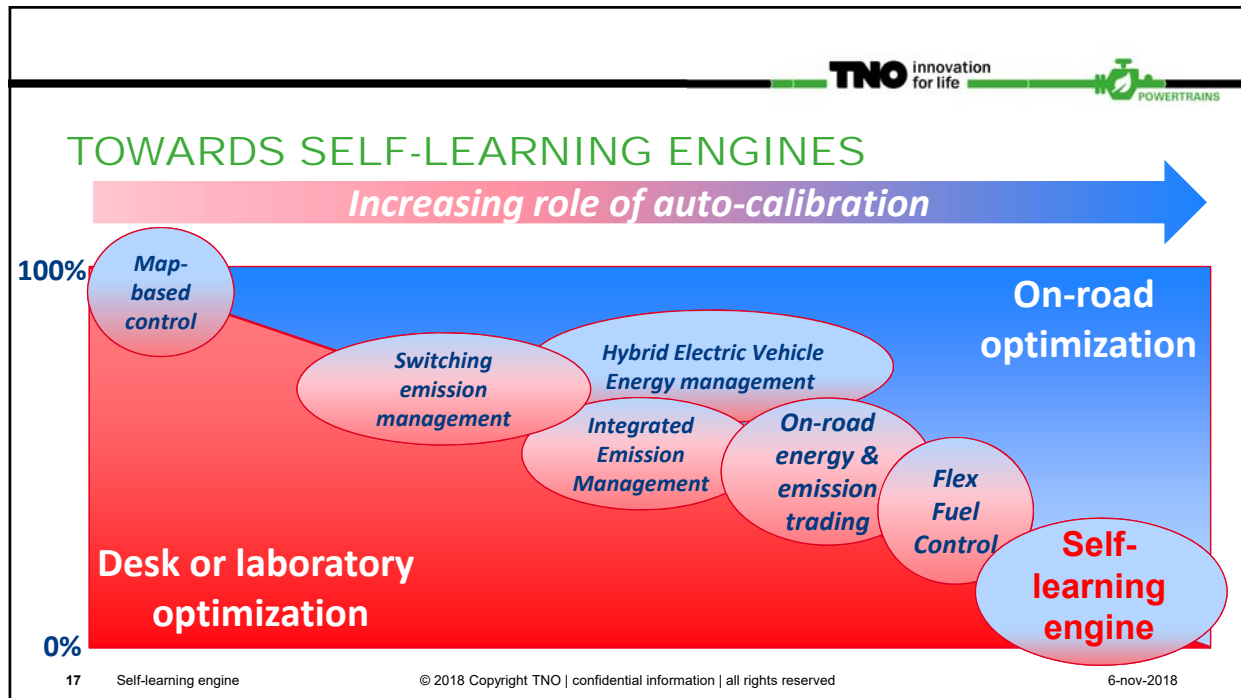
Results

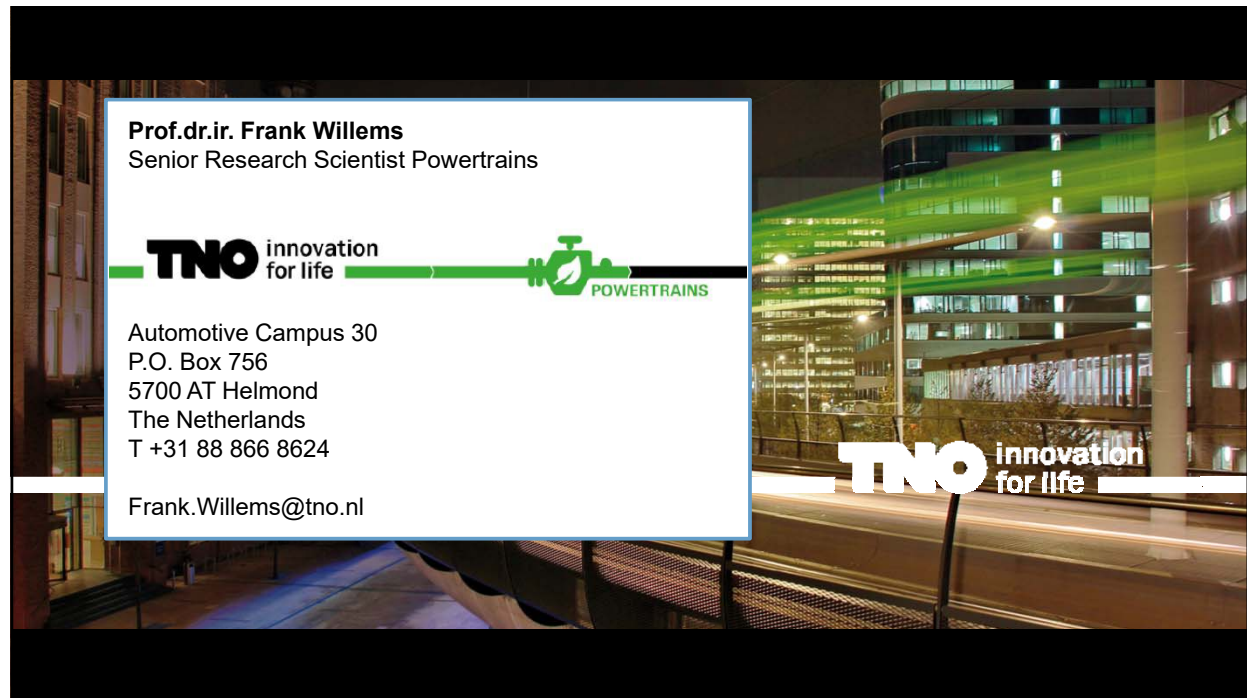
- Different optimal λ_3 for each test cycle

Optimal vs. baseline

	BSFC	Fluid Costs
RW1	-0.70%	-0.35%
RW2	-1.95%	-1.7%


- Adaptive control** will improve real-world performance
 - Future: use preview information about route





Prof.dr.ir. Frank Willems
Senior Research Scientist Powertrains

TNO innovation
for life



POWERTRAINS

Automotive Campus 30
P.O. Box 756
5700 AT Helmond
The Netherlands
T +31 88 866 8624

Frank.Willems@tno.nl

TNO innovation
for life