Research School for Transport,
Infrastructure and Logistics

TRAIL seminar

Road Network Design and Management for Automated Driving

18 January 2020

10.15 h – 12.00 h

Microsoft Teams

On 20 January 2021, TRAIL PhD researcher **Bahman Madadi** will defend his PhD thesis Design and Optimization of Road Networks for Automated Vehicles at Delft University of Technology. The defence is public, and you are invited to join. The research of Bahman Madadi is part of the research program STAD http://stad.tudelft.nl/.

On the occasion of this public defence, TRAIL and TU Delft have set up a seminar on Road Network Design and Management for Automated driving. Relying on driving automation technology alone without infrastructure support might compromise the potential safety and efficiency of automated vehicles. Therefore, this seminar starts with a presentation on physical and digital infrastructure requirements of highly automated vehicles. Besides private automated vehicles also fleets of shared Autonomous Vehicles are expected to hit the market. An important question that will be addressed in two different presentations is how these fleets can best be managed. In this seminar, experts in the field will share conceptual and methodological advancements which will help governments and service providers to prepare for a future with automated vehicles.

Programme webinar
Chairman: Maaike Snelder

10.15 – 10.30h	Opening and welcome
10.30 – 11.00h	**Risto Kulmala** - physical and digital infrastructure requirements of highly automated vehicles
11.00 – 11.30h	**Frederik Schulte** - dynamic fleet management for autonomous vehicles
11.30 – 12.00h	**Costas Antoniou** – a game theoretic approach for modelling of reservation-based shared autonomous vehicle services

Registration
Participation is free, registration is required: *CLICK HERE*.

You will receive a Teams invitation on 13 January 2020.

Public defence
The online public defence of Bahman Madadi will take place at 15:00h on the 20th of January 2021.

Physical and digital infrastructure requirements of highly automated vehicles

In order to facilitate highly automated driving (SAE Level 4) it is essential to understand the requirements of such automated vehicles on the road infrastructures. In this, the ODDs (Operational Design Domains) of the automated vehicles are the key starting point. Information on the ODDs is available from the automated driving system developers' own statements and reports (e.g. the voluntary safety self-assessment reports provided to the NHTSA) but also from European projects. On the basis of these sources, we have compiled a list of ODD attributes relevant to road operators. Many of these attributes deal with physical and digital road infrastructure. The presentation will discuss the infrastructure attributes and sub-attributes as well as the likely costs for deploying the physical and digital infrastructure elements. It is important to note that the infrastructure requirements of automated vehicles will likely evolve along with the technology evolution of automated vehicles, and especially with regard to their sensors, software and AI capabilities.

Dr Risto Kulmala works at Traficon Ltd as a principal advisor on ITS with past positions at Finnish Transport Agency, VTT and University of Lund. He has been a coordinator of several major national and international R&D and deployment programmes and projects with more than 300 publications, and a member or chair of various international ITS bodies as well as scientific and technical committees. His areas of expertise include connected and automated driving, ICT infrastructures, ITS evaluation, deployment road maps, road safety, statistical modeling, and field studies of road user behavior.

A game theoretic approach for modelling of reservation-based shared autonomous vehicle services

Shared Autonomous Vehicles (SAVs) are expected to be used for regular and pre-planned trips. Such trips are suitable for reservation-based services, wherein the customer needs to book for a trip in advance. Systems enabling reservation of trips can allow for better planning of routes and schedules, and if optimally designed, enable higher efficiency. The primary objective of this research is to model the effects of such a system, by formulating and solving the combined Dynamic User Equilibrium and Sav Chain Formation (DUESCF) problem. The problem is formulated as a bilevel model based on game theory, involving road users and SAV service operator. Given a situation where conventional private and shared autonomous vehicles co-exist, road users select paths and departure times to maximize a perceived utility (commonly treated as minimizing a disutility) by forming a DUE (fixed point problem), and the SAV service operator tries to maximize the performance by forming appropriate SAV chains (combinatorial problem). The final objective of this bilevel model is a traffic assignment that includes SAV chain formation, such that both road users and SAV service operator obtain optimal solutions by reaching a Nash equilibrium, where no player is better off by unilaterally changing their decisions. A solution approach, based on Iterative Optimization and Assignment (IOA) method, is proposed with path flow and SAV performance changes as convergence criteria. Further, the solution approach is tested for its robustness, and a scenario analysis is carried out to evaluate the impacts of reservation-based SAV services. The results show that a ridesharing SAV system is better compared to a carsharing and a mixed system consisting of both, in terms of total system travel time, congestion levels, total vehicle kilometres travelled and vehicle requirements.

Constantinos Antoniou is a Full Professor in the Chair of Transportation Systems Engineering at the Technical University of Munich (TUM), Germany. He holds a Diploma in Civil Engineering from NTUA (1995), a MS in Transportation (1997) and a PhD in Transportation Systems (2004), both from MIT. His research focuses on modelling and optimization of transportation systems, data analytics and machine learning for transportation systems, and human factors for future mobility systems. He is/has been PI of several research projects (e.g. H2020 iDREAMS, MOMENTUM, Drive2thefuture, DFG DVanPool and TRAMPA). He has authored more than 400 scientific publications, including more than 125 papers in international, peer-reviewed journals, 250 in international conference proceedings, 3 books and 20 book chapters. He is a member of several professional and scientific organizations, editorial boards (Associate Editor of Transportation Research – Part A: Policy and Practice, Editorial Member of Transportation Research – Part C, Accident Analysis and Prevention, Journal of Intelligent Transportation Systems, Smart Cities; Deputy Editor in Chief of IET Intelligent Transportation Systems; Associate Editor of Transportation Letters; Editor of EURO Journal on Transportation and Logistics), committees (such as TRB committees AHB45 – Traffic Flow Theory and Characteristics and ABJ70 - Artificial Intelligence and Advanced Computing Applications, Steering Committee of hEART – The European Association for Research in Transportation, and FGSV Committee 3.10 "Theoretical fundamentals of road traffic"), and a frequent reviewer for a large number of scientific journals, scientific conferences, research proposals and scholarships.