

Commencement of Study: 1. March 2026

Department of Applied Mathematics (K611)

Study programme: Smart Cities

Supervisor:

prof. Ing. Ondřej Příbyl, Ph.D. (e-mail contact: pribylo@fd.cvut.cz)

Topic:

Integration of cooperative and automated vehicles into traffic management

Language:

English

Abstract:

This topic explores strategies for integrating Cooperative and Automated Vehicles (CAVs) into urban transportation systems, with a focus on traffic control optimization and the potential role of automated shuttles in Mobility on Demand (MoD) or city logistics. While CAV technology is rapidly advancing, effective methods for their seamless integration into existing traffic networks remain an open challenge. The research will focus on developing and testing algorithms to optimize traffic flow, reduce congestion, and improve coordination between automated and conventional vehicles. The study will focus on:

- Traffic control optimization for mixed traffic environments, integrating CAVs into urban networks.
- Algorithms for dynamic routing and load balancing, minimizing congestion and improving traffic efficiency.
- Automated shuttle planning, assessing their role in demand-responsive transport or city logistics.
- Simulation-based evaluation using tools such as SUMO or MATSim to quantify the impact of proposed strategies on traffic and sustainability.

References:

Příbyl, O.; Blokpoel, R.; Matowicki, M. Addressing EU climate targets: Reducing CO₂ emissions using cooperative and automated vehicles. Transportation Research Part D: Transport and Environment. 2020, 2020(86), ISSN 1361-9209.

Vreeswijk, J., Příbyl, O., Blokpoel, R., Schindler, J., Rondinonee, M. (2017). Managing automated vehicle at signalized intersections. In Proceedings: International Conference on Intelligent Transport Systems in Theory and Practice, mobil.TUM, Munich.

Blokpoel, R., Lu, M. (2018). Cooperative systems for future automated road transport and traffic management in urban areas. In Proceedings: The 7th Transport Research Arena (TRA), 16-19 April 2018, Vienna. Lu, M. (Ed.) (2019). Cooperative Intelligent Transport Systems: Towards High-Level Automated Driving. IET (Institution of Engineering and Technology), London.

Number of doctoral students: 1

Form of study: full-time

Supervisor: prof. Ing. Ondřej Příbyl, Ph.D. (e-mail contact: pribylo@fd.cvut.cz)
Topic: Digital Twins for Data-Driven Decision-Making in Urban Mobility
Language: English
Abstract: This thesis aims to enhance traffic digital twins as a tool for data-driven policy-making in urban mobility. Building on the existing Evropská Digital Traffic Twin (D3E), the research will develop new functionalities to support municipalities in evaluating the impact of transportation policies. The focus will be on simulating and assessing the effects of interventions such as traffic control strategies, road closures, travel demand shifts, and modal changes, while also integrating algorithms to quantify congestion costs and sustainability metrics (e.g., ESG indicators). The study will focus on: • Extending the capabilities of the D3E digital twin, integrating new data layers for real-time decision support. • Developing evaluation tools to measure the impact of traffic measures (e.g., road closures, demand shifts, modal split changes). • Designing algorithms to calculate the cost of congestion and sustainability impacts using ESG metrics. • Validating the enhanced digital twin through simulations and real-world data, ensuring usability for urban planners and policymakers.
References: - Emmert-Streib, F. Defining a Digital Twin: A Data Science-Based Unification. Mach. Learn. Knowl. Extr. 2023, 5, 1036-1054. https://doi.org/10.3390/make5030054 - Yeon, H., Eom, T., Jang, K. et al. DTUMOS, digital twin for large-scale urban mobility operating system. Sci Rep 13, 5154 (2023). https://doi.org/10.1038/s41598-023-32326-9 - Yingchao You, Chong Chen, Fu Hu, Ying Liu, Ze Ji, Advances of Digital Twins for Predictive Maintenance, Procedia Computer Science, Volume 200, 2022, ISSN 1877-0509, https://doi.org/10.1016/j.procs.2022.01.348 .
Number of doctoral students: 1
Form of study: full-time

Supervisor: prof. Ing. Ondřej Příbyl, Ph.D. (e-mail contact: pribylo@fd.cvut.cz)
Topic: Modeling of activity behavior with respect to mobility in smart cities
Language: English
Abstract: This topic focuses on investigation of the factors influencing travel behavior in smart cities, particularly in the context of emerging mobility concepts such as Mobility on Demand (MoD) and Mobility-as-a-Service (MaaS). The research will focus on developing mathematical models and microscopic simulations to analyze daily activity plans and decision-making processes related to travel choices. The core of the study will center around integrated solutions for sustainable urban mobility, emphasizing demand-responsive transport and its impact on transportation systems. To achieve this, the thesis will: • Develop mathematical models to represent individual travel decision-making processes in smart cities. • Utilize existing microscopic simulation tools (e.g., MATSim, SUMO) to evaluate the effects of mobility policies on travel behavior. • Assess the role of Mobility-as-a-Service (MaaS) and Mobility on Demand (MoD) in shaping transportation networks. • Validate the proposed approach through simulations, measuring the impact of different policy interventions and transportation strategies.
References: Matowicki, M.; Pecherková, P.; Příbyl, O. Project SMART Understanding Mode Choice Decisions of the Czech Population: Models and Results Praha: CESKE VYSOKE UCENI TECHNICKE V PRAZE, 2023. ISBN 978-80-01-07090-1. Maia Pereira, A.; Dingil, A.; Příbyl, O.; Myška, V.; Vorel, J.; Kříž, M. An Advanced Travel Demand Synthesis Process for Creating a MATSim Activity Model: The Case of Ústí nad Labem Applied Sciences. 2022, 12(19), ISSN 2076-3417.
Number of doctoral students: 1
<i>Form of study:</i> full-time