## Master's Thesis

# Platoon Formation using Swarm Intelligence

The ongoing growth of passenger transport results in more road traffic and, therefore, more traffic jams and pollution. Researchers and car manufacturers are trying to improve driving, using Inter-Vehicle Communication (IVC) via Vehicular Ad Hoc Networks (VANETs) or cellular technologies, resulting in trends like Intelligent Transportation Systems (ITSs) or cooperative driving. One of the biggest developments in the field of cooperative driving is Cooperative Adaptive Cruise Control (CACC) or *platooning*, which promises to improve today's driving (e.g., due to higher road utilization, less fuel consumption, enhanced safety).

A typical scenario for platooning is a freeway. Studies about platooning on freeways typically just consider a given platoon for evaluating a certain platooning system or protocol. However, in order to do utilize all of these benefits, vehicles have to get into a platoon first. Therefore, platoon formation, i.e., forming a platoon out of multiple individually driving vehicles, is another important challenge.

We recently studied platoon formation strategies from the perspective of individual cars by optimizing platoon assignments regarding individual capabilities and properties [1]. Simulations using simple heuristics already indicate that these, and the willingness to compromise, have a huge impact on the resulting assignments.

A different approach for platooning might be swarm intelligence [2], where multiple agents perform individual actions and achieve a greater goal. Concepts like distributed opinion building [3] could be applicable for coming up with car-to-platoon assignments. Therefore, the feasibility of swarm intelligence concepts for platoon formation needs to be investigated.

This thesis is in cooperation with Prof. Dr.-Ing. Heiko Hamann[1] from University of Lübeck.

## Goals of the thesis

In this thesis, the feasibility of platoon formation using swarm intelligence concepts should be investigated. As an example, the concept of distributed opinion building [3] can be used. In order to research this question and to successfully achieve the goal of this thesis, you have to complete the following steps:

- Design and implement a formation algorithm, which considers individual properties of cars, using a swarm intelligence approach.
- Conduct a simulation study in order to evaluate the performance of the developed algorithm and compare it to other approaches, e.g., our recent study [1].

## Keywords

Platooning, Platoon Formation, Swarm Intelligence, Vehicular Networking, Network Simulation, C++

[1] J. Heinovski and F. Dressler, "Platoon Formation: Optimized Car to Platoon Assignment Strategies and Protocols," in *10th IEEE Vehicular Networking Conference (VNC 2018)*, O. Altintas, H.-M. Tsai, L. Kate, B. Mate, C.-Y. Wang, and T. Sahin, Eds., Taipei, Taiwan: IEEE, Dec. 2018. DOI: 10.1109/VNC.2018.8628396.

[2] L. Li, R. Hao, W. Ma, X. Qi, and C. Diao, "Swarm Intelligence Based Algorithm for Management of Autonomous Vehicles on Arterials," SAE International, SAE Technical Paper 2018-01-1646, Aug. 2018. DOI: 10.4271/2018-01-1646.

[3] S. Motsch and E. Tadmor, "Heterophilious Dynamics Enhances Consensus," *SIAM Review*, vol. 56, no. 4, pp. 577–621, Nov. 2014. DOI: 10.1137/120901866.

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