TSoS Control Approach-based Traffic Flow Optimization Method by means of a Microscopic Traffic Simulation Model

Master's Thesis of Ugnius Aliubavicius

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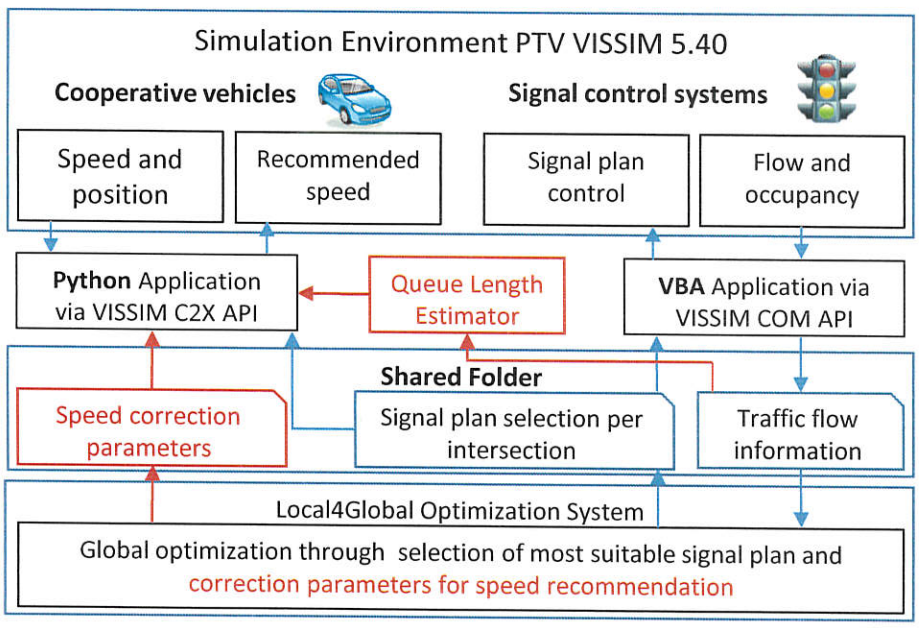


The concept of Technical Systems of Systems (TSoS) with machine learning capabilities is basis of the LOCAL4GLOBAL (L4G) project and this master thesis. A TSoS is composed of specific semi-autonomous constituent systems that are working in local environment, optimizing themselves and together improving overall performance of the global level. Two basic classes of constituent systems are suggested: dynamically signalized traffic junctions and connected vehicles with speed control capabilities. Both systems receive a correction from the L4GCAO global optimizer.

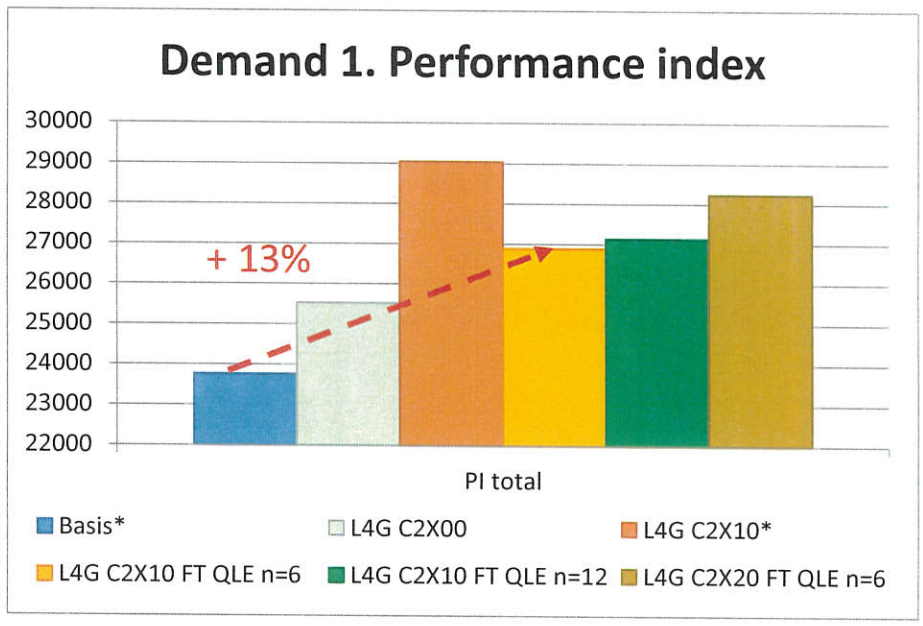
Description of the simulation framework could be found in figure on the left side where red colour refers to the modules implemented during this master thesis. Simulation framework consists of four components – VISSIM 5.40 simulation environment with two constituent system classes, two VISSIM API controlling constituent systems and queue length estimator, shared folder and L4G optimization system.

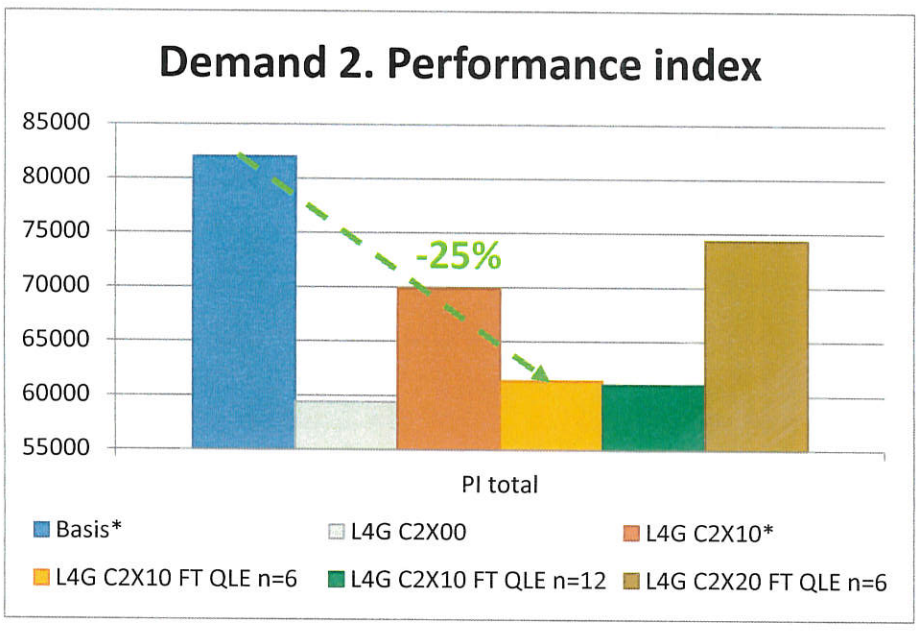
The test bed of L4G traffic use case is a 7 km stretch in north of Munich (Germany). Two traffic demand scenarios have been simulated:

- Demand 1 (off-peak) - 9:30 a.m. to 2:30 .m.;
- Demand 2 (rush-hour) - 3:00 p.m. to 8:00 p.m.

For Demand 1 scenario (figure on the right) fixed signal plan (Basis) shows best performance in terms of performance index (PI) which describes traffic quality in the network considering waiting time and number of stops (lower value reflects better performance). However, in Demand 2 scenario (figure below), L4G strategy decreased PI by 25% compared to the basis scenario.

Introduction of cooperative vehicles (C2X10/C2X20) increased PI compared to scenario without cooperative vehicles (C2X00), however implemented optimisation of speed recommendations, queue length estimator and extension of signal plans library (FT QLE n=6/12) decreased PI compared to the LG4 C2X10* scenario.





Successfully implemented queue length estimator and optimization algorithm for the speed recommendations have improved overall results.

L4G strategy significantly improves performance of the network in rush hour scenario in terms of performance index, travel time, mean network speed and waiting times. Nevertheless, for the off-peak scenario additional adjustments in algorithms of optimisation and speed recommendations are needed before real implementation.

L4G concept has great potential in the future since it is easily scalable and transposable to other test beds without much human effort due to provided "plug & play" concept and adaptability. Machine learning capabilities enhance project potential and show positive trend toward improvements.