Traffic Optimization for Signalized Corridors (TOSCo) Development and Evaluation in VISSIM

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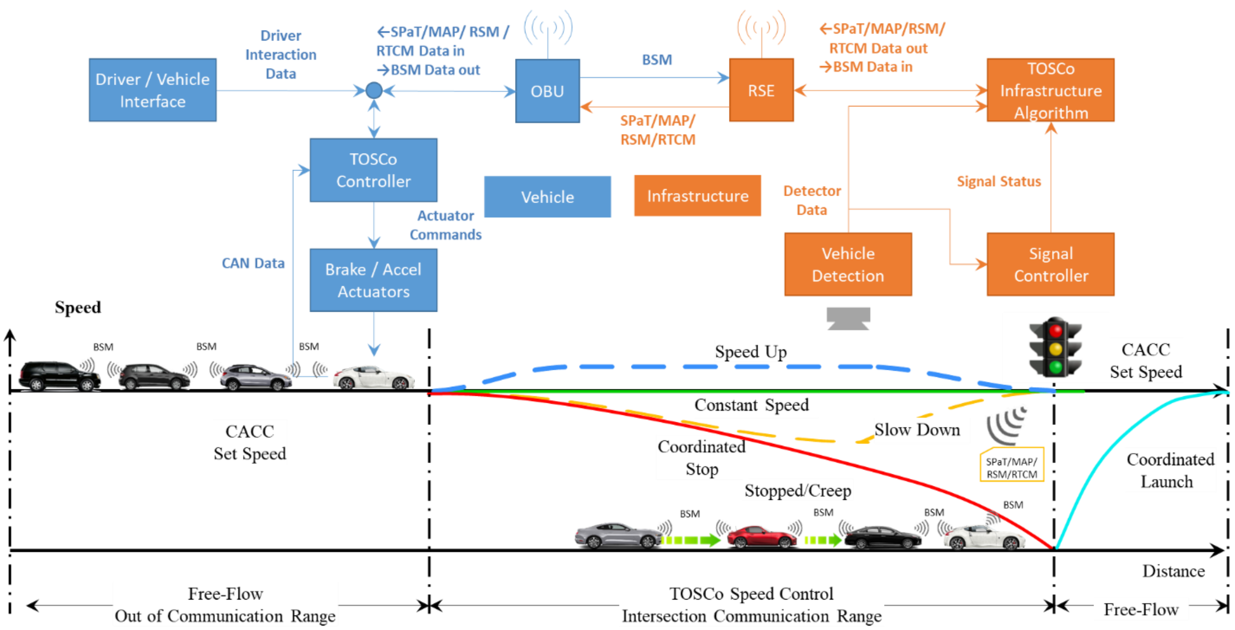
This presentation will describe the simulation environments created using VISSIM for the Traffic Optimization for Signalized Corridors (TOSCo) Small Scale Test and Evaluation Project. The performing agencies for this project are the V2I Consortium of Crash Avoidance Metrics Partners LLC (CAMP), consisting of Ford, General Motors, Honda, Hyundai-Kia Motors, Mazda, Nissan, Subaru, Volkswagen Group of America and Volvo Truck, in conjunction with the University of Michigan Transportation Research Institute (UMTRI), the Texas A&M Transportation Institute (TTI) and the University of California-Riverside (UCR). This material is based upon work supported by the U.S. Department of Transportation under Cooperative Agreement No. DTFH6114H00002. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the Author(s) and do not necessarily reflect the view of the U.S. Department of Transportation.



Source: CAMP

The TOSCo system uses a combination of infrastructure and vehicle-based components and applications along with wireless data communications to position the equipped TOSCo vehicles to pass an intersection during the "green window" at specially designated signalized intersections. TOSCo-equipped intersections continually broadcast information via DSRC messages to nearby vehicles about the intersection geometry, signal status for each phase at the intersection, and the presences of queues at the intersection. As a TOSCo-equipped vehicle enters the DSRC communication range at the intersection it receives each of these messages. The TOSCo vehicle uses this information to plan a speed trajectory that allows it to either pass through the intersection without stopping or stop in a smooth, coordinated fashion to reduce the amount of time stopped at the intersection. TOSCo vehicles that must stop at an intersection will perform a coordinated launch maneuver (meaning that a string of TOSCo vehicles all start moving at the same time) at the start of green. This function allows a string of TOSCo vehicles to clear the intersection with reduced headways compared to manually driven vehicles. The TOSCo vehicle will pass without stopping by either speeding up slightly to the speed limit, maintaining a constant speed, or slowing down slightly to allow the queued vehicles ahead of it to clear the intersection before it arrives. Once the TOSCo vehicles leave communications range of the intersection, they revert to their previous operating mode (ACC or CACC depending where the TOSCo vehicle is in the string).

One significant outcome of this project has been the development of the TOSCo Simulation Environments. The research team utilized two innovative simulation environments to support the development and assessment of the TOSCo functionality. One environment models TOSCo using the tool developed for a CACC Small Scale Test by CAMP[1], referred to as the vehicle level simulation. This tool focuses on representing the data flow within a real vehicle using data from the simulation in high detail to enable TOSCo system development without requiring a vehicle in the field. The vehicle level simulation represents vehicle dynamics (kinematics/inertia), communication delay, radar model, GPS model, and more detailed representations of the conditions for a vehicle in the field. This simulation platform allows prototyping of the TOSCo algorithm within an environment that provided information on the string of vehicles, acceleration and jerk limits, and traffic law adherence. This simulation runs representations of up to five TOSCo vehicles on three separate machines: one operating VISSIM with the DriverModel.dll API and an Infrastructure representation, another computer operating a detailed vehicle model within Matlab/Simulink, and a third operating the TOSCo application as if it were a vehicle in the field. The team tested, verified, and revised the same TOSCo algorithm code that will eventually reside vehicles with the vehicle level model with this environment.

The second simulation environment represents a simplified version of the TOSCo system vehicle and infrastructure logic to quantify the potential intersection, corridor, and network-level benefits of deploying TOSCo in the real-world. This environment is referred to as the traffic level simulation and consists of only two components: VISSIM (with DriverModel.dll and EmissionModel.dll APIs) and an infrastructure representation with both operating on the same computer. This platform gives the team the ability to examine the environmental and mobility benefits associated with operating conditions and scenarios. The simplified TOSCo representation in this environment does not use the radar model, GPS, or the communication delay model. Instead, the information from VISSIM provided in the DriverModel.dll feed into the TOSCo logic. The traffic level simulation enable the evaluation of TOSCo's performance in several hundreds of vehicles with several different market penetration rates of the traffic.

To appeal to the audience of VISSIM users, this presentation will focus on the setup and operations of the two simulation environments after explaining TOSCo at a high level. Most of the presentation will discuss the setup of each environment, with the focus on the traffic level environment. The presentation will also cover the advantages of using simulation for TOSCo, the traffic level simulation results, and lessons learned with respect to both using VISSIM for vehicle system design and the design TOSCo application.

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[1] Meier, J., Abuchaar, O, Abubakr, M., Adla, R., Ali, M., Bitar, G., Ibrahim, U., Kailas, A., Kelkar, P., Kumar, V., Moradi-Pari, E., Parikh, J., Rajab, S., Sakakida, M., Yamamoto, M. and Deering, R. Cooperative Adaptive Cruise Control Small Scale Test – Phase 1 Final Report. CAMP. July 2017.