An Integrated Safety Assessment Tool for Connected and Automated Vehicles

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Our ultimate goal is to integrate sensor, communication, traffic and driver behaviors, vehicle dynamics, and environment conditions in a unison framework to increase safety, reliability, performance, and security of connected and automated vehicles within a mix traffic condition. To achieve this goal, we developed an architecture shown in Figure 1, that leverages existing tools like PTV VISSIM, CarSim, PreScan, MADYMO, and Matlab/Simulink to analyze and simulate multiple aspects of CAVs like dynamics, weather and traffic conditions, and safety and security constraints. This tool that we name CAVSim will enable users to develop and validate techniques to improve traffic congestion, safety, security, and network performance. We will develop CAVSim by integrating the tools such as VISSIM, PreScan, CarSim, Driving Simulator, and Matlab/Simulink, and MADYMO.

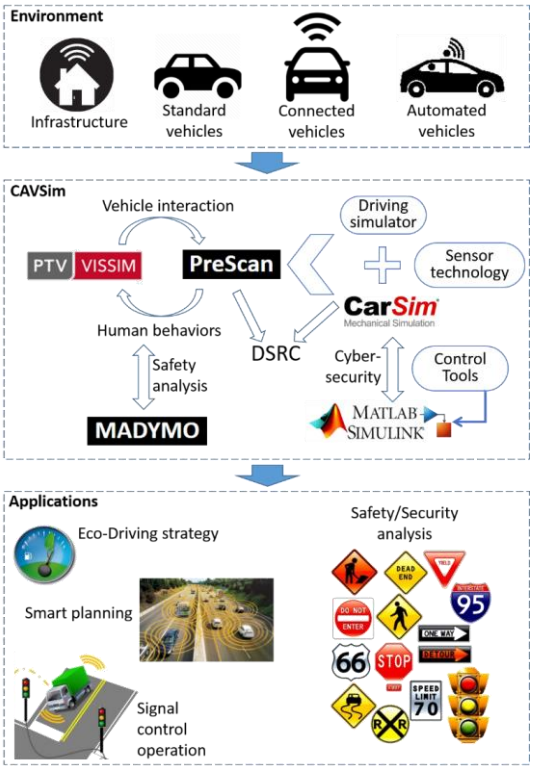

Figure 1. Proposed CAVSim Architecture and Applications

In this presentation, we will present an integrated safety assessment tool that integrated PTV VISSIM, PreScan, Driving Simulator, and MADYMO. Obviously, PTV VISSIM is the core of the proposed tool that properly models transportation system with drivers, traffic control devices, and roadway geometrics. We added PreScan to explicitly consider sensor and communication technology and control algorithms, MADYMO to estimate crash severities, Driving Simulator to allow a human driver interacting with CAVs, and CarSim to include realistic vehicle dynamics. The proposed integration was achieved using C++ program with COM interface and MATLAB/SIMULINK. For example, we integrated VISSIM, PreScan and Driving Simulator as follows: In order to send location information of each vehicle in VISSIM to PreScan (note that the driving simulator is a part of PreScan), a transport layer protocol UDP was used (note that TCP/IP had an issue with VISSIM's Driving Simulator DLL module). The received vehicle information is shown to the human driver at the Driving Simulator using PreScan so that the driver can make decisions (i.e. acceleration, deceleration, lane changing, and so on) based on the traffic environment. The updated information of the human-driven vehicle is sent back to VISSIM through a UDP protocol. With this information, other vehicles in VISSIM interacts with the human driven vehicle. This whole integration process is repeated every time step during the simulation. This integration allows users to consider human-in-the-loop, interaction with human driver and CAVs (to be realized by VISSIM COM interface), and latencies in communications and errors in sensor technologies (available in PreScan). We are currently in the process of integrating our tool with MADYMO and/or surrogate safety assessment model (SSAM) for safety assessment. We will present our integrated tool with several scenarios including safety impacts of CAVs, as well as CAVs and human-driven vehicle. In addition to safety impact, we will present mobility and environmental impacts.