Annual Report 2019

TRANSPORTATION RESEARCH BOARD
JOINT TRAFFIC SIMULATION
SUBCOMMITTEE

AHB45 (1)

SimSub

Chair's Message

SimSub Chair
Dr. Mohammed Hadi
Florida International University

Happy new year to all.

It is an exciting time to be a part of the simulation community as new methods, algorithms, and guidance are developed and implemented to support the planning, design, operations and management of the transportation system. With the increasing need to understand the impacts of transformative technologies on the transportation system, there is a need for significant advancements of simulation modeling research, development, and applications. This past year was a very active year in providing strong basis for these advancements. We will hear at the TRB about the state of the development of the Transportation System Simulation Manual (TSSM) and the role that we can play in future development and application of the TSSM. The TSSM development effort is expected to be an important focus of the simulation modeling community in the coming years and I encourage you to attend the SimSub meeting at the TRB annual meeting to hear more about it. This meeting will also provide an important review of national research efforts on simulation and on many other topics of interest. You can find the agenda of the program in this newsletter.

My sincere thanks to David Hale for preparing this newsletter. The time that he has devoted to this activity in recent years is greatly appreciated. A number of conferences and meetings related to simulation and advanced technology topics are occurring this coming year. Many of them are listed in the newsletter. I want to bring your attention to a workshop organized by our subcommittee, as part of the 2018 TRB annual meeting. Thanks to Jim Sturrock and John Halkias for their help in organizing the workshop. The workshop title is "Data Driven Simulation to Support Decision Making in the 21st Century: Barriers and Potential Benefits." You can find more details about the workshop and other related TRB annual meeting activities in this newsletter and the TRB annual meeting program.

I look forward to seeing you all and to our discussions at the TRB annual meeting.

Sponsor Committees

AHB45:	Traffic Flow Theory
AHB40:	Highway Capacity and Quality of Service
AHB20:	Freeway Operations
AHB25:	Traffic Signal Systems
ADB30:	Transportation Network Modeling
AHB55:	Work Zone Traffic Control
ADC20:	Transportation and Air Quality
AHB35:	Managed Lanes

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SimSub Web Site

Pengfei (Taylor) Li, Webmaster **http://sites.google.com/site/trbcommitteeahb45**

CAV AMS Twinning Activities

BACKGROUND

The European Commission (EC) and the United States Department of Transportation (USDOT FHWA) are sponsoring a twinning initiative to encourage collaboration between projects in Europe and the United States. CoEXist and two related FHWA Projects were paired because of their similar research objectives and project timelines. This agreement is intended to provide a background of the shared research concept and describe objectives of the partnership.

RESEARCH AREAS

Connected and automated vehicle (CAV) technologies offer potentially transformative societal impacts – including significant mobility, safety, and environmental benefits. In order for CAV applications to be deployed – transportation agencies must first be able to effectively and fully quantify the impacts of such deployments, identify which application best addresses their unique transportation problem, and prepare the infrastructure for their deployment. Current analysis, modeling, and simulation (AMS) tools are not well-suited for evaluating CAV applications due to their inability to incorporate vehicle connectivity/communication and automated features. The purpose of CoEXist and FHWA Projects are to develop AMS tools that incorporate CAV technologies, apply AMS tools to several "real-world" case studies, and have these case studies inform the impact of CAV technologies and deployment guidance.

TWINNING INTEREST

These FHWA and EC projects were paired as twinning candidates because they both aim to model CAV technologies in simulation models to deepen the understanding of how these technologies will impact transportation operations. Both project teams are aiming to identify a foundation or framework defining the technology being modeled. In addition, each group intends to expand the developed framework into realistic case studies – and develop new CAV models based on existing/collected data. Collaborative efforts will facilitate the development of more robust products – from each project – as well as open dialog about model and case study consistency.

INDIVIDUAL PROJECT DESCRIPTIONS

European Commission

1. CoEXist – "AV-Ready" Transport Models and Road Infrastructure for Coexistence of Automated and Conventional Vehicles

Federal Highway Administration

1. Development of an AMS Framework for CAV Systems
2. Developing AMS Tools for CAV Applications

US-EU Twinning Partners Meeting at TRB, January 2018

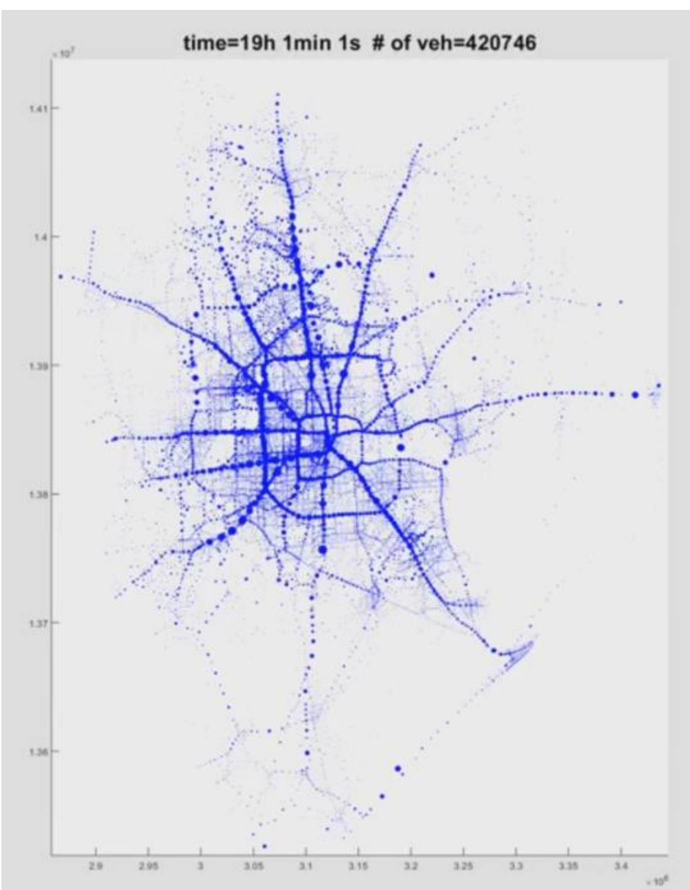
Featured Article #1

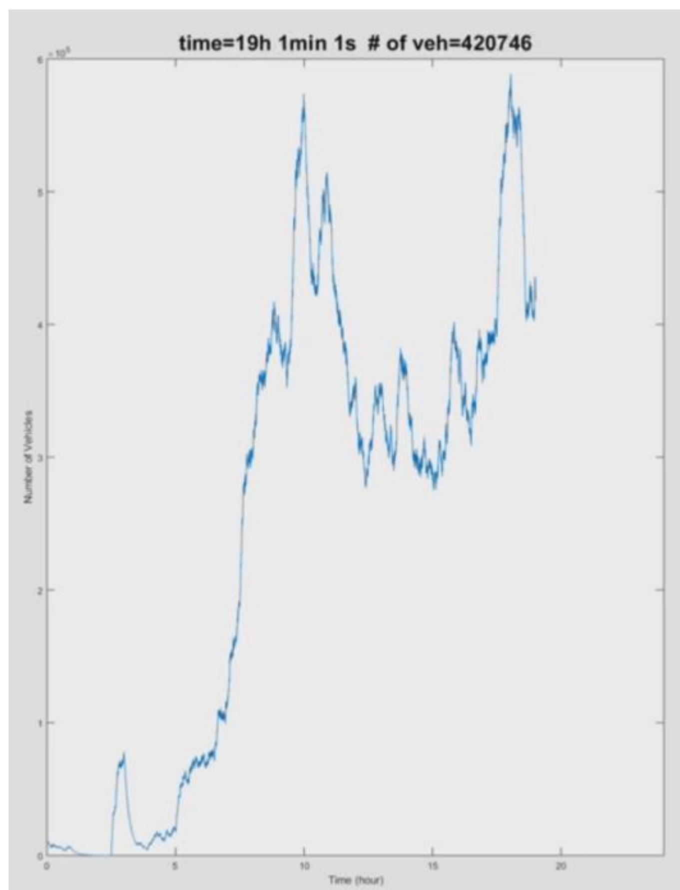
Mega-Scale Agent-Based Simulation Model on High Performance Computing Clusters

by Pengfei (Taylor) Li
Mississippi State University

An interdisciplinary research team led by Taylor Li has developed a discrete-event agent-based simulation with the environment of high-performance-computing (HPC) clusters. Sponsored by Institute of Systems Engineering Research (ISER) at Mississippi State University, a gateway institute between university and US Army Engineer Research and Development Center (ERDC), this research aims at developing a multi-purpose simulation engine and providing support for large-scale to mega-scale simulation and decision making in multiple areas, including transportation, manufacturing, etc.

The prototype passed a scalability test in which 2,800 million vehicles are generated for 24 hours and then simulated sec-by-sec in the capacitated road network. The engine adopts two types of HPC techniques to maximize scalability: (a) collective message passing interface (MPI) for obtaining shortest paths for each individual vehicle and (b) peer-to-peer MPI communication plus multi-threading for traffic loading. The 24-hr animation of Houston TX can be watched at: https://youtu.be/-Kxg3wluEXY





Featured Article #2

Alternative Tools for Simulation of Cooperative Automated Vehicle (CAV) Applications

by Alireza Talebpour
Texas A&M University

AirSim

AirSim is an opensource simulator for autonomous systems. It was initially developed as a simulator to support drones (*1*) by Shah et. al. AirSim adopts a modular design that supports the extensibility. Recently, the Project Road Runner team of the Microsoft has provided the means to simulate the autonomous vehicles (AV) using the AirSim simulator. The main AirSim is built on Unreal Engine (*2*) and also has experimental release on Unity (*3*). The Unreal Engine supports a realistic visual and physical simulation environment.

The main components of the simulator are the environment model, vehicle model, physics engine, sensor models, rendering interface, public API layer, and an interface layer for vehicle firmware. The physics engine enables the AirSim to support the hardware-in-the-loop-capability. AirSim facilitates simulating under different weather conditions such as rain, snow, and fog. Moreover, this simulator can provide the camera, LiDAR, and GPS sensors as well as the other sensory information such as speed and acceleration of the vehicle to support the autonomous driving task. The simulator by default uses five cameras mounted at center, left, right, reverse, and the driver position. The camera data includes the simple RGB image, depth map and semantic segmentation that could be used for the training of different perception models.

AirSim supports both manual control mode and programmable mode. The manual control takes the car control commands such as steering, throttle, brake, and gear from a joystick or alike. At each simulation time step, AirSim provides the state of the vehicle in the form of position, orientation, gear, speed and acceleration that can be used with the programmable control mode. The programmable mode takes the car control commands using the APIs that enable interaction between the car and the user coded control. These APIs provide the vehicle state to and take the car control commands from the user coded control. One of the advantages of the programmable APIs of the AirSim is that they can support multiple coding languages such as C++ and Python. These APIs give the flexibility to model modular pipeline and end-to-end driving models for AV. In addition, the newer version of the AirSim enables multiple vehicle modeling that gives the opportunity to use different control models for AVs and even adding user-defined human-driver models.

AirSim supplies a detailed urban environment with more than 12 km of driving-area with different driving conditions and neighborhoods such as at intersections and semi-urban areas. The AirSim simulator works as a plugin to the Unreal Engine that enables the users to use it on their custom environments based on their need (e.g., rural roadways, and highways). However, creating custom environments require hardcoding environments in Unreal Engine. Moreover, the simulator enables controlling the number of vehicles in the environment as well as their location and orientation which can help to control the vehicular traffic in different directions.

CARLA (Car Learning to Act)

Car Learning to Act (CARLA) (*4*) is an open source simulation engine developed by Dosovitskiy et al. to simulate the AVs in the complex urban environment. CARLA allows simulating various urban layouts with different vehicles, buildings, pedestrians, and bikes. This simulation is a layer over the Unreal Engine 4 (UE4) (*2*) that provides high-quality image rendering and realistic physics. CARLA is a server-client system such that the server runs the simulation based on the clients' responses and renders a new scene. The client API (e.g. AV agent) is implemented in Python and interacts with the server. The connection between the clients and servers are through sockets, the clients receive data from the server and send commands back to the server. For the case of an AV client, the server sends sensory data collected from the simulated environment to the client and receives commands in the form of the steering angle, acceleration, and braking from the client. The server -client setup gives the opportunity to simulate and train different approaches to AV driving including the modular pipelines, and end-to-end driving models via imitation learning or reinforcement learning. At each simulation step, the client is provided with an observation (e.g. sensory data), and the client produces appropriate action (e.g. control commands). The modular pipeline driving models adopt different modules for visual perception, path planning, and control to produce the commands. While the end-to-end driving models map the sensory information directly to driving control commands (e.g. steering, acceleration, and braking). In both AV driving models, the simulator uses a global planner that decides the high-level route of the vehicle through the environment similar to the GPS navigation suits used in personal vehicles.

The CARLA sensor suite supports the camera and ray-cast based LiDAR that can be mounted at different location and orientation on the AV client. Other sensor information such as speed, location (e.g., GPS) and acceleration are also provided to the client. In addition, the CARLA sensor suites produce depth map and semantic segmentation that can be used for the training of different perception models. The CARLA simulator supports different weather conditions and illumination, and the inflow of traffic is controlled by the density of vehicles. The earlier versions of the CARLA use basic non-player logic to navigate and move the non-player vehicles through the simulation environment with respect to the speed limit, lane following, traffic lights, and intersection decision making. However, the new developer version of the CARLA supports the multi-client and multi-agent that give the opportunity to control every vehicle in the simulation. The multi-client developer version could potentially help in adopting different human-driving models. CARLA is designed to simulate the urban environment, however, changing the roadway map is a little challenging. In order to change the roadway setting, the user needs to manually change the simulator's map generator seed until a map with satisfying geometry is generated.

Metamoto's Simulation Platform

Metamoto is a scalable cloud platform to design, develop, test, debug, and validate automated vehicle system (*5*). The software features continuous test and integration discipline, simulation, computer vision, machine learning, standards, and regulations. The Metamoto Inc., is founded in 2016 by a team of veteran entrepreneurs with a remarkable background in software engineering and automated systems. The simulator includes three main components: Director, Designer, and Analyzer (*5*).

In Designer, a generic test scenario consisting of a road geometry, an ego vehicle, pedestrians, signals, and buildings can be created via user interface. Capturing the required variables for a specific test matrix can be done by simply checking the box next to each variable: ego and other vehicle speeds, weather, lighting, road markings, etc. Docker virtual containers and protobuf API's are then used to connect the algorithm to be tested and the simulation scenario. Parameterizing the base scenario using the selected variables, and choosing a testing strategy (e.g., exhaustive, random over parameters, edges only or single case) can be done via a virtual editor in Director with no need for test automation scripting or coding. Everything is accessible through a web-based user interface and the only hardware needed is a computer running on any type of operating system, with a browser. A comprehensive analysis tool is also provided to assess vehicle's performance in specific simulations. Using Analyzer, users can synchronize all of the sensor data streams, vehicle dynamics time and/or signal traces, and log file messages in an interactive playback window, providing the ability to debug AV stack or code performance with a high degree of granularity (*5*).

Millions of runs can be parallelly executes in a single cycle in Metamoto simulator, leading to billions of virtual test miles. The scalability feature of the software enables users to better identify isolated outcomes, performance boundaries and system tolerances (*6*). Users can build their own scenarios inside virtual scenes. Scenarios are executable for a variety of environments (e.g., different levels of traffic demand, road and weather conditions, etc.), hardware parameters (vehicle properties, sensor settings and placement, etc.), and unique edge cases including the behavior of the ego vehicle (*6*).

Using tools like Jenkins and Jira, Metamoto provides the opportunity to insert on-demand simulation into the AV system lifecycle and enables users to do regression analysis, control version, etc., when vehicles, sensors, and/or infrastructures change. The software offers an accurate multi-sensor simulation solution for autonomous vehicles using a variety of sensors including, but not limited to, LiDAR, camera, radar, GPS, ultrasound, and IMU (*5*). In addition, the interoperability feature of the software enables Metomoto to play a supplementary role for other mobility software companies. For example, Metamoto Inc., have recently announced its partnership with Renovo's AWare Automated Mobility Ecosystem, targeting scalable automated system testing, validating, and deployments (*7*).

MathWorks's Driving Scenario Designer

MathWorks's Driving Scenario Designer (*8*) is a MATLAB application that allows for the creation of driving scenarios consisting of roadways and the subjects or "actors" which exist in the environment (i.e. vehicles and pedestrians). The primary purpose of the application is to collect synthetic sensor detections rather than simulating autonomous driving. Vehicles and roads can be placed within the environment by using the application's drag-and-drop interface. Vehicles can be designed to be equipped with two sensor types: cameras and radar detectors. The coverage area of each sensor can be configured individually. The output of the sensors can be exported to MATLAB in order to test sensor fusion or control algorithms. The application does not support hardware-in-the-loop simulation. Vehicles cannot move according to any car-following model. Instead, vehicles (and pedestrians) will move along a predefined series of waypoints at user-defined speeds. The user may either set one constant speed along all the points or set different speeds between pairs of waypoints. The application's interface facilitates simple and quick creation of roadways. The number of lanes, the lane widths, the horizontal banking (superelevation), and the pavement marking styles/colors call all be modified by the user prior to the scenario run time. OpenDRIVE roads and their configurations may be imported. Although intersections can be created, the application does not support adding/importing traffic signs and signals. Furthermore, different levels of inflow cannot be simulated; each vehicle in the scenario needs to be added manually prior to run time.

Udacity's Simulation Platform

Udacity's Unity-based Driving Simulator (*9*) provides an environment which can be customized for the purpose of testing autonomous driving. By default, a single vehicle is provided. This sole vehicle contains two modes of operation: manual and autonomous. While in manual, the user can take full control of the vehicle's steering and acceleration, and this setting is primarily designed for data collection (i.e. images, speed, position). Autonomous mode, on the other hand, is designed to test autonomous vehicle control systems designed by the user. The default sensor type provided by Udacity's is the camera; other sensor types such as lidar/radar can be built in with C# code. Any custom C# code can be added and then utilized as a component of an object within the simulator. Furthermore, ROS bridge can be used to subscribe to external code components designed for various purposes (i.e. lane detection, sign detection, etc.). Although there are no built in car-following models for human drivers, they can be hard-coded into the simulator. Additionally, Udacity's simulator comes with a number of roadway prefabs that can be used to create custom roads with a limited number of configurations. For full flexibility, the Road Architect asset can be imported in order to create roads, pavement markings, traffic signs, and simple traffic signals which abide by standards included in the MUTCD. The simulator cannot simulate different levels of demand/inflow by default. Using custom C# code, however, it is possible to include this feature into the simulator. Overall, significant coding effort is required to develop a fully functional traffic simulation tool using this platform.

PreScan

PreScan (*10*) enables the integration of diverse vehicle models provided by CarSim/TruckSim vehicle dynamics, MATLAB/Simulink, ASM vehicle dynamics of dSPACE, National Instrument/Labview and so on. Furthermore, PreScan can be used to test various sensors by being able to implement them on the available virtual vehicles models. Therefore, users can test necessary sensors for the autonomous cars such as radar, LiDAR, infrared (NIR), camera, ultrasonic, GPS and V2X communication.
PreScan provides hardware-in-the-loop capability. Basically, it offers ECU testing for Advanced Driver Assistance Systems (ADAS). Accordingly, users can flexibly and directly test and evaluate algorithms on real ECUs.

As a member of the MathWorks Connections Program, the PreScan requires MATLAB/Simulink to be installed on the same machine. Consequently, users can design algorithm verify them utilizing MATLAB/Simulink. This is quite powerful feature of PreScan, which makes it more appealing for users who work on various aspects of autonomous driving such as decision-making system, fusing sensor data, and vehicle control.

In terms of the simulation world modelling, PreScan is flexible. Users can easily design the simulation scenarios using PreScan GUI. Users just need to pick the elements of the desing from scenario database. It contains many choices considering many important elements in real life driving such as road sections, infrastructure components, road users, weather conditions and light sources. Particularly, regarding the elements that represent road users, users can choose cars, pedestrians and so on, which have a big impact on testing autonomous cars.
Recently, PreScan and VISSIM offered the capability of creating a two-way connection between the two software. Accordingly, roadway traffic in VISSIM can be translated into to the PreScan environment and PreScan vehicles can interact with the traffic in VISSIM. This capability makes PreScan and VISSIM a favorable choice for automated vehicle simulation.

CarSim

CarSim (*11*) is compatible with many software packages such as MATLAB/Simulink, Labview, C/C++ and so on, and because of that, users can easily automate or extend the vehicle math models provided by CarSim to other platforms. Vehicle dynamic models in CarSim consist of diverse dynamic parts, which includes tire, steering, suspension and so on. Moreover, the vehicle model is quite realistic considering that their parts interact each other. Particularly, four-wheeled vehicles are modelled with over 110 ordinary differential equations. Besides, there are more than 90 ADAS sensors with various types that can be equipped on the vehicle model. Therefore, It provides a lot of flexibility in terms of building the automated vehicle in the simulation environment.

Basically, the CarSim math model is a DLL file and users can run it on many different environments. For example, CarSim models can be represented as blocks in some simulation environments such as MATLAB/Simulink and LabView. Moreover, users can use CarSim with any programming languages if they are capable of loading DLL files and accessing their functions with VS API. For instance, C/C++ can be used to extend or modify the CarSim math models or changing specific parameter values.
CarSim provides hardware-in-the-loop capability. Users can test hardware physically and do simulation in real-time based on the vehicle dynamic model mentioned above. CarSim can work in conjunction with MATLAB/Simulink and Labview to access the models in CarSim and to evaluate the hardware.

CarSim offers a flexible simulation environment. Users can design the roads and reference using segments such as lines, arcs and so on. This can be easi-

Featured Article #2

ly done using the Segment Builder Library. Moreover, users can also create moving objects. The number of moving objects such as vehicles can be up to 200 at most, and their motions and locations can be easily determined by users as constant numbers or any algebraic equations. Accordingly, traffic can be only modeled at a small scale.

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2018 SimSub Awards

Awards committee:
Tomer Toledo, **Kaan Ozbay**, and **Jorge Laval**

Lifetime Achievement Award:
John Halkias (FHWA)
Alex Skabardonis (UC Berkeley)

2018 SimSub Awards

Awards committee:
Tomer Toledo, **Kaan Ozbay**, and **Jorge Laval**

Best Paper Award:

Improving Scalability of Generic Online Calibration for Real-Time Dynamic Traffic Assignment Systems

by Prakash, Seshadri, Antoniou, Pereira, and Ben-Akiva

TRB 2019 Simulation Papers

Quick Scan of TRB 2019 Papers with a Tie-In to Traffic Simulation
by David K. Hale, Leidos Inc.

Total number of papers: 194

Keyword hits
Microsimulation: 43
CV and/or CAV: 20
Signal: 19
Trajectory: 14
Safety and/or crash: 14
Calibration: 13
Car-following: 9
Agent-based: 9
Multimodal: 7
Lane-changing: 6
Learning: 5
Traffic assignment: 5
Shared mobility: 5
Managed lanes: 5

1. FHWA Analysis, Modeling and Simulation for Connected and Automated Vehicles
2. Frontiers in Modeling AVs and Mobility-on-Demand
3. Integrating Autonomous Vehicle Fleer Services in Dynamic Multimodal Network Models
4. Microsim+Deep-RL+Cloud: Disrupting the Fuiture of Mixed Autonomy
5. Simulating Connected and Autonomous Vehicles with Aimsun, Next: Case Studies
6. PTV: Adapting Traffic Simulation Tools for Calibrating and Validating Connected and Automated Vehicles' Models
7. Opportunistic Mapping and Sensor Calibration for Connected and Autonomous Vehicles
8. Data Availability and Needs for Modeling Connected Automated Vehicles
9. Tour-based Mode Choice Model in Activity-based Modelling Framework
10. A System of Shared Autonomous Vehicles for Chicago: Anticipating Impacts at Multiple Stages of Adoption
11. Modeling Travel Behavior with the Advent of Electric and Automated Vehicle Technologies
12. Distributed Robust Connected Automated Car Following Strategy to Stabilize Mixed Traffic
13. Development of a Prototype Shorter-term Decisions Simulator (SDS)
14. Connected Autonomous Vehicles: Capacity Analysis, Trajectory Optimization, and Speed Harmonization
15. Investigation of Lane-Changing Behaviour: A Comparative Study of Connected and Traditional Vehicles
16. Dynamic Pricing and Long-term Planning Models for Managed Lanes with Multiple Entrances and Exits
17. Modeling Route Choice in Public Transport Systems Using Automatic Fare Collection Data
18. Modelling Ground Accessibility to Airports
19. Machine Learning and Information Theory in Travel Behavior Models: A Generative Modelling Approach
20. A Microscopic Agent-based Simulation System for Smart Off-street Parking Facilities
21. From Discrete Choice Models to Deep Neural Network: Tradeoff Between Interpretability and Predictability
22. Evaluating the Rear-end Collision Risks of Mandatory Lane-Changing Behaviors Using Trajectory Data
23. Trajectory-based Identification of Critical Instantaneous Decision Events at Mixed-Flow Signalized Intersections
24. Vehicle-Trajectory-based Real-time Safety Analysis
25. Crash Risk Prediction Model for Expressway Diverging Areas Based on Traffic Conflict Technique and Microscopic Simulation
26. Assessing Rear-end Collision Risk during Driver's Evasive Action Using Vehicle Dynamics and Trajectories
27. Simulation-Optimization Framework to Evaluate a Sustainable First Mile Transit Access Program Using Shared Mobility
28. Validation of MFD-based models with microscopic simulations on real networks: Importance of production hysteresis and trip lengths estimation
29. Assessing Impacts of Predictive Transportation Management over Responsive Action Plans Using Simulation Based Approach

TRB 2019 Simulation Papers

30. Evaluating the Effectiveness of Bundled Connected Automated Vehicle Applications Applied to Freeway Managed Lanes
31. Analysis of the Effects of an HOV Lane on a German Freeway - A Simulation Study with PTV Vissim
32. Development and Application of a Queue Accumulator Model In Toll Road and Managed Lane Modeling
33. Traffic and Revenue Forecast Model for I-95 Phases 1, 2, and 3 Express Lanes in South Florida
34. A Microscopic Simulation Tool for Off-Street Parking Systems
35. A Simulation Study of the Efficiency of Unmarked On-Street Parking and Vehicle Downsizing
36. Incentives for Reduction of Peak-Hour Traffic Congestion: Models, Costs and Optimal Transport
37. Mode Shift Impacts of Optimal Time-Dependent Congestion Pricing in Large Networks: A Simulation-Based Case Study in the Greater Toronto Area
38. Evaluating Operational Efficiency of Freeway Truck Climbing Lane through Microsimulation
39. AR-PED: Augmented Reality Enabled Pedestrian-in-the-Loop Simulation
40. A Framework for Incorporating Human Factors in Microsimulation Using Driving Simulator Observations
41. An Efficient Calibration Methodology of Microsimulation Model for Signalized Intersections Under Heterogeneous and Indiscipline Traffic Environment
42. Distraction effects in driving behavior and traffic flow models
43. How the Responsibility-Sensitive Safety Framework Affects Traffic Flows on a Freeway Microsimulation Scenario
44. Comparing Route Choice Models for Managed Lane Networks with Multiple Entrances and Exits
45. INTEGRATED SAFETY AND OPERATIONAL ANALYSIS OF THE ACCESS DESIGN OF MANAGED TOLL LANES
46. High-Occupancy Vehicle Lanes on the Right: An Alternative Design for Congestion Reduction at Freeway Merge, Diverge, and Weaving Areas
47. Applicability of Microscopic Traffic Simulation to Quantify the Impacts of Continuous Access and Limited Access High Occupancy Vehicle Lanes on a Highly Congested Arterial
48. Comprehensive Transportation and Energy Analysis: A Price Sensitive, Time-Specific Microsimulation of Electric Vehicles
49. Simulation-Based Scenario Analysis on Growth of Medium-Duty and Heavy-Duty Hydrogen Fuel Cell Vehicles and Their Refueling Infrastructure Needs in California
50. Comparison of Empirical Bayes and Propensity Score Methods for Road Safety Evaluation: a Simulation Study
51. Modeling highly unbalanced crash injury severity data by ensemble methods and global sensitivity analysis
52. Alternative Model Structures for Multivariate Crash Frequency Analysis: Comparing Simulation-based Multivariate Model with Copula-based Multivariate Model
53. Fast Calibration for Traffic Microsimulation Using Trajectory Data
54. IMPACT OF CONNECTED VEHICLE TECHNOLOGY ON DRIVER'S MERGING BEHAVIOR AT FREEWAY ON-RAMPS BASED ON DRIVER'S AGE: A MICRO SIMULATION APPROACH
55. Genetic Algorithm-Based Simulation Optimization of the ALINEA Ramp-Metering System: A Case Study in Atlanta
56. Fuzzy Logic-Based Decision Models for Mandatory Lane Changes on Freeways
57. MULTI-OBJECTIVE STOCHASTIC OPTIMIZATION ALGORITHMS TO CALIBRATE MICROSIMULATION MODELS
58. Pedestrian Microsimulation Model for Emergency Evacuation at Ottawa International Airport
59. AN INTEGRATED CELLULAR AUTOMATA APPROACH FOR SPATIAL EVACUATION SIMULATION ON METRO PLATFORM WITH SMOKE SPREADING
60. Vulnerability Assessment during Mass Evacuation: An Integrated Microsimulation-based Evacuation Modeling Approach

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61. Simulation-based Optimization of Emergency Response Considering Rationality of Travelers
62. AUTOMATED VEHICLE SCENARIOS: SIMULATION OF SYSTEM-LEVEL TRAVEL EFFECTS IN THE SAN FRANCISCO BAY AREA
63. Calibration of Microsimulation Car-Following Models for Narrow Freeway Lanes
64. Operational Evaluation of U-Turns at At-Grade Signalized Diamond Interchanges
65. Operating Performance of Diverging Diamond Interchanges
66. Introducing the Super DDI as a Promising Alternative Service Interchange
67. A MICROSIMULATION APPROACH TO ACCESS THE ENVIRONMENTAL IMPACTS OF DIFFERENT RAMP METERING SCENARIOS; A CASE STUDY OF EISENHOWER EXPRESSWAY IN CHICAGO
68. EVALUATING THE ENVIRONMENTAL BENEFITS OF MEDIAN BUS LANES: A MICROSCOPIC SIMULATION APPROACH
69. Design and Simulation-based Evaluation of an Eco-driving Strategy at Signalized Intersections Considering Mixed Traffic
70. COMPARISON OF TRAFFIC SITUATION BASED AND INSTANTANEOUS EMISSION MODELS FOR EMISSION CALCULATION FOR DYNAMIC TRAFFIC MANAGEMENT
71. Comparison of Simulation and Highway Capacity Manual LOS Results for an Off-Street Pedestrian and Bicycle Facility
72. Agent-Based Evacuation Simulation from Subway Train and Platform
73. Study of Impact of Modal Shift of Private Vehicles towards Public Transport using Microscopic Simulation Model: A Case Study of Three Metropolitan Cities in India
74. Integrated Modeling for SMART Mobility Analysis
75. SIMULATION ANALYSIS OF THE ENERGY AND MOBILITY IMPACTS OF PRIVATELY OWNED FULLY AUTONOMOUS VEHICLES
76. Modelling the effects of stress in the car-following model using driving simulator and physiological sensor data
77. Development of Car-Following Model Considering Driver's Eye Glance Behavior to Simulate Hazardous Situation
78. Microscopic Simulation Model Study of Vehicle Non-strict Priority Give Way Behavior at Intersection
79. Truck CACC Implementation and Test to Verify Control Performance
80. Optimizing Freeway Merge Operations under Conventional and Automated Vehicle Traffic
81. Platoon-Based Trajectory Optimization for Connected and Automated Vehicles at a Signalized Intersection
82. Traffic Signal Cooperation for Enhancing Cooperative Adaptive Cruise Control (CACC) Vehicle String Operations
83. Dynamic Cooperative Speed Optimization at Signalized Arterials with Various Platoons
84. Cooperative Lane Control Application for Connected and Automated Vehicles
85. Impact on Car Following Behavior of a Forward Collision Warning System with Headway Monitoring
86. Simulation-Based Optimization of Transit Priority Signal Plans for a Network of Adjacent Intersections
87. Exploring the Impact of Connected and Autonomous Vehicles on Freeway Capacity Using Microscopic Traffic Simulation
88. Comparing Alternatives of a 2+1 Highway with Two-lane Highways through Simulation
89. Development and Calibration of VISSIM Models for Rural Freeway Lane Closures: A Novel Approach to the Modification of Key Parameters
90. Estimating Passenger Car Equivalent Using the 2016 HCM PCE Methodology on Four-Lane Level Freeway Segments in Western U.S.
91. Assessment of Travel Delay, Value-of-Time and Potential Safety Impacts of Truck Route Diversion using VISSIM Micro-Simulation Model
92. Controlled Deterministic Microsimulation Modelling: Expected Value Calculation of Development Events in Alberta
93. Demand Calibration of Multimodal Microscopic Traffic Simulation Using W-DSPSA
94. Methods to Obtain Representative Car-Following Model Parameters from Trajectory-Level Data for Use in Microsimulation

TRB 2019 Simulation Papers

95. Traffic Microsimulation for Flexible Utilization of Urban Roadways
96. Towards the Development of Weather-Dependent Microsimulation Models
97. MFC Free-Flow Model: Introducing Vehicle Dynamics in Microsimulation
98. A Simulation-based Study of Right-Turn Deceleration Lane for Operational Impacts on Multimodal Users at Signalized Intersections
99. Characterization of Traffic Operation on 2+1 Roads Using Microsimulation with Field Data
100. Using Field and Simulation Data to Assess Passing Zone Behavior on Rural Two-Lane Highways
101. Modeling Wrong-Way Driving Entries at Limited Access Facility Exit Ramps in Florida
102. Benefits and Risks of Truck Platooning on Freeway Operations near Entrance Ramp
103. Optimal Lane Changing Assistant at Vehicle Incidents with Connected Vehicles
104. Integrated Traffic Control for Freeways Using Variable Speed Limits and Lane Change Control Actions
105. Ensemble Model to Estimate Incident Clearance Durations using Sequential Partitioning Process and Robust Regression
106. Effect of lane-changing management on operational efficiency at on-ramp and off-ramp pair areas based on cellular automaton model
107. Identifying Optimal Traffic Operation Strategy Responses to Incident By Using Simulation-Based Optimization Model
108. Defining Maximum Information Load of Graphic Route Information Panels at Motorway Junctions
109. Extracting Contribution of On-ramps Traffic to Freeway Bottlenecks with Vehicle Trajectory Data and Applying to Coordinated Ramp Metering
110. Database Development and Model Re-Calibration for Quantification of Impacts of Freeway Incidents: A Case Study of Metropolitan Las Vegas Using Fast Freeway Data
111. Traffic State Estimation as a Complement to Stationary Detectors in Variable Speed Limit Systems
112. Evaluation of Different Freeway Merging Strategies in a Fully Autonomous Vehicle Environment
113. Towards Vision-based Ramp Metering via Deep Reinforcement Learning
114. Using Dynamic Vehicle Routing Model to Dispatch Emergency Response Teams for Freeway Incidents
115. Cooperative Lane Changing Strategies to Improve Traffic Operation and Safety Near Freeway Off-Ramps in a Connected and Automated Vehicles Environment
116. Improving Variable Speed Limit Control Strategy Using Microscopic Traffic-Flow Data
117. Stochastic Control: Theory and Application to Mainline Metering
118. Effectiveness of Treatments to Reduce Congestion at Level Crossings: A Traffic Simulation Evaluation
119. Modelling Bus Operations in Arterial Roads
120. Impact of Transit Signal Priority on Isolated Intersection Operations: A Microscopic Simulation Evaluation
121. Distributed Microscopic Traffic Simulation with Human-in-the-Loop Enabled by Virtual Reality Technologies
122. Left Turn Crash Risk Analysis: Development to a Microsimulation Modeling Approach
123. An Efficient Simulation Framework for Estimating Work-Zone Impacts
124. Trajectory-data-based Evaluation of the Green Time Utilization for Pre-timed Traffic Signal
125. Continuous Updating of Traffic Signal Timing Plans Using Bluetooth and Wifi Data
126. Signal Retiming Based on Comprehensive Field Data Analysis and High-Fidelity Simulation Modeling
127. Trajectory Analytics: Application to Traffic Signal System Performance Assessment
128. A stochastic LWR model with heterogeneous time gaps: Theory, Applications and Simulations
129. A Critical Evaluation of the Next Generation Simulation (NGSIM) Vehicle Trajectory Dataset
130. Evaluating the impacts of start-up and clearance behaviors in a signalized network: A network fundamental diagram approach
131. Flow exchanges in multi-trip MFD-based systems: A validation study against microscopic

simulation
132. A Multidimensional Rubric for Calibrating and Validating Car-Following Models
133. A Macroscopic Traffic Flow Model for the Highway Work Zone
134. Simulation of Autonomous Vehicles Based on Wiedemann's Car Following Model in PTV Vissim
135. Modeling the Heterogeneous Traffic Flow of the Urban Signalized Intersection with the Straddling Work Zone
136. Development of an Adaptive Automated Controller for Platoon Merging Using a Simulation-Based Approach
137. On Development of State-Based Fundamental Diagram for Signalized Intersection using Connected Vehicle Trajectory
138. The LWR model with a stochastic speed-density relation
139. Evaluating Safety with Automated Vehicles at Signalized Intersections: Application of Adaptive Cruise Control in Mixed Traffic
140. Predictive Speed Harmonization in a Connected Environment: A Machine Learning Approach
141. DEVELOPMENT OF A MULTIMODAL MICROSIMULATION-BASED EVACUATION MODEL
142. A Dynamic Transit Vehicle Routing System in Emergency Evacuation
143. Understanding the Multimodal Evacuation Behavior for a Near-field Tsunami
144. A SIMULATION-BASED MULTI-MODAL EMERGENCY EVACUATION MODEL CONSIDERING SHARED BICYCLES FOR URBAN RAIL TRANSIT BREAKDOWNS
145. A CONTROL APPROACH TO MITIGATE CYBERATTACKS ON A CONNECTED VEHICLE PLATOON USING AN IMPROVED INTELLIGENT DRIVER MODEL
146. TRAJECTORY-BASED HIERARCHICAL DEFENSE MODEL TO DETECT CYBER-ATTACKS ON TRANSPORTATION INFRASTRUCTURE
147. Collision-Inclusive Microsimulation Framework for Assessing Silence-based Pseudonym Change Schemes
148. Modeling and simulation of cascading failures in transportation systems during hurricane evacuations
149. Prototype Microsimulation Modeling of Vehicle Type Choice within the iTLE Urban Systems Model
150. Modeling and Simulation of Activity Participation, Time Allocation and Shared Travel Choices
151. SIMULATING A RICH RIDE-SHARE MOBILITY SERVICE USING AGENT-BASED MODELS
152. Behavioral Modeling of On-Demand Mobility Services: General Framework and Application to Sustainable Travel Incentives
153. Incorporating the Mobility as a Service Concept into Transport Modelling and Simulation Frameworks
154. Privately Owned Autonomous Vehicle Optimization Model Development and Integration with ABM-DTA Framework
155. Route Choice Behavior Analysis: An Agent-based Simulation Perspective
156. Traffic Oscillation Using a Stochastic Lagrangian Dynamics: Simulation and Mitigation via Control of Autonomous Vehicles
157. A Stochastic Collocation Method for Uncertainty Quantification and Calibration of Microscopic Traffic Simulation Models
158. Roundabout safety performances from micro-simulation considering autonomous vehicles operations
159. Evaluation of Dedicated Lanes for Automated vehicles at Roundabouts with Various Flow Patterns
160. A Rail Transit Simulation System for Multi-modal Eco-Routing Applications
161. Modeling and Simulation of Urban Rail Transit Station Distribution Service Network based on Any Logic
162. Experimental Design for Measuring Operational Performance of Truck Parking Terminal Using Simulation Technique
163. Toward agent-based microsimulation of cyclist following behavior: Estimation of reward function parameters using inverse reinforcement learning
164. Pairing discrete mode choice models and agent-based transport simulation with MATSim

TRB 2019 Simulation Papers

165. Bayesian Optimization for Transportation Simulators
166. Microscopic Travel Demand Modeling: Using the Agility of Agent-Based Modeling Without the Complexity of Activity-Based Models
167. Calibrating activity-based travel demand model systems via microsimulation
168. Integrating Microsimulation Models of Short Distance and Long Distant Trips for Statewide Applications
169. Regional Microsimulation as a Tool for Improving Project Evaluation and Cutting the Costs of Microsimulation Studies
170. Capacity Analysis and Cooperative Lane-changing for Connected and Automated Vehicles: an Entropy-based Assessment Method
171. Analyzing Simulation-Based Active Traffic Management Impact on Large-Scale Regional Network
172. Safety and Operational Impacts of Integrated Variable Speed Limit with Dynamic Hard Shoulder Running
173. Agent-Based Simulation Approach for Evaluating VMS-Based ATIS Effects on Urban Road Network Performance
174. Evaluating the Hero Ramp-Metering Algorithm Using San Diego's Integrated Corridor Management System Model
175. Simulation Framework for Cooperative Adaptive Cruise Control With Empirical DSRC Module
176. Ramp Merging: Effects of Mixed Traffic Users and Cooperative Merging
177. A dynamic traffic assignment framework for MFD multi-regional models
178. Mixed Traffic of Connected and Autonomous Vehicles and Human-Driven Vehicles: Traffic Evolution and Control Using Spring-Mass-Damper System
179. Investigating Heterogeneity in Car-following Behavior due to Driving Style and Lead Vehicle Type: Implications for the Wiedemann Model
180. A Sub-Microscopic Traffic Flow Simulation Framework: Mathematical Formulation and Implementation Prototype
181. Multi-objective Calibration of Traffic Flow and Safety for Microscopic Highway Simulation
182. ECONOMIC COMPARISON BETWEEN VEHICLE-TO-VEHICLE (V2V) AND VEHICLE-TO-INFRASTRUCTURE (V2I) BASED ON MICROSCOPIC SIMULATIONS
183. Cooperative Traffic Signal and Perimeter Control in Semi-Connected Urban-Street Networks
184. Simulation-based User Equilibrium: Improving the Fixed Point Solution Methods
185. Individualized Gap-Based Convergence in an Agent-Based Dynamic Traffic Assignment Model Using an Information Mixing Approach for Time-Dependent Travel Times
186. Real-Time Traffic Flow Pattern Matching to Improve Predictive Performance of Online Simulation-Based Dynamic Traffic Assignment
187. Inefficient Link Detection Using Traffic Assignment Models
188. Data-driven Mesoscopic Network Modeling With Cars and Trucks: A Case Study in Pittsburgh
189. Energy and Mobility Impacts of System Optimal Dynamic Traffic Assignment for a Mixed Traffic of Legacy and Autonomous Vehicles
190. Transit Route Origin-Destination Matrix Estimation Using Compressed Sensing
191. Efficient Metamodel Framework for Nonlinear OD Matrix Estimation Problem
192. Day-to-Day Learning Framework for Online Origin-Destination Demand Estimation and Network State Prediction
193. Introduction to Autonomie
194. Introduction to FASTSim

2019 Upcoming Events

Road Safety & Simulation 2019 Conference

The Road Safety and Simulation (RSS) conference series was established in Rome in 2007 and, since then, has provided a bi-annual platform for researchers and professionals from various disciplines to share expertise and the latest insights in the field of road safety and simulation. RSS2019 will be held 14-17 October 2019 in Iowa City, Iowa, USA. Iowa City and the University of Iowa are home to some of the most advanced transportation safety simulators in the world, all of which are participating in RSS2019. Some of these simulation centers and laboratories include: National Advanced Driving Simulator, Hank Virtual Environments Laboratory (bicycle and pedestrian), Visual Intelligence Laboratory, Operator Performance Laboratory (flight), ATV, and Virtual Soldier.

Call for Abstracts:
We welcome abstracts on any of the conference topics that present original research not published or presented prior to the RSS2019 conference. Abstracts are due by 1 February 2019. Abstracts are limited to 1 page and should follow the RSS2019 abstract template format.

Submitted abstracts will be reviewed by the Technical and Scientific Committee. Individual abstracts will receive at least two reviews. Abstract review criteria will include:

- Relevance to RSS2019 audience and topics
- Sufficient description of research for review decision

Conference Theme:
Transformations in Transportation
Technology is transforming transportation at an accelerated rate, introducing radical shifts in the roles of all roadway users. Increasing levels of automation, connected vehicles, and roads users connected through cell phone applications and other media devices are just a few examples of developments (or changes) on the horizon (that are becoming realities).

Conference topics include, but are not limited to:

- *Automated Vehicles Technology* - Road users' responses to, interactions with, and perceptions of automated vehicles, augmented reality, and in-vehicle safety systems
- *Connected Vehicles Technology* - User responses to, interactions with, and perceptions of connected vehicles technology (e.g., V2V, V2P, I2B)
- *Vulnerable Road Users* - Interactions between types of road users and risk factors for collisions with vehicles (e.g., transportation workers, bicyclists, children, and the elderly)
- *Roadway Infrastructure Design* - Safety of drivers', bicyclists', and pedestrians' interactions with roadway infrastructure designs
- *Distributed Simulation Technology* - Understanding real-time traffic conflicts between drivers, bicyclists, and pedestrians through connected simulation

Papers:
Abstract authors determined to be of interest and high quality will be invited to submit a full paper for presentation at the conference. Following abstract acceptance, full papers should be submitted following the RSS2019 paper template format. Full papers are due 1 May 2019.

Please note that full papers must include research results in order to be considered for paper review. On-going studies that present preliminary results at this stage, but can guarantee to present the full results by the conference date, will also be considered for paper review.

Full paper submissions will be peer reviewed by the Technical and Scientific Committee. Review assignments will be based on area of expertise. Each paper will be assigned to three reviewers who will provide feedback on the paper content and recommendations on paper acceptance. Accepted papers will be selected either for oral presentation or poster presentation. Review criteria include:

- Paper structure
- Research methodology
- Originality
- Validity of results
- Scientific contribution

Paper authors will be asked to revise papers based on reviewer comments and submit a final paper for inclusion in the conference proceedings. During submission, authors have various options regarding inclusion in conference proceedings and consideration for special issues.

Deadlines:

Abstracts are due by 1 February 2019

Notification of abstract acceptance is 1 March 2019

Full papers are due 1 May 2019

Notification of paper acceptance is 1 July 2019

Final paper and confirmation to present is 15 August 2019

More details on RSS2019 and templates can be found at www.rss2019.org.

2019 Upcoming Events

The 10th International Conference on Ambient Systems, Networks and Technologies (ANT-2019)

The 8th International Workshop on Agent-based Mobility, Traffic and Transportation Models, Methodologies and Applications (ABMTRANS'19)

http://cs-conferences.acadiau.ca/ant-19/workshop_approved
http://www.abmtrans.eu/

ABMTRANS 2019 provides an international forum on the latest technologies and research in the field of traffic and transportation modeling using an agent-based approach.

ABMTRANS 2019 will be held in Leuven, Belgium (April 29-May 2, 2019) in conjunction with The 10th International Conference on Ambient Systems, Networks and Technologies (ANT-2019).

Transportation Research Institute (IMOB)
Hasselt University
Wetenschapspark 5 bus 6
B-3590 Diepenbeek, Belgium

ELSEVIER

imob TRANSPORTATION RESEARCH INSTITUTE UHASSELT

2019 Upcoming Events

ANT-2019 - Modeling and Simulation in Transportation Sciences

The 10th International Conference on Ambient Systems, Networks and Technologies (ANT-2019)

Track on Modeling and Simulation in Transportation Science

http://cs-conferences.acadiau.ca/ant-19/

Leuven, Belgium (April 29—May 2, 2019)

ANT-2019 is a leading international conference for researchers and industry practitioners to share their new ideas, original research results and practical development experiences from all Ambient Systems, Networks and Technologies related areas.

ANT-2019 will be held in conjunction with the Second International Conference on Emerging Data and Industry [EDI40).

ANT 2019 will be held in Leuven, Belgium (April 29— May 2, 2018).

Transportation Research Institute (IMOB)
Hasselt University
Wetenschapspark 5 bus 6
B-3590 Diepenbeek, Belgium

January 2018 SimSub Meeting

Transportation Research Board Annual Meeting
Monday, January 8th, 2018, 7:30-9:30PM
Marriott Marquis Ballroom Salon 10 (M2)

Introductions – **Mohammed Hadi**
Sponsoring Committee Representative Remarks – attending chairs or liaisons
Task Group Reports
- Research Needs and Resources Task Group
- Calibration, Verification and Validation Task Group – **Ray Benekohal**
- Awards – **Kaan Ozbay**
- SimSub Reports – **David Hale**
- Agent-Based Simulation Task Group – **Monty Abbas**
- Joint SimSub and SimCap task group – **Sanhita Lahiri** and **David Petrucci**
- Safety modeling task group – **David Petrucci**
- Liaison and Outreach
- Annual Workshop Report –**Jim Sturrock**

Transportation System Simulation Manual (TSSM) development effort update – **George List**
FHWA Work Zone/Driver Model Software - **James Colyar**
Other FHWA Programs and Activities – **John Halkias** and **Jim Sturrock**
SimSub website and Google Group Open Discussion – **Aleks Stevanovic**
Freight Modeling – **Mihalis Golias** and **Evangelos Kaisar**
Potential for new sponsoring committees (ITS and Freight)
New Business
- Summer meetings
- 2019 Annual Workshop Planning
- Other Business

Closing