

Volunteer Network of Professionals Working Together to Support, Promote, and Improve Best Practices in the Application of Traffic Simulation and Capacity Analysis

JOINTLY HOSTED BY WTS-GREATER BATON ROUGE CHAPTER



Advancing women Advancing transportation > Greater Baton Rouge

#### 10/21/2021 Educational Meeting #10

# **Meeting Agenda**



# Simulation in the '00s – Continued Improvements and Growth

Wrap-Up

# SimCap Louisiana

#### 3

#### Mission

 <u>Volunteer</u> network of professionals sharing experiences and promoting best practices <u>in the application of traffic</u> <u>simulation and capacity analysis tool/methods</u>

#### Goals

- <u>Provide a forum</u> for the meaningful exchange of ideas, research, questions, and trends;
- <u>Serve as a resource</u> for practitioners and organizations by sharking experiences and developing guidance and best practices; and
- <u>Advocate</u> for consistently, reliability, and advances to the current state of the practice



# SimCap Chapters

Canada Active chapters Interested chapters 0 0 30 Inactive chapters Hawaii Alaska

TRAFFIC ENGINEERING COUNCIL

# **ITE SimCap Committee**

- Held session at 2021 ITE Annual Meeting (Jul. 28)
  - Traffic Analysis, Modeling, and Simulation Cornucopia
- Held joint meeting with SimSub (Aug. 4)
  - SimCap/SimSub updates, vendor presentations
- Upcoming joint meeting in Fall
  - Presenters needed!



# **TRB Standing Committee on Traffic Simulation**

- Held 2021 ACP80 Summer Meeting (Sept. 15-16)
  - Updates, discussion on scoping, data, calibration, model outputs, TSSM
- Held NOCoE webinar (Oct. 7)
  - The Role and Benefit of Traffic Simulation in TSMO
- Meetings at 2022 TRB Annual Meeting (Jan. 11)
  - ACP80 Committee: 8:00 9:30a EST
  - ACP80 Lectern: 10:30 12:00p EST
  - SimSub: 6:00 7:30p EST



# Local Updates

- FHWA Louisiana Division Office
- LaDOTD
- Louisiana MPOs/Planning Commissions
- Other





# **Contact Information**

8

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**Karl Wunderlich** 





John Halkias



#### Simulation in the '00s – Continued Improvements and Growth

# Traffic Simulation in the 2000s: Impact of the Next Generation Simulation (NGSIM) Program



Karl Wunderlich, Ph.D. – Noblis John Halkias, Ph.D – FHWA (retired)

21 October 2021

# **NGSIM Background**

- NGSIM = Next Generation Simulation
- FHWA/USDOT Program (2001-2008) addressing fundamental issues in the quality of traffic simulation
  - FHWA Office of Operations and Office of Operations R&D
  - USDOT ITS JPO
- In the 2000s, the NGSIM program marked a fundamental change in federal role in traffic simulation
- In the 2010s/2020s, NSGIM program still relevant because of the long-standing impact of the vehicle trajectory data sets collected and shared



### NGSIM Program Changes FHWA Role in Simulation

- What motivated NGSIM?
- New Role for FHWA:
  - Do not compete with private sector software development market - instead, act as *market facilitator*
  - Provide open, freely distributed products to benefit entire traffic community – users, vendors, researchers
- Influence and stimulate the commercial modeling market
- Develop a core of driver behavior algorithms
  - Open source for free public use
  - Supporting documentation and validation data
- Collect new data sets to support algorithm development



# **NGSIM Program Goals**

- Primary goal of NGSIM:
  - Improve simulation tools for <u>better decision-making</u>
- Key question:
  - How does NGSIM lead to better decision-making?





# **Growing Demand for Increasingly Complex Traffic Simulation Analyses**

- Transportation decisions are becoming increasingly complex
  - Congestion is increasingly widespread and intense Recurrent sources (e.g., bottlenecks) Non-recurrent sources (e.g., work zones, crashes)
  - Innovative solutions are being considered (HOV/HOT lanes, congestion pricing, ITS, multi-modal, complex geometrics)
- Simulation growing in popularity BUT widespread recognition that contemporary tools had fundamental issues in complex networks
  - Particularly with respect to <u>congestion dynamics</u> and representing <u>new innovative technologies/solutions</u>



## Pre-NGSIM Simulation Market: Fundamental Flaws Not Addressed





### **NGSIM Algorithm Prioritization**

#### Rank Most Critical Scenarios

- **1** Lane selection on arterials
- 2 Oversaturated freeways
- 3 Freeway lane distribution
- 4 Weaving sections
- 5 2-way left hand turn lanes
- 6 Response to VMS
- 7 Pedestrians
- 8 Heavy vehicles
- 9 Work zone behavior
- 10 Effects of incidents
- **11 Freeway interchanges**
- 12 Urban grid
- 13 Roundabouts
- 14 Freeway geometry
- **15 Transit operations**
- 16 Unsafe maneuvers
- 17 Uncontrolled movements
- 18 HOV lane usage
- **19 Illegal Maneuvers**
- 20 Stop line behavior

#### March 2003 Stakeholder Workshop

- 35+ critical scenarios identified by users where current tools are deficient
- Poor accuracy under congested conditions is a pervasive concern

#### Current NGSIM efforts focus on top 4 critical scenarios



## Post-NGSIM Simulation Market: Enhanced Tools, Better Decision Support





#### **NGSIM Pathway to Success**





### **NGSIM Data Sets**

NGSIM data are high-value vehicle trajectory data

- Near 100% of all vehicle position traced at 0.1 sec intervals
- Detailed lane position and disposition to other vehicles
- Expensive to collect, few non-NGSIM data sets exist
- Trajectory data are the key required data for micro-level simulation development and validation





### Freeway Dataset: I-80 in San Francisco

- 12-lane freeway with HOV lane
- 0.5 KM of freeway weaving/merging section
- Commuter traffic
- Collected:
  - NB and SB
  - 5 hours in each of AM and PM peak periods
- Processed:
  - NB PM 45 minutes
  - At congestion and transition





### Freeway Dataset: US 101 in Los Angeles

- I0-lane freeway
- 0.64 KM of freeway weaving/merging section
- Next to Universal Studios
- Commuter and tourist traffic
- Collected:
  - NB: 7 hours in PM peak period
  - SB: 5 hours in each of AM and PM peak periods
- Processed:
  - SB AM 45 minutes (at congestion and transition)





### Arterial Dataset: Lankershim Blvd. in Los Angeles

- 10-lane arterial
- 0.5 KM of arterial section with 4 signalized intersections
- Collected in June 2005:
  - 5 hours in each of AM and PM peak periods
- Data processing completed Feb. 2006





### **Dataset Contents**

- 45 minutes of vehicle trajectories
  - Near 100% of vehicles every 1/10 seconds

#### Contents

- Vehicle trajectory data
- Raw and processed video
- Aerial orthorectified photos
- CAD diagram and GIS files
- Detector data
- Signal timings and signs
- Weather information
- Open source license



#### **Example of NGSIM Program Impact:** Freeway Lane Selection Algorithm

- Algorithm Development
  - Developed by MIT and validated in MITSIMLab
  - Introduces concept of target lanes selected by freeway drivers
  - Algorithm is freely available at NGSIM website 200+ downloads since January 2005
  - MITSIMLab is available with open-source license to facilitate independent verification/validation of developed algorithm

#### Tested/validated in commercial simulation models

- Collaborative effort with three commercial simulation vendors (Aimsun, Paramics, Vissim)
- Cube DynaSim and TransModeler have also tested in their commercial models



### HOV/HOT Modeling Hampered by Inability to Address Complex Lane Selection Issue

Inability to model realistic HOV/HOT lane utilization could result in faulty decision-making:

#### **Modeling Inaccuracy**

 Underutilization of HOV/HOT lanes

#### **Faulty Decisions**

- Not recommending HOV/HOT lanes when needed
- Inappropriate HOV/HOT policies
- Improper pricing of HOT lanes

- Simulated drivers act unrealistically
  - Get in the wrong lane oblivious to upcoming congestion
  - Unrealistically wild maneuvers to change lanes over short stretches

- Inappropriate merging/ weaving design (auxiliary lanes, accel/decel lanes, ramp meter)
- Over-design freeway at false bottleneck locations



### Software Vendors Implementing the NGSIM FLS Algorithm

- MITSimLab: Errors in mean speed reduced by 20-50%
- Vissim: HOV modeling is significantly improved
- Aimsun: FLS algorithm compares favorably against Aimsun's trial-and-error process
- Paramics: FLS algorithm works under a wide range of scenarios & achieves its goal of encouraging drivers to consider all instead of only adjacent lanes
- Other commercial vendors implemented the FLS algorithm in their commercial simulation model (Cube, TransModeler, others)

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### **Additional NGSIM Algorithms**

- Cooperative/forced freeway merging
  - Explicitly consider cooperation and competition in merging at congested freeway merging and weaving areas

#### Arterial lane selection

 Consider both pre-emptive/tactical lane positioning behaviors and more aggressive overtaking behaviors on congested arterial corridors

#### Oversaturated freeway flow

 Focus on car-following and lane-changing behaviors during congested, stop-and-go conditions



### Summary: NGSIM and Better Decision Making

- NGSIM has improving transportation decisionmaking
  - Fundamentally improving tools used in decision support
  - Speeding the incorporation of innovation into tools
  - Providing the necessary data to develop algorithms that solve long-standing issues
  - Establishing a long-term vision for data preservation and market facilitation



#### Decades Later: NGSIM Data Sets Continue to Generate Value

- 500+ TRB papers, conference presentations, and other documents citing NGSIM data
- ITS Data Hub: NGSIM most viewed data in last 30 days
  - still downloaded more than 140 times per month



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USDOT ITS Data Hub Accessed 10/17/2021

### **Thank You – Questions?**

#### • NGSIM Program Key Contributors

- John Halkias
- James Colyar
- Gene McHale
- Vassili Alexiadis
- Alex Skabardonis
- Karl Wunderlich
- Meenakshy Vasudevan
- ...and many more





# **Thank You for Attending!**



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