Applications of Microscopic Traffic Simulation Model for Integrated Networks




by
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Center for Transportation Research and Education
Iowa State University

Our Location

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Infrastructure

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International Port & Hub

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Agenda

- *CORSIM*
- *Modules in Traffic Simulation Models*
- *Applications of Traffic Simulation Models*
- *Related Research @ NJIT*

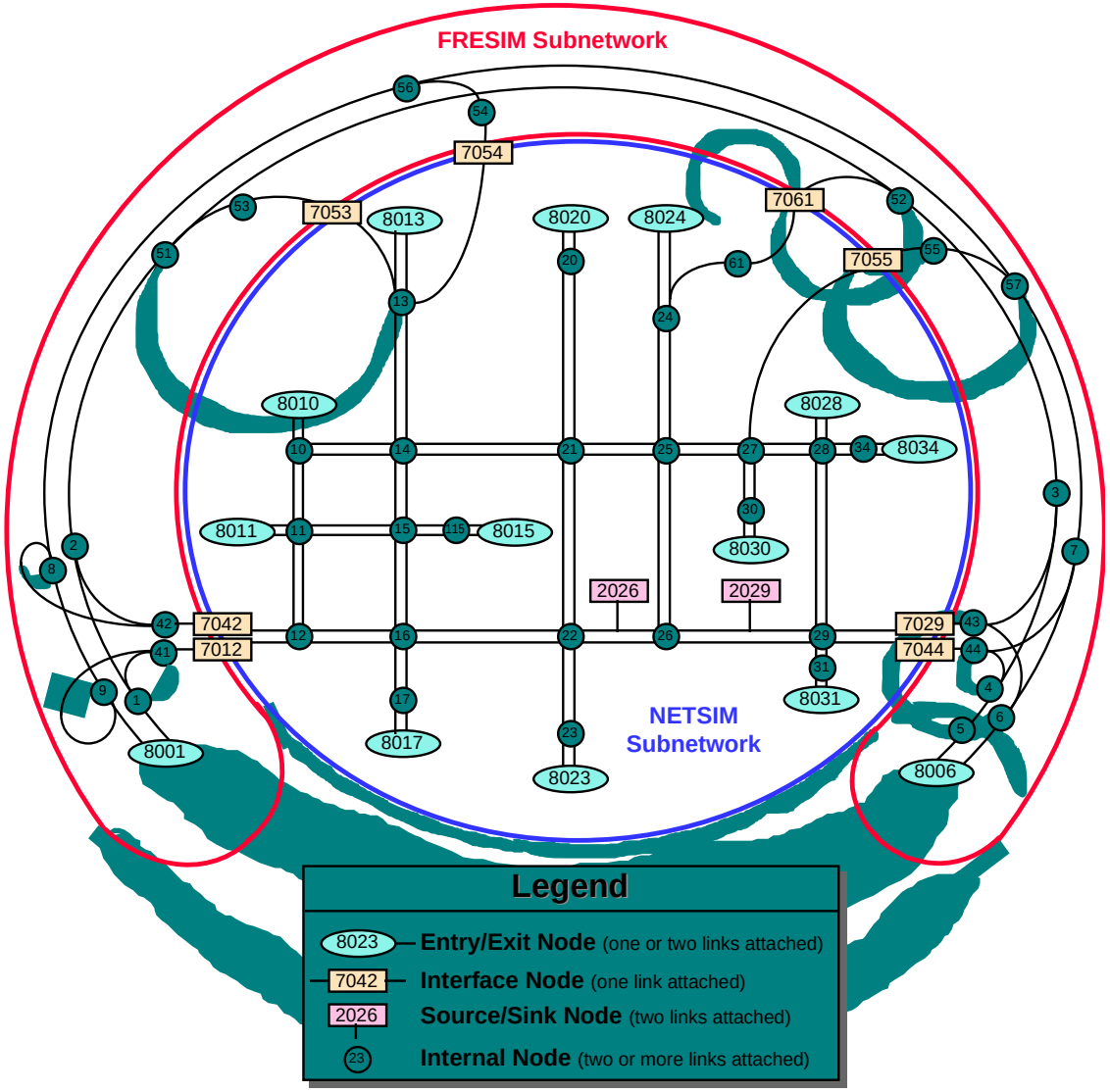
CORSIM

- A microscopic, stochastic traffic simulation model that represents the real world dynamic traffic environment for freeways and streets
- A powerful traffic engineering tool producing a variety of MoE's and graphics files for analysis

Model Representation

- Network representation
  - Link-node concept
  - Nodes depict
    - changes in geometry;
    - trip generators;
    - sign and signal control points
  - Links depict roadways between two nodes
- Traffic representation
  - Up to 4 different fleet components
    - Cars, carpools, buses, and trucks

Sample Network



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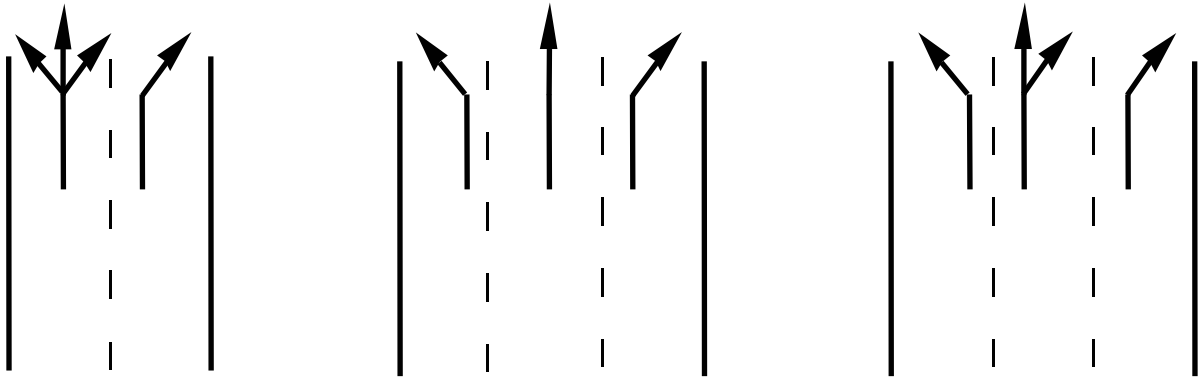
Model Features

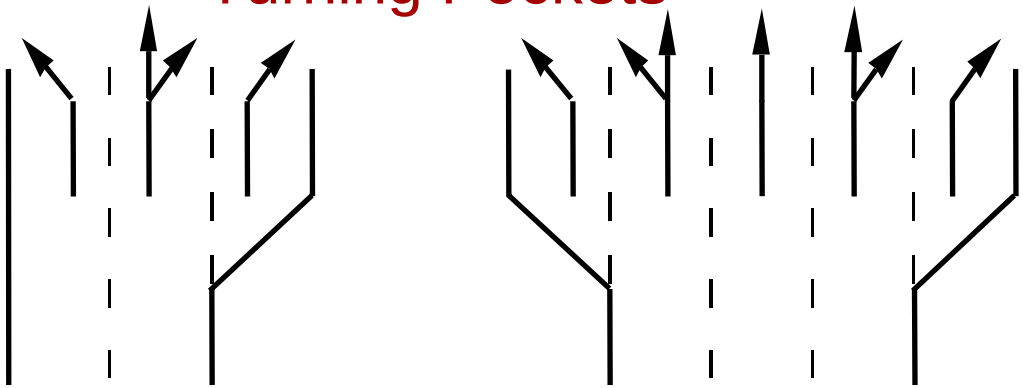
- Network geometry
- Sign & signal control
- Human behavior
- Vehicle movements
- Stochastic Simulation
- Others

Network Geometry

Lane Channelization at Intersections

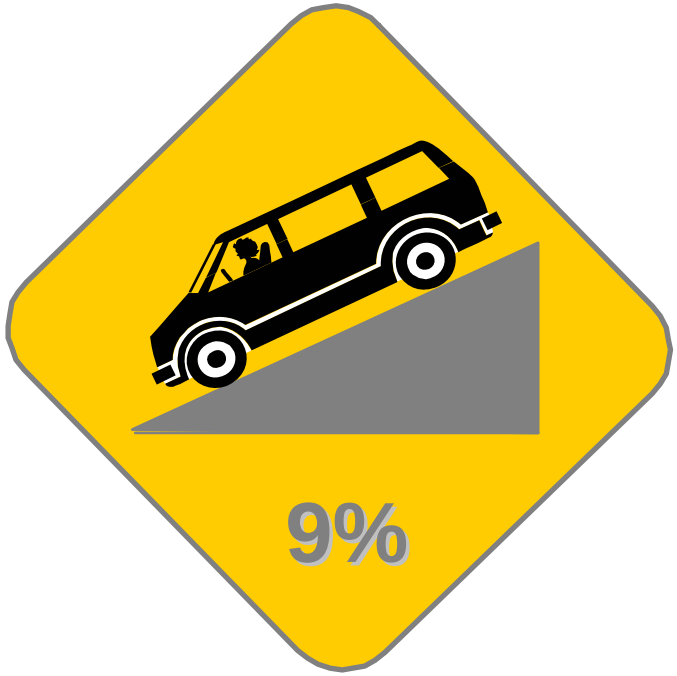


Turning Pockets

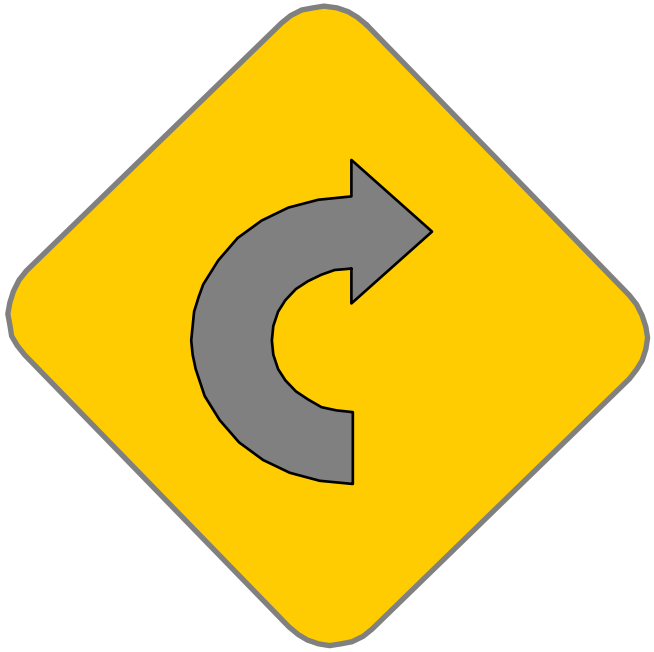


Network Geometry

Grade (%)

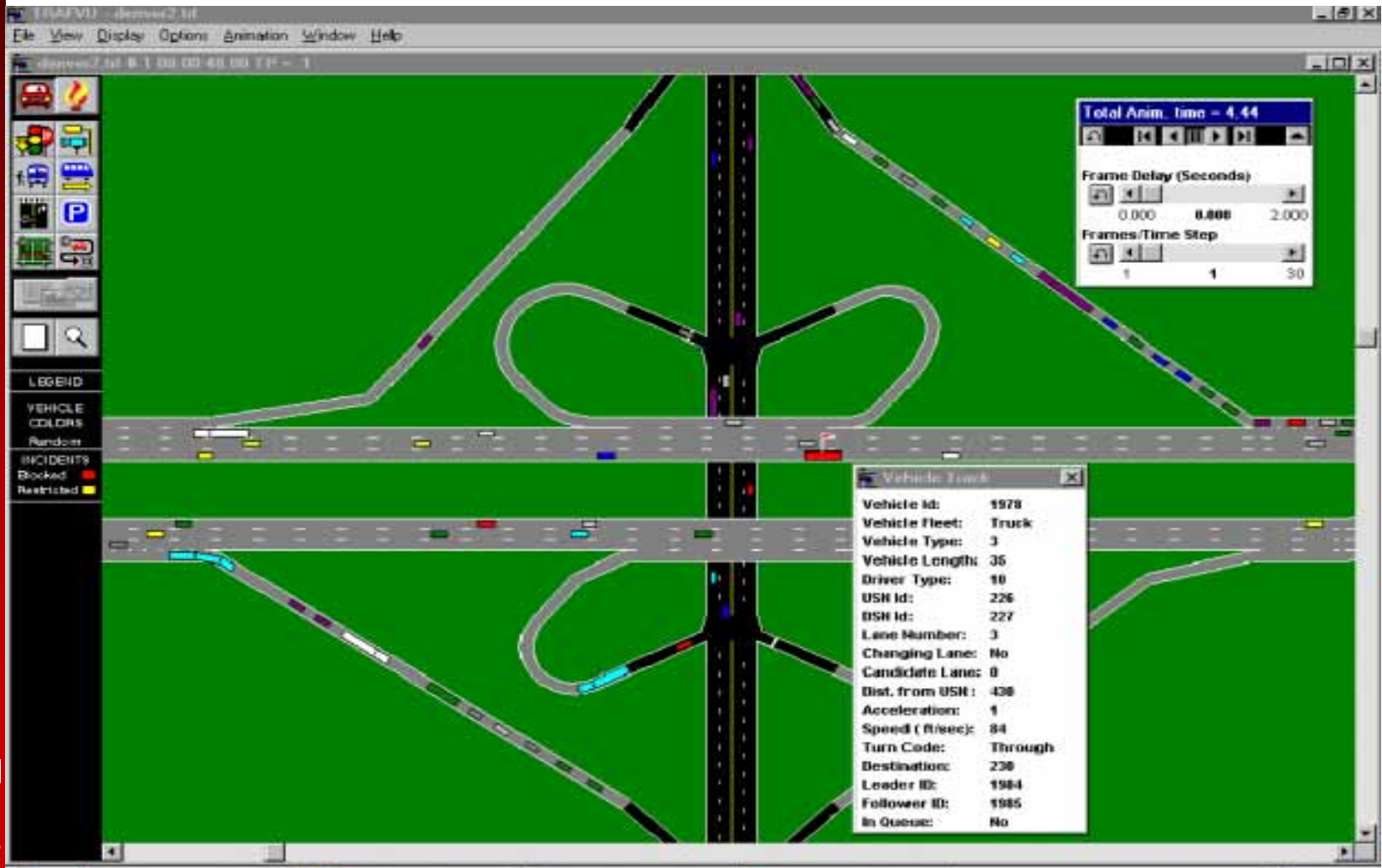


Radius of Curvature & Super-Elevation



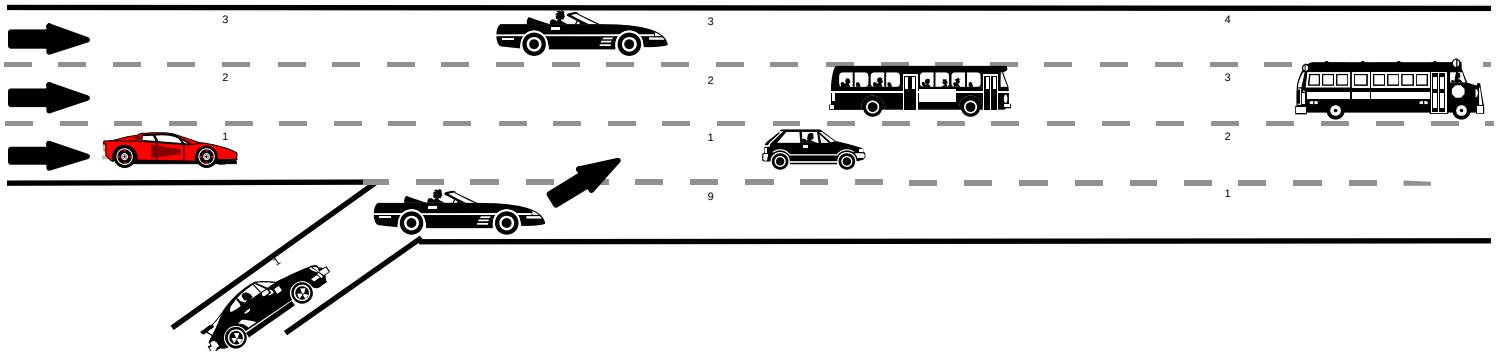
Network Geometry

Grade Separation (Up to 8 Levels)

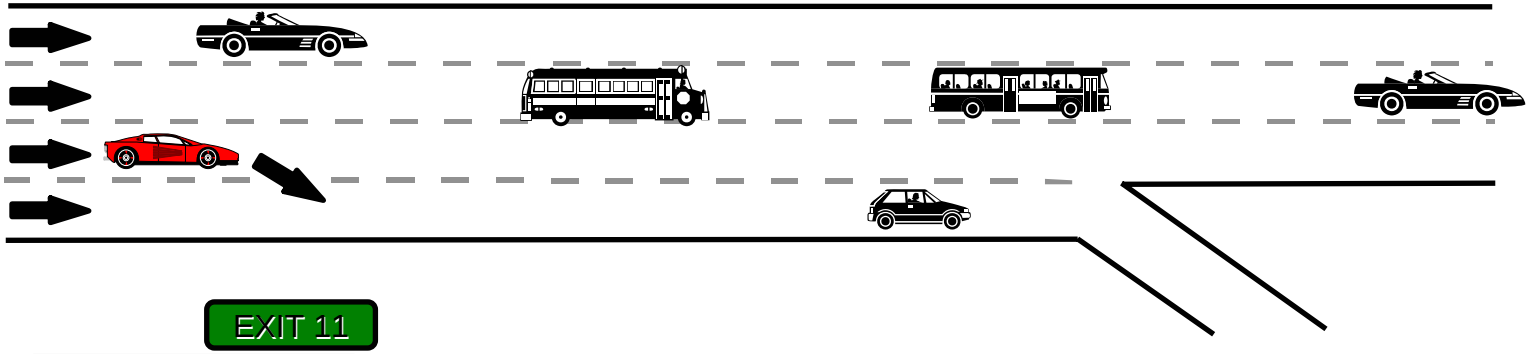


Network Geometry

On-Ramp Traffic Merging Operations



Off-Ramp Traffic Diverging Operations

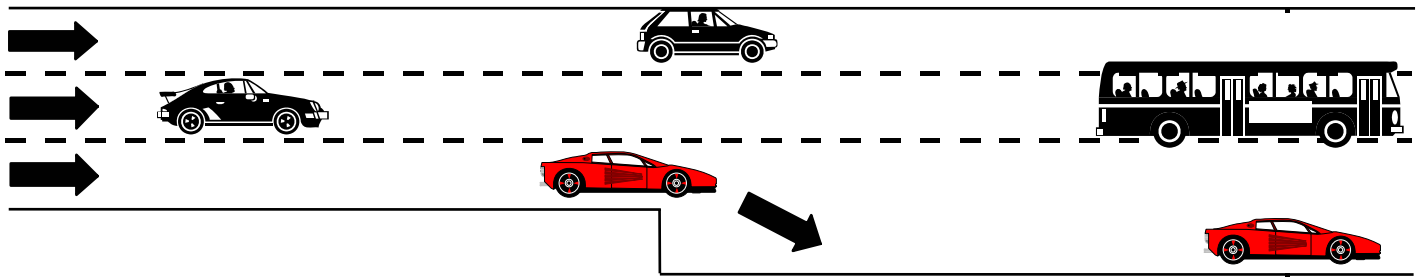


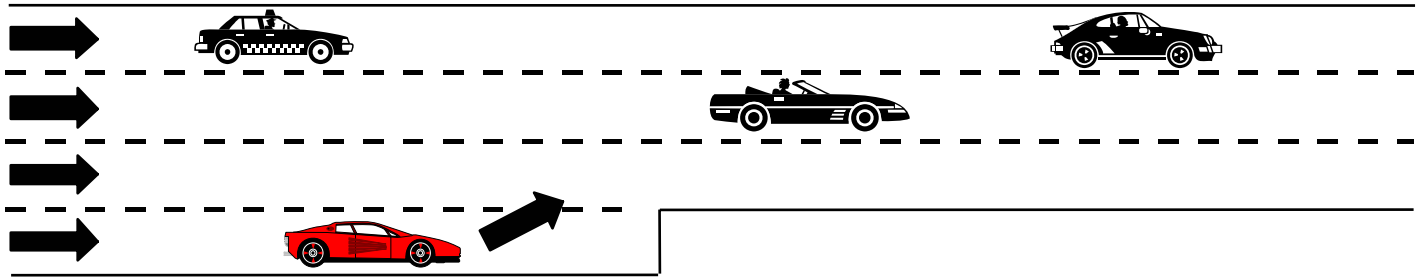
EXIT 11

CORSIM
1 MILE

Network Geometry

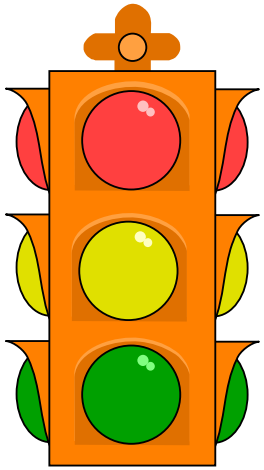
Lane Additions & Drops

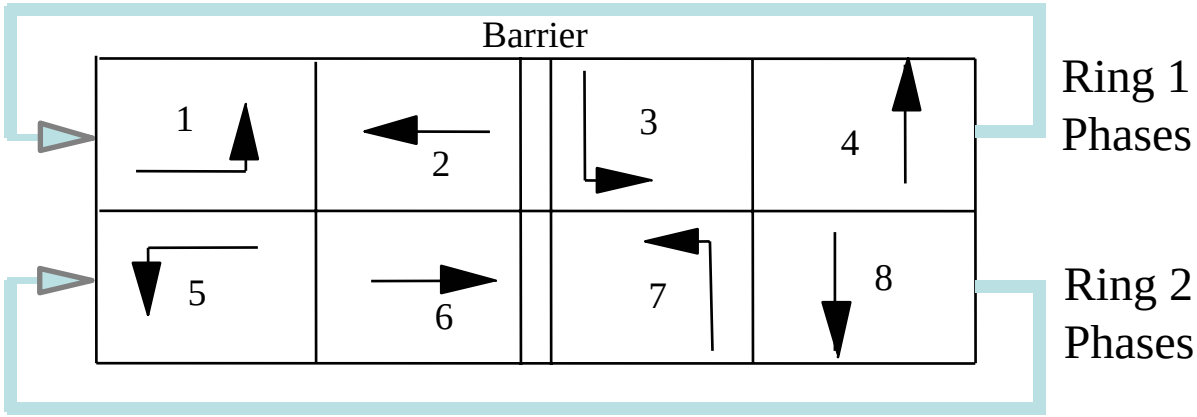




Sign & Signal Control

Pre-timed Signals
Actuated Signals (Type 170 & NEMA)



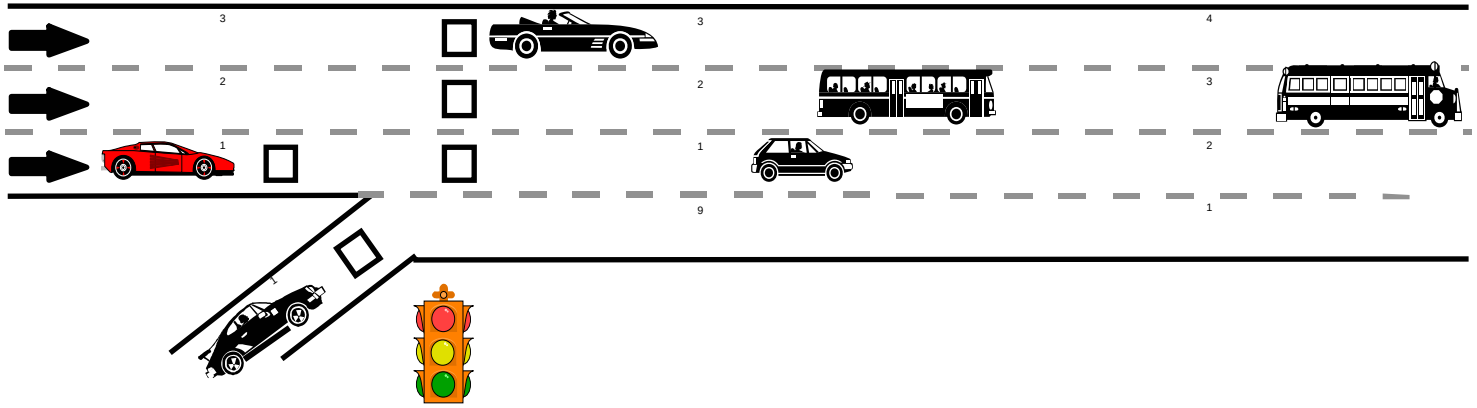


Yield and 2-Way Stop Signs

Sign & Signal Control

Ramp-Metering Control:

- Clock Time
- Demand/Capacity
- Speed
- Occupancy



Stochastic Simulation

10 Types of Driver Behaviors

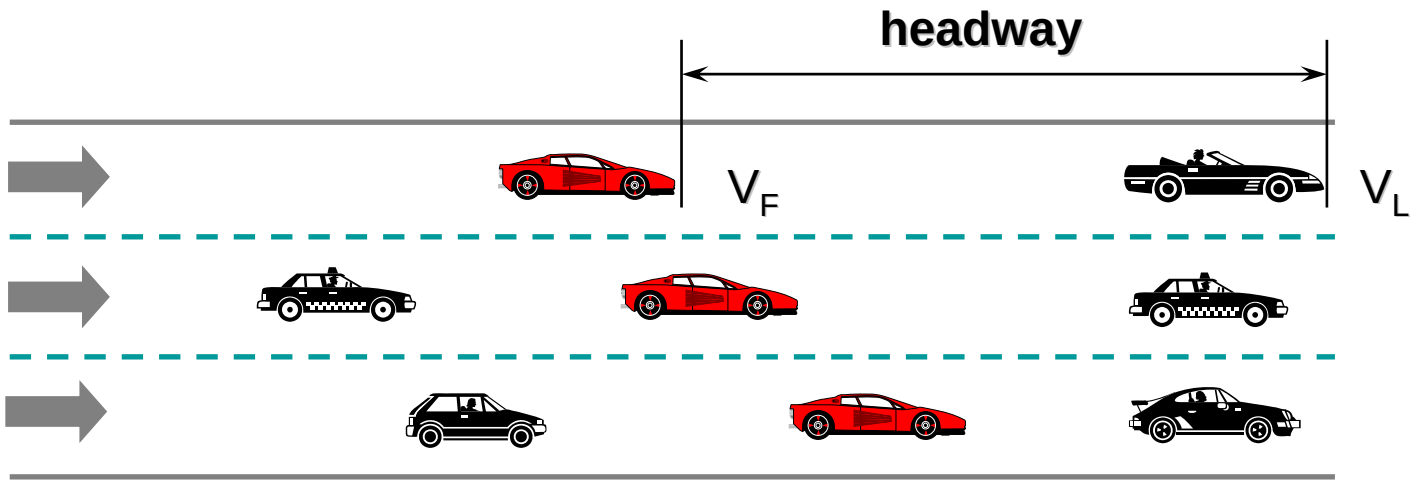
Stochastic Simulation

Major parameters affected by driver types:

- Desired free flow speed
- Headway for car-following
- Gap acceptance for lane-changing
- Start-up lost time and queue discharge headway
- Gap acceptance for minor street traffic
- Amber interval response
- Gap acceptance for permissive left-turns

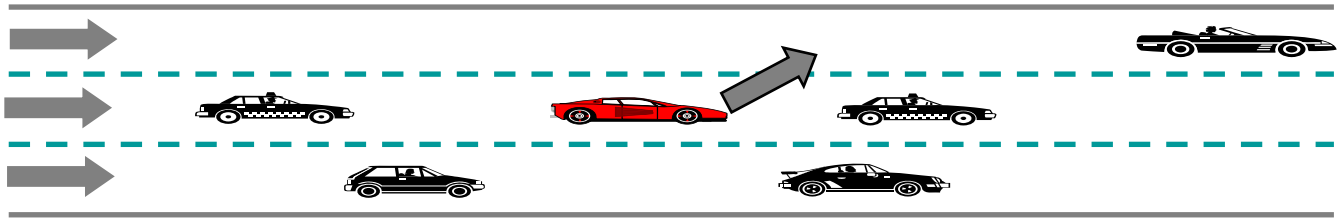
Car-Following Logic

$$\text{Headway} = F(L, V_L, V_F)$$

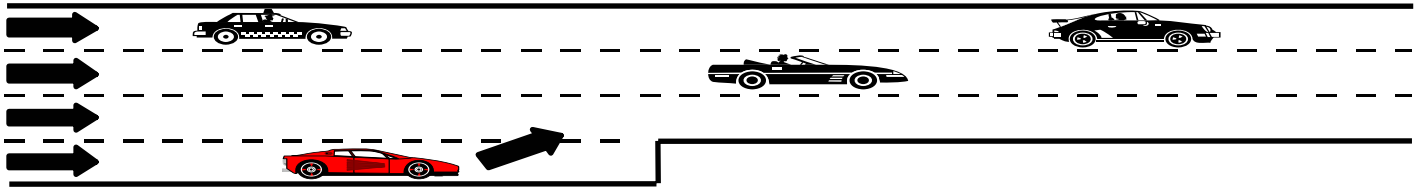


Lane-Changing Logic

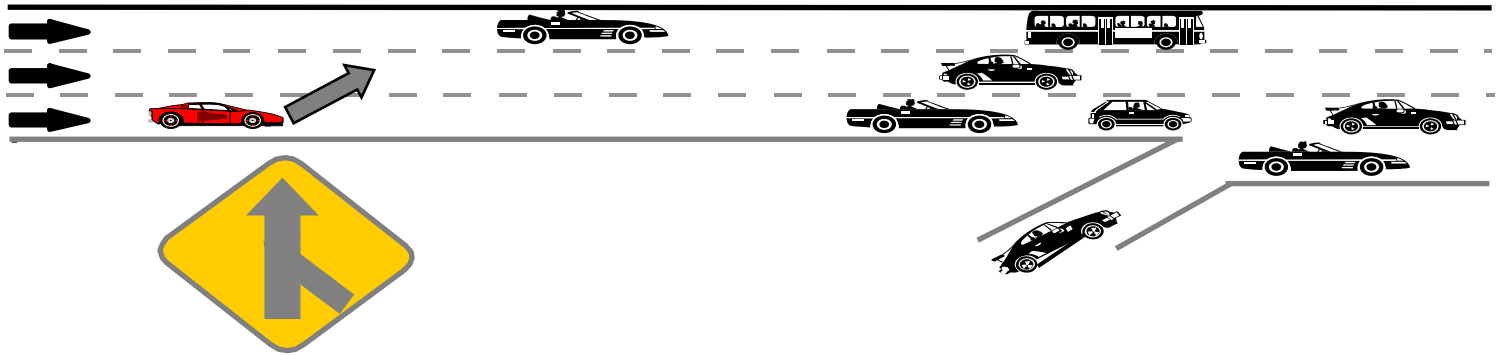
- Discretionary Lane Changing



- Mandatory Lane Changing

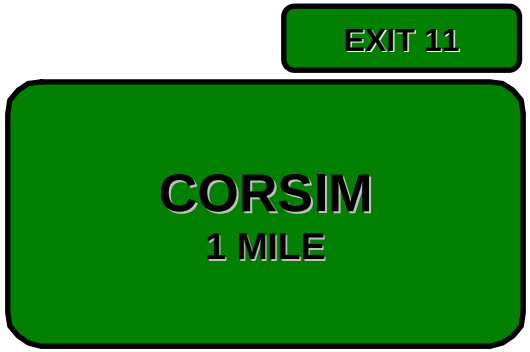


- Anticipatory Lane Changing



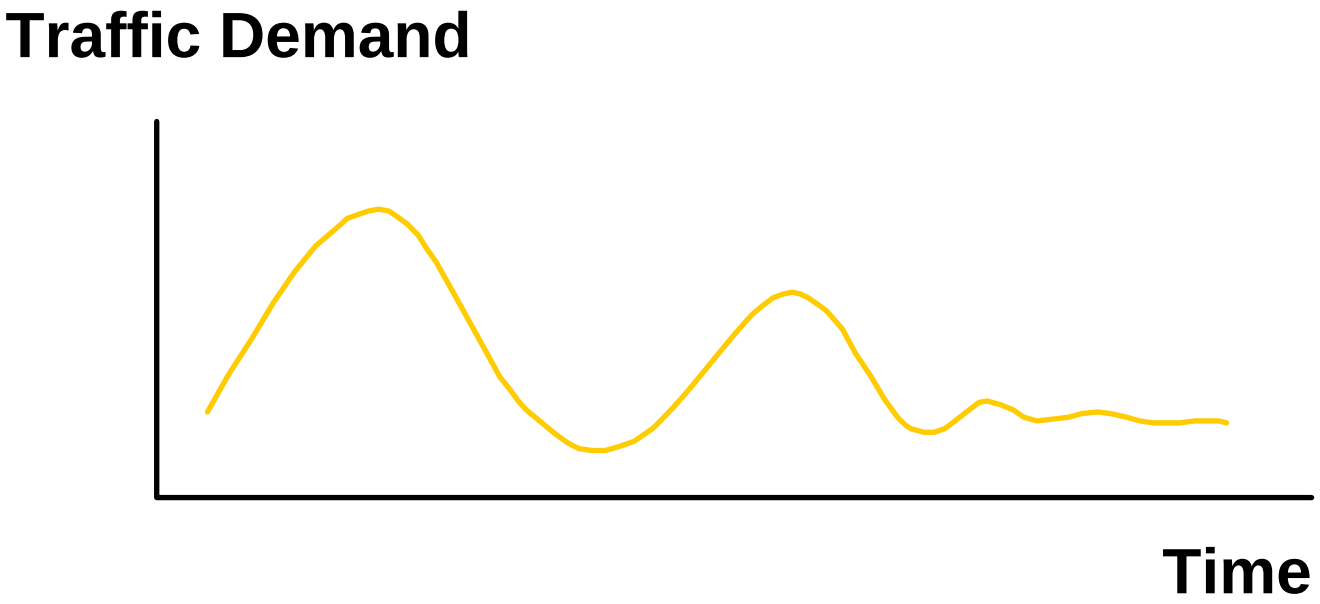
Look-Ahead Features

Responses to Advanced Warning Signs on Freeways



Bus Transit Operations

Time-Varying Demand



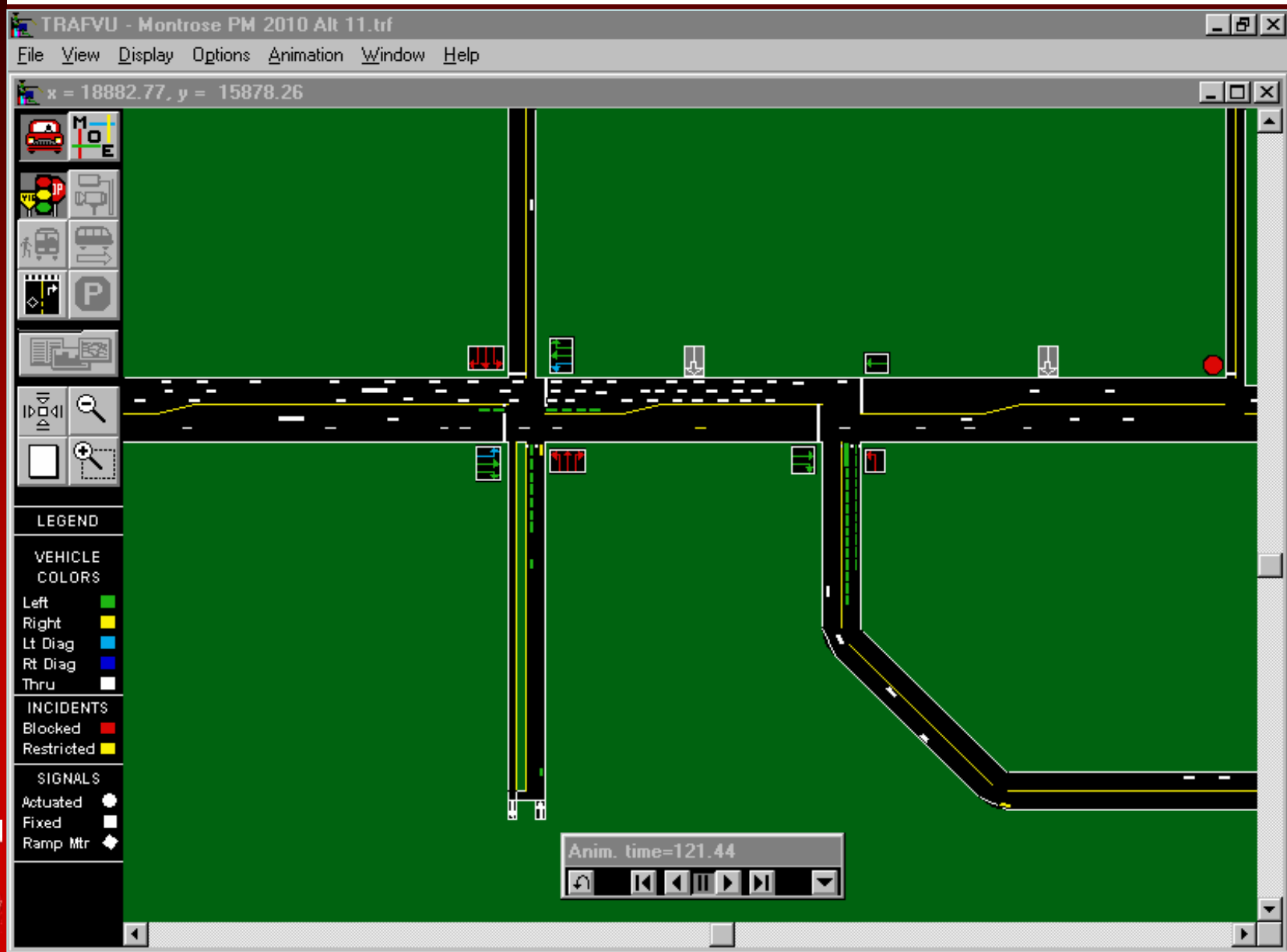
Input Data Requirements

- Run control data
- Network geometry data
- Traffic control data
- Traffic operations data
- Traffic demand data
- Calibration data
- Others

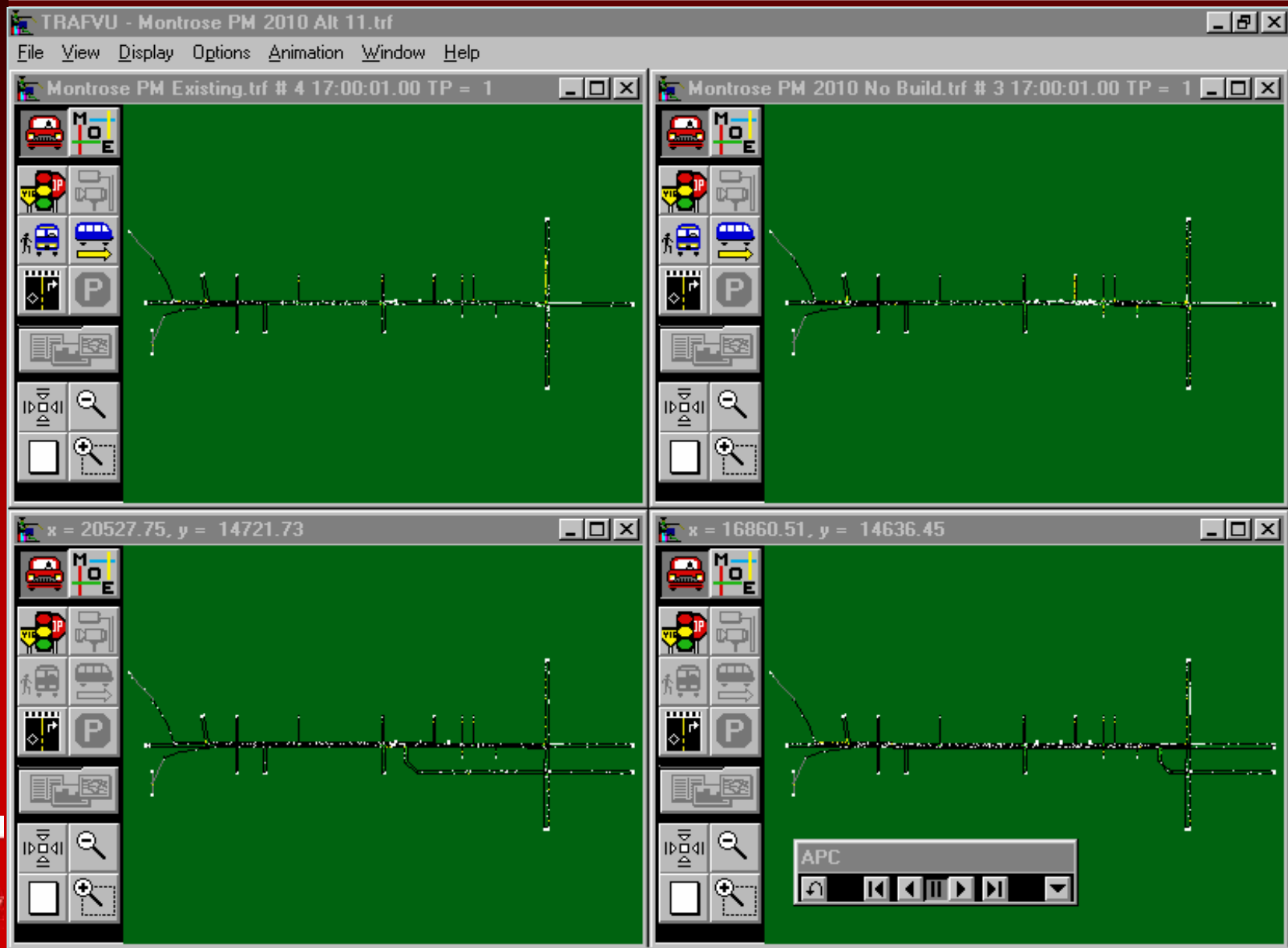
Outputs

- Graphics (Animation) files
- Static MOE's
  - Throughputs (vehicle trips; person trips)
  - Vehicle-miles or person-miles
  - Vehicle-minutes; person-minutes
  - Speed (mph)
  - Volume (veh/hr)
  - Travel and delay times (min; sec/veh)
  - Queue length, stops, phase failures, etc..
  - Fuel consumption (gal; mpg)
  - Pollutant emissions (CO, HC, NOx; kg/mi-hr)

Animation

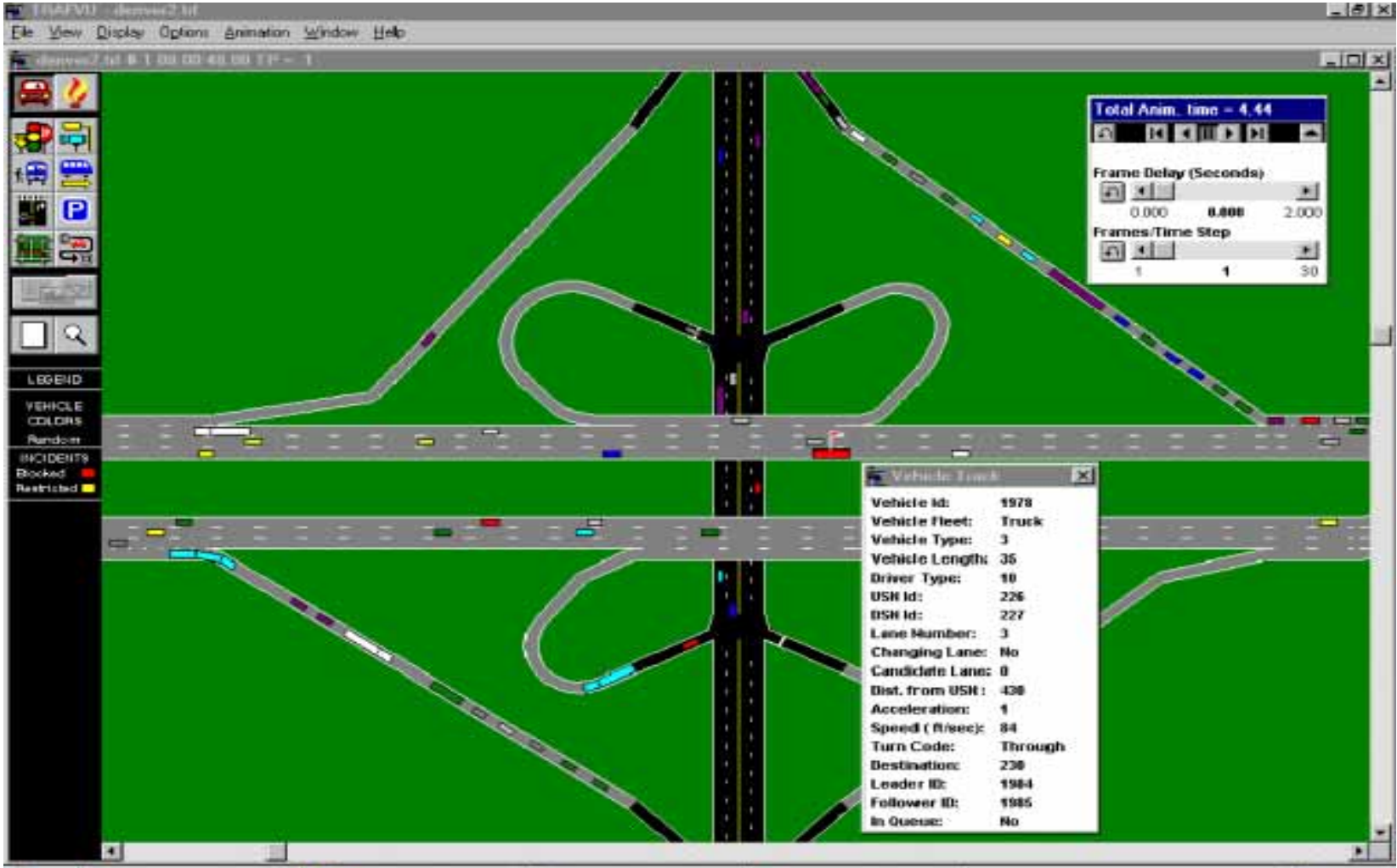


Animation



Applications

Evaluation of Geometric Improvements
Intersections, Interchanges, & On/Off-Ramps



Warning in Using Simulation Models

- Requirement of input data at a detail level
- Users' responsibility for input data accuracy
- Knowledge of simulation models capabilities and limitations
- Model calibration is not easy in some cases
- Limited capabilities in simulating ITS-related control strategies via CORSIM Run Time Extension

Microscopic Simulation Tools

- *Paramics*
- *CORSIM*
- *VISSIM*
- *INTEGRATION*
- *Dynasmart*
- *MITSIM*
- *TRANSIMS*
- *Others*

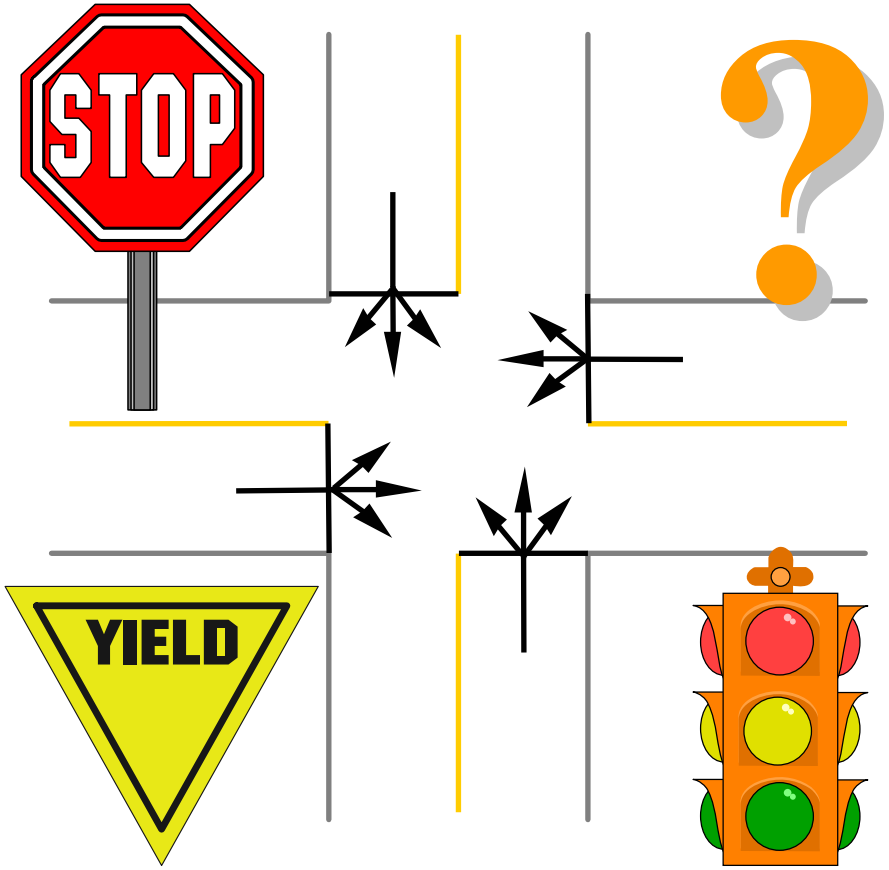
Applications

Traffic Operation Analysis

Parking Activities, One-Way System & Lane Use (HOV)

Traffic Control

Sign and Signal Control Analyses
at Intersections



Freeway Capacity Analysis

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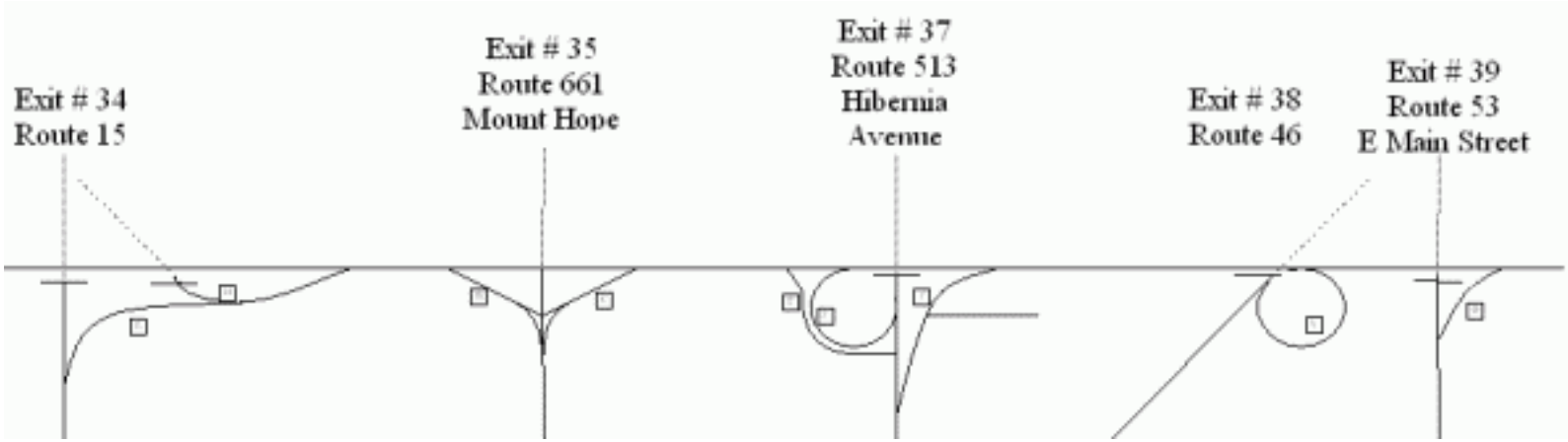
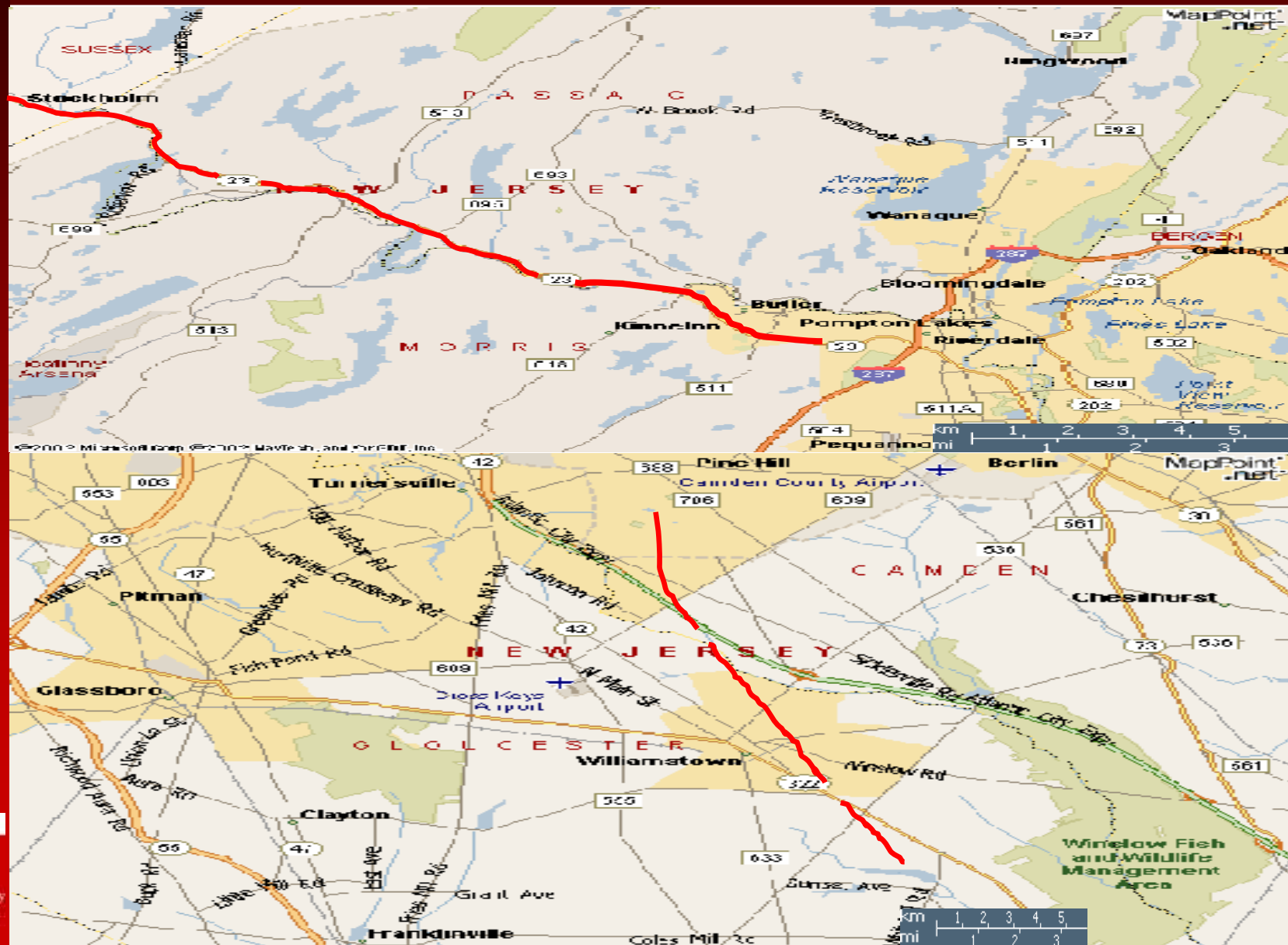
Ramp Metering on I-80



Signal Optimization on NJ Highways



Benefit Analysis – Signal Optimization

Input

Cost
- Data collection & processing
- Network modeling
- Construction/Maintenance

Benefit models:
- User delay estimation
- Vehicle operating cost estimation
- Environmental impact

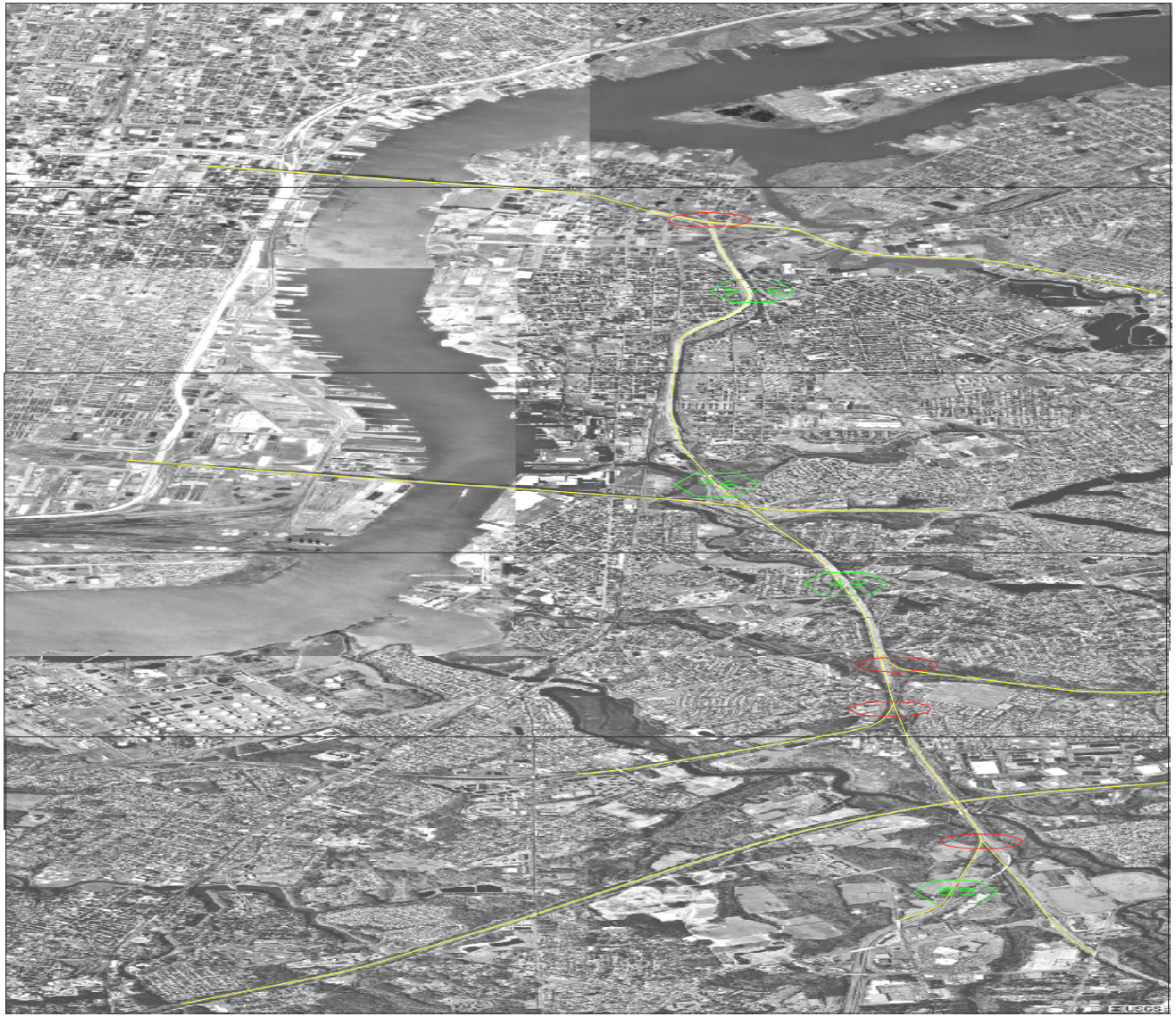
- No. of Stops
- Delays
- Travel speeds
- Value of time
- % of vehicle type
- Occupancy

Output

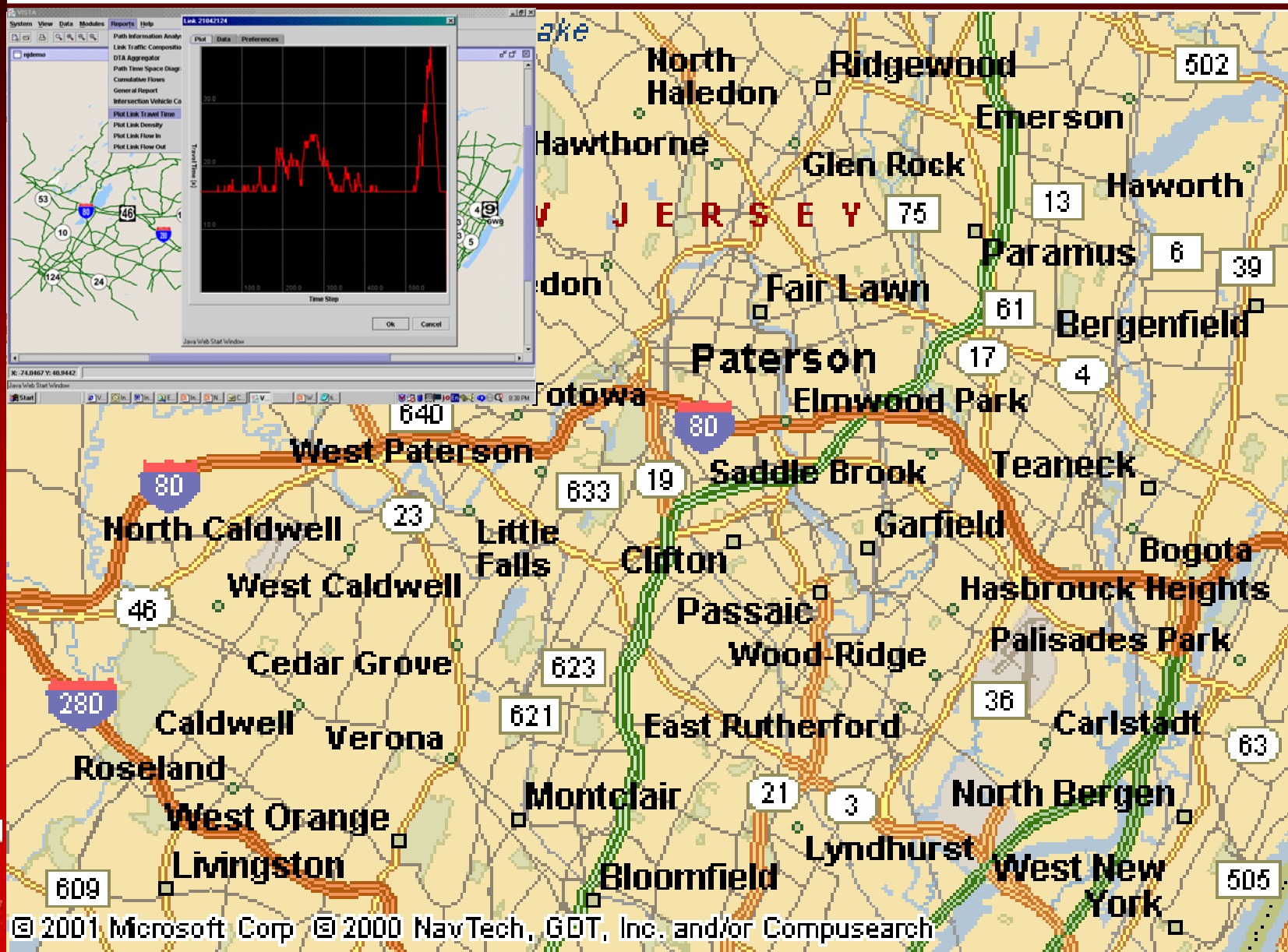
Benefits
- Delay Savings
- Fuel Savings
- Emission Savings

Sensitivity Analysis

So. Jersey Motorist Information Systems



Development of Simulation/Assignment Model for ITS Evaluation



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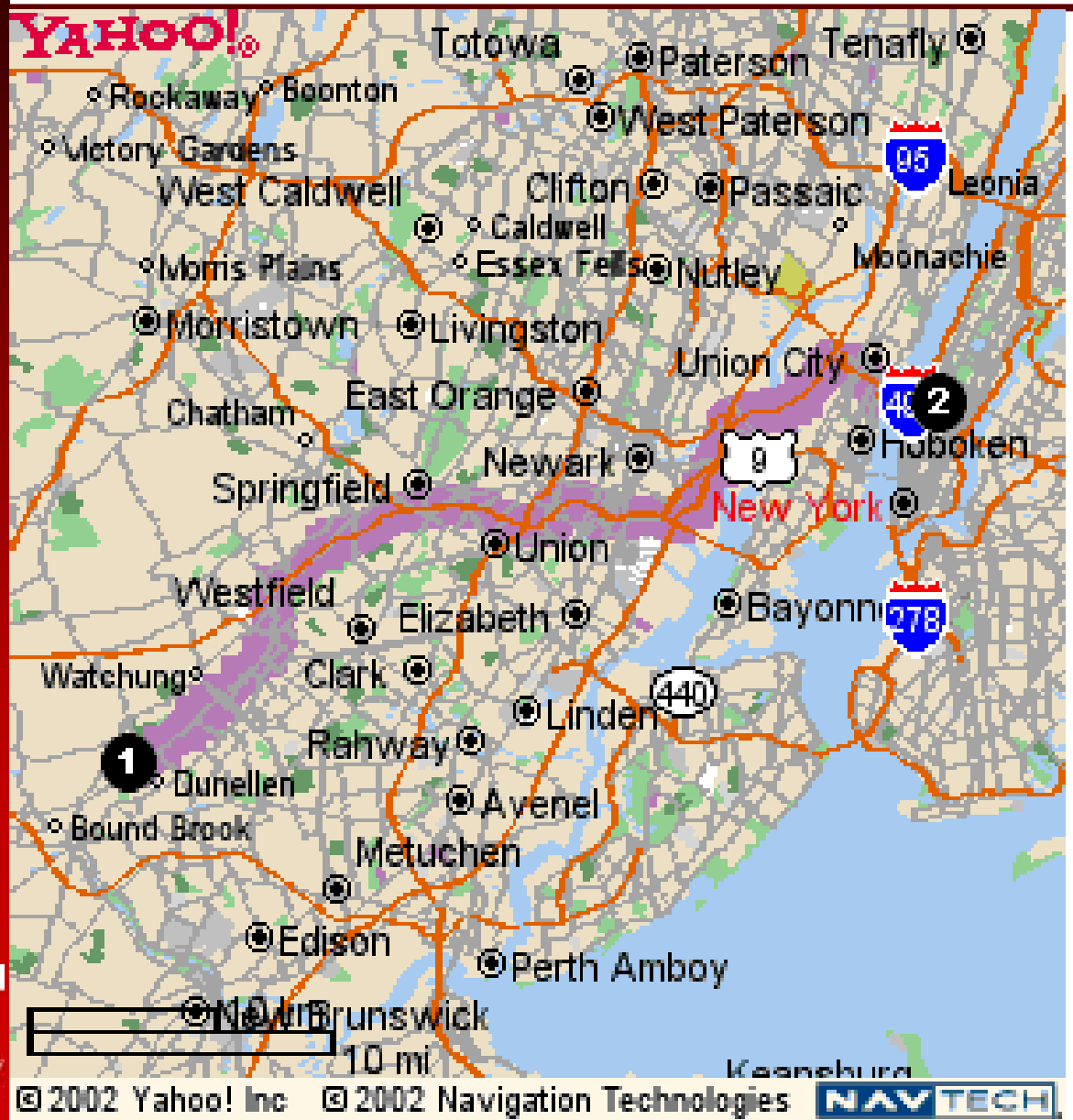
Travel Time Prediction



Starting from

22 West Way
Green Brook, NJ

Arriving at

1605 Broadway Ave., New York, NY

Distance:

36.0 miles

Travel Time:

56 minutes

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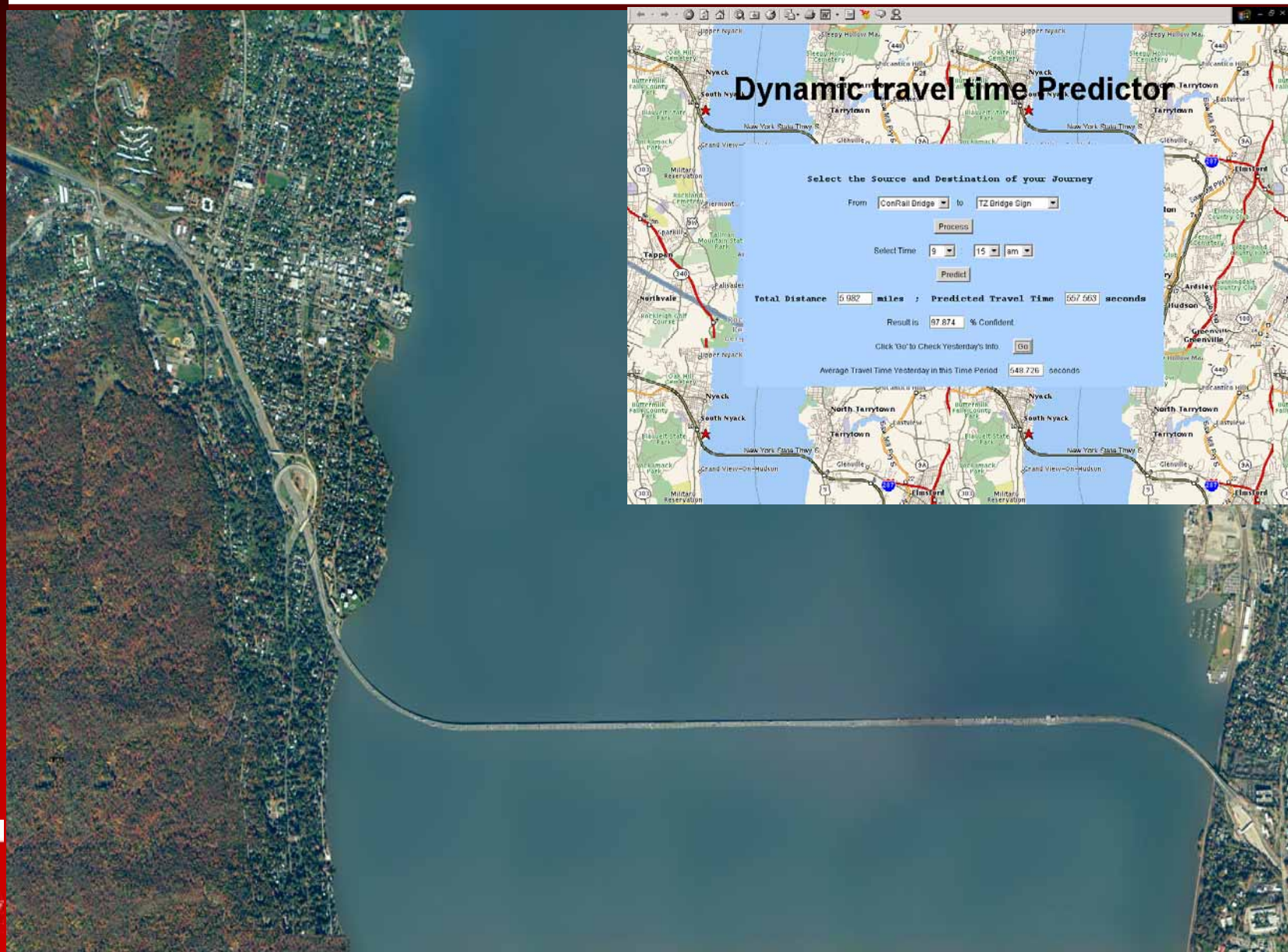
Travel Time Prediction for NY Thruway



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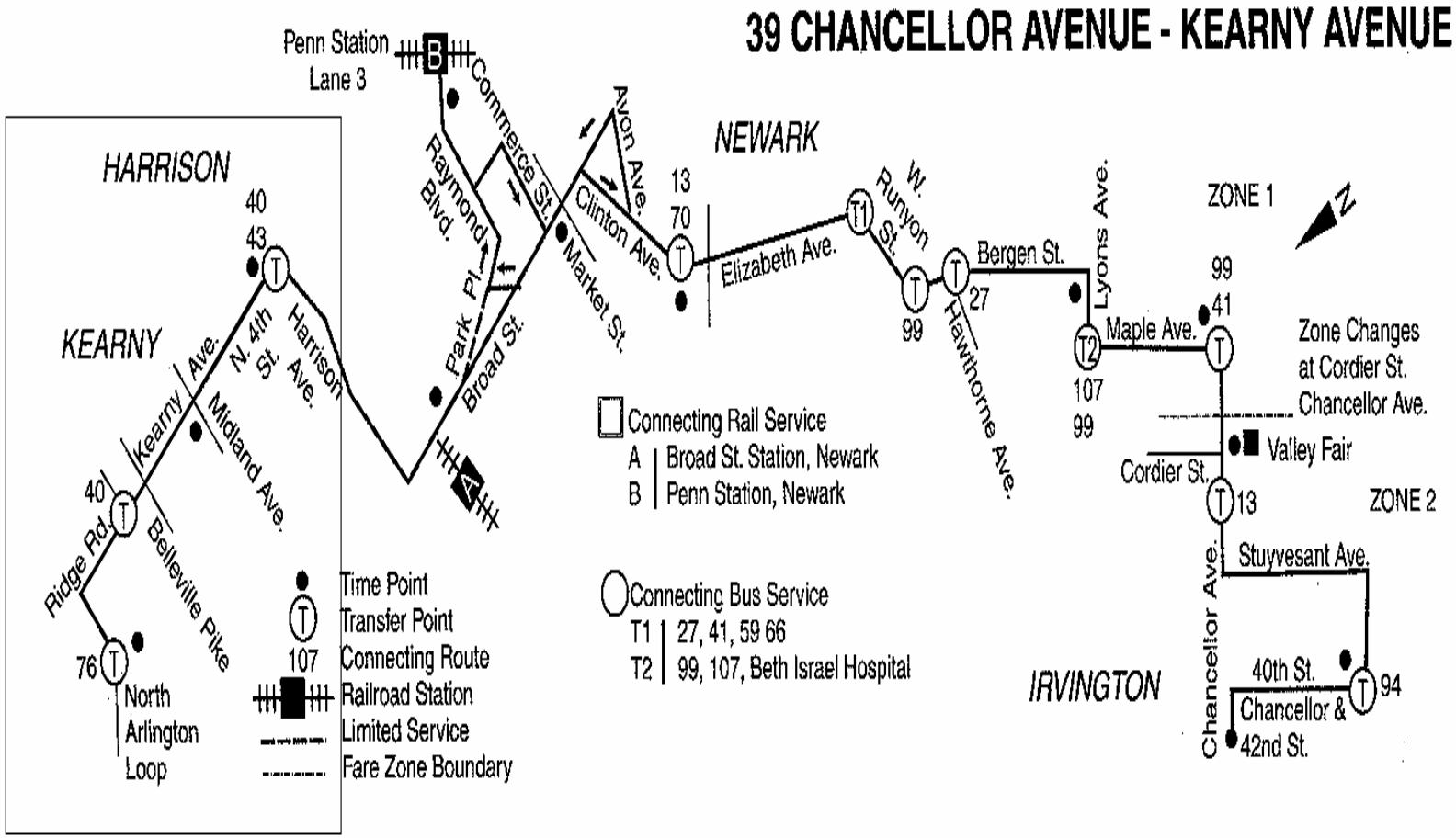
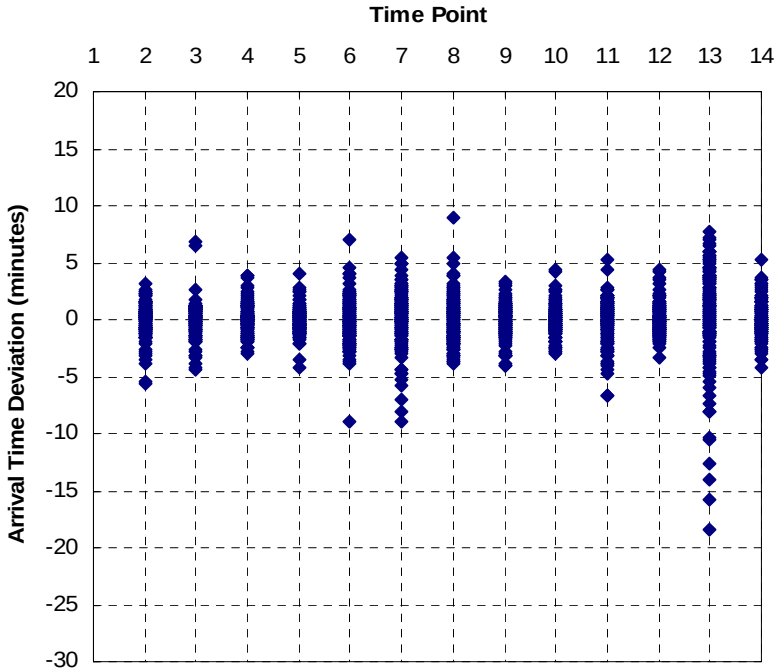
Transit Simulation Model



Neural Network/Dynamic Algorithms to Predict Bus Travel Times

Sponsor: NJDOT for NJ Transit

- Objective: Develop a neural dynamic model (e.g., the integration of artificial neural networks and Kalman filtering algorithm) that can predict bus arrival information with the use of real-time and historic data
- Algorithm was tested on a selected NJ Transit route (Bus #62) and showed promising results



Difference between predicted and actual bus arrival times

- Analysis helped to identify necessary improvements required for the successful implementation of the model

Newark Penn Station Circulation Study

Sponsor: NJDOT for NJ Transit

- Microscopic traffic simulation of Downtown Newark
- Evaluation of existing conditions and impacts of proposed improvements
- Recommended solutions for improved vehicle flow

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Network Optimization

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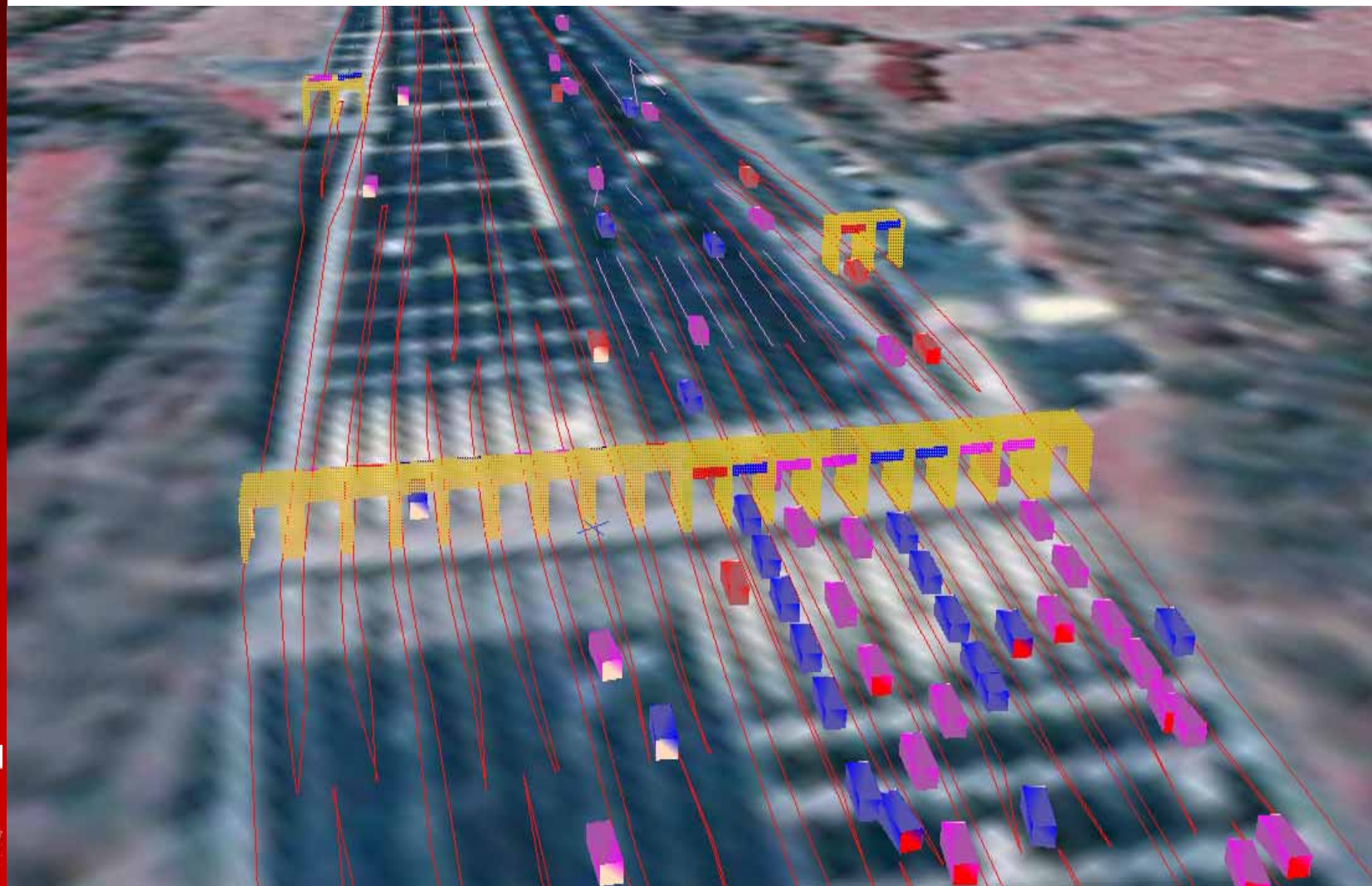
Remove Barrier Tolls on the GSP

- *Detailed Visualization Abilities*



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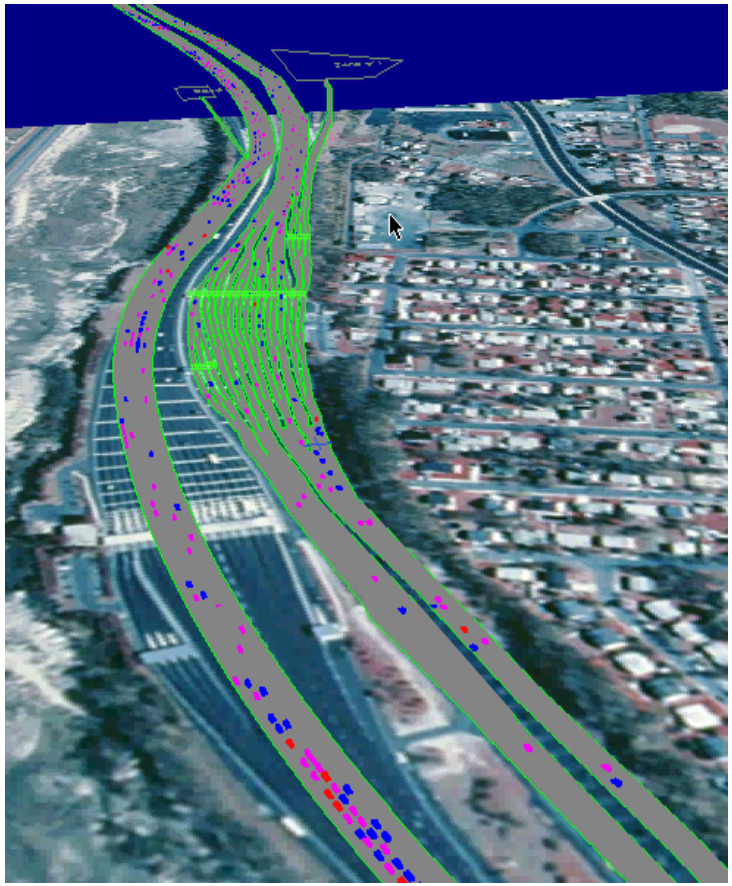
Garden State Parkway – Toll Removal Study

- Analyzed traffic congestion impacts as part of the development of a ten-year plan to remove toll barriers on Garden State Parkway
- Developed a traffic simulation model of the northern 50-mile section of the Parkway
- Alternative scenarios:
  - Maintain the existing toll plazas
  - Elimination of barriers in one or both directions
  - Construction of high-speed E-Z Pass lanes



- NJIT Report was part of the NJDOT Commissioner's submission to the Governor
- Implemented by the Acting Governor Codey

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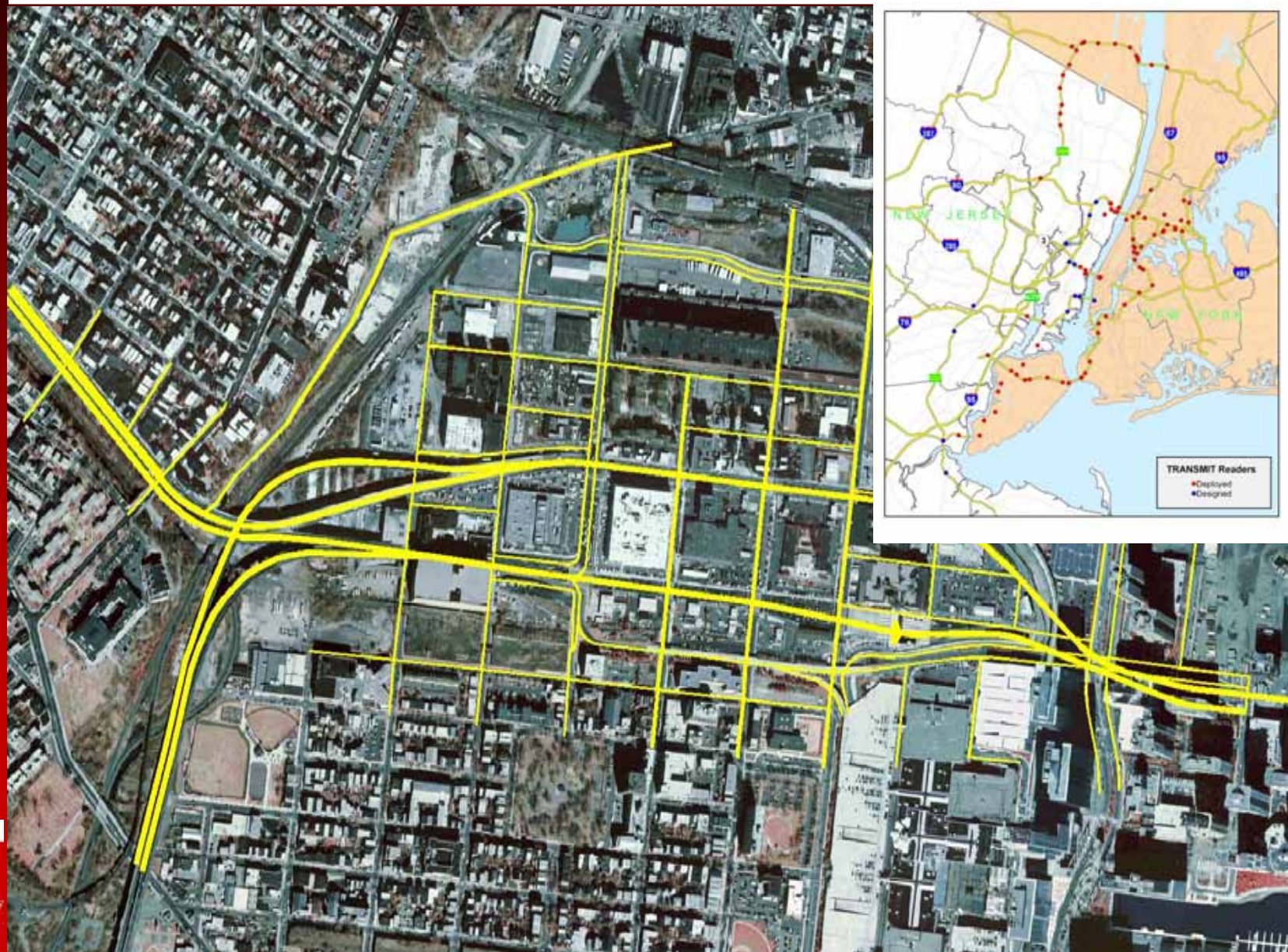
Route 139 Construction and ITS Simulation



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Work Zone Optimization

Work Zone Optimization

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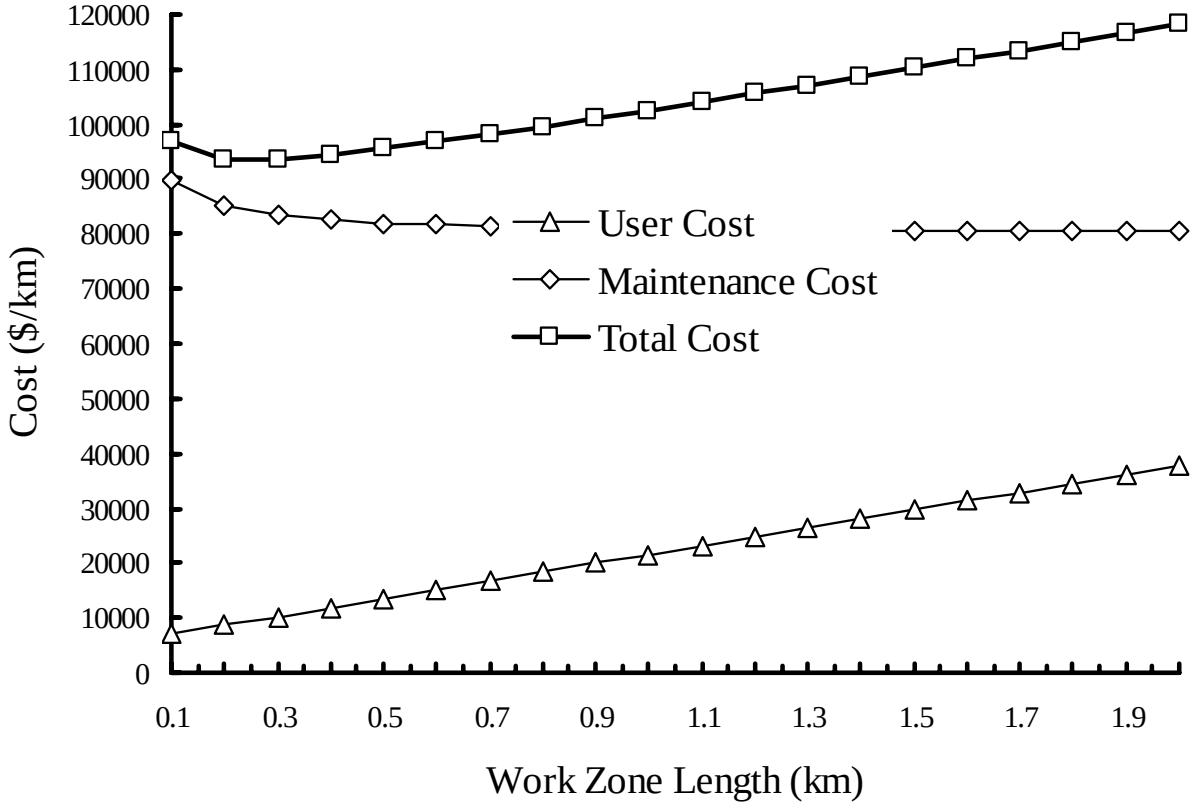
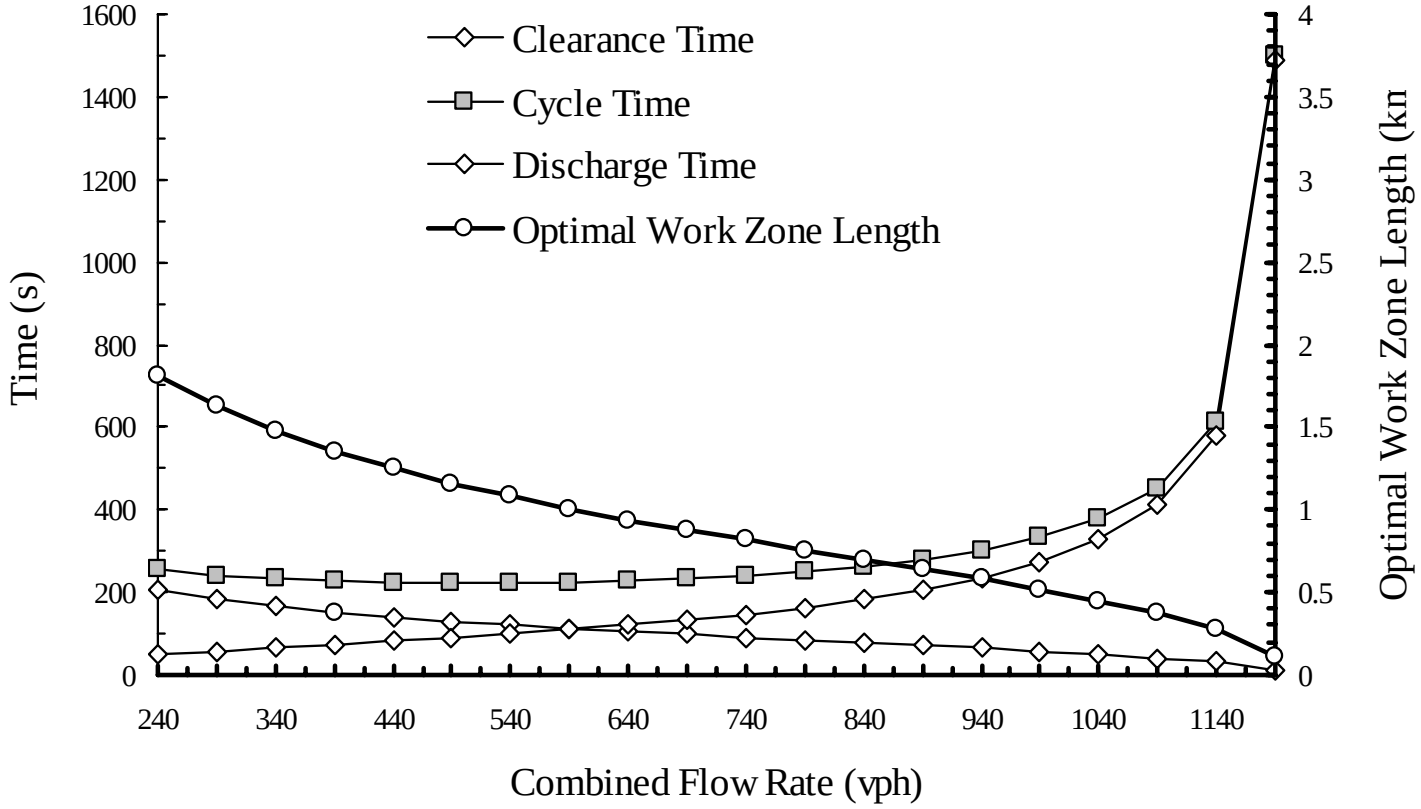
Costs vs. Work Zone Length

FIG. 6. User, Maintenance, and Total Costs vs. Various Work Zone Lengths (Combined Flow Rate = 1150 vph)



Optimal Work Zone Lengths vs. Flows

FIG. 4. Optimal Total Clearance, Discharge, Cycle Times and Optimal Work Zone Length vs. Combined Flow Rate



Emergency Events

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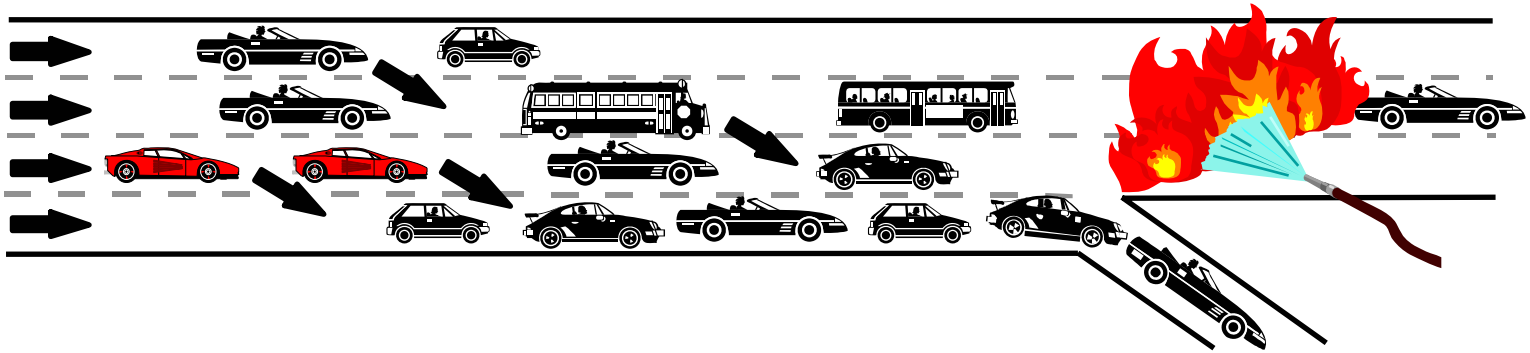
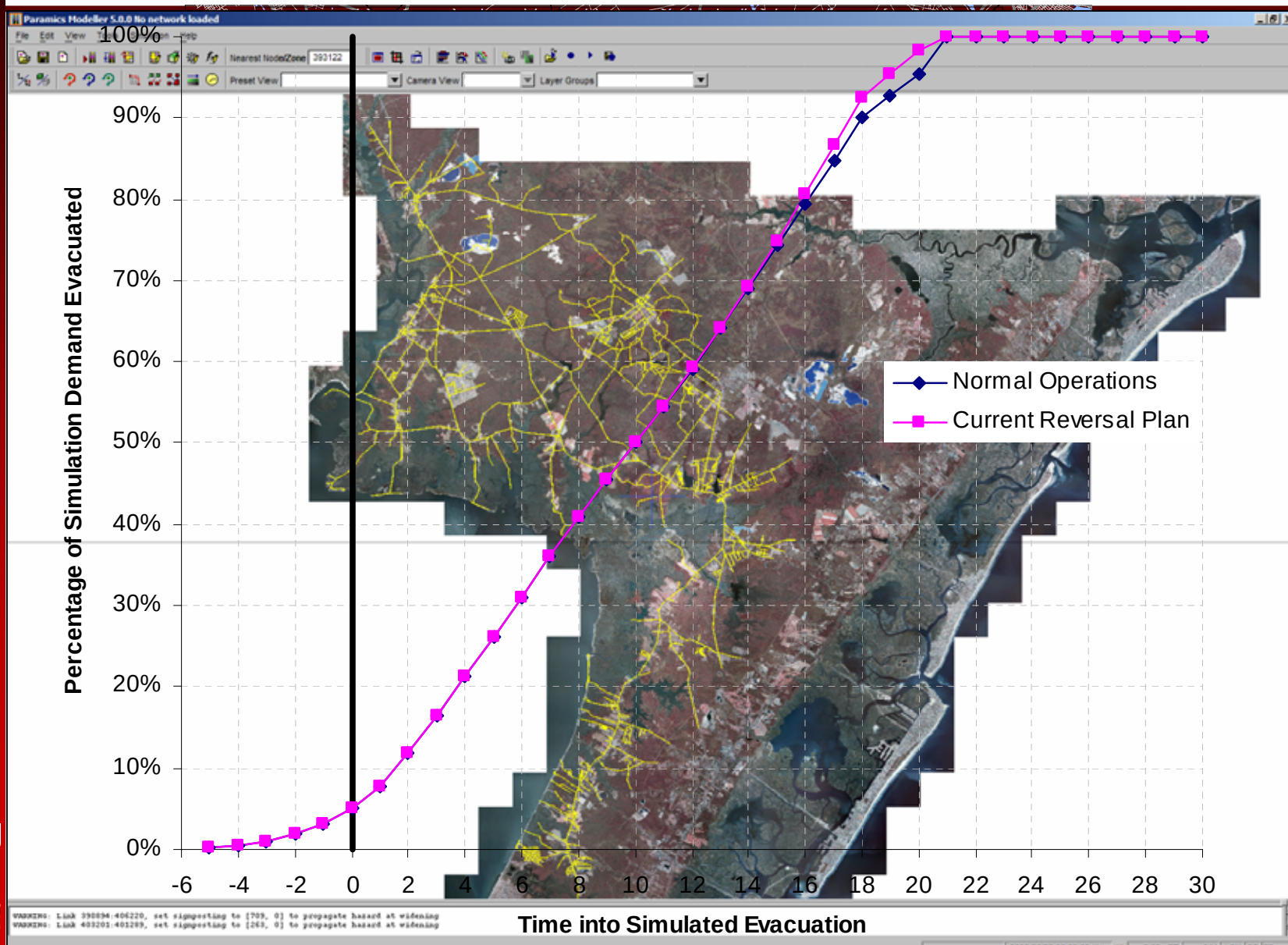
Traffic Diversion

Freeway Incidents and Diversion Analysis

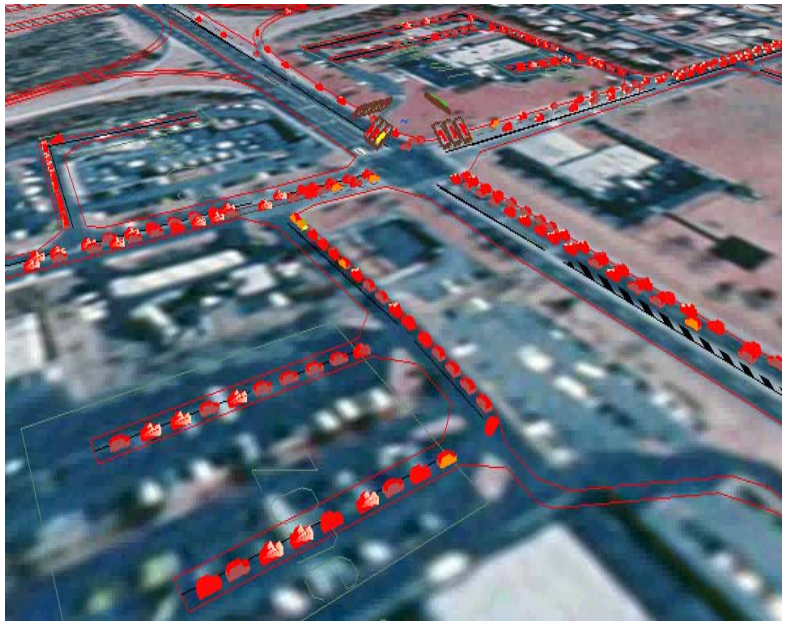


Cape May Evacuation Study

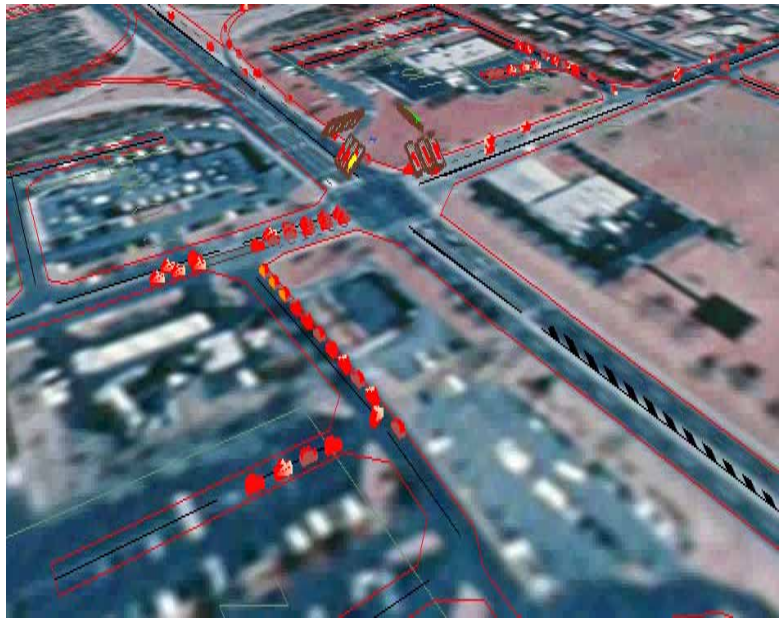


Development and Evaluation of Emergency Plans

No evacuation plan



Evacuation plan in place



Managing Highway Incidents

Traffic Operations Centers

Incident Management Program

TRANSCOM SM

TRANSPORTATION OPERATIONS COORDINATING COMMITTEE


NCTIP
National Center for Transportation and Industrial Productivity
...increasing Productivity through Transportation Improvements...
ITC
International Intermodal Transportation Center
... assists in facilitating economic development and quality of life improvement efforts linked to the International Intermodal Transportation Corridor
A Leader in Technological Solutions and Transportation Data Analysis
TRANSPORTATION
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Academic Program: Interdisciplinary Program in Transportation
Civil Engineering
Industrial Engineering
Environmental Engineering
School of Management
School of Architecture
BROWNFIELDS
economic redevelopment
... assists in redeveloping and revitalizing abandoned and underutilized industrial sites
tide
Transportation Information and Decision Engineering
... center committed to encouraging the growth of the Transportation Information and Decision Engineering industry in New Jersey

Thank You