MITSIMLab

1. Technical Information

MITSIMLab is a simulation-based laboratory that was developed for evaluating the impacts of alternative traffic management system designs at the operational level and assisting in subsequent refinement. Examples of systems that can be evaluated with MITSIMLab include advanced traffic management systems (ATMS) and route guidance systems.

MITSIMLab was developed at MIT's Intelligent Transportation Systems (ITS) Program. Professor Ben-Akiva, Director of the ITS Program at MIT, and Dr. Koutsopoulos, from the Volpe Center, were co-principal investigators in the development of MITSIMLab. Dr. Qi Yang, of MIT and Caliper Corporation, was the principal developer.

The evaluation framework using MITSIMLab is outlined in Figure 1. Based on the objectives of the system under evaluation, scenarios are generated that test the design. Appropriate measures are used to evaluate the performance and may lead to subsequent design refinements.

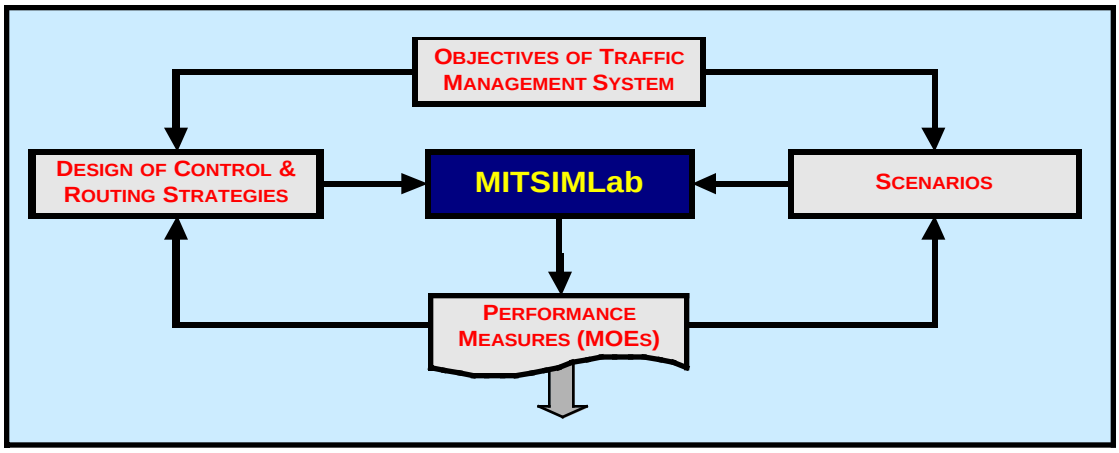

Figure 1. Evaluation framework

MITSMLab is a synthesis of a number of different models and has the following characteristics:

- represents a wide range of traffic management system designs;
- models the response of drivers to real-time traffic information and controls; and,
- incorporates the dynamic interaction between the traffic management system and the drivers on the network.

The various components of MITSIMLab are organized in three modules:

- Microscopic Traffic Simulator (**MITSIM**)
- Traffic Management Simulator (**TMS**)
- Graphical User Interface (**GUI**)

The interactions among the various MITSIMLab modules are shown in Figure 2. A microscopic simulation approach, in which movements of individual vehicles are represented, is adopted for modeling traffic flow in the traffic flow simulator (MITSIM). This level of detail is necessary for an evaluation at the operational level. The Traffic Management Simulator (TMS)

represents the candidate traffic control and routing logic under evaluation. The control and routing strategies generated by the traffic management module determine the status of the traffic control and route guidance devices. Drivers respond to the various traffic controls and guidance while interacting with each other.

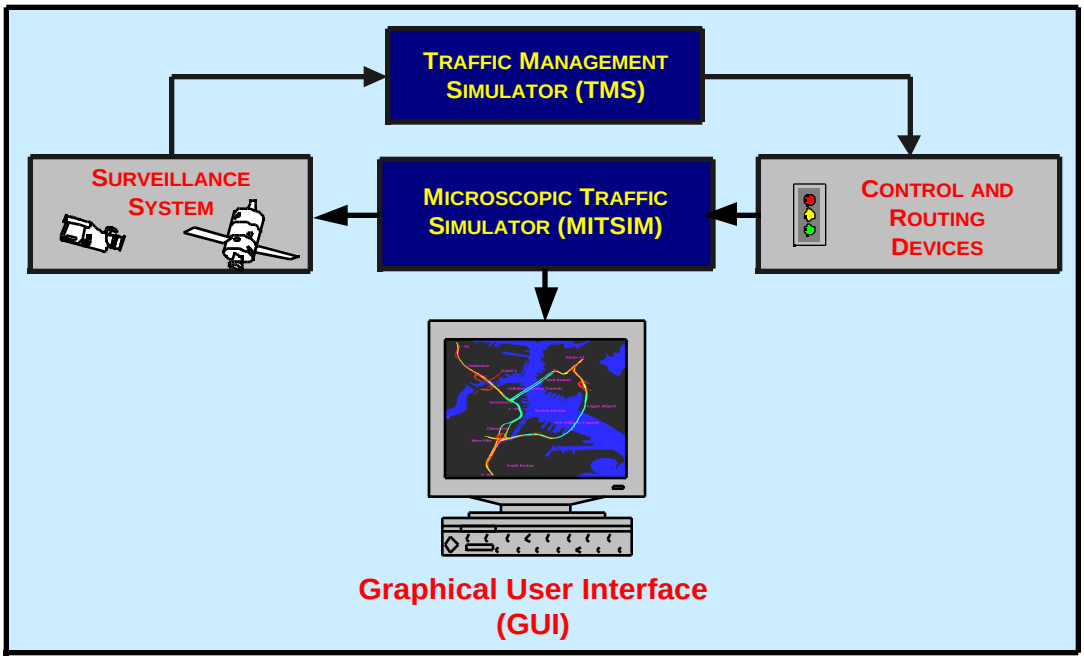

Figure 2. Elements of MITSMLab and their interactions

Traffic Flow Simulator (MITSIM). The role of MITSIM is to represent the "world". The traffic and network elements are represented in detail in order to capture the sensitivity of traffic flows to the control and routing strategies. The main elements of MITSIM are:

Network Components: The road network along with the traffic controls and surveillance devices are represented at the microscopic level. The road network consists of nodes, links, segments (links are divided into segments with uniform geometric characteristics), and lanes.

Travel Demand and Route Choice: The traffic simulator accepts as input time-dependent origin to destination trip tables. These OD tables represent either expected conditions or are defined as part of a scenario for evaluation. A probabilistic route choice model is used to capture drivers' route choice decisions.

Driving Behavior: The origin/destination flows are translated into individual vehicles wishing to enter the network at a specific time. Behavior parameters (such as desired speed, aggressiveness, etc.) and vehicle characteristics are assigned to each vehicle/driver combination. MITSIM moves vehicles according to car-following and lane-changing models. The car-following model captures the response of a driver to conditions ahead as a function of relative speed, headway and other traffic measures. The lane changing model distinguishes between mandatory and discretionary lane changes. Merging, drivers' responses to traffic signals, speed limits, incidents, and toll booths are also captured.

Rigorous econometric methods have been developed for the calibration of the various parameters and driving behavior models.

Traffic Management Simulator (TMS). The traffic management simulator mimics the traffic control system under evaluation. A wide range of traffic control and route guidance systems can be evaluated, such as:

- Ramp control
- Freeway mainline control
  - lane control signs (LCS)
  - variable speed limit signs (VSLS)
  - portal signals at tunnel entrances (PS)
- Intersection control
- Variable Message Signs (VMS)
- In-vehicle route guidance

TMS has a generic structure that can represent different designs of such systems with logic at varying levels of sophistication (from pre-timed to responsive).

Graphical User Interface (GUI). The simulation laboratory has an extensive graphical user interface that is used for both, debugging purposes and demonstration of traffic impacts through vehicle animation. Figure 3 shows examples of a GUI. The figure on the left illustrates a high level view of the network. Links are color coded to demonstrate congestion levels. The figure on the right focus on the details of the operations of a complex interchange.

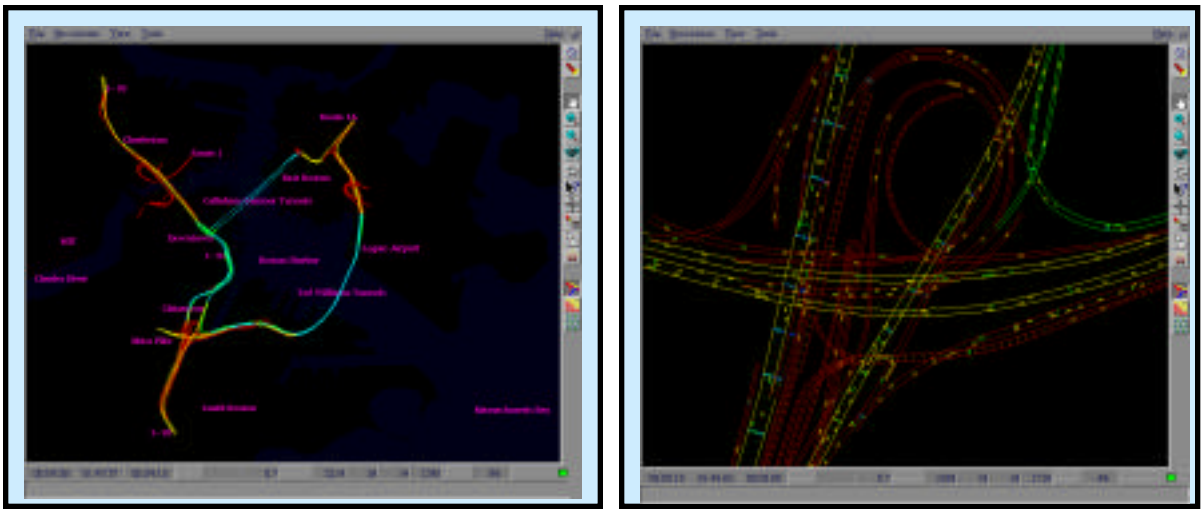

Figure 3. Example of Graphical User Interface

2. Applications

MITSIMLab is currently used in applications in the city of Stockholm, Sweden, funded by the City of Stockholm's Real Estate and Traffic Administration (GFK), which is responsible for traffic planning and operations within the city. Initially, MITSIMLab was evaluated or its applicability in that city. As part of the project, MIT enhanced the simulation models and calibrated the model parameters to match the observed conditions in Stockholm. Validation of the simulation model was performed by the Royal Institute of Technology (KTH) in Stockholm.

The network chosen for the evaluation was a ring network around Brunnsviken, north of Stockholm (see Figure 5). The network has both freeway and urban sections, and it operates under heavy congestion during the peak periods.

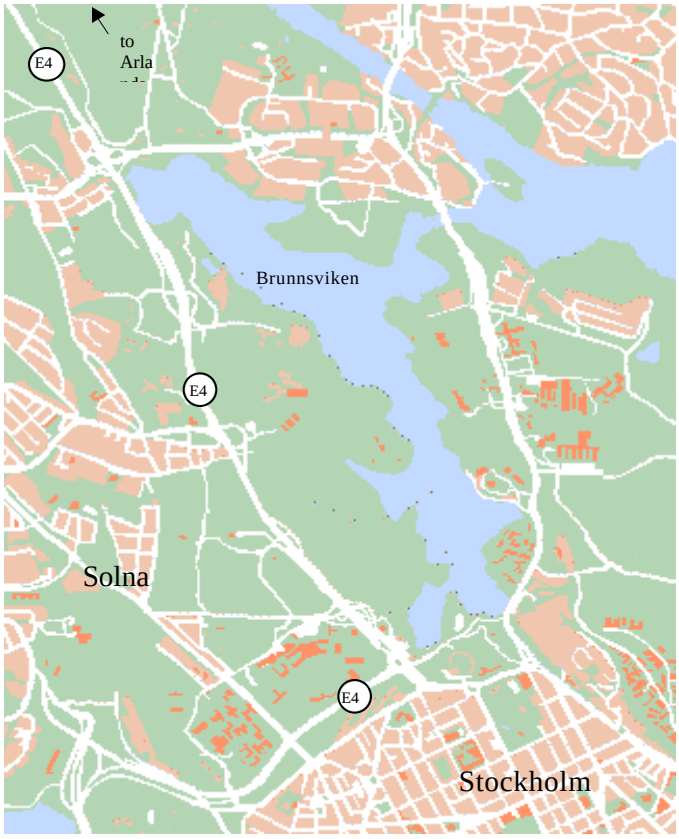

Figure 4: Stockholm simulation network

MITSIMLab was calibrated by MIT based on traffic data from observations in 1999. The calibrated MITSIMLab was then used to simulate the network conditions in 2000, and validation was performed by KTH using queue lengths and point-to-point travel times within the network. The validation showed that MITSIMLab was able to replicate the actual measurements quite well, and it was concluded that MITSIMLab should be recommended for use in Swedish cities.

MITSIMLab is currently being applied in Stockholm for GFK. The applications include evaluation of advanced signal control strategies and evaluation of strategies for bus priority at signalized urban intersections.