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Tech Brief

Development of a Simulation/Assignment Model for the NJDOT I-80 ITS Priority Corridor

FHWA/NJ-2005-011 June 2005

SUMMARY

The objective of this study was to develop a prototype dynamic traffic simulation and assignment tool to assist NJDOT engineers, planners and policy makers in decision-making and effective design. The tool adopted for this purpose is the Visual Interactive System for Transport Applications, called VISTA. The NJDOT I-80 Intelligent Transportation System (ITS) priority corridor was identified as the application corridor.

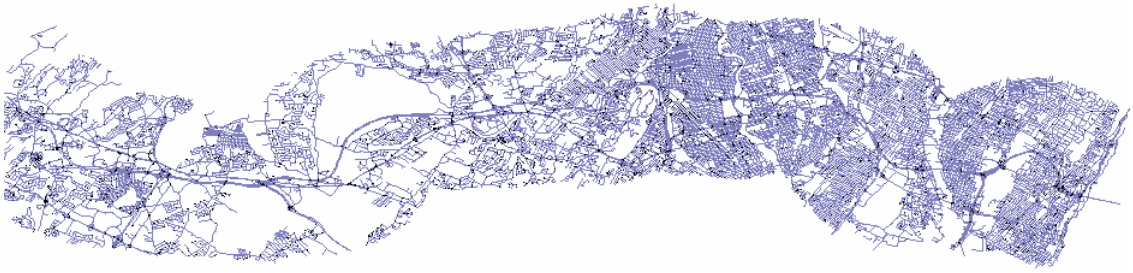

Figure 1. The I-80 Corridor Roads GIS Data from NJIT

INTRODUCTION

VISTA is a simulation-based Dynamic Traffic Assignment (DTA) models, whose principal output is the spatio-temporal trajectory of each vehicle based on route choice behavior rules [e.g. User Equilibrium (UE), System Optimal (SO)]. The DTA models were envisioned by the Federal Highway Administration (FHWA) as tools to evaluate various types of Intelligent Transportation Systems (ITS) technologies and infrastructure improvements, and overcome the inherent deficiencies of static traffic assignment models.

The main traffic flow components of the NJDOT-VISTA model are:

- A Dynamic OD matrix aggregated to 15-minute intervals was estimated from a static OD matrix obtained from the North Jersey Transportation Planning Authority (NJTPA) and 15-minute traffic counts obtained from NJDOT detection locations using a special OD estimation algorithm;
- The mesoscopic traffic simulator called RouteSim was implemented using detailed roadway geometry, GIS, traffic control data (signal timing, speed limit, lane designation). RouteSim moves the vehicles from their origin to their destination at every iteration of the DTA algorithm;
- A network loading module that assigns vehicles for each OD pair, and at each iteration on the generated paths – up to the present iteration – using an algorithm that has proven to converge to UE solution.

The main functional characteristics of the VISTA system include:

- A modern data model that is based on a PostgreSQL database. All input and output data are stored in the SQL database.
- A user-friendly GIS database platform that was specifically designed to include all necessary transportation data and interface it with the data warehouse and transportation algorithms (DTA, mesoscopic/microcopic traffic simulator RouteSim, vehicle routing, OD estimation, signal optimization) in an efficient way.
- A web-based user interface that allows any user to access it from anywhere and utilize it based on his/her authorization level.

RESEARCH APPROACH

The following tasks have been conducted to achieve the objectives:

- Conduct extensive literature review of the ITS priority corridor application.
- Collect data for the I-80 corridor
- Develop NJDOT-VISTA for the NJDOT I-80 ITS priority corridor
- Evaluate NJDOT-VISTA with Cost/Benefit Analysis case studies

All types of collected data for the I-80 corridor were obtained from the NJDOT, the NJ Turnpike Authority, TRANSCOM, the Port Authority of NY and NJ, the NJTPA, and from NJ Institute of Technology. By applying the collected data, the NJDOT-VISTA model was developed.

RESULTS

In the implementation of VISTA on the NJDOT I-80 corridor (called NJDOT-VISTA), the following functionality was demonstrated:

- Functionality, location and number of various vehicle detection devices (inductive loop detectors and fixed location Automated Vehicle Identification (AVI) detectors. TRANSCOM's System for Managing Incidents and Traffic (TRANSMIT) AVI detectors were emulated within the NJDOT-VISTA;
- An Incident Management module was implemented and enhanced that allows the user to emulate an incident (specifying the location, occurrence time, incident duration, capacity reduction) and emulate the functionality of Variable Message Signs. The user specifies the location of a VMS and selects a set of downstream paths whose estimated path travel time is desired to be displayed at a VMS. The user then has the option to specify the percentage of travelers that choose each designated path, run the DTA (UE) module (assuming that all travelers have perfect information about the incident) or simply leave the travelers to continue on the same paths as before the incident (run the RouteSim only). Several cases of incidents were emulated and parametric analysis on the potential impact of route diversion at the George Washington Bridge's (GWB) upper and lower level was conducted;
- Estimation of environmental impacts through an integrated module of VISTA and FHWA's air quality analysis software called MOBILE6;
- Implementation of a construction module and conduct of parametric analysis on potential route diversion routes in a similar manner as the incident management module;

- Evaluation of various truck related infrastructure changes such as increase/decrease the number of lanes, special lanes for trucks only. Case studies were developed in the area near the GWB.

The present form of the RouteSim simulator as implemented on the I-80 corridor that has 2,656 nodes, 5,818 links and 444,829 OD trips requires about 10 minutes to simulate a four hour time period. In another implementation in Chicago, IL for a network that has 17,122 nodes, 50,079 links and 1,142,520 OD trips, it requires 2 hours to simulate a 5-hour period. These execution times are very encouraging even for real time operations as the model could also be used to run various what-if scenarios in cases of real time emergencies (e.g. incident management).

CONCLUSIONS

- This project developed core capabilities for NJDOT within a framework known as VISTA to enable planners and engineers to evaluate basic ITS technologies considered to be used on its roadway system; as ITS technologies advance such needs for assessing their impact are expected to be increased.
- VISTA was customized for the NJDOT needs as identified by their engineers, planners and administrators in a series of meetings and tutorial sessions held throughout the project performance period.
- The I-80 corridor was identified as the application corridor, data were collected from a number of agencies that operate on this corridor, and the necessary functionality was built to address the identified needs.
- NJDOT-VISTA has been completed and demonstrated to NJDOT engineers and administrators in a final tutorial session on June 2003.

RECOMMENDATIONS

- Establish a comprehensive Universal Data Model (UDM) for NJDOT and provide full integration with all necessary NJDOT databases and statewide GIS system. NJDOT should establish seamless procedures for the continuous updating of the database, ensuring data quality and security.
- Enhance the incident management, VMS and construction zone modules and customize them for NJ corridors.

- Develop a DTA-based traffic forecasting system by integrating the VISTA system to the NJDOT's traffic surveillance system and all other related databases. The I80 could serve as a prototype since it has the most complete traffic surveillance system in NJ.
- Replace the Static Traffic Assignment (STA) that is currently used for both the NJDOT North and South transportation planning models with one DTA model for the entire state. The transportation planners, traffic engineers and policy makers will then have a common model that will provide consistency among all stakeholders that operate on New Jersey's transportation system.
- Integrate into the NJDOT-VISTA model bus and train operations, park and ride facilities and detailed truck operations and develop an intermodal NJDOT-VISTA DTA model.
- Given the establishment of a comprehensive NJDOT-VISTA DTA model, the NJDOT should require that all developers and consultants use this model to conduct their traffic impact analyses, which will provide consistency to the results of all studies.
- Develop a statewide off-line and on-line response/emergency model that would be based on the NJDOT-VISTA DTA model. Use the off-line model to conduct analyses of various emergency scenarios and potential response strategies as well as training of emergency/security personnel. Use the on-line model as a traffic-forecasting tool and as an evaluation tool of various strategies based on the current and predicted status of the transportation network under a state of emergency (hurricanes, severe flooding, fires, security threats, other).

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A final report is available online at: **http://www.state.nj.us/transportation/refdata/research/**

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609)530-3722 or send an email to **Research@dot.state.nj.us** and ask for:

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