Florida Intelligent Transportation Systems Evaluation (FITSEVAL) Tools – Phase II

Final Report

Prepared by

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For

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Contents

Literature Review

The advantage of DTA/Simulation model on ITS evaluation

DTA/Microscopic traffic simulation models are very powerful tools as they provide inexpensive, fast, and risk-free evaluation environments. They not only provide the simulation of scenarios that cannot be practically tested in real world conditions, but also allow various network wide performance measures including travel times, delay, and emissions. Traffic simulation models offer several advantages over traditional planning models. The benefits include more detailed results, superior graphics, capability to model ITS applications, and over saturated facilities.

According to Sundaram et al. (2011), the main requirements for a DTA/simulation-based model system to be used for short-term applications are:

- Realistic Simulation Models for Traveler Behavior (demand) that are sensitive to the policy variables of interest, such as capacity, pricing, and information systems. These models must also reflect heterogeneity among travelers, both to provide accurate forecasts of network performance and to estimate impacts across different classes of users.
- Dynamic Network Performance (supply) to accurately model day-to-day and within-day behavior of travelers in response to a variety of scenarios.
- Demand–supply interactions such as the estimation of time-dependent OD matrices necessary to simulate and capture dynamics.
- Representation of stochasticity, particularly important in the context of ATIS evaluation, in which much of the benefit derives from providing information under atypical travel conditions.
- Sensitivity to ITS, which requires a simulation framework that can generate both the guidance to the travelers and their response to this guidance. The system must also be able to incorporate various design parameters of traffic information provision strategies such as the frequency with which the information is updated, delay of information, and type of information (prescriptive or descriptive).

Disadvantages

1. When a microscopic traffic simulation model is used to evaluate ITS projects, it is necessary to ensure that the model reflects real world conditions. Hence, high fidelity stochastic and microscopic simulation models are used and the models are calibrated using field traffic data.

2. There is a need to develop appropriate methodology and gain experience in practical usage of traffic simulation models to evaluate ITS deployments.

Antoniou, C., Koutsopoulos,H.N., Ben-Akiva, M. and Chauhan, A.S., (2011). Evaluation of diversion strategies using dynamic traffic assignment. Transportation planning and technology. Vol. 34(3), PP. 199-216.

Antoniou et al. (2011) developed a framework for the evaluation of the effectiveness of traffic diversion strategies for non-recurrent congestion, based on predictive guidance and using dynamic traffic assignment. Predictive guidance is based on a short-term prediction of traffic conditions, incorporating user reaction to information and guidance. DynaMIT-P is used to evaluate diversion strategies based on predicted conditions, which take into account drivers' response to traffic information. The operations of VMS are evaluated in a case study. The empirical findings suggest that incident diversion strategies based on predictive guidance result in travel time savings and increased travel time reliability.

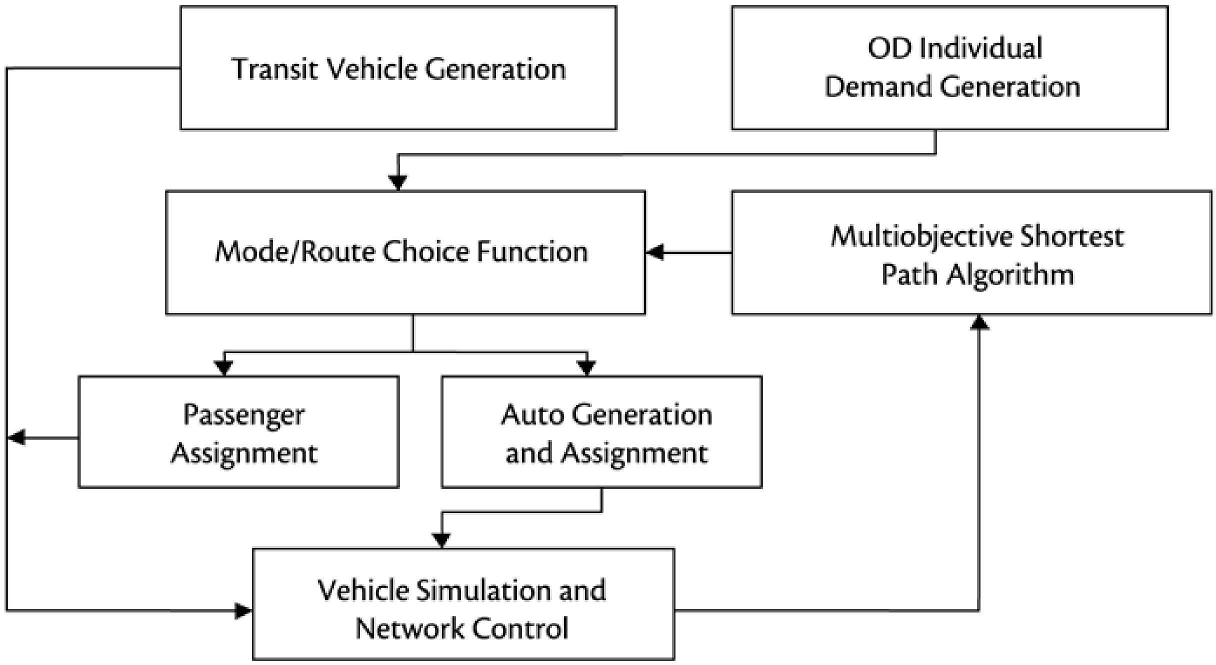
Yun, I. and Park, B. (2003). Development of ITS Evaluation Test-Bed Using Microscopic Simulation-City of Hampton Case Study. Research Report No. UVACTS-15-0-45.

Yun and Park (2003) proposed an entire process for building a microscopic traffic simulation-based test-bed for ITS using a case study. The process consists of building a basic traffic simulation network, the API development for coordinated actuated signal control and, the dynamic O-D matrix estimation for the network. In order to estimate the dynamic O-D matrix, an approach using GA and QUEENSOD method coupled with traffic simulation model is introduced. The built-in traffic signal control logic in PARAMICS is only designed for pretimed signals under single ring structure. Thus, the advanced signal control logics (coordinated actuated signal control) were developed through API in PARAMICS by C++.

Abdelghany, K.F., Abdelghany, A.F. Mahmassani, H.S., and Abdelfatah, A.S. (2006). Modeling Bus Priority Using Intermodal Dynamic Network Assignment-Simulation Methodology. Journal of Public Transportation, Vol. 9(5), PP. 1-22.

Abdelghany et al. (2006) developed a modeling framework that represents bus priority at signalized intersections in the context of its potential network-level and intermodal effects. The model incorporates bus priority within an intermodal dynamic traffic assignment simulation model. It dynamically assigns travelers to different modes and routes in the network according to prevailing traffic conditions, which result from applying a certain network control/bus priority scheme. The model considers changes in traffic conditions as a result of (1) drivers' route choice adjustments due to changes in traffic signals settings and (2) modal shifts by travelers to take advantage of improved transit service. Three different bus priority strategies are considered: phase (green) extension, red truncation, and phase advance. A set of simulation experiments is performed to compare these strategies using two different assignment scenarios: single-mode assignment and intermodal assignment. The results of these experiments highlight the importance of considering reassignment and potential modal shifts in evaluating traffic network performance under different control schemes, especially when these schemes are expected to affect the modal split in the network such as bus priority.

The developed model can capture the interaction between mode choice and traffic assignment under different traffic control schemes, and under different information provision strategies. The figure below illustrates the framework and the different components of the methodology.



Standridge, C., Choudhuri, S. and Zeitler, D. (2010). Management and analysis of Michigan intelligent transportation systems center data with application to the Detroit area I-75 Corridor. Report No: MIOH UTC TS21p1 Final MDOT Report No: RC1545.

Standridge et al. (2010) developed a framework for evaluating the benefit of guidance in re-routing traffic as a result of a traffic incident. The micro simulation model AIMSUN was used by integrating a previously developed routing model.

Evaluation of the Impacts of ITS Information Strategies on I-4 Corridor, Yueliang Zuo (2004) Master thesis University of Central Florida, Orlando, Florida.

This study evaluated the impacts of ITS information strategies under incident conditions in Interstate 4 (I-4) corridor of Orlando. The analysis was performed using DYNASMART-P software package. The ITS information strategies range from pre-trip information, en-route information, and variable message signs.

Chien, S.I, Mouskos, K.C. Ziliaskopoulos, A.K. (2005). Development of a Simulation/Assignment Model for the NJDOT I-80 ITS Priority Corridor. New Jersey DOT Final Report. NJ.

Chien et al. (2005) implemented a Dynamic Simulation/Assignment Model on NJDOT's I80 ITS priority corridor from I287 to the George Washington Bridge (GWB). The Visual Interactive System for Transport Algorithms (VISTA) was used to evaluate ITS technologies. The NJDOT-VISTA system was developed and calibrated by identifying the infrastructure data and by estimating dynamic OD matrix. The calibrated model for the I80 corridor was then utilized to construct several case studies to evaluate traffic management/operations, traveler information, and transportation planning. Specifically, the following case studies were developed:

- An incident management case study that included the evaluation of VMS sign location under incident conditions;
- A construction management case study that demonstrated the potential savings if information on the construction zone is provided to all travelers;
- A planning study on the evaluation of a set of potential combinations of VMS signs given a historical set of incident types for the network under consideration;
- A planning study on the evaluation of potential truck-related roadway improvements (special truck lanes, truck restriction).

The case studies demonstrated the substantial usefulness of DTA in ITS strategy evaluation.

Farhan, M. Martin, P.T. (2012). Evaluation of the Benefits of Route Guidance System Using Combined Traffic Assignment and Control Framework, Journal of basic and applied scientific research. Vol.2(1), PP.237-246.

Farhan and Martin (2012) evaluated the benefits of Route Guidance Systems RGS in a traffic system using Combined Traffic Assignment and Control Framework (CTAC). Eleven scenarios were tested with different proportions of RGS equipped demand under Dynamic Traffic Assignment (DTA) and vehicle actuated traffic controls. The test results suggest that system-wide travel time improvements and delay reductions can be achieved through RGS. The travel time improvement and delay reduction benefits were the minimum in the scenario with only 10% RGS equipped demand, and the benefits were the maximum in the scenario with 100% RGS equipped demand.

In this study, RGS module in VISSIM is used to re-route vehicles based on prevailing traffic conditions in each simulated-iteration. The rerouting caused by the VISSIM based RGS module is always to search the best route from the current vehicle position to the destination parking lot. The criteria for the re-routing search are the general cost with travel times measured in the current simulation. The travel times taken into account for the re-routing are not necessarily the most recent travel times but travel times measured based on user defined offset. The offset is introduced to model the processing time of typical route guidance systems. Whether a vehicle type is equipped with RGS can be selected while defining the vehicle type characteristics. The traffic composition, with proportions on equipped and non-equipped vehicles in the traffic demand can be defined using traffic composition tool of VISSIM software. For this paper, RGS was tested with 25% increments of equipped traffic demand starting from 0% equipped to 100% equipped. Two sets of scenarios were tested. The first set of tests had RGS interval of 120 minutes, and the second set of scenarios tested had 60 minutes RGS interval.

Ma, Y., Fries, R., Chowdhury, M, and Inamdar, I. (2012). Evaluation of the integrated application of intelligent transportation system technologies using stochastic incident generation and resolution modeling. Simulation. Vol. 88(1), PP. 123-133.

Ma et al. (2012) presented the use of the microscopic vehicle traffic simulation software PARAMICS to evaluate different incident management implementation alternatives in South Carolina. This study customized the simulation model for random spatial and temporal traffic incident generation, and modeled different incident alternatives through an application programming interface. This incident management system integrated incident reporting hotlines, traffic cameras, traffic sensors, and freeway service patrols (FSPs), finding that this approach to incident management outperformed the application of traffic cameras or FSPs alone. The integrated application of intelligent transportation system technologies significantly reduced incident duration and total vehicle hours of travel during an incident. In addition, FSP response policy and headway affected the incident management performance.

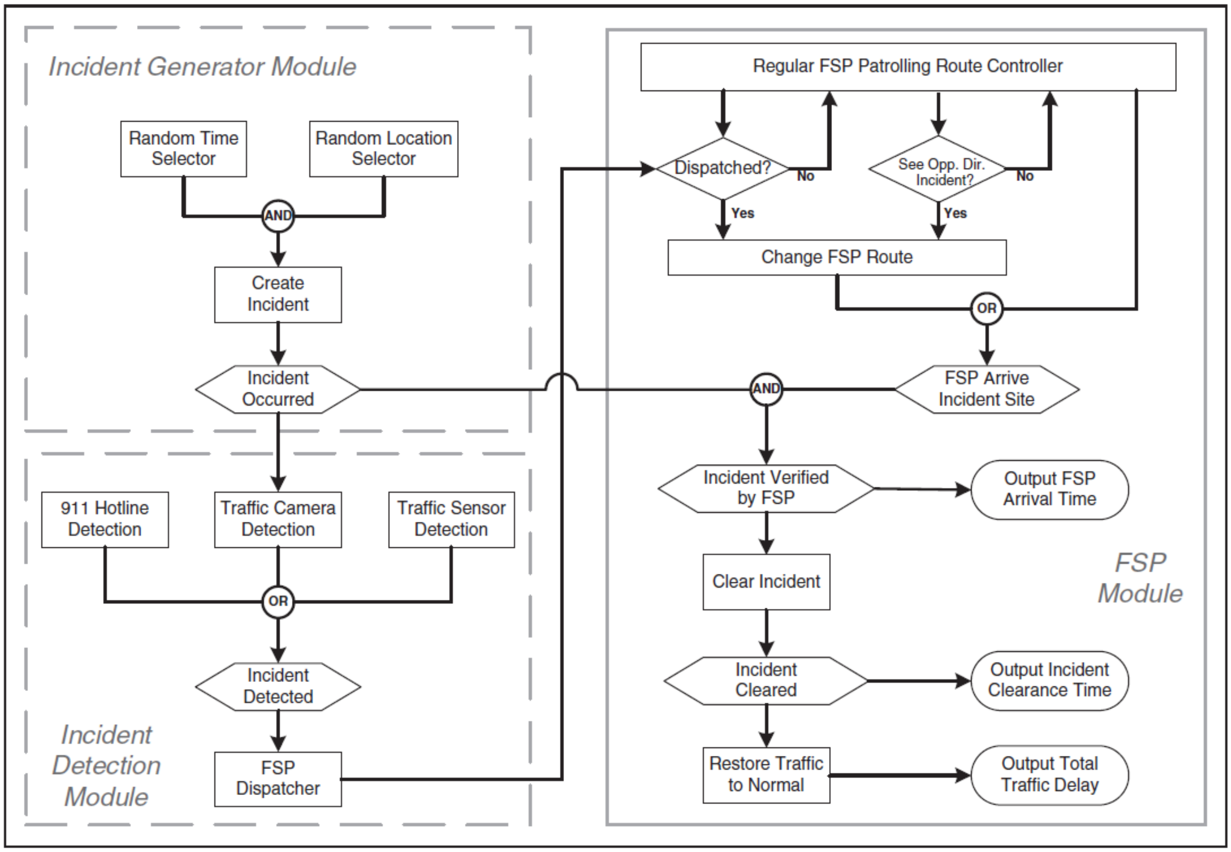
The entire model framework is presented in the figure below, which consists of three individual modules: the incident generator, incident detection, and FSP. The integrated application of ITS technologies can be modeled by incorporating all these three modules and implementing the interaction between them.

A discrete random number generator was used through the PARAMICS Programmer API to determine incident start time and a location based on the historic incident data. The incident generator randomly determined each incident blocking none, one, or two travel lanes, based on the distribution of the historical incident data.

Incident detection module includes traffic cameras, incident reporting hotlines, and freeway service patrols (FSPs). Each incident detection technology operated individually and the time distributions and response unit behavior are described as follows:

- Incident reporting hotline system detection time has a normal distribution with an average incident detection time of 126 seconds and an assumed standard deviation of 60 seconds, based on call center data for urban areas.
- The traffic camera detection and verification times were selected from a normal distribution with a mean detection time of 240 seconds and a standard deviation of 76 seconds. Once an incident was identified, the FSP immediately proceeded to the incident scene, turning around at the interchanges if necessary.

At the beginning of the simulation run, FSPs are released into the simulation network as predetermined route vehicles that follow the main freeway links. During the simulation, the FSP vehicles made the decision when to use the shoulder, based on link congestion. If the level of service of the left-most lane was F, then FSPs chose to travel on the shoulder, where the travel speed was at most 35 mph, as suggested by the South Carolina State Highway Patrol. Otherwise, FSPs traveled on the normal travel lanes.



Kaan M.A. Ozbay, K.M.A, Xiao, W., Jaiswal, G., Bartin, B., Kachroo, P., Baykal-Gursoy, M. (2009), Evaluation of incident management strategies and technologies using an integrated traffic/incident management simulation World Review of Intermodal Transportation Research Volume 2 (2-3), PP.155-186.

This paper describes Rutgers Incident Management System (RIMS) software that is developed to evaluate the benefits of various incident management strategies and technologies. This tool can generate incidents and test various response strategies and technologies. South Jersey highway network is used as a test network due to the available historical incident data. The evaluated incident management strategies include the deployment of Variable Message Signs (VMS) to divert traffic during incidents and the use of Freeway Service Patrols (FSPs) for detecting and verifying incidents efficiently. The simulation-based evaluations also include the effect of cellular phone users in the network on the incident detection and verification times. The results show that the studied incident management strategies have positive impacts on reducing incident durations while being cost effective. More specifically, the deployment of VMS for diverting traffic in case of an incident results in a benefit cost ratio of 9.2:1; an additional service unit in freeway patrol results in reduced incident detection and verification time with a corresponding benefit-cost ratio of 3.9:1.

Burghout,W., Koutsopoulos, H.N., Andreasson, I.J. (2010). Incident Management and Traffic Information Tools and Methods for Simulation-Based Traffic Prediction Transportation Research Record: Journal of the Transportation Research Board Vol.(2161), PP. 20-28.

Burghout et al. (2010) used mesoscopic simulation model MEZZO to provide decision support for incident management. Numerous essential modeling components are described and tested, including modeling the incident response logic, a mixed-logit model, and a method for generating alternatives for drivers switching routes.

Williams,B.M ., Khattak, A.J., Jia, A., Huynh, N., Hu, H., Liu, C., and Rouphail, N.M. (2011). Assessing Operational, Pricing, and Intelligent Transportation System Strategies for the I-40 Corridor Using DYNASMART-P. The North Carolina Department of Transportation Research and Development Unit, Raleigh, NC.

Williams et al. (2011) assessed the system performance impacts of a variety of operational strategies for I-40 corridor. The strategies include HOV/HOT lanes, congestion or value pricing, ramp metering, system-wide signal coordination, incident and work zone management, and expanded traveler information. The model's performance assessment capability was demonstrated through application of the Triangle DynusT model to a series of carefully selected evaluation scenarios.

DynusT can only simulate a time-dependent toll rate for HOT lanes. In order to apply relatively reasonable toll rate (for SOV users) in the HOT lanes scenario, the following steps were undertaken:

- If the corridor density is greater than 25 veh/mi, the toll rate is set at $1/mile, which is based on the maximum toll rates ($/mile) of the HOT applications in U.S. based on a scan of a readily available online information;
- If the density is less than 25 veh/mi, the toll rate will be set based on multiple trials using toll rates of $0.1/mi, $0.25/mi, $0.5/mi and $0.75/mi. The minimum toll rates that will keep the corridor density below 25 veh/mi are selected.

Since the traffic-responsive ramp metering algorithm in the current version of DynusT does not yield reasonable results, Williams et al. (2011) employed an analogous way to determine the metering rate by using the following metering rate table suggested by FHWA (2003):

Suggested Metering Rate based on Occupancy

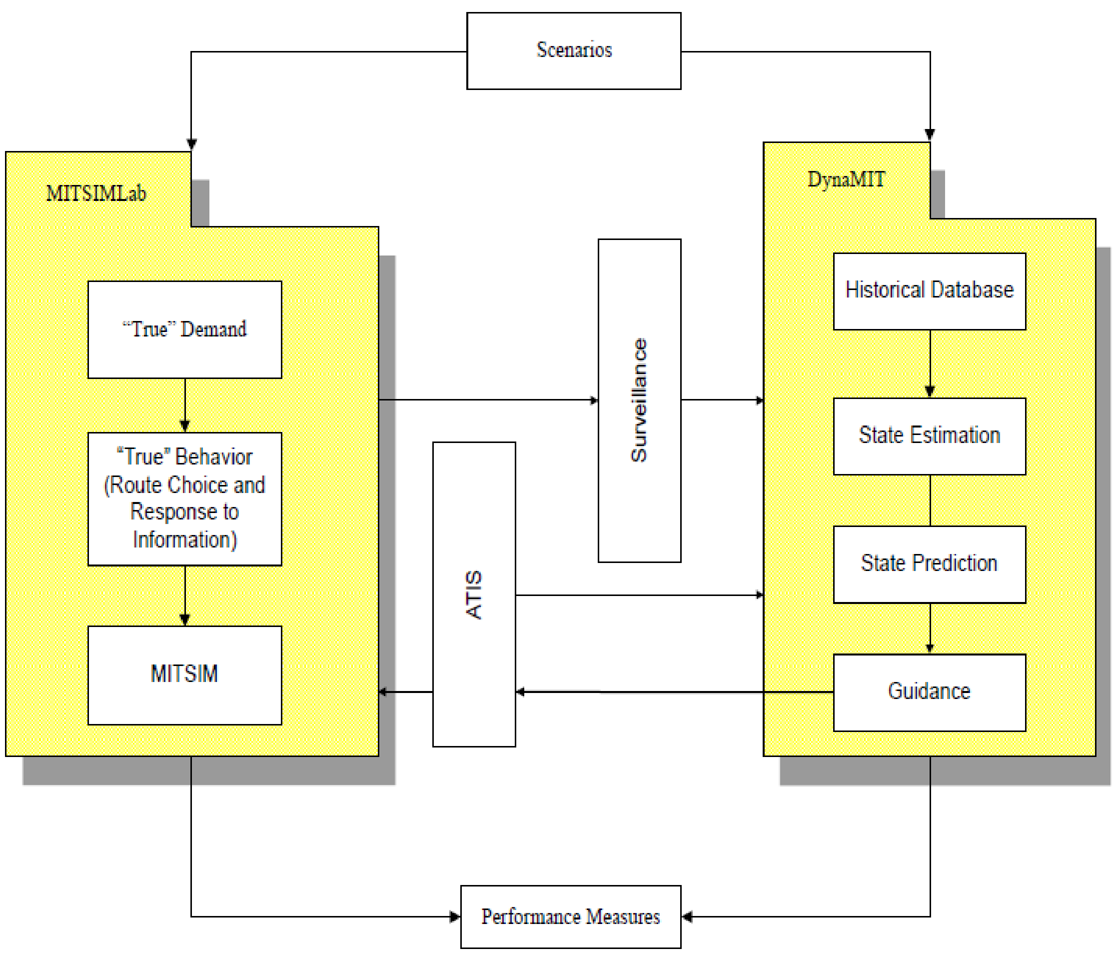
Occupancy (%)	**Metering Rate (Vehicles/Minute)**
≤10	12
11-16	10
17-22	8
23-28	6
29-34	4
>34	3

Source: Freeway Management and Operations Handbook

Rathi, V. (2007). Assessment of Impact of Dynamic Route Guidance through Variable Message Signs, Master Thesis. Massachusetts Institute of Technology, Cambridge, MA.

Rathi (2007) evaluated the performance of VMS with the dissemination of predictive route guidance in case of severe incidents. The evaluation was done by developing a tool using the "closed loop" integration between MITSIMLab, a microscopic traffic simulator as a proxy for the real traffic conditions, and DynaMIT, a DTA tool that is capable of generating predictive and consistent guidance. A case study was performed to show the benefits of using VMS by simulating incidents of major severity in Lower Westchester County, NY.

The overall framework integrating MITSIMLab and DynaMIT in a "closed loop" is presented in Figure below. MITSIMLab provides DynaMIT with surveillance reports (i.e. sensor counts) of simulated "real world" traffic flows. DynaMIT uses the surveillance report to perform consistent demand estimations and to generate unbiased guidance predictions. These guidance forecasts are relayed to MITSIMLab for dissemination to simulated drivers. The results of the MITSIMLab simulation are representative of what would occur in reality, and any relevant measures of effectiveness available in the MITSIMLab reporting capabilities can be used as a basis for an evaluation of the effectiveness of ATIS.



Kamga, C.N., Mouskos, K.C. and Paaswell, R.E. (2011). A Methodology to Estimate Travel Time Using Dynamic Traffic Assignment (DTA) Under Incident Conditions. Transportation Research Part C, Vol. 19, PP. 1215–1224. What kind of DTA software.

Kamga et al. (2011) present results from a research case study that examined the distribution of travel time of origin–destination (OD) pairs on a transportation network under incident conditions. By using a transportation simulation dynamic traffic assignment (DTA) model, incident on a transportation network is executed under normal conditions, incident conditions without traveler information availability, and incident conditions assuming that users had perfect knowledge of the incident conditions and could select paths to avoid the incident location. The results suggest that incidents have a different impact on different OD pairs. The results confirm that an effective traveler information system has the potential to ease the impacts of incident conditions network wide. Yet it is also important to note that the use of information may detriment some OD pairs while benefiting other OD pairs. The methodology demonstrated in this paper provides insights into the usefulness of embedding a fully calibrated DTA model into the analysis tools of a traffic management and information center.

Sundaram, S. ,Koutsopoulos, H.N., Ben-Akiva, M. , Antoniou, C. and Balakrishna, R. (2011). Simulation-based dynamic traffic assignment for short-term planning applications. Simulation Modeling Practice and Theory, Vol. 19, PP. 450–462.

Sundaram et al. (2011) present a methodological simulation-based framework for ITS evaluation and implement it in the context of dynamic traffic assignment. The framework consists of a mesoscopic supply simulator and a demand simulator that combines OD estimation capabilities with discrete travel behavior models.

The figure below represents the framework to model an ATIS system with instantaneous travel time information. The frequency with which the information is updated is a design parameter and is an input. The planning OD matrix is disaggregated to produce a list of travelers. Based on the information available about the percentage of unguided and guided travelers, the list of travelers is divided into two driver classes: informed and uninformed drivers. The habitual paths of both classes of drivers are obtained by the standard route choice model using the equilibrium travel times. Uninformed travelers are loaded into the supply with the habitual paths and do not make en-route decisions unless they encounter a VMS message. Informed vehicles, on the other hand, may change their routes dynamically based on both in-vehicle and VMS information.

Instantaneous information is obtained by aggregating travel time information from the supply, after every information update period. These informed drivers then make en-route choices depending on the travel times supplied to them, using appropriate compliance and en-route choice models. The travel times provided to drivers can be on certain links or on certain paths depending on the characteristics of the ATIS. In the case of a VMS message, information could either be prescriptive (recommended routes) or descriptive (information regarding travel times/delays on certain links or paths). During the supply simulation, whenever any vehicle passes a link, which has a VMS message, the driver may respond to VMS with certain probabilities. Typically, a compliance model, (e.g. a simple binary LOGIT model) can be used to update the path in the case of prescriptive information. In the case of descriptive information, the utilities for the en-route choice models are computed based on the travel times provided by the

VMS (for the specific links or paths) and equilibrium travel times for all the other links. A nested LOGIT model could also be used for this purpose, where the first decision level is to decide whether to comply with the VMS message or not and the second level of decision-making is to update the current path.

The figure below represents the framework to model an ATIS system with predictive travel times information. An important aspect of traffic prediction is the concept of consistency. Based on the guidance provided, travelers' response to the guidance will influence network conditions and hence the guidance strategy. Any ATIS based on predictive guidance has to iterate so that the outcome of the guidance strategy matches the network conditions after travelers' reactions to the guidance. An initial set of predicted travel times is assumed (typically the equilibrium travel times) and network conditions are simulated. Based on the simulated travel times, algorithms are used to predict new travel times which are used for guidance generation. If the resulting travel times do not match the predictive travel times provided to travelers, then consistency has not been achieved and more iterations are necessary, as indicated by the solid line in the following figure. On convergence, a consistent guidance strategy is obtained. The guidance-generating algorithm generates the new set of travel times by a linear combination of the previous guidance and the latest simulated travel times.

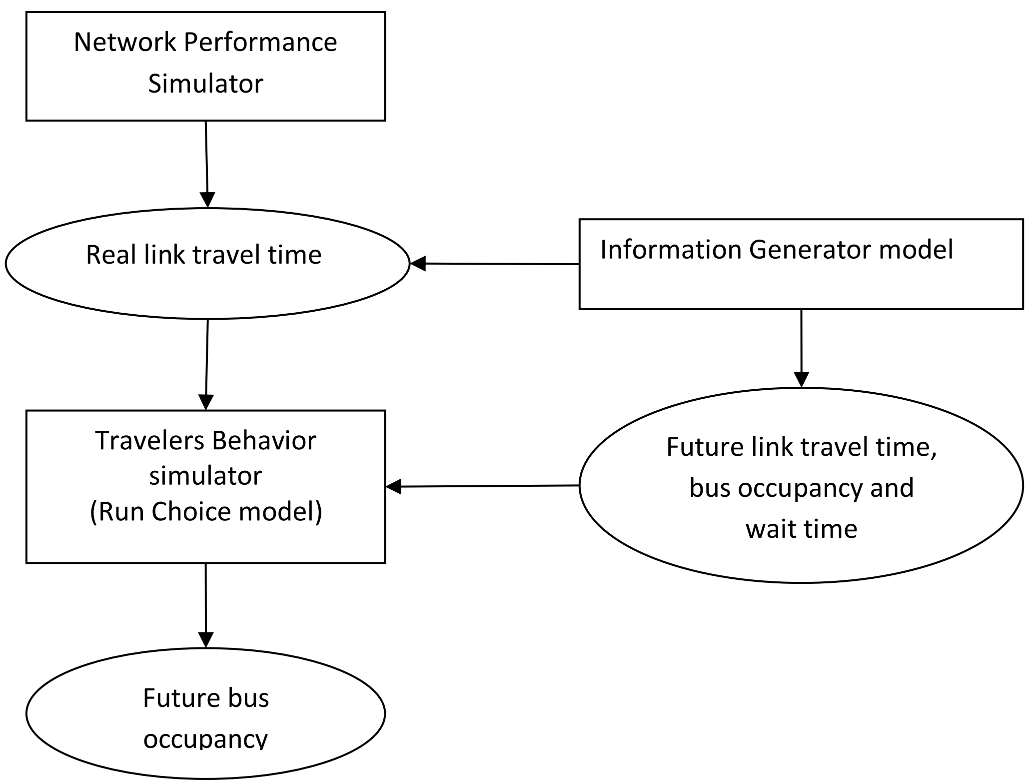
(a) Modeling instantaneous ATIS scenarios (b) Modeling predictive ATIS scenarios

Coppola, P., and Rosati, L. (2009). Simulation-based evaluation of advanced public transportation information systems (APTIS). in Wilson, N. H. M and Nuzzolo, A. (Ed.), Schedule-Based Modeling of Transportation Networks: Theory and Applications (pp. 195-216), New York: Springer.

Coppola and Rosati (2009) used a realistic case study of the city of Naples (South-Italy), to investigate the impacts of information offered in a Public Transportation (PT) network under different network conditions (i.e. irregular vs. regular services, congested vs. un-congested lines). The focus is on APTIS deploying shared en-route descriptive information. The results presented are based on the simulation of the three main components of the PT system, namely the network, the information provider (i.e. the Operation Control Center), and the travelers. The simulation of these components and their interaction is achieved using different modeling approaches as:

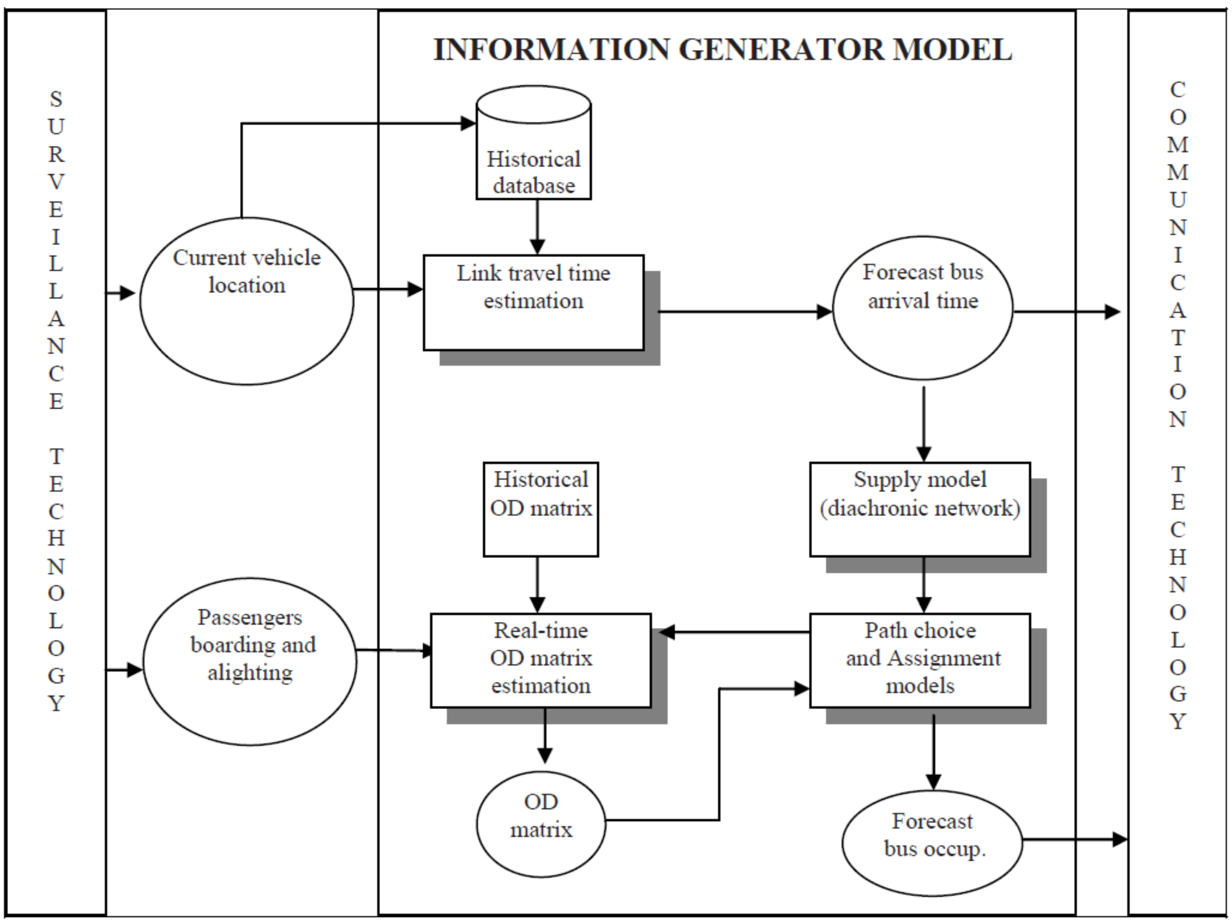
- The schedule-based approach for the network representation and traffic assignment,
- A statistical model based on the Kalman filter for the prediction of the network performance within the simulation period, and
- Behavioral discrete choice models, based on Random Utility Theory, for simulating traveler's behavior under different network conditions and information availability.

The simulation schematic representation of this study is shown as follows.



The modeling architecture developed to forecast real-time, the bus arrival times at the stops, and the bus occupancy is conceived to work in a software environment interfaced (Coppola and Rosati, 2002). On the one hand, with a surveillance system gathering raw data from the "real world" and, on the other hand, with a communication system broadcasting the transformed data (i.e. the information) to PT operators and travelers. The surveillance systems consist of monitoring technologies such as Global Positioning System (GPS), Automated Vehicles Monitoring (AVM), and Infra-Red Motion Analysis (IRMA). Such technologies are able to detect the location of the buses on the network at any point in time, the number of passengers boarding alighting from a bus at stops, and transmit these to the Operation Control Center (OCC). Based on the data collected, the model systems proposed can predict the arrival time and the level of occupancy of the incoming buses at the stops.

Finally, this information can be transmitted to the operators and the travelers by means of the communication system consisting of long-range radio communication, cables, etc. A schematic representation of the model system developed to predict the above information is depicted in below figure. Here the main components of the model as well as the interactions with the external environment (the surveillance system and the communication technology) are clearly outlined. It can be seen that the main components of the model system are the link travel time estimator and schedule-based dynamic transit assignment model.



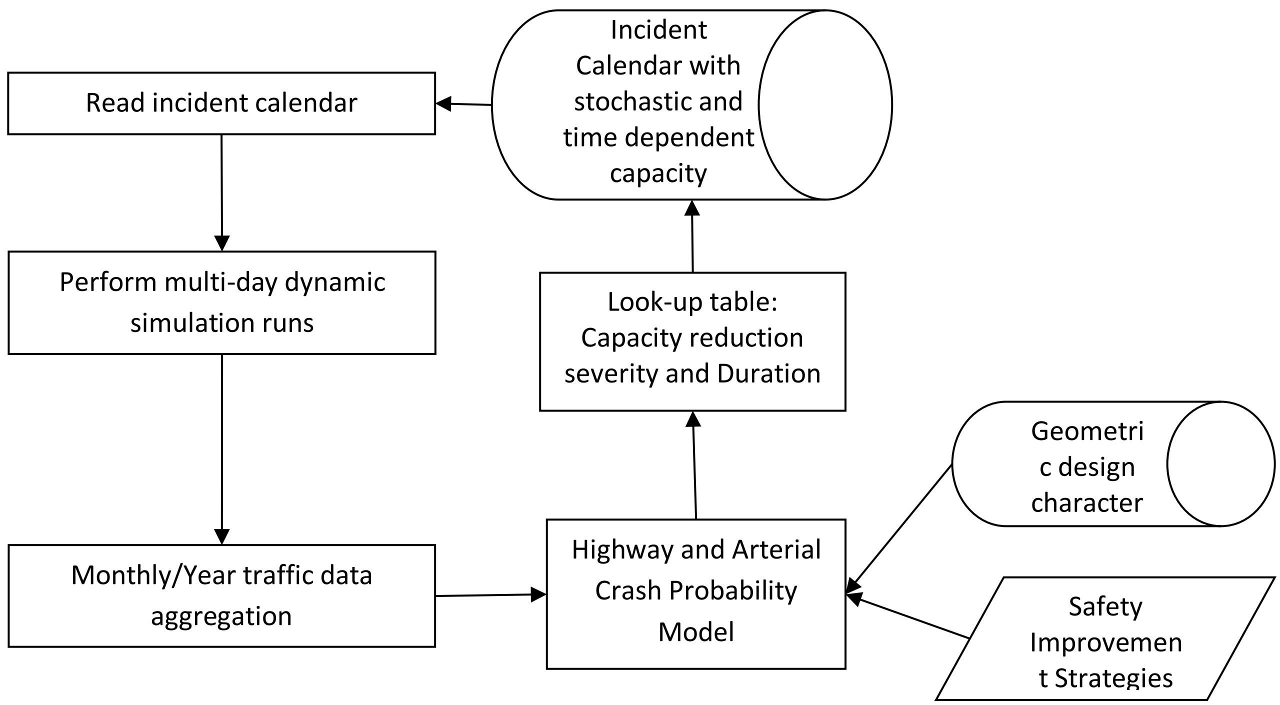
Run arrival times and occupancy predictions are based on the modeling framework schematically depicted in the above figure. In principle, arrival time prediction are simpler than run occupancy prediction since they do not require the simulation of traveler’s behavior with respect to current network condition and to information provided. Examples of algorithms to predict link travel times and hence arrival times at stops are widely reported in the literature (Miyata et al. 1997).

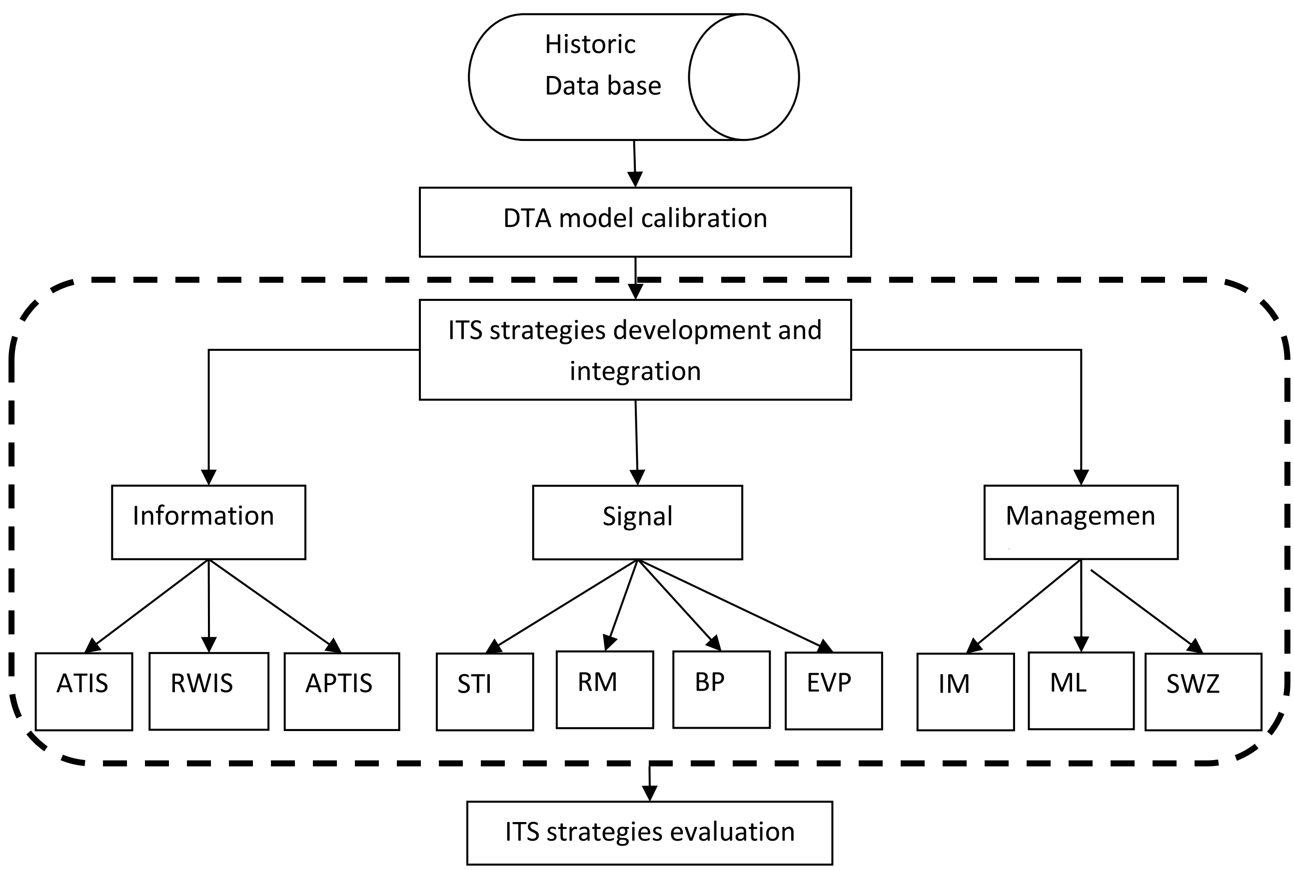
The overall modeling framework built up to predict run occupancy in PT network consists of:

- A time-varying O-D matrix estimation procedure based on real-time observation of number of passenger boarded and alighted from vehicles at stops;
- A supply model aiming at representing time-dependent transit network, whose temporal co-ordinates are updated in real time in relation to the information on vehicle location;
- A sequential path choice model based on random utility theory, simulating PT traveler behavior;
- A within-day dynamic assignment procedure following a schedule-based approach, estimating the loads on each run of the transit system at any time of the reference period.

Przybyla, J., Taylor, J., Zhou, X. and Porter, R.J. (2012). Crash Event Modeling Approach for Dynamic Traffic Assignment. The Compendium of the 4th Transportation Research Board Conference on Innovations in Travel Modeling (ITM), Tampa, Fl.

Przybyla et al. (2012) used a dynamic traffic assignment approach to model safety. By using an incident calendar, the vehicles are assigned to an OD pair based on the shortest path. Multi-day simulations are run which will output the average link travel times across different days. The link with the least expected travel time path can be identified and a path assigned shift can be done to move vehicles to the shortest path. The model is then checked for convergence using a gap function. When the model converges, a crash probability model is introduced which can consider the effects of highway design characteristics and safety improvement strategies. A new incident calendar is developed, which includes stochastic and time-dependent capacity for all links by day, and the model is reiterated. Additionally, link travel times are determined using a hybrid analytical/simulation approach to improve simulation run times. This model represents a significant enhancement compared to previous related studies, where static safety estimates and deterministic queue analysis techniques limited analytical capabilities.


Incident Calendar with stochastic and time dependent capacity
Read incident calendar
Perform multi-day dynamic simulation runs
Look-up table: Capacity reduction severity and Duration
Geometric design character
Monthly/Year traffic data aggregation
Highway and Arterial Crash Probability Model
Safety Improvement Strategies


Historic Data base
DTA model calibration
ITS strategies development and integration
Information
Signal
Managemen
ATIS
RWIS
APTIS
STI
RM
BP
EVP
IM
ML
SWZ
ITS strategies evaluation

Elefteriadou, L., Washburn,S.S., Yin, Y., Modi, V., and Letter, .C. (2012). Variable Speed Limit (VSL) – Best Management Practice. FDOT Contract BDK77 977-11. The FDOT Research Center. FL.

The Variable Speed Limit (VSL) system on the I-4 corridor in Orlando was implemented by the Florida Department of Transportation (FDOT) in 2008, and since its deployment, it was revealed that the majority of traffic exceeds the speed limit by more mph when the speed limit is reduced versus when it is at the baseline level. The overall objective of this project was to gain a better understanding of the drivers' perception of the I-4 VSL system, to evaluate operations along the VSL zone of the I-4, and to investigate VSL strategies that have the potential to improve operations along I-4. Focus group studies as well as in-vehicle observation studies were conducted to evaluate driver perceptions. Participants indicated they would typically not reduce their speeds unless the drivers/motorists in their surroundings reduce theirs, and they suggested installing the VSL sign boards on both sides of the roadway and, if possible, on the overhead sign boards at each lane. Through a combination of sensor data analysis and aerial reconnaissance, the research team identified bottleneck locations and congestion times. Based on these, a CORSIM simulation of the I-4 VSL zone was built in order to evaluate various potential VSL algorithms and their respective settings. It was concluded that changing the detector configuration and using the data from the worst performing detector have the potential to increase speeds and to improve operations for some of the VSL scenarios tested. A VSL system along I-4 may be able to provide some limited operational improvement at specific bottlenecks and/or along the entire network. However, there is no clear pattern regarding the type of algorithm that would be most beneficial at a particular bottleneck, nor any clear patterns regarding the VSL sign configuration.

Existing Sketch Planning Tools for ITS evaluation

Intelligent Transportation Systems (ITS) planning requires the use of tools to assess the performance of ITS deployment alternatives relative to each other and to other types of transportation system improvement alternatives. A number of sketch planning tools have been developed to support the evaluation of ITS alternatives based on the utility-based and/or the economical-based approaches. These tools range in details from simple spreadsheets with simplified assumptions like the Screening Analysis for ITS (SCRITS) tool, to more sophisticated tools like the ITS Deployment Analysis System (IDAS), and the ITS Options Analysis Model (ITSAOM).

The FDOT led an effort to develop an approach to interface the FSUTMS and IDAS programs. An additional FDOT effort, customized the IDAS benefit and cost parameters and databases to better reflect the Florida benefit/cost values.

Despite the powerful modeling capabilities of IDAS, a number of issues are associated with its use to evaluate ITS alternatives in Florida. First, IDAS includes internal models that are different from the calibrated regional demand models. This results in inconsistencies in the evaluation and forecasting processes between IDAS and the regional models. Second, IDAS was written in the mid 1990s, thus rendering the software‘s operations and user interface relatively inflexible and out-of-date. Third, the evaluation methodologies and the ITS components included in the IDAS evaluations were established in the 1990s, when the ITS field was just beginning to be deployed. The ITS field has experienced considerable developments and advancements since then. Thus, a re-evaluation of the methodologies and parameters used in sketch planning tools in needed, based on what has been learned in the past 10 years of ITS deployments.

The Intelligent Transportation Systems (ITS) Deployment Analysis System (IDAS)

The Intelligent Transportation Systems (ITS) Deployment Analysis System (IDAS) is an ITS sketch planning analysis tool that can be used to estimate the impacts and costs resulting from the deployment of various ITS components. IDAS assesses changes in several performance measures, such as travel time/speed, travel time reliability, fuel costs, operating costs, accidents, emissions, and noise. IDAS also provides benefit to cost comparisons of ITS improvements individually and in combinations. IDAS can assess the impacts and costs of 12 different categories of ITS deployments. These deployments include: arterial traffic management systems (ATMS), freeway traffic management systems (FTMS), advanced public transit systems (APTS), incident management systems (IMS), electronic payment collection, rail road grade crossings, emergency management services, regional multimodal traveler information systems, commercial vehicle operations (CVO), advanced vehicle control and safety systems, supporting deployments, and generic deployments. The IDAS software includes default values for the inputs required to calculate the costs and benefits of ITS deployments. These defaults are based on the analysis of the data presented in the USDOT ITS Benefits and ITS Unit Costs Databases. The default benefits are also based on an extensive review of literature performed by the IDAS developers during the initial development stages of the software. IDAS also allows users to assign weights to ITS project performance measures to determine the overall benefit valuation of the project.

ITSOAM (The ITS Options Analysis Model)

The ITS Options Analysis Model (ITSOAM) is an intelligent transportation system sketch planning tool developed for the New York State Department of Transportation by Calspan UB Research Center and the University of Buffalo. The ITS elements evaluated in the ITSOAM software are:

- Advanced traveler information systems including dynamic message signs (DMS), highway advisory radio (HAR), information kiosks, and other non-subscription information services.
- Detection sensors and surveillance systems
- Highway emergency service patrol
- Adaptive ramp metering
- Adaptive traffic control systems
- Road weather information systems
- Weigh-in-motion

ITSOAM does not calculate the benefit/cost ratios of ITS deployment alternatives. Rather, it estimates the benefits of the alternatives.

SCRITS (SCReening for ITS)

SCRITS (SCReening for ITS) is a spreadsheet analysis tool for estimating the benefits and costs of ITS. SCRITS is structured in a Microsoft Excel workbook format and requires the user to provide baseline data from other local sources such as count data and demand forecasting model data. Examples of SCRITS inputs include vehicle miles traveled and vehicle hours travelled. SCRITS produces benefit estimates based on total daily data. The only analysis that uses peak period analysis is the ramp metering analysis. Sixteen ITS applications are included in the SCRITS spreadsheet. The SCRITS manual states that applications were selected based on a prioritization of analysis needs and an assessment of information available to use as the basis for analysis. The sixteen applications included in the SCRITS spreadsheets are:

- Closed circuit television (CCTV)
- Detection
- Highway advisory radio (HAR)
- Variable message signs (VMS)
- Pager-based systems
- Kiosks
- Commercial vehicle operations (CVO) kiosks
- Traffic information over the Internet
- Automated vehicle location (AVL) systems for buses
- Electronic fare collection for buses
- Signal priority for buses
- Electronic toll collection
- Ramp metering
- Weigh-in-motion (WIM) systems
- Highway/rail grade crossing applications
- Traffic signalization strategies

Performance Measure	IDAS	SCRITS	ITSOAM
Mobility			
Time Savings	√	√	√
Travel Time Reliability	√		
Safety			
Accident	√	√	√
Vehicle Operation			
Fuel Consumption	√	√	√
Non-fuel Operation Costs	√		
Environment			
Emissions	√	√	√

Note: IDAS actually calculates travel time reliability as non-recurring delay.

Incident management

Neither IDAS nor ITSOAM consider the benefits of incident management on arterial streets due to the difficulty in estimating incident impacts on arterial streets.

As in IDAS, it is assumed that 21 percent of fatalities are shifted to injuries due to quick incident detection, verification, and response of incident management systems. However, in addition to the above benefits, a reduction in accident rate is assumed due to an expected reduction in secondary accidents since the incident management system reduces the period of time that the hazardous driving conditions exist due to primary incidents.

Instead of using default reduction factors for emissions and fuel consumption due to incident management as is done in IDAS, the FSUTMS implementation calculates the emission and fuel consumption with and without incident management based on the speeds of queued and non-queued vehicles and the vehicle-miles in queue.

Driver information dissemination

IDAS assumes that the benefits per diverted vehicle is assumed to be constant and is not affected by traffic or incident conditions. In addition, driver information dissemination is treated as a separate component from incident management with the number of DMS activations are set as a user input independent of the number of the incidents on the freeway. In reality, the number of DMS activations is a function of the total number of incidents and/or the number of lane blockage incidents, depending on the policy of DMS activation in the region. In addition, the diversion rate and savings due to this diversion is expected to be a function of the incident severity and the conditions in the network.

Advanced Traveler Information Systems

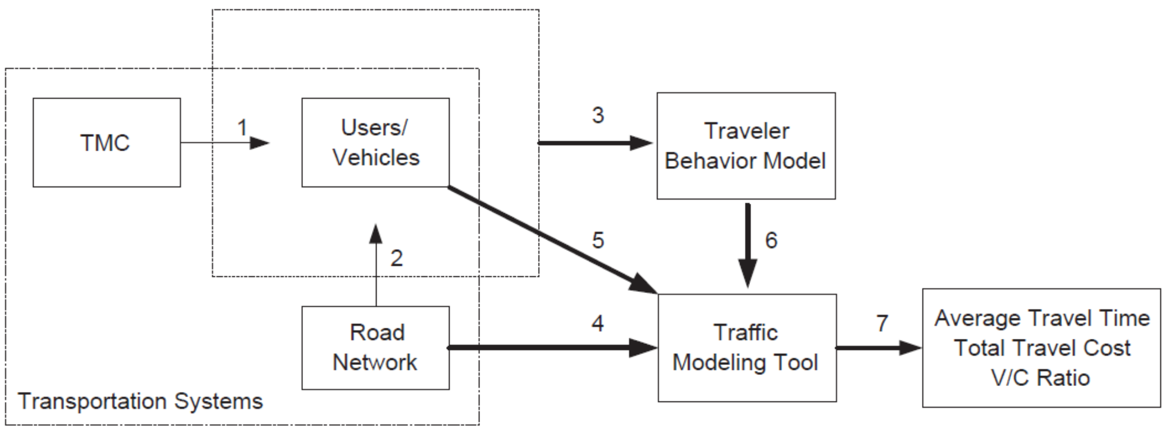
Zhang L., and Levinson, D. (2008). Determinants of Route Choice and Value of Traveler Information: A Field Experiment. Transportation Research Record: Journal of the Transportation Research Board, No. 2086, PP. 81-92.

Drivers receive value from traveler information in several ways, including the ability to save time, but perhaps more important is the value of certainty as it affects other personal, social, safety, or psychological factors. This information can be economically valued. The benefit of reduction in driver uncertainty when information is provided at the beginning of the trip is the main variable measured in this research. User preferences for routes were assessed as a function of the presence and accuracy of information while controlling for other trip and route attributes. Data were collected in a field experiment in which 113 drivers, given real-time travel time information with varying degrees of accuracy, drove four alternative routes between a preselected origin-destination pair in the Twin Cities, Minnesota, metropolitan area. Ordinary regression, multinomial, and rank-ordered logit models produced estimates of the value of information with some variation. Results showed that travelers were willing to pay up to $1 per trip for pretrip travel-time information. The value of information is higher for commute and event trips and when congestion on the usual route is heavier. The accuracy of the traveler information was also a crucial factor. Travelers will not pay for information unless they perceive it to be accurate. Most travelers (70%) prefer that such information be provided free by the public sector, whereas some (19%) believe that it is better for the private sector to provide such service at a charge.

Pan, X., and Khattak, A.J. (2008). Evaluating Traveler Information Effects on Commercial and Noncommercial Users. Transportation Research Record: Journal of the Transportation Research Board, No. 2086, PP. 56-63.

Incidents often account for nearly half of traffic congestion in urban areas and add uncertainty to transportation networks. The costs of incident induced congestion, often in the form of delays, are borne by motorists and commercial carriers or associated businesses. In fact, a higher burden is borne by commercial carriers, given their higher costs and value of time. Dynamic traveler information about incidents disseminated through electronic media can benefit users. The extent of benefits associated with dynamic traveler information and whether network delays increase or decline were explored when (a) travelers can observe incidents, (b) commercial truck percentages increase in traffic, (c) truck drivers divert to alternate routes in the same way motorists do, as opposed to having lower diversion rates, and (d) commercial trucks have a higher value of time compared with passenger vehicles. With a behavioral route diversion model, the movement of commercial trucks and passenger vehicles in a simple transportation network was simulated. The results show how dynamic traveler information may or may not benefit commercial and noncommercial users under different scenarios.

This study attempts to fill in the gaps in the literature by exploring the benefits of dynamic information when commercial truck percentages increase in the traffic stream, when commercial trucks divert to alternate routes in the face of incident congestion, and when commercial trucks have a higher VOT.



The real transportation system can be represented as a combination and an interaction of users, vehicles, and road network.

One of them is to disseminate dynamic traveler information to road users and vehicles (Arrow 1). At the same time, users and vehicles themselves may or may not observe the incident-induced queue from the road network (Arrow 2). These messages (whether a user or vehicle receives traveler information and whether a user or vehicle observes incident-induced congestion) are inputs to a traveler behavior model (Arrow 3). The output of this behavioral model is the travelers' route choice.

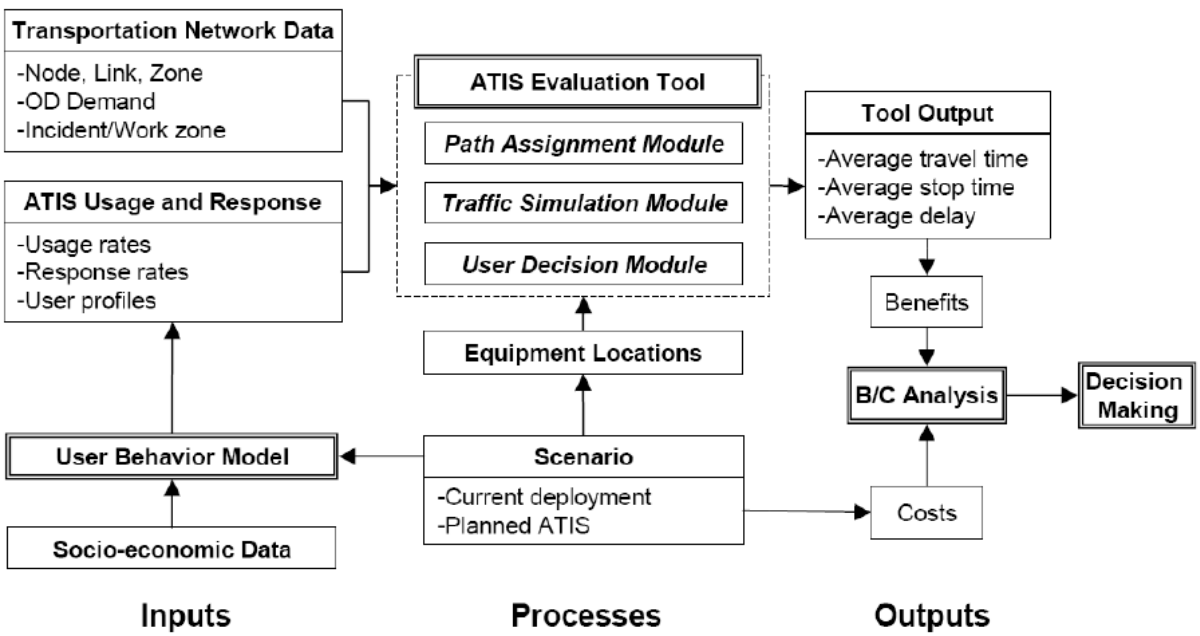
Three types of information are provided to the traffic flow modeling tool for evaluating the dynamic traveler information. First, the road network information together with the traffic flow condition is needed (Arrow 4). Then, user or vehicle information is needed to test whether information provides dissimilar benefits to different users or vehicles, under incident-induced congestion (Arrow 5). Finally, travelers' route choice from the traveler behavior model is an important aspect for evaluating the traveler information system (Arrow 6). Outputs of the composite modeling tool include network average travel time, total travel time, and volume over capacity (v/c) ratio, which are direct performance measures for the proposed traveler information evaluation process (Arrow 7).

A behavioral model (Binary Logit model) was chosen on the basis of a behavioral survey of travelers. Specifically, the survey focused on automobile travelers who made repeated trips to downtown Chicago.

Traffic flow modeling

The FREEVAL model was used in this study to estimate the effects of queuing and vehicle delay for traffic flow, even for incident conditions. FREEVAL replicates the freeway facility methodology in Chapter 22 of the Highway Capacity Manual 2000 (30), which enables modeling of the effect of incidents on traffic operations macroscopically. A macro was compiled to represent the proposed traveler behavior model, which is combined with the FREEVAL modeling tool for evaluating a traveler information system.

Hu, H. (2009). Measuring the Effectiveness of Advanced Traveler Information Systems (ATIS). Ph.D. Dissertation. North Carolina State University. Raleigh, North Carolina.



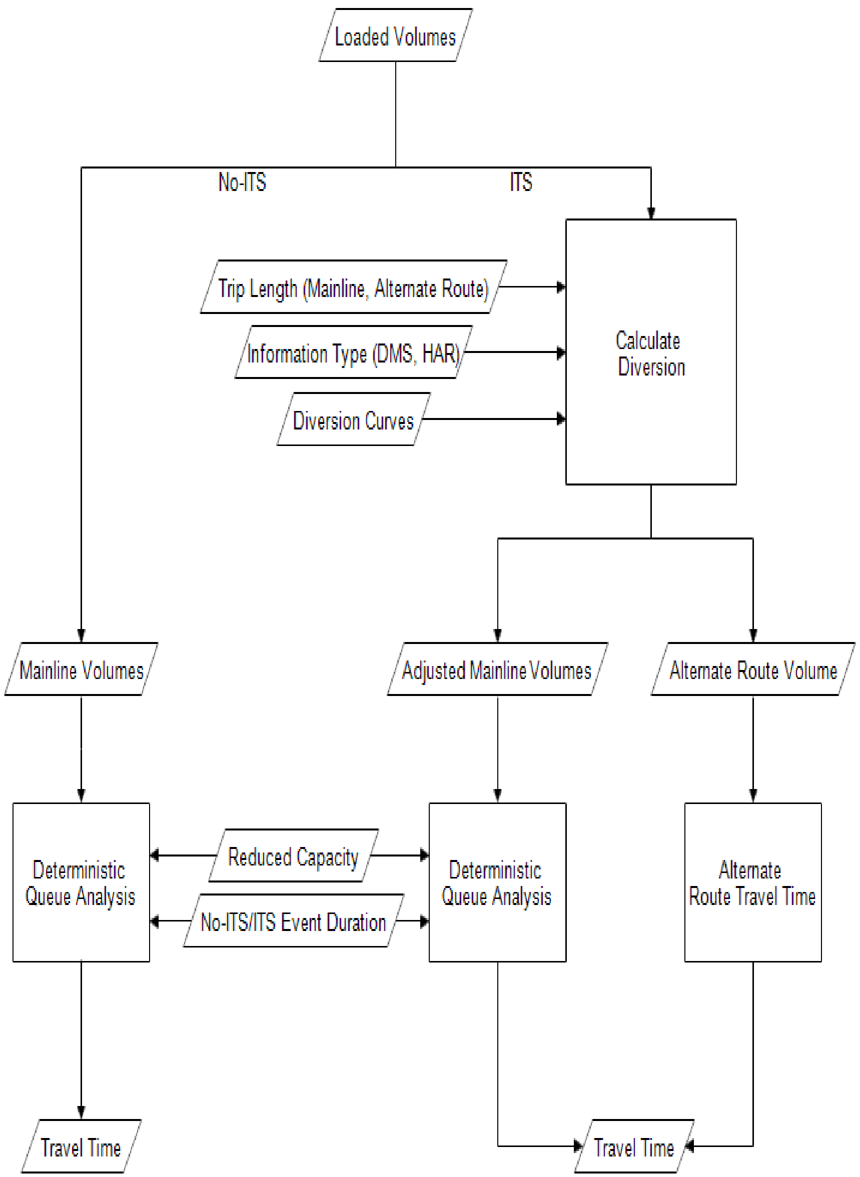
The evaluation methodology involves modeling of traffic operations under the various scenarios selected for analysis. The ideal ATIS evaluation tool must include robust modules for traffic simulation, user decisions, and path assignment. The pilot study selected DYNASMART-P as the integration tool for an institutional ATIS evaluation framework for several reasons. Above all, DYNASMART-P is a mesoscopic simulation tool which integrates the two classes of tools: network assignment models and traffic simulation models. In particular, mesoscopic traffic simulation models can allow a richer representation of traveler behavior decisions, an explicit description of traffic processes and their time-varying properties, and a more complete representation of the network elements, including signalization and other operational controls. In addition, DYNASMART-P provides rich capabilities for modeling and evaluating problems which have traffic operation and route planning characteristics. In this study, this dynamic assignment system is specifically used to evaluate traveler information supply strategies such as pre-trip information, real-time en-route information, and varying types of variable message signs (VMS). Other important features in the data preparation stage include the relative ease of incorporating network and origin-destination data from regional travel demand models and dynamic traffic assignment.

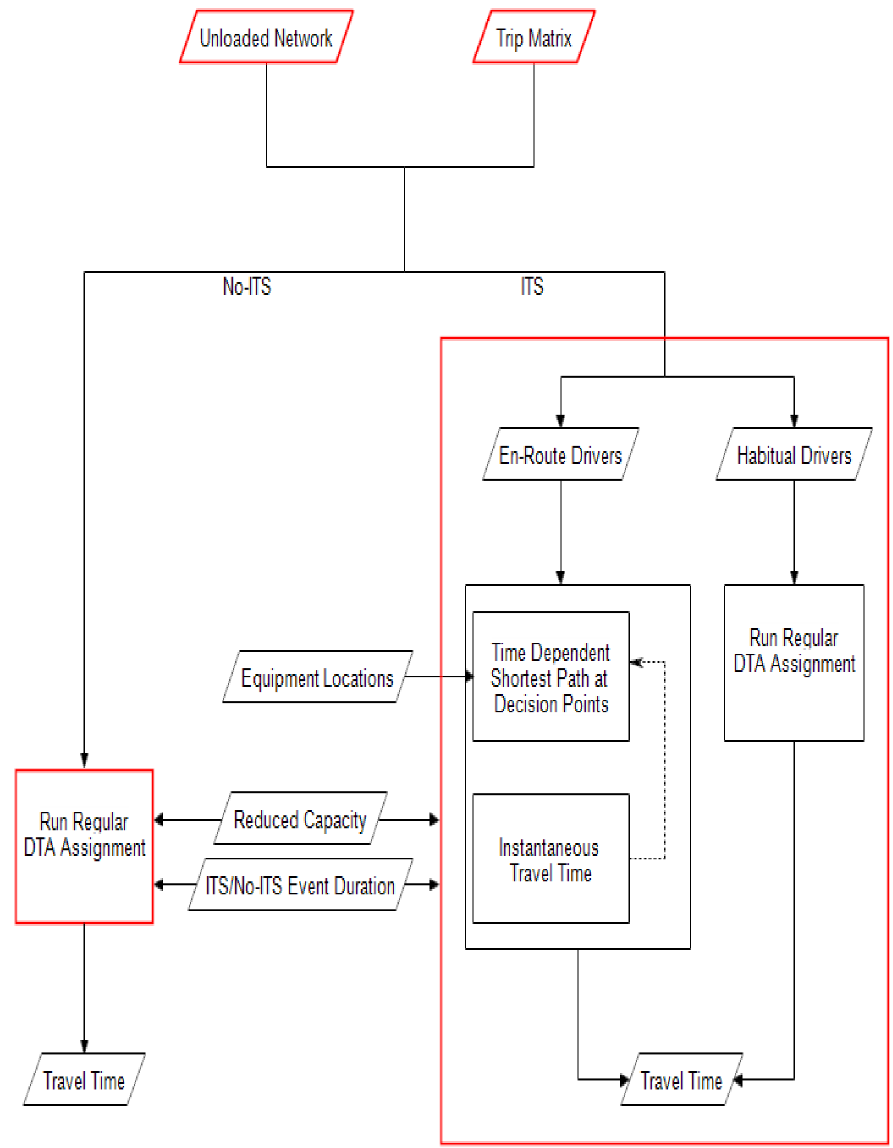
The objective of this study was to develop valid methodologies for addressing several limitations of the current Advanced Traveler Information Systems (ATIS) evaluation tools. This study was focused mainly on three enhancements. First, the queue propagation algorithm of the selected tool (DYNASMART-P) was modified to more realistically model traffic congestion. The author proposed the addition of transfer flow capacity and backward gated flow constraints for more accurately calculating transfer flow rate. Second, the study modeled the natural diversion behaviors of drivers who do not receive traveler information. Lastly, statistical models of user responses to traveler information were developed using binary and multinomial logit methods to understand and model the relationship between drivers' socio-economic characteristics and their responses to traveler information. Among these three enhancements, the first two (improved queue propagation and natural diversion behavior algorithms) were implemented in the enhanced model. The user behavior models, however, were not implemented because their predictive power was not acceptable due to limitations in the data set. The enhanced model was applied to two case studies: 1) verifying the capabilities of the model under a recurring bottleneck scenario on I-40 corridor in the Triangle region of North Carolina, and 2) demonstrating the capability of the enhanced model to measure the effectiveness of U-Transportation (similar to the Vehicle Infrastructure Integration [VII] program in the USA) which has been under development in Korea. The first case study results showed that the improved queue propagation algorithm simulated the bottleneck queue much closer to the real data than the original model. The simulation results also indicated that the actual diversion rate under recurring congestion in the study network was very low. The results of the second case study demonstrated that the enhanced model can evaluate the network impact of new advanced technology in flooding situations and can evaluate the effect of market penetration of the communication technology.

DTA Methodologies

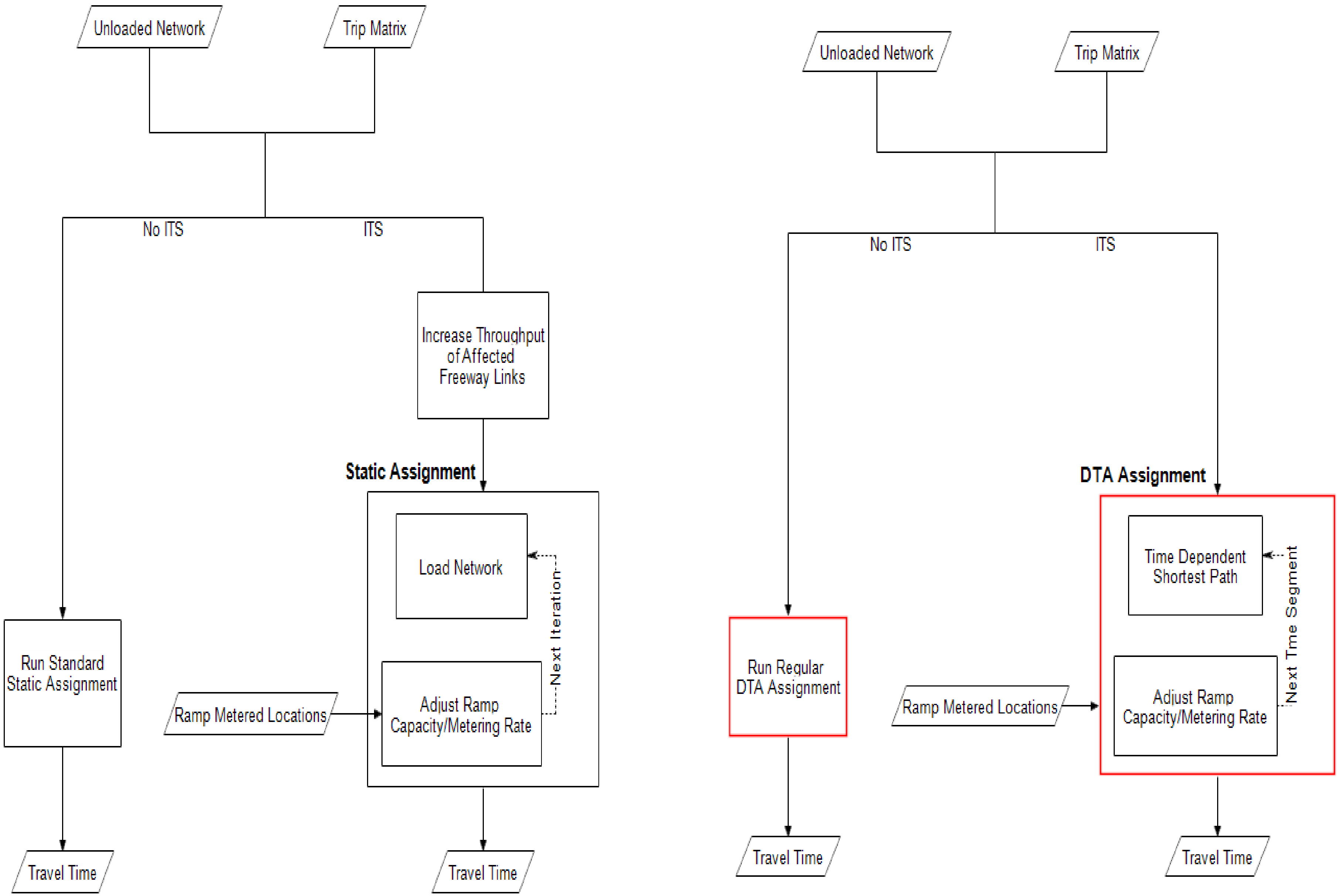
The following section contains the flow charts for the different DTA methodologies adopted in this project. Each ITS strategy has two flow charts. The flow chart on the left documents the existing static assignment methodology used in Phase I and the flow chart on the right describe the proposed DTA methodology. Three ITS strategies (Incident Management Systems, Smart Work Zones and Advanced Traveler Information Systems) follow the same DTA methodology and there are grouped together. Two of the ITS strategies involving public transit also include the mode choice component from the travel demand model as part of the DTA methodology. All of the methodologies focus on the time dependent characteristics of Dynamic Traffic Assignment and their impact on ITS implementation.

Incident Management, Smart Work Zones, Advanced Traveler Information System

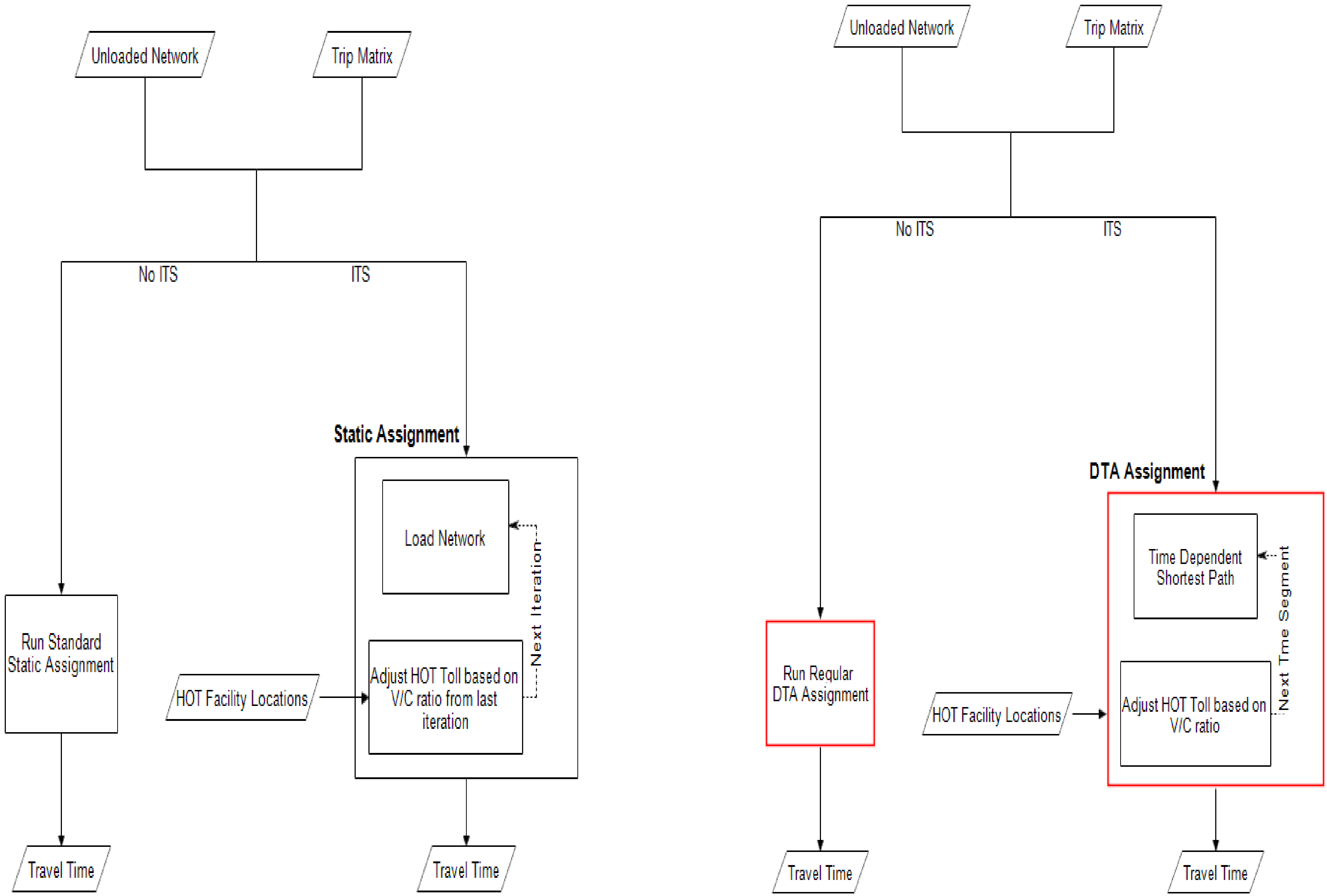




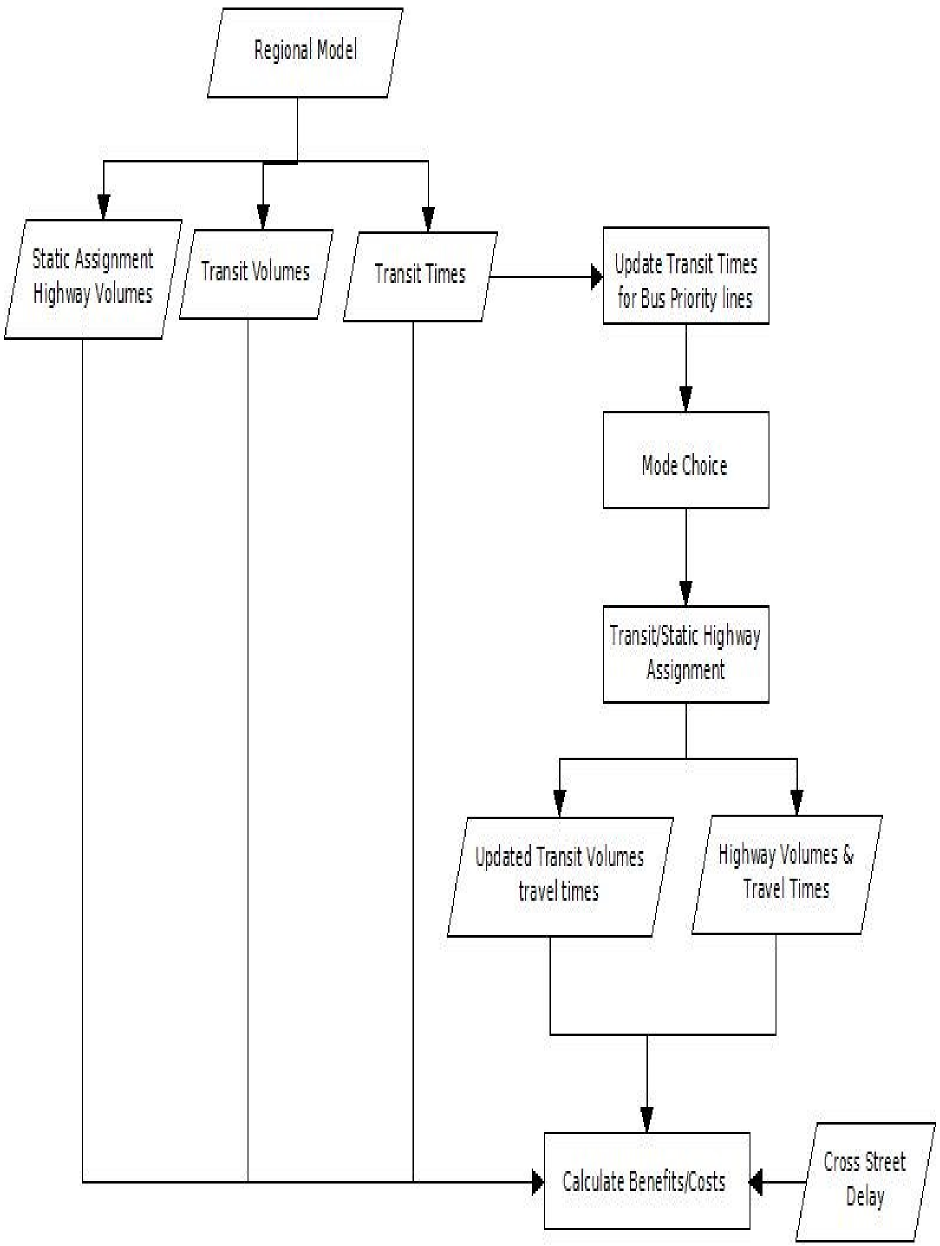
Ramp Metering

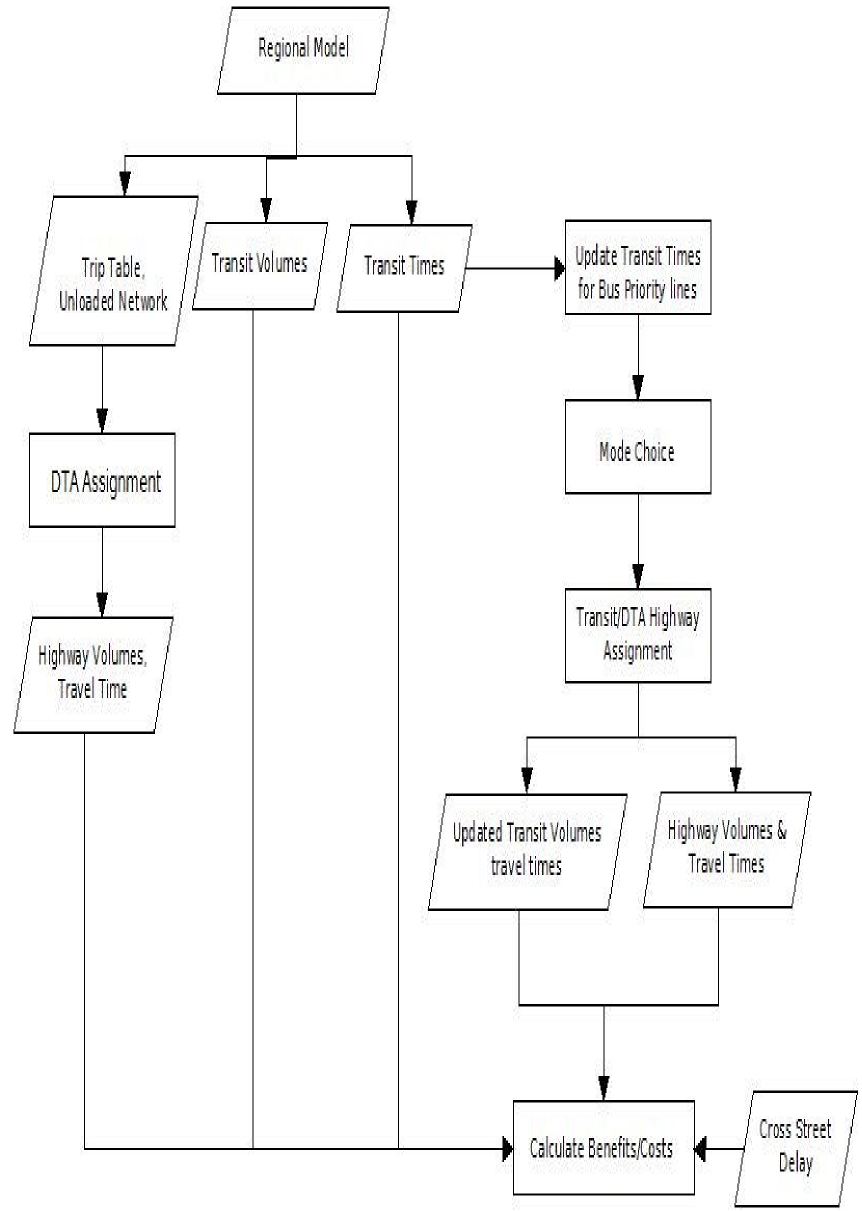


Managed Lanes

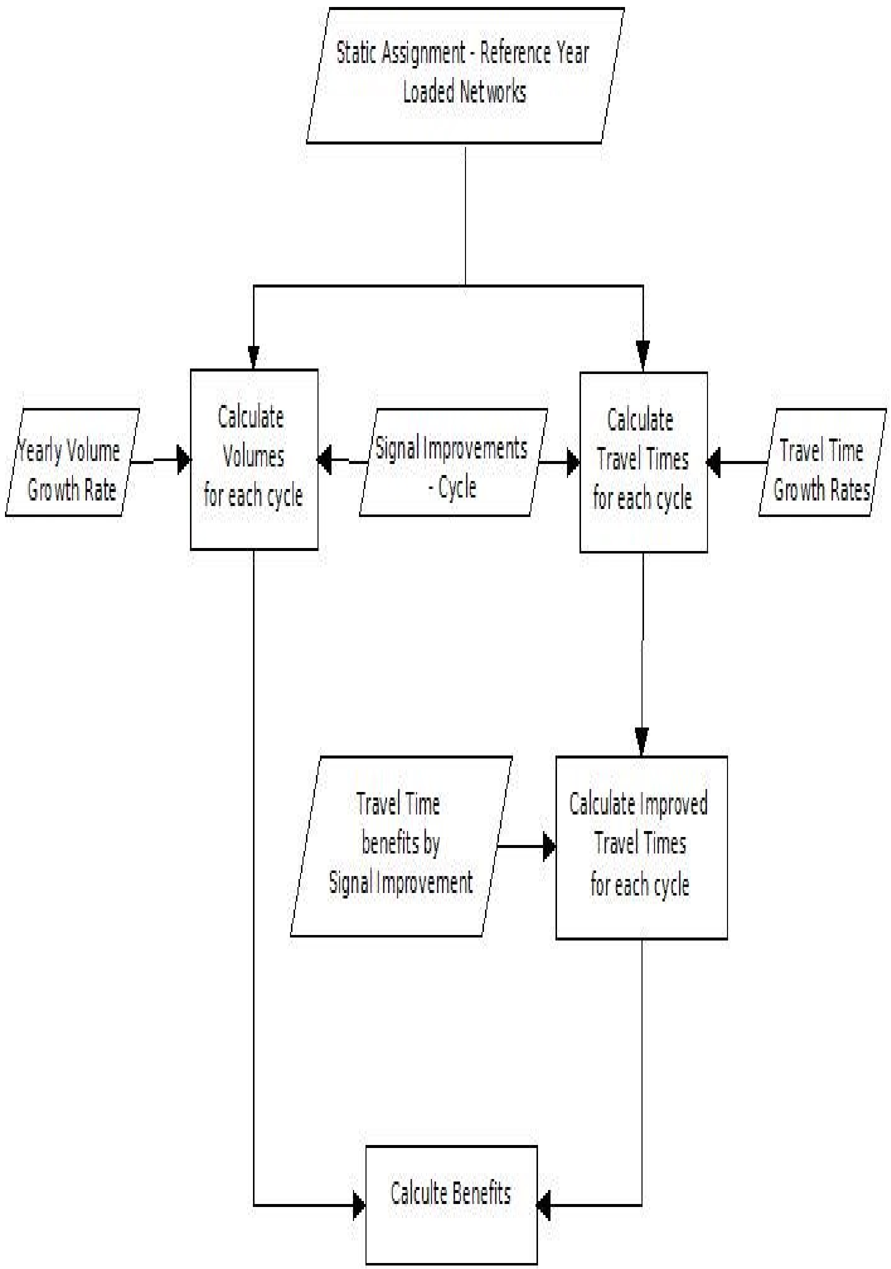


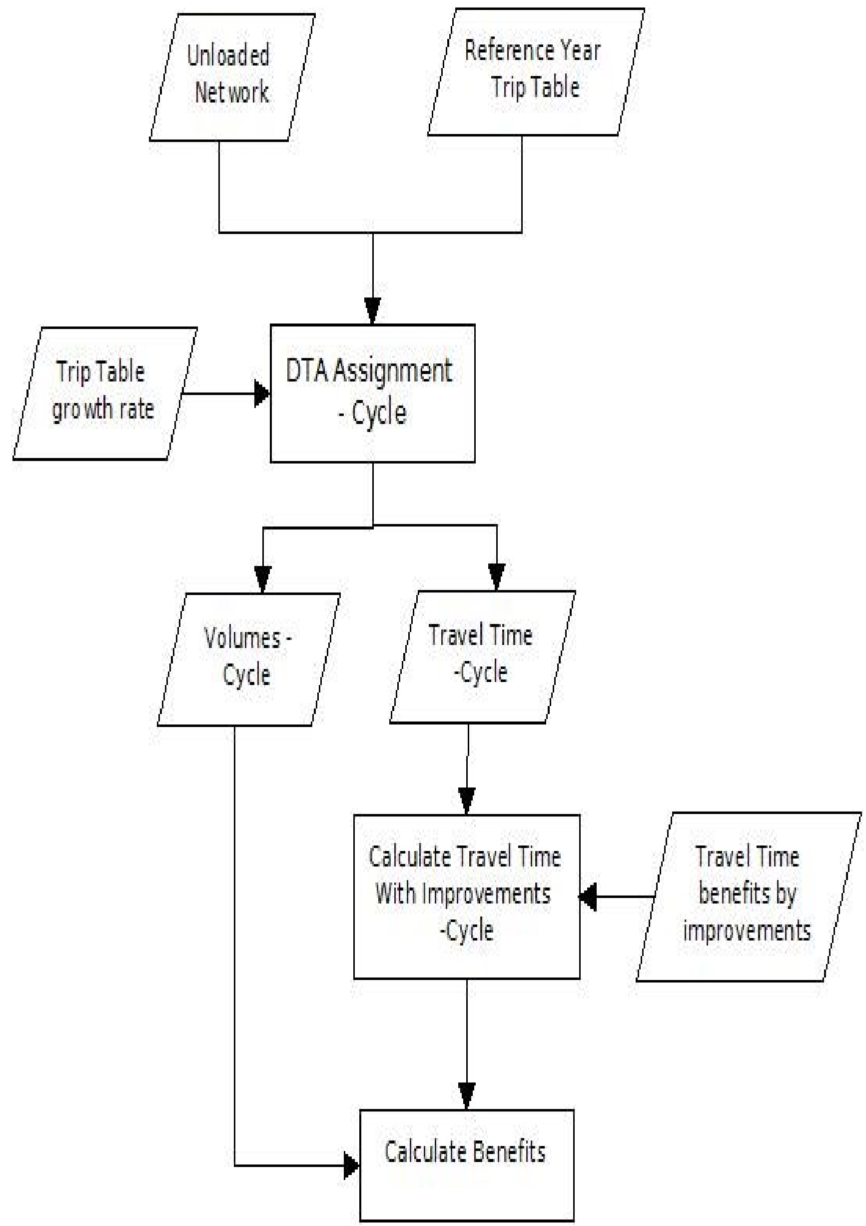
Bus Priority/Advanced Public Transit System





Signal Timing Improvement





DTA Implementation

The DTA methodologies developed were implemented using standard FSUTMS models. There different models were chosen for implementation. The ITS strategies implemented and the models are given in the table below

#	ITS Strategy	Model Region
1	Incident Management	District 4 (SERPM)
2	Ramp Metering	District 6 (SERPM)
3	Managed Lanes	District 4 (SERPM)
4	Smart Work Zones	District 5 (CFRPM)
5	Advanced Traveler Information Systems	District 5 (CFRPM)
7	Advanced Public Transit Systems	District 5 (CFRPM)
8	Signal Timing Improvements	District 2 (NERPM)
10	Bus Priority	District 2 (NERPM)

The DTA methodologies were implemented at a sub-area level. However, these methodologies are also applicable to the entire regional model boundaries. Sub areas were chosen based on the availability of locations for implementing the DTA methodologies. The following section describes the parameters used in the implementation of the DTA methodologies for each of the strategy.

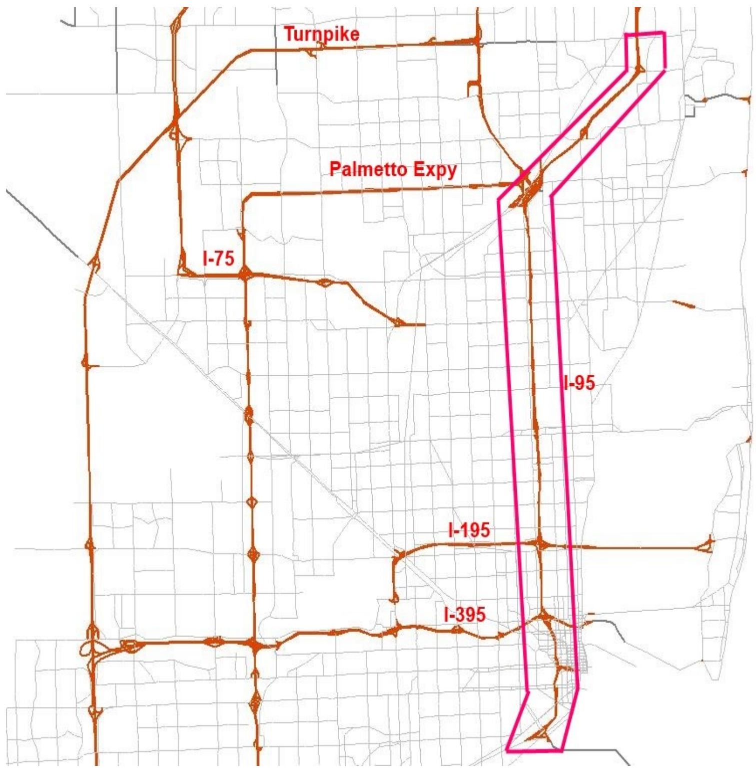
SERPM Model

The SERPM model region was chosen for the implementation of Incident Management, Ramp Metering and Managed Lanes strategy. The figure below shows the sub-area selected for this implementation. The sub area includes the I-95 corridor between SR-820 in the north to SR-94 in the south. This section of I-95 includes the Road Ranger program (incident management), ramp metering and managed lanes. The original number of zones/externals in the SERPM model is 4120 and the sub area had 1005 zones/externals.

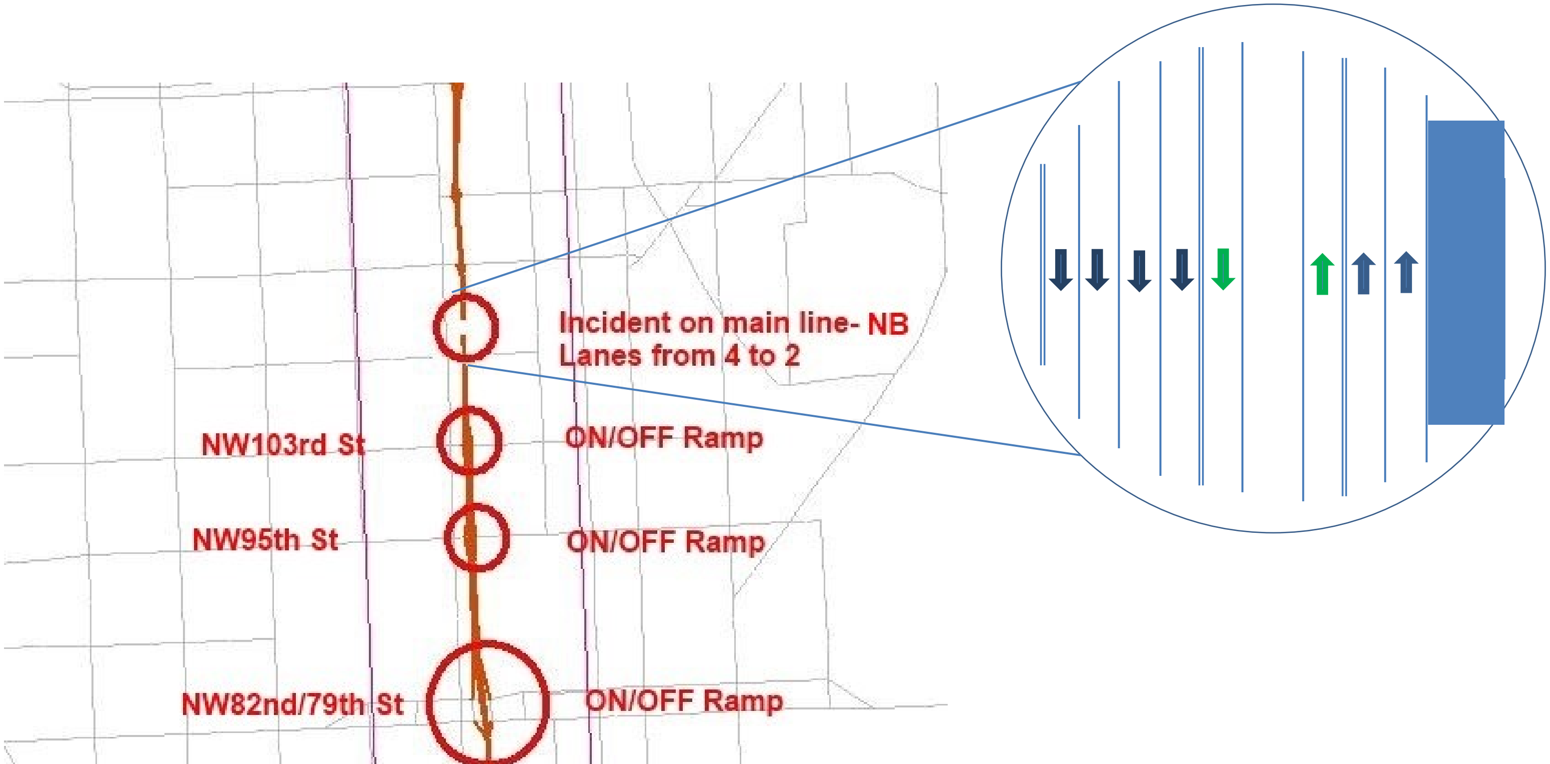
Incident Management

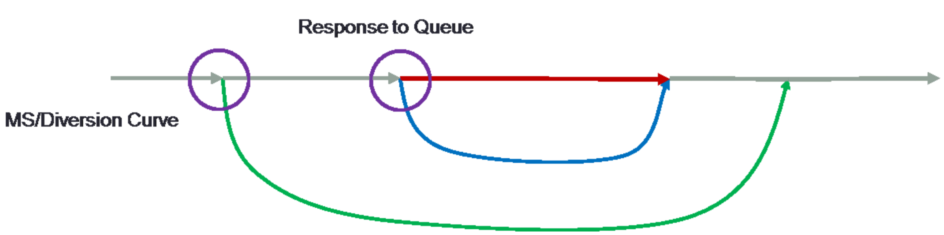
Incident Management strategy was implemented in one section of the I-95 corridor. The implementation captures the effects of an incident along a segment of the corridor during the PM peak period. The below figures show the boundary of the Road Ranger program and the location of the incident for this implementation.

Road Ranger Program



Incident Management Location





Below is the model set-up for the Incident Management implementation

- PM Peak Hour (3 hours – 15 minute time segments)

- Incident duration
  - No IM - 30 minutes (2 time segments)
  - With IM – 15 minutes (1 time segment)

- Incident beings at start of 2 hour (5th time segment)

- Number of lanes reduced from 4 to 2
  - CAPACITY - Reduced by ½
  - STORAGE – number of lanes * length of link * vehicles per unit length
  - Free Flow Speed – user input (60% of original FFS)

- Split trip table
  - Drivers responding to DMS (40%)
  - Drivers not-responding to DMS

- Path builds for responding drivers excludes links downstream of DMS location

- Separate path load statements for responding and non-responding drivers

Cube Scripting for Incident Management

- Update Capacity, Storage and Free flow speed

```
IF (A=23362)
DYNAMIC C[5]= (LI.LOSECAP/LI.CONFACPMP)*0.5, (LI.LOSECAP/LI.CONFACPMP)*0.5
IF (TIMESEGEMT=5-6)
   STORAGE= 2* LI.DISTANCE * 120
   T0=(DISTANCE/(SPEED*0.6)) * 60
ENDIF
ENDIF
```

- Path loading statements

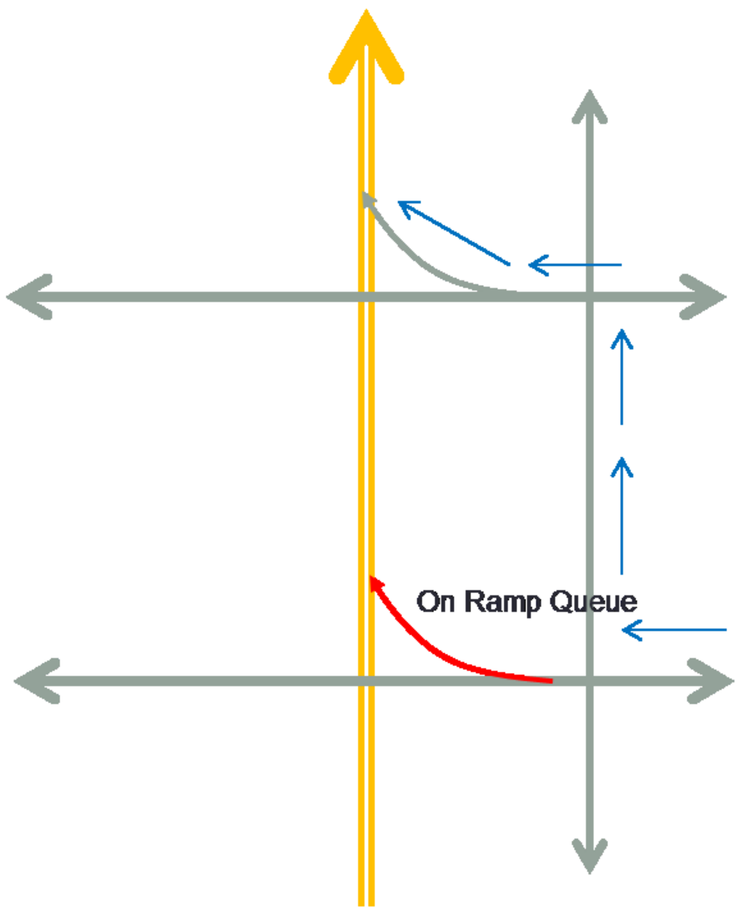
```
IF (A=INLIST(23376, 23375, 23371, 23370, 23366, 23365, 23364, 23362, 23357)
ADDTOGROUP=32
; Path load for non-responding drivers
DYNAMICLOAD PATH=COST, PACKETSIZE=10, VOL[1]=MW[(1+__TS__*0)], PENI=1-2,
EXCLUDEGROUP=1,2,9  ;Without HOV
DYNAMICLOAD PATH=COST, PACKETSIZE=10, VOL[2]=MW[(2+__TS__*0)], PENI=1-2,
EXCLUDEGROUP=2,3,9  ;With HOV2 -Note Here, Trucks are NOT alowed on HOV lanes
DYNAMICLOAD PATH=TIME, PACKETSIZE=10, VOL[3]=MW[(3+__TS__*0)], PENI=1-2,
EXCLUDEGROUP=2,9  ;With HOV3+ -Note Here, Trucks are NOT alowed on HOV lanes
DYNAMICLOAD PATH=TIME, PACKETSIZE=10, VOL[4]=MW[(4+__TS__*0)], PENI=1-2,
EXCLUDEGROUP=1,2,9,8 ;Without HOV - Truck Trips
; Path load for responding drivers
DYNAMICLOAD PATH=COST, PACKETSIZE=10, VOL[1]=MW[(11+__TS__*0)], PENI=1-2,
EXCLUDEGROUP=1,2,9,32  ;Without HOV
DYNAMICLOAD PATH=COST, PACKETSIZE=10, VOL[2]=MW[(12+__TS__*0)], PENI=1-2,
EXCLUDEGROUP=2,3,9,32  ;With HOV2 -Note Here, Trucks are NOT alowed on HOV
lanes
DYNAMICLOAD PATH=TIME, PACKETSIZE=10, VOL[3]=MW[(13+__TS__*0)], PENI=1-2,
EXCLUDEGROUP=2,9,32  ;With HOV3+ -Note Here, Trucks are NOT alowed on HOV
lanes
DYNAMICLOAD PATH=TIME, PACKETSIZE=10, VOL[4]=MW[(14+__TS__*0)], PENI=1-2,
EXCLUDEGROUP=1,2,9,8,32 ;Without HOV - Truck Trips
```

Ramp Metering

The Ramp Metering strategy was implemented in the I-95 corridor at locations in the NB direction. The locations are based on the actual location in the corridor. Ramp Metering is enforced during weekday runs hours and during incidents. Below figure shows the location of the Ramp Metering locations on the I-95 corridor and the alternate path capture due to Ramp Metering.

Ramp Metering Locations

Ramp Metering Alternate Routes



Cube Scripting for Ramp Metering

- Calculate upstream volume in ADJUST phase

```
PHASE=ADJUST
    LOOP _M=1,12                        ;Loop through time segments
         IF (A=23366 & TIMESEGMENT=_M) _upvol[_M]= VOL[1] + VOL[2] + VOL[3] +
      VOL[4]        ;get volume from up-stream link for time segment _m
    ENDLOOP
ENDPHASE
```

- Calculate metering rate and apply in LINKREAD phase

```
;next iteration
PHASE=LINKREAD
IF (A=23365)
      _downcapacity= (LI.LOSECAP/LI.CONFACPMP)/12                          ;
downstream capacity per time segment
      _downstorage=LI.LANES*LI.DISTANCE*120
ENDIF
IF (A=23367)          ;on-ramp
LOOP _n=1,12                         ;loop through time segments
      DYNAMIC C[_n]= (_downcapacity - _upvol[_n]) + _downstorage
ENDLOOP
ENDIF
ENDPHASE
```

Managed Lanes

The Managed Lanes implementation was also implemented in the I-95 corridor because of the existing managed lanes in this corridor. The below figure shows the managed lane corridor location in the I-95 corridor.

Managed Lane Locations

Below is the set-up for Managed Lanes implementation

- Hourly toll rate fluctuations can be modeled and validated from field data
- Traffic volume shift by time segment from/to general purpose lanes and express lanes can be captured.
- HOT toll rate adjusted by time segment

$$(1) \quad (V/C)_{t-1} = \frac{Volume_{t-1}}{Capacity}$$

$$(2)\ HOT\ Toll\ Rate_t = Min.\ Toll + (Max.Toll - Min.Toll)/(1 + e^{\left(6-9*\left(\frac{V}{C}\right)_{t-1}\right)})$$

- Toll rates during peak hour
- Speeds & Volumes on general purpose lanes and express lanes

Cube Scripting for Managed Lanes

- Calculate HOT toll rate in ADJUST phase

```
PHASE=ADJUST
LOOP _M=1,12                    ;Loop through time segments
 IF (HOT=1 & TIMESEGMENT=_M)
 _volume= VOL[1] + VOL[2] + VOL[3] + VOL[4] ;get volume for time segment _m
 _capacity=(LOSECAP/LI.CONFACPMP)/12             ;calculate capacity
 _VC=_volume/_capacity
 _tollrate[_M]= {MINHOTTOLL}+({MAXHOTTOLL}-{MINHOTTOLL})/(1+EXP(6-9*_VC))
ENDLOOP
ENDPHASE


;next iteration
PHASE=LINKREAD
      IF (HOT=1)
      LOOP _n=1,12      ;loop through time segments
      IF (TIMESEGMENT=_N) HOTTOLL=_tollrate[_N]
      ENDLOOP
      ENDIF
ENDPHASE
```

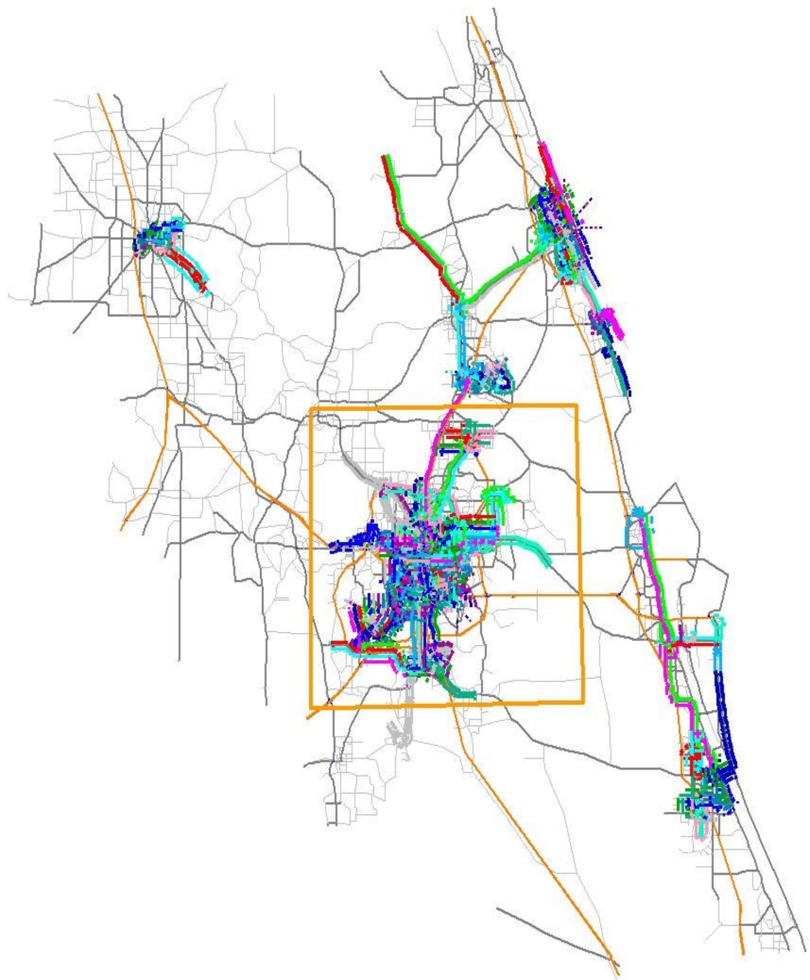
CFRPM Model

Three ITS strategies were implemented in the CFRPM model region. These include

- Advanced Traveler Information Systems
- Advanced Public Transit Systems
- Smart Work Zones

Since the CFRPM model implementation included a transit ITS strategy, the sub area was chosen based on the transit coverage in the region. The original number of zones/externals in the model was 4549 from which the sub area was derived with 1378 zones/externals. The below figure shows the CFRPM sub area along with the transit network in the region.

CFRPM Sub Area

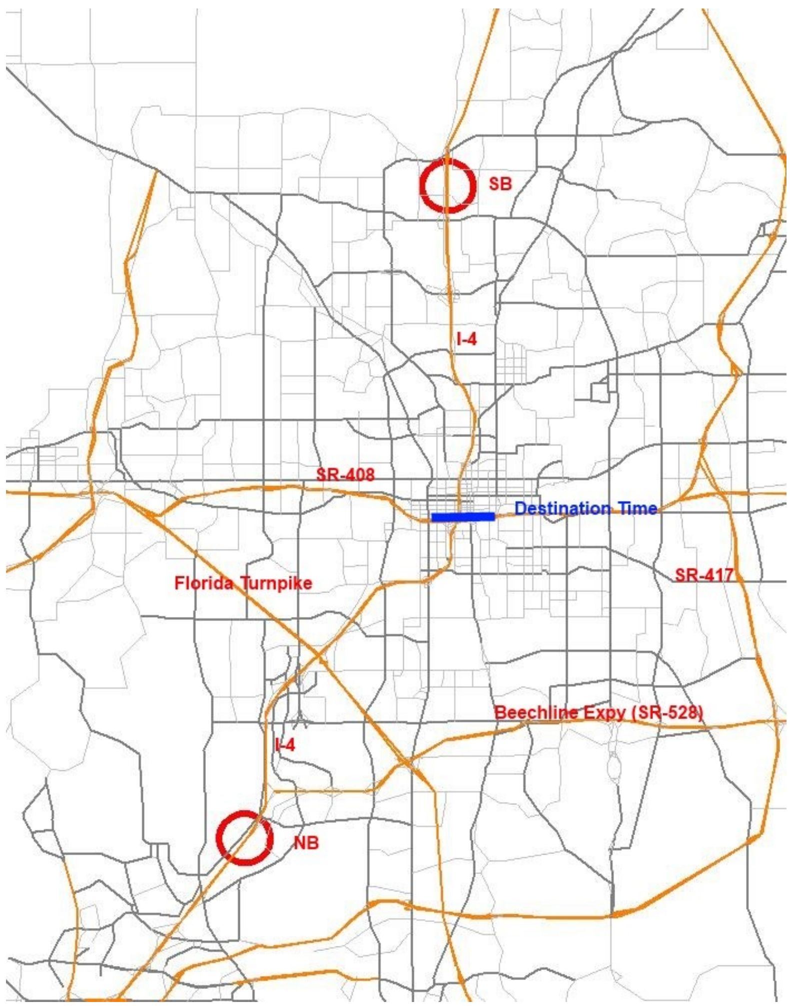


Advanced Traveler Information Systems

Dynamic Message Signs

- Two locations on I-4
- NB south of Florida 328
- SB north of SR 436
- Time point is downtown Orlando

ATIS implementation Location



ATIS Model Set-up

- 24 HR highway assignment (30 minute time segments – 48 total segments)
- Information systems activated during time segments 30-36
- Methodology is similar to IM but route diversion is based on travel time savings

- Travel time information
- Delay= Free flow travel time – Congested travel time
- Diversion Rate

Minutes over the typical travel time	% Responding Drivers
5	0
10	0
15	6%
20	11%
30	23%
45	40%
60	40%

ATIS Cube Scripting

- Calculate travel time in ADJUST phase

```
PHASE=ADJUST
LOOP _M=30,36
;loop through time segments 30 to 36
IF (A=<link list>) _traveltime[_M]=_traveltime[_M] + TIME[LINKNO]
;calculate travel time to destination at the end of each time segment
ENDLOOP
ENDPHASE
```

- Split time segment trip matrices by delay

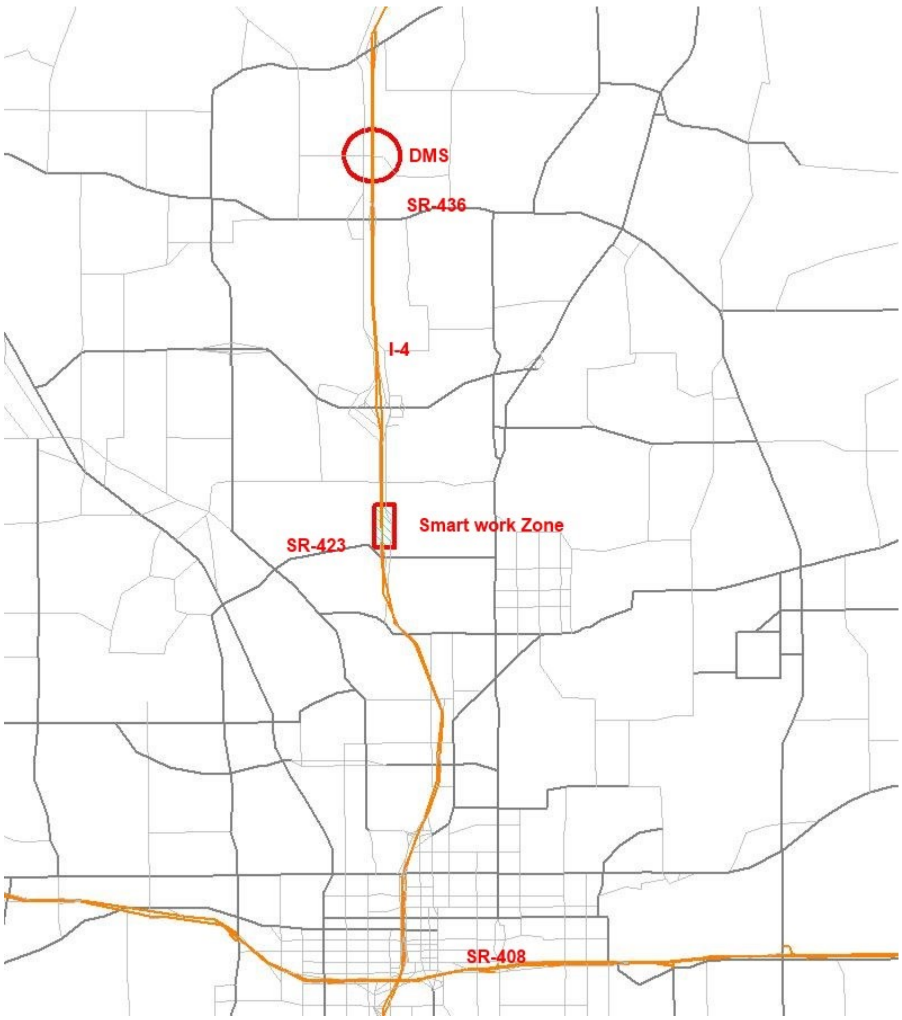
```
;next iteration
PHASE=LINKREAD
IF (A=<link list>) _fftime = _fftime + li.time
;calculate free flow travel time
IF (TIMESEGMENT=30-36)
_delay=_traveltime[_N] - _fftime
;calculate delay
_split=(1, _delay)
MW[100+__TS__] = MW[1+__TS__]*_split
MW[200+__TS__]= MW[1+__TS__] - MW[100+__TS__]
ENDIF
ENDPHASE
```

Smart Work Zones

Smart Work Zones use DMS to provide speed advisories and alternate route information. Smart Work zones were implemented in the following location

- Work Zone on SB direction of I-4
- DMS with advisory

Smart Work Zone Location

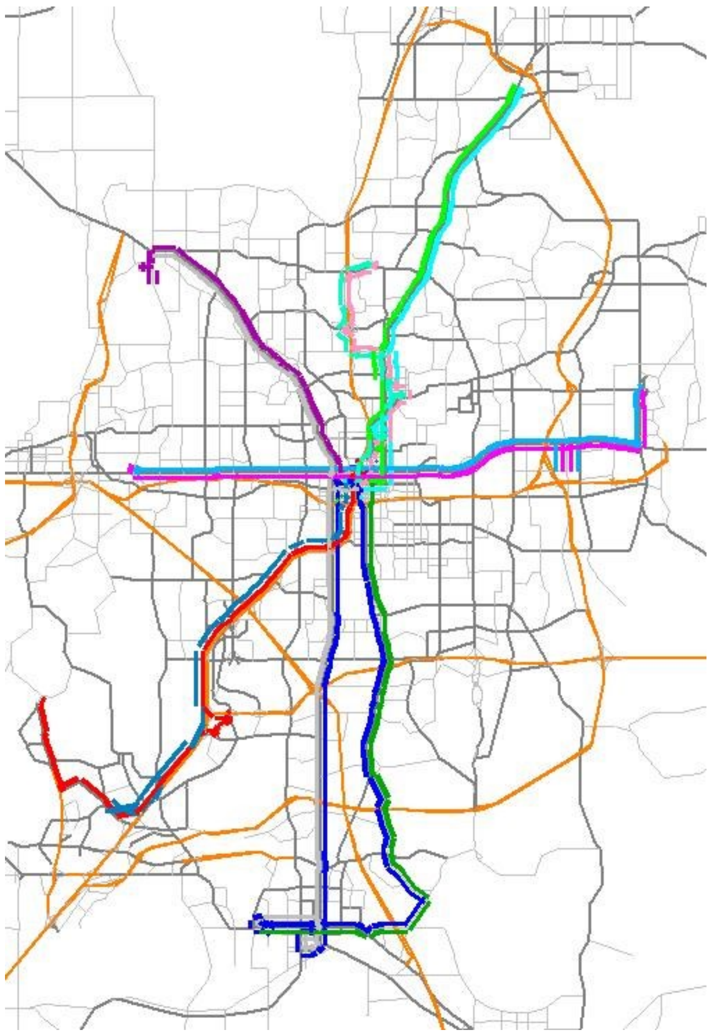


Below is the set-up for the implementation of the Smart Work Zones strategy

- 24 HR assignment (30 minute time segments – 48 total segments)
- Work zone from time segment 30 to 36
- 4 lanes reduced to 2 lanes
- Free Flow speeds reduced 60% of original FFS
- Drivers responding to DMS – 40%
- Methodology is similar to IM

Advanced Public Transit System

The APTS system includes AVL, ATSS, EPS,TIS and security systems. Mobility benefits are realized in EPS and TIS. EPS and TIS reduce transit travel times and thereby increase ridership. For the APTS implementation 14 transit lines are chosen as shown below



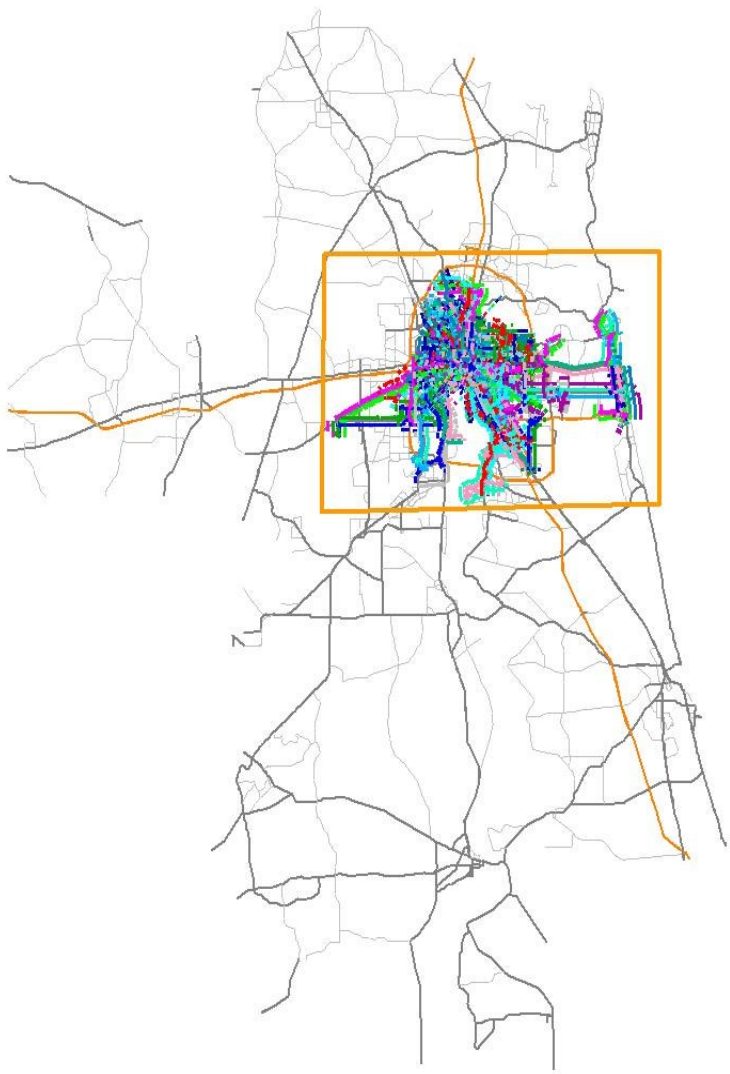
Below is the model set-up for APTS implementation

- 24 HR model
- Evaluated at the transit line level and not the origin-destination level
- Runtime for the improved lines are adjusted using the RUNTIME factor in PT
- RUNTIME factor is user input (default is 10% reduction)
- Mode Choice from the regional model re-run based on new transit skims

NERPM Model

The NERPM model was used to implement the Signal Timing Improvements and Bus Priority strategies. The sub area was chosen considering the transit coverage of the region. The original model included 2,578 zones/externals, whereas the sub area extracted 1511 zones/externals.

NERPM Model Sub Area

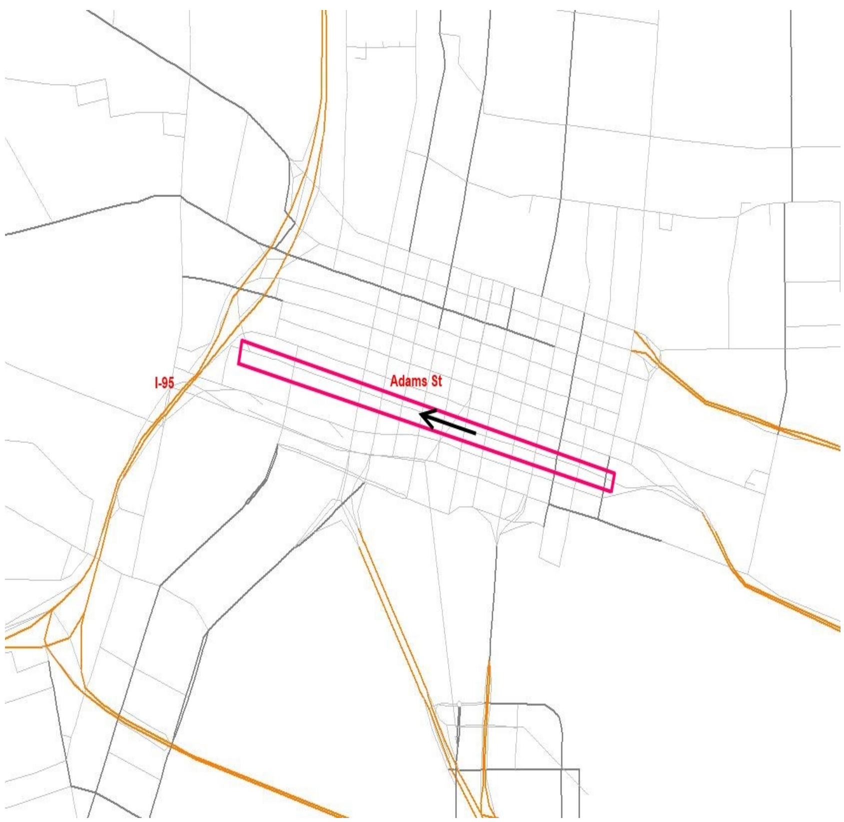


Signal Timing Improvement

Below is the model set-up for the implementation of Signal Timing Improvement strategy. The figure below shows the location of the implementation

- Adams St located in downtown Jacksonville
- One-way street
- 12 signalized intersections
- PM peak period
- 15 –minute time segments
- Improvement Type II – Co-ordinate existing isolated signals
- Travel time reduction for type I – 11.5%
- Free flow time for approach links adjusted in the LINKREAD phase

Signal Timing Location Implementation

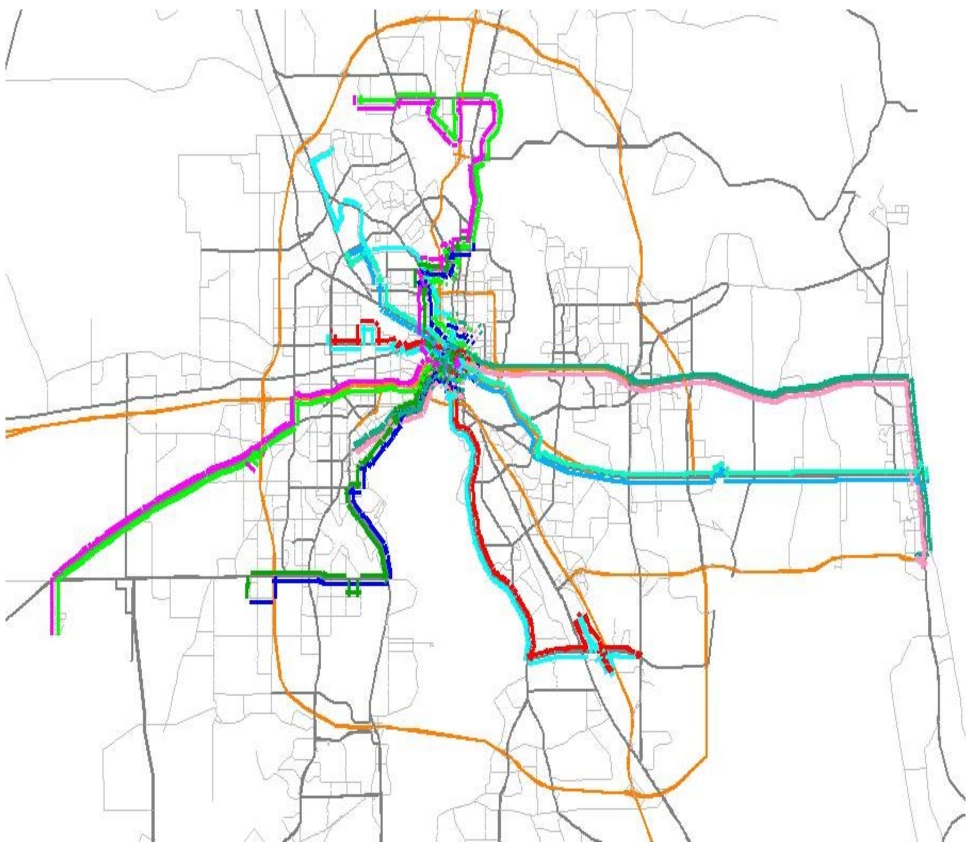


Bus Priority

Below is the model set-up for the bus priority strategy

- Bus Priority improves transit travel times on links
- Highway travel times on cross streets will increase
- 13 transit lines were assigned bus priority
- Implementation of transit travel time is similar to APTS (using RUNFACTOR)
- RUNFACTOR is set-up as user input (default is 20% reduction)
- Cross Street delay
- Free flow time on cross street approaches at BP intersections increased by 6%
- Regional model mode choice is re-run based on updated transit/highway skims

Bus Priority Transit Lines



Appendix A: Description of Inputs

For the ten FITSEVAL programs in Cube, there are different sets of input files and parameters. The user needs to prepare them and input them into the FITSEVAL Cube program. The following section describes the input files and parameters for each FITSEVAL cube program. It also gives the structure of the variable replacement files for each network input.

Advanced Public Transit (APT)

Table 1: Inputs for APT Program

Input	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Internal Zones	The number of internal zones
Number of periods per year	The number of work days per year
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
Select modules to run	User can choose safety evaluation, Travel Time evaluation, Fuel Consumption, Emission Evaluation, Board evaluation, and Time of Day modeling
Base Case loaded network	Loaded highway network
Base case network variable replacement	The look up table that converts the network variable name into standard variable name.
Transit lines equipped with APTS	The transit line file, including the APTS information
Peak period transit link volumes	Peak period transit link ridership
Off period transit link volume	Off peak period transit link ridership
Type of transit system implementation	User can choose different APTS strategies: AVL, ATSS, AVL/ATSS, TSS, TIS, EPS
Analysis parameters	User can choose the capacity for LOS C or LOS E
Maximum V/C ratio for BPR Equation	The maximum V/C ratio for BPR Equation (Default is 4)
Ridership Increasing Rate (%)	Ridership increasing rate (5 percent).
Market penetration rate for TIS or EFC (%)	Market penetration rate for TIS or EFC (20 percent)
Average Transit Fare ($)	Average transit fare (1$)
Discount Rate (%)	Discount rate (default=7%)
Transit system vehicle cost	Transit system vehicle cost ($250,000)

Input	Description
($)	
Agency fleet size	Agency fleet size (250 buses)
Fleet size reduction for AVL/ATSS	Fleet size reduction for AVL, ATSS or AVL/ATSS (1 percent)
Fleet size reduction for AVL (or) ATSS	Fleet size reduction for AVL, ATSS or AVL/ATSS (1 percent)
Useful life of vehicle (years)	Useful life of vehicle (15 years).
Agency operation and maintenance cost ($/year)	Agency operation and maintenance cost ($1,000,000/year)
Operation and maintenance cost reduction for AVL (%)	Agency operation and maintenance cost reduction for AVL, ATSS or AVL/ATSS (5 percent)
Performance summary	The output file for ITS strategies performance summary
Benefit/Cost summary	The output file for Benefit and cost summary

Table 2: APT base case network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
LOSCCAP_AMPKPD	li	CAPACITY	AM capacity under LOS C
LOSCCAP_OFPKPD	li	CAPACITY	OP capacity under LOS C
UROADFACTOR	li	UROADFACTOR	UROAD factor
AM_TOTVOL	li	AM_TV	AM total volume
AM_TRKVOL	li	TRUCK_TAXI_AM	AM toal truck volume
OF_TOTVOL	li	OP_TV	OP total volume
OF_TRKVOL	li	TRUCK_TAXI_OP	OP total truck volume
FREEFLOWTIME	li	TIME	Free flow time
BPRCOEFFICIENT	li	BPRCOEFFICIENT	BPR equation coefficient a
BPREXPONENT	li	BPREXPONENT	BPR equation coefficient b
DISTANCE	li	DISTANCE	Link distance
FTC2	li	FTYPE	Facility type code (two digits)
AT2_OLD	li	ATYPE	Area type code (two digits)
AREA_TYPE	li	ATYPE1	Area type code (one digits)

Emergency Vehicle preemption (EVP)

Table 3: Inputs for EVP Program

Field name	Description
Alternative	Alternative letter (for example, R)

Field name	Description
Year	Current model year, two digits
Number of periods per year	The number of work days per year
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
AM loaded network	Loaded AM highway network
PM loaded network	Loaded AM highway network
Off-peak loaded network	Loaded Off-peak highway network
AM loaded network variable replacement	The look up table that converts the AM network variable name into standard variable name.
PM loaded network variable replacement	The look up table that converts the PM network variable name into standard variable name.
Off peak loaded network variable replacement	The look up table that converts the Off peak network variable name into standard variable name.
Select modules to run	User can choose Cross street delay evaluation, life threat evaluation, property loss evaluation and crash evaluation
EVP coded network	The highway network with EVP coded
EVP coded network variable replacement	The look up table that converts the EVP coded network variable name into standard variable name.
Number of intersection to be improved	The number of intersection with EVP system
Percentage of trucks in Truck-taxi trip (%)	The percentage of Trucks in Truck-taxi trip
Auto Occupancy	The auto occupancy for passenger
Year in which the project starts	Corresponds to the year the program became operational (four digits)
Year in which the project finishes	Corresponds to the end of the project evaluation period (four digits)
Discount Rate (%)	Discount rate (default=7%)
Cost factor for contingency	
Travel time reduction per intersection due to EVP (Seconds)	Travel time saving per intersection for emergency vehicle due to EVP system (default = 15 sec).
Cost of a Fatality ($)	Defines the cost of losing a life (default = $3,000,000)
Average property value	Average property value
Average cost of an EV crash	The average cost of having an emergency vehicle crashed en route to the emergency site (default = $15000).
Crash rate without EVP	Defines the rate of crashes per year per station per call when a preemption system is not utilized (default = 0.0287 per year per station per intersection)
Crash rate with EVP	Defines the rate of crashes per year per station per call when a preemption system is utilized (default = 0.0116 per year per

Field name	Description
	station per intersection)
Performance summary ($)	The output file for ITS strategies performance summary
Benefit/Cost summary	The output file for Benefit and cost summary

Table 4: EVP AM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
FTC2	li	FTYPE	;Facility type code (two digits)
AM_TRKVOL	li	TRUCK_TAXI_AM	;AM total truck volume
AM_TOTVOL	li	AM_TV	;AM total volume

Table 5: EVP PM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
FTC2	li	FTYPE	;Facility type code (two digits)
PM_TRKVOL	li	TRUCK_TAXI_PM	;PM total truck volume
PM_TOTVOL	li	PM_TV	;PM total volume

Table 6: EVP off peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
FTC2	li	FTYPE	;Facility type code (two digits)
OF_TRKVOL	li	TRUCK_TAXI_OP	;OP total truck volume
OF_TOTVOL	li	OP_TV	;OP total volume

Table 7: EVP coded network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
PREEMPTED	ni	PREEMPTED	;IF THE NODE IS PREEMTED RECORDS THE NODE NUMBER AND SOME RELEVANT INFORMATION IS RECORDED IN DIFFERENT ARRAYS
pph	ni	pph	;NUMBER OF PREEMPTION PER HOUR
CYCLEAM	ni	CYCLEAM	;NODE CYCLE AM
CYCLEPM	ni	CYCLEPM	;NODE CYCLE PM

Standard Variable	Link/Node field	Replaced Variable	Description
CYCLEOP	ni	CYCLEOP	;NODE CYCLE OP
FLAG	ni	FLAG	;IF THE NODE IS A FLAG THE NODE NUMBER AND SOME RELEVANT INFORMATION ID RECORDED IN DIFFERENT ARRAYS
FIRE_STATION	ni	FIRE_STATION	;Node is fire station
LIFE_CALLS	ni	LIFE_CALLS	;LIFE THREATENING CALLS IN A YEAR
RESP_TIME	ni	RESP_TIME	;CALL AVERAGE RESPONSE TIME IN SECONDS FOR THIS STATION
AV_INTER	ni	AV_INTER	;AVERAGE NUMBER OF INTERSECTIONS TO CROSS IN A CALL
COVERAGE	ni	COVERAGE	;PERCENTAGE OF THE CALLS OF THIS STATION THAT WILL BE SERVED BY THE IMPROVEMENT
FIRE_CALLS	ni	FIRE_CALLS	; FIRE CALLS IN A YEAR
TOTAL_CALLS	Ni	TOTAL_CALLS	;TOTAL CALLS IN A YEAR
FTC2	Li	FTYPE	;Facility type (2 digit code)

Incident Management (IM)

Table 8: Inputs for IM Program

Field name	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Model type	The user can choose 24 hour model or Time of day model
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
24 HR loaded network	24 hour loaded highway network
24 HR loaded network variable replacement	The look up table that converts the 24 hour network variable name into standard variable name.
AM loaded network	Loaded AM highway network
PM loaded network	Loaded AM highway network
Off-peak loaded network	Loaded Off-peak highway network
AM loaded network variable replacement	The look up table that converts the AM network variable name into standard variable name.
PM loaded network variable replacement	The look up table that converts the PM network variable name into standard variable name.

Field name	Description
Off peak loaded network variable replacement	The look up table that converts the Off peak network variable name into standard variable name.
Select modules to run	User can choose Safety evaluation module, travel time evaluation module, fuel consumption module, emission evaluation module and road ranger evaluation module
Type of incident management system	The user can choose incident management system only, DMS only, HAR only, Combined incident management system with DMS, Combined Incident management system with HAR, Combined DMS with HAR, Combined incident management system with both DMS and HAR, and None.
ITS information type	The user can choose Descriptive information or detailed descriptive information
The level of capacity used for evaluation	The user can choose LOS C capacity or LOS E capacity
Maximum Volume-over-capacity ratio for BPR Equation	The maximum volume-over-capacity ratio for BPR equation (Default is 4)
Auto Occupancy	The auto occupancy for passenger
Percentage of Truck in Truck-Taxi trip (%)	The percentage of truck in Truck-Taxi trip
Fatality reduction factor	Percentage of fatalities that are shifted to injury due to faster response (default = 21 percent)
Crash reduction factor	Percentage reduction in total crash rate due to reduction in secondary incidents (default = 2.8 percent)
Average trip length for the network (Miles)	Average trip length on the mainline (default = 8 miles)
Average trip length on the alternative route (Miles)	Average trip length on the alternative route (default = 8.2 miles)
Percentage of diverted drivers using freeway as alternative route (%)	Percentage of diverted vehicles using freeways as opposite to arterials when diverting to alternative routes (default = 0 percent)
Discount rate (%)	The discount rate
Performance summary ($)	The output file for ITS strategies performance summary
Benefit/Cost summary	The output file for Benefit and cost summary

Table 9: IM AM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AM_ToTVol	li	AM_TV	; AM total volume
AM_DAVOL	li	DRV_ALONE_AM	; AM drive alone volume
AM_SRVOL	li	CARPOOL_AM	; AM carpool volume

Standard Variable	Link/Node field	Replaced Variable	Description
AM_TRKVOL	li	TRUCK_TAXI_AM	; AM truck volume
CAPACITY	li	CAPACITY	; Link capacity (LOS E)
LOSCCAP	li	CAPACITY	; Capacity under LOS C
AM_VCLOSC	li	VOLCAP_AM	; AM V/C ratio under LOS C capacity
AM_CONGTIME	li	CGSTD_TIME_AM	; AM link congested travel time
AM_CONGSPD	li	CGSTD_SPEED_AM	; AM link congested speed
AM_VMT	li	AM_VMT	; AM Vehicle mile traveled
AM_VHT	li	AM_VHT	; AM vehicle hour traveled
AT2_OLD	li	ATYPE	; Link area type code (2 digits)
AREA_TYPE	li	ATYPE1	; Link area type code (1 digit)
FTC2	li	FTYPE	; Link facility type code (2 digits)
Time	li	TIME	; Daily link free flow speed
Distance	li	DISTANCE	; Link distance (miles)
BPRCOEFFICIENT	li	BPRCOEFFICIENT	; BPR equation parameter a
BPREXPONENT	li	BPREXPONENT	; BPR equation parameter b
FREEFLOWSPEED	li	SPEED	; Link free flow speed
CONFACAMP	li	CONFAC_AM	; AM CONF factor
Num_Lanes	li	LANES	; link number of lanes

Table 10: IM PM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
PM_ToTVol	li	PM_TV	;PM total volume
PM_DAVol	li	DRV_ALONE_PM	; PM drive alone volume
PM_SRVOL	li	CARPOOL_PM	; PM carpool volume
PM_TRKVOL	li	TRUCK_TAXI_PM	; PM truck volume
CAPACITY	li	CAPACITY	; Link capacity (LOS E)
LOSCCAP	li	CAPACITY	; Capacity under LOS C
PM_VCLOSC	li	VOLCAP_PM	; PM V/C ratio under LOS C capacity
PM_CONGTIME	li	CGSTD_TIME_PM	; PM link congested travel time
PM_CONGSPD	li	CGSTD_SPEED_PM	; PM link congested speed
PM_VHT	li	PM_VHT	; PM Vehicle mile traveled
PM_VMT	li	PM_VMT	; PM vehicle hour traveled
AT2_OLD	li	ATYPE	; Link area type code (2 digits)
AREA_TYPE	li	ATYPE1	; Link area type code (1 digit)
FTC2	li	FTYPE	; Link facility type code (2 digits)
Time	li	TIME	; link free flow speed

Standard Variable	Link/Node field	Replaced Variable	Description
Distance	li	DISTANCE	; Link distance (miles)
BPRCOEFFICIENT	li	BPRCOEFFICIENT	; BPR equation parameter a
BPREXPONENT	li	BPREXPONENT	; BPR equation parameter b
FREEFLOWSPEED	li	SPEED	; Link free flow speed
CONFACPMP	li	CONFAC_PM	; PM CONF factor
Num_Lanes	li	LANES	; link number of lanes

Table 11: IM off peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
OF_ToTVol	li	OP_TV	; OF total volume
OF_DAVol	li	DRV_ALONE_OP	; OF drive alone volume
OF_SRVOL	li	CARPOOL_OP	; OF carpool volume
OF_TRKVOL	li	TRUCK_TAXI_OP	; OF truck volume
CAPACITY	li	CAPACITY	; Link capacity (LOS E)
LOSCCAP	li	CAPACITY	; Capacity under LOS C
OF_VCLOSC	li	VOLCAP_OP	; OF V/C ratio under LOS C capacity
OF_VMT	li	OP_VMT	; OF link congested travel time
OF_CONGTIME	li	CGSTD_TIME_OP	; OF link congested speed
OF_CONGSPD	li	CGSTD_SPEED_OP	; OF Vehicle mile traveled
OF_VHT	li	OP_VHT	; OF vehicle hour traveled
AT2_OLD	li	ATYPE	; Link area type code (2 digits)
AREA_TYPE	li	ATYPE1	; Link area type code (1 digit)
FTC2	li	FTYPE	; Link facility type code (2 digits)
Time	li	TIME	; link free flow speed
Distance	li	DISTANCE	; Link distance (miles)
BPRCOEFFICIENT	li	BPRCOEFFICIENT	; BPR equation parameter a
BPREXPONENT	li	BPREXPONENT	; BPR equation parameter b
FREEFLOWSPEED	li	SPEED	; Link free flow speed
CONFACOFP	li	CONFAC_OP	; OF CONF factor
Num_Lanes	li	LANES	; link number of lanes

Table 12: IM 24 hour network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AD_TotVol	li	TOTALVOL	; Daily total volume
AD_DAVOL	li	DRIVE_ALONE	; Daily drive alone volume

Standard Variable	Link/Node field	Replaced Variable	Description
AD_SRVOL	li	CARPOOL	; Daily carpool volume
AD_TRKVOL	li	TRUCK_TAXI	; Daily truck volume
AD_VMT	li	VMT	; Daily Vehicle mile traveled
AD_VHT	li	VHT	; Daily vehicle hour traveled
AD_VCLOSC	li	VOLCAP	; Daily V/C ratio under LOS C capacity
AD_CONGTIME	li	CGSTD_TIME	; Daily link congested travel time
AD_CONGSPD	li	CGSTD_SPEED	;Daily link congested speed
TIME	li	TIME	;Daily link free flow time
FreeFlowSpeed	li	SPEED	; Daily link free flow speed
BPRCOEFFICIENT	li	BPRCOEFFICIENT	; BPR equation parameter a
BPREXPONENT	li	BPREXPONENT	; BPR equation parameter b
DISTANCE	li	DISTANCE	; Link distance (miles)
AT2_OLD	li	ATYPE	; Link area type code (2 digits)
Area_Type	li	ATYPE1	; Link area type code (1 digit)
FTC2	li	FTYPE	; Link facility type code (2 digits)
LOSCCAP	li	CAPACITY	; Capacity under LOS C
CONFAC24H	li	CONFAC	; Daily Confac factor
Capacity	li	CAPACITY	; Link capacity
Num_Lanes	li	LANES	; link number of lanes

Bus Priority (BP)

Table 13: Inputs for BP Program

Field name	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Internal Zones	The number of internal zones
Lowest node number in highway network	The lowest node number in highway network
Number of Periods per year	The number of studying periods per year
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
Select modules to run	The user can choose safety evaluation, travel time evaluation, fuel consumption, emission evaluation, Boarding evaluation module, and time of day modeling
Bus priority network	Bus priority road network with BP coded
Bus priority network	The look up table that converts the Bus priority network

Field name	Description
variable replacement	variable name into standard variable name.
Transit line file	Transit line file (*.lin)
Transit system file	Transit system file (*.PTS)
Transit lines equipped with APTS	Transit line file equipped with APTS (*.DBF)
Peak period transit link volumes	Peak period transit link ridership (*.DBF)
Off peak period transit link volumes	Off Peak period transit link ridership (*.DBF)
LOS for capacity	LOS for capacity (E or C)
Maximum V/C ratio for BPR equation	Maximum V/C ratio for BPR equation
Ridership Increasing rate (%)	Transit ridership increasing rate due to BP
Market penetration rate for TIS or EFC	Make penetration rate for TIS (Traveler information system) or EFC (electric fare system)
Number of maximum preemption	Maximum number priority calls at each intersection that is considered in the calculation (default = 5).
Intersection cycle length	Intersection cycle length (default = 120 sec).
Cross street green time	Average cross street green time (default = 30 sec)
Bus priority route-on-time performance	Bus priority route on-time performance: percentage of vehicles that are meeting their schedule at any given time (default = 60 percent).
Peak period cross street delay per vehicle	Peak period cross street delay per vehicle (15 seconds)
Off peak period cross street delay per vehicle	Off peak period cross street delay per vehicle (6 second)
Average transit fare	Average transit fare (default = $1).
Discount rate	Discount rate
Performance summary	The output file for ITS strategies performance summary
Benefit/Cost summary ($)	The output file for Benefit and cost summary

Table 14: BP 24 hour network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
DISTANCE	li	DISTANCE	Link distance (Mile)
FREEFLOWTIME	li	TIME	Link freeflow time
TIME	li	TIME	Link freeflow time
FTC2	li	FTYPE	Link facility type code (two digits)
AT2_OLD	li	ATYPE	Area type code (two digits)
AREA_TYPE	li	ATYPE1	Area type code (1 digit)

Standard Variable	Link/Node field	Replaced Variable	Description
LOSCCAP_AMPKPD	li	CAPACITY	AM Link capacity under LOS C
LOSCCAP_OFPKPD	li	CAPACITY	OP Link capacity under LOS C
AM_TOTVOL	li	AM_TV	AM link total volume
AM_TRKVOL	li	TRUCK_TAXI_AM	AM link truck volume
OF_TOTVOL	li	OP_TV	OP link total volume
OF_TRKVOL	li	TRUCK_TAXI_OP	OP link truck volume
BPRCOEFFICIENT	li	BPRCOEFFICIENT	BPR equation coefficient a
BPREXPONENT	li	BPREXPONENT	BPR equation coefficient b
UROADFACTOR	li	UROADFACTOR	UROAD factor
BusPriority	li	BusPriority	Link flag for bus Priority deployment, 1 for main street, and 2 for cross street

Smart Work Zone (SWZ)

Table 15: Inputs for SWZ Program

Field name	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Model type	The user can choose time of day model or 24 hour model
Lowest node number in highway network	The lowest node number in highway network
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
24 hour loaded network	24 hour loaded highway network
24 hour loaded network variable replacement	The look up table that converts the 24 hour loaded network variable name into standard variable name.
AM peak loaded network	AM loaded highway network
PM peak loaded network	PM loaded highway network
Off peak loaded network	Off peak loaded highway network
AM peak loaded network variable replacement	The look up table that converts the AM loaded network variable name into standard variable name
PM peak loaded network variable replacement	The look up table that converts the PM loaded network variable name into standard variable name
Off peak loaded network variable replacement	The look up table that converts the Off peak hour loaded network variable name into standard variable name
Select modules to run	The user can choose safety evaluation, travel time evaluation, fuel consumption, emission evaluation, and Road ranger

Field name	Description
	evaluation
Level of capacity used for evaluation	The user can choose LOS E capacity or LOS C capacity
Maximum V/C ratio for BPR Equation	Maximum volume/capacity ratio for BPR equation
Auto Occupancy	Auto Occupancy
Percentage of Trucks in Truck-Taxi trips	Percentage of trucks in the Truck-taxi trip table
Passenger Car Equivalent for Heavy Vehicles	Passenger car equivalent factor for heavy vehicle
Work zone capacity adjustment factor	Work zone capacity adjustment factor for construction type, work intensity, and location of the work activities
Work zone capacity adjustment factor for ramps if ramp is located within taper area or 500 ft downstream of the work zone	Work zone capacity adjustment factor for ramps that are within the taper area or 500 ft downstream of the work zone
Percentage reduction in speed variation due to speed advisory in work zone (10% with radar and VMS; 20% with safe speed calculated)	Percentage reduction in speed variance (defaults = 10 percent for smart work zone with radar and VMS display, and 20 percent for smart work zone with an algorithm to calculate the safe speed).
Percentage reduction in crash rate with queue warning system (%)	Percentage reduction in crash rate (default = 7 percent)
Average trip length for the network (Miles)	Average trip length on the mainline (default = 8 miles).
Average trip length on alternative route (%)	Average trip length on the alternative route (default = 8.2 miles).
Percentage of diverted drivers using freeway as alternative route (%)	Percentage of diverted vehicles using freeways (default = 0 percent).
Diversion rate due to SWZ (%) (Default value 5% for providing delay information 15% for providing alternative route information)	Diversion rate due to SWZ (%) (Default value 5% for providing delay information 15% for providing alternative route information)
Percentage increase in work zone capacity due to the deployment of dynamic lane merge system (%)	Percentage increase in work zone capacity (default = 5 percent).

Field name	Description
Percentage reduction in crash rate with dynamic lane merge system (%)	Percentage reduction in crash rate (default = 7 percent)
Type of SWZ	The user can choose dynamic merge systems, speed advisory with a radar and feedback VMS display, speed advisory based on algorithm for safe speed, Queue warning systems, systems that provide delay information, systems that provide alternative route information
Discount rate	Discount rate
Performance summary	The output file for ITS strategies performance summary
Benefit/Cost summary ($)	The output file for Benefit and cost summary

Table 16: SWZ AM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AM_TOTVOL	li	AM_TV	AM Total volume
AM_DAVOL	li	DRV_ALONE_AM	AM Drive alone volume
AM_SRVOL	li	CARPOOL_AM	AM Carpool volume
AM_TRKVOL	li	TRUCK_TAXI_AM	AM Truck volume
Capacity	li	CAPACITY	Link capacity (LOS E)
LOSCCap	li	CAPACITY	Link capacity (LOS C)
Num_Lanes	li	LANES	Number of lanes
AM_VCLOSC	li	VOLCAP_AM	AM V/C ratio (LOS C capacity)
AM_VMT	li	AM_VMT	AM VMT
AM_CONGTIME	li	CGSTD_TIME_AM	AM link congestion time
AM_CONGSPD	li	CGSTD_SPEED_AM	AM link congestion speed
AM_VHT	li	AM_VHT	AM link VHT
TIME	li	TIME	AM link free flow time (Minute)
BPRCoefficient	li	BPRCoefficient	Link BPR coefficient a
BPRExponent	li	BPRExponent	Link BPR coefficient b
Distance	li	Distance	Link distance (Mile)
AT2_Old	li	ATYPE	Link Area type (Two digits)
Area_Type	li	ATYPE1	Link Area type (One digits)
SWZ	li	SWZ	Flag for Smart work zone
FTC2	li	FTYPE	Facility type code (Two digits)
Lanes_Open	li	Lanes_Open	number of lane opened for work zone

Standard Variable	Link/Node field	Replaced Variable	Description
CONFAC24H	li	CONFAC	CONFAC factor for 24 Daily model
CONFACAMP	li	CONFAC_AM	CONFAC factor for AM model
CONFACPMP	li	CONFAC_PM	CONFAC factor for PM model
CONFACOFP	li	CONFAC_OP	CONFAC factor for OP model
FreeFlowSpeed	li	SPEED	Link Free flow speed (Mile/Hour)
AM_TOTVOL2	li	AM_TW_TV	AM Total two-way volume

Table 17: SWZ PM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
PM_TOTVOL	li	PM_TV	PM Total volume
PM_DAVOL	li	DRV_ALONE_PM	PM Drive alone volume
PM_SRVOL	li	CARPOOL_PM	PM Carpool volume
PM_TRKVOL	li	TRUCK_TAXI_PM	PM Truck volume
Capacity	li	CAPACITY	Link capacity (LOS E)
LOSCCap	li	CAPACITY	Link capacity (LOS C)
Num_Lanes	li	LANES	Number of lanes
PM_VCLOSC	li	VOLCAP_PM	PM V/C ratio (LOS C capacity)
PM_VMT	li	PM_VMT	PM VMT
PM_CONGTIME	li	CGSTD_TIME_PM	PM link congestion time
PM_CONGSPD	li	CGSTD_SPEED_PM	PM link congestion speed
PM_VHT	li	PM_VHT	PM link VHT
TIME	li	TIME	PM link free flow time (Minute)
BPRCoefficient	li	BPRCoefficient	Link BPR coefficient a
BPRExponent	li	BPRExponent	Link BPR coefficient b
Distance	li	Distance	Link distance (Mile)
AT2_Old	li	ATYPE	Link Area type (Two digits)
Area_Type	li	ATYPE1	Link Area type (One digits)
SWZ	li	SWZ	Flag for Smart work zone
FTC2	li	FTYPE	Facility type code (Two digits)
Lanes_Open	li	Lanes_Open	number of lane opened for work zone
CONFAC24H	li	CONFAC	CONFAC factor for 24 Daily model
CONFACAMP	li	CONFAC_AM	CONFAC factor for AM model
CONFACPMP	li	CONFAC_PM	CONFAC factor for PM model
CONFACOFP	li	CONFAC_OP	CONFAC factor for OP model
FreeFlowSpeed	li	SPEED	Link Free flow speed (Mile/Hour)
PM_TOTVOL2	li	PM_TW_TV	PM Total two-way volume

Table 18: SWZ off peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
OF_TOTVOL	li	OP_TV	OP Total volume
OF_DAVOL	li	DRV_ALONE_OP	OP Drive alone volume
OF_SRVOL	li	CARPOOL_OP	OP Carpool volume
OF_TRKVOL	li	TRUCK_TAXI_OP	OP Truck volume
Capacity	li	CAPACITY	Link capacity (LOS E)
LOSCCap	li	CAPACITY	Link capacity (LOS C)
Num_Lanes	li	LANES	Number of lanes
OF_VCLOSC	li	VOLCAP_OP	OP V/C ratio (LOS C capacity)
OF_VMT	li	OP_VMT	OP VMT
OF_CONGTIME	li	CGSTD_TIME_OP	OP link congestion time
OF_CONGSPD	li	CGSTD_SPEED_OP	OP link congestion speed
OF_VHT	li	OP_VHT	OP link VHT
TIME	li	TIME	OP link free flow time (Minute)
BPRCoefficient	li	BPRCoefficient	Link BPR coefficient a
BPRExponent	li	BPRExponent	Link BPR coefficient b
Distance	li	Distance	Link distance (Mile)
AT2_Old	li	ATYPE	Link Area type (Two digits)
Area_Type	li	ATYPE1	Link Area type (One digits)
SWZ	li	SWZ	Flag for Smart work zone
FTC2	li	FTYPE	Facility type code (Two digits)
Lanes_Open	li	Lanes_Open	number of lane opened for work zone
CONFAC24H	li	CONFAC	CONFAC factor for 24 Daily model
CONFACAMP	li	CONFAC_AM	CONFAC factor for AM model
CONFACPMP	li	CONFAC_PM	CONFAC factor for PM model
CONFACOFP	li	CONFAC_OP	CONFAC factor for OP model
FreeFlowSpeed	li	SPEED	Link Free flow speed (Mile/Hour)
OF_TOTVOL2	li	OP_TW_TV	OP Total two-way volume

Table 19: SWZ 24 hour network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AD_TOTVOL	li	TOTALVOL	Daily Total volume
AD_DAVOL	li	DRIVE_ALONE	Daily Drive alone volume
AD_SRVOL	li	CARPOOL	Daily Carpool volume
AD_TRKVOL	li	TRUCK_TAXI	Daily Truck volume

Standard Variable	Link/Node field	Replaced Variable	Description
Capacity	li	CAPACITY	Link capacity (LOS E)
LOSCCap	li	CAPACITY	Link capacity (LOS C)
Num_Lanes	li	LANES	Number of lanes
AD_VCLOSC	li	VOLCAP	Daily V/C ratio (LOS C capacity)
AD_VMT	li	VMT	Daily VMT
AD_CONGTIME	li	CGSTD_TIME	Daily link congestion time
AD_CONGSPD	li	CGSTD_SPEED	Daily link congestion speed
AD_VHT	li	VHT	Daily link VHT
TIME	li	TIME	Daily link free flow time (Minute)
BPRCoefficient	li	BPRCoefficient	Link BPR coefficient a
BPRExponent	li	BPRExponent	Link BPR coefficient b
Distance	li	Distance	Link distance (Mile)
AT2_Old	li	ATYPE	Link Area type (Two digits)
Area_Type	li	ATYPE1	Link Area type (One digits)
SWZ	li	SWZ	Flag for Smart work zone
FTC2	li	FTYPE	Facility type code (Two digits)
Lanes_Open	li	Lanes_Open	number of lane opened for work zone
CONFAC24H	li	CONFAC	CONFAC factor for 24 Daily model
CONFACAMP	li	CONFAC_AM	CONFAC factor for AM Daily model
CONFACPMP	li	CONFAC_PM	CONFAC factor for PM Daily model
CONFACOFP	li	CONFAC_OP	CONFAC factor for OP Daily model
FreeFlowSpeed	li	SPEED	Link Free flow speed (Mile/Hour)
AD_TOTVOL2	li	TOT_TWOWAY_VOL	Total two-way volume

Road Weather Information (RWI)

Table 20: Inputs for RWI Program

Field name	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Model type	The user can choose time of day model or 24 hour model
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
24 hour loaded network	24 hour loaded highway network
24 hour loaded network variable replacement	The look up table that converts the 24 hour loaded network variable name into standard variable name.
AM peak loaded network	AM loaded highway network

Field name	Description
PM peak loaded network	PM loaded highway network
Off peak loaded network	Off peak loaded highway network
AM peak loaded network variable replacement	The look up table that converts the AM loaded network variable name into standard variable name
PM peak loaded network variable replacement	The look up table that converts the PM loaded network variable name into standard variable name
Off peak loaded network variable replacement	The look up table that converts the Off peak hour loaded network variable name into standard variable name
Select modules to run	The user can choose safety evaluation
Level of capacity used for evaluation	The user can choose LOS E capacity or LOS C capacity
Maximum V/C ratio for BPR Equation	Maximum volume/capacity ratio for BPR equation
Percentage of Trucks in Truck-Taxi trips	Percentage of trucks in the Truck-taxi trip table
Percentage of fatality that occurs under rain and wet pavement conditions (%)	Percentage of fatalities that occur under the rain and wet pavement conditions (defaults = 13 percent).
Percentage of injury that occurs under rain and wet pavement conditions (%)	Percentage of injuries that occur under the rain and wet pavement conditions (default = 17 percent).
Percentage of PDO that occurs under rain and wet pavement conditions (%)	Percentage of PDO that occur under the rain and wet pavement conditions (default = 18 percent).
Percentage reduction in Arterial crash rate with RWIS (%)	Percentage reduction in arterial crashes with RWIS (default = 10 percent).
Percentage reduction in freeway crash rate with RWIS (%)	Percentage reduction in freeway crashes with RWIS (default = 15 percent).
Discount rate (%)	Discount rate
Number of RWI system (Except ESS station) used in the implementation	Number of RWIS system (except the ESS stations) needed in the implementation (default = 1)
Number of ESS stations used in the implementation	Number of ESS stations needed in the implementation (default = 1).
Performance summary	The output file for ITS strategies performance summary
Benefit/Cost summary ($)	The output file for Benefit and cost summary

Table 21: RWI AM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AM_TOTVOL	li	AM_TV	AM total volume
AM_DAVOL	li	DRV_ALONE_AM	AM drive alone volume
AM_SRVOL	li	CARPOOL_AM	AM car pool volume
AM_TRKVOL	li	TRUCK_TAXI_AM	AM truck volume
Capacity	li	Capacity	Link capacity (LOS E capacity)
Num_Lanes	li	Lanes	Link number of lanes
AM_VCLOSC	li	VOLCAP_AM	AM V/C ratio based on LOSC capacity
LOSCCap	li	CAPACITY	LOS C capacity
AM_VMT	li	AM_VMT	AM link vehicle mile traveled
AM_CONGTIME	li	CGSTD_TIME_AM	AM link congested time
AM_CONGSPD	li	CGSTD_SPEED_AM	AM link congested speed
AM_VHT	li	AM_VHT	AM link vehicle hour traveled
TIME	li	TIME	Link travel time
BPRCoefficient	li	BPRCoefficient	Link BPR coefficient a
BPRExponent	li	BPRExponent	Link BPR coefficient b
Distance	li	Distance	Link Distance
AT2_Old	li	ATYPE	Link area type code (two digits)
Area_Type	li	ATYPE1	Link Area type code
RWIS	li	RWIS	The flag meaning RWIS implemented in certain link
FTC2	li	FTYPE	Facility type code with 2 digits
AM_TOTVOL2	li	AM_TW_TV	AM Total two way volume

Table 22: RWI PM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
PM_TOTVOL	li	PM_TV	PM total volume
PM_DAVOL	li	DRV_ALONE_PM	PM drive alone volume
PM_SRVOL	li	CARPOOL_PM	PM car pool volume
PM_TRKVOL	li	TRUCK_TAXI_PM	PM truck volume
Capacity	li	Capacity	Link capacity (LOS E capacity)
Num_Lanes	li	Lanes	Link number of lanes
PM_VCLOSC	li	VOLCAP_PM	PM V/C ratio based on LOSC capacity
LOSCCap	li	CAPACITY	LOS C capacity
PM_VMT	li	PM_VMT	PM link vehicle mile traveled
PM_CONGTIME	li	CGSTD_TIME_PM	PM link congested time
PM_CONGSPD	li	CGSTD_SPEED_PM	PM link congested speed
PM_VHT	li	PM_VHT	PM link vehicle hour traveled

Standard Variable	Link/Node field	Replaced Variable	Description
TIME	li	TIME	Link travel time
BPRCoefficient	li	BPRCoefficient	Link BPR coefficient a
BPRExponent	li	BPRExponent	Link BPR coefficient b
Distance	li	Distance	Link Distance
AT2_Old	li	ATYPE	Link area type code (two digits)
Area_Type	li	ATYPE1	Link Area type code
RWIS	li	RWIS	The flag meaning RWIS implemented in certain link
FTC2	li	FTYPE	Facility type code with 2 digits
PM_TOTVOL2	li	PM_TW_TV	PM Total two way volume

Table 23: RWI off-peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
OF_TOTVOL	li	OP_TV	OP total volume
OF_DAVOL	li	DRV_ALONE_OP	OP drive alone volume
OF_SRVOL	li	CARPOOL_OP	OP car pool volume
OF_TRKVOL	li	TRUCK_TAXI_OP	OP truck volume
Capacity	li	Capacity	Link capacity (LOS E capacity)
Num_Lanes	li	Lanes	Link number of lanes
OF_VCLOSC	li	VOLCAP_OP	OP V/C ratio based on LOSC capacity
LOSCCap	li	CAPACITY	LOS C capacity
OF_VMT	li	OP_VMT	OP link vehicle mile traveled
OF_CONGTIME	li	CGSTD_TIME_OP	OP link congested time
OF_CONGSPD	li	CGSTD_SPEED_OP	OP link congested speed
OF_VHT	li	OP_VHT	OP link vehicle hour traveled
TIME	li	TIME	Link travel time
BPRCoefficient	li	BPRCoefficient	Link BPR coefficient a
BPRExponent	li	BPRExponent	Link BPR coefficient b
Distance	li	Distance	Link Distance
AT2_Old	li	ATYPE	Link area type code (two digits)
Area_Type	li	ATYPE1	Link Area type code
RWIS	li	RWIS	The flag meaning RWIS implemented in certain link
FTC2	li	FTYPE	Facility type code with 2 digits
OF_TOTVOL2	li	OP_TW_TV	OP Total two way volume

Table 24: RWI 24 hr network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AD_TOTVOL	li	TOTALVOL	Daily total volume
AD_DAVOL	li	DRIVE_ALONE	Daily drive alone volume
AD_SRVOL	li	CARPOOL	Daily car pool volume
AD_TRKVOL	li	TRUCK_TAXI	Daily truck volume
Capacity	li	CAPACITY	link capacity (LOS E capacity)
LOSCCap	li	CAPACITY	Link capacity (LOS C capacity)
Num_Lanes	li	LANES	Number of lanes
AD_VCLOSC	li	VOLCAP	Daily V/C ratio based on LOSC capcity
AD_VMT	li	VMT	Daily vehicle mile traveled
AD_CONGTIME	li	CGSTD_TIME	Daily congested travel time
AD_CONGSPD	li	CGSTD_SPEED	Daily congested speed
AD_VHT	li	VHT	Daily vehicle hour traveled
TIME	li	TIME	Link travel time
BPRCoefficient	li	BPRCoefficient	BPR equation coefficient a
BPRExponent	li	BPRExponent	BPR equation coefficient b
Distance	li	Distance	Link length (Mile)
AT2_Old	li	ATYPE	OLD Area type code with 2 digits
Area_Type	li	ATYPE1	Area Type code
RWIS	li	RWIS	The flag meaning RWIS implemented in certain link
FTC2	li	FTYPE	Facility type code with 2 digits
AD_TOTVOL2	li	TOT_TWOWAY_VOL	Total two way volume

Signal Timing Improving (STI)

Table 25: Inputs for STI Program

Field name	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Number of periods per year	The number of study periods per year
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
AM peak loaded network	AM loaded highway network
PM peak loaded network	PM loaded highway network
Off peak loaded network	Off peak loaded highway network

AM peak loaded network variable replacement	The look up table that converts the AM loaded network variable name into standard variable name
PM peak loaded network variable replacement	The look up table that converts the PM loaded network variable name into standard variable name
Off peak loaded network variable replacement	The look up table that converts the Off peak hour loaded network variable name into standard variable name
Select modules to run	The user can choose safety evaluation, Travel time evaluation, Fuel consumption, Emission Evaluation
STI coded network	STI coded network
STI coded network variable replacement	The look up table that converts the STI coded network variable name into standard variable name
Type of improvement	The type of improvement
Reference year	The reference year (four digits)
Number of intersections to be improved	The total number of intersections to be improved as part of the project. This number is not used for benefit calculations. Instead, it is used to compute the total cost of the project.
Use NaZTEC System	Use NAZTEC system
Use OPAC System	Use OPAC System
Use SCATS System	Use SCATS System
Use SCOOTS system	Use SCOOTS system
Percentage of Trucks in Truck-Taxi trips	Percentage of trucks in the Truck-taxi trip table
Auto Occupancy	Auto Occupancy
Annual traffic growth rate	Annual traffic growth rate
Annual truck traffic growth rate	Annual truck traffic growth rate
Optimistic growth rate for travel time	Optimistic growth rate for travel time
Pessimistic growth rate for travel time	Pessimistic growth rate for travel time
Year in which the project starts	Corresponds to the year becomes operational
Year in which the 1st period starts	The year when the first timing update is done.
Year in which the 2nd period starts	The year when the second timing update is done.
Year in which the 3rd period starts	The year when the third timing update is done.
Year in which the 4th period starts	The year when the fourth timing update is done.
Year in which the 5th period starts	The year when the fifth user defined the timing update is done.

Year in which the project finish	The end of the project evaluation period
Discount rate (%)	Discount rate
Cost factor for contingency	Cost factor for contingency
Performance summary	The output file for ITS strategies performance summary
Benefit/Cost summary ($)	The output file for Benefit and cost summary

Table 26: STI AM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AM_TOTVOL	li	AM_TV	;AM Total Volume
AM_TRKVOL	li	TRUCK_TAXI_AM	;AM Truck Volume
Distance	li	Distance	;Link distance (mile)
AM_CONGTIME	li	CGSTD_TIME_AM	;AM Congested time
AM_CONGSPD	li	CGSTD_SPEED_AM	;AM Congested speed (Mile/Hour)
FTC2	li	FTYPE	;Facility type code (two digits)

Table 27: STI PM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
PM_TOTVOL	li	PM_TV	;PM Total Volume
PM_TRKVOL	li	TRUCK_TAXI_PM	;PM Truck Volume
Distance	li	Distance	;Link distance (mile)
PM_CONGTIME	li	CGSTD_TIME_PM	;PM Congested time
PM_CONGSPD	li	CGSTD_SPEED_PM	;PM Congested speed (Mile/Hour)
FTC2	li	FTYPE	;Facility type code (two digits)

Table 28: STI off-peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
OF_TOTVOL	li	OP_TV	;OF Total Volume
OF_TRKVOL	li	TRUCK_TAXI_OP	;OF Truck Volume
Distance	li	Distance	;Link distance (mile)
OF_CONGTIME	li	CGSTD_TIME_OP	;OP Congested time
OF_CONGSPD	li	CGSTD_SPEED_OP	;OF Congested speed (Mile/Hour)
FTC2	li	FTYPE	;Facility type code (two digits)

Table 29: STI coded network variable replacement

Standard Variable	link/Node field	Replaced Variable	Description
improved	li	Improved	; Flag indicating the main street implemented the signal timing improvement

Ramp Metering (RM)

Table 30: Inputs for RM Program

Field name	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Model type	The user can choose 24 hour model or Time of day model
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
24 HR loaded network	24 hour loaded highway network
24 HR loaded network variable replacement	The look up table that converts the 24 hour network variable name into standard variable name.
AM loaded network	Loaded AM highway network
PM loaded network	Loaded AM highway network
Off-peak loaded network	Loaded Off-peak highway network
AM loaded network variable replacement	The look up table that converts the AM network variable name into standard variable name.
PM loaded network variable replacement	The look up table that converts the PM network variable name into standard variable name.
Off peak loaded network variable replacement	The look up table that converts the Off peak network variable name into standard variable name.
Select modules to run	User can choose Safety evaluation module, travel time evaluation module, fuel consumption module, emission evaluation module and road ranger evaluation module
Base Case AM Peak Loaded Network	AM peak loaded network without ramp metering
Base Case PM Peak Loaded Network	PM peak loaded network without ramp metering
Base Case Off Peak Loaded Network	Off peak loaded network without ramp metering
RM AM Peak Loaded Network	AM peak loaded network with ramp metering
RM PM Peak Loaded	PM peak loaded network with ramp metering

Field name	Description
Network	
RM Off Peak Loaded Network	Off peak loaded network with ramp metering
Base Case/RM Loaded Network Variable Replacement	Variable replacement file for the loaded networks
RM Info AM Peak	Ramp Metering info for AM peak
RM Info PM Peak	Ramp Metering info for PM peak
RM Info Off Peak	Ramp Metering info for Off peak
Auto Occupancy	The auto occupancy for passenger
Percentage of Truck in Truck-Taxi trip (%)	The percentage of truck in Truck-Taxi trip
Crash Rate reduction factor	Percentage reduction in total crash rate due to reduction in secondary incidents (default = 25 percent)
Discount rate (%)	The discount rate
Performance summary ($)	The output file for ITS strategies performance summary
Benefit/Cost summary	The output file for Benefit and cost summary

Table 31: RM AM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
RM	li	RM	;Flag indicating the Ramp metering (0,1)
Corr	li	Corr	;Flag indicating the Corridor (0,1)
Affected_Fwy	li	Affected_Fwy	;Flag indicating the affected freeway mainline by the ramp metering
AM_TOTVOL	li	AM_TOTVOL	;AM Total traffic volume
AM_DAVOL	li	AM_DAVOL	;AM drive alone volume
AM_SRVOL	li	AM_SRVOL	;AM carpool volume
AM_TRKVOL	li	AM_TRKVOL	;AM truck volume

Standard Variable	Link/Node field	Replaced Variable	Description
AM_VCLOSC	li	AM_VCLOSC	;AM link V/C ratio under LOS C
AM_VMT	li	AM_VMT	;AM link vehicle mile traveled
AM_VHT	li	AM_VHT	;AM link vehicle hour traveled
AM_CONGTIME	li	AM_CONGTIME	;AM link congested travel time
AM_CONGSPD	li	AM_CONGSPD	;AM link congested speed
CONFACAMP	li	CONFACAMP	;AM peak Link CONFAC factor
Capacity	li	Capacity	;Link capacity with LOS E
Num_Lanes	li	Num_Lanes	;Link number of lanes
Distance	li	Distance	;Link distance
Area_Type	li	Area_Type	;Link area type code (1 digit)
AT2_Old	li	AT2_Old	;Link area type code (two digits)
FTC2	li	FTC2	;Link facility type code (two digits)
LOSCCAP_AMPKPD	li	LOSCCAP_AMPKPD	;Los C Capacity
BPRCOEFFICIENT	li	BPRCOEFFICIENT	;HIGHWAY BPR equation coefficient a
BPREXPONENT	li	BPREXPONENT	;HIGHWAY BPR equation coefficient b
Time	li	Time	;HIGHWAY link free flow travel time
FREEFLOWSPEED	li	FREEFLOWSPEED	;HIGHWAY Link free flow speed
TOLL	li	TOLL	;HIGHWAY Flag indicating if the link is toll link
CARTOLL	li	CARTOLL	;HIGHWAY Vehicle toll rate
TOLLTYPE	li	TOLLTYPE	;HIGHWAY Toll type (1,2,3)
RCTOLL	li	RCTOLL	;Factor converting the toll into time
SVCMINUTES	li	SVCMINUTES	;HIGHWAY Toll plaza service time (minutes)

Standard Variable	Link/Node field	Replaced Variable	Description
SVCSECONDS	li	SVCSECONDS	;HIGHWAY Toll plaza service time (Seconds)
plzalnsmin	li	plzalnsmin	;HIGHWAY Toll plaza minimum number of lanes
PLZALNSMAX	li	PLZALNSMAX	;HIGHWAY Toll plaza maximum number of lanes
TOLL_ACC	li	TOLL_ACC	;HIGHWAY Toll plaza vehicle accelerate speed
TOLL_DEC	li	TOLL_DEC	;HIGHWAY Toll plaza vehicle decelerate speed
plzadescm	li	plzadescm	;HIGHWAY Plaza description
pcttrucks	li	pcttrucks	;HIGHWAY Percentage of truck of link volume
REVERSIBLE	li	REVERSIBLE	;HIGHWAY flag indicating if the lane is reversible
HOT	li	HOT	;HIGHWAY Flag indicating if the lane is hot lane
ROUNDNODECLS	li	ROUNDNODECLS	;Flag code for junction Data (0,1)
CNT_AMPRD	li	CNT_AMPRD	;Count AM peak period
LOSCCAP	li	LOSCCAP	;Los C Capacity
FWYRNDNODE	ni	FWYRNDNODE	;Freeway round about node

Table 32: RM PM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
RM	li	RM	;Flag indicating the Ramp metering (0,1)

Standard Variable	Link/Node field	Replaced Variable	Description
Corr	li	Corr	;Flag indicating the Corridor (0,1)
Affected_Fwy	li	Affected_Fwy	;Flag indicating the affected freeway mainline by the ramp metering
PM_TOTVOL	li	PM_TOTVOL	;PM Total traffic volume
PM_DAVOL	li	PM_DAVOL	;PM drive alone volume
PM_SRVOL	li	PM_SRVOL	;PM carpool volume
PM_TRKVOL	li	PM_TRKVOL	;PM truck volume
PM_VCLOSC	li	PM_VCLOSC	;PM link V/C ratio under LOS C
PM_VMT	li	PM_VMT	;PM link vehicle mile traveled
PM_VHT	li	PM_VHT	;PM link vehicle hour traveled
PM_CONGTIME	li	PM_CONGTIME	;PM link congested travel time
PM_CONGSPD	li	PM_CONGSPD	;PM link congested speed
CONFACPMP	li	CONFACPMP	;PM peak link CONFAC factor
Capacity	li	Capacity	;Link capacity with LOS E
Num_Lanes	li	Num_Lanes	;Link number of lanes
Distance	li	Distance	;Link distance
Area_Type	li	Area_Type	;Link area type code (1 digit)
AT2_Old	li	AT2_Old	;Link area type code (two digits)
FTC2	li	FTC2	;Link facility type code (two digits)
LOSCCAP_PMPKPD	li	LOSCCAP_PMPKPD	;Los C Capacity
BPRCOEFFICIENT	li	BPRCOEFFICIENT	;HIGHWAY BPR equation coefficient a
BPREXPONENT	li	BPREXPONENT	;HIGHWAY BPR equation coefficient b
Time	li	Time	;HIGHWAY link free flow travel time

Standard Variable	Link/Node field	Replaced Variable	Description
FREEFLOWSPEED	li	FREEFLOWSPEED	;HIGHWAY Link free flow speed
TOLL	li	TOLL	;HIGHWAY Flag indicating if the link is toll link
CARTOLL	li	CARTOLL	;HIGHWAY Vehicle toll rate
TOLLTYPE	li	TOLLTYPE	;HIGHWAY Toll type (1,2,3)
RCTOLL	li	RCTOLL	;Factor converting the toll into
SVCMINUTES	li	SVCMINUTES	;HIGHWAY Toll plaza service time (minutes)
SVCSECONDS	li	SVCSECONDS	;HIGHWAY Toll plaza service time (Seconds)
plzalnsmin	li	plzalnsmin	;HIGHWAY Toll plaza minimum number of lanes
PLZALNSMAX	li	PLZALNSMAX	;HIGHWAY Toll plaza maximum number of lanes
TOLL_ACC	li	TOLL_ACC	;HIGHWAY Toll plaza vehicle accelerate speed
TOLL_DEC	li	TOLL_DEC	;HIGHWAY Toll plaza vehicle decelerate speed
plzadescm	li	plzadescm	;HIGHWAY Plaza description
pcttrucks	li	pcttrucks	;HIGHWAY Percentage of truck of link volume
REVERSIBLE	li	REVERSIBLE	;HIGHWAY flag indicating if the lane is reversible
HOT	li	HOT	;HIGHWAY Flag indicating if the lane is hot lane
ROUNDNODECLS	li	ROUNDNODECLS	;Flag code for junction Data (0,1)
CNT_PMPRD	li	CNT_PMPRD	;Count PM peak period
LOSCCAP	li	LOSCCAP	;Los C Capacity

Standard Variable	Link/Node field	Replaced Variable	Description
FWYRNDNODE	ni	FWYRNDNODE	;Freeway round about node

Table 33: RM off peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
RM	Li	RM	;Flag indicating the Ramp metering (0,1)
Corr	Li	Corr	;Flag indicating the Corridor (0,1)
Affected_Fwy	Li	Affected_Fwy	;Flag indicating the affected freeway mainline by the ramp metering
OF_TOTVOL	Li	OF_TOTVOL	;OP Period Total traffic volume
OF_DAVOL	Li	OF_DAVOL	;OP Period drive alone volume
OF_SRVOL	Li	OF_SRVOL	;OP Period carpool volume
OF_TRKVOL	Li	OF_TRKVOL	;OP Period truck volume
OF_VCLOSC	Li	OF_VCLOSC	;OP Period link V/C ratio under LOS C
OF_VMT	Li	OF_VMT	;OP Period link vehicle mile traveled
OF_VHT	Li	OF_VHT	;OP Period link vehicle hour traveled
OF_CONGTIME	Li	OF_CONGTIME	;OP Period link congested travel time
OF_CONGSPD	Li	OF_CONGSPD	;OP Period link congested speed
CONFACOFP	Li	CONFACOFP	;OP Period Link CONFAC factor
Capacity	Li	Capacity	;Link capacity with LOS E
Num_Lanes	Li	Num_Lanes	;Link number of lanes
Distance	Li	Distance	;Link distance
Area_Type	Li	Area_Type	;Link area type code (1 digit)
AT2_Old	Li	AT2_Old	;Link area type code (two digits)

Standard Variable	Link/Node field	Replaced Variable	Description
FTC2	Li	FTC2	;Link facility type code (two digits)
LOSCCAP_OFPKPD	li	LOSCCAP_OFPKPD	;Los C Capacity
BPRCOEFFICIENT	Li	BPRCOEFFICIENT	;HIGHWAY BPR equation coefficient a
BPREXPONENT	Li	BPREXPONENT	;HIGHWAY BPR equation coefficient b
Time	Li	Time	;HIGHWAY link free flow travel time
FREEFLOWSPEED	Li	FREEFLOWSPEED	;HIGHWAY Link free flow speed
TOLL	Li	TOLL	;HIGHWAY Flag indicating if the link is toll link
CARTOLL	Li	CARTOLL	;HIGHWAY Vehicle toll rate
TOLLTYPE	Li	TOLLTYPE	;HIGHWAY Toll type (1,2,3)
RCTOLL	Li	RCTOLL	;Factor converting the toll into time
SVCMINUTES	Li	SVCMINUTES	;HIGHWAY Toll plaza service time (minutes)
SVCSECONDS	Li	SVCSECONDS	;HIGHWAY Toll plaza service time (Seconds)
plzalnsmin	Li	plzalnsmin	;HIGHWAY Toll plaza minimum number of lanes
PLZALNSMAX	Li	PLZALNSMAX	;HIGHWAY Toll plaza maximum number of lanes
TOLL_ACC	Li	TOLL_ACC	;HIGHWAY Toll plaza vehicle accelerate speed
TOLL_DEC	Li	TOLL_DEC	;HIGHWAY Toll plaza vehicle decelerate speed
plzadescm	Li	plzadescm	;HIGHWAY Plaza description
pcttrucks	Li	pcttrucks	;HIGHWAY Percentage of truck of link volume
REVERSIBLE	Li	REVERSIBLE	;HIGHWAY flag indicating if the lane is

Standard Variable	Link/Node field	Replaced Variable	Description
			reversible
HOT	Li	HOT	;HIGHWAY Flag indicating if the lane is hot lane
ROUNDNODECLS	li	ROUNDNODECLS	;Flag code for junction Data (0,1)
CNT_OFPRD	li	CNT_OFPRD	;Count AM peak period
LOSCCAP	li	LOSCCAP	;Los C Capacity
FWYRNDNODE	ni	FWYRNDNODE	;Freeway round about node

Table 34: RM 24 hour network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
RM	li	RM	;Flag indicating the Ramp metering (0,1)
Corr	li	Corr	;Flag indicating the Corridor (0,1)
Affected_Fwy	li	Affected_Fwy	;Flag indicating the affected freeway mainline by the ramp metering
AD_TOTVOL	li	AD_TOTVOL	;Daily Total traffic volume
AD_DAVOL	li	AD_DAVOL	;Daily drive alone volume
AD_SRVOL	li	AD_SRVOL	;Daily carpool volume
AD_TRKVOL	li	AD_TRKVOL	;Daily truck volume
AD_VCLOSC	li	AD_VCLOSC	;Daily link V/C ratio under LOS C
AD_VMT	li	AD_VMT	;Daily link vehicle mile traveled
AD_VHT	li	AD_VHT	;Daily link vehicle hour traveled
AD_CONGTIME	li	AD_CONGTIME	;Daily link congested travel time
AD_CONGSPD	li	AD_CONGSPD	;Daily link congested speed
CONFAC24H	li	CONFAC24H	;Daily Link CONFAC factor

Standard Variable	Link/Node field	Replaced Variable	Description
CAPACITY	li	Capacity	;Link capacity with LOS E
Num_Lanes	li	Num_Lanes	;Link number of lanes
Distance	li	Distance	;Link distance
Area_Type	li	Area_Type	;Link area type code (1 digit)
AT2_Old	li	AT2_Old	;Link area type code (two digits)
FTC2	li	FTC2	;Link facility type code (two digits)
LOSCCAP	li	LOSCCAP	;Los C Capacity
BPRCOEFFICIENT	li	BPRCOEFFICIENT	;HIGHWAY BPR equation coefficient a
BPREXPONENT	li	BPREXPONENT	;HIGHWAY BPR equation coefficient b
Time	li	Time	;HIGHWAY link free flow travel time
FREEFLOWSPEED	li	FREEFLOWSPEED	;HIGHWAY Link free flow speed
TOLL	li	TOLL	;HIGHWAY Flag indicating if the link is toll link
CARTOLL	li	CARTOLL	;HIGHWAY Vehicle toll rate
TOLLTYPE	li	TOLLTYPE	;HIGHWAY Toll type (1,2,3)
RCTOLL	li	RCTOLL	;Factor converting the toll into time
SVCMINUTES	li	SVCMINUTES	;HIGHWAY Toll plaza service time (minutes)
SVCSECONDS	li	SVCSECONDS	;HIGHWAY Toll plaza service time (Seconds)
plzalnsmin	li	plzalnsmin	;HIGHWAY Toll plaza minimum number of lanes
PLZALNSMAX	li	PLZALNSMAX	;HIGHWAY Toll plaza maximum number of lanes
TOLL_ACC	li	TOLL_ACC	;HIGHWAY Toll plaza vehicle accelerate speed

Standard Variable	Link/Node field	Replaced Variable	Description
TOLL_DEC	li	TOLL_DEC	;HIGHWAY Toll plaza vehicle decelerate speed
plzadescm	li	plzadescm	;HIGHWAY Plaza description
pcttrucks	li	pcttrucks	;HIGHWAY Percentage of truck of link volume
REVERSIBLE	li	REVERSIBLE	;HIGHWAY flag indicating if the lane is reversible
HOT	li	HOT	;HIGHWAY Flag indicating if the lane is hot lane
ROUNDNODECLS	li	ROUNDNODECLS	;Flag code for junction Data (0,1)
COUNT	li	COUNT	;Count
FWYRNDNODE	ni	FWYRNDNODE	;Freeway round about node

Table 35: RM Base Case/RM Loaded Network Variable Replacement

Standard Variable	Link/Node field	Replaced Variable	Description
Drive_Alone	li	Drive_Alone	; Drive alone volume
Carpool	li	Carpool	; Carpool volume
Truck_Taxi	li	Truck_Taxi	; Truck volume
Distance	li	Distance	; Link distance (Mile)
Capacity	li	Capacity	; Link capacity
VolCap	li	VolCap	; Link V/C ratio
FreeFlowSpeed	li	FreeFlowSpeed	; Link free flow speed (Mile/Hour)

Standard Variable	Link/Node field	Replaced Variable	Description
CGSTD_Time	li	CGSTD_Time	; Link Congested Time (Minute)
VMT	li	VMT	; Link VMT
VHT	li	VHT	; Link VHT
FTC2	li	FTC2	; Link Facility type code (2 digits)
AT2_OLD	li	AT2_OLD	; Link area type code (2 digits)
Affected_Fwy	li	Affected_Fwy	; Flag for the affected freeway (0.1)
RM	li	RM	; Flag for RM metering implement in ramps (0,1)
Corr	li	Corr	; Corridor number

Managed Lanes (ML)

Table 36: Inputs for ML Program

Field name	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
Select modules to run	The user can choose safety evaluation, travel time evaluation, fuel consumption, emission evaluation and toll benefits module to run
Base Case Loaded Network	Loaded network for the base case
HOT Loaded Network	Loaded network for the HOT alternative
Base Case Loaded Network Variable Replacement	Variable replacement file for base case loaded network
HOT Loaded Network Variable Replacement	Variable replacement file for HOT alternative loaded network
HOT Corridor Type	Type of HOT corridor (default=14)
GP Corridor Type	Type of general purpose corridor (default=24)
Discount rate	Discount rate
Value of Time	Default=4
Performance summary	The output file for ITS strategies performance summary

Field name	Description
Benefit/Cost summary ($)	The output file for Benefit and cost summary

Table 37: ML base case loaded network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
Distance	li	Distance	; AM period link distance
CORTYPE	li	CORTYPE	; Link corridor type code
FTC2	li	FTC2	; Link facility type code (with two digits)
Area_Type	li	Area_Type	; Link area type code (with two digits)
HOT	li	HOT	; Link HOT flag (0,1)
AM_DAVOL	li	AM_DAVOL	; AM period drive alone volume
AM_SR2VOL	li	AM_SR2VOL	; AM period vehicle volume with 2 passenger
AM_SR3VOL	li	AM_SR3VOL	; AM period vehicle volume with 3+ passenger
AM_TRKVOL	li	AM_TRKVOL	; AM period Truck volume
AM_CONGSPD	li	AM_CONGSPD	; AM period link congested speed
AM_CONGTIME	li	AM_CONGTIME	; AM period link congested travel time
AM_VMT	li	AM_VMT	; AM period link vehicle mile traveled
AM_VHT	li	AM_VHT	; AM period link vehicle hour traveled
AM_VCLOSC	li	AM_VCLOSC	; AM period link capacity V/C ratio based on LOS C capacity
PM_DAVOL	li	PM_DAVOL	; PM period drive alone volume
PM_SR2VOL	li	PM_SR2VOL	; PM period vehicle volume with 2 passenger
PM_SR3VOL	li	PM_SR3VOL	; PM period vehicle volume with 3+ passenger

Standard Variable	Link/Node field	Replaced Variable	Description
PM_TRKVOL	li	PM_TRKVOL	; PM period Truck volume
PM_CONGSPD	li	PM_CONGSPD	; PM period link congested speed
PM_CONGTIME	li	PM_CONGTIME	; PM period link congested travel time
PM_VMT	li	PM_VMT	; PM period link vehicle mile traveled
PM_VHT	li	PM_VHT	; PM period link vehicle hour traveled
PM_VCLOSC	li	PM_VCLOSC	; PM period link capacity V/C ratio based on LOS C capacity
OF_DAVOL	li	OF_DAVOL	; OP period drive alone volume
OF_SR2VOL	li	OF_SR2VOL	; OP period vehicle volume with 2 passenger
OF_SR3VOL	li	OF_SR3VOL	; OP period vehicle volume with 3+ passenger
OF_TRKVOL	li	OF_TRKVOL	; OP period Truck volume
OF_CONGSPD	li	OF_CONGSPD	; OP period link congested speed
OF_CONGTIME	li	OF_CONGTIME	; OP period link congested travel time
OF_VMT	li	OF_VMT	; OP period link vehicle mile traveled
OF_VHT	li	OF_VHT	; OP period link vehicle hour traveled
OF_VCLOSC	li	OF_VCLOSC	; OP period link capacity V/C ratio based on LOS C capacity

Table 38: ML HOT alternative loaded network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
Distance	li	Distance	; AM period link distance
CORTYPE	li	CORTYPE	; Link corridor type code

Standard Variable	Link/Node field	Replaced Variable	Description
FTC2	li	FTC2	; Link facility type code (with two digits)
Area_Type	li	Area_Type	; Link area type code (with two digits)
HOT	li	HOT	; Link HOT flag (0,1)
AM_DAVOL	li	AM_DAVOL	; AM period drive alone volume
AM_SR2VOL	li	AM_SR2VOL	; AM period vehicle volume with 2 passenger
AM_SR3VOL	li	AM_SR3VOL	; AM period vehicle volume with 3+ passenger
AM_TRKVOL	li	AM_TRKVOL	; AM period Truck volume
AM_CONGSPD	li	AM_CONGSPD	; AM period link congested speed
AM_CONGTIME	li	AM_CONGTIME	; AM period link congested travel time
AM_VMT	li	AM_VMT	; AM period link vehicle mile traveled
AM_VHT	li	AM_VHT	; AM period link vehicle hour traveled
AM_VCLOSC	li	AM_VCLOSC	; AM period link capacity V/C ratio based on LOS C capacity
PM_DAVOL	li	PM_DAVOL	; PM period drive alone volume
PM_SR2VOL	li	PM_SR2VOL	; PM period vehicle volume with 2 passenger
PM_SR3VOL	li	PM_SR3VOL	; PM period vehicle volume with 3+ passenger
PM_TRKVOL	li	PM_TRKVOL	; PM period Truck volume
PM_CONGSPD	li	PM_CONGSPD	; PM period link congested speed
PM_CONGTIME	li	PM_CONGTIME	; PM period link congested travel time
PM_VMT	li	PM_VMT	; PM period link vehicle mile traveled
PM_VHT	li	PM_VHT	; PM period link vehicle hour traveled

Standard Variable	Link/Node field	Replaced Variable	Description
PM_VCLOSC	li	PM_VCLOSC	; PM period link capacity V/C ratio based on LOS C capacity
OF_DAVOL	li	OF_DAVOL	; OP period drive alone volume
OF_SR2VOL	li	OF_SR2VOL	; OP period vehicle volume with 2 passenger
OF_SR3VOL	li	OF_SR3VOL	; OP period vehicle volume with 3+ passenger
OF_TRKVOL	li	OF_TRKVOL	; OP period Truck volume
OF_CONGSPD	li	OF_CONGSPD	; OP period link congested speed
OF_CONGTIME	li	OF_CONGTIME	; OP period link congested travel time
OF_VMT	li	OF_VMT	; OP period link vehicle mile traveled
OF_VHT	li	OF_VHT	; OP period link vehicle hour traveled
OF_VCLOSC	li	OF_VCLOSC	; OP period link capacity V/C ratio based on LOS C capacity

Advanced Traveler Information (ATI)

Table 39: Inputs for ATI Program

Field name	Description
Alternative	Alternative letter (for example, R)
Year	Current model year, two digits
Model type	The user can choose 24 hour model or Time of day model
Analysis periods, days and volume/Trip factors	Analysis periods, hours and days in each period and Volume factors to convert the daily volume to volume in each period.
24 HR loaded network	24 hour loaded highway network
24 HR loaded network variable replacement	The look up table that converts the 24 hour network variable name into standard variable name.
AM loaded network	Loaded AM highway network

Field name	Description
PM loaded network	Loaded AM highway network
Off-peak loaded network	Loaded Off-peak highway network
AM loaded network variable replacement	The look up table that converts the AM network variable name into standard variable name.
PM loaded network variable replacement	The look up table that converts the PM network variable name into standard variable name.
Off peak loaded network variable replacement	The look up table that converts the Off peak network variable name into standard variable name.
Select modules to run	User can choose Safety evaluation module, travel time evaluation module, road ranger and cost estimation using select link matrices
AM Peak ATIS Select Link Matrix	AM peak ATIS select link matrix with 4 user class tables named – Sel_DA, Sel_SR2, Sel_SR3P, Sel_TRKS
PM Peak ATIS Select Link Matrix	PM peak ATIS select link matrix with 4 user class tables named – Sel_DA, Sel_SR2, Sel_SR3P, Sel_TRKS
Off Peak ATIS Select Link Matrix	Off peak ATIS select link matrix with 4 user class tables named – Sel_DA, Sel_SR2, Sel_SR3P, Sel_TRKS
The level of capacity used for evaluation	The user can choose LOS C capacity or LOS E capacity
Maximum Volume-over-capacity ratio for BPR Equation	The maximum volume-over-capacity ratio for BPR equation (Default is 4)
Auto Occupancy	The auto occupancy for passenger trips
Percentage of Truck in Truck-Taxi trip (%)	The percentage of truck in Truck-Taxi trip (default=90%)
Arterial Adjustment Factor	Adjustment factor for arterial incident delays relative to freeways (default=1.25)
ATIS Market Penetration	Database with ATIS market penetration information. Contains the fields: YEAR, %MARKETP
ATIS Compliance Rate	Database with ATIS compliance rate information. Contains the fields: TIMESAVED, %COMPLI
Average trip length for the network (Miles)	Average trip length on the mainline (default = 8 miles)
Average trip length on the alternative route (Miles)	Average trip length on the alternative route (default = 8.2 miles)
Percentage of diverted drivers using freeway as alternative route (%)	Percentage of diverted vehicles using freeways as opposite to arterials when diverting to alternative routes (default = 0 percent)
Discount rate (%)	The discount rate
Performance summary ($)	The output file for ITS strategies performance summary
Benefit/Cost summary	The output file for Benefit and cost summary

Table 40: ATI AM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AM_TOTVOL	li	AM_TOTVOL	AM total volume
AM_DAVOL	li	AM_DAVOL	AM drive alone volume
AM_SRVOL	li	AM_SRVOL	AM car pool volume
AM_TRKVOL	li	AM_TRKVOL	AM truck volume
AM_VCLOSC	li	AM_VCLOSC	AM V/C ratio based on the LOSC
LOSCCap	li	LOSCCap	AM link capacity under LOS C
AM_VMT	li	AM_VMT	AM vehicle hour traveled
AM_VHT	li	AM_VHT	AM vehicle mile traveled
AM_CONGTIME	li	AM_CONGTIME	AM link congestion time (Minutes)
AM_CONGSPD	li	AM_CONGSPD	AM link congestion speed (Mile/Hour)
AM_LnkJctDelay	li	AM_LnkJctDelay	AM link delay due to junction (minutes)
HOT	li	HOT	Flag code for Hot lane (0,1)
REVERSIBLE	li	REVERSIBLE	Flag code for reversible lane (0,1)
CONFACAMP	li	CONFACAMP	CONFAC factor for AM peak period loaded network
FTC2	li	FTC2	Link facility type code (Two digits)
Capacity	li	Capacity	Link Capacity for LOS E
LOSCCap	li	LOSCCap	Link Capacity for LOS C
Num_Lanes	li	Num_Lanes	Number of lanes for link
TIME	li	TIME	Link free flow travel time (Mile/Hour)
BPRCoefficient	li	BPRCoefficient	BPR Equation coefficient a
BPRExponent	li	BPRExponent	BPR Equation coefficient b

Standard Variable	Link/Node field	Replaced Variable	Description
Distance	li	Distance	Link length (Mile)
ATIS	li	ATIS	Flag code for ATIS strategy (0,1)
RCTOLL	li	RCTOLL	Factor converting Car toll ($) to time (Hour)
CARTOLL	li	CARTOLL	Car toll rate ($)
SVCMINUTES	li	SVCMINUTES	Toll service time (minutes)
SVCSECONDS	li	SVCSECONDS	Toll service time (seconds)
PLZALNSMAX	li	PLZALNSMAX	Number of lanes for toll plaza
TOLLTYPE	li	TOLLTYPE	Toll type (0, 1, 2, 3)
TOLL_ACC	li	TOLL_ACC	Accelerate speed rate (Mile/hour2)
TOLL_DEC	li	TOLL_DEC	Decelerate speed rate (Mile/hour2)
toll	li	toll	Toll???
FREEFLOWSPEED	li	FREEFLOWSPEED	Free flow speed (Mile/Hour)
ROUNDNODECLS	li	ROUNDNODECLS	Flag code for junction Data (0,1)
AM_TOTVOL2	li	AM_TOTVOL2	AM peak total two way volume

Table 41: ATI PM peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
PM_TOTVOL	Li	PM_TOTVOL	PM total volume
PM_DAVOL	Li	PM_DAVOL	PM drive alone volume
PM_SRVOL	Li	PM_SRVOL	PM car pool volume
PM_TRKVOL	Li	PM_TRKVOL	PM truck volume
PM_VCLOSC	Li	PM_VCLOSC	PM V/C ratio based on the LOSC

Standard Variable	Link/Node field	Replaced Variable	Description
LOSCCap	Li	LOSCCap	PM link capacity under LOS C
PM_VMT	Li	PM_VMT	PM vehicle hour traveled
PM_VHT	Li	PM_VHT	PM vehicle mile traveled
PM_CONGTIME	Li	PM_CONGTIME	PM link congestion time (Minutes)
PM_CONGSPD	Li	PM_CONGSPD	PM link congestion speed (Mile/Hour)
PM_LnkJctDelay	Li	PM_LnkJctDelay	PM link delay due to junction (minutes)
HOT	Li	HOT	Flag code for Hot lane (0,1)
REVERSIBLE	Li	REVERSIBLE	Flag code for reversible lane (0,1)
CONFACPMP	Li	CONFACPMP	CONFAC factor for PM period loaded network
FTC2	Li	FTC2	Link facility type code (Two digits)
Capacity	Li	Capacity	Link Capacity for LOS E
LOSCCap	Li	LOSCCap	Link Capacity for LOS C
Num_Lanes	Li	Num_Lanes	Number of lanes for link
TIME	Li	TIME	Link free flow travel time (Mile/Hour)
BPRCoefficient	Li	BPRCoefficient	BPR Equation coefficient a
BPRExponent	Li	BPRExponent	BPR Equation coefficient b
Distance	Li	Distance	Link length (Mile)
ATIS	Li	ATIS	Flag code for ATIS strategy (0,1)
RCTOLL	Li	RCTOLL	Factor converting Car toll ($) to time (Hour)
CARTOLL	Li	CARTOLL	Car toll rate ($)
SVCMINUTES	Li	SVCMINUTES	Toll service time (minutes)
SVCSECONDS	Li	SVCSECONDS	Toll service time (seconds)

Standard Variable	Link/Node field	Replaced Variable	Description
PLZALNSMAX	Li	PLZALNSMAX	Number of lanes for toll plaza
TOLLTYPE	Li	TOLLTYPE	Toll type (0, 1, 2, 3)
TOLL_ACC	Li	TOLL_ACC	Accelerate speed rate (Mile/hour2)
TOLL_DEC	Li	TOLL_DEC	Decelerate speed rate (Mile/hour2)
toll	Li	toll	Toll???
FREEFLOWSPEED	Li	FREEFLOWSPEED	Free flow speed (Mile/Hour)
ROUNDNODECLS	Li	ROUNDNODECLS	Flag code for junction Data (0,1)
PM_TOTVOL2	li	PM_TOTVOL2	PM peak total two way volume

Table 42: ATI off peak network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
OF_TOTVOL	li	OF_TOTVOL	OP total volume
OF_DAVOL	li	OF_DAVOL	OP drive alone volume
OF_SRVOL	li	OF_SRVOL	OP car pool volume
OF_TRKVOL	li	OF_TRKVOL	OP truck volume
OF_VCLOSC	li	OF_VCLOSC	OP V/C ratio based on the LOSC
LOSCCap	li	LOSCCap	OP link capacity under LOS C
OF_VMT	li	OF_VMT	OP vehicle hour traveled
OF_CONGTIME	li	OF_CONGTIME	OP vehicle mile traveled
OF_CONGSPD	li	OF_CONGSPD	OP link congestion time (Minutes)
OF_VHT	li	OF_VHT	OP link congestion speed (Mile/Hour)
OF_LnkJctDelay	li	OF_LnkJctDelay	OP link delay due to junction (minutes)

Standard Variable	Link/Node field	Replaced Variable	Description
HOT	li	HOT	Flag code for Hot lane (0,1)
REVERSIBLE	li	REVERSIBLE	Flag code for reversible lane (0,1)
CONFACOFP	li	CONFACOFP	CONFAC factor for Off peak period loaded network
FTC2	li	FTC2	Link facility type code (Two digits)
Capacity	li	Capacity	Link Capacity for LOS E
LOSCCap	li	LOSCCap	Link Capacity for LOS C
Num_Lanes	li	Num_Lanes	Number of lanes for link
TIME	li	TIME	Link free flow travel time (Mile/Hour)
BPRCoefficient	li	BPRCoefficient	BPR Equation coefficient a
BPRExponent	li	BPRExponent	BPR Equation coefficient b
Distance	li	Distance	Link length (Mile)
ATIS	li	ATIS	Flag code for ATIS strategy (0,1)
RCTOLL	li	RCTOLL	Factor converting Car toll ($) to time (Hour)
CARTOLL	li	CARTOLL	Car toll rate ($)
SVCMINUTES	li	SVCMINUTES	Toll service time (minutes)
SVCSECONDS	li	SVCSECONDS	Toll service time (seconds)
PLZALNSMAX	li	PLZALNSMAX	Number of lanes for toll plaza
TOLLTYPE	li	TOLLTYPE	Toll type (0, 1, 2, 3)
TOLL_ACC	li	TOLL_ACC	Accelerate speed rate (Mile/hour2)
TOLL_DEC	li	TOLL_DEC	Decelerate speed rate (Mile/hour2)
toll	li	toll	Toll
FREEFLOWSPEED	li	FREEFLOWSPEED	Free flow speed (Mile/Hour)
ROUNDNODECLS	li	ROUNDNODECLS	Flag code for junction Data (0,1)

Standard Variable	Link/Node field	Replaced Variable	Description
OF_TOTVOL2	li	OF_TOTVOL2	Off-peak total two way volume

Table 43: ATI 24 hour network variable replacement

Standard Variable	Link/Node field	Replaced Variable	Description
AD_TotVol	li	AD_TotVol	Daily total volume
AD_DAVOL	li	AD_DAVOL	Daily drive alone volume
AD_SRVOL	li	AD_SRVOL	Daily car pool volume
AD_TRKVOL	li	AD_TRKVOL	Daily truck volume
AD_VCLOSC	li	AD_VCLOSC	Daily V/C ratio based on the LOSC
LOSCCap	li	LOSCCap	Daily link capacity under LOS C
AD_VHT	li	AD_VHT	Daily vehicle hour traveled
AD_VMT	li	AD_VMT	Daily vehicle mile traveled
AD_CONGTIME	li	AD_CONGTIME	Daily link congestion time (Minutes)
AD_CONGSPD	li	AD_CONGSPD	Daily link congestion speed (Mile/Hour)
AD_LnkJctDelay	li	AD_LnkJctDelay	Daily link delay due to junction (minutes)
HOT	li	HOT	Flag code for Hot lane (0,1)
REVERSIBLE	li	REVERSIBLE	Flag code for reversible lane (0,1)
CONFAC24H	li	CONFAC24H	CONFAC factor for 24 hour loaded network
FTC2	li	FTC2	Link facility type code (Two digits)
Capacity	li	Capacity	Link Capacity for LOS E
LOSCCap	li	LOSCCap	Link Capacity for LOS C
Num_Lanes	li	Num_Lanes	Number of lanes for link

Standard Variable	Link/Node field	Replaced Variable	Description
TIME	li	TIME	Link free flow travel time (Mile/Hour)
BPRCoefficient	li	BPRCoefficient	BPR Equation coefficient a
BPRExponent	li	BPRExponent	BPR Equation coefficient b
Distance	li	Distance	Link length (Mile)
ATIS	li	ATIS	Flag code for ATIS strategy (0,1)
RCTOLL	li	RCTOLL	Factor converting Car toll ($) to time (Hour)
CARTOLL	li	CARTOLL	Car toll rate ($)
SVCMINUTES	li	SVCMINUTES	Toll service time (minutes)
SVCSECONDS	li	SVCSECONDS	Toll service time (seconds)
UROADFACTOR	li	UROADFACTOR	URoad factor
PLZALNSMAX	li	PLZALNSMAX	Number of lanes for toll plaza
TOLLTYPE	li	TOLLTYPE	Toll type (0, 1, 2, 3)
TOLL_ACC	li	TOLL_ACC	Accelerate speed rate (Mile/hour2)
TOLL_DEC	li	TOLL_DEC	Decelerate speed rate (Mile/hour2)
toll	li	toll	Flag for toll
FREEFLOWSPEED	li	FREEFLOWSPEED	Free flow speed (Mile/Hour)
ROUNDNODECLS	li	ROUNDNODECLS	Flag code for junction Data (0,1)
AD_TOTVOL2	li	AD_TOTVOL2	Daily total two way volume