PTV TRAFFIC PLATFORM

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EXECUTIVE SUMMARY

This report presents an overview of the PTV TrafficPlatform software, which is designed as a tool to help in the training process of traffic operations center (TOC) operators. TrafficPlatform is based on an integration of VISSIM microsimulation, VISUM macrosimulation, SQL database, and a user-friendly graphical user interface (GUI). It is designed to allow for implementation of incident management strategies by the user (trainee) and a presentation of outputs from these strategies. It also allows for an off-line analysis of different types of incidents and incident management strategies. In addition to off-line data, TrafficPlatform has abilities to receive real time on-line data from traffic monitoring stations via VISUM Online underlying software and to use these data for traffic analysis.

1. INTRODUCTION

1.1 Background

Over the past ten years, the University of Utah Traffic Laboratory (UTL) has been working closely with the Utah Department of Transportation (UDOT) to provide operational support and basic training for the traffic operation center (TOC) operators. The operator training was performed in the instructor-to-trainee manner. The trainees were given basic instruction on the proper responses in cases of incidents and major traffic disruptions. They were lacking the hands-on experience in these types of situations.

For this reason, the UTL and UDOT have acquired PTV's TrafficPlatform based TOC Staff Training Simulator. It is a simulation-based replica of the real-world traffic and incident management system. The goals of the TOC Staff Training Simulator are as follows (*1*):

- To develop an activity based TOC staff training system for advanced operators and engineers
- To allow trainees to observe traffic flow on freeways and arterials as it is in real-life
- To allow trainees to respond to incidents by changing control devices, such as ramp meters and Variable Message Signs (VMS)
- To enable a UTL administrator to define various training conditions for trainees to respond to
- To quantify improvements or degradations to traffic flow resulting from the trainee's actions

When building the simulator, different software technologies had to be combined to achieve the goals. The simulator combines TrafficPlatform technology (VISUM Online based operational planning software) and VISSIM (microsimulation based traffic management software). VISSIM replicates traffic flow and feeds the data into the TrafficPlatform for traffic state calculation. It allows the users to test various scenarios in microsimulation, observe the impact to the whole network through TrafficPlatform, and select the best alternative to benefit the system. The data that VISSIM sends to the TrafficPlatform are microsimulation based, which means that the TrafficPlatform uses high fidelity traffic data (as opposed to macrosimulation based). The TrafficPlatform and VISSIM simulations are running at the same time, and any actions that a trainee performs in the TrafficPlatform are simulated in VISSIM. An advantage of using VISSIM simulation is that it provides a collection of outputs in different formats. Any output from the microsimulation can be used to compare the performance of different traffic management decisions. This will allow the trainee to see the effects of his/her decisions and gain valuable experience for real world situations.

1.2 Major Features

The major technical features of the TrafficPlatform based TOC Staff Training Simulator can be summarized as follows (*1*).

Web-based user interface (TrafficInsight) provides a straightforward and familiar way to gain training experiences. The traffic state estimates, traffic management devices and countermeasures (ramp meters, VMS), and incident events are all visualized in layers on the user-driven web map display. The traffic control decisions are also sent from the user interface to the background to affect the traffic operations.

The system elements are organized in a modularized structure for easy updates and upgrades. The Salt Lake City TrafficPatform system, the VISSIM model for sub-networks, the traffic management measures can all be updated or replaced with new components separately or together to redefine different training use.

The modularized system structure also suggests the potential field deployment of the Salt Lake City TrafficPlatform (SLC-TP) system underlying the Training Simulator. The SLC-TP system has been developed for field deployment in the TOC. Once the meta-data become available, the SLC-TP can be adapted to accommodate the online data feeds from the field detectors and traffic messages, which will lead to a functioning TP production system that monitors the traffic states for the entire Salt Lake City metropolitan area at the granularity of five-minute increments.

The Staff Training Simulator is delivered in a portable form of a virtual machine (VM) that can be easily moved across different platforms. As long as the computing resource requirements are met, the Simulator virtual machine can be migrated to different server computers, no matter if the host server is in a Linux, Unix or Windows operating system.

The development of the simulator has required careful observation of the open-source programming standards, for example, the base map for the Salt Lake City area in the web interface has applied OpenStreetMap; the TrafficInsight database has applied the PostGreSQL database, and the web-interface development also follows the Open Geospatial Consortium (OGC) standards.

1.3 Review of Past Research

The UTL is a research group based within the department of Civil and Environmental Engineering at the University of Utah (*2*). Since its founding, the UTL has served as "shadow," a mini-replica of UDOT TOC. The UTL has had a direct communication link to the TOC, providing a real-time data exchange between the two entities. The purpose of the UTL can be summarized as follows (*3*):

- Serve as a test bed for new technologies of interest to UDOT and the ITS community
- Serve as a teaching laboratory for undergraduate and graduate students
- Serve as a training facility for public and private entities
- Serve as a research facility benefiting from a supply of real-time video and detection data
- Serve as an operational traffic control center (TCC) to support the UDOT TOC and other TCCs during times of special events/need

The UTL based TOC has been designed to include the following abilities (*2*):

- View intersection signal timings, on individual or network basis
- View detector data in its proprietary form within the Advanced Traveler Management System (ATMS)
- Control and view Pan-Tilt-Zoom (PTZ) camera video streams within the ATMS
- View current messages and message logs from any VMS within the ATMS
- Archive data for future use in offline simulations and analysis
- Connect simulation and modeling packages directly to the TOC inputs from the ATMS for use of real-time data as input for simulations
- Connect via a teleconference system to remote locations for training and teaching
- Capture, record, and edit camera video clips for use in teaching applications
- Connect additional equipment and devices to the TOC inputs for performance testing and use in modeling

These UTL TOC abilities enable activities such as modeling, general research, training, and teaching, which, on the other hand, allowed UTL to meet its obligations to the University of Utah and UDOT and to draw funding for new research projects through contracts and publication. For modeling purposes, the real time data inputs from the ATMS are invaluable in modeling networks and transportation problems.

For general research, statistical analysis can be performed on a variety of different data types to examine measures of effectiveness (MOEs) and compare performance. This also allows testing and validating new equipment types, which can be tested offline using real time data to validate their performance. The UTL based TOC is designed to serve as a training facility for offline operator training for the control centers owned by UDOT, Salt Lake City, and Salt Lake County. This allows operators and managers to be trained in the operation and theory of the ATMS. Finally, the UTL TOC data and equipment provide valuable resources for demonstrative teaching and research. The UTL TOC capabilities allow students to get a hands-on experience in ITS and ATMS.

In cooperation with UDOT, the UTL developed a formalized training program where new recruits for the TOC can be trained and certified in the UTL (*4*). Operator training and certification off-site, in the UTL, has many benefits for UDOT, such as the following:

- UDOT does not waste time and effort training the operators "on-the-job"
- The training program can be highly structured, allowing the preparation of the new hires quickly for their work
- The training is standardized, and the trainees are certified upon the successful completion

The TOC Operator Training scope details how a UTL based program will train new recruits quickly, efficiently, and to a consistent standard of competence. Training consists of three parts:

1) Basic Training
2) Advanced Training
3) Scenario Simulation Training

The basic training developed at the UTL introduces a military approach to train the operators (*4*). The first step is to identify operator tasks that are necessary to allow the UDOT TOC to achieve its mission, which is defined through the mission statement. The mission essential task list is more detailed than a generalized job description, but it is not overwhelmingly long. Twenty-two tasks of various difficulties are identified. While each task must be taught using different techniques, simplifying the job into these tasks enables building the two-week course from a list that is quantifiable but not unmanageable. Through observation and pilot training, it was determined that the most critical component of an operator's knowledge is an understanding of the local transportation network, so the entire training course is built around this concept. The training sessions are organized to begin with the local transportation network (roadway design and characteristics), regional geography, and travel trends. These aspects are essential for efficient incident management. Once the operator can precisely locate an incident, he or she can work around to find the best alternative for the traffic system and redirect the traffic around the incident. This means that the trainee still needs to learn various day-to-day operations and programs used by operators. These programs, as well as UDOT internal policies and procedures, comprise the remainder of the operator course. The trainees are taught to use the four applications of the UDOTS TransSuite ATMS software package. Those applications are the ATMS map, incident management system (IMS), traveler information system (TIS), and the video control system (VCS). When learning these programs, the operators use them as they would in the course of managing an incident. The standard operator procedure for incident management is as follows:

- Verify incident on camera
- Post VMS sign if applicable
- Create incident in IMS (which populates CommuterLink website and 511)
- Monitor until the incident is clear

The one operation of incident management that relies heavily upon current research and accepted practice is VMS messaging. Although TIS is the program the UDOT TOC utilizes to post messages to signs, more classroom time is spent on messaging theory and application than on the TIS program itself. Operators must understand the importance of VMS messages since they reach the most critical travelers – those immediately approaching the incident. While IMS is important because it populates the CommuterLink website, the 511 travel advisory hotline, and other public outputs, none of these outlets have as much of an immediate effect on the network as a VMS message. Operators also must understand the basic human factors involved in VMS messaging, such as sign readability based on letter height and approach speed, use of easily recognizable phrases, and message phasing. Although the TIS program and many signs are highly advanced, the best practice is to keep messages as clear and concise as possible. A timely respond and quality information sent to the system users is essential for keeping the impacts on traffic minimal during the incident.

This approach to the basic operator training has been proven to be effective. However, it also shows some limitations. The first one is the private nature of much of the information gathered, analyzed, and disseminated at the TOC. The UTL does not have access (nor it will probably even have) to the computer automated dispatch (CAD) or radio traffic coming from the Department of Public Safety (DPS) dispatch center. Since the TOC is co-located with dispatch, operators have easy access to these outlets without compromising the private nature of the information. The UTL, on the other hand, is a less secure facility, so DPS is reluctant to provide access to the CAD and radio frequencies at the UTL. This is unfortunate because listening to the constant radio transmissions and extracting relevant information is one of the most difficult and important skills of the operator. Another limitation to the training program is the overall layout of the UTL. While the TOC layout features a central control room with administrative offices adjacent, the UTL has more of an open floor plan. The video wall is in the same room where all graduate students work throughout the year. This setup does not allow operator trainees to focus on the operator job as they would in the control room.

The next level in TOC operator training is advanced training. These sessions propose a specific training program to use the opportunities available to traffic operators by training them how to identify and solve advanced transportation management and operation problems (*5*). The most important components in the advanced training are as follows:

- To establish the definition of a good operator and the preparation needed to give advanced training
- To introduce a specific curriculum that develops the necessary knowledge, skill, and ability to identify and solve advanced transportation management and operation problems
- To suggest a method for measuring the performance of the operator on the knowledge, skill, and ability gained from the curriculum

Depending on the level of training, different levels of aptitude of a traffic operator are determined. The first level of aptitude is the entry level. Entry level operators are new employees with no prior work experience in TOCs. Training for the entry level includes the basic training, which can take up to two weeks. The next level of aptitude is the full performance level. Operators can be considered full-performance when they have an understanding of the knowledge, skill, and abilities to perform their duties and tasks. Training to reach full-performance is done through recurrent training. Recurrent training is commonly given to operators in the form of monthly meetings or instruction from other operators. Recurrent training to entry level employees should be given from one to two years until the full-performance level is met. The full-performance level operators who are considered good operators can become candidates to receive the advanced training program. An operator who seeks to reach the advanced level must be fully capable in all the duties and tasks at each previous level. Other preparation in receiving advanced training is that an operator must show an ability to work with others and take interest in situations that are beyond the entry and full-performance level tasks and duties.

The developed curriculum for the advanced training includes certain capabilities that an advanced level operator should be able to complete. The list of these capabilities includes, but is not limited to the following:

- Handle difficult phone calls
- Respond to hazardous materials (HAZMAT)
- Fix broken traffic signal timing
- Identify all road elements
- Calculate superelevation
- Lead – train other employees
- Understand traffic flow theory
- Performance Measurement System (PeMS) – Report delay times
- Manage work zones
- Manage ramp-meters

The advanced level curriculum consists of three courses. The first one is called advanced operator techniques. This course trains operators advanced customer service skills, knowledge to respond to atypical traffic crises, and information to manage traffic signals. The advanced operator techniques course develops the capabilities of good operators to identify and solve the advanced transportation problems in operations. The next course in the curriculum is a geometric design basics training. Geometric design is the understanding of the road itself, the cross-section, road elements, and curvature. Understanding the road will help operators determine if problem areas are driver error, poor maintenance, or road geometry related. Operators study the road looking for traffic incidents. By learning the geometric design training the operators will begin to look for geometric design problems as they look at the road. The geometric design course is focused on the identification of advanced transportation problems. The final course developed in the curriculum is the traffic flow training. Understanding traffic flow is a key element in traffic management. Having an understanding of capacity, flow, and demand, the basic elements of traffic flow, helps operators see how efficiency in traffic management can benefit the travel time of the users. The other subjects covered in this course are the PeMS software usage and traffic monitoring through vehicle detection technologies. The traffic flow course helps good operators identify and solve advanced transportation problems in transportation management.

The output of the advanced training is also a method for measuring the performance of the operator about the knowledge, skill, and ability gained from the curriculum. Performance is measured on how well operators perform, including identifying and solving advanced transportation management and operation problems. It gives an assessment of current employee levels through a checklist method. Three checklists are developed for the basic, full-performance, and advanced levels. The checklists follow the quality and quantity guidelines and limit the number of performance measures to no more than 10 specific areas of assessment. The basic level checklist measures the knowledge, skills, and ability of an employee after the basic training and two full weeks of on-the-job experience. The full-performance level checklist is given to an employee six months to a year after the basic level performance is achieved. The advanced level checklist is given to the employee after the advanced training and after a month of using the knowledge and skills that were learned.

After the completion of the advanced training, the operators are evaluated on the given courses. This testing is critical to determine what was learned and how capable the operator is of applying the training, specifically in identifying and solving engineering problems.

The proposed advanced training program does increase the capabilities of good operators to identify and solve advanced transportation management operation problems. It accomplishes this by helping TOCs identify which operators qualify for the training, providing a specific curriculum, and providing a way to determine if the curriculum was successful in its training. This program is recommended to TOCs that have 24/7 monitoring operations, and to TOCs that want to improve the production of operators.

In addition to the basic and advanced training, the scope of the TOC operator training includes the Scenario simulation training. It was determined that this type of training would be delivered using the PTV America TrafficPlatform. The TrafficPlatform is based on VISUM Online, a traffic management system for processing online traffic data (*6*). VISUM Online is a software suite that integrates the transportation planning model, VISUM, with a set of traffic estimation and propagation models and real-time traffic data. It is used to improve the following:

- Online traffic prediction
- Traffic data archival
- Traffic management
- Transportation planning

VISUM Online combines advantages of various real-time traffic management systems, providing them with very useful features. The most distinguished features are data archiving; data propagation; filling the data that is missing, considered bad or suspect; providing information to travelers; incident information; short term prediction (approximately next hour); and long term prediction (next coming days).

The inputs of VISUM Online consist of traffic infrastructure, inter-zonal trips, and real-time counts (measurements, probes, incidents) propagated throughout the system. These data are fed into the VISUM Online models, which contain the traffic assignment, detector propagation, forecasting, message handling, etc. MOdeling NETworks (MONET) is a simulation model and the core calculation algorithm in VISUM Online. It generates traffic conditions and performs short term forecast. It combines historical data with measured and estimated values and calculates the actual conditions. The measured traffic data (from over 500 freeway loop detectors in the Salt Lake Metropolitan Region, as well as probe data) are stored in a centralized archive database. It includes information about traffic volumes, speeds, and incidents. These data can be further used in VISUM Online.

The main output from VISUM Online is the current conditions calculated for the entire road network. VISUM Online uses measured data and hourly OD matrices in conjunction with a traffic assignment to calculate the current traffic conditions and to propagate traffic throughout the network. Another output is the short term forecast, a process that begins by predicting locally measured values using cluster analysis.

The primary user groups that can benefit from VISUM Online include, but are not limited to the following:

- TOCs, which can use real-time traffic management and control strategies to observe current traffic conditions, and predict future conditions.
- Planners, who can use VISUM Online to evaluate the best transportation alternatives more reliably than by using traditional static traffic assignment techniques.
- Researchers, who will be able to explore and develop innovative ITS strategies, or use the archived data to perform offline research and analysis
- Traffic engineers, who can use VISUM Online to evaluate a variety of traffic control strategies in a simulated environment
- Travel information system providers, who can translate predictive real-time traffic data into traveler information
- Travelers, who receive the information supplied by the travel information service

Another group that can realize great benefits from the system are the TOC operator trainees. That was one of the ideas behind developing the TrafficPlatform, a follow-up system of VISUM Online.

2. TRAFFIC PLATFORM OPERATIONS

2.1 Overview of the TrafficPlatform and TOC Staff Training Simulator Operations

Combining VISUM Online and operator training techniques is accomplished through the development of the TrafficPlatform and the TOC Training Simulator. The development of the TrafficPlatform is divided into two phases. Phase I builds a system that can monitor and estimate traffic operations within the Salt Lake City metropolitan area. Phase II develops the user interface for the TrafficPlatform based TOC Staff Training Simulator. In Phase II, one incident case is predefined to test the performance of the system. It is also developed to support a flexible architecture which allows for upgrading the simulator and defines separate training cases for further operation.

To achieve the given goals, different technologies are combined within the TrafficPlatform. VISSIM microsimulation software is integrated with the TrafficPlatform with the purpose of performing several tasks. First, if the TrafficPlatform for some reason cannot access the online detector and measurement data, the VISSIM microsimulation serves to replicate traffic flow measurements and feeds the data to the TrafficPlatform for traffic state calculation. In this case, the VISSIM simulation detectors must be defined exactly as the real-world detectors (position and number). The traffic system is simulated in micro-simulation, with the traffic states that are provided through the TrafficPlatform. Any management decision given through the TrafficPlatform can directly change the simulation course, emulating the real world incident management. Furthermore, the VISSIM microsimulation can provide different outputs for measures of effectiveness (MOEs), allowing detailed analysis of each decision.

TrafficPlatform is essentially a traffic assignment VISUM based simulator. Building a TrafficPlatform system begins with constructing an offline traffic model that reflects a typical daily pattern of the area. It uses historical detector values and base OD matrices, and through cluster analysis, provides typical daily patterns and performs OD matrix calibration. Generally, this can be done for each period of the day where the system will load the corresponding OD matrices and perform the pre-calibrated traffic assignment. Then, using real-time hourly based OD matrices and the network model, it recalculates traffic assignment (route estimation) for a one-hour interval. Using current real-time detector values and calculated routes, it performs measurement propagation for five-minute intervals and calculates the current traffic state. This step is also where incidents and traffic control can take place. For every incident and management decision, the system will recalculate traffic assignment and through measurement propagation, the new traffic state.

For the purpose of the training simulator, the online data can either be gathered in real-time (if the connection is possible) or be generated through the VISSIM microsimulation. The real-world traffic control and guidance also have their counterparts in the simulation model. This actually puts the TrafficPlatform into a virtual environment (TP-Lab), where the traffic data collection process and ITS applications are not limited by the field conditions. Furthermore, the TP-Lab offers potential to design various training use cases for the simulator.

2.2 Training Session Design

The architecture of the staff training simulator allows the rebuilding of different training scenarios or use cases. Different severity levels, from minor crashes to major incidents, as well as a set of responses, can be designed and analyzed. For the purpose of testing the simulator, one major incident is designed and tested in this study. The incident consists of a crash on I-15 SB near state route 171 (3300 S) during the PM peak period (at 4:30 PM), resulting in a blockage of four general purpose lanes for 45 minutes (*1*). Once the incident is created, two options for incident management are available: VMS information and ramp metering adjustments within the area of interest around the incident. Both options are addressed through the Web based TrafficPlatform interface (TrafficInsight) by changing the database of the model. The VMSs can contain three levels of information:

- Level 1: Incident occurrence/location only
- Level 2: Incident location + detour route suggestion
- Level 3: Incident location + delay + detour route suggestion

Each of the levels can have different impacts on drivers' decisions to change the route. The literature suggests that for level 1, the percentage of drivers responding to the VMS is 5% – 10%; for level 2, 10% – 30%; and for level 3, 40% – 80%. These data are used when defining the routing decision after the VMS is posted. The VMS information is then transferred to the VISSIM simulation model, in a form of partial routes, where each partial route is defined according to the level of the VMS information.

Changing the ramp meters changes the pattern in which the traffic is fed from arterials or other freeways to the observed freeway. It affects the flow on the freeway, but can also affect the flow on the ramp and feeding arterial/freeway. New ramp meter settings are simulated in VISSIM through changed traffic control for the ramp meters.

The outputs from the VISSIM simulation give a vast amount of data that can analyze and compare different management strategies. The performed test shows the usefulness of the TrafficPlatform based simulator. For each incident that is to be created with the TrafficPlatform, the incident information, routing decision, and ramp meter traffic control must be reprogrammed in VISUM underlying the TrafficPlatform, but also must be checked in the exported VISSIM model and fine-tuned if necessary.

The following appendices include the TrafficPlatform User Manual, which describes the software in detail, and a short manual composed by the researchers during the software customization.

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4. APPENDIX

The Appendix is a collection of the following documents:

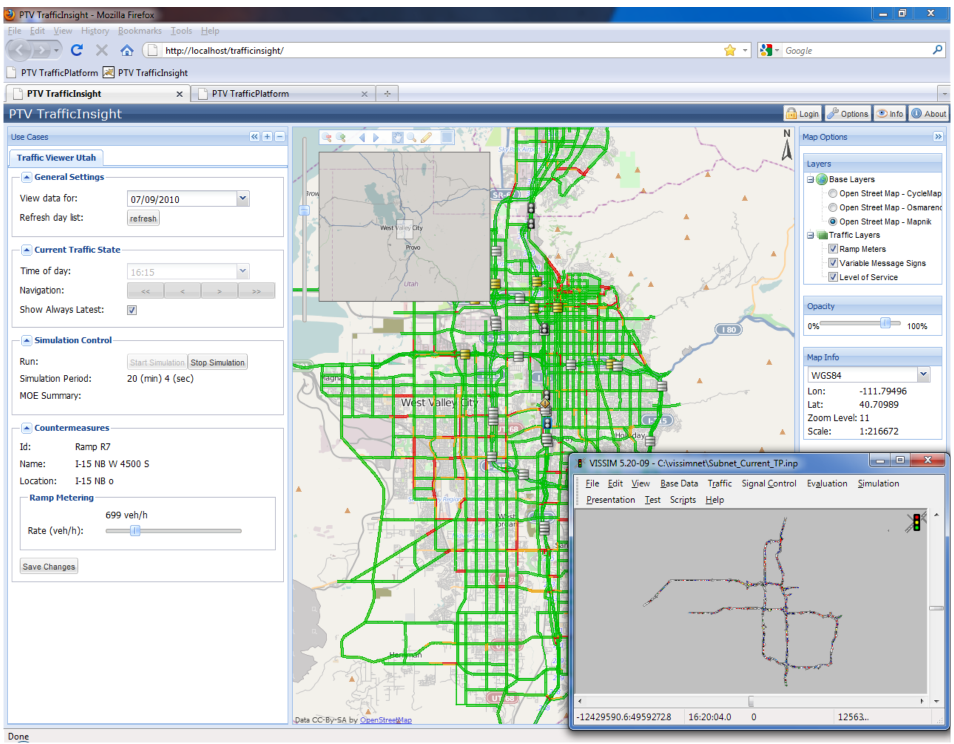
- Utah Traffic Lab and Utah DOT Traffic Operations Center Staff Training Simulator: Administrator and Trainee Manual
- TrafficPlatform: Start and Customization Manual

UTAH TRAFFIC LAB AND UTAH DOT TRAFFIC OPERATIONS CENTER STAFF TRAINING SIMULATOR: ADMINISTRATOR AND TRAINEE MANUAL

Utah Traffic Lab and Utah DOT Traffic Operations Center Staff Training Simulator

Administrator and Trainee Manual

Version 1.2



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Introduction and System Overview

This manual is to introduce the Traffic Operations Center (TOC) Staff Training Simulator ("Training Simulator" or "Simulator") developed for Utah Traffic Lab (UTL) of the University of Utah and Utah Department of Transportation (UDOT) Traffic Operations Center. PTV America and PTV AG have jointly worked on this task to deliver the Simulator system in a virtualized environment.

The manual is organized into six chapters. The first chapter introduces the system. Chapter 2 explains the system configuration and basic operations. Chapter 3 describes the basic steps in training scenario design, while Chapter 4 explains how to handle the Simulator. Chapter 2, 3 and 4 are dedicated to the system administrators. Chapter 5 describes a training session procedure and it is dedicated to the system administrators and trainees. The final chapter describes troubleshooting problems and methods for overcoming them. The appendices provide a literature review on drivers' response to traveler information, and a working paper on multi-resolution modeling.

Background and PTV Technology

Five main goals that have been set for the Simulator development:

1. To develop an activity based Traffic Operations Center (TOC) staff training system for advanced operators and engineers
2. To create a virtual environment of the TOC and allow trainees to observe traffic in the metropolitan Salt Lake City area as if they were within the TOC
3. To allow the trainees to respond to incidents by changing control devices such as ramp meters and variable message signs
4. To enable UTL administrator staff to define various training conditions for trainees to respond to
5. To quantify improvements or degradations to traffic flow resulting from the trainee's actions

It is apparent that no single transportation system analysis tools can accomplish all these goals. The region wide traffic operations need to be monitored in a real time manner and various staff expertise levels would require a friendly user interface. Therefore, it has been obvious from the start of the project that combining and integrating different software technologies as they evolve will be the primary approach to build the Simulator.

The development efforts were generally divided into two phases. Phase I was to build the subsystem that can estimate and monitor the traffic operations for the Salt Lake City metropolitan area. This is based on the proven VISUM Online based TrafficPlatform technology that has been deployed for a number of European and US regions. After the SLC TrafficPlatform subsystem was developed, Phase II of the project was to build the user interface for the Simulator and to design one pre-set training use case for Goal #2 and #3. Special attention has also been paid to different modules of the Simulator so that the architecture is flexible enough to allow for upgrading the Simulator system and re-defining separate training use cases to fulfill Goal #4.

In implementing the Phase II tasks, two factors led to the recourse of the original plan of the "training scenario manager" to a more open-structured and user friendly web-based interface. The first factor was the inability to gather sufficient information from the online detector and event data format (meta-data), while this information is necessary to allow streamlining the real time detector data and event data into the SLC TrafficPlatform. This became the bottleneck to upgrade the SLC TrafficPlatform system to a fully functioning dynamic traffic monitoring and forecasting system for the Salt Lake City area. The lack of this information also precludes the Simulator from dealing with the Salt Lake City traffic in a real time manner.

Thanks to recent successful applications of integrating different PTV technologies, however, a new extension of TrafficPlatform has proven a powerful tool to emulate the ITS application environment in a more true-to-life way. This extension, termed as TrafficPlatform Laboratory (TP-Lab), uses VISSIM simulation to replicate traffic flow and any available ITS measures in the real world, and feeds simulated detector data to the TrafficPlatform for traffic state calculation. In later phases, when the measurement data from the VISUM Online based TrafficPlatform become sufficient, the system can use the real-time data instead of microsimulation information.

TP-Lab allows the users to test various scenarios in micro-simulation, observe their impact upon the whole network through TrafficPlatform, and select the most promising candidate that benefits the entire system. Applying TP-Lab far exceeds the capabilities of traditional traffic simulation modeling, and provides the virtual reality for traffic authorities to interact with their systems more realistically with quicker turnarounds. Therefore, this TP-Lab extension was selected for developing the Staff Training Simulator in this project.

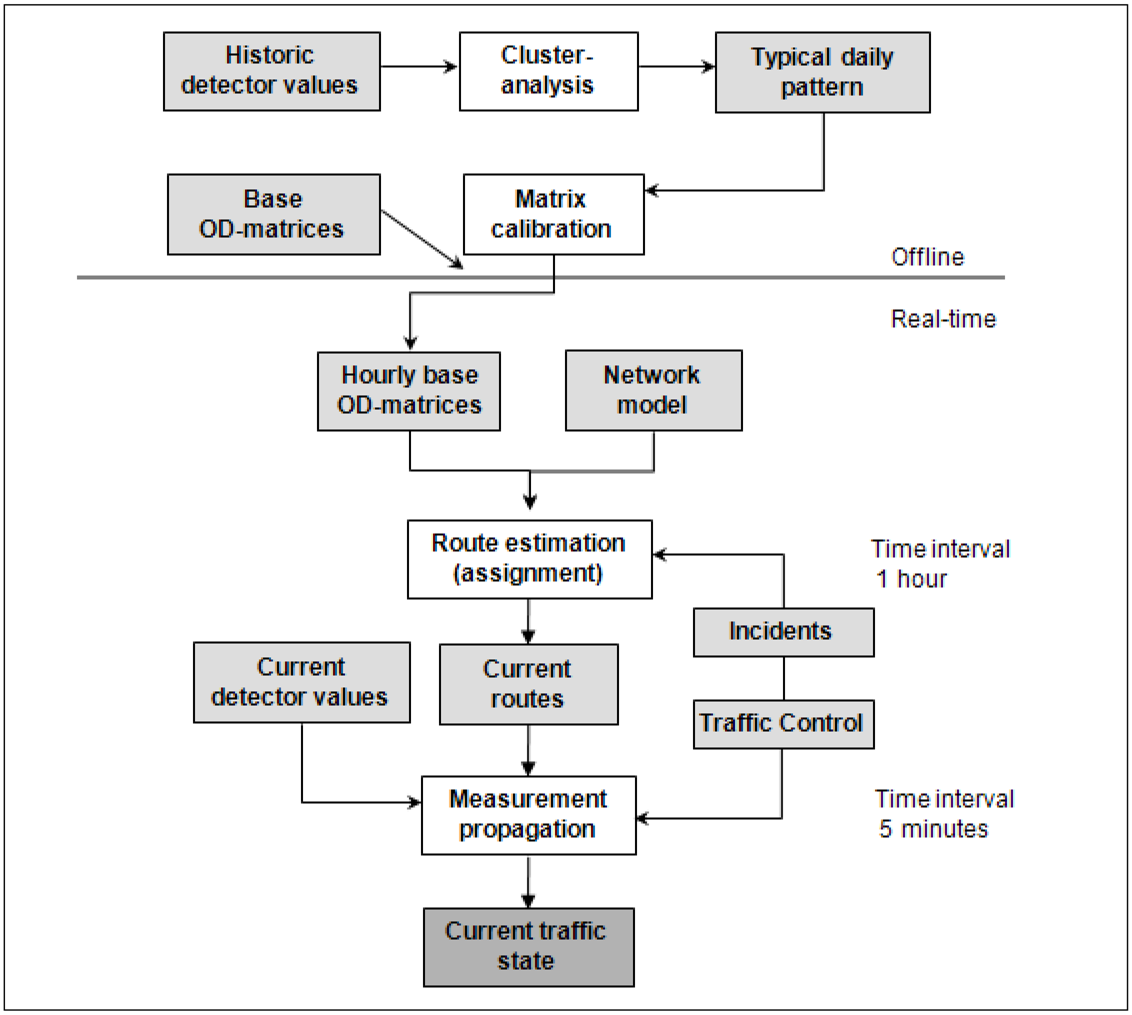
A number of breakthroughs have been specifically made for the Simulator development in adapting the TP-Lab framework. The first highlight is streamlining the traffic data from VISSIM simulation to SLC TrafficPlatform while the simulation is running. In this way the traffic estimation and monitoring in the Training Simulator virtual environment use the high fidelity data provided by VISSIM simulation.

The other highlight is the trainee's traffic management decisions can directly change the simulation course, which also emulates the real world incident management decision process. Another advantage of applying the VISSIM simulation as the virtual ITS application environment is the convenient collection of output in many forms after the simulation (i.e., the training session). Any possible output from micro simulation can be used to compare the performance of different traffic management decisions. This will allow the trainee to gain valuable experiences to better handle events that may otherwise be detrimental to the region wide traffic operation. This adequately fulfills goal #5 of developing the Simulator.

System Architecture

The Staff Training Simulator is considered an extension application originated from the TrafficPlatform architecture, and thus it is necessary to first introduce the general workflow of a typical TrafficPlatform application.

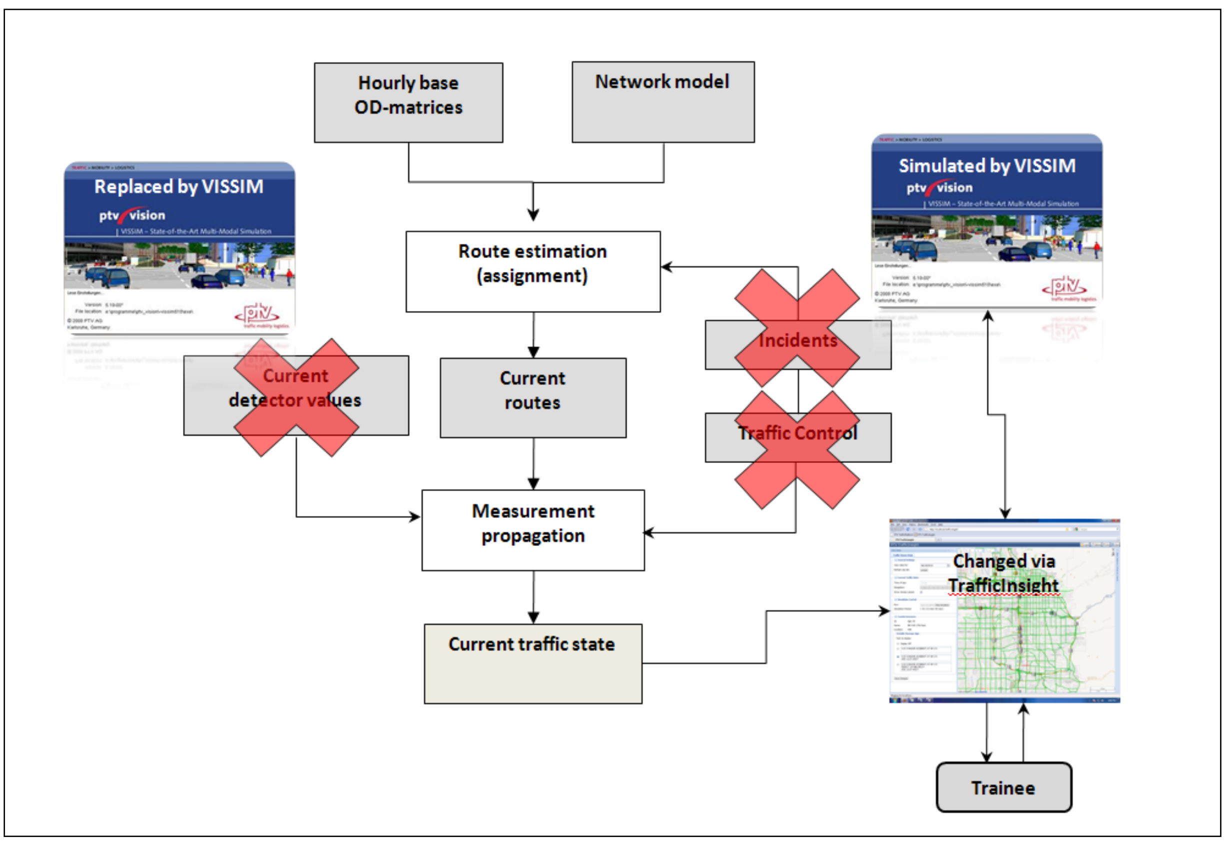
The following flowchart provides an overview of a typical TrafficPlatform (TP) system. This flowchart also applies to the Salt Lake City TP system underlying the Training Simulator.



Building a TP system begins with constructing an offline traffic model that reflects the typical daily travel pattern of the area. If needed, the traffic model can separate day types where the travel patterns are significantly different from each other and these different patterns are all of concern. For the Salt Lake City TP system, one typical weekday traffic pattern was constructed.

The typical traffic pattern in the TP system is represented by the base origin-destination information stored for different time of the day (generally in hourly increments) and the route estimation from traffic assignment. At each period of the day, the TP system will load the corresponding O-D matrices and perform the pre-calibrated traffic assignment procedures and estimate the traffic pattern for the particular period. This traffic pattern is then perturbed by the continuously feeding online data including the flow rates and occupancy from detectors, traffic control updates (e.g., ramp metering rates and signal timing plan changes) and incident or construction work zone events. These data will be interpreted by different TP procedures and methods to calibrate the routes in real time, estimate the traffic states of the entire area and perform short-term forecast. For a fully deployed TP system, these processes are configured to run automatically to provide the traffic monitoring and forecasting in a non-stop way.

In the context of the Training Simulator, however, TP is extended in a number of ways. Seen from the following exhibit, VISSIM simulation has replaced the real world online data feeds by the simulated traffic condition. The real world traffic control and guidance is also replaced by their counterparts in the simulation model. This extension puts the TP system into a virtual environment (TP-Lab), where the traffic data collection and ITS applications are no longer limited by the field conditions. Rather TP-Lab presents a great array of potentials to design various training use cases for the Simulator.



As the above figure shows, the trainee is only facing the web-based interface (TrafficInsight) to monitor the traffic states for the entire region, and to send the congestion mitigation decisions through the interface as well. The specific decision made by the trainee will be automatically transferred to the TrafficPlatform, simulated in VISSIM, which will further provide the output for the defined measures of effectiveness. This simplifies the experience requirements with other traffic analysis tools, provides the flexibility of mimicking the real world incident response planning and operations to the greatest extent, and opens the possibility for future improvements.

Major Features

The major technical features of the TrafficPlatform based TOC Staff Training Simulator can be summarized as follows.

- Web-based user interface (TrafficInsight) provides a straightforward and familiar way to operate the Simulator, monitor traffic and manage incidents. The traffic state estimates, traffic management devices and countermeasures (ramp meters, variable message signs) and incident events are all visualized in layers on the user-driven web map display. The traffic control decisions are also sent from the user interface to the background simulation software to affect the traffic operations.
- The system elements are organized in a modularized structure for easy updates and upgrades. The Salt Lake City TrafficPatform system, the VISSIM model for sub-networks, the traffic management measures can all be updated or replaced with new components separately or together to redefine a different training use cases.
- The modularized system structure also suggests the potential field deployment of the Salt Lake City TrafficPlatform (SLC-TP) system underlying the Training Simulator. The SLC-TP system has been developed with the aim for field deployment in the Traffic Operations Center. Once the meta-data become available through the VISUM Online concept, the SLC-TP can be adapted to accommodate the online data feeds from the field detectors and traffic messages, which will lead to a functioning TP production system that monitors the traffic states for the entire Salt Lake City metropolitan area at the granularity of 5-minute increments.
- The Staff Training Simulator is delivered in a portable form of a virtual machine (VM) that can be easily moved across different platforms. As long as the computing resource requirements are met, the Simulator virtual machine can be migrated to different server computers, no matter the host server is in Linux, Unix or Windows operating system.
- The development of the Simulator has been observing the open-source programming standards as closely as possible, for example, the base map for the Salt Lake City area in the web interface has

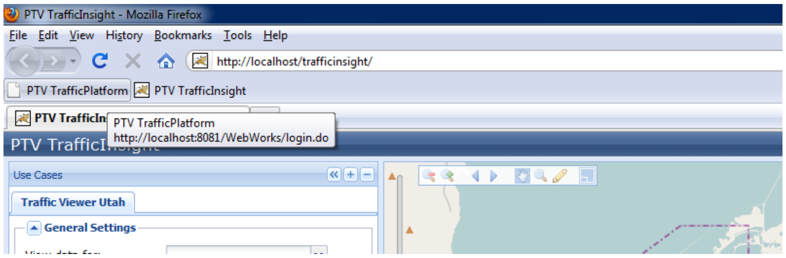
applied OpenStreetMap; the TrafficInsight database has applied the PostGreSQL database, and the web-interface development also follows the Open Geospatial Consortium (OGC) standards.

Traffic Platform Configuration

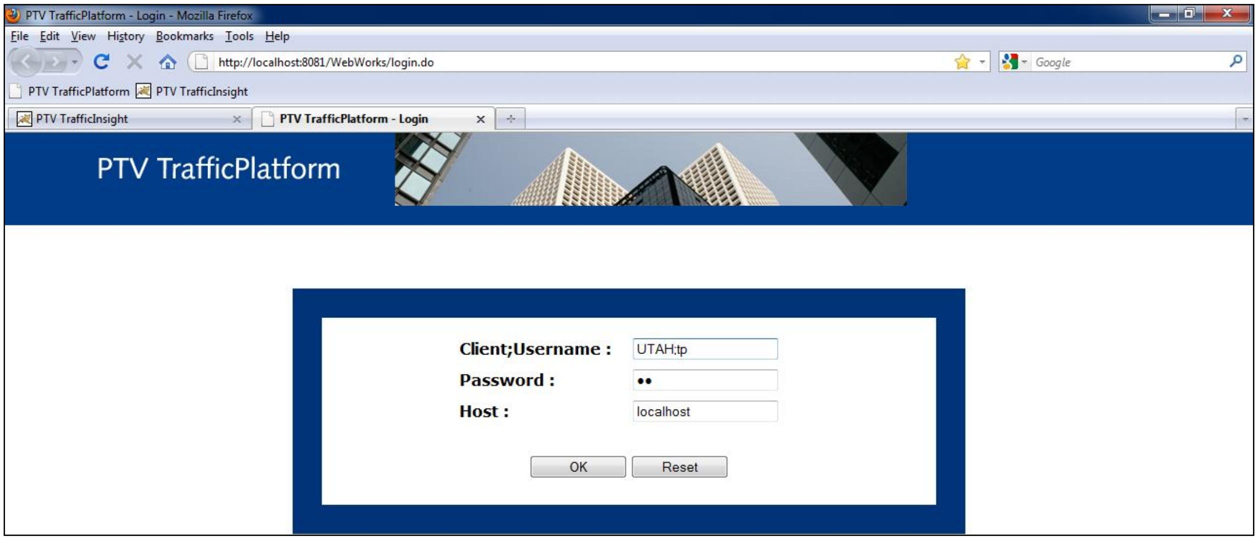
Salt Lake City TrafficPlatform and Administration

TrafficPlatform is the traffic state data supplier to the front-end of the Training Simulator. It is important to ensure that the SLC-TP is properly working. The Simulator has been configured to let users monitor the TrafficPlatform operations in the training session.

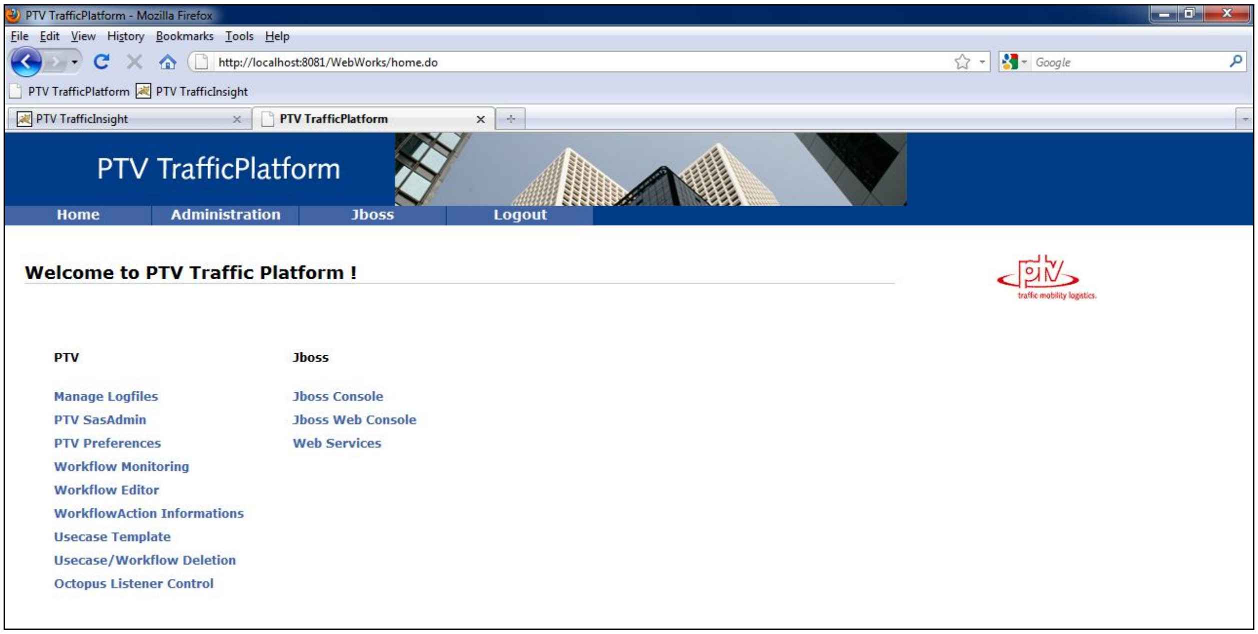
The web-based Simulator interface includes the access to the underlying Salt Lake City TrafficPlatform, marked in the Bookmark toolbar.



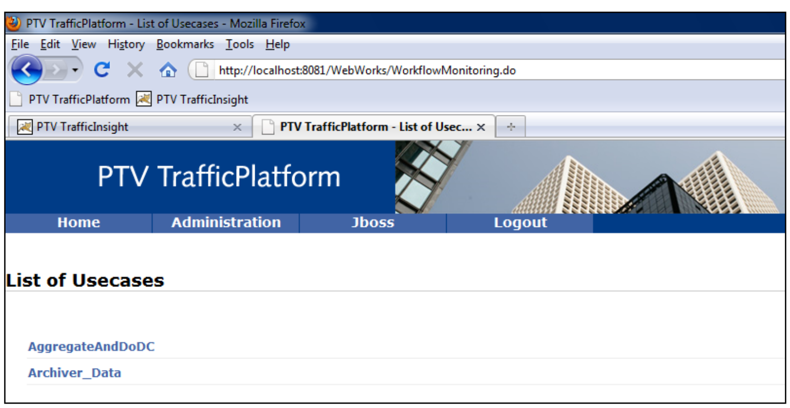
To access the TrafficPlatform, first create a new tab in Firefox, and then click the “PTV TrafficPlatform” bookmark.



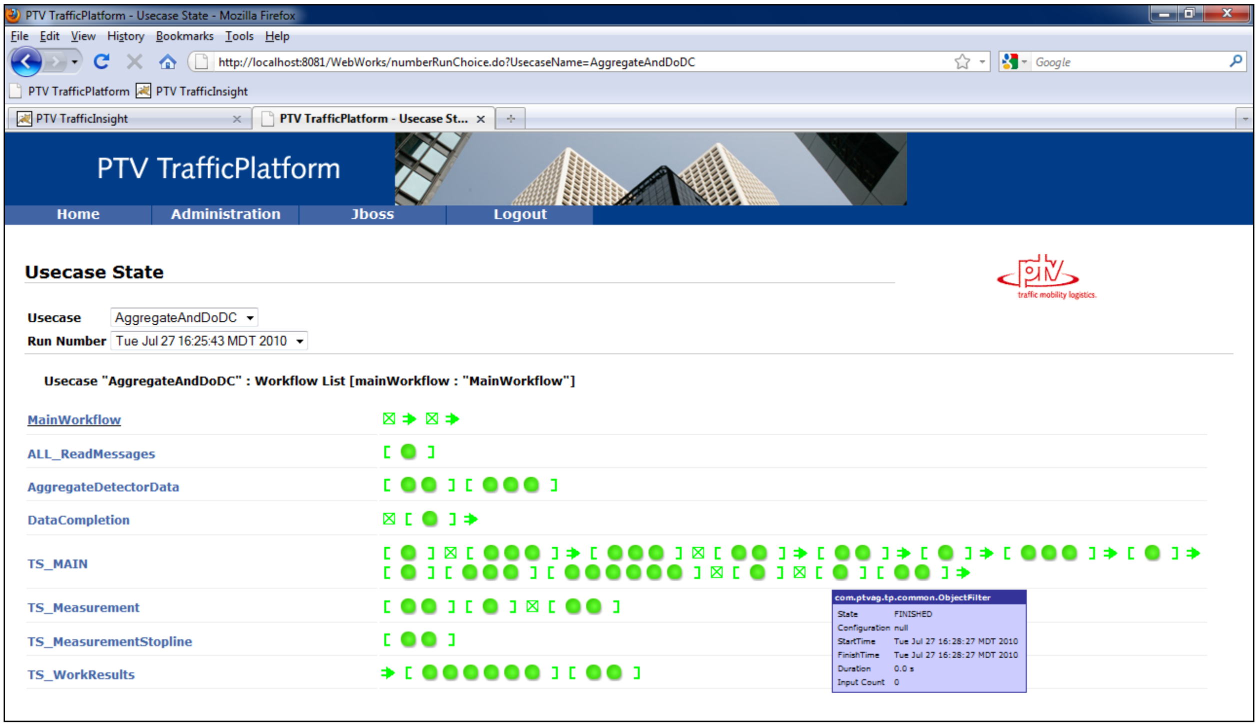
Logging into the Salt Lake City system needs the “Client;Username” info as above (“UTAH;tp”), and the password is “tp”.



Once the TP system is logged in, the welcome page lists all configurable modules and TP system admin tools. The module directly related to monitoring the Salt Lake City traffic state estimation is the “Workflow Monitoring”. Select the usecase of “AggregateAndDoDC” after the *Workflow monitoring* is selected.



When the training session starts, the SLC-TP system will be started, and the system clock is automatically set to be synchronizing with the simulated period (4:00PM on a typical weekday in the pre-defined training scenario).



During the training session, the main workflow process, *AggregateAndDoDC*, is configured to be running in a 5-minute cycle by receiving the updated real time traffic feeds from VISSIM simulation. The progress of the workflow can be thus monitored and if there are any errors happening. The corresponding component will show red in the workflow monitor.

Salt Lake City TrafficPlatform System Setup

The Salt Lake City TrafficPlatform system should start as a Windows service automatically. If the traffic states are not being updated during any training session, use the above monitoring tool for process check. If none of the processes starts, refer to the troubleshooting sessions for further info.

In the Simulator virtual machine, the TrafficPlatform is installed under C:\TrafficPlatform. The Salt Lake City application system is under C:\Utah, and it includes the following sub directories and functional modules. The maintenance suggestions are also listed.

congestions	congestions files, output from TrafficPlatform, files can be deleted after simulation run
matrices	matrices
network	VISUM version file
output	output of the DataCompletion (.ver files), output from TrafficPlatform, files can be deleted after simulation run
Para	parameter files for the Assignment and the Propagation

The TrafficPlatform database administration info can be found in the following box.

Database

Version	Oracle XE 10.2.0
Installation Folder	C:\oraclexe
Startup Mode	Windows Service, Automatic
User	tp_showcase
Password	tp
Sys-User	sys
Sys-Password	szs

The Simulator bundles a collection of PTV technologies to build this interactive traffic management decision support system. By its functional classification, the three major modules that comprise the Simulator are:

- Real-time traffic state estimation for the entire Salt Lake City (SLC) metropolitan area by TrafficPlatform;
- Virtual online data feeds for SLC freeways and ramps and controllable ATMS test bed by VISSIM simulation (the overall structure internally termed "TrafficPlatform Laboratory" – TPLab);
- Web-based front-end user interface by TrafficInsight.

Real Time Traffic Estimation in TrafficPlatform

TrafficPlatform is the traffic state data supplier to the front-end of the Simulator. It is important to ensure that the SLC-TP is properly working. The Simulator has been configured to let users monitor the TP operations in the training session.

The typical traffic pattern in the TP system is represented by the base origin-destination (O-D) information stored for different time of the day and the route estimation from traffic assignment. At each period of the day, the TP system will load the corresponding O-D matrices and perform the pre-calibrated traffic assignment procedures and estimate the traffic pattern for the particular period. This traffic pattern is then perturbed by the continuously feeding online data including the flow rates and occupancy from detectors, traffic control updates and incident or construction work zone events. These data will be interpreted by different TP procedures and methods to calibrate the routes in real time, estimate the traffic states of the entire area and perform short-term forecast. For a fully deployed TP system, these processes are configured to run automatically to provide the traffic monitoring and forecasting in a non-stop way.

Virtual Online Data Feeds and ATMS Test Environment: VISSIM Simulation

VISSIM micro simulation is running in synchronization with other modules of the Simulator. It serves three purposes in the Simulator. The first one is collecting the traffic data in the way similar as being reported by the real world detectors (and other possible sources such as probe vehicles), and feeding these data to the TP. The second one is receiving the real-time traffic management decisions made by the trainee and changing the control parameters of the devices being simulated. The last purpose of the VISSIM simulation is reporting the performance of the traffic network that serves to evaluate management decision made by the trainee.

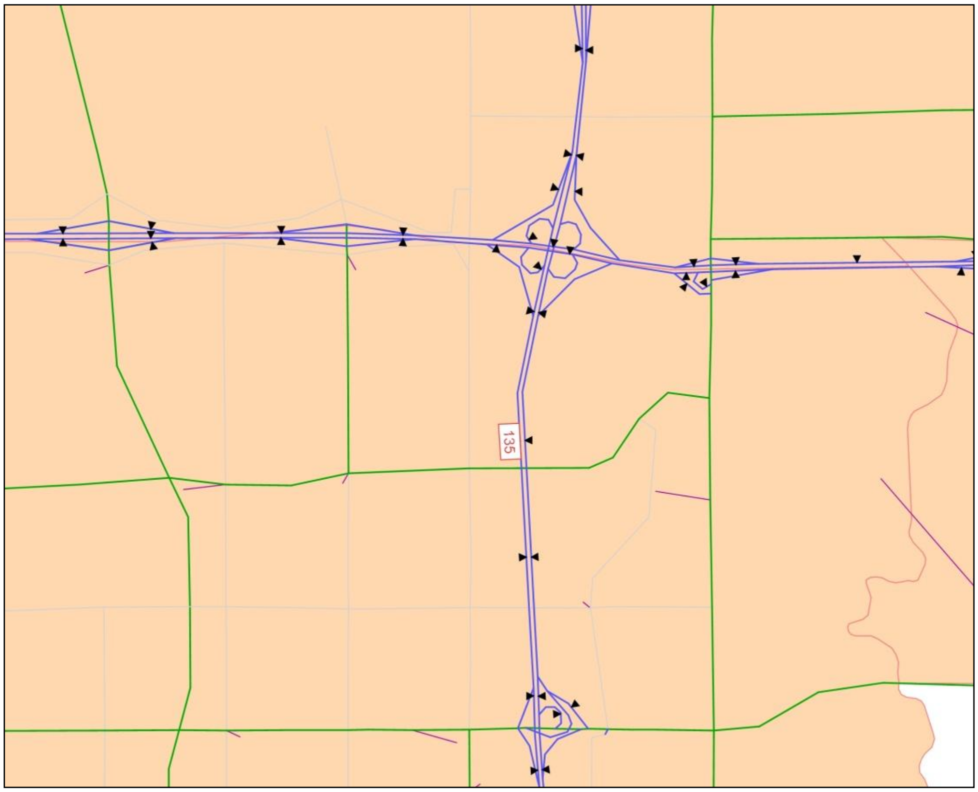
For the Simulator, the VISSIM model, the output data and all associated files are put under the folder C:\vissimnet.

VISSIM online data collection configuration

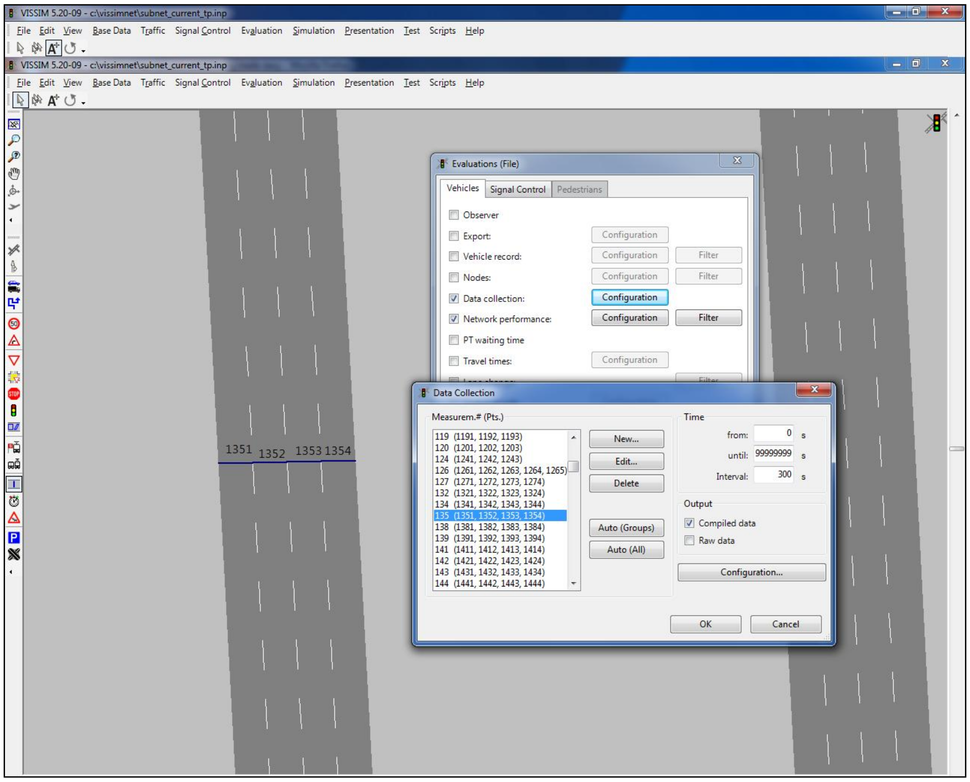
VISSIM simulation can collect and report a great array of simulation performance outputs that are all configurable by the system administrator. For the proper functioning of the Simulator, two sets of outputs are minimum requirements: the *Data Collection* (reported by the "data collection points" in VISSIM model) and the *Network Performance*. More detailed information on this can be found in the VISSIM user manual, under "*Evaluation Types*".

The online output from VISSIM simulation is sent to the TP system where the loop detectors on Salt Lake City freeways have their counterparts in the database. It is therefore required to properly define the data collection points in the VISSIM model.

For example, the TP VISUM model (under c:\Utah\network, see the above file system for Salt Lake City TrafficPlatform) includes a vehicle detection station numbered 135 (I-215 SB between SR-201 and Parkway Blvd) in the system. In VISUM, it is defined as *CountLocation*. This detection station is shown in the following figure.



In the VISSIM model, this section has four lanes and the data collection points are defined accordingly on each lane as shown in the figure below.

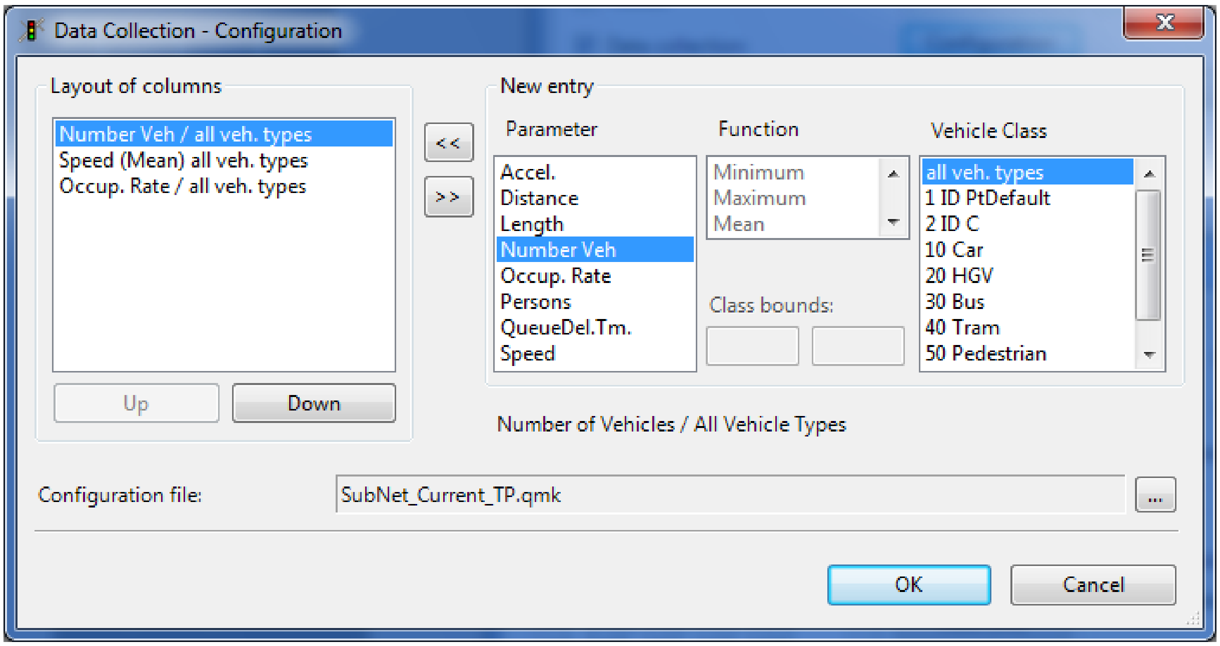


When these data collection points are configured in the definition window, they need be grouped together into *Measurement* numbers, and this number must be corresponding to the VISUM *CountLocation* number, 135.

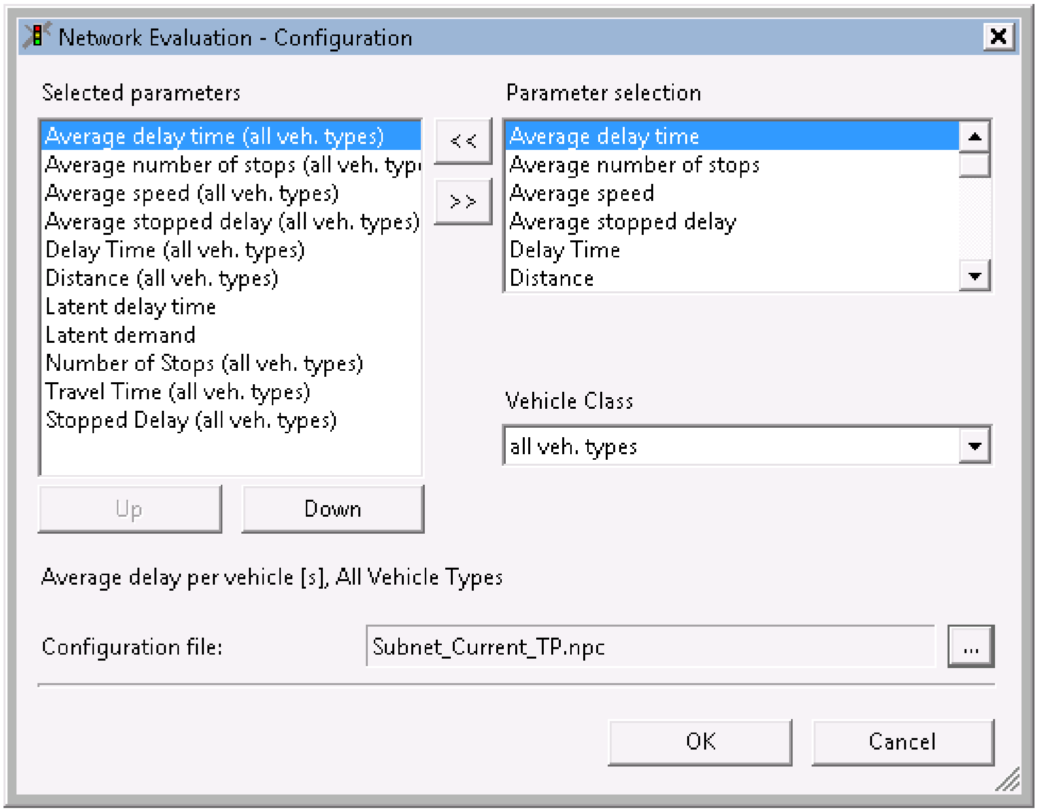
If the VISSIM Measurement location is numbered incorrectly or does not have a counterpart in the VISUM model, the detector data will not be reported properly and thus could lead to distorted traffic estimation and forecast results from TrafficPlatform.

The data collection interval should be 5 minutes (300 seconds), and the output should be compiled data, as shown in the above illustration. These data are the replacement for the on-line detector data. The data are sent to other TP modules for traffic state calculation and estimation.

In VISSIM, the collected data layout is defined in the .qmk file. This definition can be re-used for creating other training scenarios. The main performance measures that need to be defined for collection are *Number of vehicles*, *Speed (Mean)*, and *Occupancy rate*, all configured for *All vehicle types*. The layout is as shown below.



The other output file that needs to be configured in VISSIM is the *Network Evaluation* file. It is configured to compare the traffic operations resulted from the trainee's actions. The current (and recommended) setting configuration is shown in the next figure. In addition to these, VISSIM allows a configuration of many other measures of effectiveness (speeds, travel times, delays, stops etc.) on a more detailed level (segments, ramps, intersections etc.).



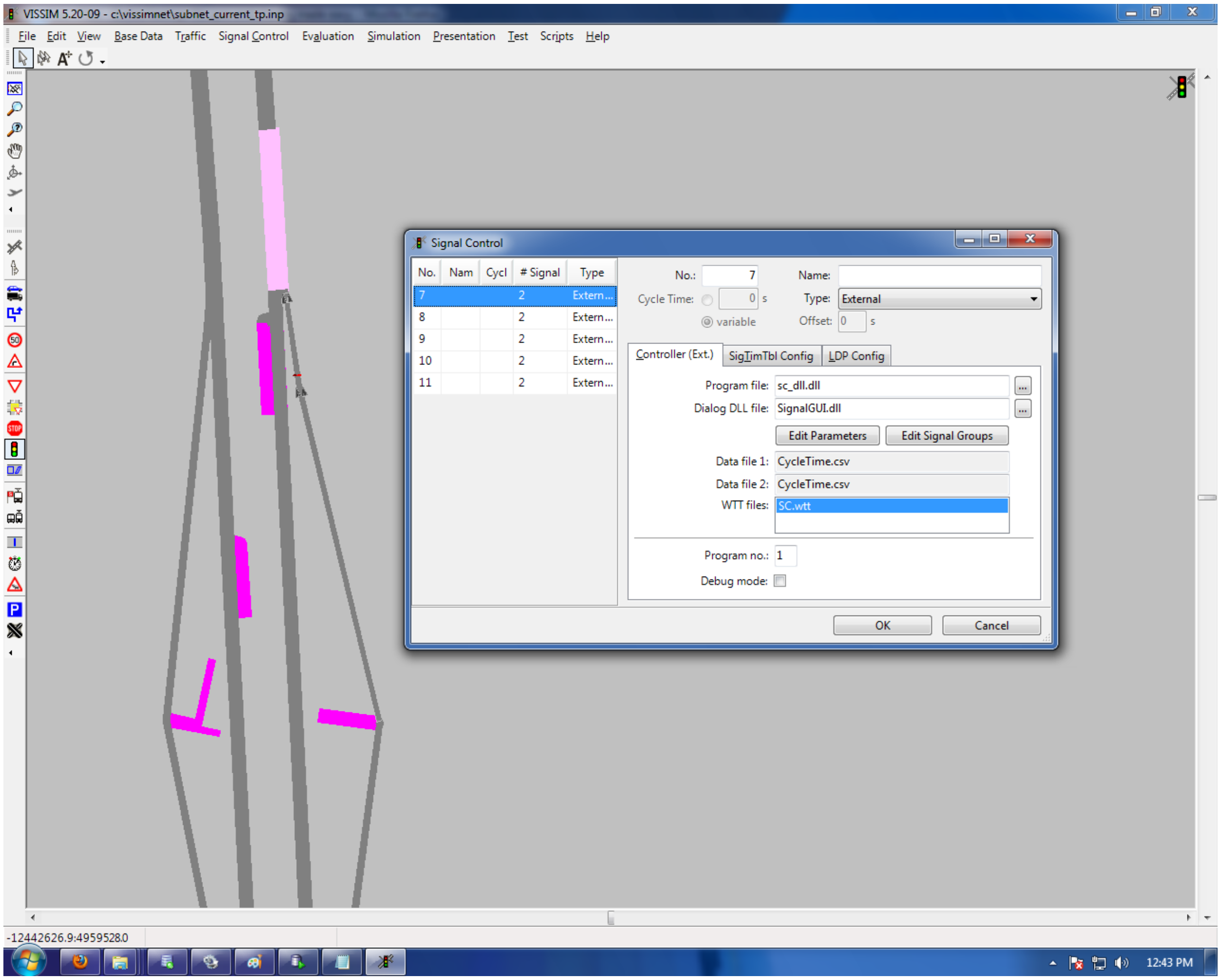
Traffic management countermeasure configurations

Two types of traffic control and management devices can be defined to allow the trainee to change their control parameters for mitigating the congestion: ramp meters and variable message signs.

Ramp meter signal controller

A ramp meter signal controller is configured as a regular traffic controller in VISSIM. Detailed information on modeling signal controllers, signal heads/groups, and other signal settings can be found in the VISSIM user manual section "*Signal Controllers*".

During the training session, the ramp metering rates can be changed by the trainee through the web-based interface. The trainee is using a slide bar to change the ramp flow rates, which automatically changes ramp meter signal settings in VISSIM. This is implemented by a customized signal controller in VISSIM as of type "external", shown in the figure below.



The required program file DLL (sc_dll.dll) and the dialog DLL file (signalGUI.dll), the WTT files are provided under the VISSIM model folder (C:\vissimnet) but can be moved to anywhere in the Simulator virtual machine. The data file (CylceTime.csv) must be put under the VISSIM model folder (C:\vissimnet).

The data file (CycleTime.csv) is a comma separated values file format; the definition is:

Signal controller ID; Cycle length in seconds

No comments should be put in the data file.

When the Simulator is first configured when a scenario is designed, a complete list of the ramp meter controllers and the initial cycle length should be defined. For example, the following CycleTime.csv is defined for the pre-set training scenario (I-15 SB incident).

```
7; 4
8; 4
9;4
10;4
11;4
```

The green time is set to be at a fixed interval of 2 seconds every cycle (roughly per vehicle); the above file will initialize the metering rates as 900 vehicles/hour/lane at the metered ramp.

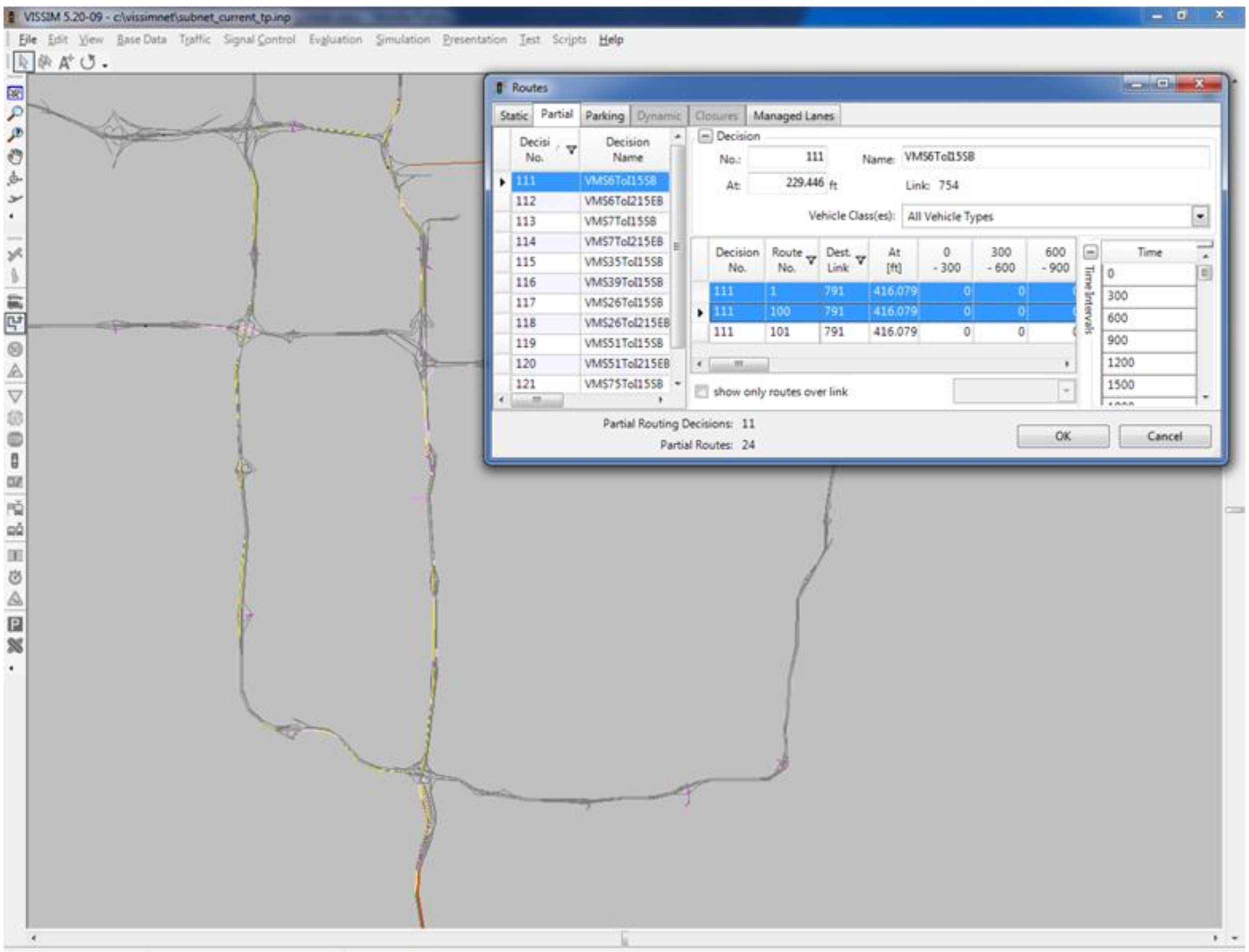
During the incident mitigation management, the trainee does not change the signal system parameters (cycle lengths). Instead, he/she decides on the ramp flow rate in vehicles/hour/lane and defines it through the interface. These ramp metering rates will automatically be translated into equivalent cycle lengths and put into this file. The external controller will select the value and make the signal head display changes every simulation step.

Variable message sign modeling: partial routes in VISSIM

A partial route defines a section of one or more static routes where vehicles should be re-distributed according to the routes and percentages defined by the partial routes. After leaving the partial route vehicles continue to travel on their original route. More information on partial routes can be found in the VISSIM manual, under "*Routing Decisions and Routes*".

The *Partial Routes* feature in VISSIM makes it possible to interactively change the vehicle routing at any moment in any duration during the simulation via the COM interface. This feature well fits the variable message sign impact modeling. When constructing the VISSIM simulation model, possible detour routes from the specific VMS signs should be studied, and their counterparts in the VISSIM model should be built. The task of the administrator during an incident design is to define the area of influence of the accident and possible alternative routes. The administrator also configures the percentage of vehicles choosing each route for the three levels of information provided through the VMS information.

For example, the VMS #6 ("I-15 SB 400 North") is modeled by Partial Route Decision #111 and two more alternative routes (100, 101) are created in addition to the main route (1).



The configuration file for any newly created VMS/Partial Route decision (VMSPartialRoutes.csv) should be put under the VISSIM model folder (C:\vissimnet) to create the mapping between the VMS and corresponding partial routes in VISSIM. Its format is as follows:

VMS ID; Routing Decision#; Route#; Level 0; Level 1; Level 2; Level3

The different levels indicate how much proportion of the *relevant traffic* will be diverted to the alternative routes other than the main route. The relevant traffic is the traffic directly impacted by the incident. This depends on the level of information provided to the vehicles in the simulation. Level 0 represents a blank VMS, with no messages displayed and the vehicles follow predefined routing decisions. Level 1 means that only the incident occurrence is displayed. Level 2 is the information on incident occurrence and the best alternative route. Level 3 is the incident occurrence, best alternative route and information on expected delays. Each level of information will have different impact on real-life drivers, so the partial routes are defined accordingly for each level.

Appendix 1 provides a literature review on the driver response to VMS signage. The review shows that the content of the VMS message, the location of the VMS and drivers' characteristics all contribute to the diversion, the following assumptions are made:

1. "relevant" drivers will be those that are directly heading toward the incident location;
2. The relevant drivers will make diversion (or not) decisions when they see the VMS messages.
3. Three levels of diversion rates are appropriate to set up the route diversion rates;
4. The VMS message contents will affect the levels of the diversion rates;
5. There are three relevant types/levels of VMS messages:
    - Level I: Incident occurrence/location only;
    - Level II: Incident location + detour route suggestion;
    - Level III: Incident location + (real time) delay + detour route suggestion.
6. The following diversion rates for relevant traffic are proposed for the SLC traffic patterns (interstate freeways, weekday PM peak):
    - Level I: 5% - 10%
    - Level II: 10% - 30%
    - Level III: 40% - 80%

The last two assumptions are the most important conclusions from the literature review and can be directly used in the incident design and configuration.

For example, the Partial Route decision configuration for VMS #6 can look like this:

```
6;111;1;0.0;0.90;0.75;0.55;
6;111;100;0.0;0.07;0.20;0.35;
6;111;101;0.0;0.03;0.05;0.10;
6;112;2;0.0;0.90;0.70;0.50;
6;112;200;0.0;0.07;0.25;0.40;
6;112;201;0.0;0.03;0.05;0.10;
```

Traffic incident definition

The administrators (UTL personnel) will be in charge of defining different incidents in the network. Defining the incident in the VISSIM simulation can be done through time-dependent S*peed reduction areas*. Refer to the "*Reduced Speed Area"* coding in the VISSIM user manual for details.

In the Simulator, the incident information should be defined on the basis of the VISUM model underlying the SLC-TP. The location, name, starting time, duration, link capacity and additional text should be defined in a csv file named "IncidentDef". The format of the file should be as in the following example:

```
VISUM_link_id;VISUM_link_fromNode;Incident_name;Incident_start(sec);Incident_Duration(sec);Section_capacity(veh/hr);Display_text

1012010550;10120;Accident1;1800;2700;2000;Accident on I-15 South. \  Four shoulder general purpose lanes blocked at W 3900 S. \ Expected clear time: 45 minutes.
```

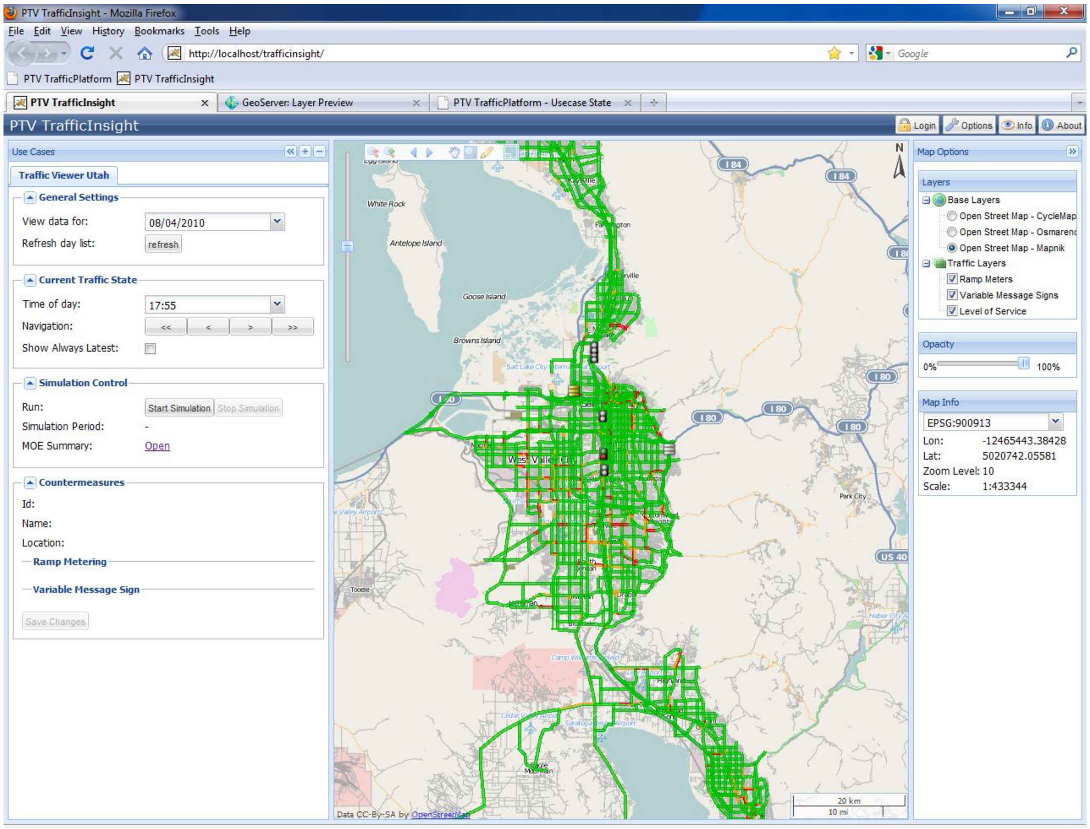
When the training session starts, this information will be sent to TrafficPlatform for calculating impacts on the network. Note that the incident definition in VISSIM must be consistent with the incident definition in this file.

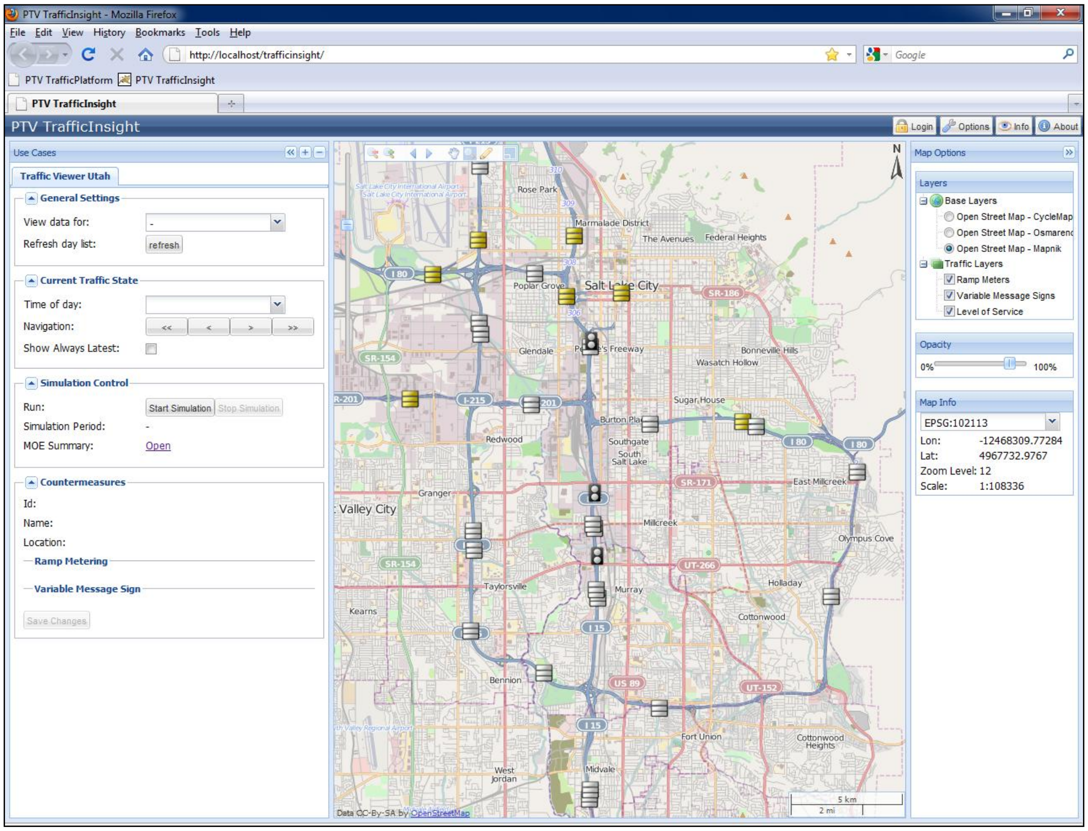
TrafficInsight: Web-based User Interface

TrafficInsight is the web-GUI application that serves as the central panel for visualizing the static and real-time traffic data, disseminating dynamic traveler information and route guidance, supporting and implementing dynamic traffic management decisions and integrating with other geospatial analysis services. It can use both PTV feature map services and other web mapping services such as Google maps and Bing maps; it can incorporate the analysis results from the TrafficPlatform, VISSIM simulation, VISUM travel forecast and live data exchange with other traffic data providers. A number of successful TrafficInsight use cases in both Europe and North America have proven its versatile capabilities and potentials in assisting professional traffic analysis, improving end-user decision-making and user experience as well as development efficiency (time to market, use and trust open source software, rule of keeping simple for users).

TrafficInsight is the only interface that a trainee is facing during a training session. However, the administrator has to be very familiar with this interface in order to provide a better understanding and guidance for the trainee.

Screenshots of the TrafficInsight interface for the SLC Simulator are given in the following figures.


PTV TrafficInsight - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/trafficinsight/
PTV TrafficPlatform PTV TrafficInsight
PTV TrafficInsight
GeoServer: Layer Preview
PTV TrafficPlatform - Usecase State
PTV TrafficInsight
Login Options Info About
Use Cases
Traffic Viewer Utah
General Settings
View data for: 08/04/2010
Refresh day list: refresh
Current Traffic State
Time of day: 17:55
Navigation:
Show Always Latest:
Simulation Control
Run: Start Simulation Stop Simulation
Simulation Period: -
MOE Summary: Open
Countermeasures
Id:
Name:
Location:
Ramp Metering
Variable Message Sign
Save Changes
Map Options
Layers
Base Layers
Open Street Map - CycleMap
Open Street Map - Mapnik
Traffic Layers
Ramp Meters
Variable Message Signs
Level of Service
Opacity
0% 100%
Map Info
EPSG:900913
Lon: -12465443.38428
Lat: 5020742.05581
Zoom Level: 10
Scale: 1:433344
20 km
10 mi



The Training Simulator interface powered by TrafficInsight consists of three major sections:

1. Map options: the map layers (base map and traffic objects), the control of base map appearances and the projection system;
2. Map view display: the network view and the navigation and selection tool bars;
3. Traffic Viewer and control panel: the traffic state navigation, Simulation Control that starts and ends the VISSIM simulation, and the countermeasures panel.

Map options

The *map options* panel on the right hand of the interface allows a configuration the settings of the map display.

Layers

The *layers* section lists the base map layer and the traffic object layers specific to Utah Salt Lake City metropolitan area.

The base layers are all based on the OpenStreetMap data, an open source geospatial web mapping data source. The traffic layer includes three types of traffic objects: ramp meters, variable message signs and roadway segment level of service color displays. The traffic layers can be toggled on and off separately.

Opacity

This allows the user to adjust the transparency settings for the base map; this can be useful when the level of service layer is turned on.

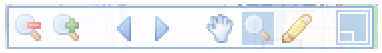
Map Info

This panel lets the user switch between different project systems. The internal reference of the Simulator applies the “EPSG:900913” projection system. The longitude and latitude data of any particular place can be read from the info text below the drop down list.

Map Display

The map display area shows the traffic states estimated for the Utah Salt Lake City area when the Simulator starts. It includes the navigation toolbar and the vertical zoom level sliding bar both on the upper left corner.

The vertical zoom level vertical bar allows the user to select one specific level of display. Scrolling the mouse middle wheel also allows for zooming in and out of the display area.



The above navigation toolbar includes a series of standard navigation tools.

The zoom in and zoom out buttons have the same function as the vertical zoom level scroll bar and the mouse middle wheel scrolling.

The left and right arrows allow the user to go back and forward between previously viewed map regions. The pan tool allows the user to move the map display by holding the left mouse click down and move to the desired direction.

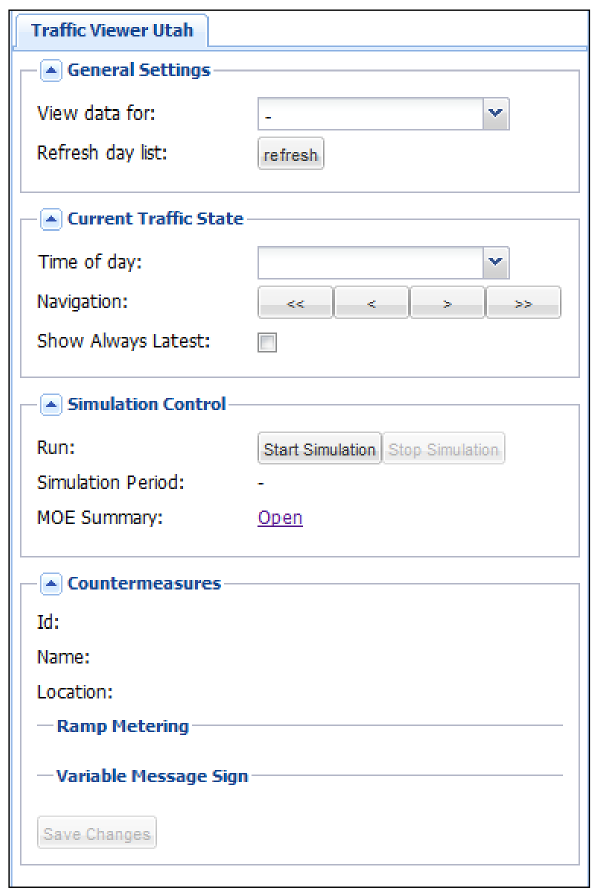
The magnifying glass icon indicates the zoom by drawing rectangles around the target area.

The map drawing tool allows the user to draw polylines continuously to make measurements when necessary. Drawing the polyline starts with right click of the start place and release; vertices are determined by either left or right mouse clicks successively, and closing the polyline is finished by double left clicks.

The picture in picture tool lets the user have an overview of the display area in a zoom-out level.

TrafficViewer Control Panel

The TrafficViewer control panel is the control console of the Training Simulator. The *General Settings* section includes refreshing the data archived in the database.



The *Current Traffic State* section allows the user to load the traffic estimate results of different time intervals for the Salt Lake City region. Users can switch between different time intervals either during the training session or after the training session is over. The “Show always latest” option will let the Training Simulator always display the latest traffic states in the map display area during the training session.

The *SimulationControl* Panel is where to start the training session. Click the “Start Simulation” button, the training session will begin. The training session will continue in the real time speed; every simulation second is equal one second in the real time. The pre-set training session lasts two hours (designed to represent the traffic conditions of Salt Lake City for 4-6pm.

Once the training session begins, the “Simulation period” will display how much time the training has elapsed; this can also be seen from the VISSIM simulation in the background.

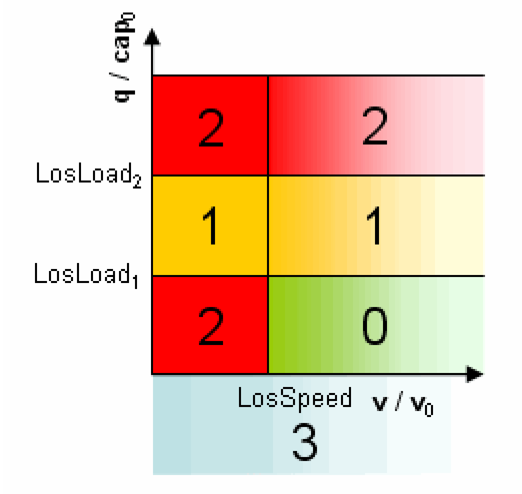
When the training session is over, click “open” will bring out another web page that displays the overall traffic performance of the past training session.

The *Countermeasures* section will display the current control settings for the selected traffic management and control devices including ramp meters and variable message signs. Once selected, the internal ID, the name and the location identifier of the device will be listed. For the ramp meter, the current metering rates will be displayed as a sliding bar, while for the VMS sign, three levels of display text will be displayed for the user to choose from.

The “Save Changes” option will commit the changes to the control parameters, e.g., ramp metering rate or levels of display text for VMS, to the Simulator. The changes will be taken by VISSIM simulation to change the traffic operations.

Level of Service Indicator

The traffic level of service (LOS) layer can be toggled on and off from the Map Options panel. The LOS color indication scheme is in the following chart. Adding the estimated speed to the LOS indicator overcomes the shortcoming of the volume-capacity ratio based LOS definitions in the stop-and-go traffic situation where low flow rates and resulting low v/c ratio actually denotes high congestion.



The LOS criteria for the Salt Lake City TrafficPlatform system have been configured as follows: v/c ratio (q/cap_0 in the chart) load level_1 equals 0.85, and load level 2 equals 1; the speed ratio is set to be 0.2.

TrafficInsight Configuration

The TrafficInsight components run in a Tomcat web Server, and the installation and default configuration is as follows.

Details

Installation folder	C:\Program Files\apache-tomcat-6.0.26
Startup Mode	Windows Service, Automatic (Delayed)
Log folder	C:\Program Files\apache-tomcat-6.0.26\logs
Deploy folder	C:\Program Files\apache-tomcat-6.0.26\webapps

The web mapping services (WMS), web feature services (WFS), web coverage service(WCS) and global webcache (GWC) within TrafficInsight are all provided by the GeoServer. The installation and monitoring info are as follows:

Geoserver

Monitoring	http://localhost/geoserver, Login user: admin Password: geoserver
Data dir	C:\Program Files\GeoServer 2.0.2\data_dir
Deploy folder	C:\Program Files\apache-tomcat-6.0.26\webapps

The traffic control actions made by the user through the web interface, the simulation data collected during the simulation run are developed as a module named SimulationControl. The admin information is as follows.

SimulationControl

Installation folder	SimulationControl.war in C:\Program Files\apache-tomcat-6.0.26\webapps
Data folder	C:\vissimnet
Vissim Installation folder	C:\program files\PTV Vision
Vissim Version	5.20
Vissim Model folder	C:\vissimnet

Lastly, the geospatial database for TrafficInsight is managed through PostGIS:

PostGis

Installation folder	C:\
Startup Mode	Windows Service, Automatic
Monitoring	PGAdmin (Startmenu, Programs, Postgres), database: traffic_insight, user: postgres, password: tp

Training Session Design

This chapter describes the process of designing and customizing different training use cases in the Simulator. The administrator should be familiar with this procedure to be able to design different training scenarios and make sure that the Simulator is working properly.

Overview of Scenario Customization

The modularized architecture of the Simulator is very suitable for rebuilding different training scenarios or use cases. Each of the three most important components, TrafficPlatform calculations, TrafficInsight GUI and VISSIM simulation can be updated without interfering with the other two as long as the inter-reference is maintained. Under the current Simulator architecture, two major customization scenarios can be built fairly quickly. The first one is to upgrade the Salt Lake City TrafficPlatform system, and the other is to update or even replace the VISSIM simulation model with a different one.

The next section introduces the process of building a training scenario. The example shown is for an I-15 SB incident management scenario, which was used to test the Simulator. It shows the procedure that was followed to build the training scenario, where most common techniques to upgrade the Simulator can be illustrated.

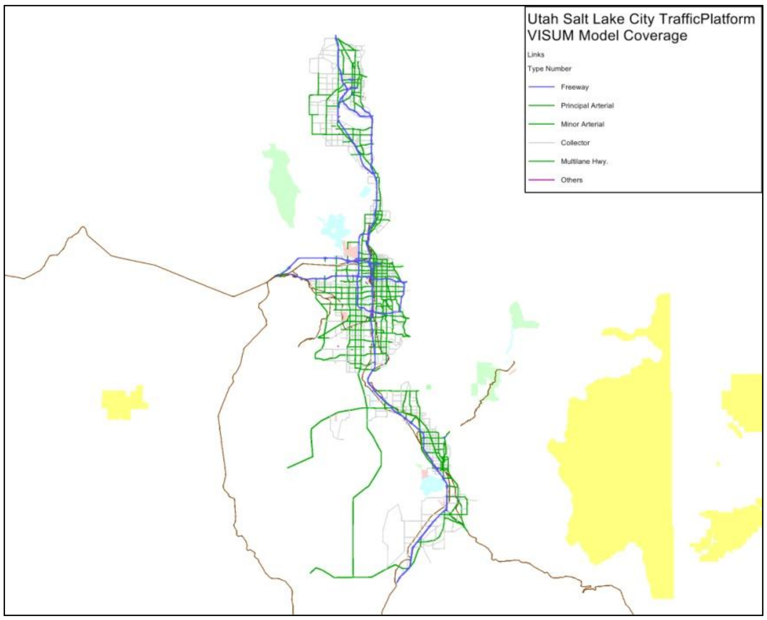
The Pre-set Training Use Case: I-15 SB Incident Management

The pre-set training scenario, or *use case*, in the delivered Simulator is designed as a freeway incident management scenario. In addition to the conceptual design of the work flow for the incident management, building the training use case consists of two tasks: constructing the VISSIM simulation model and applying the traffic management countermeasures (ramp meters and variable message signs in this use case).

Constructing the Salt Lake City Freeway system VISSIM Simulation Model

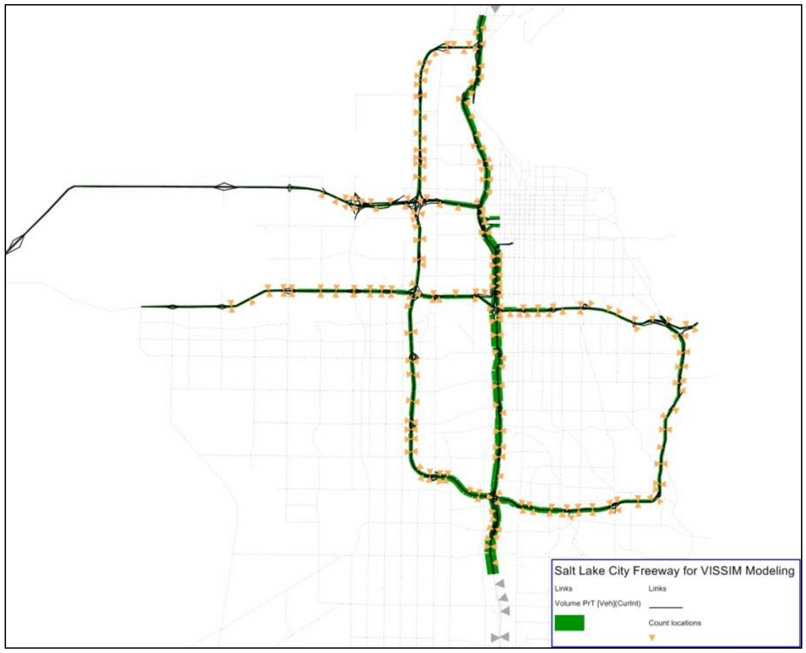
The first task of VISSIM model construction started with an analysis of the hour by hour travel patterns of the Salt Lake City area as built in the TrafficPlatform system. Thanks to the Phase I construction of

TrafficPlatform, the typical daily travel demand that is reflected by the hour by hour OD matrices has been modeled in VISUM based on a network imported from the regional travel demand forecast model (see the following exhibit). The model is composed of 1,499 traffic analysis zones and 12,342 links, with necessary transportation system infrastructure such as loop detectors (modeled as *CountLocation* in VISUM), variable message signs and ramp meters (imported as *Point of Interest*). This infrastructure greatly facilitates the construction of the VISSIM model for the Simulator.



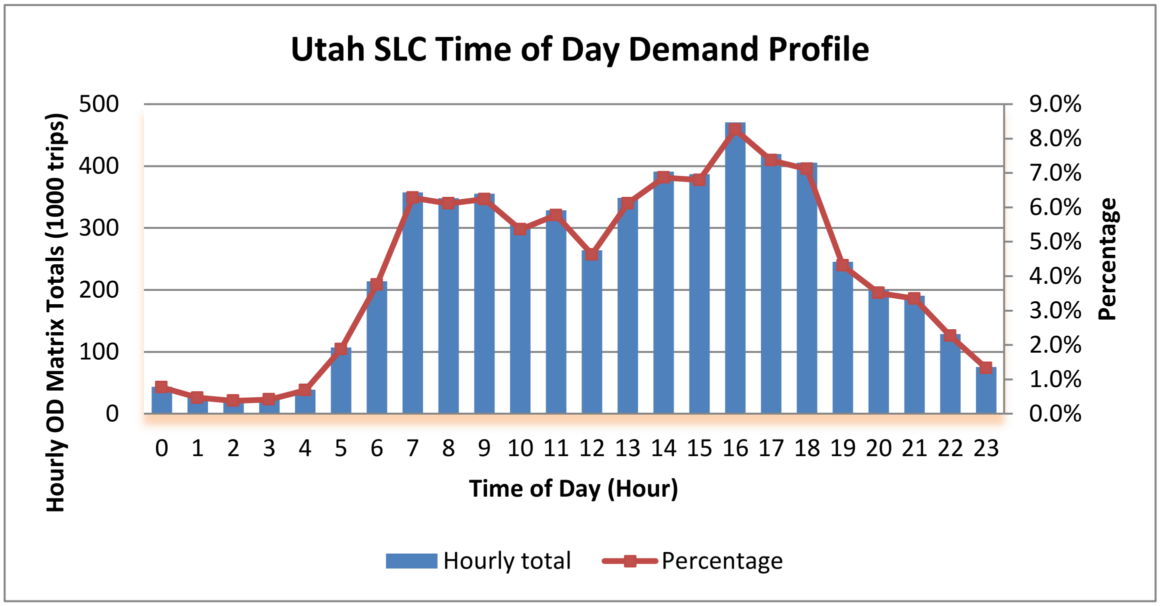
The VISUM model provides a good basis for building a VISSIM simulation model. In fact, recent trend in micro simulation modeling is to utilize the data in the demand model to assist the simulation model construction. This integrated modeling approach proves a much more efficient approach than building the VISSIM network from scratch.

With the “Spatial selection mode” () in VISUM, The Salt Lake City freeways (with the respective vehicle detection stations) are selected as illustrated in the following exhibit.



Salt Lake City Freeway for VISSIM Modeling
Links
Volume PrT [Veh](CurInt)
Links
Count locations

With the 24 hourly origin-destination demand matrices, the dynamic traffic flow pattern for the Salt Lake City region can be characterized by the dynamic user equilibrium (DUE) traffic assignment. The aggregate hourly traffic volumes at the freeway and on-ramp entrances from the above selected sub-network are illustrated in the following chart.



This chart clearly indicates that 4-6PM are the peak period. This period is thus selected as the VISSIM modeling period for the incident management scenario in the Simulator, for the impact of the incident could be most harmful when the accident happens during this period.

The other benefit from applying a DUE procedure to the Salt Lake City regional model was the path flows export from the regional model to the SLC freeway sub-network. This feature allows for the Abstract Network Model (ANM) export from VISUM into VISSIM. The geometries and the driving behavior model parameters at critical locations are also adjusted for more realistic representation of the SLC freeway system and the travel patterns.

The major techniques involved in building a VISSIM model based on the existing regional VISUM model using an integrated modeling are summarized as follows:

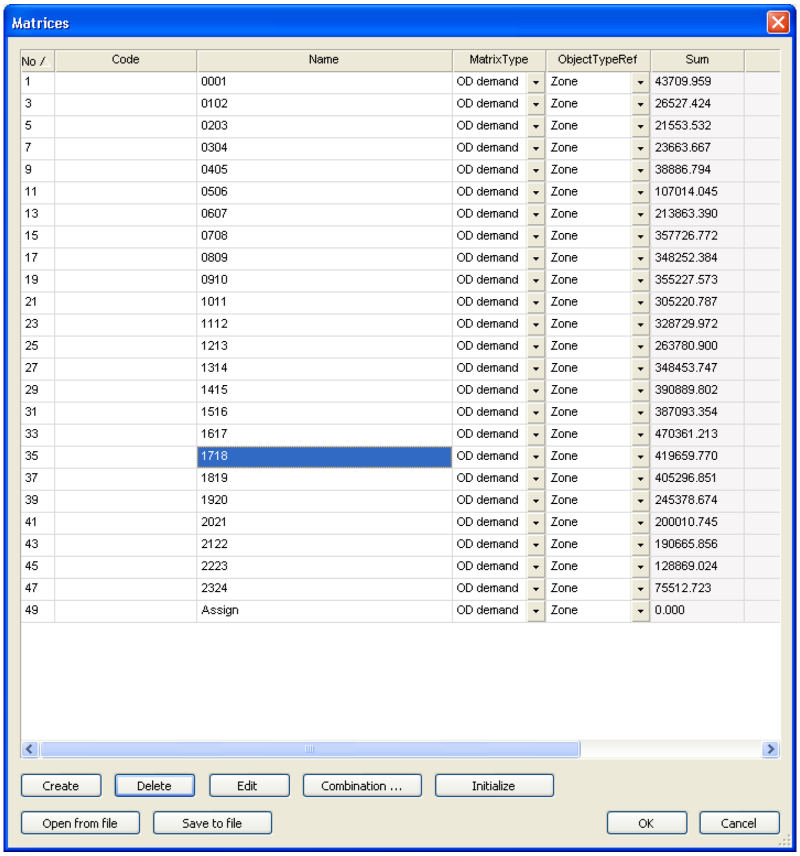
- Dynamic user equilibrium (DUE) traffic assignment in VISUM: the DUE process provides a good basis for generating the time-varying demand input and vehicle routing for VISSIM;
- Sub-network generator: to generate the corridor network from selecting the corresponding network elements from the regional model;
- Abstract network model (ANM): export the VISUM network to the ANM format that can be imported directly or adaptively into VISSIM.

Implementing a dynamic traffic assignment process in the Salt Lake City regional VISUM model served two purposes: one is to identify the peak traffic period in the region, and the other to prepare the sub-network generation for the freeway corridor system.

Time series input for SLC regional DUE

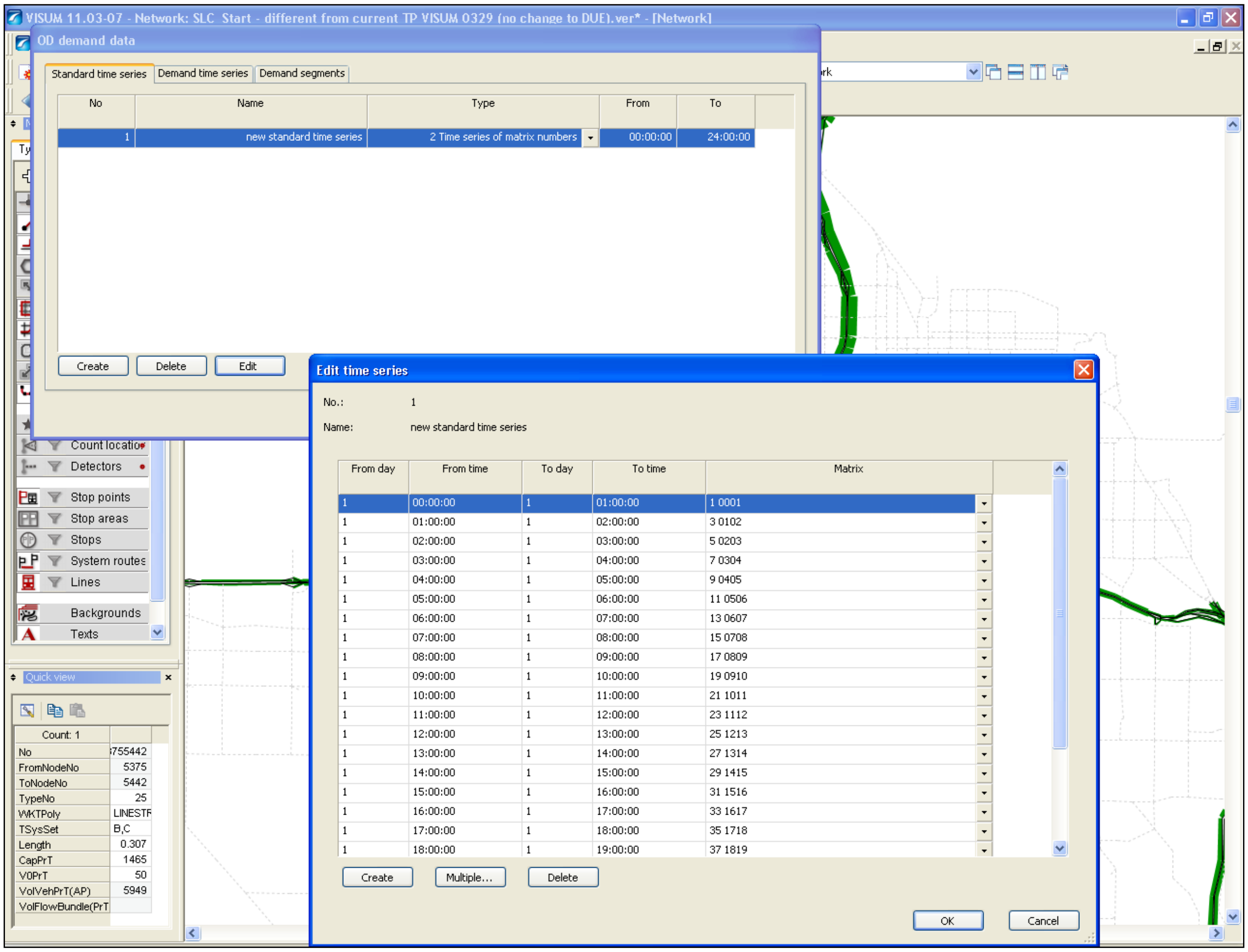
The first basic input for VISUM DUE is the time series, i.e., the time-varying characteristics of the traffic demand. For the VISUM model in the SLC TP system, the hourly O-D demand matrices are used for entering the time series data.

The 24 hourly OD matrices have been stored in the version file shown in the following figure:

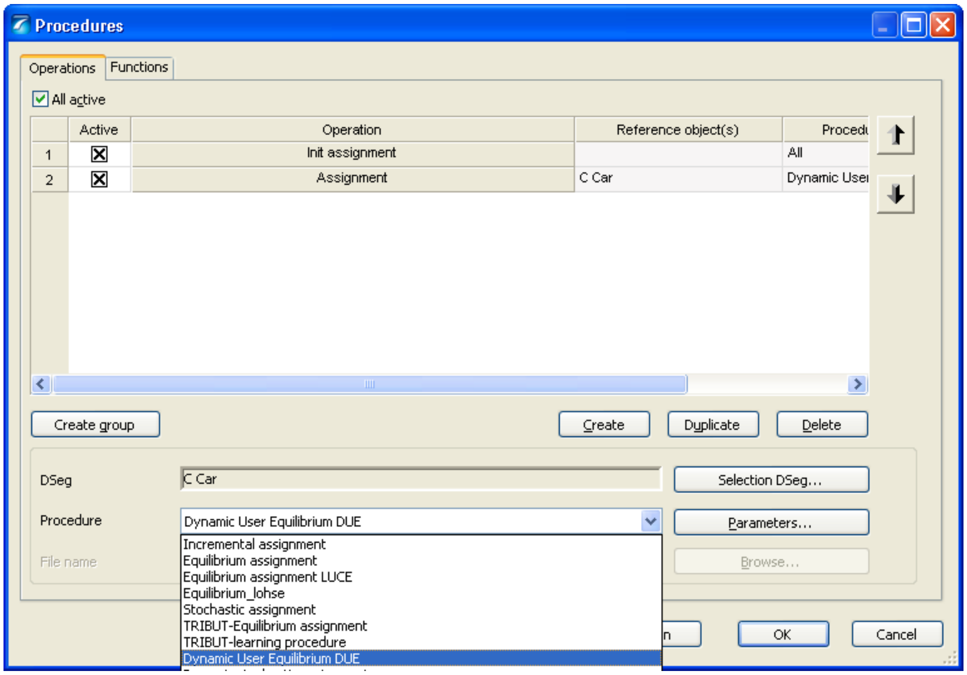


No	Code	Name	MatrixType	ObjectTypeRef	Sum
1		0001	OD demand	Zone	43709.959
3		0102	OD demand	Zone	26527.424
5		0203	OD demand	Zone	21553.532
7		0304	OD demand	Zone	23663.667
9		0405	OD demand	Zone	38886.794
11		0506	OD demand	Zone	107014.045
13		0607	OD demand	Zone	213863.390
15		0708	OD demand	Zone	357726.772
17		0809	OD demand	Zone	348252.384
19		0910	OD demand	Zone	355227.573
21		1011	OD demand	Zone	305220.787
23		1112	OD demand	Zone	328729.972
25		1213	OD demand	Zone	263780.900
27		1314	OD demand	Zone	348453.747
29		1415	OD demand	Zone	390889.802
31		1516	OD demand	Zone	387093.354
33		1617	OD demand	Zone	470361.213
35		1718	OD demand	Zone	419659.770
37		1819	OD demand	Zone	405296.851
39		1920	OD demand	Zone	245378.674
41		2021	OD demand	Zone	200010.745
43		2122	OD demand	Zone	190665.856
45		2223	OD demand	Zone	128869.024
47		2324	OD demand	Zone	75512.723
49		Assign	OD demand	Zone	0.000

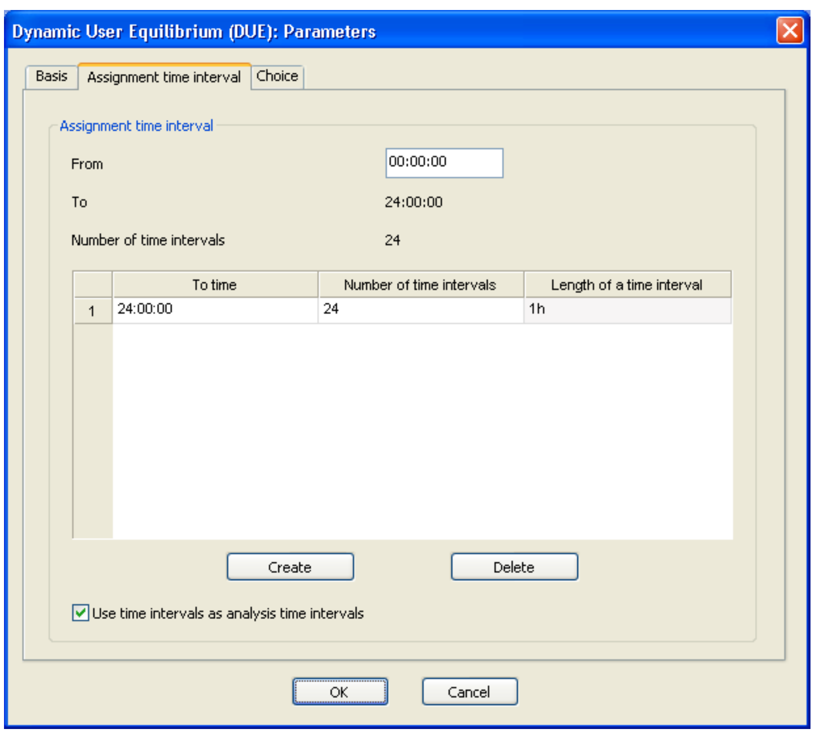
Entering the time series data in VISUM is accessed from menu – Demand – Demand data. From the *Standard time series* tab, create one and then Edit – entering the association of the 24 matrices with each hour.



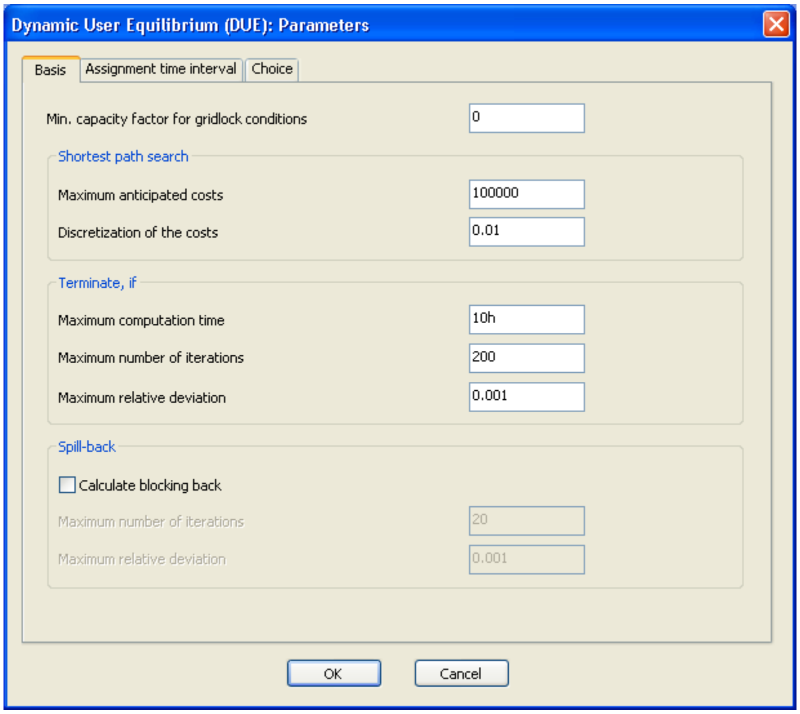
Choose the DUE assignment procedure from the dropdown list of traffic assignment:



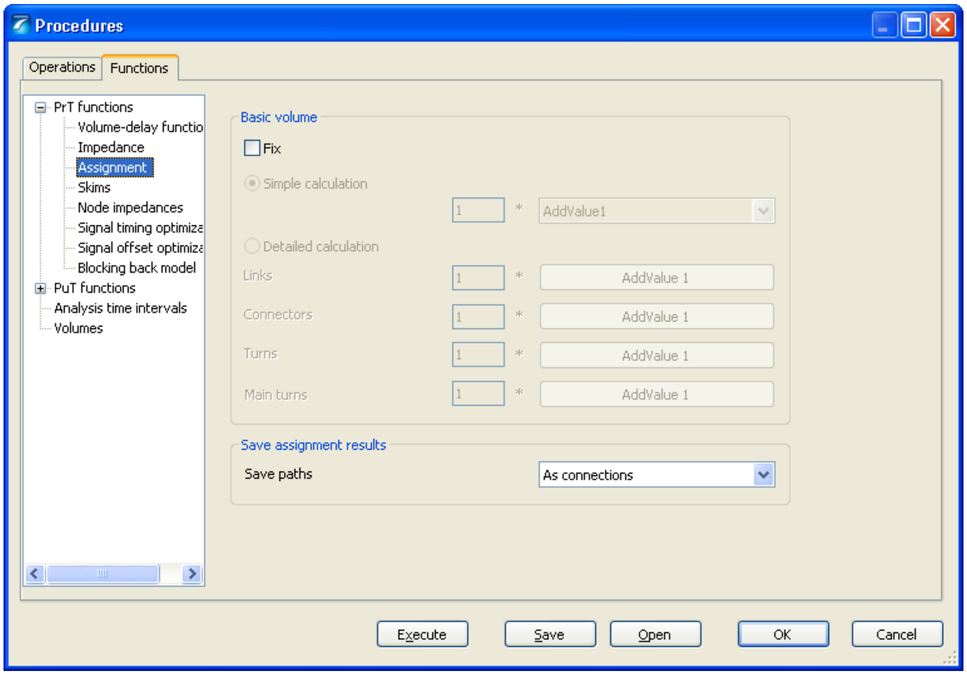
The parameters for DUE assignment can be set from the "Parameters…" dialog. Select the tab *Assignment time interval* first:



Make sure the “Use time intervals as analysis time intervals” option is checked. The default parameters on the tab *Choice* can be accepted. On the *Basis* tab, change the termination parameters, shortest path search parameters as shown below:

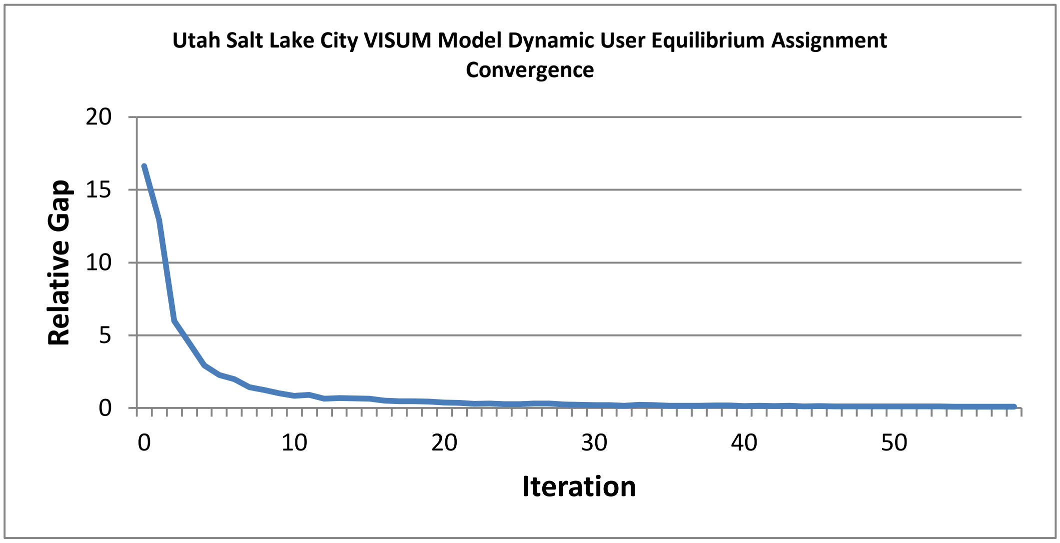


On the Functions tab of the Procedure dialog, select the Assignment node from the left panel and then select the “Save paths as connections” option:



This will allow the storage of all paths after the DUE process converges for generating the corridor. With this option turned on, the computation must be running on a 64-bit computer with at least 8GB RAM for the DUE calculation and path storage will take a significant amount of CPU and RAM beyond the capacity of a 32-bit system.

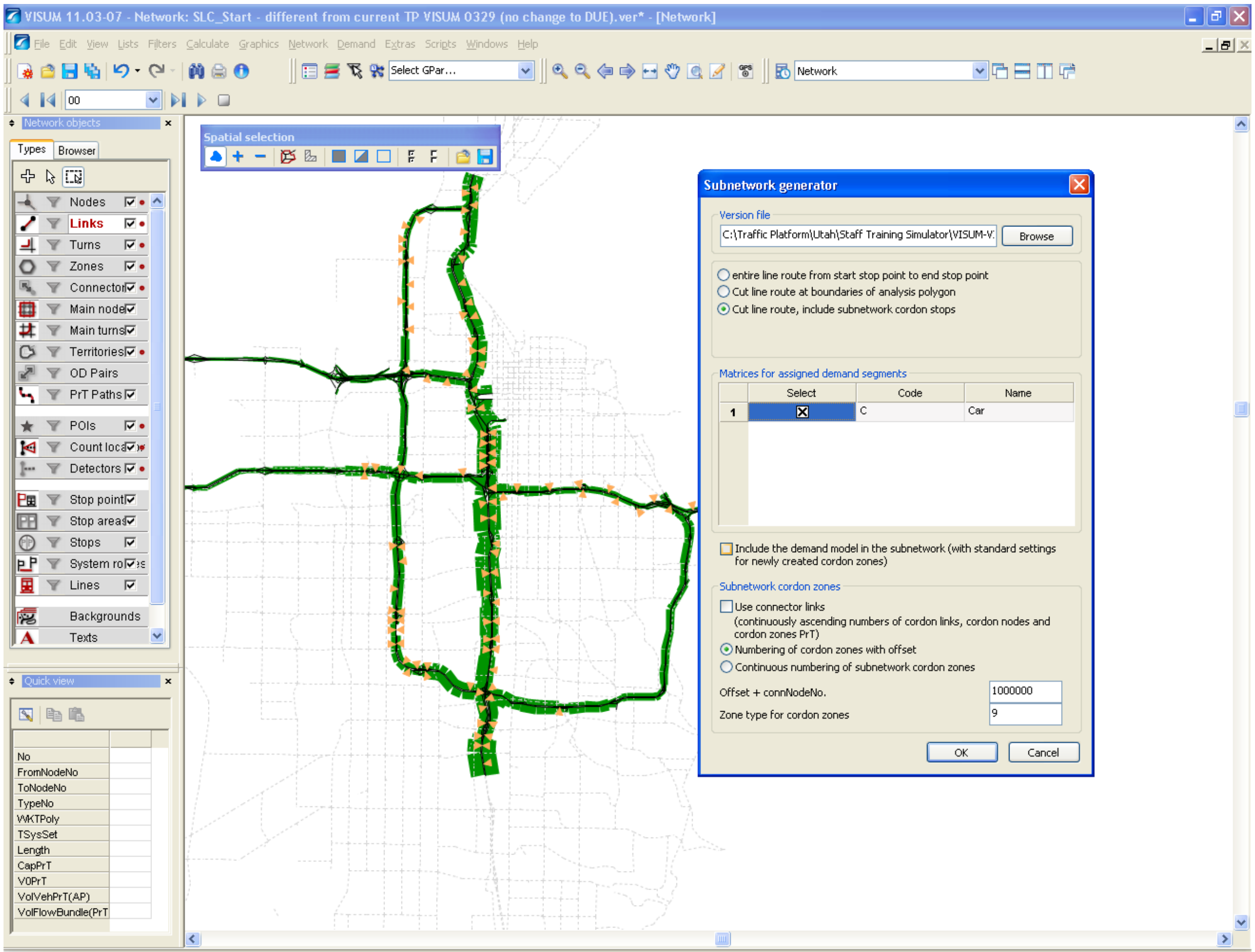
Note that no other adjustments were made to the network as the link capacities established in the existing VISUM model will continue to be used for DUE assignment. The DUE convergence process for the SLC 24-hour DUE assignment is as follows.



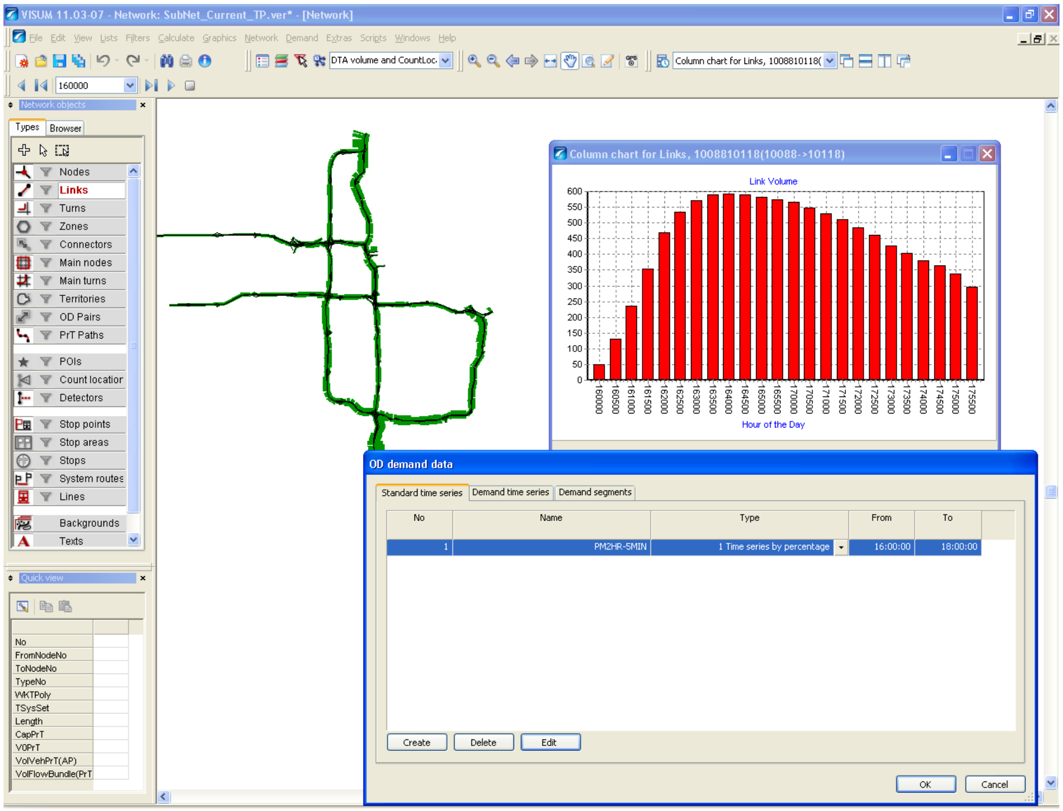
After about 60 iterations, the Relative gap stabilizes to the final convergence criterion level.

Generating the subnetwork for Salt Lake City freeway corridor system and subnetwork refinement

Once the traffic assignment is performed for the regional model, the area of interest can be selected under the *Spatial selection mode*. The selection can be saved as *active network object* files(.ane) that can be loaded directly to reactivate the selected areas. Then the “Subnetwork generator” can be opened from menu – Calculate – Subnetwork Generator to generate the subnetwork.



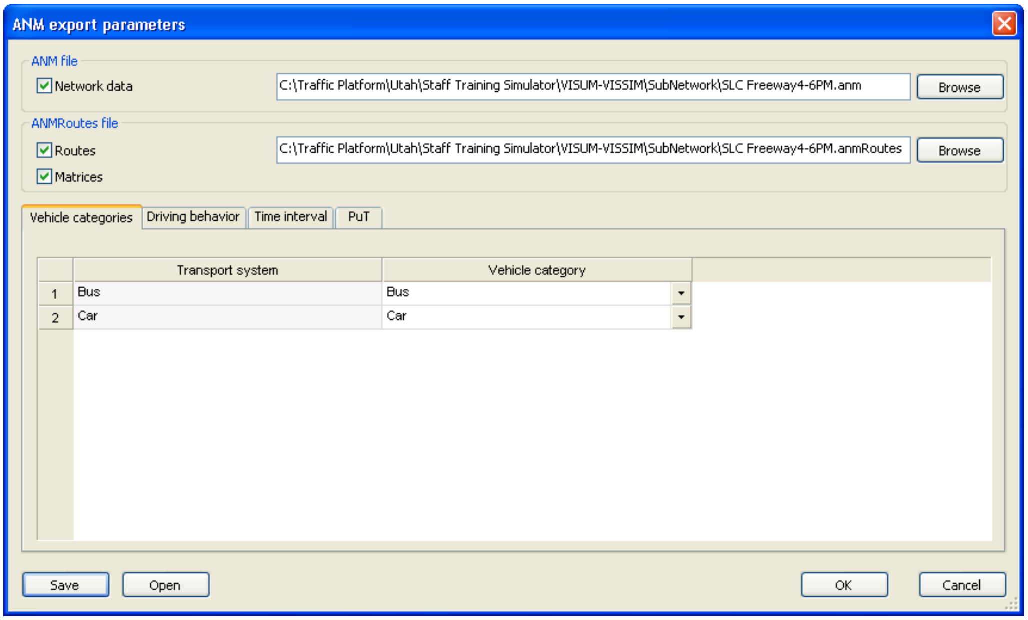
After the corridor network is obtained, the 4pm-6pm period is selected for another dynamic user equilibrium process to generate the traffic demand input and vehicle routing. This DUE process is based on a 5-minute increment with the percentage demand input option. With no direct input from the Salt Lake City freeway detector data, the percentages for each of the 5-minute increment for 4pm-6pm in the predefined training scenario are based on a typical pattern that is also seen in other metropolitan areas. For designing new training scenario, these percentages can be updated based on the real-time traffic data.



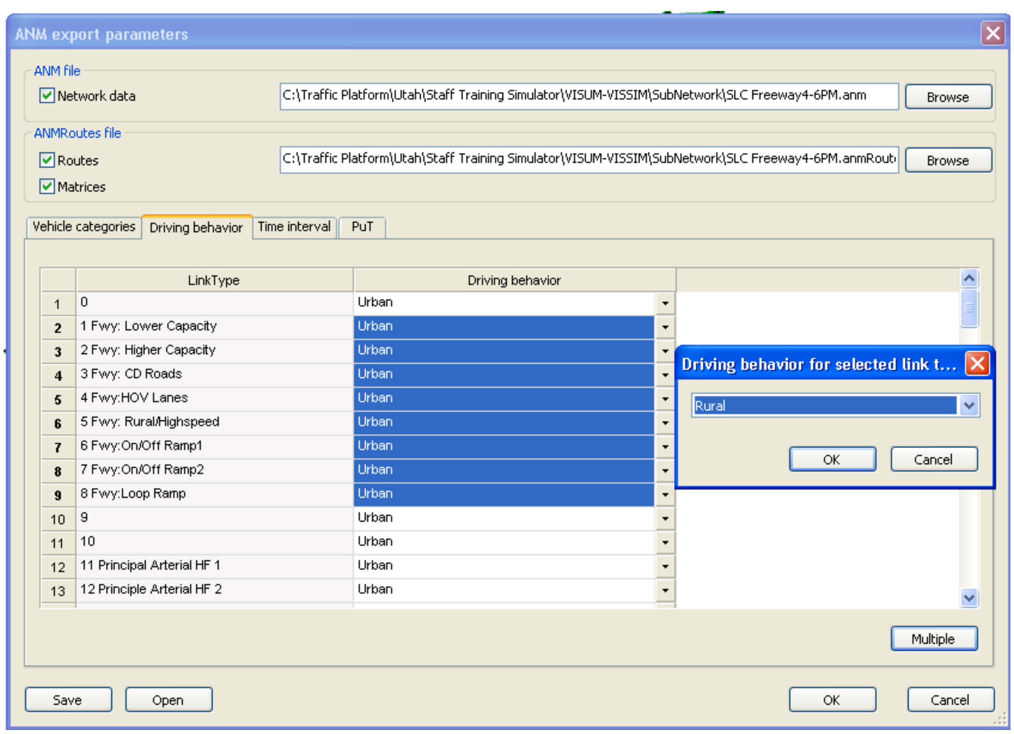
Once this assignment process is done and calibrated against the field traffic pattern, it is ready to be exported for building the VISSIM model. Note that the Assignment "Save path as connections" must be used for proper generation of the paths.

VISSIM model construction from ANM and model enhancements

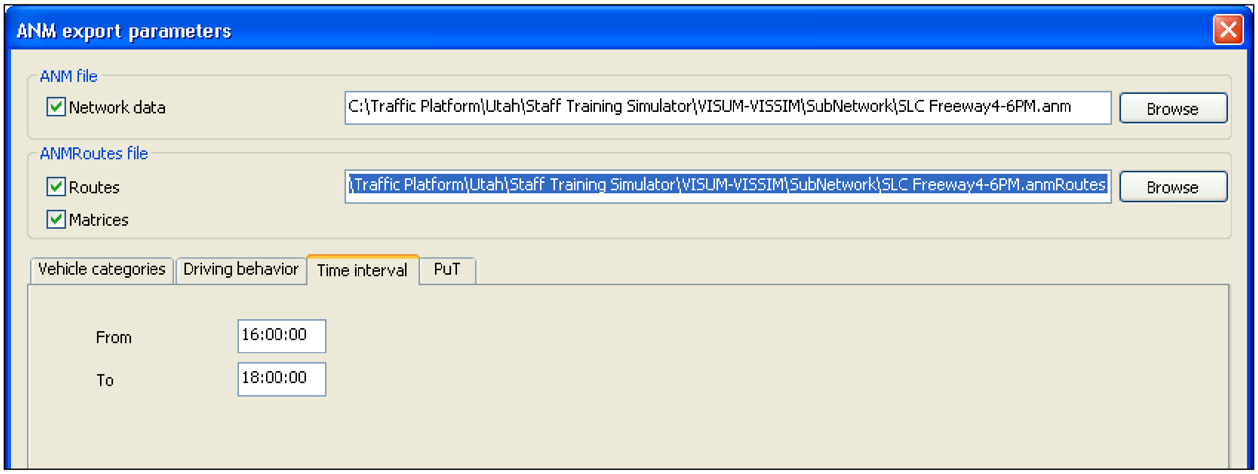
The selected VISUM network can be directly exported into VISSIM, eliminating the need of creating the VISSIM model from scratch. Exporting the corridor network from VISUM to VISSIM is carried out through the abstract network model (ANM) module from menu File-Export – VISSIM (ANM). The following *ANM export parameters* dialog will open, and a series of parameters will need to be specified for a proper export/import for constructing the VISSIM network. The transportation system specifications are on the first tab (Vehicle categories):



The *Driving behavior* tab allows specifying the link behavior for each link type that correspond to the link behavior types in VISSIM. A multi-editing feature is also available to change multiple link types at a time.

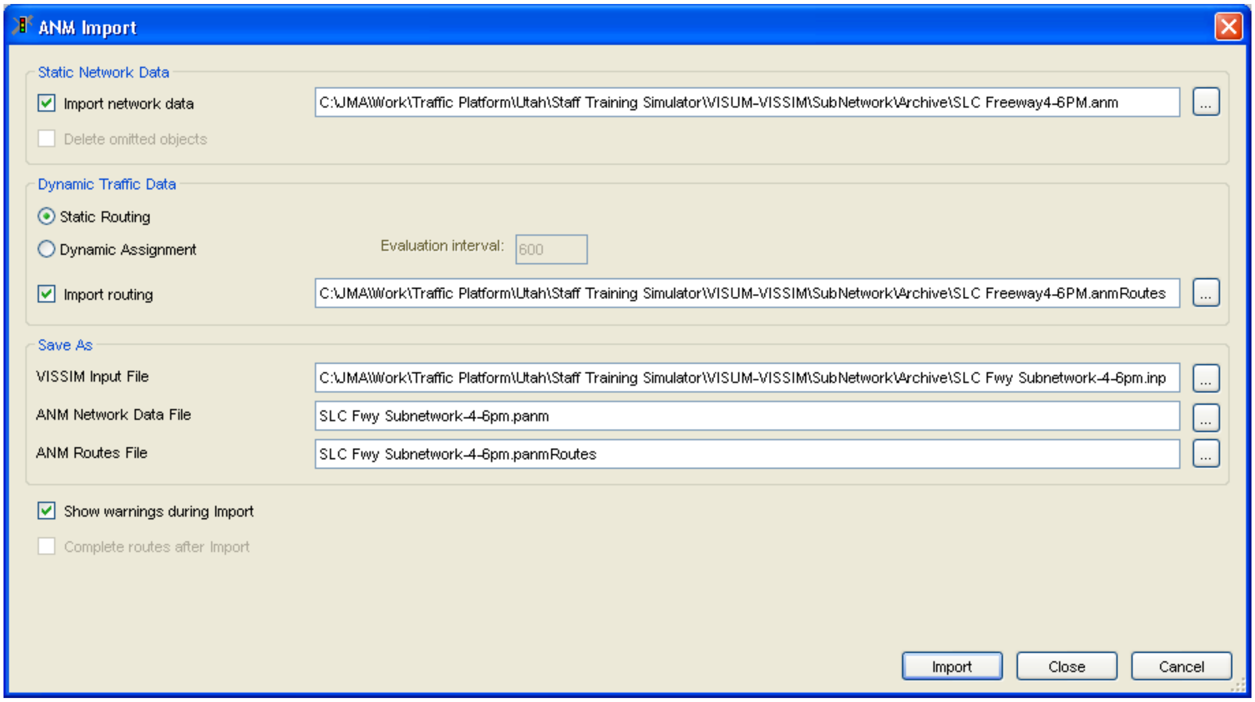


The time interval for the pre-set use case should be 4-6pm:

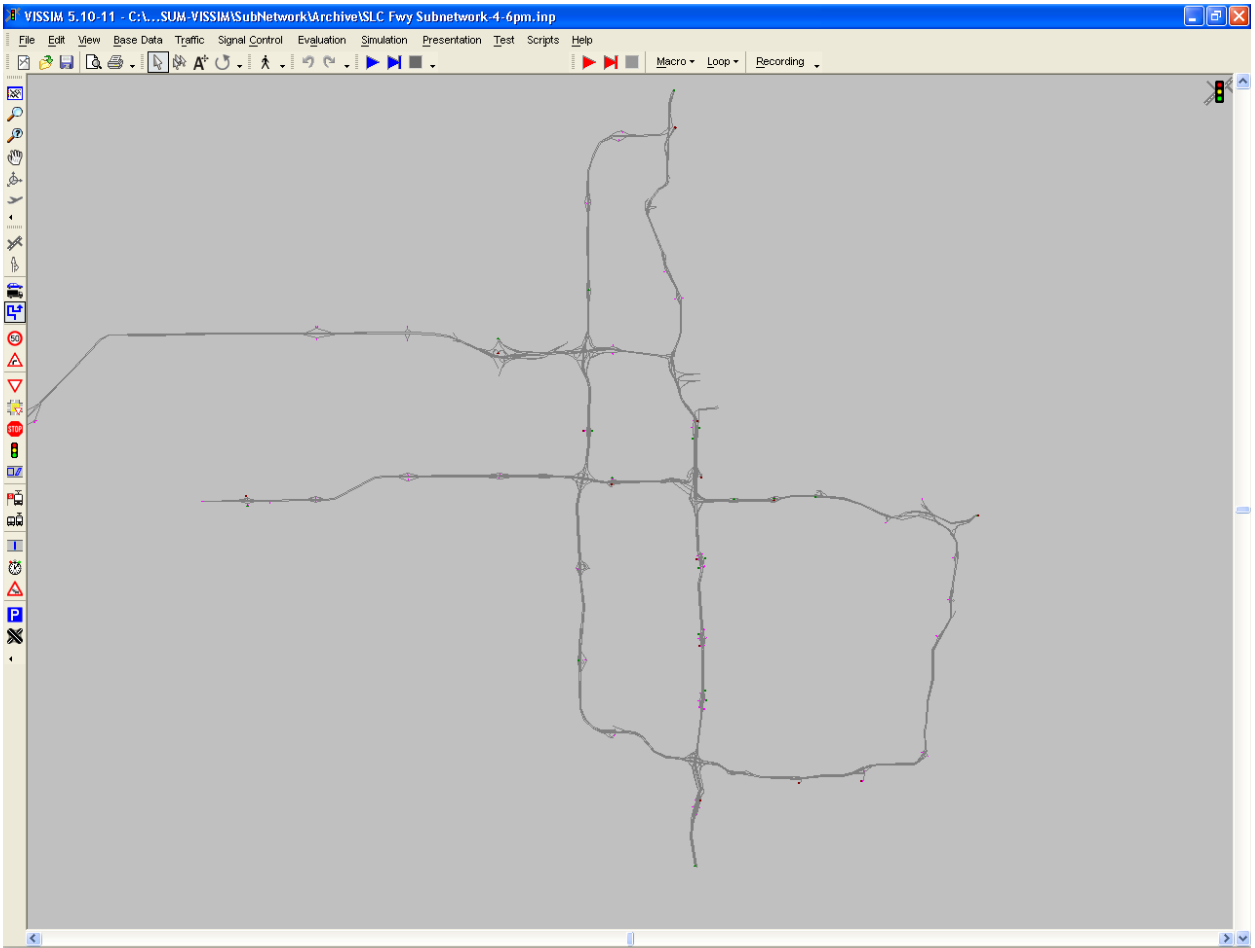


Once all parameters are specified, clicking OK will start the export process. The end results from this process are two xml files that contain the network element definitions as specified (.anm) and the traffic demand and routing information (.anmRoutes). These are the input files for creating the VISSIM model.

The files are now imported into VISSIM. In a blank VISSIM window, the initial ANM import is done from menu File – Import ANM. The ANM import dialog will open.



In the pre-set use case, the option "Static Routing" is chosen in accordance with the partial routing setup for the VMS interactive changes. Once all proper input and output settings are entered, click the "Import" button will begin the process of interpreting the network elements and vehicle routing information and translating into VISSIM model elements. The end result is a VISSIM model that with all necessary components transferred from the VISUM corridor model. The given example is shown in the figure below.



Note that the imported VISSIM model saves the network coding time and provides a good basis for model calibration, but it will need further adjustments at critical locations for more realistic representation of the system as well as the driving behavior parameter fine-tuning. In the case of model updates such as demand adjustments, geometric changes etc., the *ANM adaptive import* can be used to have the more convenient adjustments in the VISUM model and re-export/import.

Incident conditions and traffic management countermeasures

The next step in the incident scenario design is to define the incident conditions and the management countermeasures through VMS information and ramp metering adjustments.

In the pre-set training scenario, only one incident is “scheduled” in the network:

Pre-set I-15 SB incident information

Time of occurance: 4:30PM

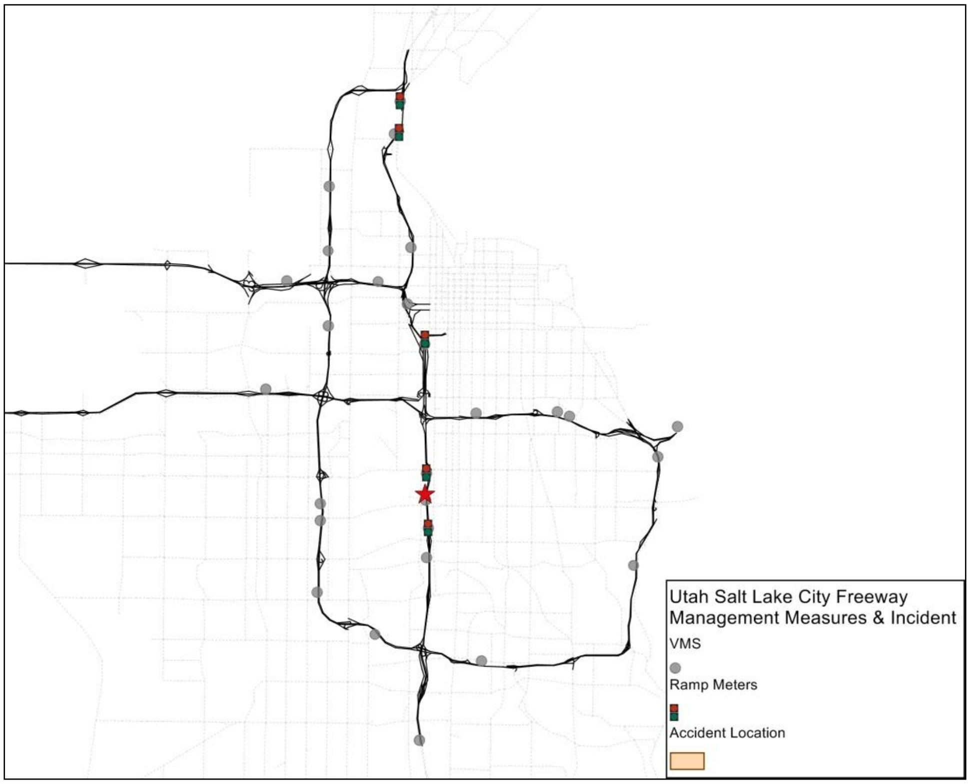
Duration: 45 minutes

Location: I-15 southbound near State Route 171

Severity: major crash accident blocking 4 general purpose lanes

In the VISSIM model, the incident is modeled by a set of time-dependent *speed reduction areas* that become active 30 minutes (1800 seconds) into the simulation (at 4:30 pm). The speed reduction area can be simply defined by setting the speed to zero, completely stopping the traffic on all (or selected) traffic lanes. The duration of the speed reduction can also be defined, simulating the time needed for clearing the incident.

Traffic management countermeasures to mitigate the incident impact are variable message signs and ramp meters. The incident location, available variable message and ramp meters signs (VMS) for the described example are indicated in the following illustration.

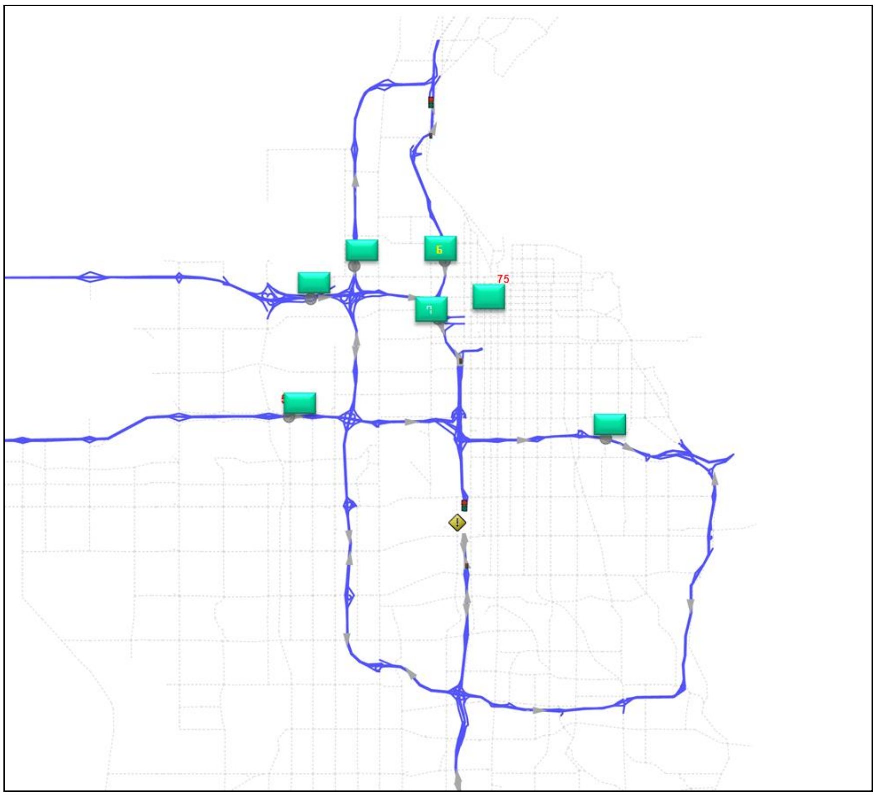


In total 35 VMS signs are identified within the modeled Salt Lake City freeway system, and all of them were verified against Google StreetView. Their locations and settings can be found in the following illustration.

- The “Editable” attribute indicate whether the display text can be changed from the Training Simulator interface, “1” being editable;
- The routing text levels indicate different levels of text (level 1 – incident occurrence only; level 2 – incident occurrence + alternative route; level 3 – incident occurrence + expected delay + alternative route). The level of text is directly related to the Partial routes decision (the percentage of vehicles choosing different alternative routes).

Number	VISUM link ID	link-Fromnode	EDITABLE	NAME	routing1 text	routing2 text (two lines of text)	routing3 text (three lines of text)
6	1051710521	10517	1	I15 SB 400 North	CRASH AT SR 171	CRASH AT SR 171	CRASH AT SR 171
						USE I-215 WEST	EXPECT 30 MIN DELAY
							USE I-215 WEST
7	1006110527	10061	1	I15 SB 600 South	CRASH AT SR 171	CRASH AT SR 171	CRASH AT SR 171
						USE I-215 WEST	EXPECT 25 MIN DELAY
							USE I-215 WEST
8	1055010122	10550	0	I15 SB 4000 South			
9	1012410126	10124	0	I15 SB 5000 South			
10	1056012844	10560	0	I15 SB 8000 South			
15	1164010166	12843	0	I15 NB 8000 South			
16	1012710125	10127	0	I15 NB 5000 South			
17	1012310552	10123	0	I15 NB 4000 South			
18	1285110539	12851	0	I15 NB 1300 South			
26	1067810195	10678	1	I80 EB 3400 West	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171
						USE I-215 WEST	EXPECT 30 MIN DELAY
							USE I-215 WEST
27	1286612867	12866	0	I80 EB 1500 West			
28	1022110677	10221	0	I80 EB 300 East			
29	1067110669	10671	0	I80 EB 2000 East			
35	1067010672	10670	1	I80 WB 1700 East	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171
						USE I-215 WEST	EXPECT 25 MIN DELAY
							USE I-215 WEST
39	1025010589	10250	1	I215 W SB 500 North	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171
						USE I-215 WEST	EXPECT 30 MIN DELAY
							USE I-215 WEST
40	1059210305	10592	0	I215 W SB 1000 South			
41	1027210597	10272	0	I215 W SB 3900 South			
42	1285410598	12854	0	I215 W SB 5400 South			
43	1027610595	10276	0	I215 W NB 4100 South			
44	1030610591	10306	0	I215 W NB 1000 South			
45	1286010247	12860	0	I215 W NB 1700 North			
46	1061610297	10616	0	I215 S EB 400 East			
48	1061010608	10610	0	I215 S WB 1500 West			
49	1031910641	10319	0	I215 E NB 3100 South			
50	1063710635	10637	0	I215 E SB 4800 South			
51	42344245	4234	1	SR201 EB 3600 West	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171
						USE I-215 WEST	EXPECT 30 MIN DELAY
							USE I-215 WEST
52	425810030	4258	0	SR201 EB 1300 West			
75	39593951	3959	1	500 S WB Main St.	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171	I-15 S CRASH AT SR 171
						USE I-215 WEST	EXPECT 25 MIN DELAY
							USE I-215 WEST

The implementation of VMS impact in VISSIM simulation is done through the *Partial Route* feature; however, not all VMS will contribute to the specific incident. The network analysis reveals the following VMS could potentially re-route the traffic heading to the incident location in this example and they are applicable in this training scenario (indicated "editable" in the above list). In the process of designing incident scenarios, the editable VMS have to be defined for each of them.



The following list indicates these VMS and the corresponding *Partial Route* decisions configured in the VISSIM model.

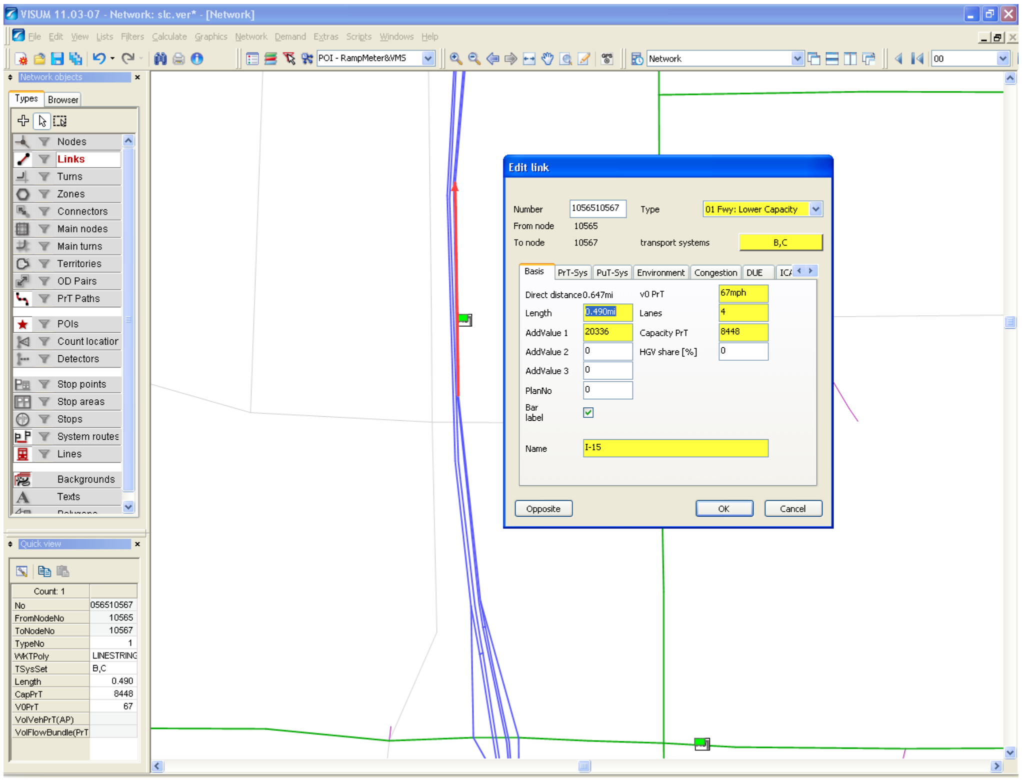
VMS#	Routing Decision #	Route #	Level 0	Level 1	Level 2	Level 3
6	111	1	0	90	75	55
		100	0	7	20	35
		101	0	3	5	10
	112	2	0	90	70	50
		200	0	7	25	40

VMS#	Routing Decision #	Route #	Level 0	Level 1	Level 2	Level 3
		201	0	3	5	10
7	113	1	0	90	75	55
		100	0	10	25	45
	114	2	0	90	75	55
		200	0	10	25	45
35	115	1	0	90	75	55
		100	0	10	25	45
39	116	1	0	85	60	20
		100	0	15	40	80
26	117	1	0	85	60	20
		100	0	15	40	80
	118	2	0	85	60	20
		200	0	15	40	80
51	119	1	0	85	55	25
		100	0	15	45	75
	120	2	0	85	55	25
		200	0	15	45	75
75	121	1	0	90	75	50
		100	0	10	25	50

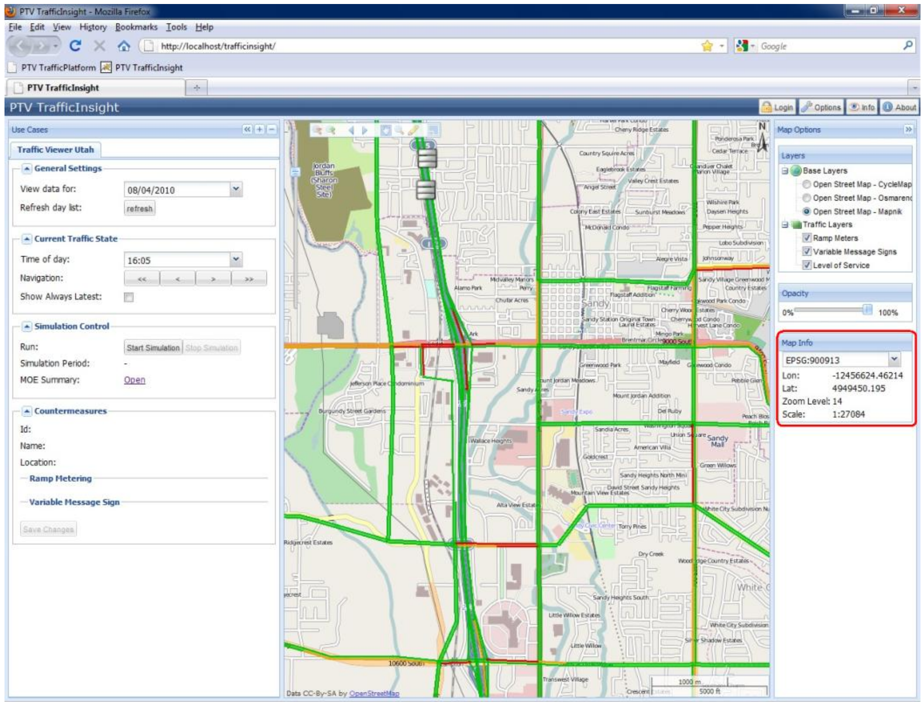
Ramp meter and VMS design in VISSIM

Adding new ramp meters in VISSIM for the Simulator consist of the following procedures:

1. Append the line in the CycleTime.csv following the convention of “ID; initial cycle length” for the ramp meter to be added.
2. Adding a signal controller with a proper ID and associated signal heads at the proper link. It is recommended to observe the number of corresponding point of interest (POI) (category 27, “Ramp Meters”) from the VISUM model of the SLC TrafficPlatform system. Associate the proper parameter files (sc_dll.dll, SignalGUI.dll, CycleTime.csv, SC.wtt).
3. Keep note of the following information for the new signal head(s) for this info will be used to generate the objects on the interface of the Simulator in TrafficInsight:
    a. ID and name of the ramp meter;
    b. VISUM link id and the from node id of the link that the signal heads reside on. This should be read from the VISUM model from the SLC TP system;



c. The latitude and longitude information for the ramp meter from the *Map Info* section in the current TrafficInsight interface on the projection system *EPSG:900913*. This also applies to the VMS locations. For example, the following screenshot shows the location when the mouse is positioned at the place where VMS #14 is located. The lat/long info for this VMS should read as (-12456624.6 4949450.2).



For updating the VMS, partial route decision points for the specific VMS locations should be created.

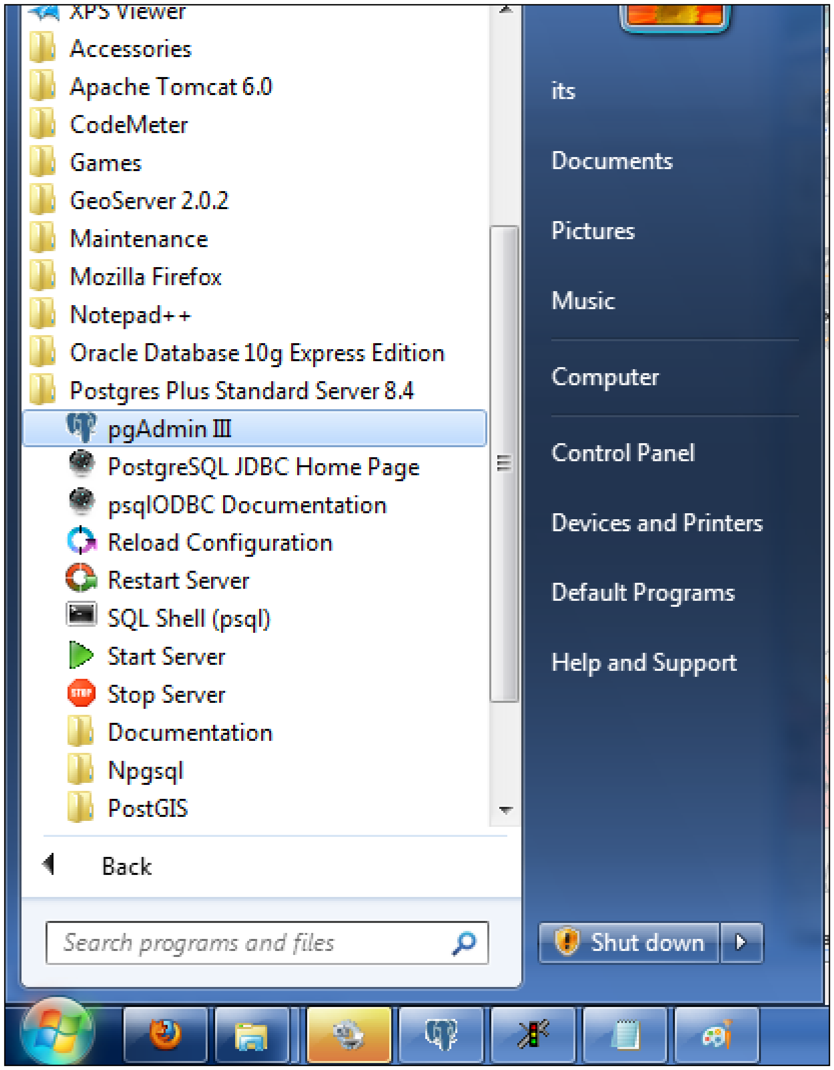
Similar information should be kept for new or updated VMS to update the TrafficInsight database as in the above step 3:

1. VMS ID and name;
2. VISUM link ID and fromNode ID;
3. Lat/long info for the VMS position from TrafficInsight for the EPSG:900913 project system.
4. Editable or non-editable: Editable will indicate that partial routes have been set up for this VMS location, and the display text levels can be adjusted from TrafficInsight interface.
5. Different levels of texts.

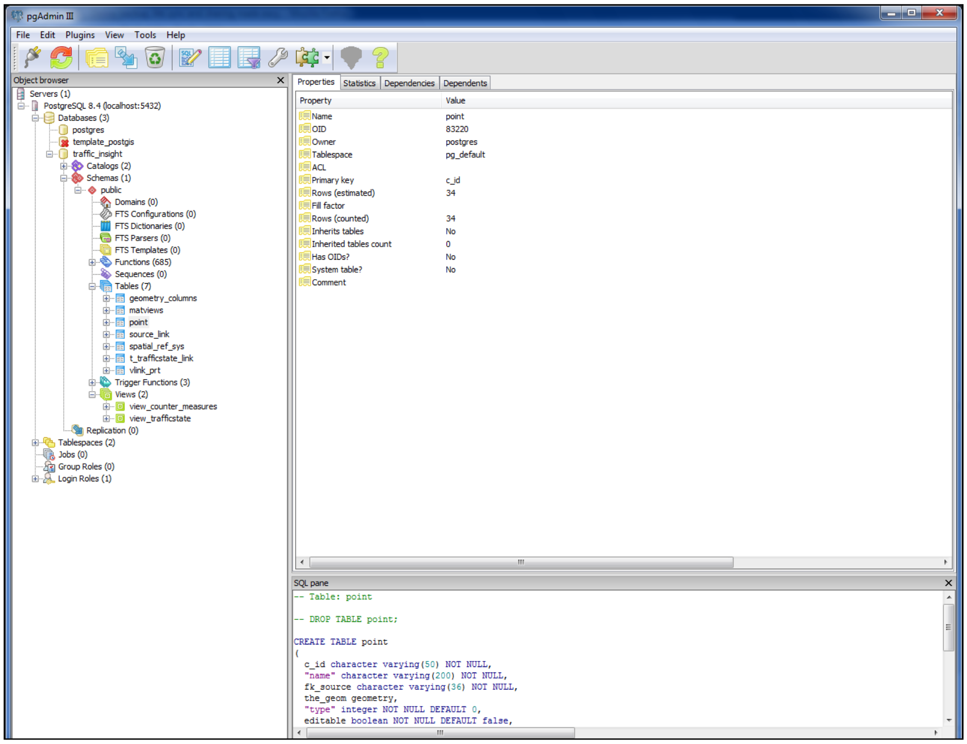
Traffic object redefinition and updates

Updating the traffic object layers (ramp meters, variable message signs) on the TrafficInsight interface is done through operating the database. This is performed from the PostGres database administration tool *pgAdmin III*.

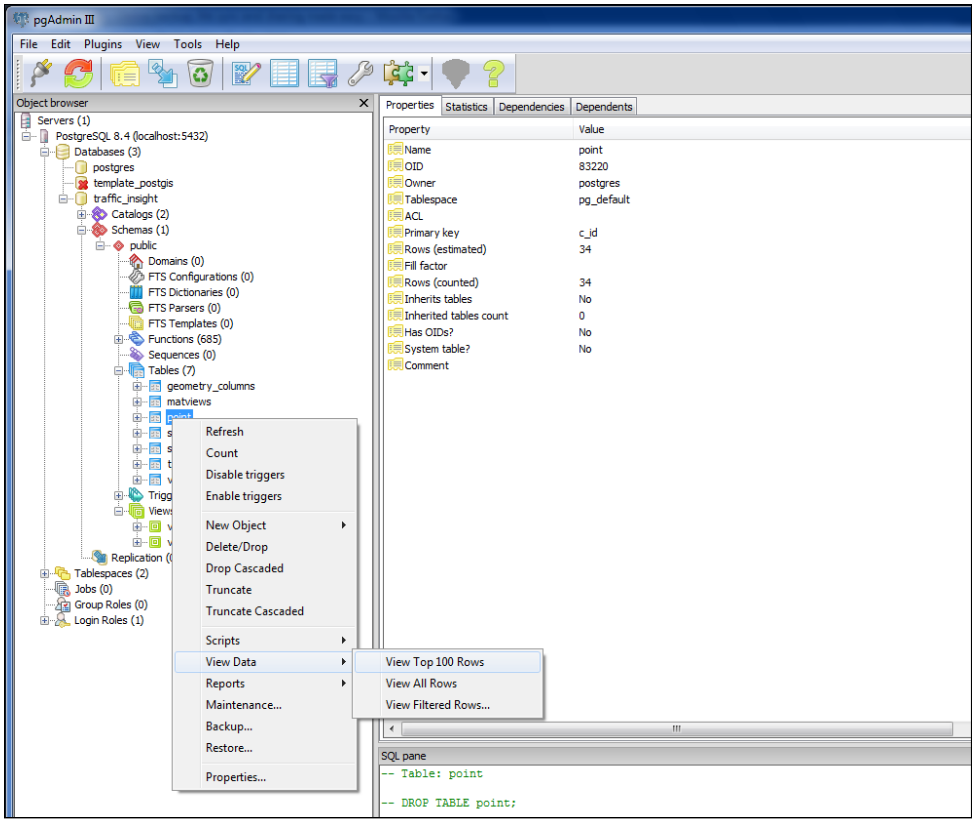
Within the Simulator virtual environment, the pgAdmin III tool is accessed from Windows Start – Postgres Plus Standard Server 8.4 - pgAdmin III.



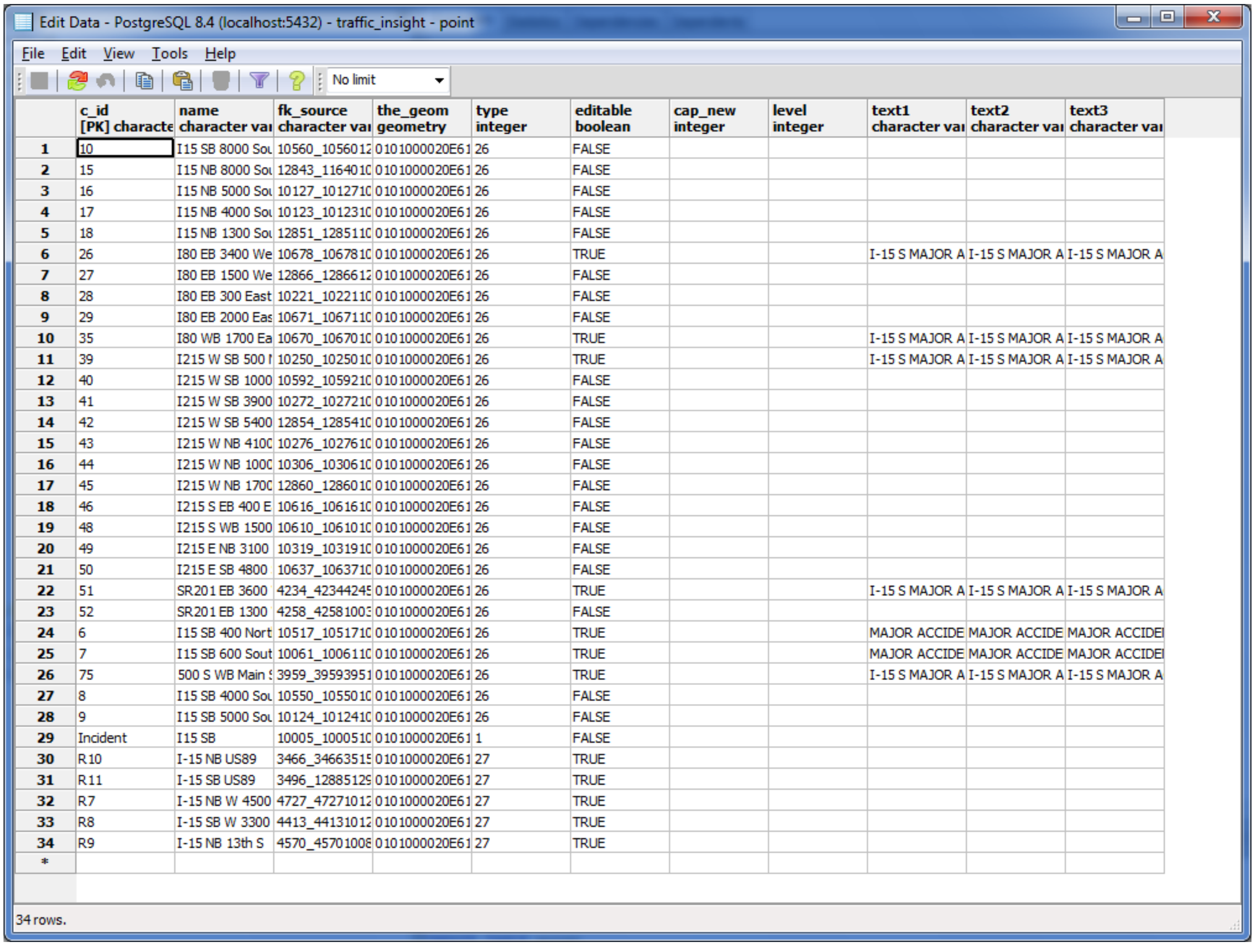
The TrafficInisht database is hosted on the local Server. The database tables are stored at the Traffic_Insight database – Schemas.public. The table that contains the ramp meter and VMS is “point”.



Accessing the data of the table can be done by right click menu from the table “point”:

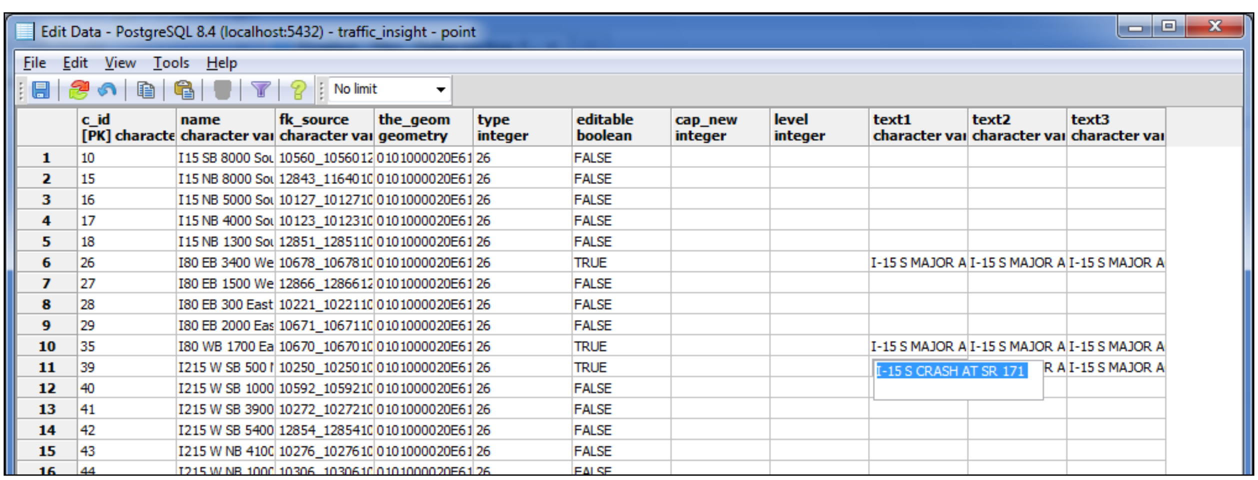


The “Edit data” dialog should open with the data view:



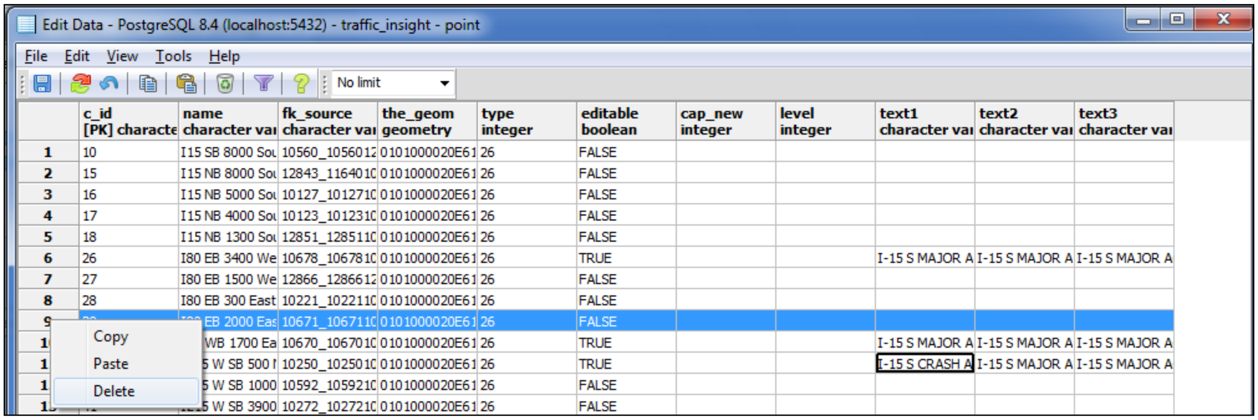
	c_id [PK] characte	name character vai	fk_source character vai	the_geom geometry	type integer	editable boolean	cap_new integer	level integer	text1 character vai	text2 character vai	text3 character vai
1	10	I15 SB 8000 Sou	10560_1056012	0101000020E61	26	FALSE					
2	15	I15 NB 8000 Sou	12843_116401C	0101000020E61	26	FALSE					
3	16	I15 NB 5000 Sou	10127_101271C	0101000020E61	26	FALSE					
4	17	I15 NB 4000 Sou	10123_101231C	0101000020E61	26	FALSE					
5	18	I15 NB 1300 Sou	12851_128511C	0101000020E61	26	FALSE					
6	26	I80 EB 3400 We	10678_106781C	0101000020E61	26	TRUE			I-15 S MAJOR A	I-15 S MAJOR A	I-15 S MAJOR A
7	27	I80 EB 1500 We	12866_1286612	0101000020E61	26	FALSE					
8	28	I80 EB 300 East	10221_102211C	0101000020E61	26	FALSE					
9	29	I80 EB 2000 Eas	10671_106711C	0101000020E61	26	FALSE					
10	35	I80 WB 1700 Ea	10670_106701C	0101000020E61	26	TRUE			I-15 S MAJOR A	I-15 S MAJOR A	I-15 S MAJOR A
11	39	I215 W SB 500 I	10250_102501C	0101000020E61	26	TRUE			I-15 S MAJOR A	I-15 S MAJOR A	I-15 S MAJOR A
12	40	I215 W SB 1000	10592_105921C	0101000020E61	26	FALSE					
13	41	I215 W SB 3900	10272_102721C	0101000020E61	26	FALSE					
14	42	I215 W SB 5400	12854_128541C	0101000020E61	26	FALSE					
15	43	I215 W NB 410C	10276_102761C	0101000020E61	26	FALSE					
16	44	I215 W NB 100C	10306_103061C	0101000020E61	26	FALSE					
17	45	I215 W NB 170C	12860_128601C	0101000020E61	26	FALSE					
18	46	I215 S EB 400 E	10616_106161C	0101000020E61	26	FALSE					
19	48	I215 S WB 1500	10610_106101C	0101000020E61	26	FALSE					
20	49	I215 E NB 3100	10319_103191C	0101000020E61	26	FALSE					
21	50	I215 E SB 4800	10637_106371C	0101000020E61	26	FALSE					
22	51	SR201 EB 3600	4234_42344245	0101000020E61	26	TRUE			I-15 S MAJOR A	I-15 S MAJOR A	I-15 S MAJOR A
23	52	SR201 EB 1300	4258_42581003	0101000020E61	26	FALSE					
24	6	I15 SB 400 Nort	10517_105171C	0101000020E61	26	TRUE			MAJOR ACCIDE	MAJOR ACCIDE	MAJOR ACCIDEI
25	7	I15 SB 600 Sout	10061_100611C	0101000020E61	26	TRUE			MAJOR ACCIDE	MAJOR ACCIDE	MAJOR ACCIDEI
26	75	500 S WB Main S	3959_39593951	0101000020E61	26	TRUE			I-15 S MAJOR A	I-15 S MAJOR A	I-15 S MAJOR A
27	8	I15 SB 4000 Sou	10550_105501C	0101000020E61	26	FALSE					
28	9	I15 SB 5000 Sou	10124_101241C	0101000020E61	26	FALSE					
29	Incident	I15 SB	10005_100051C	0101000020E61	1	FALSE					
30	R10	I-15 NB US89	3466_34663515	0101000020E61	27	TRUE					
31	R11	I-15 SB US89	3496_12885129	0101000020E61	27	TRUE					
32	R7	I-15 NB W 4500	4727_47271012	0101000020E61	27	TRUE					
33	R8	I-15 SB W 3300	4413_44131012	0101000020E61	27	TRUE					
34	R9	I-15 NB 13th S	4570_45701008	0101000020E61	27	TRUE					
*											

Updating the data for specific traffic object, either ramp meter or variable message signs, can be directly done from this data view for the target field. For example, the text at different levels of VMS display can be edited directly by double clicking the corresponding field at the corresponding VMS locations.



	c_id [PK] characte	name character vai	fk_source character vai	the_geom geometry	type integer	editable boolean	cap_new integer	level integer	text1 character vai	text2 character vai	text3 character vai
1	10	I15 SB 8000 Sou	10560_1056012	0101000020E61	26	FALSE					
2	15	I15 NB 8000 Sou	12843_116401C	0101000020E61	26	FALSE					
3	16	I15 NB 5000 Sou	10127_101271C	0101000020E61	26	FALSE					
4	17	I15 NB 4000 Sou	10123_101231C	0101000020E61	26	FALSE					
5	18	I15 NB 1300 Sou	12851_128511C	0101000020E61	26	FALSE					
6	26	I80 EB 3400 We	10678_106781C	0101000020E61	26	TRUE			I-15 S MAJOR A	I-15 S MAJOR A	I-15 S MAJOR A
7	27	I80 EB 1500 We	12866_1286612	0101000020E61	26	FALSE					
8	28	I80 EB 300 East	10221_102211C	0101000020E61	26	FALSE					
9	29	I80 EB 2000 Eas	10671_106711C	0101000020E61	26	FALSE					
10	35	I80 WB 1700 Ea	10670_106701C	0101000020E61	26	TRUE			I-15 S MAJOR A	I-15 S MAJOR A	I-15 S MAJOR A
11	39	I215 W SB 500 I	10250_102501C	0101000020E61	26	TRUE			I-15 S CRASH AT SR 171	R A	I-15 S MAJOR A
12	40	I215 W SB 1000	10592_105921C	0101000020E61	26	FALSE					
13	41	I215 W SB 3900	10272_102721C	0101000020E61	26	FALSE					
14	42	I215 W SB 5400	12854_128541C	0101000020E61	26	FALSE					
15	43	I215 W NB 410C	10276_102761C	0101000020E61	26	FALSE					
16	44	I215 W NB 100C	10306_103061C	0101000020E61	26	FALSE					

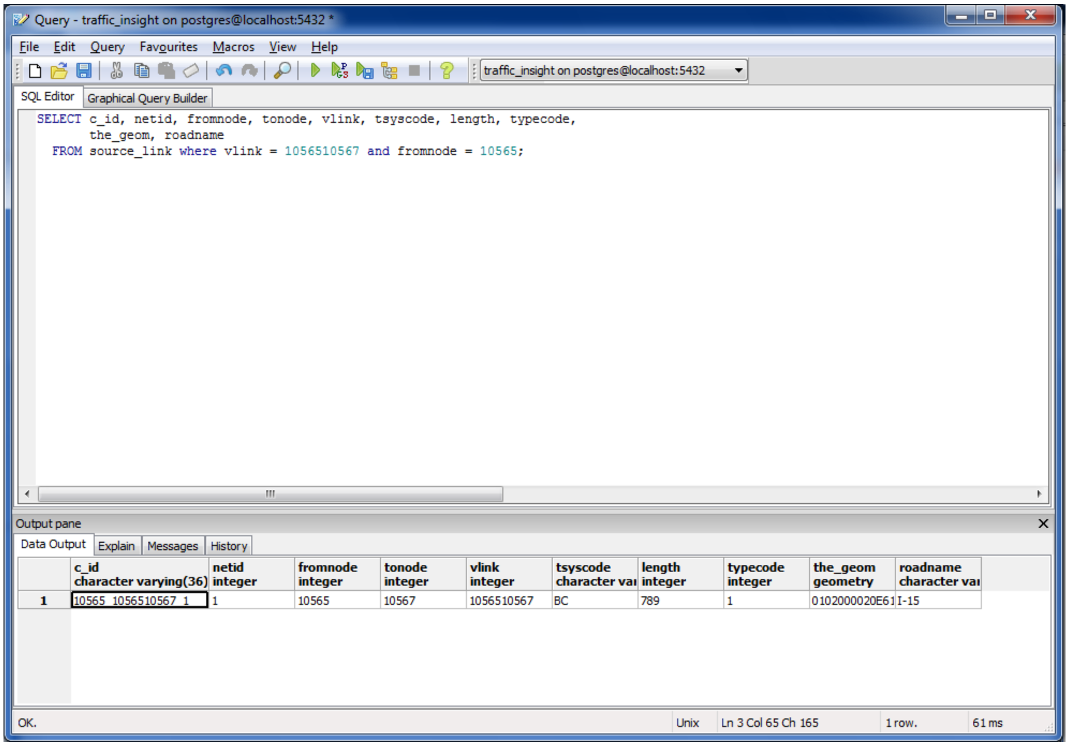
Deleting a certain record, either ramp meter or variable message sign, can also be done from the data view. By right clicking the record number, the pop-up menu will indicate the actions that can be taken for this record including *delete*:



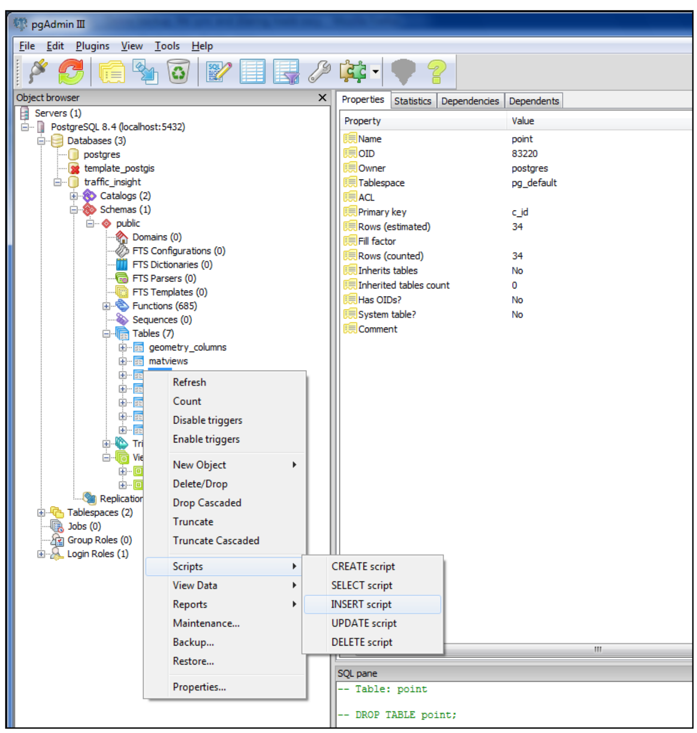
Adding a certain record, either a ramp meter or a variable message sign, is done through a SQL script. For example, the following VMS sign needs to be added to the Simulator interface for visualization:

VMS ID: 14
VMS Name: I15 NB 10200 South
Associated VISUM Link: Id: 1056510567, fromnode number: 10565
Lat/long read from TrafficInsight for its position: (-12456624.5 4949450.2)
Editable: 0

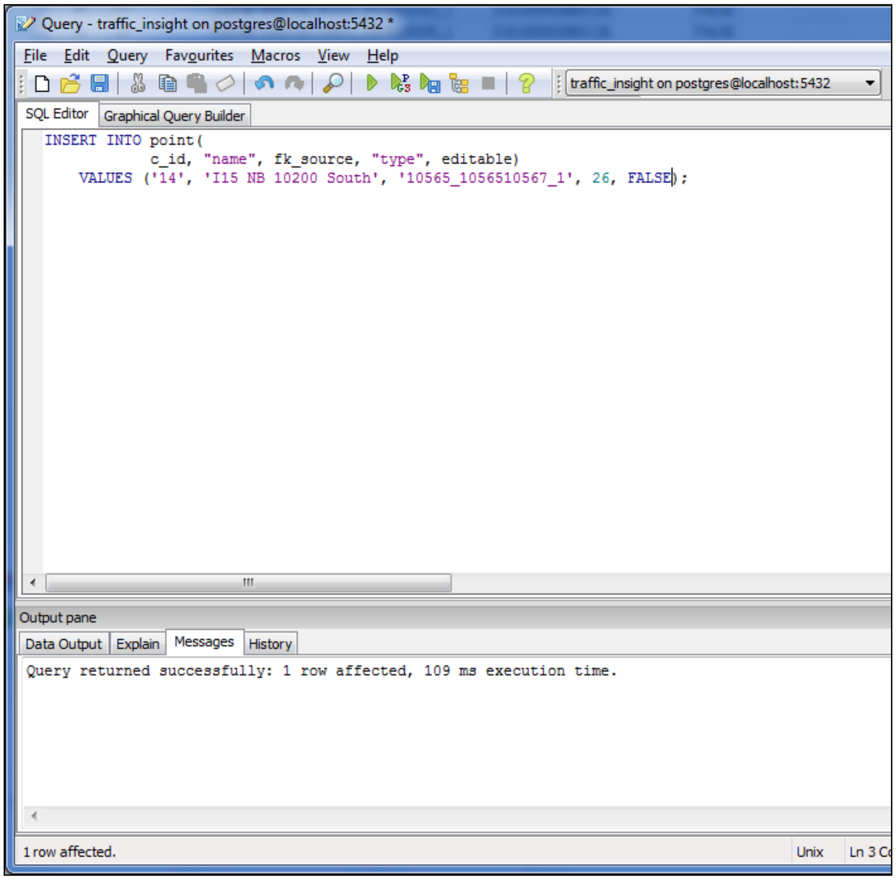
From the table "Source_link" right click menu, select the Script-select. This is to find the foreign key for the link that the VMS resides in:



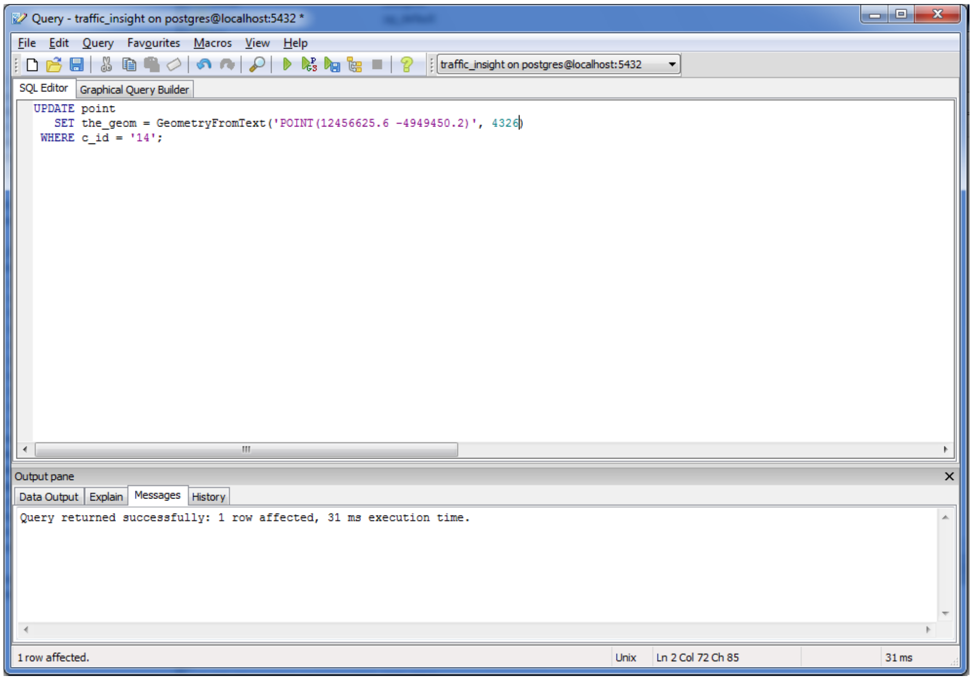
Keep note of the c_id field for the select SQL statement: 10565_1056510567_1. Now Insert the VMS record with the right menu from table "point":



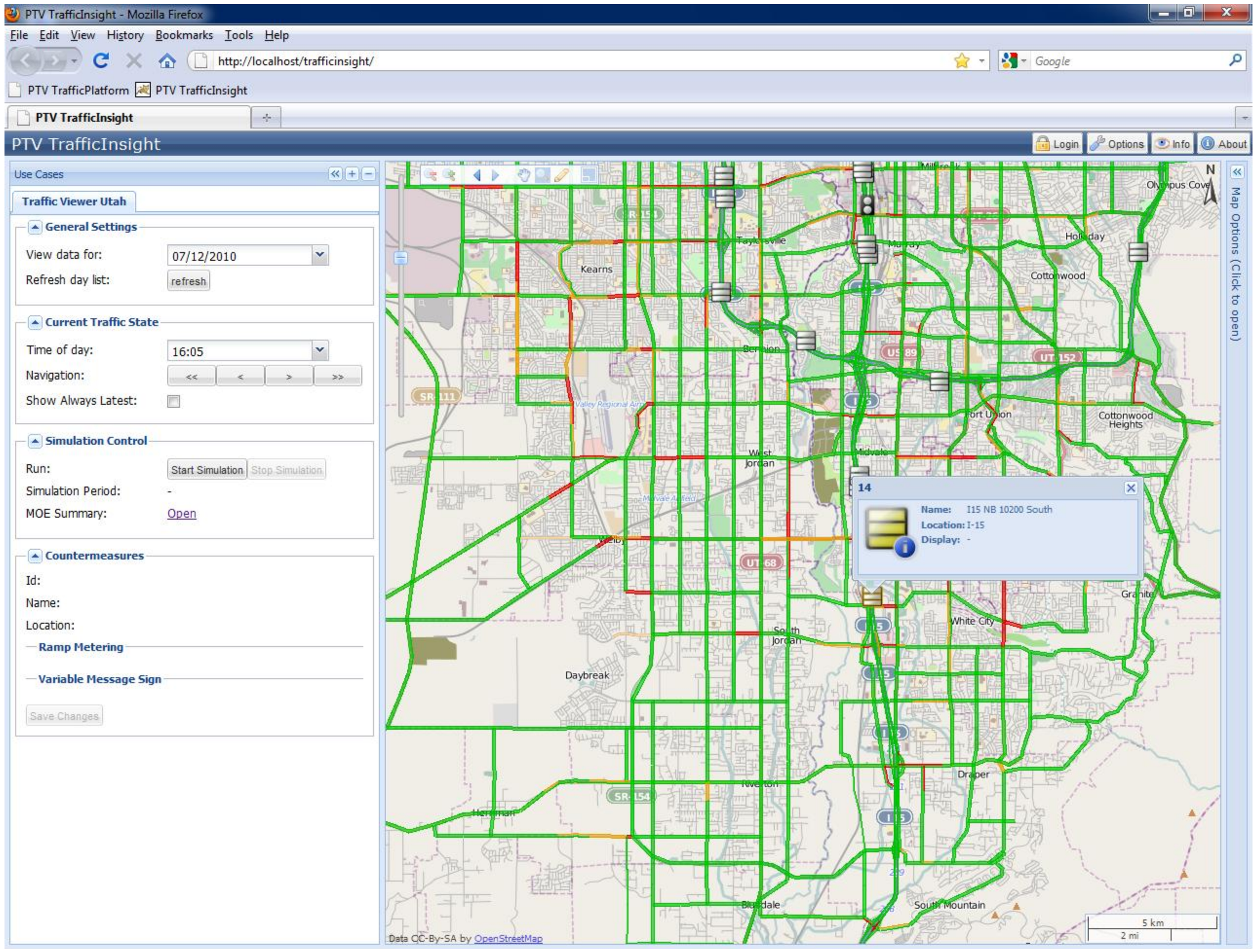
From the pop-up Query window, replace the corresponding fields with the following:



The last step is to append the *the_geom* field for adding the location information for the newly added VMS: This is done by an update SQL script:



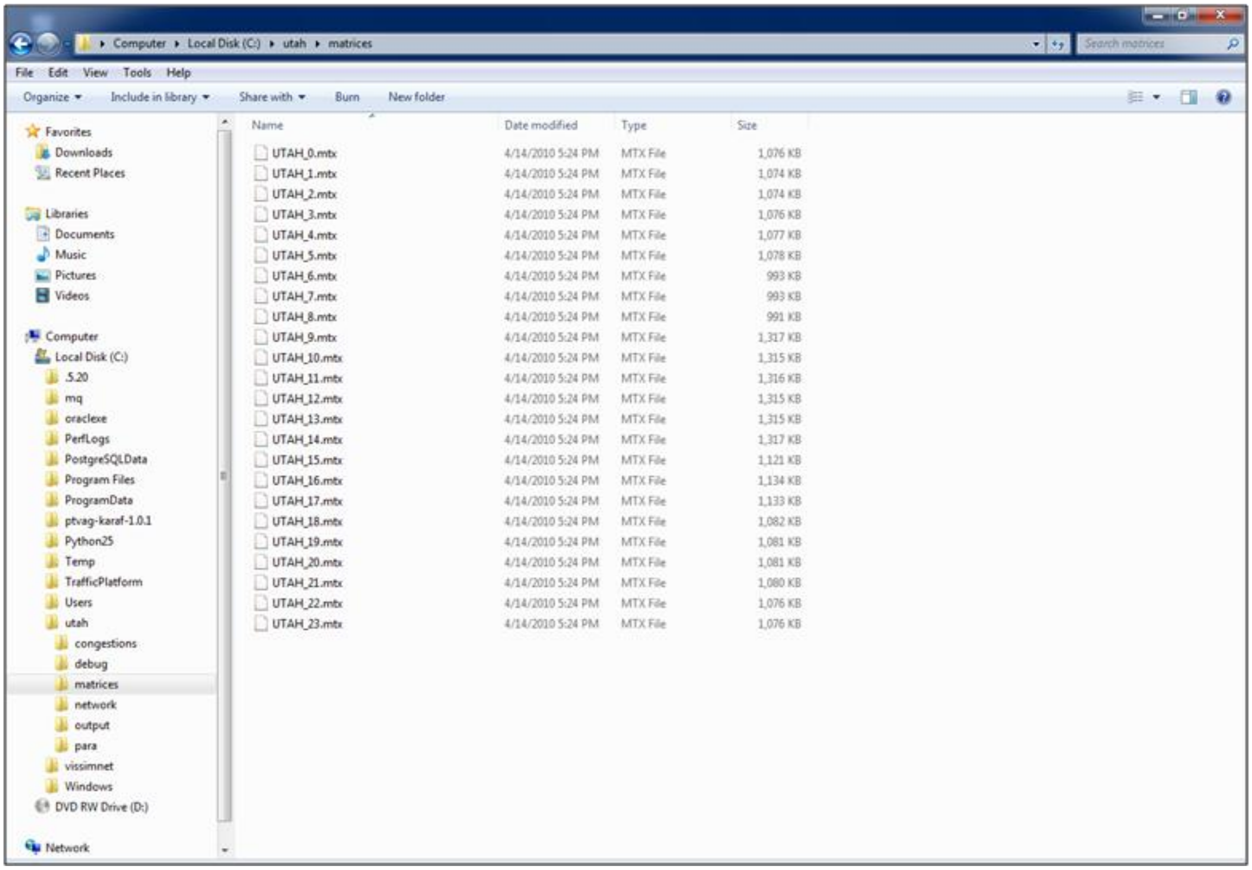
Now re-open TrafficInsight, the newly added VMS #14 appears on the interface:



Note that for ramp meters, the *c_id* should start with "R" to differentiate with VMS, for example, if a ramp meter is numbered 20, the *c_id* field should be "R20".

Customization Scenario I: Overall SLC VISUM Model Update and TP Reconfiguration - Traffic Pattern Update

The SLC-TP system is based on a calibrated typical day traffic operations in the SLC metropolitan area. This is reflected by the hourly origin-destination matrices stored in the database of the Simulator. The next figure shows how to access the matrices.



When the training session begins, for example in the case of the pre-set scenario, SLC TrafficPlatform will load the matrices for 4PM (UTAH_16.mtx) and then perform the estimation of the traffic states for the entire network. At this time, the TrafficPlatform uses the "online" traffic input from the VISSIM simulation. If the on-line detector data is available, the TrafficPlatform can be reconfigured to use these data instead of the VISSIM simulation. The process of the traffic state estimation cycles every 5 minutes (300 seconds) as configured in the VISSIM *Data Collection* output file, until the simulation time elapses to the next hour when TrafficPlatform will load the new matrices and continue.

A complete upgrade of the SLC_TP starts with the traffic demand update. The general process of updating the SLC TrafficPlatform can then be as follows:

1. Take the Salt Lake City VISUM model in the TrafficPlatform (c:\utah\network\slc.ver), and perform the demand estimation for the demand pattern scenarios based on this version;

2. Rename the estimated matrices to the corresponding hour as shown above, for example, the dated
3. Perform VISSIM model update if necessary.

Customization Scenario II: VISSIM Model Updating

Updating the VISSSIM model for customizing a different training scenario can have the two following options:

1. Updating the existing SLC freeway VISSIM model in the pre-set scenario with different incidents, different demand patterns or different traffic management countermeasures;
2. Creating a VISSIM model covering different areas of Salt Lake City and replacing the existing VISSIM model in the pre-set scenario.

Option 2 is one step above the first option; herein option 1 is introduced first and the extra step to be taken in option 2 will be described next.

VISSIM model update for the Staff Training Simulator needs to maintain the reference with the SLC TrafficPlatform system. This reference is ensured by matching the transportation system elements with the VISUM model underlying the SLC TrafficPlatform. Matching the elements will at minimum include the following:

- Traffic data collection and feeding: vehicle detection stations in the real world vs. data collection points in VISSIM and CountLocations in VISUM;
- Traffic control measure definitions: ramp meters, variable message signs in the real world vs. signal controllers and partial route settings in VISSIM and corresponding changes in TrafficInsight database;
- Traffic incident definitions: incident info from the design vs. VISSIM settings, message importer to TrafficPlatform and display settings in TrafficInsight.

VISSIM basic updates: network, driving behavior, traffic demand and vehicle routing

One of the primary tasks VISSIM simulation performs in the Simulator is to provide the traffic data as collected by the real world traffic detection devices such as loop detectors. For this version of the Simulator, the virtual on line data feeds from VISSIM to TrafficPlatform are only the traffic data from input from the updated VISSIM model to the TrafficPlatform will be the correct mapping of vehicle detection between VISSIM and TrafficPlatform.

The requirements for numbering the data collection points are:

- Group the data collection points at the same cross section into *measurement points*. This is done through the Data collection configuration from VISSIM (Evaluation – Files…).
- Make sure the *measurement point* number is matching the corresponding *CountLocation* number in the VISUM model from the TrafficPlatform system.

The next step is to configure the *data collection* parameters for traffic data reporting. The parameters are as follows:

Collection time: from start (0 second) to end of simulation (or put 999999)

Collection interval: 300 seconds

Output: compiled data

The data collection configuration should be for *all vehicle types*, and the configuration file (.qmk) file should look like:

```
VEHCOUNT;SUM;0
SPEED;MEAN;0
OCC;SUM;0
```

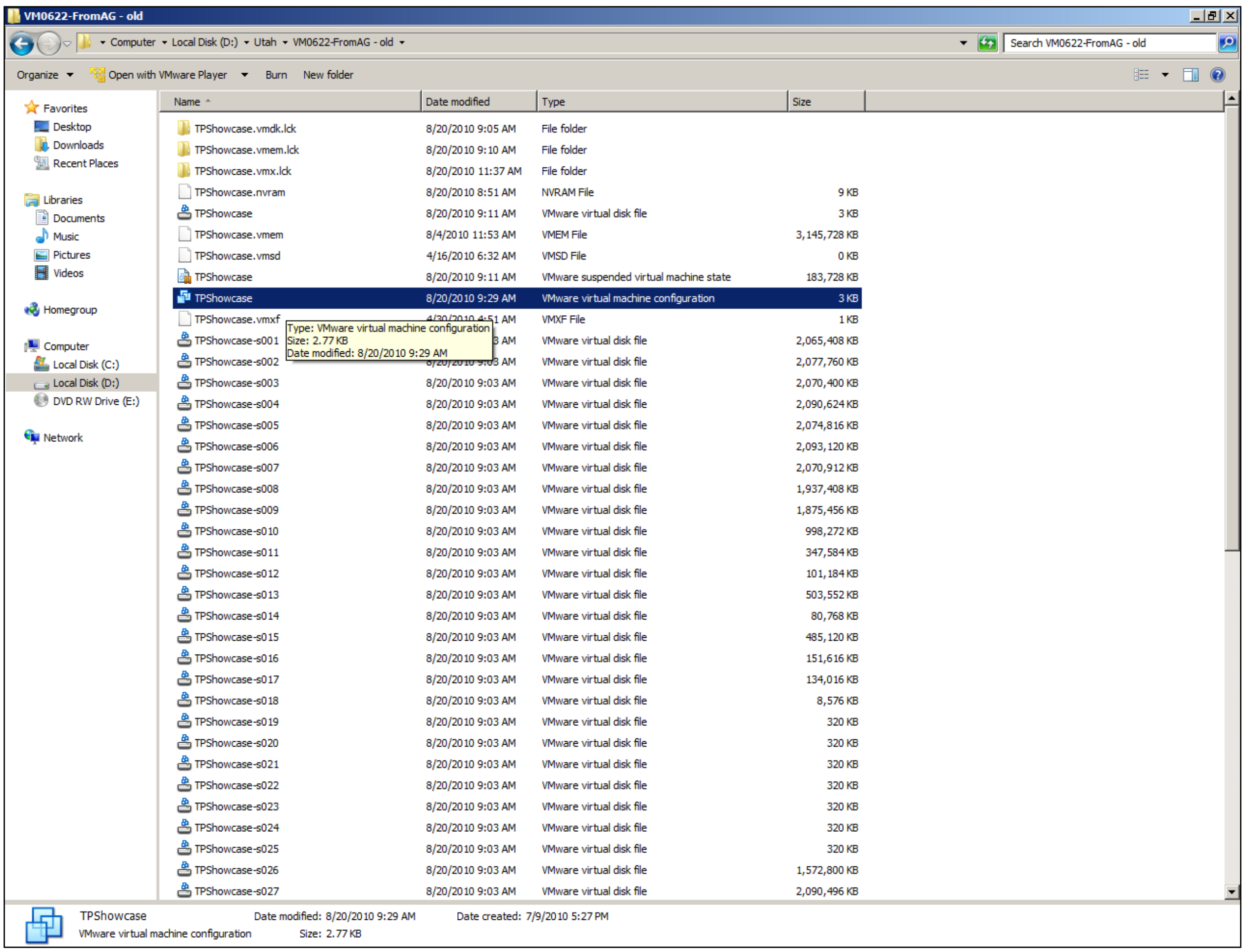
The Abstract Network Model (ANM) export/import between VISUM and VISSIM is considered the easiest way to build or update the VISSIM model from the existing VISUM model in the current SLC-TP.

Deleting one *measurement point* group can simply be done from the *data collection* configuration. Adding new vehicle detection stations will have to go through the underlying VISUM model and consequent database update for SLC TrafficPlatform.

Handling the Simulator

Start and close of the Staff Training Simulator virtual machine

The Training Simulator resides completely in a virtual machine (VM) that is independent of the operating system of the host server computer. The portal program to boot the Simulator VM is with the extension .vmx.

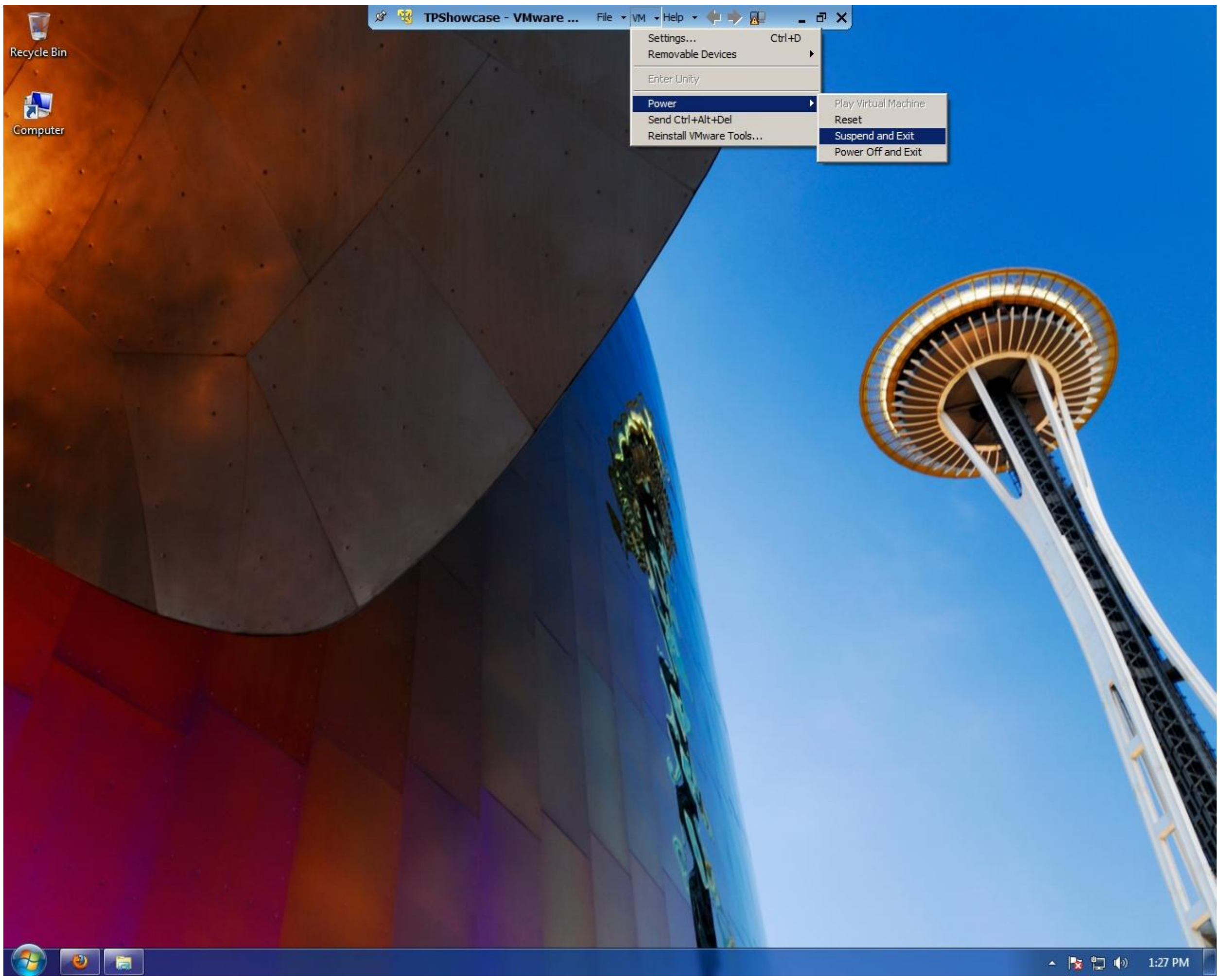


Double click the .vmx will start the virtual machine where the Simulator dwells.

The Simulator VM uses the Windows 7 operating system. At the start of the virtual machine, it could notify that the PTV Vision CodeMeter dongle is available.

Click OK and accept the settings. It is advised not to check the "Do not show this hint again" option just to ensure that the CodeMeter dongle is plugged each time the Simulator starts.

When the training session is over, closing the virtual machine is done through the VMWare control panel at the top of the Windows Desktop.



Two options are available for the Training Simulator: "Suspend and Exit" and "Power off and Exit". The first option of "Suspend and Exit" provides a quicker recovery of the current virtual machine status by suspending the virtual machine operations. The later will shut down the Windows 7 OS completely and thus needs more time to reboot.

Start of Staff Training Simulator

The Staff Training Simulator interface is web-based, and the virtual machine of the Simulator has been configured to start the Simulator automatically once the default web browser Firefox is started. Simply open the Firefox browser, the Simulator start page "PTV TrafficInsight" will be loaded automatically.

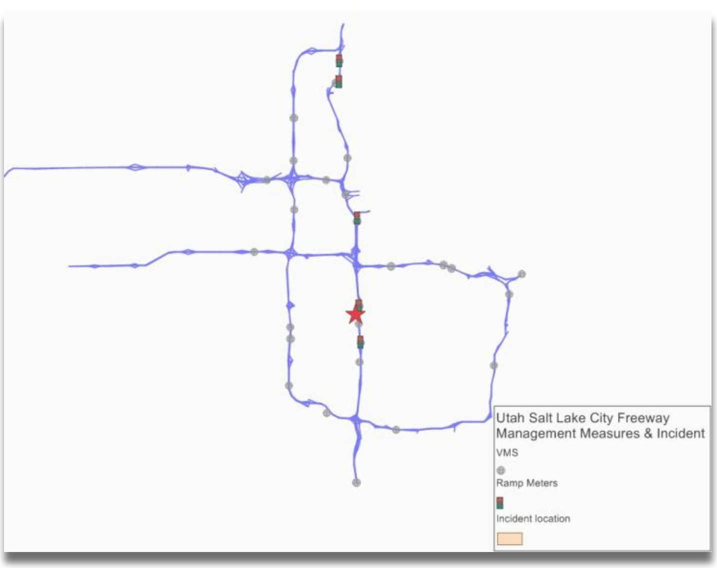
Pre-set Training Session in the Simulator

Training Session Design – what to expect

The pre-set training session is designed to be a freeway incident management scenario. The training session assumes the typical PM peak traffic for the hour of 4-6pm. The incident information is as follows:

- Number of incidents: 1
- Start time of the incident: 4:30pm
- Duration: 45 minutes
- Location: SB I-15 near SR 171
- Severity: major crash blocks 4 general purpose lanes

To handle this incident, the ramp meters and variable message signs will be used to manage the traffic approaching this location.



The following ramp meters and VMS have been configured to be active for this incident.

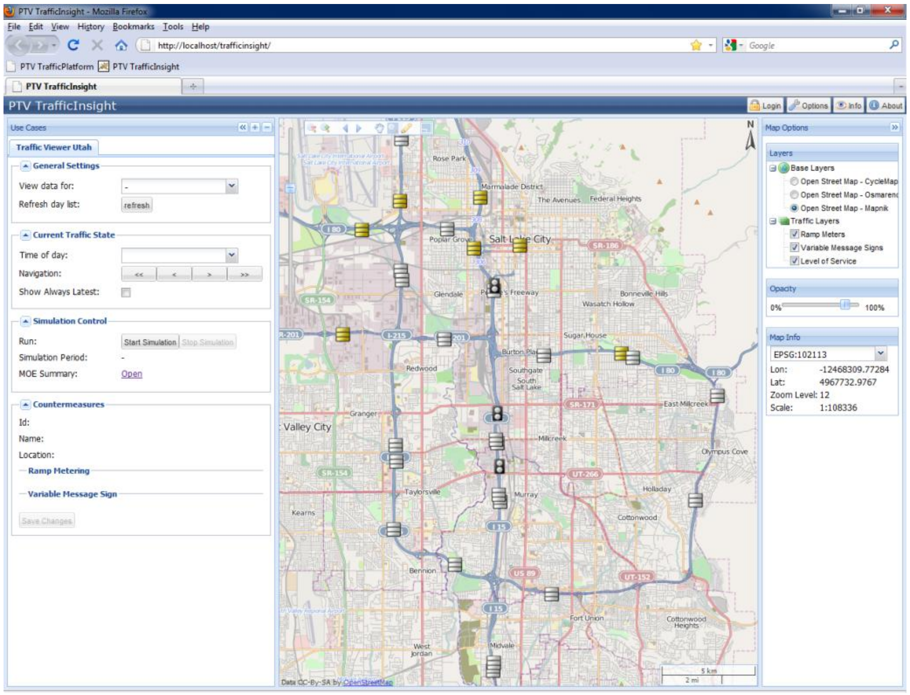
Countermeasure Type	ID	Name
Ramp meter	7	I-15 NB W 4500 S
Ramp meter	8	I-15 SB W 3300 S
Ramp meter	9	I-15 NB 13th S
Ramp meter	10	I-15 NB US89
Ramp meter	11	I-15 SB US89
VMS	6	I15 SB 400 North
VMS	7	I15 SB 600 South
VMS	26	I80 EB 3400 West
VMS	35	I80 WB 1700 East
VMS	39	I215 W SB 500 North
VMS	51	SR201 EB 3600 West
VMS	75	500 S WB Main St.

For ramp meter, the metering rates can be changed to directly affect the ramp links and the local streets. For VMS signs, different levels of texts can be selected, and various levels of display texts will have different impact on the traffic that passes the VMS location.

Demonstration of a Typical Training Session

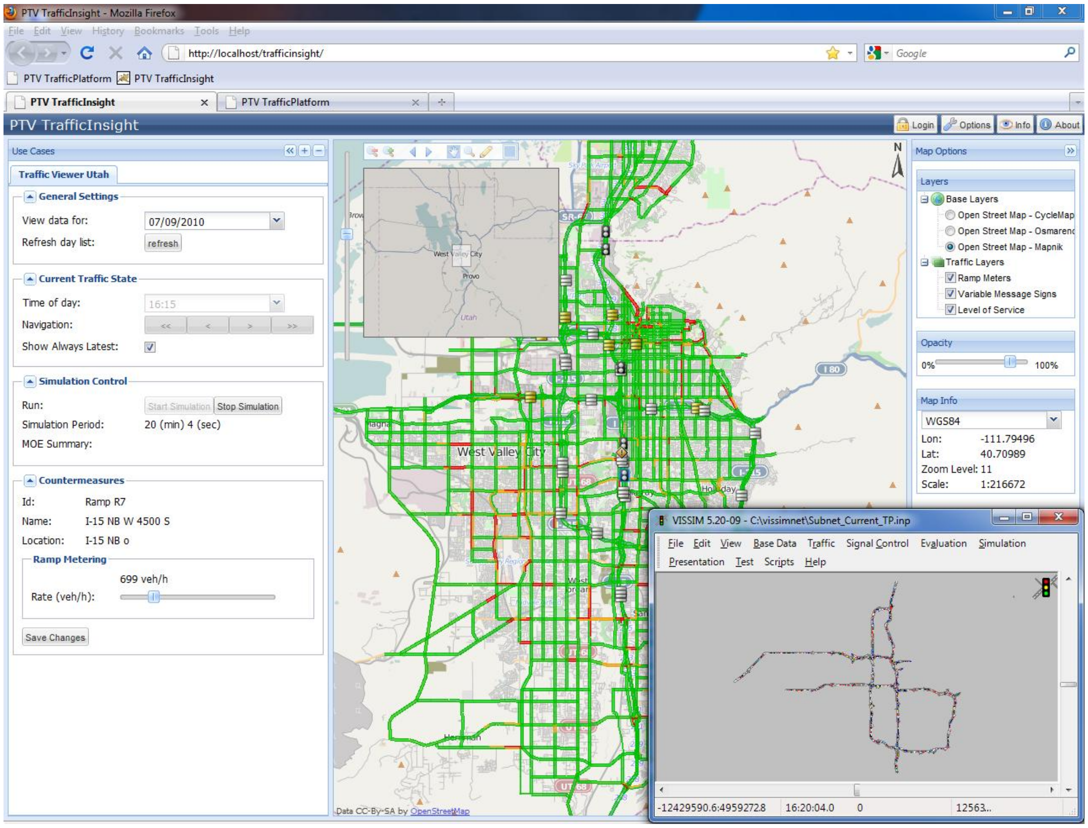
Start the training session

After the TrafficInsight webpage is open and all "TrafficViewer" control panel sections are ready, click the "StartSimulation" will start the training session. The Salt Lake City freeway VISSIM model will open and the simulation will start automatically. The Simulation period will indicate the progress of the training session.



Monitor the traffic operations

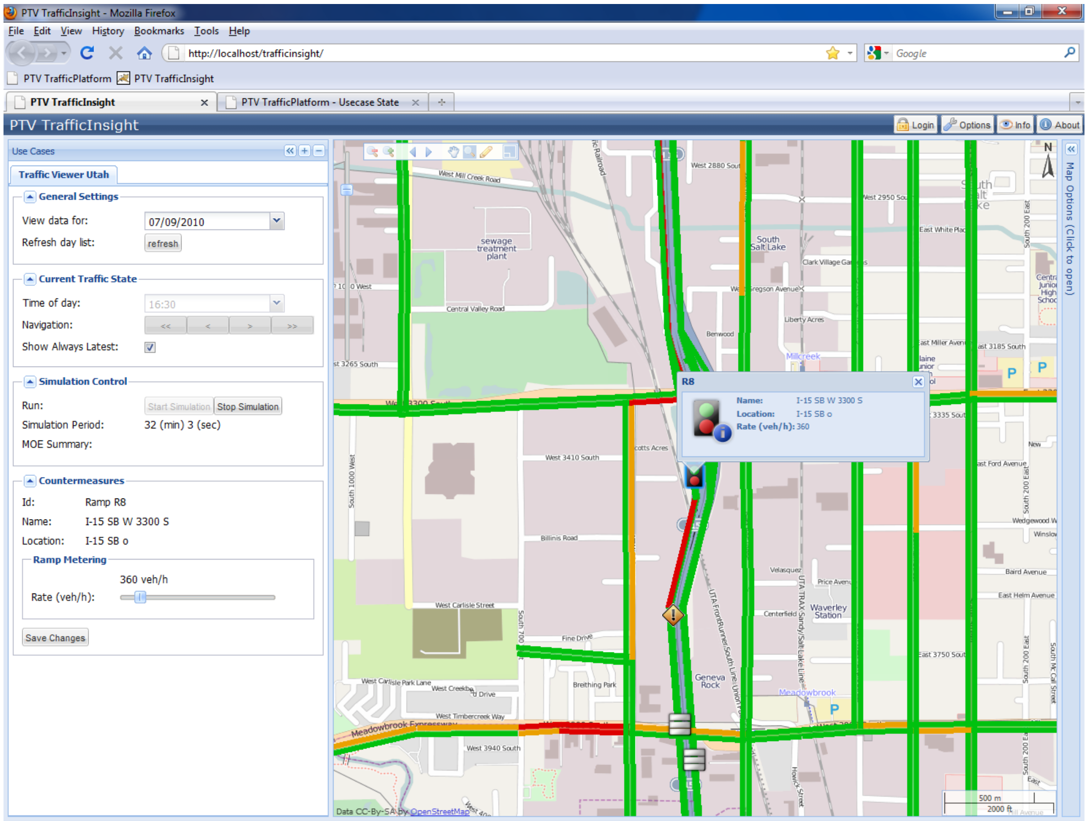
The detector data from the VISSIM simulation is constantly fed into the TrafficPlatform. While the session progresses, the traffic states are constantly estimated at 5-minute increments, and the available intervals for view can be accessed from the “Current Traffic State” navigation tools. Note that the traffic states of the first 5-minute (16:00-16:05) will take about 9 minutes to be calculated and loaded correctly.



Incident occurrence and traffic management countermeasures

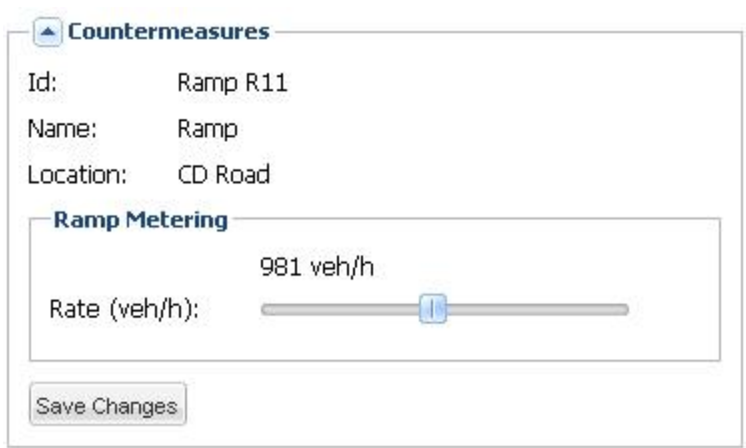
The incident will occur at the designated place at 30 minutes into the session. The VISSIM simulation models this event by blocking four lanes through the *Speed Reduction Areas* for the next 45 minutes.

The trainee is expected to identify the available countermeasures and try to mitigate the impact by changing the control parameters.



Select the identified countermeasure by left clicking the object, and the corresponding information will display at the *Countermeasure* section.

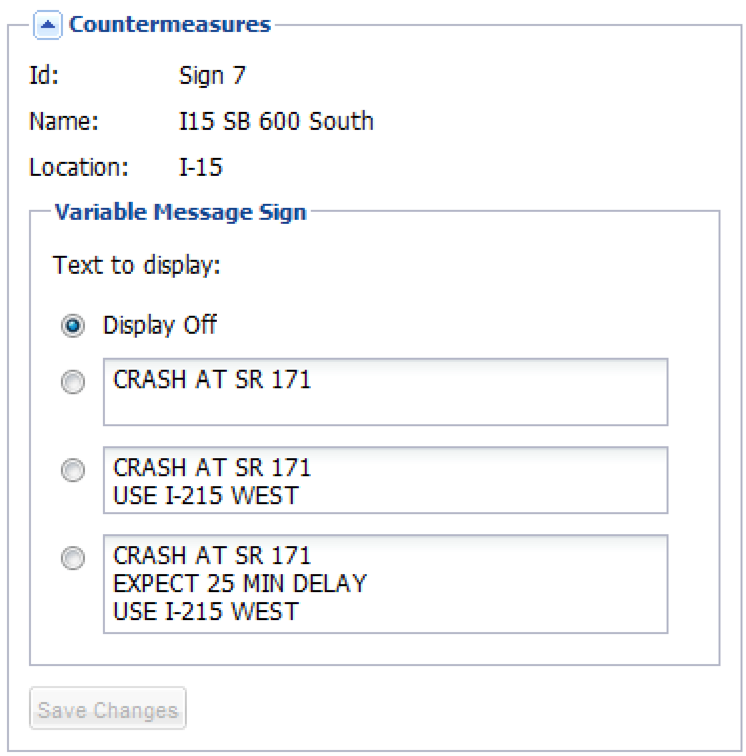
For the ramp meter, change the ramp flow rate by moving the slider, and then hit "Save Changes". The updated ramp metering rate will be put to the VISSIM simulation model for continuous feeding of the updated network condition. Note that the ramp meter flow rate is in vehicles/hour/lane.



The display of the icons is distinguished as follows:

	Meter Off
	Meter Off + Hovered
	Meter Off + Selected
	Changed Rate
	Changed Rate + Hovered
	Changed Rate + Selected

For the variable message signs, select the object, and the available levels of texts will be displayed. The text is predefined in the TP database, but can also be amended through this interface. Choose one level, and hit "Save changes".



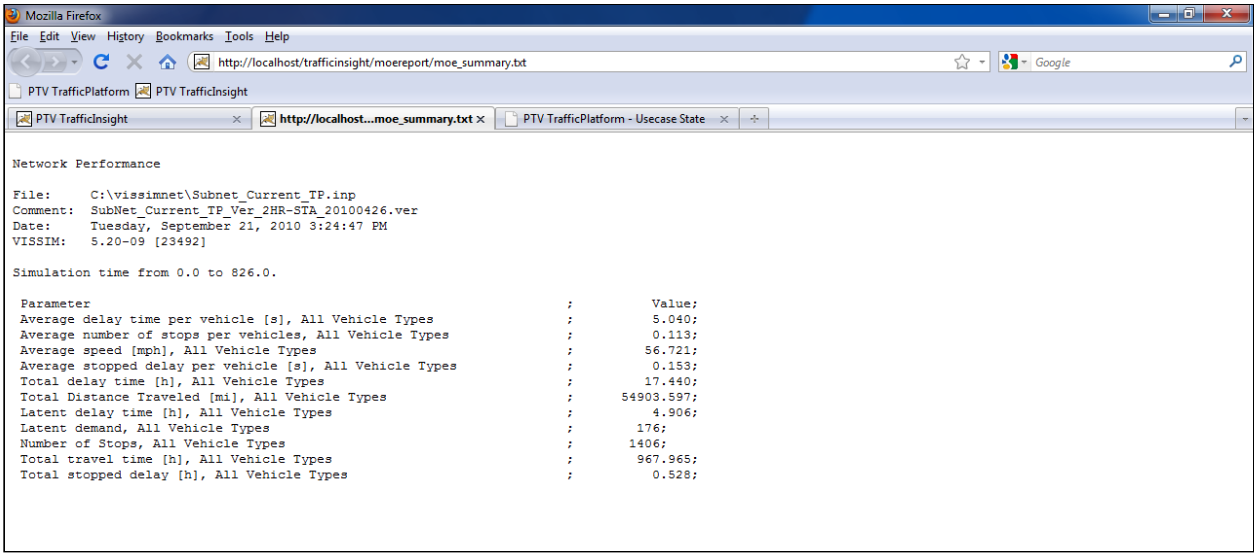
The traffic in the VISSIM model will be rerouted through the pre-defined Partial routing decisions. The updated traffic patterns will be monitored in VISISM through *Data Collection*, and fed back to the traffic state estimator for monitoring and successive decision changes.

The icon display of the variable message signs is distinguished as follows.

	Not Editable
	Not Editable + Hovered
	Not Editable + Selected
	Editable + Display Off
	Editable + Display Off + Hovered
	Editable + Display Off + Selected
	Editable + Text 1 Displayed
	Editable + Text 1 Displayed + Hovered
	Editable + Text 1 Displayed + Selected
	Editable + Text 2 Displayed
	Editable + Text 2 Displayed + Hovered
	Editable + Text 2 Displayed + Selected
	Editable + Text 3 Displayed
	Editable + Text 3 Displayed + Hovered
	Editable + Text 3 Displayed + Selected

End training session and review performance

Once the training session ends, the “StopSimulation” button will be grayed out; this means the VISSIM simulation has completed and the training session is over. The “open” button next to the MOE summary in the Simulation Control panel will be active. Click this button, a new web page will open and display the network wide performance.




```
Network Performance

File:     C:\vissimnet\Subnet_Current_TP.inp
Comment:  SubNet_Current_TP_Ver_2HR-STA_20100426.ver
Date:     Tuesday, September 21, 2010 3:24:47 PM
VISSIM:   5.20-09 [23492]

Simulation time from 0.0 to 826.0.

 Parameter                                                        ;         Value;
 Average delay time per vehicle [s], All Vehicle Types            ;         5.040;
 Average number of stops per vehicles, All Vehicle Types          ;         0.113;
 Average speed [mph], All Vehicle Types                           ;        56.721;
 Average stopped delay per vehicle [s], All Vehicle Types         ;         0.153;
 Total delay time [h], All Vehicle Types                          ;        17.440;
 Total Distance Traveled [mi], All Vehicle Types                  ;     54903.597;
 Latent delay time [h], All Vehicle Types                         ;         4.906;
 Latent demand, All Vehicle Types                                 ;        176;
 Number of Stops, All Vehicle Types                               ;       1406;
 Total travel time [h], All Vehicle Types                         ;       967.965;
 Total stopped delay [h], All Vehicle Types                       ;         0.528;
```

Define detailed output for performance comparison

Since VISSIM simulation is providing the virtual reality traffic data to the Simulator, any possible output definable in VISSIM can be used to generate the performance comparison. For example, the corridor level travel time comparison. This must be defined in the underlying VISSIM model.

Troubleshooting

This troubleshooting assumes the host computer uses a Windows operating system.

1. *System does not start.*

A common error that happens with the Staff Training Simulator is from the CodeMeter dongle. If any of these following happens, the system check should first go to the CodeMeter dongle.

1. When the “Start Simulation” button is clicked and the usual system initialization time passes but the “Simulation period” indicator does not show any progress of the simulation run;
2. When the above steps are followed, but the “Stop Simulation” button is grayed out and “Start Simulation” becomes solid again.

The system check can include the following steps:

1. Check the status of CodeMeter dongle in the system tray. If it is inactive (“No CmStick connected”), make sure the CodeMeter dongle is plugged and is not damaged. To check if it is physically damaged, unplug it and plug it back in and check if the indicator light flashes. If it did not flash at all, contact PTV for a replacement.
2. If the CodeMeter is plugged in but the CodeMeter status icon remains gray, unplug the dongle, and exit the Simulator virtual machine and go to the host computer.
3. Open the Component services from the host computer, and locate the “VMWare USB Arbitration Service”. Start or restart the service.
4. Go back to the virtual machine, and plug in the CodeMeter dongle. The CodeMeter status icon the system tray should become active now.
5. Retry the system.

2. *TrafficPlatform does not start.*

One likely reason that TrafficPlatform does not start is that the Java packaged modules have not been successfully deployed yet. Copy C:\TrafficPlatform\WebWorks-1.19.ear to C:\TrafficPlatform\server\standalone\deploy.

If the TrafficPlatform tool in the bookmark tool bar does not initiate the log-in page properly, copy the following URL to the address bar and retry: http://localhost:8081/WebWorks.

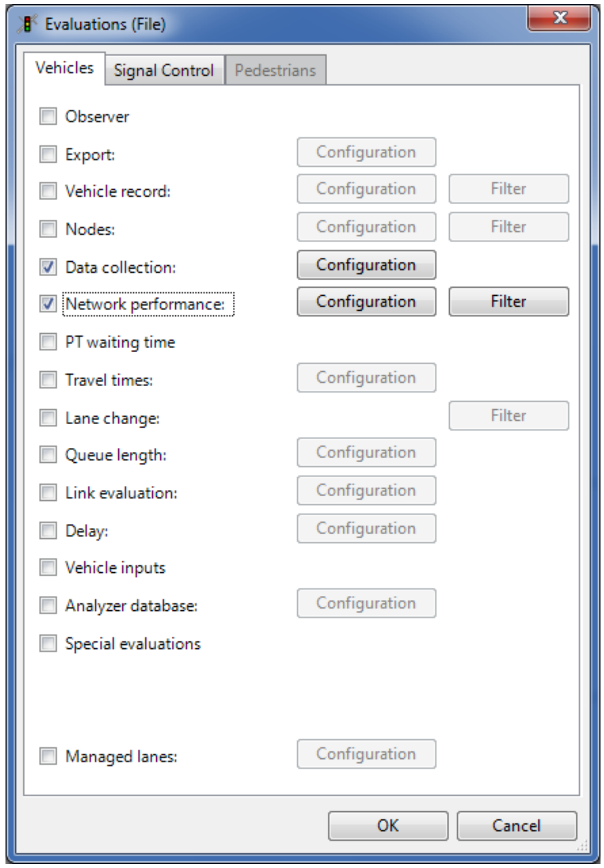
3. *Traffic State Level of Service (LOS) indicator bar not shown properly during training session*

This is most likely caused by the communication between different components of the Simulator. First try the "Refresh" function in the "General Settings" section in the *Use Cases* panel. If this does not load the LOS indicator bars in the current map view, try the "Reload current page" function of Firefox.

If neither of the two reloading functions work, try to close Firefox and reopen it. Because the VISSIM simulation is still running and Salt Lake City TrafficPlatform system is started with the start of the training session, no data is lost after the web-based TrafficInsight interface is closed. When TrafficInsight reopens, it will load the data properly.

4. *Traffic State Level of Service (LOS) indicator bar not changing from interval to interval during the training session*

The likely cause could be that the VISSIM model not properly configured, especially the traffic data collection. Stop the training session, and then try to run the VISSIM simulation model from within VISSIM. Also monitor the traffic measurements reported in the same folder. The measurement file (.mes) should be updated every five minutes; if this file does not update, this will be the reason that the traffic state not updating properly. Then configure the traffic data collection properly from within VISSIM (Evaluation – Files…). Make sure the data collection and Network performance are both checked before the Evaluations(File) dialog is closed:



Save these settings (View-Save Settings…) and override the existing vissim.ini. Close VISSIM and restart the Training Simulator.

5. VISSIM simulation will not start after "Start Simulation" is pressed

The most likely cause of this problem is due to the configuration of Karaf, the component that dynamically configures the training simulator interface (TrafficInsight). Follow the steps below to troubleshoot within the Training Simulator virtual machine:

1).Close all Simulator related application windows (TrafficInsight, Tomcat monitoring window);

2). Go to Windows 7 services, locate the "Karaf" service;

3). First stop the service, and then restart the service.

4). Go to “All programs” and locate the “TP Startup” from the “Startup” group. Start TrafficPlatform services by clicking this item.

5). Wait until the Tomcat configurations stabilize. Restart the training simulator interface, and try Start Simulation again.

Appendix 1: Drivers' Response to Traveler Information: Variable Message Sign (VMS) Impact Literature Review

This work memo is to document the findings of reviewing the studies on users' response to VMS messages and conclusion on the setup of partial route in VISSIM for Utah Salt Lake City TrafficPlatform project.

The Utah TP project is to build a traffic operations center staff training simulator, where the TOC staff can practice their incident management skills by manipulating the relevant traffic management countermeasures including VMS and ramp meters at their disposal. Recourse of the project was started at the beginning of 2010 when the Chicago downtown incident management TPLab showcase at TRB had seen successes and good potentials to include online user interaction components. The TPLab framework is considered a good fit in this situation for its following features:

- VISSIM simulation serves as the virtual reality to provide necessary information for TP calculations. This information can include detector volume, speed and occupancy data, (pre-programmed) incident information (location, duration, severity).
- Users will only be facing a friendly web interface where they can monitor the traffic states calculated and forecast by TP, and send the appropriate traffic management commands (e.g., ramp metering rate changes) to the backend VISSIM simulation.

This feedback process can provide the users valuable experiences with handling incidents in the real world.

Building a plausible VISSIM model that also accommodates possible re-routing requests from the VMS status changes by the user thus becomes the basic step for this exercise. These requests will be modeled by COM-driven partial routes in VISSIM. While no well-accepted standards exist yet for quantifying the drivers' responses to different VMS displays, we must come up with reasonable estimates of the route diversion compliance ratios under different VMS messages, because the Utah Salt Lake City (SLC) freeway network features an extensive VMS deployment on both freeways and the arterials. For example, the VISUM version file that was installed in the current TrafficPlatform system included 96 VMS signs in the partial routes construction in the VISSIM model.

Review of relevant work

Researchers have been trying hard to unveil the interaction mechanism between 1) driver characteristics (age, education, familiarity with the network, etc), 2) the message content and presentation and 3) the eventual compliance rates for VMS route diversion suggestions.

Table 1 summarizes the diversion rates indicated in different studies under various situations.

- It is also found that introducing travel time in the display message strongly increased the diversion rates (giving more confidence to the drivers to divert).
- PM route diversion rates appear higher than AM rates through four European study sites consistently. This applies to SLC, because the SLC model is also a PM 2hour peak.
- There are other studies that focused on the users reaction time to the VMS sign content, display methods (e.g. flashing or not), dimension specs and so on, but not directly related to our study here.

VMS Settings for SLC

The content of the VMS message, the location of the VMS and drivers' characteristics all contribute to the diversion rates. With the existing SLC model, the following assumptions can be made:

1. "Relevant" drivers will be those that are directly heading toward the incident location;
2. The relevant drivers will make decisions when they see the VMS messages.
3. Three levels of diversion rates are appropriate to set up the route diversion rates;
4. The VMS message contents will affect the levels of the diversion rates;
5. From the review we can assume the following three types/levels of VMS messages:
    - Level I: Incident occurrence/location only;
    - Level II: Incident location + detour route suggestion;
    - Level III: Incident location + (real time) delay + detour route suggestion.
6. The following diversion rates for relevant traffic are proposed based on the literature review against the SLC situation (interstate freeways, weekday PM peak)
    - Level I: 5% - 10%
    - Level II: 10% - 30%
    - Level III: 40% - 80%

The above two items are the most important conclusions from this literature review.

Table 1: Summary of Route diversion rates from literature

Driver characteristics	Event	Message content	Diversion Rate (all traffic)	Diversion rate (relevant traffic)	Location & Time of study	Study Approach
relevant to the incident	incident; congestion; roadwork	long delay; incident location; congestion; roadwork;	31%	53%	south Ampton, UK, 1998	
relevant to the incident		advised route	11%	40%	Toulouse, France; 1998	Survey (RP)
		advised route		43% (13%, 2%)	Turin, Italy; prior to 1999	Survey (RP)
	incident; congestion; roadwork	long delay; incident location; congestion; roadwork;	8%	13%	nine European cities; 1994-1998	Survey (RP)
work trip/other trip		comparative travel time	2%/15%	2%/15%	Bristol, UK; 1999	Survey (RP)
	incident	incident	3%		London, UK	Survey (RP)
				20%	Amsterdam; prior to 1998	
			11%		five European cities;	Survey (RP)
			6%/7%		Southampton	Survey (RP)
	peak congestion	queue length (1km/2km/3km/4km)	7%/11%/17%/31%		Paris	Measurements
relevant drivers		accident; advised route		27%-40%	West Midlands, UK, 1995	Measurements
		congestion; advised route		5%-25%	West Midlands, UK, 1995	Measurements
		congestion		2%-5%	West Midlands, UK, 1995	Measurements
	unexpected congestion	qualitative delay		46%	Brisbane, Australia; 2007	Survey (SP)
		quantitative delay		42%	Brisbane, Australia; 2007	Survey (SP)
		quantitative real-time delay on best alt. route		58%	Brisbane, Australia; 2007	Survey (SP)
		predictive delay		56%	Brisbane, Australia; 2007	Survey (SP)

Driver characteristics	Event	Message content	Diversion Rate (all traffic)	Diversion rate (relevant traffic)	Location & Time of study	Study Approach
		prescriptive best route *		64%	Brisbane, Australia; 2007	Survey (SP)
relevant drivers, familiar with VMS and routes		Occurrence of accident only		27%	Borman Expy, IN, 2005	Survey (SP)
relevant drivers, familiar with VMS and routes		Location of the accident only		29%	Borman Expy, IN, 2005	Survey (SP)
relevant drivers, familiar with VMS and routes		Expected delay only		49%	Borman Expy, IN, 2005	Survey (SP)
relevant drivers, familiar with VMS and routes		The best detour strategy only		48%	Borman Expy, IN, 2005	Survey (SP)
relevant drivers, familiar with VMS and routes		Location of the accident and the best detour strategy		69%	Borman Expy, IN, 2005	Survey (SP)
relevant drivers, familiar with VMS and routes		Location of the accident and the expected delay		80%	Borman Expy, IN, 2005	Survey (SP)
relevant drivers, familiar with VMS and routes		Expected delay and the best detour strategy		82%	Borman Expy, IN, 2005	Survey (SP)

Driver characteristics	Event	Message content	Diversion Rate (all traffic)	Diversion rate (relevant traffic)	Location & Time of study	Study Approach
relevant drivers, familiar with VMS and routes		Location of the accident, expected delay and the best detour strategy		93%	Borman Expy, IN, 2005	Survey (SP)

* (i.e., consistent with the usual route).

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Appendix 2: Multi-resolution modeling Working paper

APPLYING A MULTI-RESOLUTION MODELING APPROACH FOR MASTER PLANNING OF STATE ROUTE 285 CORRIDOR AT WENATCHEE VALLEY, WA

1. Introduction

Today's transportation professionals have two prevalent classes of traffic analysis tools available to answer the questions of either long- or medium-term planning or short-term operational problems, namely macroscopic travel demand forecast models and microscopic simulation models. Represented by the most commonly applied comprehensive four-step modeling approach, macroscopic travel demand forecast models translate regional land use for the base year and future developments into corresponding travel patterns represented by path flows and link flows during the modeled peak periods. As generally recognized [1], the static four-step modeling approach does not work well to trace the temporal evolution of the transportation network flow patterns and their changes under various traffic management and control treatments such as ITS options. On the other hand, microscopic traffic simulation models trace the detailed trajectory of every individual driver-vehicle-unit or pedestrian through the system. Consequently, they are most capable of capturing the interaction between travelers and the system under various management and control measures. However, these models will require intensive data and resource input to achieve the high model fidelity. Therefore, they usually focus on smaller study areas at the intersection or corridor level.

The shortcomings of the above two classes of analysis tools can be overcome by adding an intermediate meso-scopic layer of dynamic traffic assignment (DTA) to the macro-micro modeling process. Maintaining the same simplistic network representation as in the macroscopic models, the mesoscopic models are capable of computing the network flow patterns not only based on typical v/c ratios and resultant delays but also queues, dynamic intermittent delays, and shockwave propagation within the network. Due to its capability of dynamic modeling of the traffic flows and simplicity over detailed vehicle trajectory modeling as microscopic simulations, DTA tools can benefit the transportation planners and engineers with great savings of investment in the detailed microscopic modeling. It can serve as the screening tool for multiple improvement projects that may potentially eliminate the choke points identified from the travel demand forecast model. Once the most promising projects are chosen out of the above meso-scopic modeling process, they will be refined in microscopic simulation models for final technical assessments.

In short, the three levels of models are tailored to best utilize their relative strengths while the modeling basis and outputs from the top levels serve as the input and basis for the next levels:

- Level I: use regional 4-step static models for mapping land use pattern into origin-destination trips and link/turn volumes by trip purposes at PM peak hour;
- Level II: develop regional dynamic traffic assignment (DTA) models for screening and evaluation of various projects and scenarios
- Level III: develop corridor network micro simulation models for selecting the most promising improvement plan from a reduced number of candidates in Level II.

This paper summarizes the application of the above three-level modeling approach in corridor management planning efforts, with the focus on development of the regional DTA model. The project was intended to provide Wenatchee Valley Transportation Council (WVTC), the Metropolitan Planning Organization (MPO) in central Washington State, with a transportation improvement plan for the State Route 285 North Wenatchee Avenue Corridor, a fast-growing area along the Columbia River in Wenatchee, Washington.

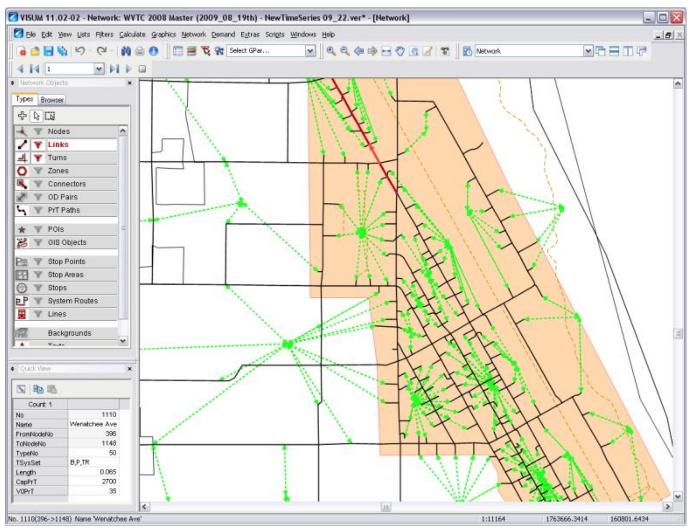
The remainder of the report is organized as follows. The second section briefly summrizes the update of the WVTC travel demand forecast model with additional data support. As the study focus, the third section describes the development of the regional DTA model in greater detail, including model period expansion, traffic flow dynamics at both the link and turn level, model calibration and validation. The next section then introduces the steps of building a working micro simulation model based on the DTA model results. The paper is concluded in the last section with the findings and lessons learned from this project.

2. Update PM Peak Four-Step Travel Demand Forecast Model

WVTC historically maintains a robust travel demand forecast model implemented in VISUM. The modeled Wenatchee area includes the area within the city limits, areas within the Urban Growth Area, and a surrounding buffer area. The WVTC model included all of the roadways classified as collector or greater within the model area. The final version of the model included 222 traffic analysis zones (TAZs) with 703 ingress/egress loading points and 11 land use categories.

The demand model for WVTC is a four-stage model for the PM peak hour (5pm-6pm), and it includes all four stages from trip generation, trip distribution, mode choice to traffic assignment. Also following the common trip purpose categorization, the private trips are divided into five personal cateogories (home-work, work-home, home-other, other-home and non-home based) and commercial trips. All 18 transit lines have also been entered in the model, with the mode split being calculated from a Logit model and the bus ridership verified against the past survey data.

Additional network detail was added to the model in the corridor area to facilitate the future data exchange with the microscopic model. This included adding minor roads previously not in the macroscopic model and driveways, both of which might affect flow in the study corridor. This detail is shown in Exhibit 1 with the additional connectors. To assure proper loading of these more minor network facilities, Multi-Point Assignment (MPA) was used. Detailed intersection geometry that was coded at this stage is discussed in more detail in section 3.3.



• Exhibit 1 Additional Network Detail with Connectors

The updated base year (2008) model was verified against the expanded traffic count date set that was provided to the study team by WVTC. This dataset includes the existing model validation link counts, intersection turn counts newly supplied by the City of Wenatchee and Washington State DOT permanent traffic recorder (PTR) station counts. These data were synthesized to ensure the data consistency within the model. The model verification process is a series of post-simulation run analyses that are designed to analyze the accuracy and degree of confidence presented in the calibrated results. Included in these analyses are tests of the screen-lines and comparisons of the traffic count data vs. modeled link volumes. Exhibit 2 shows the overall fit of the updated model.

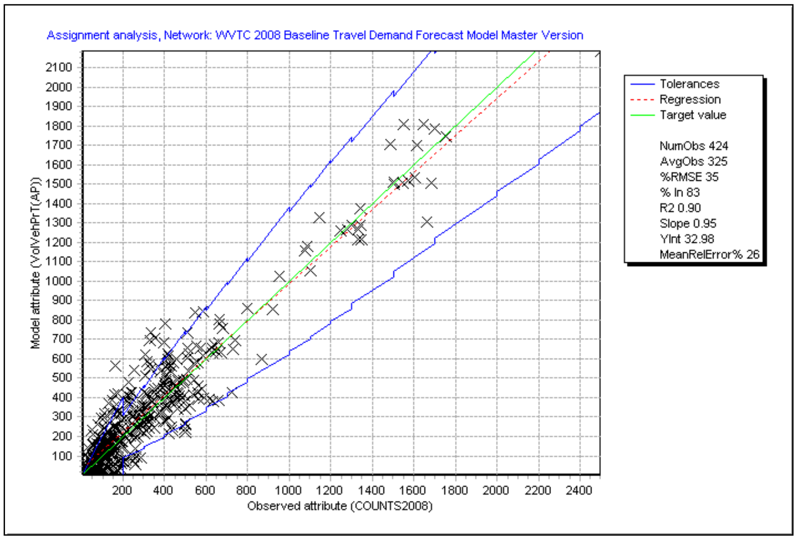


Exhibit 2 Wenatchee Automobile Model Calibration and Validation Statistics

There are no national standards for R^2 or RMSE. However, there are guidelines that have been established by Caltrans for data used in air quality analysis. The guidelines recommend an R^2 of 0.88, a maximum RMSE of 35%, and a minimum %In of 75% for links classified as Arterials and above.
In case of the WVTC model, the R^2 was 0.89, RMSE was 35%, % In was 83 and Slope was 0.95. All these values meet or exceed the suggested calibration standards.

3. Development of Dynamic Traffic Assignment (DTA) Model

In the proposed tri-level study approach, building an intermediate level of a regional DTA model will assist the corridor master planning in two aspects:

- Serve as the screening tool to evaluate various alternatives and scenarios in a cost-efficient way;
- Prepare the time-dependent traffic demand input for the VISSIM microscopic simulation.

Developing a regional DTA model at the MPO level is generally considered advanced modeling practice for a number of reasons. The DTA model does not only account for the travel patterns spatially as static traffic assignment does, but tracks the temporal evolution of the traffic patterns and thus captures the traffic peaking through the network. Consequently, adding the time dimension significantly increases the modeling complexity and thus requires more data support especially the time-varying system characteristics such as time profile for traffic volumes and control plans. This section describes the major steps and procedures to build the dynamic traffic assignment model using the dynamic user equilibrium (DUE) module in VISUM.

3.1 DTA model period expansion and demand time series

As the traffic peaking is expected to span more than just the peak hour in the Wenatchee area in the future, the first step is to expand the modeling period from the static model to a multi-hour period, 4-6 PM in this case.

The time profile of the travel demand for the Wenatchee Dynamic Assignment Model, or demand *time series*, were developed using a combination of traffic counts for two hours (4 pm-6 pm) and NCHRP 365 guidelines. The time series was developed for a two hour period in slices of 15 minutes each, i.e. the trend of demand was broken down into 15 minute time slices. Different time series were developed and applied to the three demand segments of Home based work (HBW), Home based other (HBO) and Non Home based (NHB).

In the first step, aggregate two hour matrices were developed by factoring the single peak hour matrices in the static four-step model (5-6pm) for each demand segment. The factors for the matrices were arrived at using the NCHRP 365 [2] (TABLE 41-pg 83) guidelines for proportionality of vehicle trips by hour by trip purpose for Urban size 50,000 to 199,999 (population). The number of trips for the peak hour (5pm-6pm) was assumed to be the base number of trips as a result the factor for these trip matrices was 1. The factor for the hour of 4pm-5pm was determined by trip purpose using unitary method as follows:

$$Factor_x = PercentTrips_{BaseHour(x)} \Big/ PercentTrips_{ShoulderHour(x)}$$

where:
$Factor_x$ = Factor for Trip Purpose x
PercentTripsBaseHour(x)= Percent Trips for base hour for Trip Purpose x as per NCHRP
PercentTripsShoulderHour(x)= Percent Trips for shoulder hour for Trip Purpose x as per NCHRP

After calculation of growth factors for each demand segment, these are applied to the base trip matrices for each demand segment. As a result, the three hour trip matrix was calculated as:

$$ODMatrix_{DSeg(x)} = BaseODMatrix_{DSeg(x)} \times \sum_{i=1}^{n} Factor_{DSeg(x)TimePeriod(i)}$$

The Table below shows the factors calculated and used in order to expand the base trip matrices for the HBW, HBO and NHB trip purposes.

Exhibit 3 PM Peak Time Profile for Various Trip Purposes from NCHRP 365

Trip Purpose	Time Slice	Percent Trips	Factor
HBW	4:00-5:00	10.31	0.967
	5:00-6:00	10.66	1
HBO	4:00-5:00	7.25	0.99
	5:00-6:00	7.32	1
NHB	4:00-5:00	9.28	1.084
	5:00-6:00	8.56	1

In order to arrive at the weights for the demand time series, 15 minute interval field counts were used for the first two hours and the trend was extrapolated to the last hour by means of a moving average of the difference between the previous two time slices. The general trend across three hours of traffic data for 15 minute time slices was then evaluated as a percentage of the total across three hours. After obtaining this general trend, it was further factored by the NCHRP 365 percent factors in order to capture the variation in demand across different demand segments or trip purposes. The resulting trend is shown in the chart below.

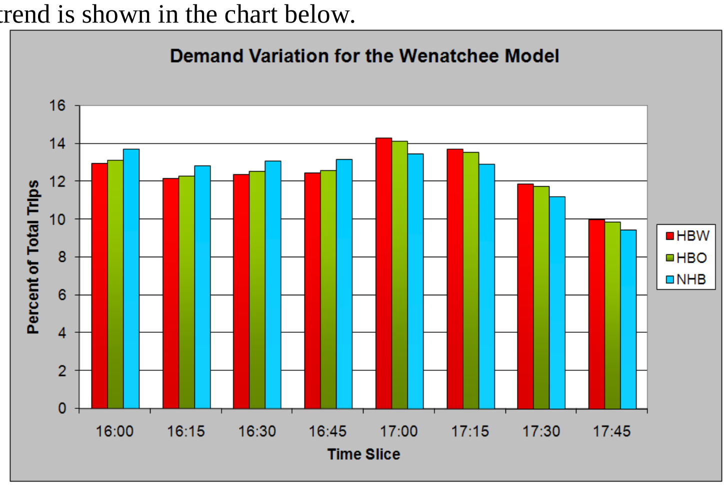


Exhibit 4 4-6 PM time series by demand segments

3.2 General DTA modeling process and the dynamic user equilibrium (DUE) module in VISUM

The dynamic user equilibrium (DUE) modeling process maps the (time-dependent) O-D matrices onto the network to obtain the time-varying characteristics of the links (arcs flows and arc performances) based on the assumptions of the day-to-day path choice and departure choice behavior of the travelers. To mimic the day to day choice behavior, therefore, solving the DUE problem is generally an iterative process whereby at each iteration the algorithm compares the experienced travel cost with the equilibrium condition and balances the path flows. Eventually the model converges to the equilibrium state that no traveler can have less experienced travel time by unilaterally changing her paths. Exhibit 5 illustrates the modeling framework of the DUE module in VISUM.

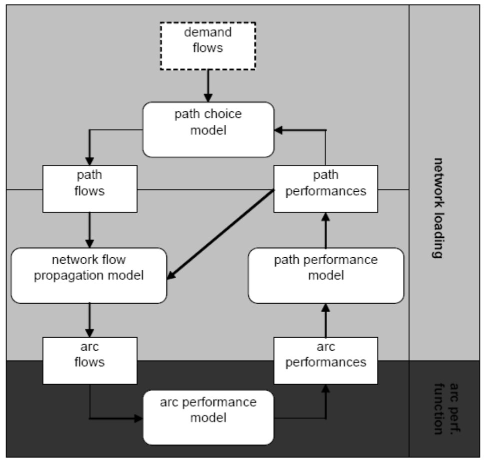


Exhibit 5 Dynamic User Equilibrium (DUE) Problem Model Flow [2]

At each iteration, the dynamic network flow pattern and the resulting link/arc characteristics are obtained by the dynamic network loading process, as depicted in the following exhibit.

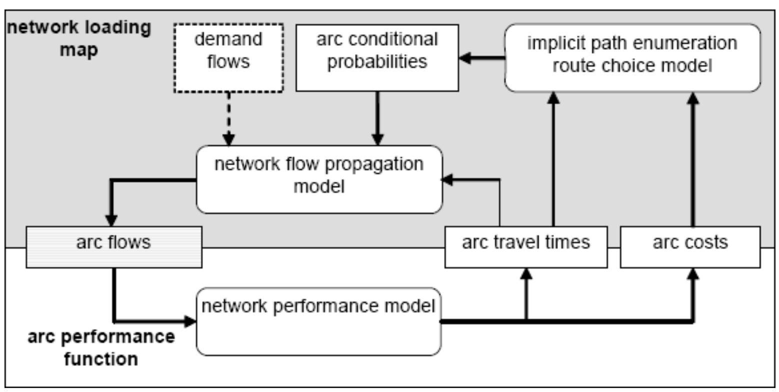


Exhibit 6 Flow Chart of the Sub-problem: Dynamic Network Loading (DNL) [2]

Dynamic traffic assignment modeling has seen over three decades of research and development now since the seminal work by Merchant and Nemhauser [4,5], and a vast array of literature is available for references [6]. As this study is focusing on the development of a DTA application model, the readers are referred to a recent TRB publication [7] for a more detailed but introductory description of the underlying theories and arguments.

It can be seen from the above two exhibits that lying as the fundamental building block of the DUE problem and its DNL sub-problem is the *arc* or link performance model, that is how the traffic flow queues and dissipates at the links and junctions and how that translates into the travel impedances for the drivers. Therefore, we in this paper focus on the detailed modeling of traffic flow dynamics at the junctions and the links.

3.3 Junction details and turn capacities

While simply represented by nodes in static models, the urban intersections and junctions are usually modeled in greater detail in the DTA models. This is due to the fact that vehicle queuing formation occurs mostly from the conflicting traffic flows competing for the right-of-way at the urban intersections and freeway junctions. The

intersection details are critical to accurately model the traffic flow dynamics in the DTA model. These details include both the geometries and control data.
The study team used information from a variety of sources to code the proper geometries and signal timing. The geometry was obtained from observing and measuring geometric features from the aerial photographs. The signal timing information came from either previous modeling efforts, WSDOT signal timing plans, or signal timing plans provided by WVTC and the City of Wenatchee. These data are critical to ensure the proper representation of the intersection details and the accuracy of the model.

A new module called *Junction Editor* from VISUM 11.0 allows the users to enter the detailed intersection or junction data including both geometric layouts, right-of-way allocations and control timing plans. These data serve multiple purposes in this study. In addition to archiving the intersection and control inventory for WVTC, the intersection capacity analysis procedures provided in VISUM is able to calculate the travel impedances for each movement at any intersection under different controls such as signal control, two-way stop signs, all-way stop signs or a roundabout using the analysis methodology established in the Highway Capacity Manual (HCM). The resulting (time-varying) capacities for these turn movements and corresponding lane groups are used as the input for the dynamic traffic assignment process.

Moreover, the coded intersection detail also greatly facilitates the tril-level modeling process, because this detail is completely transferrable into VISSIM micro simulation through an Abstract Network Model (ANM) layer that is acceptable to both macro (VISUM) and micro (VISSIM) models. This has greatly saved on the usually tedious and labor intensive network coding efforts when building the VISSIM model from scratch. The following Exhibit indicates the coded signal phases and timing plan for an intersection in downtown Wenatchee with its immediate VISSIM preview.

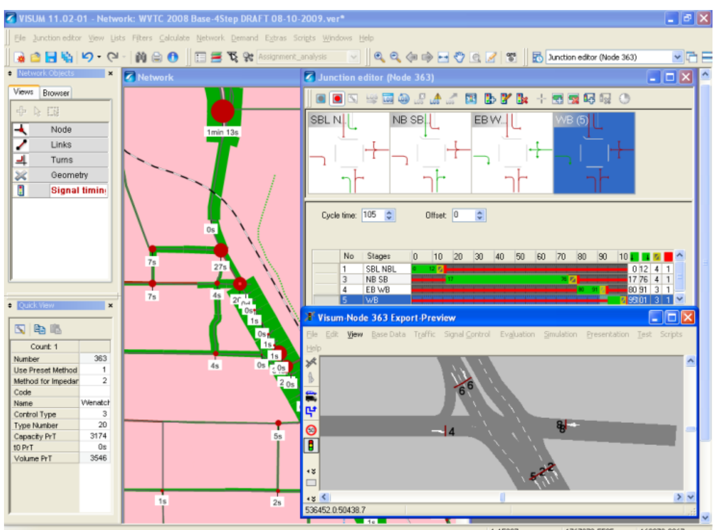


Exhibit 7 Example Intersection VISSIM Preview from Junction Editor: Wenatchee Ave and Maiden Ln

3.4 Modeling link flow dynamics for the WVTC DUE Model in VISUM

The VISUM DUE model provides the utilities to fine-tune the model parameters for better representation of traffic flow propagation in the network. The following link attributes define the basic building block for the DUE model, namely the fundamental diagram at the link level:

- **Average space required per car unit per lane**: this attribute applies when the DUE option of "block-back" is to be used in the assignment process, i.e., vehicles occupy actual spaces and when the maximum link density is reached, no more traffic can enter at that time step. In the WVTC study, this parameter ranges from the default 23 ft to 25 ft depending on the specific locations.
- **vWave**: this parameter specifies how fast the congestion can spill back upstream. It is suggested when no support data are available, 0.3 times of the free flow speed can be used. This parameter is also subject to calibration.

- **Fundamental diagram type**: the type of speed-flow or density-speed relations that affect the traffic queue propagations and traffic state transitions. A well calibrated fundamental diagram will be able to let the model estimate the vehicle queue spillback more accurately.

In this study, the subcritical linear fundamental diagram (FD) is chosen as this simplified FD has proved its effectiveness in other studies and models including the VISTA model. The shape and parameters can be seen from the following exhibit.

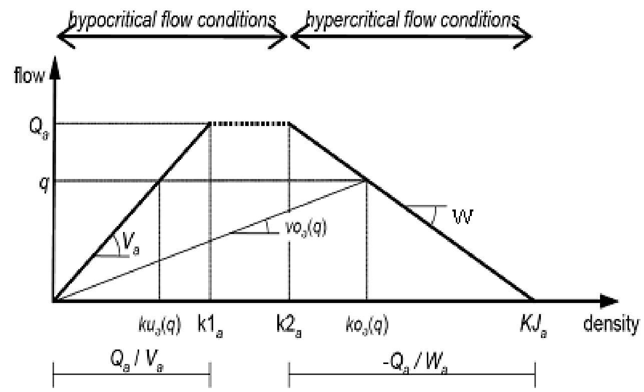


Exhibit 8 Subcritical Linear Fundamental Diagram [2] Applied in WVTC DUE Model

3.5 WVTC DUE model calibration and statistics

As new and advanced as dynamic traffic assignment modeling application is, there is no nationwide accepted standard for model calibration, i.e., when the model performance meets the criteria, the model is considered able to represent the existing transportation system well enough for future scenario evaluations. Nonetheless, Federal Highway Administration (FHWA) published "Traffic Analysis Toolbox Volumes", a series of reports that guide the development and application of traffic analysis tools. Volume III provides the guidelines for applying microscopic traffic simulation software [7].

Consider the dynamic nature of the DTA model and the data availability, we use both sets of calibration guidelines to ensure the quality of the WVTC DTA model: the guidelines for static model validation statistics at the aggregate level, and the micro-simulation model calibration targets at the disaggregate level. Specifically, the 15-minute turn counts collected at major intersections and the travel time were used to verify the WVTC DTA model.

The 15-minute turn counts collected at the major intersections serve as the calibration and validation targets in the DUE assignment. To facilitate the calibration process, the same set of calibration performance indicators used in the assignment analysis (Exhibit 1) is developed using an EXCEL spreadsheet for the statistics such as *RMSE*, R^2 and individual links and turns. These tools greatly help the validation process. Except for the warm-up period of 16:00-16:15, all the remaining 15-minute increments have exceeded the recommended values by the guideline. Exhibit 9 shows the model statistics for the four increments in the hour of 4:30-5:30pm hour.

For individual turn counts, the GEH statistic is used to compare the fitness of the model output turn volumes against the observed counts. The percentage of the GEH less than 5 is calculated for all intervals and shown in Exhibit 10. Note that except for the warm-up period (16:00-16:15), all remaining 15-minute increments have exceeded the 85% standard, as recommended in [7] (Table 4, "Wisconsin DOT freeway model caibration criteria").

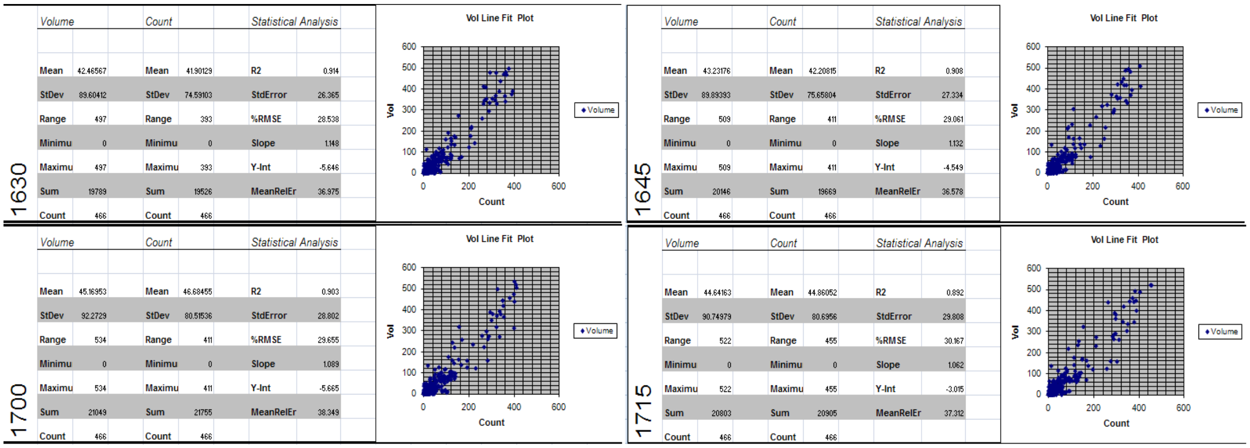


Exhibit 9 DUE Validation Spreadsheet: 15-min Increment aggregate Statistics: 16:30-16:45, 16:45-17:00, 17:00-17:15, 17:15-17:30

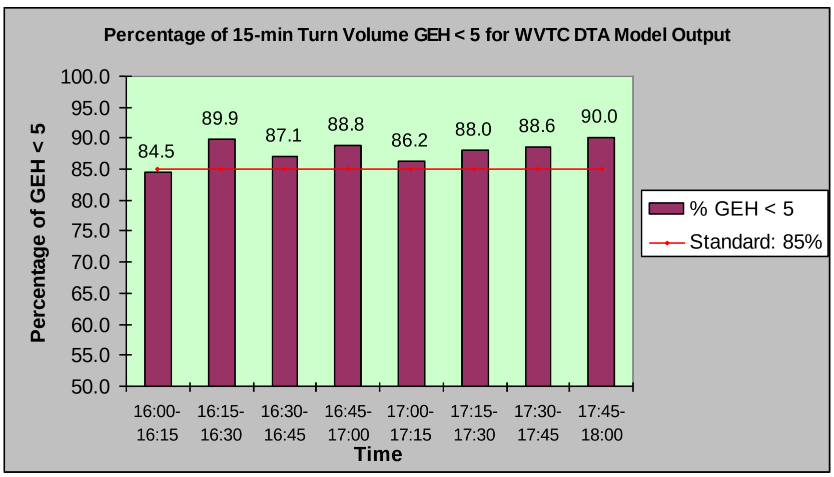


Exhibit 10 Dynamic User Equilibrium (DUE) Validation: the Percentage of Turn Locations where 15-min Individual Turn GEH < 5

The other set of validation data comes from the GPS equipped probe car travel time measurements as introduced in Section 2. The study team identified four critical segments within the SR-285 corridor that have enough GPS data coverage and can serve as travel time validation targets:

- Wenatchee/Miller to n/o Wenatchee River Bridge
- SB Wenatchee Bridge to Wenatchee Ave and Miller St.
- SB Wenatchee Bridge to Wenatchee Ave and 5th St
- SB Wenatchee Bridge to Chelan Ave and 5th St

The GPS travel time data were analyzed to provide the calibration target for all five segments. The first four segments have enough sample data to support statistically significant analyses, therefore, these four segments were selected to compare the DUE model output with the GPS travel time data. As recommended in [8], the 15% travel time threshold was established for the DUE model calibration. The following exhibits illustrate the DUE model output travel time for these four segments.

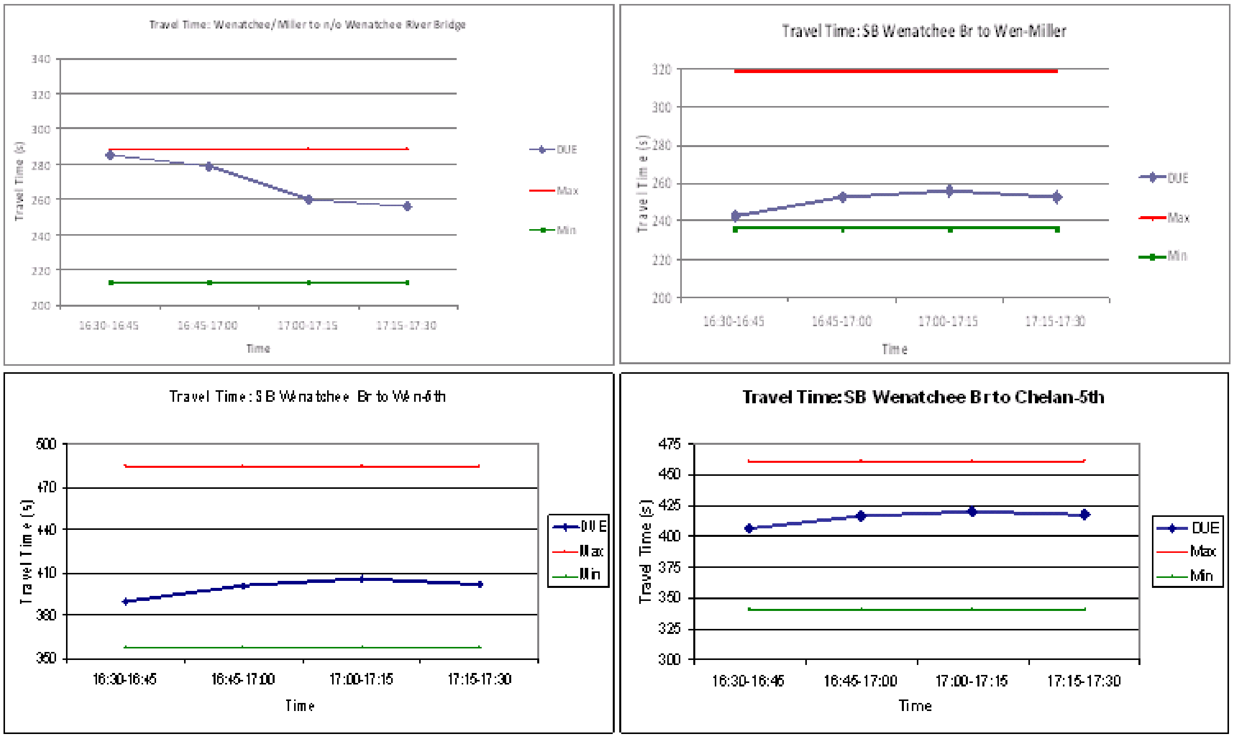


Exhibit 11 DUE Model Validation: Travel Time for SB Wenatchee Bridge to Wenatchee/Miller

The time-varying traffic count data calibration and the travel time validation indicate that the WVTC DUE model has been well calibrated, and thus is ready to be deployed for screening various projects and building the VISSIM simulation model. We skip the screening process and only describe how the VISSIM model is developed based on the WVTC DUE model in the next section.

4. Corridor Sub-network Generation and VISSIM Baseline Model Construction

The *sub-network generator* in VISUM allows users to cut the sub-area of interest for detailed analysis without loss of the reference to the original region model. This includes the (time-varying) boundary path flows and the path flows within the sub-network, the network representation and the junction and link details coded from previous steps. The SR-285 North Wenatchee Avenue Corridor sub-network was generated using this module.

The North Wenatchee Avenue Corridor VISUM sub-network was then exported into the ANM format, which was then imported directly into VISSIM to set up the initial simulation network. This way the transportation system information is carried over to the simulation model. This includes:

- Network hierarchy (freeway or urban streets) geometries and corresponding speed limits;
- Travel demand and vehicle routing;
- Traffic controls (signal groups, timing plans, right-of-way allocation at Stop or yield signs).

This process greatly facilitates building the microsimulation model since most modeling components were built automatically through ANM import. The following exhibit shows the SR 285 corridor network in VISUM after the subnetwork generation and in VISSIM after ANM export/import.

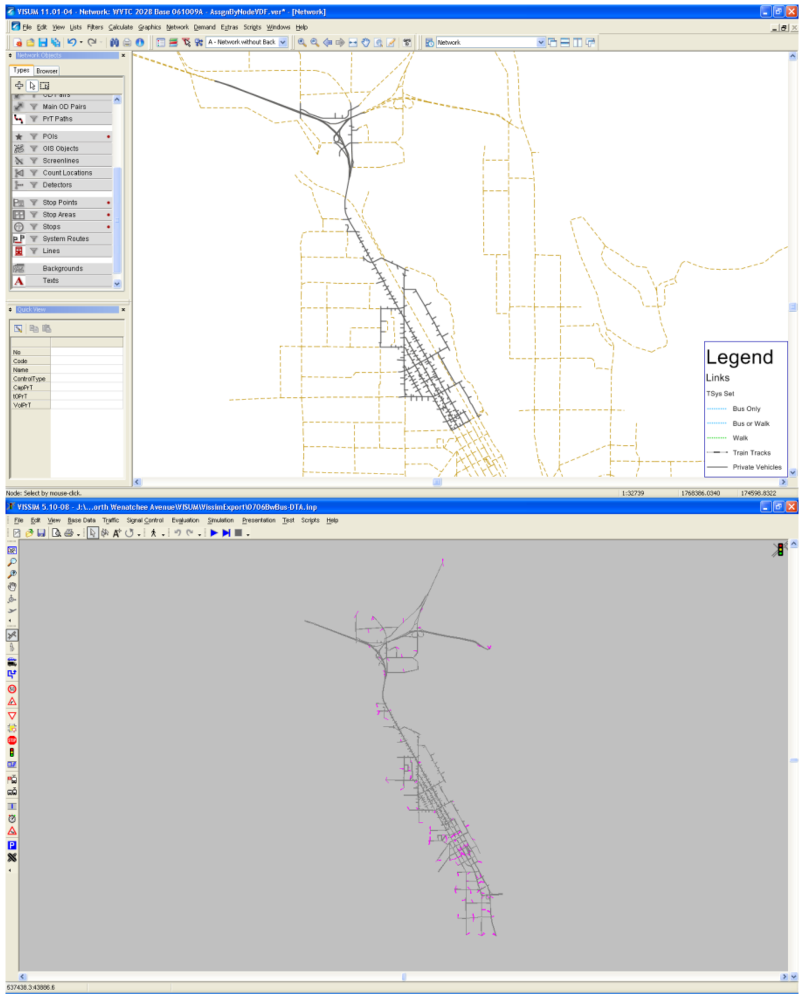


Exhibit 12 SR-285 Corridor in VISUM and VISSIM: ANM Export and Import

Once the basic network is constructed in VISSIM, the successive steps to build a reliable calibrated micro simulation model include network cleaning, error checking, model calibration and model applications. These steps will not be detailed in this paper.

5. Concluding Remarks

Nowadays it is generally agreed that building a multi-resolution model can provide a holistic and more accurate picture of the transportation system in concern while increasing the modeling productivity. This study has also showcased this approach by integrating the four-step travel demand forecast model with the microscopic simulation model for the master planning of North Wenatchee Avenue Corridor in Wenatchee, WA.

By adding a dynamic traffic assignment layer, the integrated model is able to characterize the network flow pattern both spatially and temporally. This layer does not only serve as a screening tool to evaluate the improvement projects identified in the static travel demand model to eliminate the choke points, it also provides all the modeling components to build the micro simulation model for techinical assessments. In particular, the time-varying traffic demand and vehicle routing info can be the direct traffic demand input for the micro simulation model.

Another highlight in this study is the enhancement of the macro model with increased intersection details. Many fold benefits were harvested from having traffic engineering level of details within the travel demand forecast model environment. Firstly, all transportation system information could be kept in the same central data hub of the macro level model to avoid possible errors and loss of information commonly introduced when multiple tools were used. Secondly, the traffic engineering analysis based on Highway Capacity Manual methodology can be conveniently performed to test various land use scenarios and capacity expansion projects, and the turn capacities from this HCM analysis are also used in the successive dynamic traffic assignment model. Lastly, the detailed intersection geometries and traffic control plan are transferrable to build the baseline micro simulation model with minimum network coding efforts.

In the overall WVTC modeling process, the study team has taken advantage of all available data and performed data-mining from DOT, regional, and city resources to build the multi-resolution model. We conclude from our coordinated modeling experiences that combining macro and micro models with an intermediate dynamic assignment modeling step yields great benefits in dealing with both engineering and planning needs.

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3. PTV 2010. *"Dynamic User Equilibrium"*, Section 5.15, VISUM 11.0 Basics Chapter 5. PTV AG, Karlsruhe, Germany.
4. Merchant, D. and Nemhauser, G. 1978a, A model and an algorithm for the dynamic traffic assignment problems, *Transportation Science* 12, 183-199.
5. Merchant, D. and Nemhauser, G. 1978b, Optimality conditions for a dynamic traffic assignment problems, *Transportation Science* 12, 200-207.
6. Peeta, S. & Jayakrishnan, R. 2001, Foundations of dynamic traffic assignment: the past, the present and the future, *Network and Spatial Economics*, pp 233-265.
7. TRB 2010. *A Primer for Dynamic Traffic Assignment*, TRB Transportation Network Modeling Committee (ADB30). Transportation Research Board, Washington, D.C.
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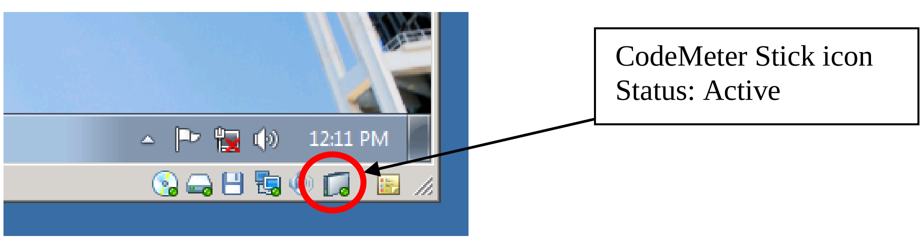
TRAFFICPLATFORM START AND CUSTOMIZATION MANUAL

TrafficPlatform (TP) start

The TP is located in a virtual machine (VM) that dwells in a host computer. Steps to start the TP are:

- From your desktop computer, go to Remote Desktop Connections and connect to: 155.98.8.113; use your UTL credentials to log on
- Go to folder C:\UTL Staff Training Simulator and locate file “TPShowcase.vmx”
- Drag the file to VMWare Workstation to open with; the shortcut is located on the desktop
- Click “Power on this virtual machine” (green triangle)
- During the VM startup, you should see two messages; the first one tells you that the VM will take over the WIBU-Systems CodeMeter Stick from the host computer, and the second one tells you that the WIBU stick can be connected to the VM; click “OK” for both messages; do not check “Do not show this message again”, we want this test to be performed every time when the VM is started
- Wait for the Java shell to load the Tomcat server (35-50 seconds); do not close the shell, just minimize it; the TP will not work without it; if you accidentally close it, go to “Start/All Programs/Startup” and click on “TP Startup”; it will reload the Tomcat server
- Open Mozilla Firefox; it will automatically load PTV TrafficInsight
- If your test scenario is ready (VISSIM model and all corresponding files), and the SQL database is updated (see below), you can start the simulation; VISSIM will upload automatically and the session will begin

NOTE
If nothing happens after the “Start simulation” button is pressed, and VISSIM does not load, check the WIBU CodeMeter Stick. The icon for the stick is located in the VM taskbar, in the lower right corner. If this icon is grey, then the stick is not connected to the VM. Right click on the icon and click “Connect (Disconnect from host)”. The icon should become active and turn green (see below). Reload Firefox and start the simulation again.



Exiting TP

- In the VM, close all running programs
- Shut down the VM (Start/Shut down)
- Close VMWare Workstation
- Log off the host computer

NOTE
Don’t turn off or log off the host computer before shutting down the VM

Updating the SQL developer database

The SQL developer database has to be updated every day when TP is used; otherwise TP won't load the simulation data correctly. Steps:

- Under Virtual machine (TrainingSimulator), open folder:
  Local disk (C:)/ sqldeveloper-2.1.1.64.45/sqldeveloper
- Start "sqldeveloper.exe"
- Hit "Run" if prompted
- When the SQL developer starts, on the left side of the screen, under Connections, click the "+" sign for "TP Showcase DB"
- When prompted, enter password: tp
- Click "+" for Tables (Filtered)
- Click "+" for DAY2DAYCATEGORY (or double-click)
- On the right panel, click the tab "Data"
- Click "Sort…", select "CALENDARDAY", select "Descending"
- Click the first column (the last date entered), right click the selection and select "Duplicate Row"
- Rename the new entry by putting today's date
- Click "Commit changes" (small cylinder icon with a green check mark just above the columns)
- Click "+" or double-click DAY2DAYTYPE, and repeat the same procedure as for DAY2DAYCATEGORY
- Click "Save all" and close the SQL developer; the database is now updated and TP can be started

ADDING VMS SIGNS

VMS on I-80 WB at Parley’s Canyon
VMS #: 80
Name: “I-80 WB Parleys Canyon”
Long/Lat from EPSG 900913: -12444048.74 4970198.07
VISUM link: 1024010238; VISUM From Node: 10240

VMS on I-80 WB at 300 E
VMS #: 81
Name: “I-80 WB 300 E”
Long/Lat from EPSG 900913: -12454537.97 4970888.39
VISUM link: 1067610220; VISUM From Node: 10676

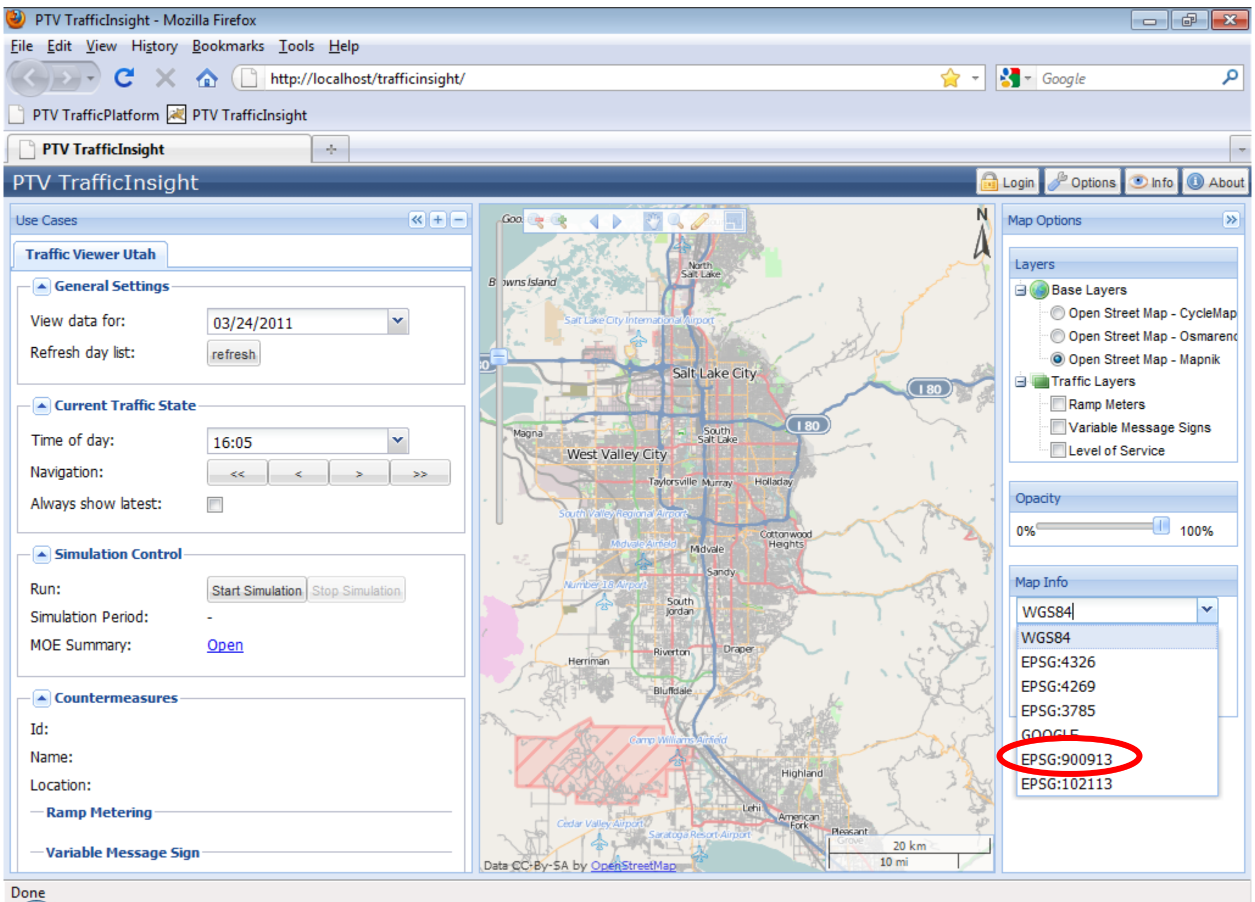
How to add a VMS sign

Open following programs:

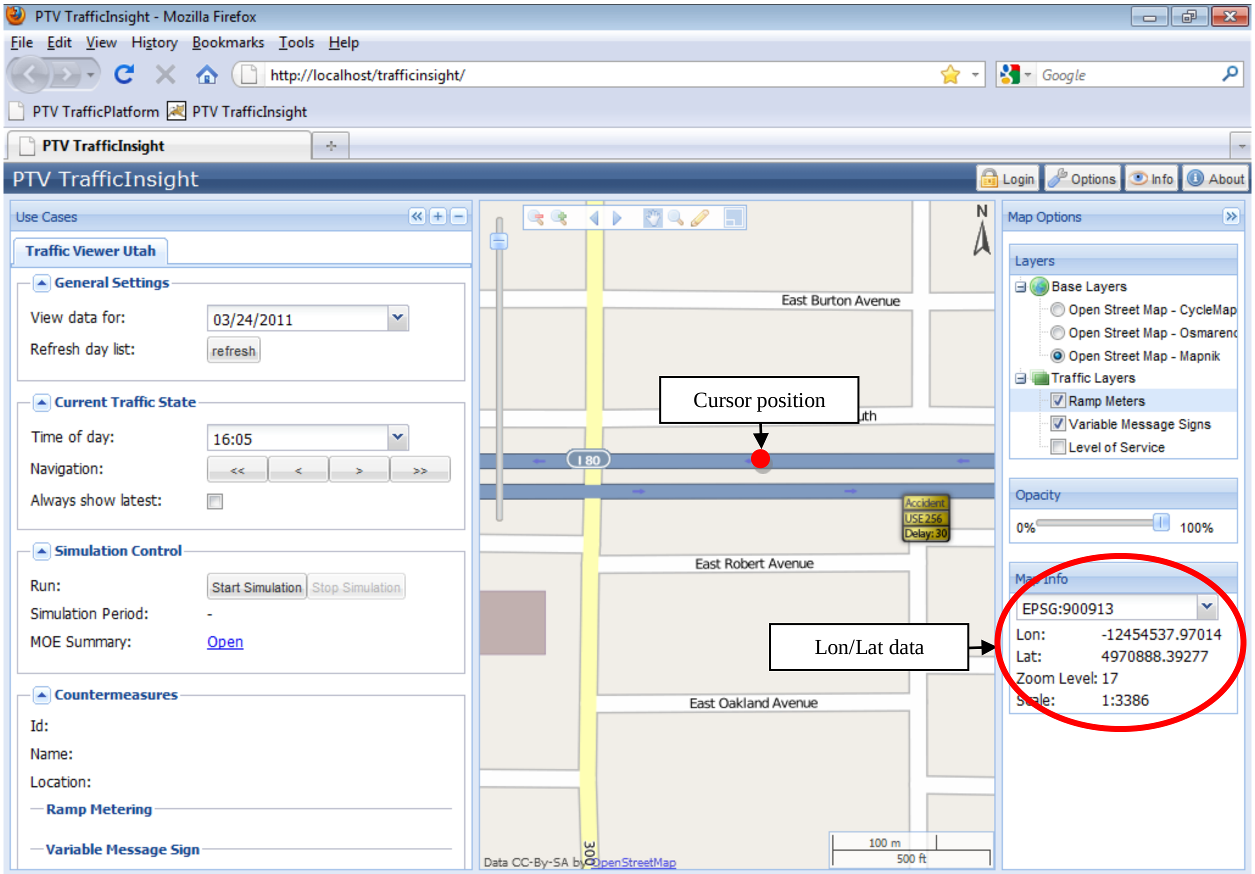
- TrafficInsight (in VM Mozilla Firefox)
- VISUM network from VM C:/utah/network/slc.ver
- pgAdmin III in VM/Start

Make notes for the new VMS:

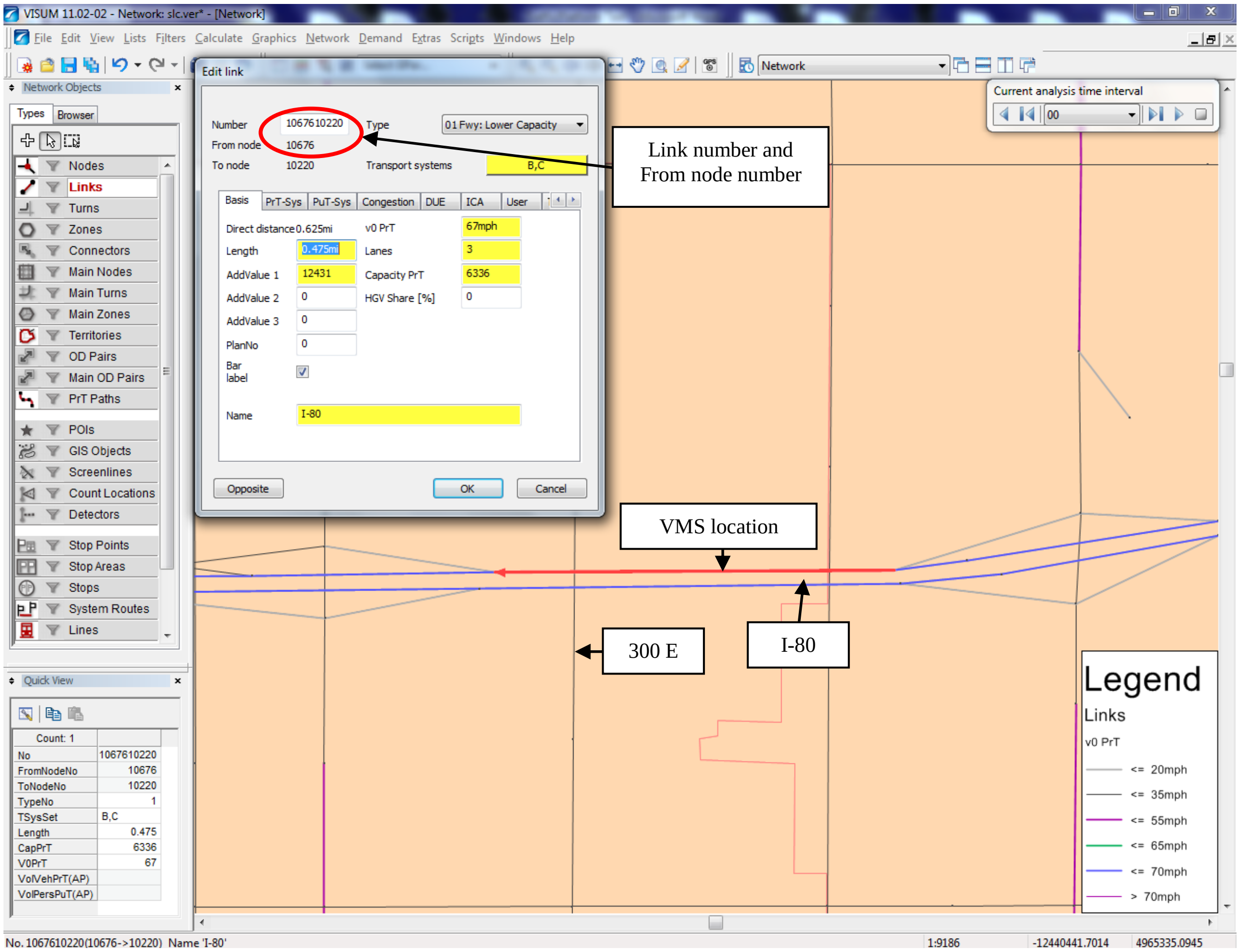
- VMS number
- VMS name
- Long/Lat data from TrafficInsight: in TrafficInsight position the mouse cursor at the location of the future VMS sign, expand the panel on the right (Map Options), and in the Map Info section select EPSG:900913 (figure below)



The example here is for a VMS on I-80 WB at 300 E:



In VISUM, open version slc.ver and find the link in question:

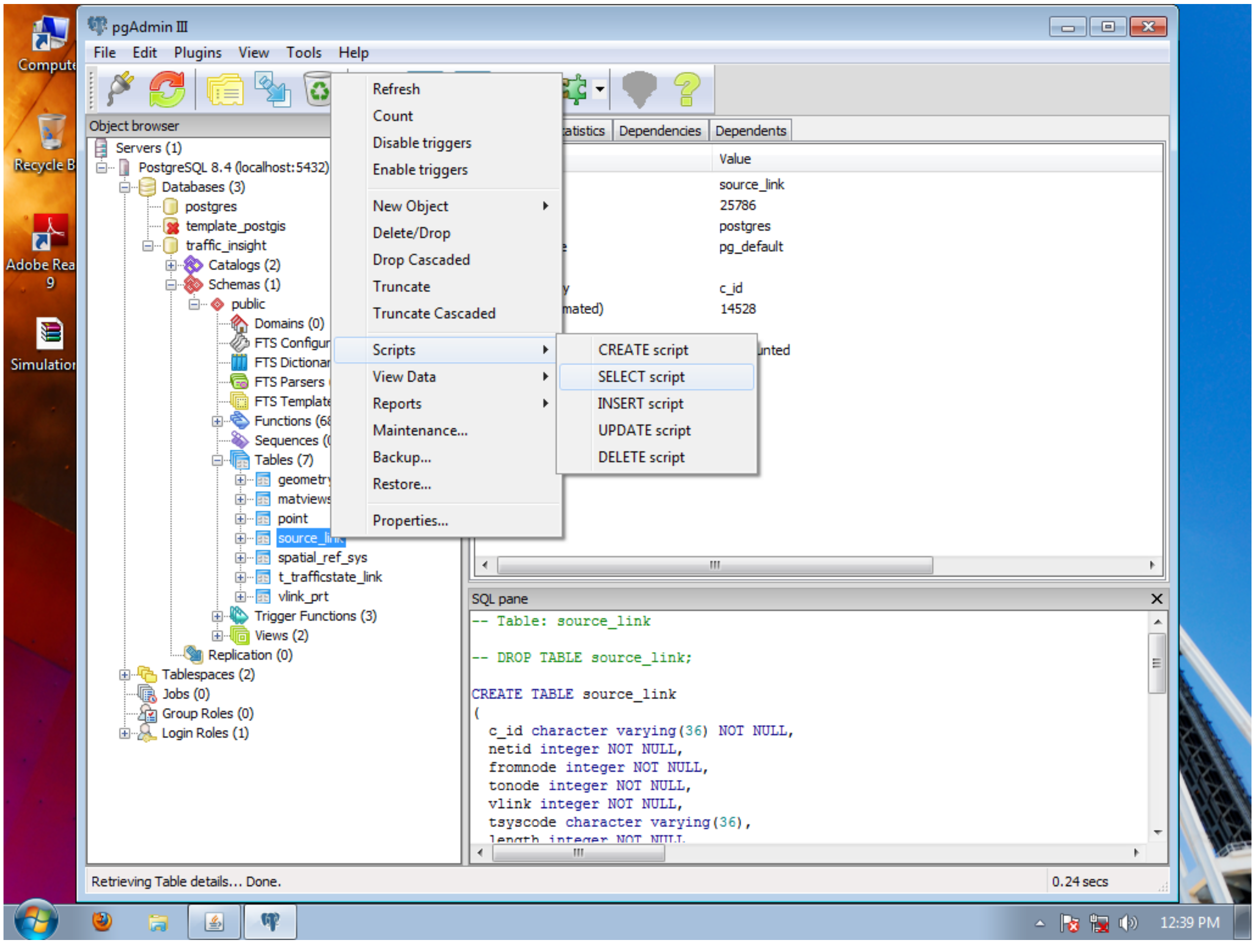


We defined this VMS to be number 81, and its name is "I-80 WB 300 E". We have all the information we need to add this VMS into the TP database.

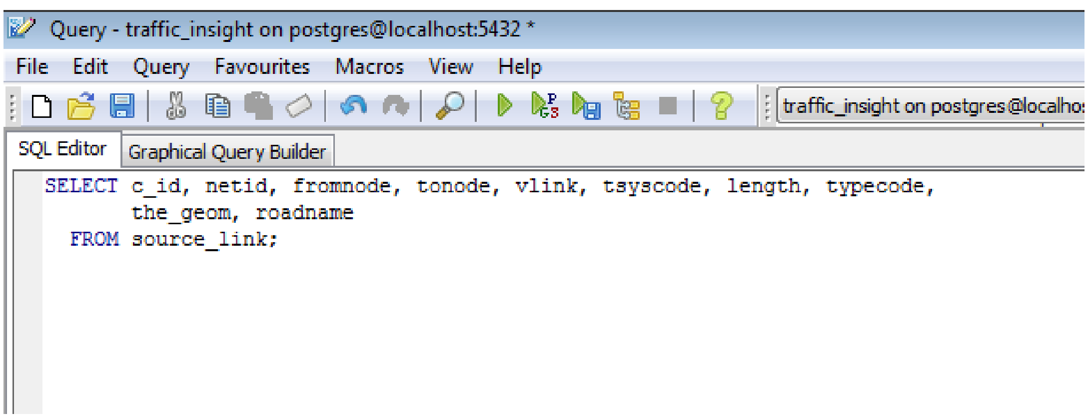
In VM, open pgAdming III (Start/pgAdmin III). Then on the left panel select:

PostgreSQL 8.4 => Databases (3) => traffic_insight => Schemas (1) => public => Tables (7)

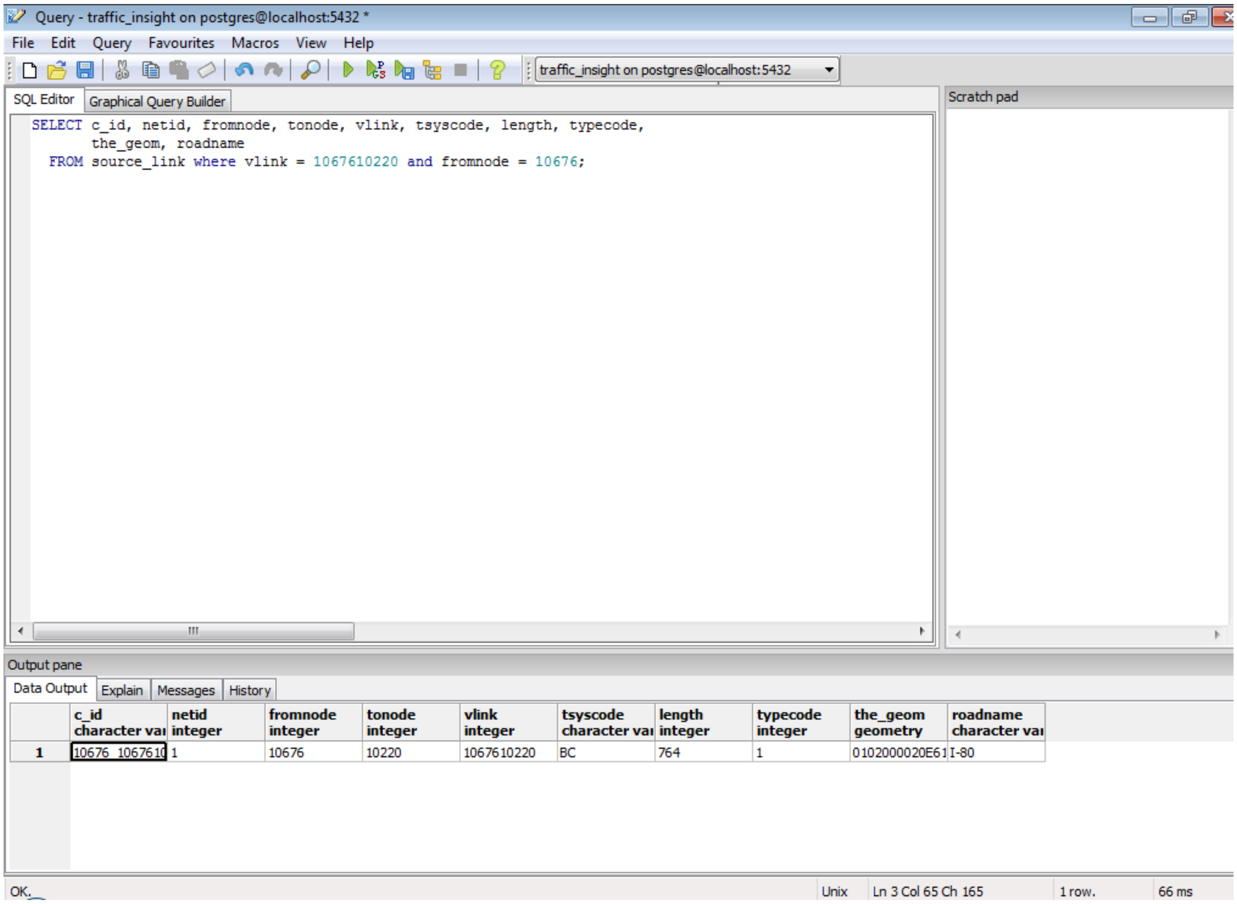
Then right click on source_link => Scripts => SELECT script (as shown in the figure below)



You will see the SQL editor that looks like this:



Here you need to input VISUM link number and VISUM From node number as follows and click on the green triangle (Execute query):

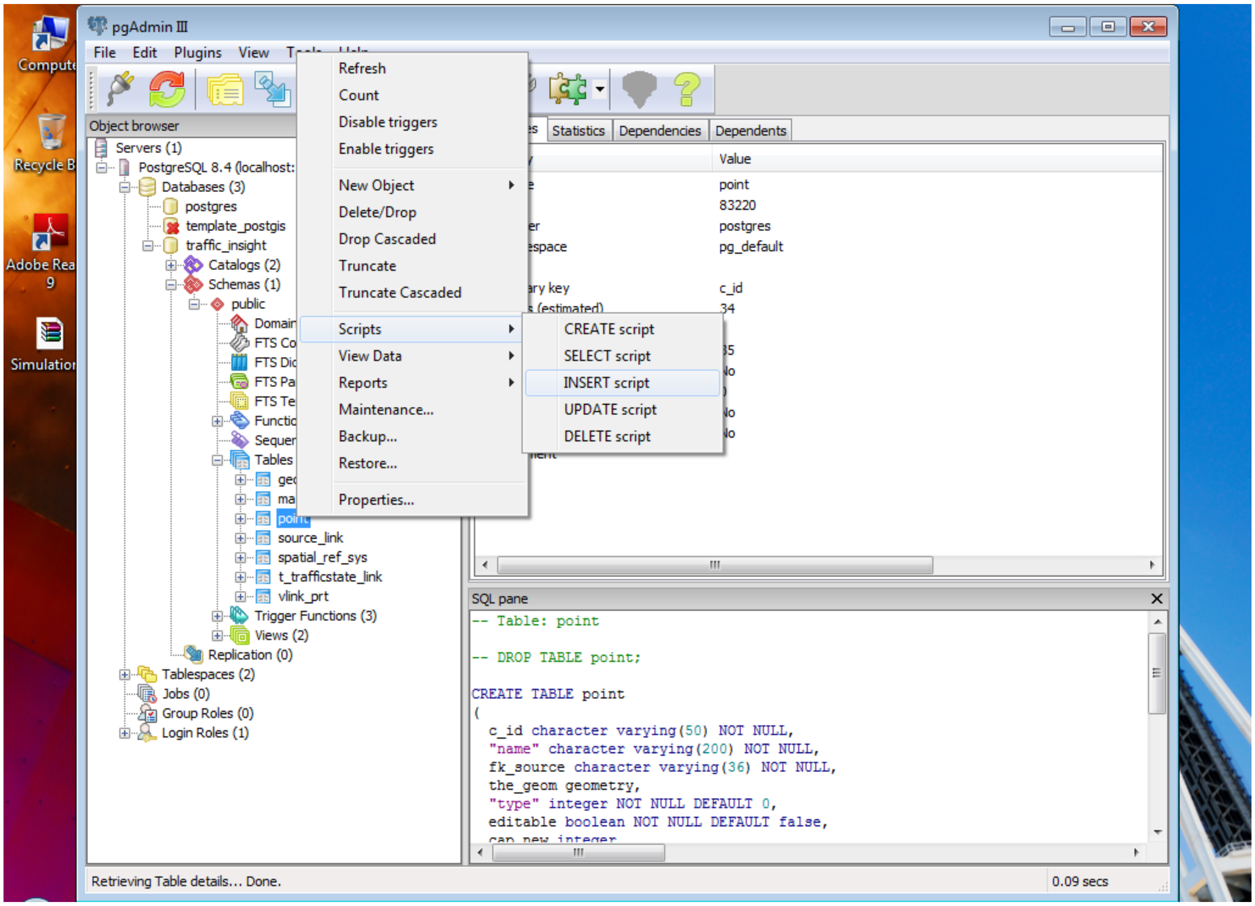


In the lower panel the SQL editor will provide the output data. Keep note of the c_id character from the Data Output table, which is essentially in format:

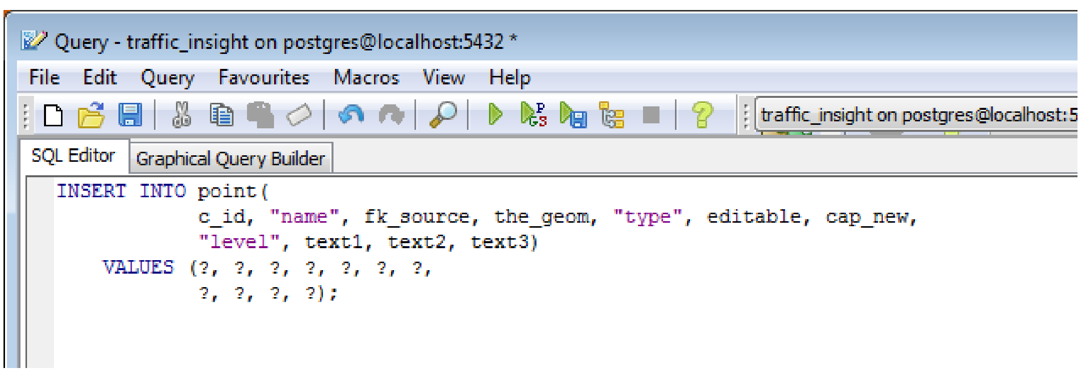
VISUM-From-node_VISUM-link-number_1

You can close this editor without saving (the query has been executed) and move on to the next step, which is to insert the VMS record in table “point”.

Right click on “point”, then Scripts => INSERT script (as shown in the figure below)



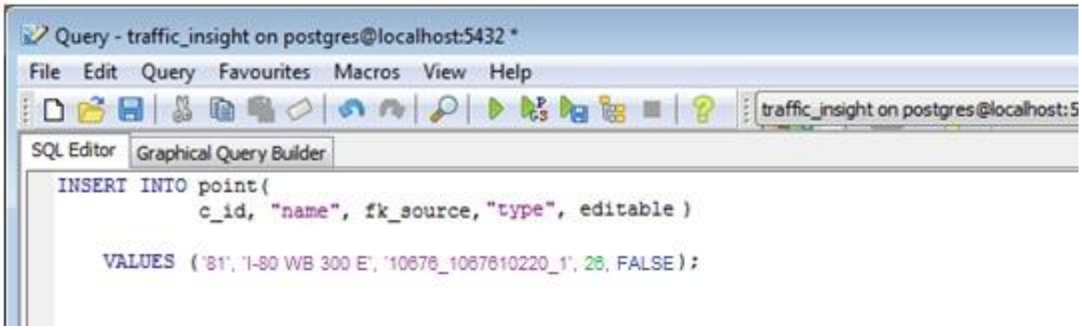
The SQL editor will look like this:



Here we don’t need “the_geom”, “cap_new”, “level”, “text1, text2, text3”, so we can delete those. All we need is: c_id, "name", fk_source, "type", editable

Within the VALUES we input VMS number, VMS name, c_id character, type (all VMS signs are type 26), and editable/not editable as follows:

VALUES ('81', 'I-80 WB 300 E', '10676_1067610220_1', 26, FALSE);

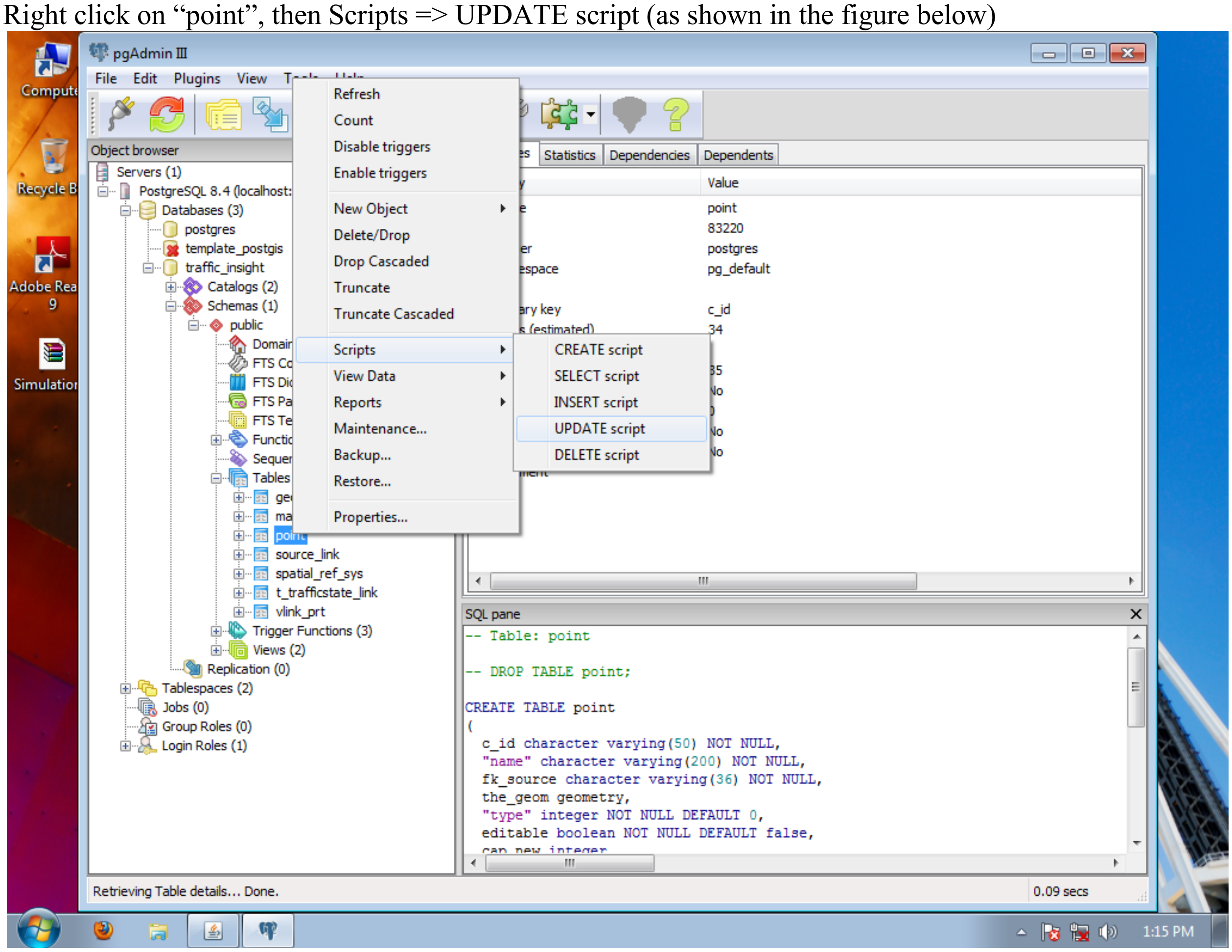


Later on the VMS can be set as editable as needed. Then we press the green triangle (Execute query) and close the SQL editor. If there were no errors, we can see the following message in the lower panel:

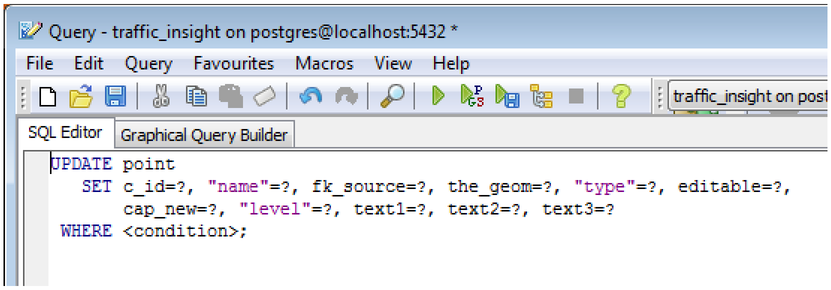
“Query returned successfully: 1 row affected, XYZ ms execution time.”

The last step is to update the geometry data for the new VMS as follows:

Right click on “point”, then Scripts => UPDATE script (as shown in the figure below)



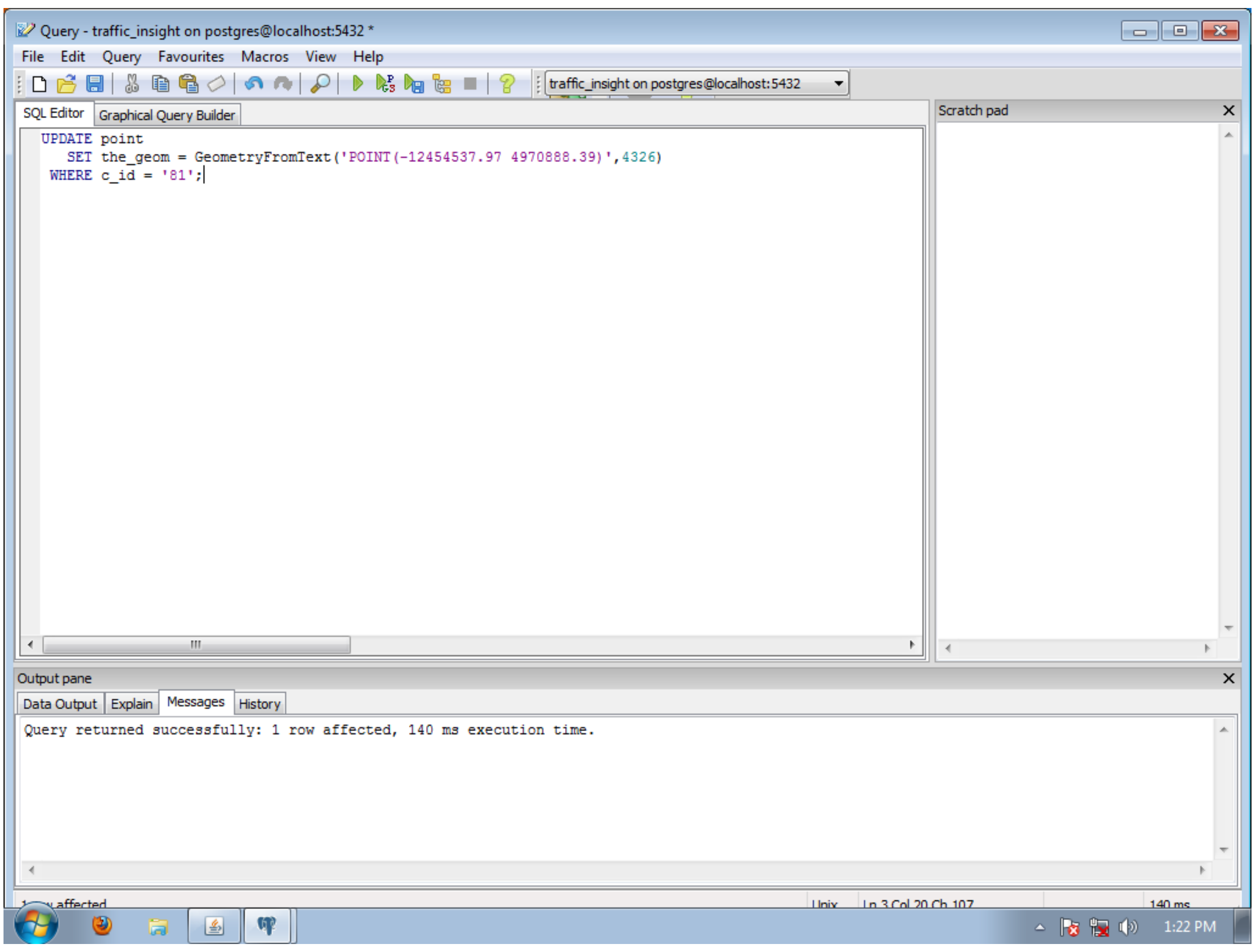
The SQL editor looks like this:



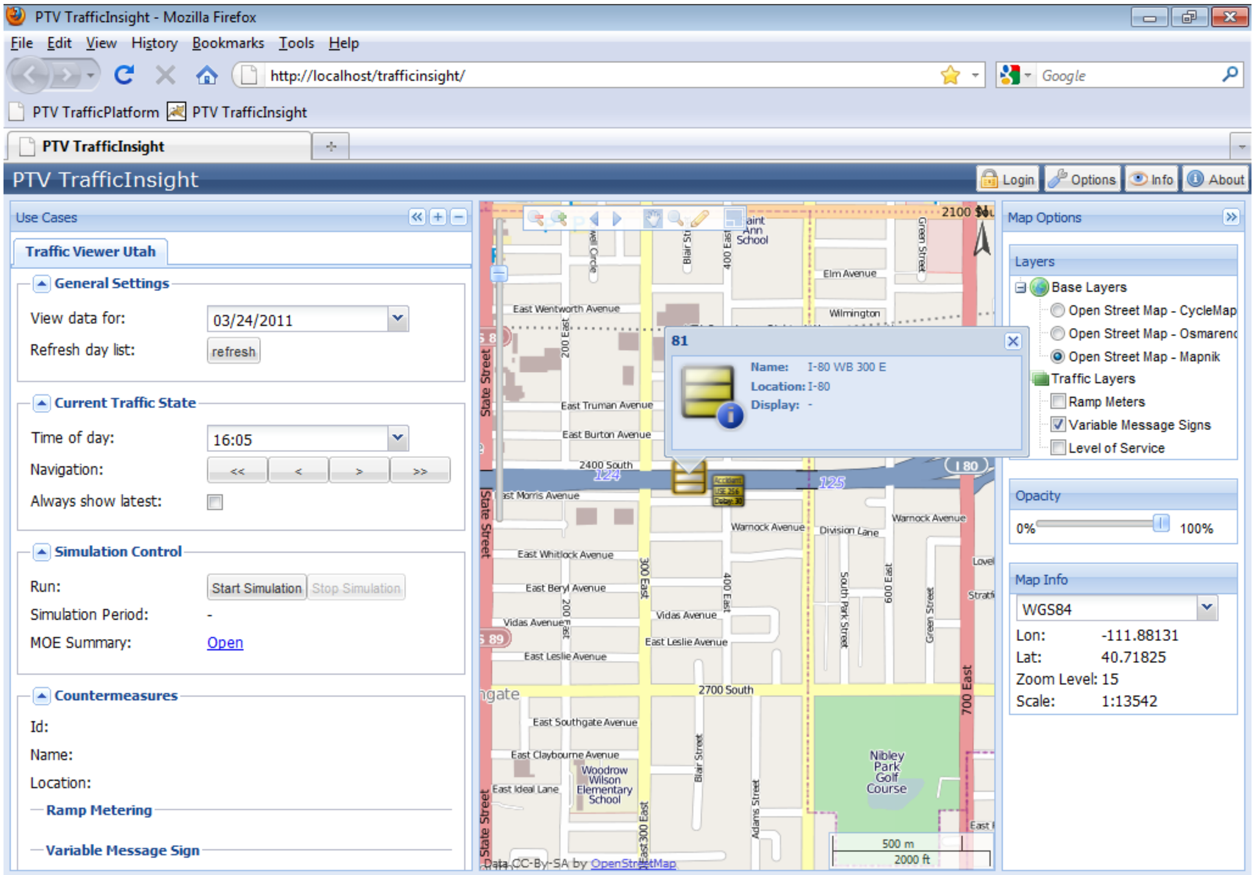
In this editor, we need only “the_geom=”, so we can delete the rest of the text. Here we input the Long/Lat data from the TrafficInsight as follows:

UPDATE point
  SET the_geom = GeometryFromText('POINT(-12454537.97 4970888.39)',4326)
 WHERE c_id = '81';

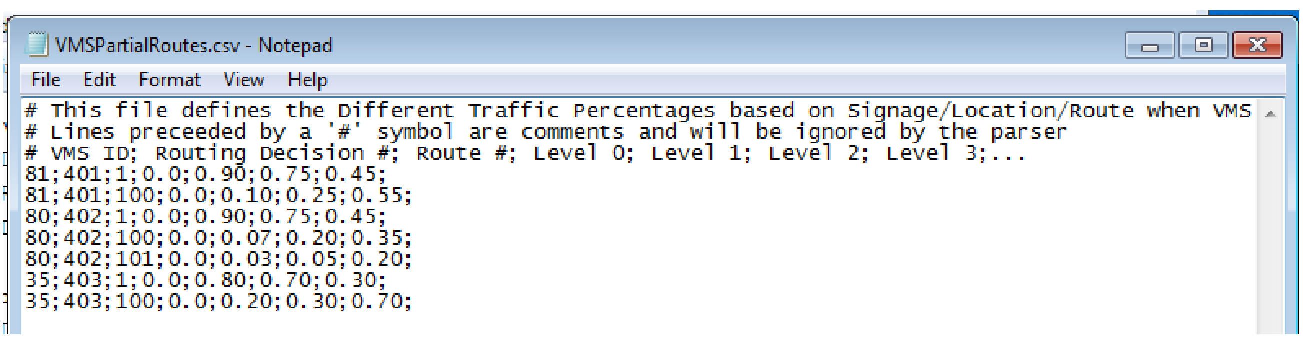
Then we execute the query (the green triangle) and the SQL editor returns a message as follows:



Now we can close the SQL editor, close pgAdmin III and start TrafficInsight (Mozilla Firefox). We should see the new VMS on the GUI:



Amend the VMSParialRoutes.csv file for the newly created VMS signs (the example below is given for the I-80 WB to I-15 SB ramp incident scenario):


VMSPartialRoutes.csv - Notepad

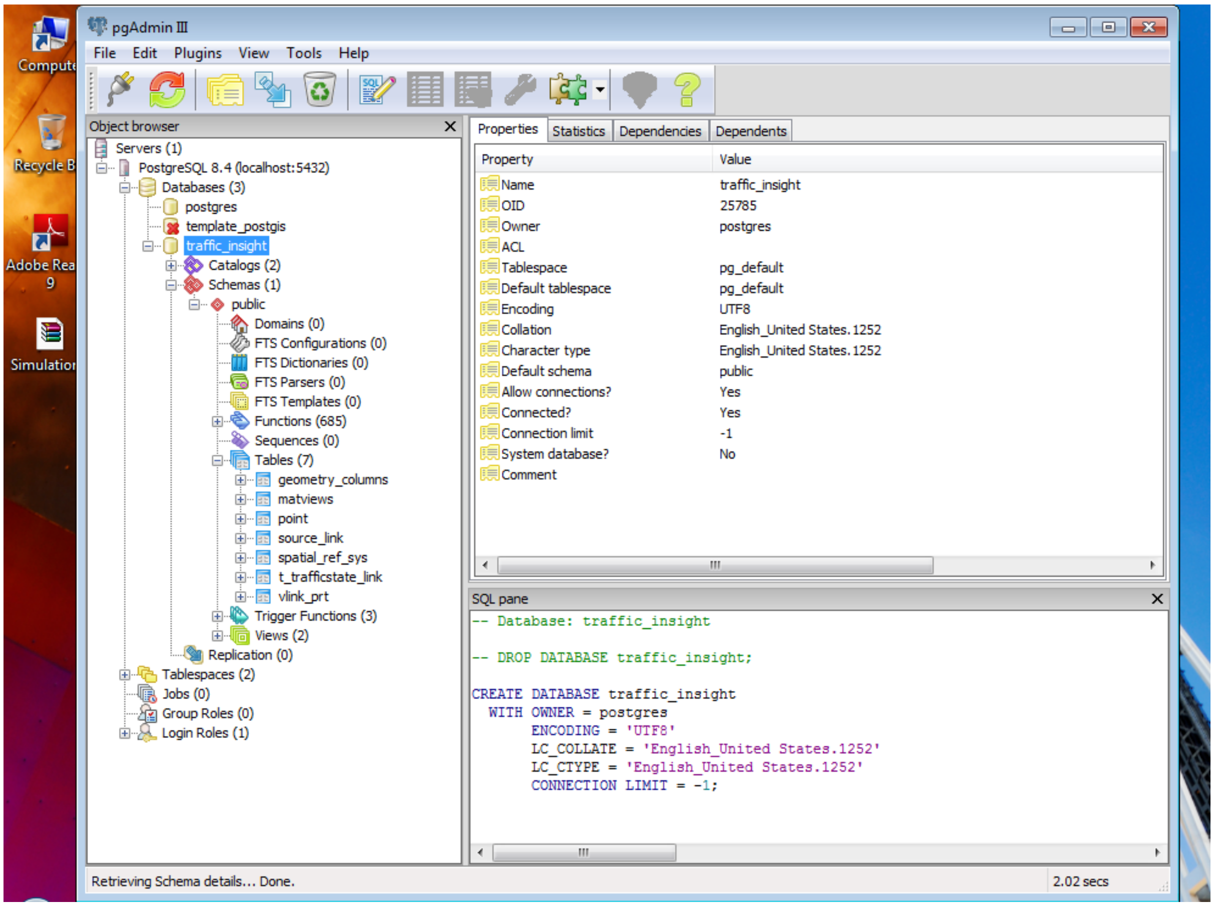
File Edit Format View Help

```
# This file defines the Different Traffic Percentages based on Signage/Location/Route when VMS
# Lines preceeded by a '#' symbol are comments and will be ignored by the parser
# VMS ID; Routing Decision #; Route #; Level 0; Level 1; Level 2; Level 3;...
81;401;1;0.0;0.90;0.75;0.45;
81;401;100;0.0;0.10;0.25;0.55;
80;402;1;0.0;0.90;0.75;0.45;
80;402;100;0.0;0.07;0.20;0.35;
80;402;101;0.0;0.03;0.05;0.20;
35;403;1;0.0;0.80;0.70;0.30;
35;403;100;0.0;0.20;0.30;0.70;
```

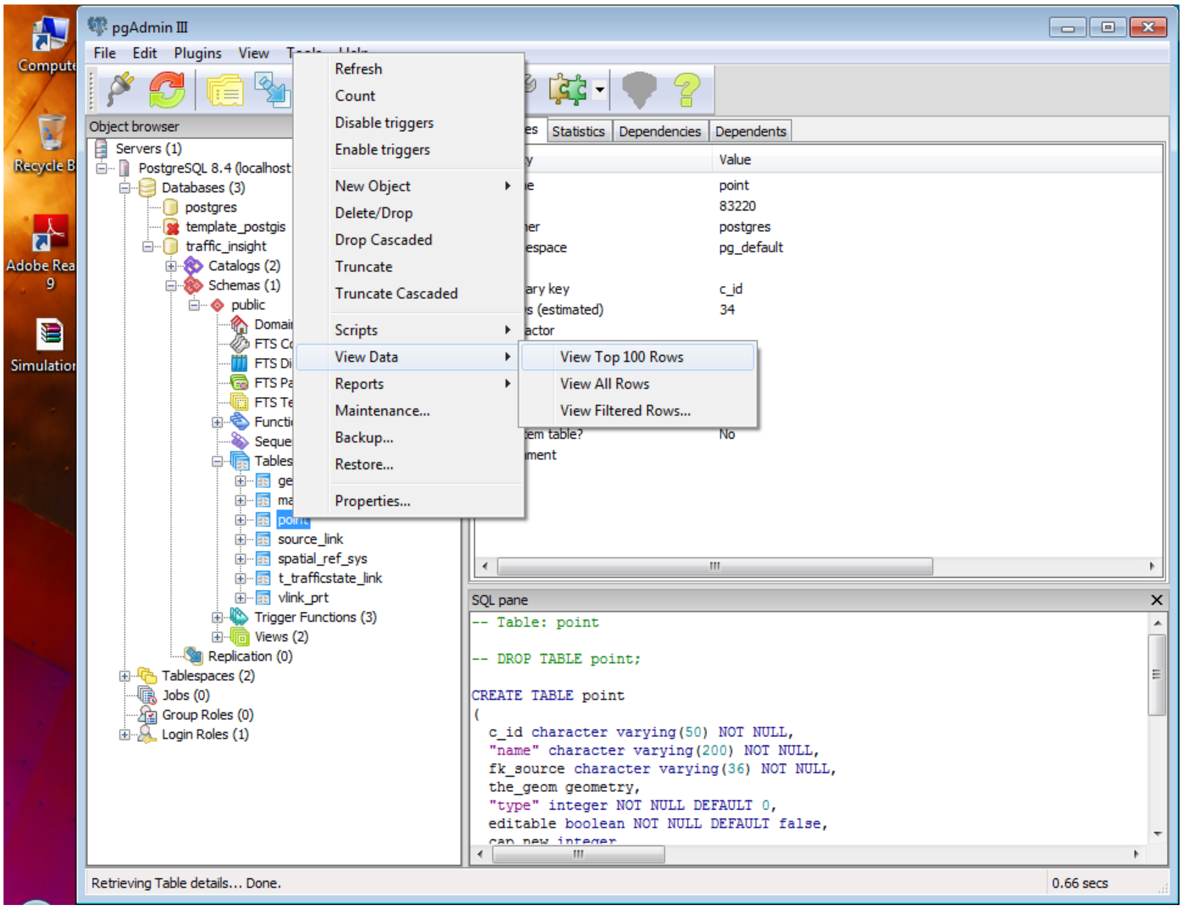
How to edit a VMS

Basic steps for editing VMS signs are as follows:

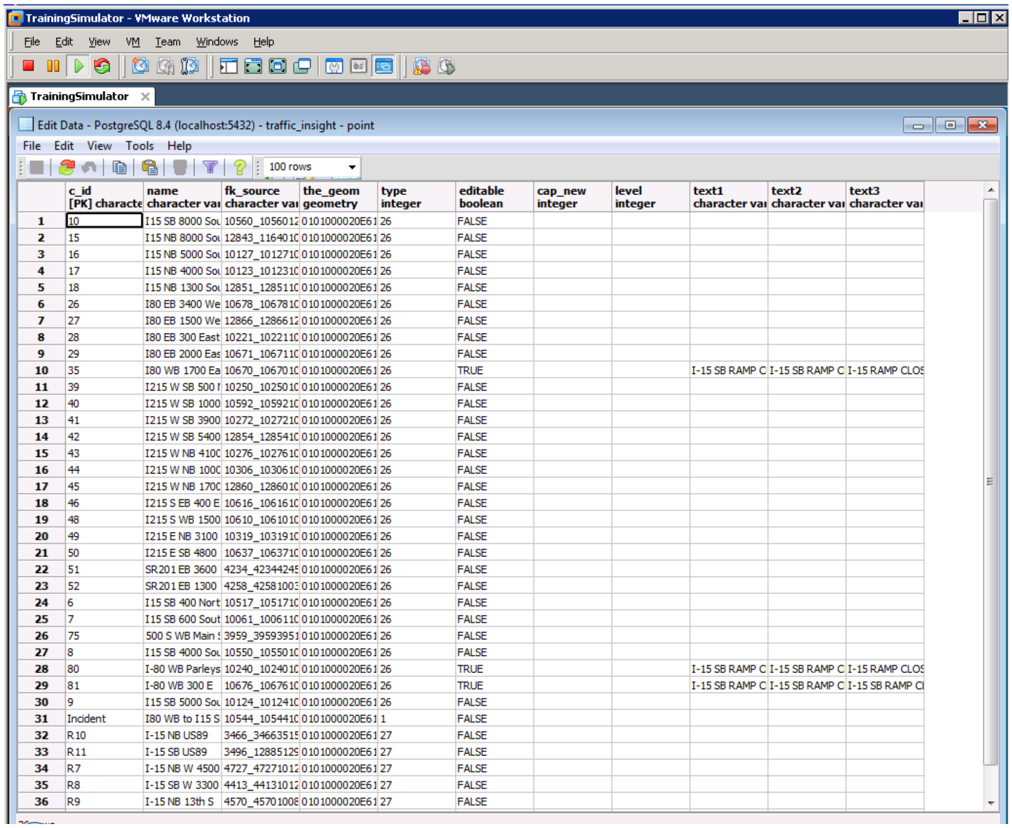
- In VM, open Start/pgAdmin III
- Go to PostgreSQL 8.4 => Databases (3) => traffic_insight => Schemas (1) => public => Tables (7) (Figure below)



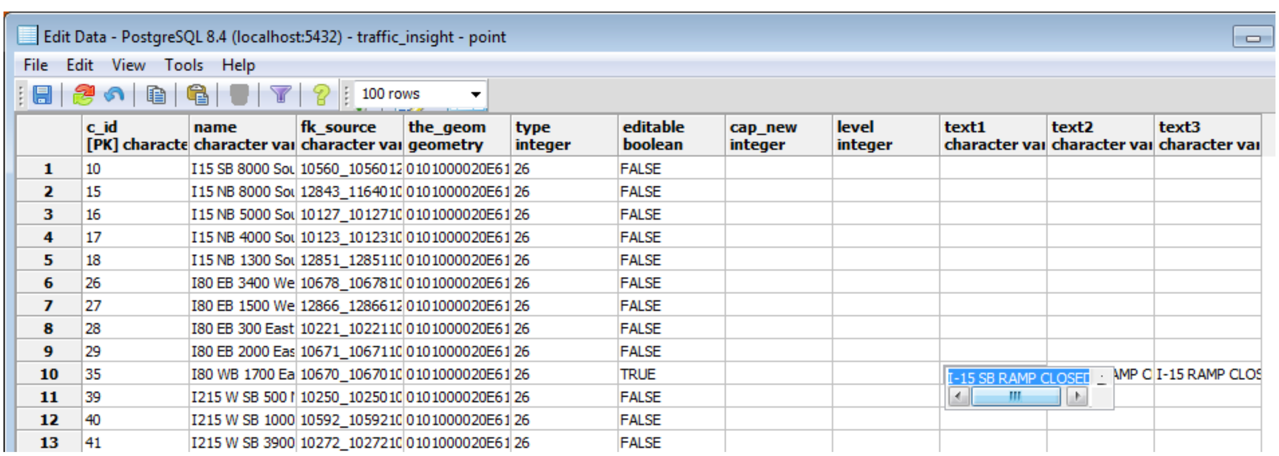
- Right click on “point”, View Data => View Top 100 Rows (as shown below)



- The editor will open and show the following table:



- For the VMS you want to edit, click within the "editable boolean" column and check the check-box; the cell should read "TRUE";
- Enter the text for the 3 VMS levels by selecting the corresponding cell; for entering two or three lines of text within the cell, use Shift+Enter



- When the text is edited, click on "Save"
- Close the editor and pgAdmin III
- When you open TP, the edited VMS should be yellow, and when you click on them you should see the text that you edited for the three VMS text levels.