DYNASMART-P

Intelligent Transportation Network Planning Tool

Version 1.0 User's Guide

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LIST OF ABBREVIATIONS

ATIS	Advanced Traffic Information System
AVG	Average
AWSC	All Way Stop Control
CPU	Central Processing Unit
DMS	Dynamic Message Signs
DSPEd	DYNASMART-P Editor
FHWA	Federal Highway Administration
FIFO	First-In First-Out
g/c	green time/cycle length
GHz	Giga Hertz
GB	Giga Bytes
GIS	Geographic Interface System
GUI	Graphical User Interface
HCM	Highway Capacity Manual
HOT	High Occupancy Toll
HOV	High Occupancy Vehicles
ID	Identification
KSP	K-Shortest Path
LOV	Low Occupancy Vehicles
LT	Left Turn
RT	Right Turn
TH	Through
MB	Mega Bytes
min	Minutes
Hrs	Hours
MOE	Measures of Effectiveness
mph	miles per hour
MUC	Multiple User Classes
No	Number
O-D	Origin–Destination
PC	Passenger Car
PCE	Passenger Car Equivalence
pcphpl	Passenger cars per hour per lane

SO	System Optimal
TAZ	Traffic Analysis Zone
TWSC	Two Way Stop Control
UE	User Equilibrium
vphpl	Vehicles per hour per lane
VMS	Variable Message Signs

1. INTRODUCTION

1.1 Purpose

This user's guide describes how to use and operate DYNASMART-P. The purpose of this guide is to provide DYNASMART-P users with a thorough understanding of how to use the software**.** The guide does not fully describe the technical aspects of traffic simulation and analysis. This guide assumes that the user is familiar with the general operation of Microsoft Windows.

1.2 Organization of the Guide

This volume is divided into eight sections and two appendices. Following this brief introduction, Section 2 presents the main features and capabilities of DYNASMART-P. Section 3 provides a quick reference for installing and using the software, with a simple hands-on-experience sample session. Section 4 describes the input files used in DYNASMART-P. Section 5 explains the various output files generated by DYNASMART-P. The Graphical User Interface (GUI) is documented in Section 6. Section 7 describes the process of creating a new data set in DYNASMART-P. Section 8 provides a list of some frequently asked questions and their responses. Appendix A discusses algorithmic aspects of the different modes of DYNASMART-P. Finally, Appendix B provides a list of possible error messages and the possible source(s) of error.

1.2.1 Typesetting Conventions

Figure 1-1 lists the typesetting conventions used throughout this guide.

Convention	*Description*
F2	Names of keys on the keyboard
ALT + **P**	Key combinations for which the user must press and hold down one key and then press another
File	Menu toolbar items have their first letter capitalized and underlined
File | Open	This means click on the File menu item and then click on the Open menu command
<Parameter Settings>	The name of the dialog box or window is underlined and enclosed between < > marks
<<Next>>, <<Control Panel>>	Icons, buttons, and names in dialog boxes are enclosed between double << >> marks.
[Traffic Management]	The name of block or tab item in a window or dialog box

Figure 1-1. Typesetting conventions

1.3 What is in the Package?

The current release of DYNASMART-P contains:

- The DYNASMART-P execution file (*DYNASMART-P.exe*), which launches the GUI, and is the main operation tool provided for dynamic traffic analysis;
- The User's Guide (*USERSGUIDE.pdf*) in electronic format for quick access;
- *WORDPAD* tool for text editing;
- An execution planning tool file (*PLANNING.exe*), which can only be accessed from within the DYNASMART-P GUI; and
- A test network (namely the Dallas Fort Worth network) with all of the input files including *control.dat*, *bus.dat* and *ramp.dat*.

1.4 Additional Sources of Information and Feedback

For training workshops, technical support, contacts, and more information about DYNASMART-P and FHWA dynamic traffic assignment research program, please check the following websites:

www.dynasmart.com
www.dynamictrafficassignment.org

Feedback may be submitted through the DYNASMART-P website.

2. DYNASMART-P FEATURES

DYNASMART-P is a state-of-the-art dynamic network analysis and evaluation tool. It was originally conceived and developed at the University of Texas at Austin, with participation of researchers at the University of Maryland, Northwestern University, Purdue University, and the University of California at Irvine. It is an intelligent transportation network design, planning, evaluation, and traffic simulation tool. DYNASMART-P models the evolution of traffic flows in a traffic network resulting from the travel decisions of individual drivers. The model is also capable of representing the travel decisions of drivers seeking to fulfill a chain of activities, at different locations in a network, over a given planning horizon. It overcomes many of the known limitations of static assignment tools used in current practice. These limitations pertain to the types of alternative measures that may be represented and evaluated, and the policy questions that planning agencies are increasingly asked to address. DYNASMART-P allows consideration of an expanded set of such measures, compared to both conventional static assignment models and traffic simulation tools. This is primarily due to:

- Richer representation of travel behavior decisions (at the discrete level) than static assignment models;
- Explicit description of traffic processes and their time-varying properties; and
- Explicit representation of traffic network elements, including signalization and other operational controls.

The modeling features chosen for implementation of DYNASMART-P achieve a balance between representation detail, computational efficiency, and input data requirements. These features include:

- Efficient hybrid traffic simulation-assignment approach, which moves individual vehicles according to robust macroscopic traffic flow relations.
- Detailed representation of traffic networks with different link types such as freeways, highways, and arterial networks. Micro-simulation of individual trip-making decisions, particularly route choice.
- Ability to load trips and simulate trip chains with several intervening stops having associated durations.
- Representation of multiple vehicle types in terms of operational performance (e.g. trucks, buses, passenger cars).
- Representation of traffic processes at signalized and non-signalized junctions, under a variety of operational controls.

- ❑ Iterative algorithms for computation of consistent flow patterns and user decisions, e.g., time-varying user equilibrium where applicable.
- ❑ Detailed output statistics at both the aggregate and the disaggregate levels. For example, DYNASMART-P generates various performance measures over time for each link in the network. These measures of effectiveness (MOE) include vehicle trips, speeds, densities, and queues. It also produces the trajectory of each vehicle in the network, from origin to destination, including intermediate activity stops. Statistics such as average travel times, average stopped times, and the overall number of vehicles in the network is also provided at varying levels of aggregation.

The following subsections provide a detailed discussion of the features, functions and capabilities of DYNASMART-P.

2.1 Network Size and Structure

DYNASMART-P is not limited by the size of the network, except for hardware-related constraints (e.g. memory). It is designed for use in urban areas of various sizes (both large and small) and is scalable, in terms of the geometric size of the network, with minimal degradation in performance. The arrays and data structures are of a variable size and limited only by the hardware. The computationally and memory taxing features of DYNASMART-P, such as shortest path calculations and simulation intervals, can be edited prior to running the program to facilitate analyzing larger networks.

DYNASMART-P can also model the fine details of transportation networks such as zones (any number of zones), intersections, links, origins and destinations. The user can specify any zonal configuration for the network, as long as it is consistent with the origin-destination demand matrix. Links may be modeled as freeways, highways, ramps, arterials, and high occupancy toll lanes, etc. Each link is represented by its length, number of lanes, existence of left-turn bays, maximum traffic speeds, etc. Two-way lane roads are modeled as two links, i.e. no overtaking is allowed by taking space in the opposing lane. Link junctions with different signalized and non-signalized control options are also modeled in DYNASMART-P. Finally, DYNASMART-P can represent trip origins, destinations and even intermediate destinations for trip chaining.

2.2 Demand Representation (Origin-Destination Matrix and Trip Chaining)

DYNASMART-P is flexible in the way it accepts loading information (time-varying rates prevailing over specified intervals, numbers of vehicles in discretized time slices, individual vehicle schedules). It can also be interfaced with demand data inputs developed from either conventional aggregate models or disaggregate micro-simulation based procedures.

There are two methods for preparing vehicle generation in DYNASMART-P. The first method is to specify Origin-Destination (O-D) matrices among origin-destination zones at different time intervals. A flexible dynamic demand input format is supported by DYNASMART-P. The user needs to define the number of loading intervals, a multiplication factor for demand generation (to facilitate experimentation at different demand loading levels), the starting time of each period, and the end of vehicle generation time (loading period). For each time period, an O-D zone matrix needs to be prepared in order to generate and load vehicles onto the network. This gives the user flexibility to specify demand level and demand distribution between different zones, for any loading period.

The second vehicle loading method is to specify the itineraries (origin and destination) of all vehicles with or without their corresponding travel plans. In this format, users can specify a trip plan (chain) for each traveler. The data required are the intermediate stops considered by each traveler, and the corresponding activity durations. This approach provides maximum flexibility to interface with micro-simulation activity-based travel demand forecasting models.

2.3 Traffic Control

DYNASMART-P can model common control strategies at link junctions such as no control, yield signs, stop signs, pre-timed signals, and actuated signals. Coordinated actuated control is not explicitly modeled, but can be approximated. At signalized intersections, users can specify any phasing pattern, the movements, and the other signal settings to represent any real network. DYNASMART-P can also model ramp metering on freeways. Users can specify any number of ramp meters, their location, and their operational period in the network.

2.4 Key Physical Properties and Spatial-Temporal Constraints

DYNASMART-P satisfies all key physical properties and spatial/temporal constraints pertaining to vehicles, traffic, and highway networks, e.g., link flow conservation equations, node-link flow transfer balance equations, physical space limitations, and the First-In First-Out (FIFO) vehicle movement principle. Ability to model the FIFO property is critically important because it is easily violated, in different ways, in virtually all analytical math programming or control theory formulations proposed in the literature. The link performance or exit function itself may lead to having vehicles that leave later but arrive earlier; the kind of functions used in static assignment often lead to such violations. Functional forms that do not produce this anomaly are under investigation, though it does not appear that such forms that satisfy various traffic realism requirements are available currently (and most likely will never be).

In time-dependent assignment problems with multiple destinations, vehicles on different paths that share one or more common links may be moved across the common link in a manner that violates FIFO; for instance, if the downstream link along one path is blocked but not for the other path(s). Unless explicitly precluded by specifying mathematical constraints for this purpose, it cannot be eliminated. The FIFO issue further highlights the advantages of a traffic simulator in the dynamic assignment context. Simulation moves vehicles based not only on their current location and speed, but also based on their current "leader" and "follower" vehicles, such that FIFO is implicitly satisfied.

2.5 Different Vehicle Types

DYNASMART-P recognizes four vehicle types: passenger cars (PC), trucks, high-occupancy vehicles (HOV), and buses. These vehicle types are recognized for their effect on traffic conditions (such as link capacity, speed, density, volume, etc.) and consequently path assignment. Note that PCs, trucks, and HOVs are specified as fractions of the overall vehicle fleet. In this case, the specified O-D demand matrix should reflect vehicular trips. Alternatively, the user may specify a separate O-D demand matrix to account for trucks and HOVs in the network. In this case, there is no need to specify the fraction of trucks or HOVs in the overall vehicle fleet.

2.6 Multiple User Classes

DYNASMART-P recognizes five different user classes (not to be confused with vehicle types) in terms of the availability of Advanced Traffic Information System (ATIS) equipment, driver's knowledge of the network, and driver response to supplied routing information. In this regard, DYNASMART-P has the ability to specify a multiple user class (MUC) distribution to be applicable across all vehicle types in the network, or separate MUC distributions for each vehicle type. It also recognizes different vehicle passenger occupancies such as HOVs and Low Occupancy Vehicles (LOVs).

2.7 Geometric and Operational Restrictions (Lane/Link Use by Vehicle Type)

DYNASMART-P explicitly accounts for the geometric and operational restrictions that impact route assignments over multiple time periods, including lane-use restrictions on: (1) HOV vehicles; and (2) High Occupancy Toll (HOT) Lanes. In particular, it is capable of separating vehicles eligible for HOV/HOT lanes from those not eligible, and is capable of simultaneously accounting for the respective travel-time differences between HOV/HOT and regular lanes at the path assignment level. Note that these restrictions are modeled through special-purpose network link representations.

This requirement has implications for three components in the methodology: (1) flow simulation, (2) provision of information to multiple user classes, and (3) path-processing component. All three are already addressed and available in the simulation-based approach. In particular, these are functional requirements that are explicitly met and exceeded by the DYNASMART-P simulation assignment model. Geometric and operational restrictions can be readily captured by modeling the street network as a multidimensional network.

Two major geometric and operational restrictions can be applied in DYNASMART-P. The first is the prohibition of certain movements at intersections over a period of time. By mapping intersection movements to a network dimension, a multidimensional network is created with a penalty associated with each movement at an intersection. If a large penalty is assigned to the movement at the time the prohibition applies (such as during a red phase), vehicles will not use this approach during the prohibited time period. The second restriction is accomplished by applying a high penalty on links (HOV lanes for example) for specific vehicle types, so as to restrict their access to these links.

It should also be stressed that the need for realistic system representation, in terms of geometric, movement restrictions, and the like, provides yet additional motivation for the use of simulation in the context of traffic assignment for planning applications.

2.8 Fixed Schedule and Background Traffic

The model is capable of representing background traffic, i.e. vehicles with predetermined routes, such as transit-type vehicles. Transit operation requirements include the representation of bus routes, start times, stop locations, and dwell times. There is no restriction on the number of buses considered, their routes, or their start times.

2.9 Network Capacity (Supply) Changes

DYNASMART-P is able to interface with time-varying capacity changes resulting from, but not limited to, incidents, lane closures and construction zones. Users can specify any capacity reduction (due to incidents, for example) on any link or group of links in the network, for any time period. The model is not limited to any number of incidents, or to any incident duration.

2.10 Generalized Cost Modeling

Shortest path calculations in DYNASMART-P are based on generalized link impedance, allowing development of route assignments responsive to travel times and out-of-pocket costs. The shortest paths are calculated differently for vehicles that encounter out-of-pocket cost (both positive and negative) along their path. Their shortest path, in this case, is calculated based on a generalized cost function rather than the travel time only. The model is also capable of reflecting the effects of congestion pricing (to manage demand) on route assignments and O-D trips. The current DYNASMART-P version, however, does not support the specification of different costs for different links of the same type. That is, the same cost is applied across the board for a given link type (HOV, HOT, or regular links).

2.11 Network Familiarity and Information Strategies

DYNASMART-P does not explicitly model drivers' knowledge of the network. However, given that driver knowledge of the network is manifested in the paths they select, it follows that limited network familiarity often leads to the selection of longer paths and vice versa. Therefore, by assigning varying paths to different vehicle user classes, DYNASMART-P is capable of implicitly incorporating the effect of drivers' familiarity with the network.

Central to this path-assigning mechanism is the ability of DYNASMART-P to model the impact of different information supply strategies, including Variable Message Signs (VMS), pre-trip information, and autonomous driver information or route guidance (for vehicles capable of receiving en-route information) on traveler behavior and overall network performance. In particular, DYNASMART-P can model vehicles having pre-trip current best path (travel time of the path is calculated based on current travel times in the network), random path (a path chosen randomly out of a set of superior paths for which their travel times are also calculated based on current travel times in the network), user equilibrium paths, and system optimal paths.

Moreover, DYNASMART-P has the flexibility to model a pre-specified proportion of vehicles that receive en-route information based on the "boundedly rational" behavior. Such vehicles may choose to respond to VMS messages as well (if the VMS preemption mode is selected). Pre-trip information should impact departure time choice. The current version of DYNASMART-P does not model the choice of departure time based on pre-trip information. However, this functionality will be implemented in the future as part of a day-to-day dynamic and equilibrium framework, which incorporates and addresses day-to-day user-choice behavior dimensions. More information about the different modes of running DYNASMART-P is given in Appendix A.

2.12 Graphical User Interface

DYNASMART-P has a GUI that allows users to easily change some of the frequently used inputs. It also allows users to conveniently view input and output files, the different statistics produced, and simulation results. The user interface is designed and implemented to work under the Windows NT, Windows 2000, and Windows XP platforms.

2.13 Computational Efficiency

The modeling features chosen for implementation of DYNASMART-P achieve a balance between representational detail, computational efficiency, and input/output data requirements. Since DYNASMART-P involves many capabilities that are not necessarily invoked simultaneously, users can always make efficient use of available computer memory by activating only the required features. This will greatly improve the computational efficiency of DYNASMART-P, and the associated running time.

2.14 Extensive Output Data and Statistics

Detailed output statistics at both the aggregate and the disaggregate levels are generated by DYNASMART-P. For example, DYNASMART-P produces various temporal link characteristics such as speeds, densities, queues etc. It also produces the trajectory for each vehicle so that the user can follow each vehicle in the network until it reaches its final destination. The trajectories include the travel time on each link and the stop duration at each node. In that regard, a classification is made for the vehicles based on their trip chaining characteristics (essentially, the number of activity stops in the chain) and statistics can be obtained for each class. In addition, DYNASMART-P outputs the summary statistics (both average and total) of travelers' characteristics including travel time, distance traveled, queues, and stopping durations. It also produces special statistics for high occupancy vehicle lanes and high occupancy toll lanes.

2.15 Computational Performance

The computational performance of DYNASMART-P version 1.0 has been tested on selected cases. Four types of computational performance tests were conducted: 1) one-shot simulation-assignment 2) pure UE assignment, 3) pure SO assignment, and 4) iterative Multiple User Class (MUC) procedure, where each of the 5 user classes was set to comprise 20% of traffic generation.

Two networks were used for the benchmark testing. The first network is the Dallas Fort Worth, TX network, consisting of 178 nodes, 441 links, and 13 Traffic Analysis Zones (TAZs). The second network is the Knoxville, TN network, consisting of 1347 nodes, 3304 links and 356 TAZs. Two PCs of varying memory and computational power were used to test these networks:

One was a Dell Desktop with Pentium IV 1.8 GHz processor and 2 GB memory; the other was a Dell Desktop with a Pentium IV 2.8 GHz processor and 4 GB memory. The former machine was used to test the Dallas Fort Worth network, whereas the latter was used to test the Knoxville network. In the Dallas Fort Worth network, test cases (scenarios 1 to 4), 55k vehicles were generated in 2 hours of simulation. For the Knoxville network (scenarios 5 to 8), 268k vehicles were loaded in 2 hours of simulation. The performance test results are summarized in Table 2-1 and Table 2-2.

Table 2-1. DYNASMART-P computational performance summary – Dallas Fort Worth network

Test Attribute	*Scenario*			
	1	*2*	*3*	*4*
Type of run	One Shot	UE	SO	MUC
KSP algorithm	Yes	Yes	Yes	Yes
MUC algorithm	No	No	No	Yes
Number of K-shortest paths	K = 1	K = 1	K = 1	K = 1
Vehicle loading method	O-D Matrix	O-D Matrix	O-D Matrix	O-D Matrix
Simulation period (hrs)	2	2	2	2
Vehicle loading period (hrs)	2	2	2	2
Number of generated vehicles	55 k	55 k	55 k	55 k
Number of nodes	180	180	180	180
Number of links	445	445	445	445
Number of TAZs	13	13	13	13
Aggregation interval (min)	1	1	1	1
Assignment interval (min)	1	1	1	1
Number of iterations	N/A	29	28	11
CPU time	00:00:40	00:46:34	00:46:47	00:29:43
Memory usage (Initial – Final, MB)	478 – 508	479-1346	605-1289	598-946

Table 2-2. DYNASMART-P computational performance summary – Knoxville network

Test Attribute	*Scenario*			
	5	*6*	*7*	*8*
Type of run	One Shot	Pure UE	Pure SO	Full MUC
KSP algorithm	Yes	Yes	Yes	Yes
MUC algorithm	No	No	No	Yes
Number of K-shortest paths	K = 1	K = 1	K = 1	K = 1
Vehicle loading method	O-D Matrix	O-D Matrix	O-D Matrix	O-D Matrix
Simulation period (hrs)	2	2	2	2
Vehicle loading period (hrs)	2	2	2	2
Number of generated vehicles	268,000	268,000	268,000	268,000
Number of nodes	1347	1347	1347	1347
Number of links	3004	3004	3004	3004
Number of TAZs	356	356	356	356
Aggregation Scheme	106	106	106	106
Aggregation interval (min)	NA	10	40	50
Assignment interval (min)	NA	10	40	50
Iteration Number	NA	5	3	3
CPU time	00:17:21	01:34:16	00:54:27	0:54:20
Memory usage (Initial – Final, MB)	700 – 1006	700 – 2350	700 – 1940	700 – 2600

In summary, memory usage increases with network size and loading period duration, and when iterative consistent assignment (equilibrium) algorithms are used. Note that the memory figures reported include a base memory of 200 MB reserved to the Windows XP operating system.

3. GETTING STARTED

DYNASMART-P is a Windows NT/2000/XP (and later versions) application, which consists of the simulation-assignment model and a front-end GUI, the intent of which is to provide a convenient environment for operating DYNASMART-P. This design allows users to open an existing project workspace or create an entirely new one. The term “project workspace” refers to a directory where all of the input and output files reside. Settings are provided for the construction of different scenarios. In constructing any particular scenario, users are supplied with assistance in fulfilling the necessary tasks. Run-time information is updated dynamically to let users know of the execution status. Once the simulation is complete, relevant statistics are made available for viewing. In addition, users can examine simulation results and other characteristics that pertain to the given scenario. The following sections describe features and functionalities of the GUI.

3.1 System Requirements

This section lists the minimum hardware and software requirements to install and execute DYNASMART-P on a personal computer. Dynamic traffic simulation-assignment procedures are both memory and processor intensive. While DYNASMART-P will operate with the minimum hardware requirements, it is recommended for most analyses that a moderately well equipped Pentium 4 be used.

3.1.1 Minimum Requirements

- ❑ Platform: Windows XP, Windows 2000, Windows ME or Windows NT 4.0 (service pack 5)
- ❑ Memory: 300 MB RAM required, 512 MB RAM or above is recommended (see Section 3.2)
- ❑ Virtual memory (initial size): 512 MB (see Section 3.2)
- ❑ Hard Drive Space: minimum 300 MB
- ❑ Recommended display (see Section 3.2)
    - ➢ Small fonts
    - ➢ Screen resolution: 1024 X 768

3.2 Remarks

If the specified hardware memory requirement cannot be met, additional memory can be allocated through virtual memory. To change virtual memory settings in the Windows XP environment (for other Windows environment, similar instructions apply) click on the <<Start>> icon. Select the <<Control Panel>> icon and then click on the <<Performance and Maintenance>> icon. Click on the <<System>> icon and select the <Advanced> tab. Click on the <<Performance Settings>> button. A new window will appear. Click on the <Advanced> tab, and then in the virtual memory block, click on <<Change>>. A dialog similar to the one below will appear (Figure 3-1). Enter 512 in the <<Initial Size>> input box. The <<Maximum Size>> can be specified as the maximum space available. Click on <<Set>> to activate the new settings.

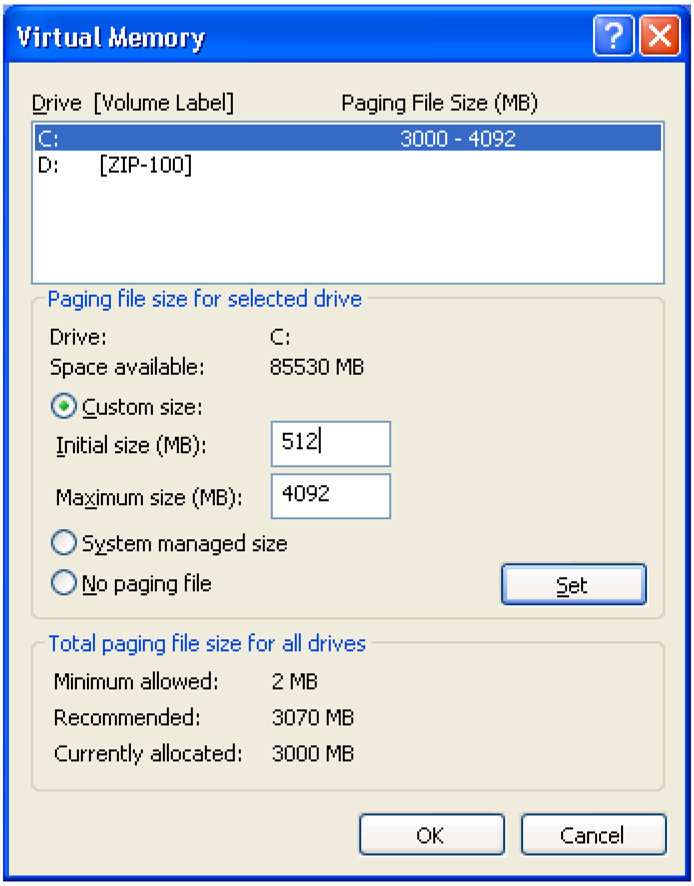


Figure 3-1. Virtual Memory dialog box

To change your display settings in Windows XP, click on the <<Start>> icon. Select the <<Control Panel>> icon, and then click on the <<Appearance and Themes>> icon. Click on the <<Display>> icon. Click the <Settings> tab, and modify the resolution according to the recommended system specifications above. The application would still work if you used large fonts; however, certain components could look awkward.

3.3 Installation

1. Insert the DYNASMART-P distribution CD into the CD-ROM drive.
2. Locate the downloaded setup file and double click it.
3. An installation wizard will guide you through the setup process.
4. Follow the instructions of the wizard.
5. Upon installation, a DYNASMART-P Menu in the Program Files Menu will be created.
6. The wizard will inform you when the install process is complete.
7. You are now ready to use DYNASMART-P.

3.4 Remove DYNASMART-P

DYNASMART-P can be removed from your system using the uninstall command located under the DYNASMART-P application menu.

1. Click on the <<Start>> icon.
2. Click on the <<All Programs>> icon.
3. Locate the DYNASMART-P program menu.
4. Click on the <<Uninstall DYNASMART-P>> option.
5. Follow the instructions.
6. The wizard will inform you when the un-install process is successful.

3.5 Starting and Quitting

3.5.1 Starting

Click on the DYNASMART-P icon from the Start | All Programs Windows XP menu command (Figure 3-2).

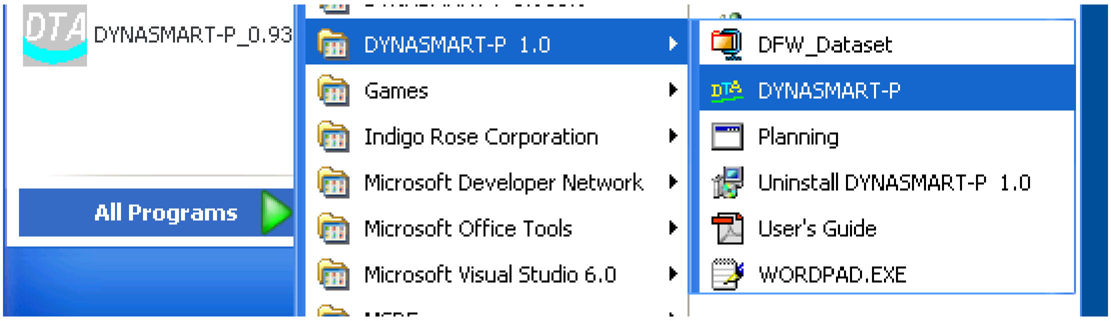


Figure 3-2. DYNASMART-P application menu

3.5.2 Quitting

To quit the program, simply close the DYNASMART-P window (click on the cross at the top right corner of the window). Alternatively, one can exit the program by selecting the File | Exit menu command (Figure 3-3). The GUI will prompt the user to save recent changes if an input file has been modified.

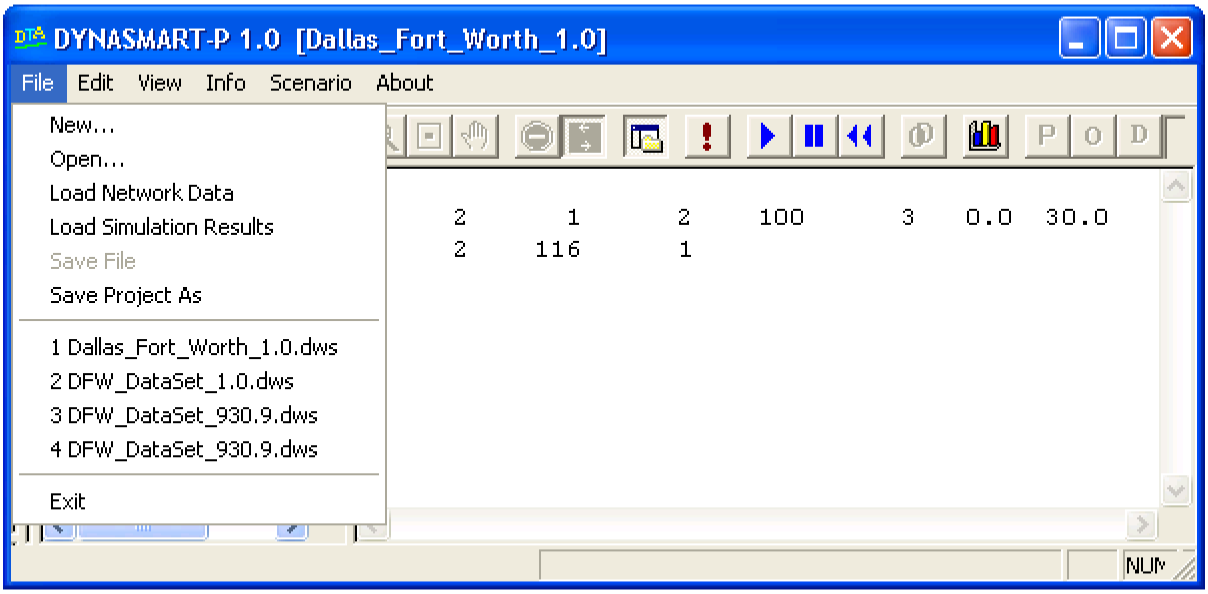


Figure 3-3. DYNASMART-P File menu

3.6 Sample Session

The purpose of this sample session is to assist users in using DYNASMART-P. In this tutorial example, DYNASMART-P is applied to evaluate the effectiveness of VMS in the presence of an incident. It assumes the complete set of input files has been prepared. For information on how to construct the necessary input files, refer to Section 4. In the scenario considered in this tutorial, it is assumed that the vehicle mix consists of 90 percent passenger cars and 10 percent trucks. Furthermore, it is assumed that 80 percent of trip-makers will follow some pre-specified paths, and are thus unresponsive to any form of route guidance, en-route or traffic information. The remaining 20 percent of trip-makers will be responsive to traffic information through variable message signs, and will thus consider switching to alternate routes when favorable (i.e. when travel time savings exceed a user-defined threshold). Furthermore, note that the 80 percent rate of unresponsive vehicles (and similarly for the percentage of vehicles that receive en-route information) applies to all vehicle types (in this case, passenger cars and trucks).

Step 1: Launch the DYNASMART-P Application

Click on the DYNASMART-P icon from the Start | All Programs menu (Figure 3-4).

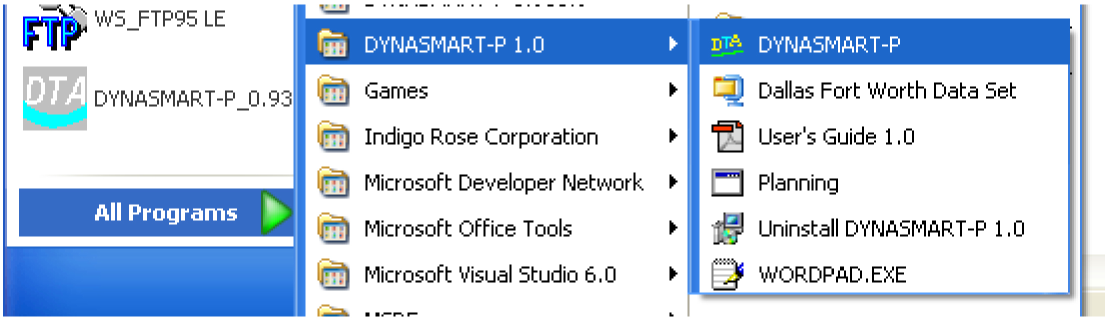


Figure 3-4. DYNASMART-P application menu

When DYNASMART-P first loads itself, you should see the following window (Figure 3-5):

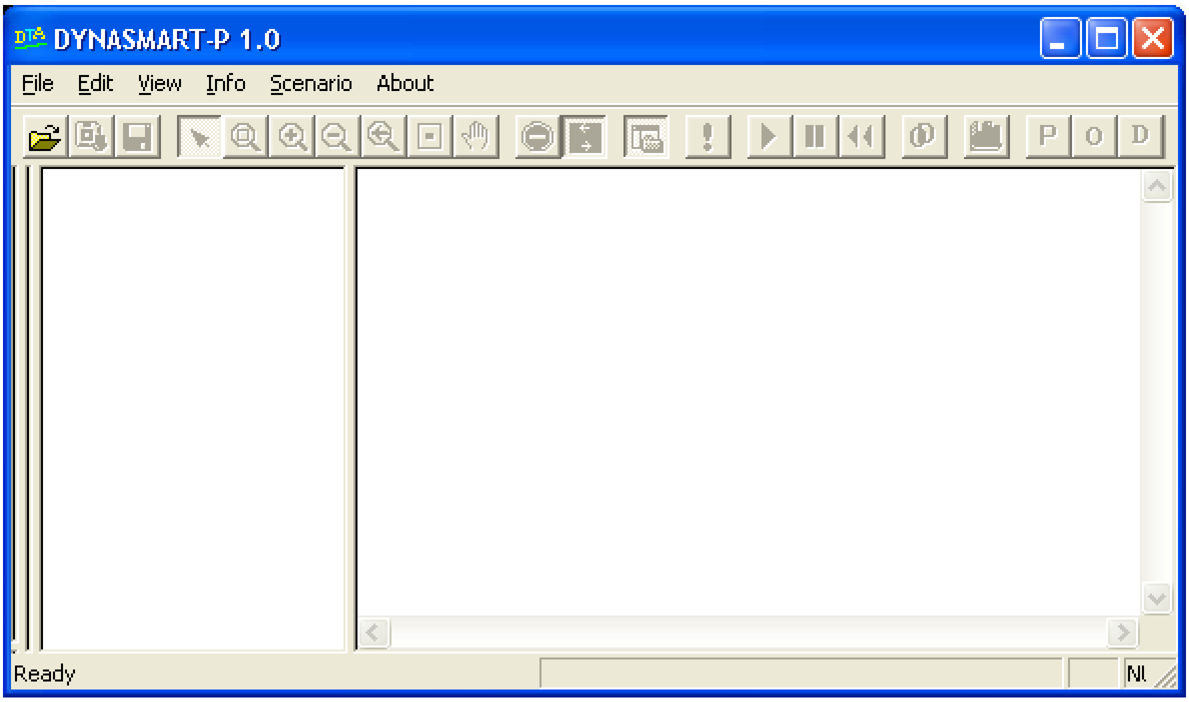


Figure 3-5. DYNASMART-P start-up window

Step 2: Unzip Dallas Fort Worth Data Set

(Skip this step if the working data set is already available on the computer)
Click on the DYNASMART-P application from the Start | All Programs menu (Figure 3-4), and select the *Dallas_Fort_Worth_Data_Set.Zip* menu item. This will launch the WINZIP utility program (Figure 3-6).

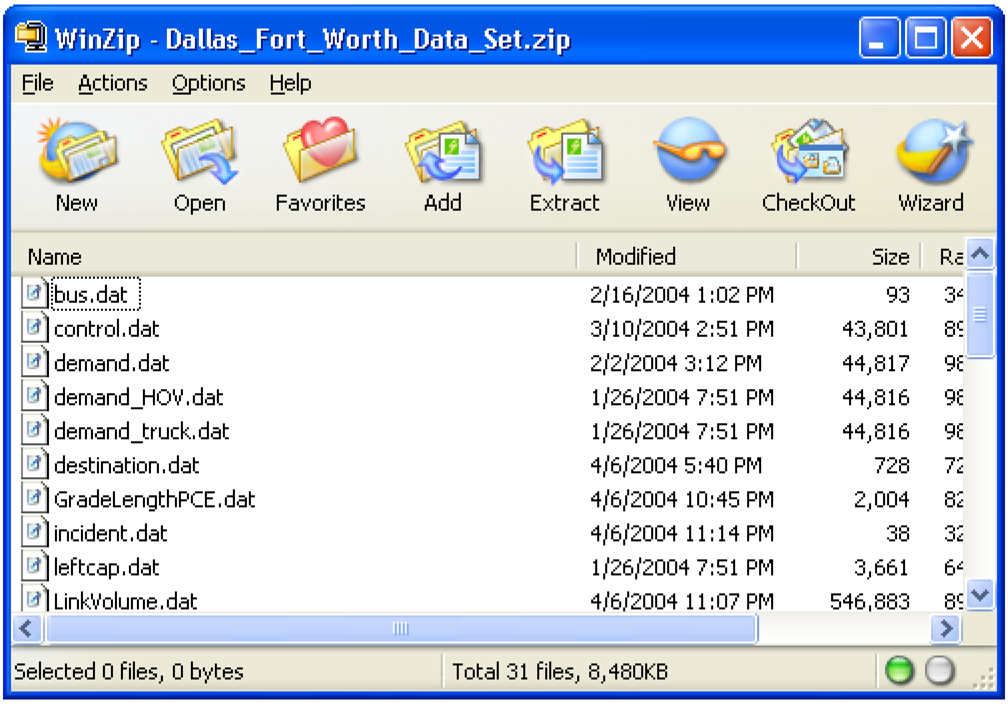


Figure 3-6. WINZIP utility program

Click on the <<Extract>> toolbar icon to launch the extract dialog box (Figure 3-7). Specify the following path C:\Program Files\DYNASMART-P 1.0\Dallas_Fort_Worth_1.0 in the <<Extract to>> text box and click <<Extract>> button. The data set has now been extracted to the specified folder.

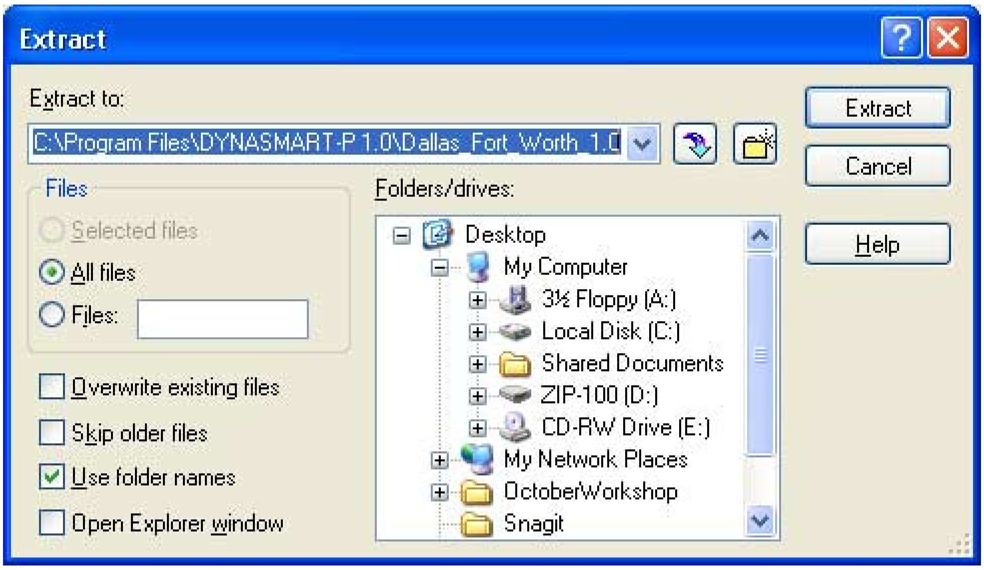


Figure 3-7. Extract dialog box

Step 3: Open a Project Workspace

Select File | Open… menu command (Figure 3-8) or select the open project button  on the DYNASMART-P tool bar):

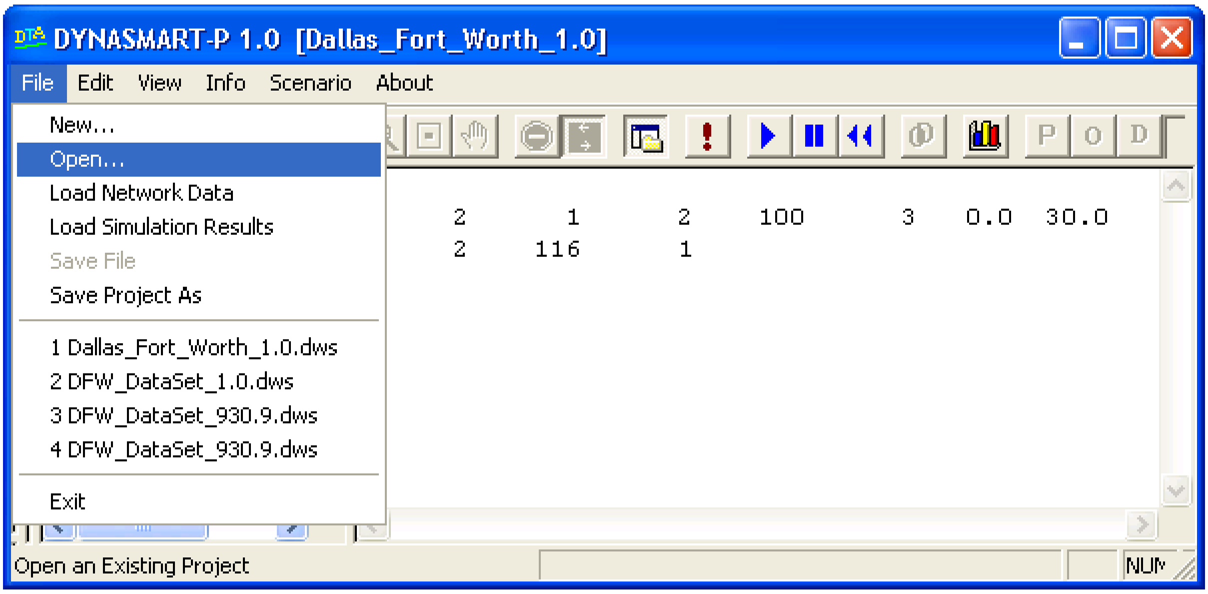


Figure 3-8. DYNASMART-P file menu

The <Open> dialog box will pop up (Figure 3-9):

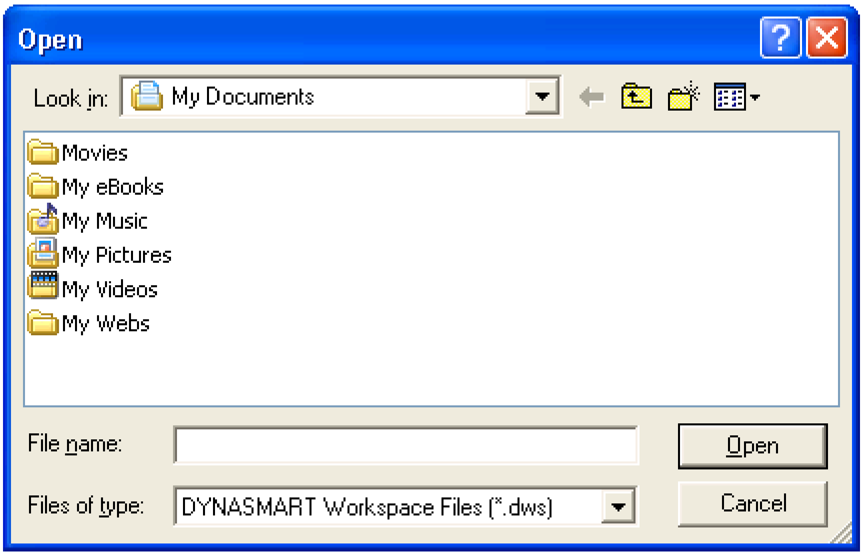


Figure 3-9. Open dialog box

Locate and double-click on the folder C:\Program Files\DYNASMART-P 1.0\Dallas_Fort_Worth_1.0. Select the file *Dallas_Fort_Worth_1.0.dws* and click <<Open>> (Figure 3-10).

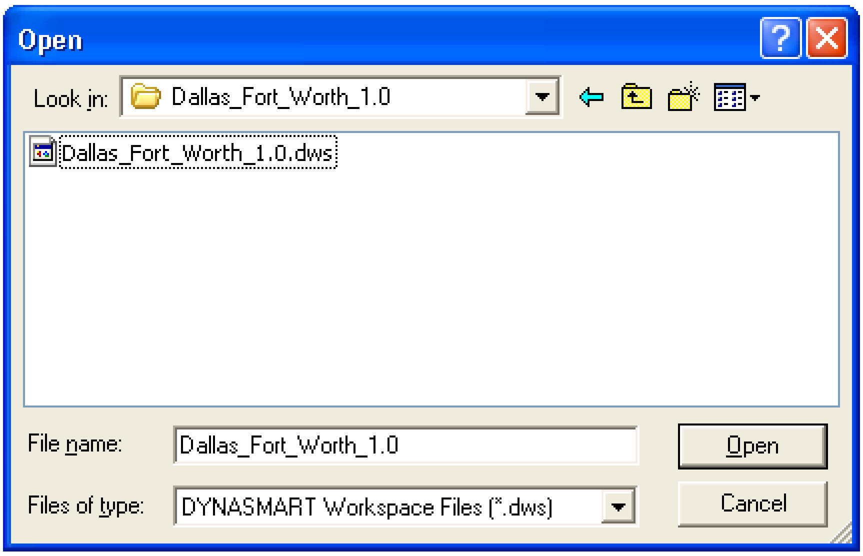


Figure 3-10. Dallas_Fort_Worth_1.0.dws file

The Fort Worth data set will be loaded and the associated input files will be shown on the file tree window (Figure 3-11).

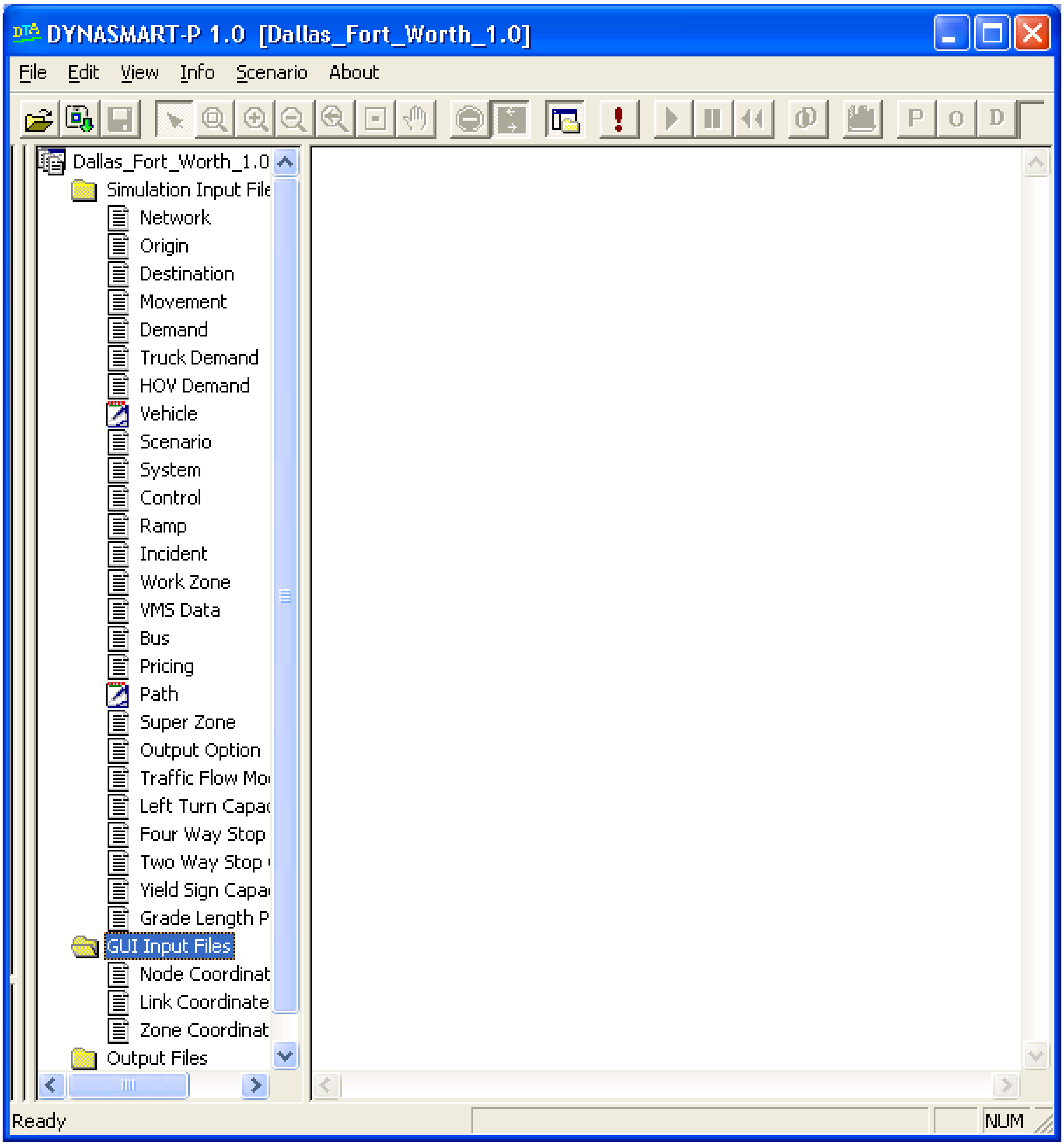


Figure 3-11. Dallas_Fort_Worth_1.0 loaded data set

<u>Step 4: Specify Scenario Parameters and Capabilities</u>

Select the <u>Scenario</u> | <u>Parameter and Capabilities…</u> menu command (Figure 3-12).

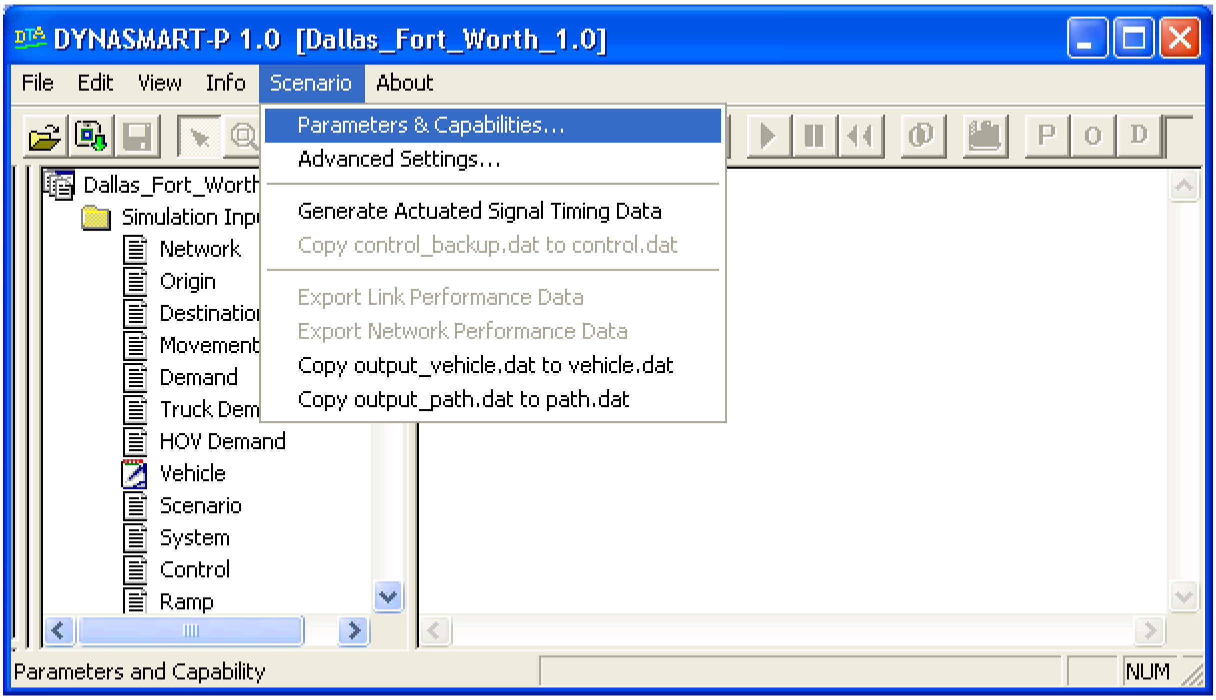


Figure 3-12. *Parameter and Capabilities* menu command

This will launch the <Parameter Settings> dialog box (Figure 3-13). By default, the one-shot simulation-assignment solution mode is selected. As the name implies, the one-shot simulation-assignment performs a single simulation run for the duration of the specified planning horizon. In this mode, vehicles are assigned to either the current-best path, a randomly selected path or a pre-determined path (e.g. a historical vehicle path) when they are loaded onto the network.

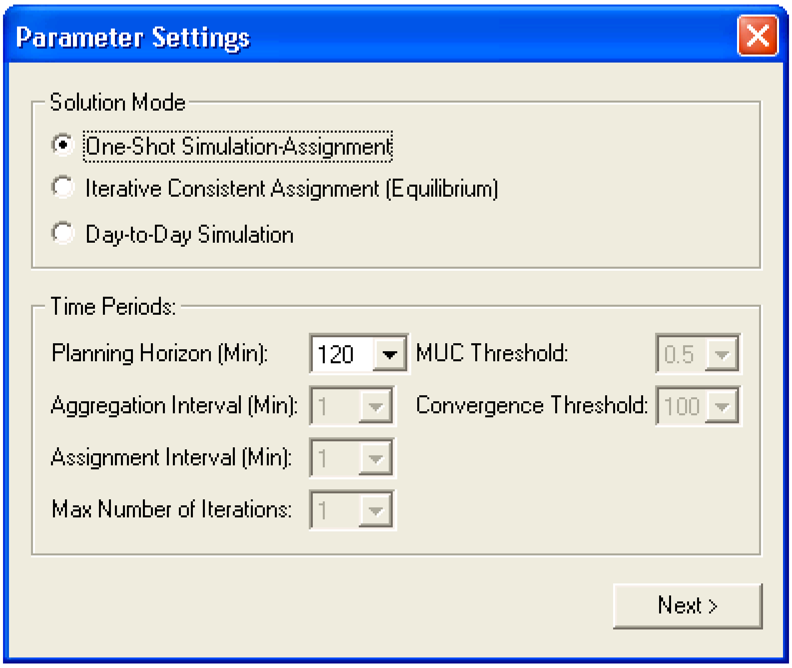


Figure 3-13. DYNASMART-P *Parameter Settings* dialog box

Click on <<Next>> to proceed to the <Capability Selection> dialog box (Figure 3-14).

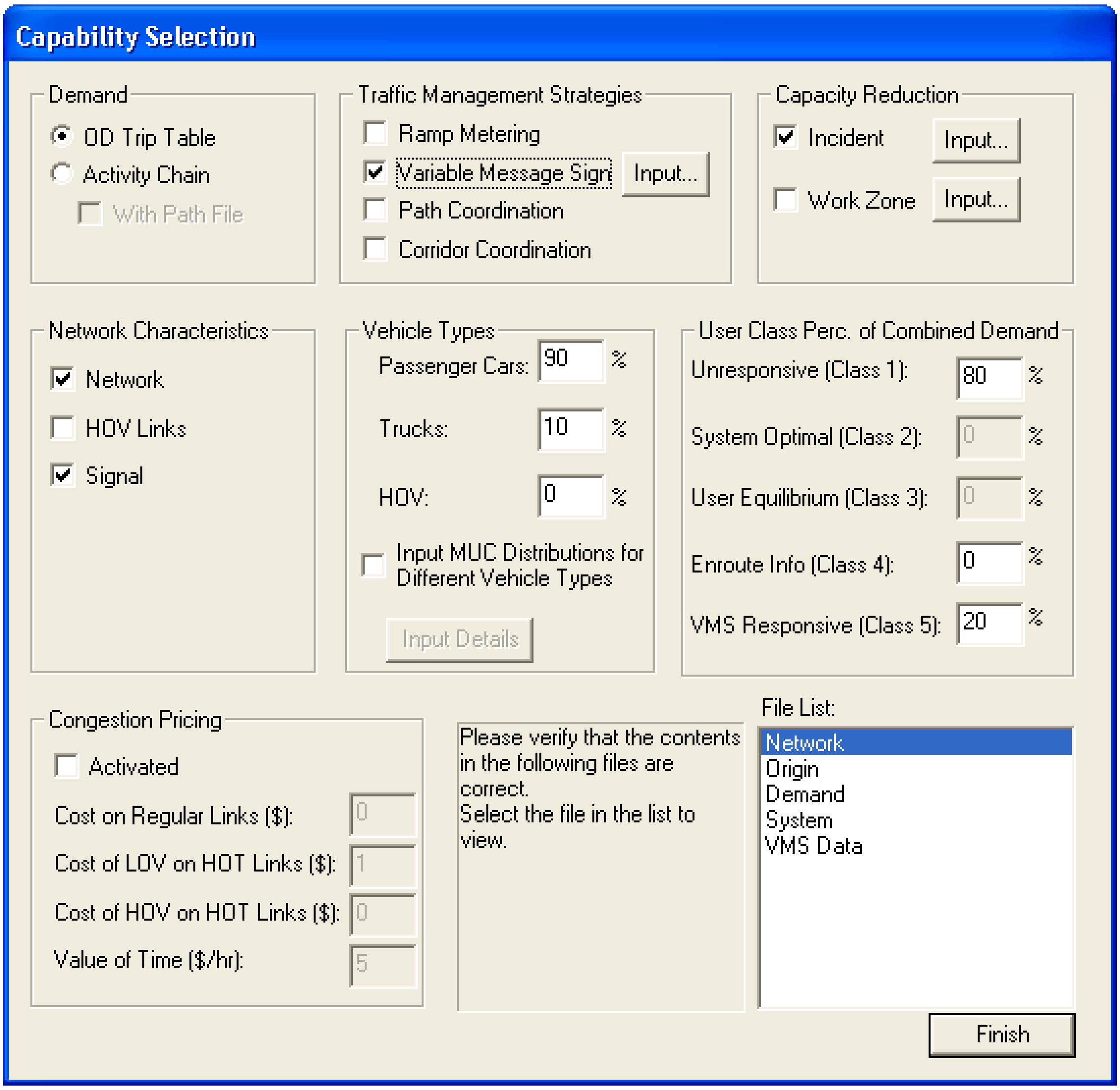


Figure 3-14. *Capabilities Selection* dialog box

Specify inputs as shown above. First, in the [Demand] data block, select the <<OD Trip Table>> option. Then, in the [Traffic Management Strategies] data block, check the <<Variable Message Sign>> option and click the <<Input…>> button to launch the <VMS Input> dialog box (Figure 3-15). Experiment with the <<Add>> and <<Delete>> buttons. You should have one speed advisory VMS on links 3 and 11, each starting at minute 30 and ending at minute 60. Specify the <<Speed Threshold>> to be 40 mph and the <<Percentage of Change>> to be 10%. This means that if the current link speed is below the specified threshold, vehicles are advised to increase their speed by 10%. Note that the time here refers to the simulation time and not actual clock time. Click the <<Add>> button to add each speed-advisory VMS into the data set.

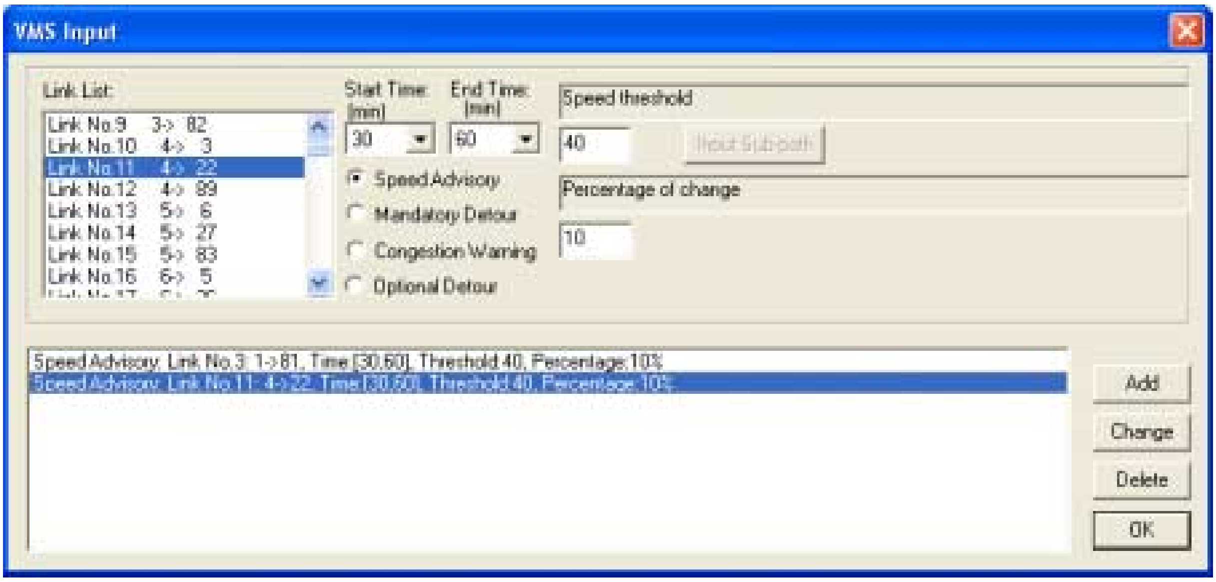


Figure 3-15. *VMS Speed Advisory Input* dialog box

Also, specify a congestion warning type VMS on link 61, starting at minute 20 and ending at minute 50, with a compliance rate of 100% and a path preference index of 1 (best path). Click the <<Add>> button to add the congestion-warning VMS into the data set (Figure 3-16). Click <<OK>> to proceed. This will cause DYNASMART-P to revert back to the <Capabilities Selection> dialog box.

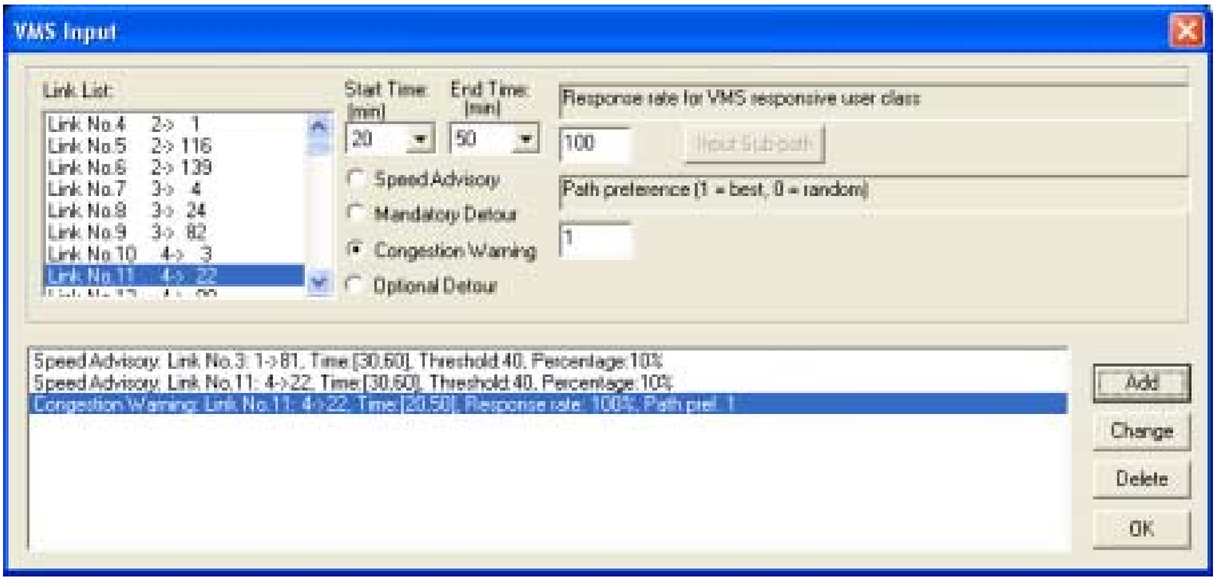


Figure 3-16. *Congestion Warning VMS Input* dialog box

In the [Vehicle Types] data block (Figure 3-14), enter 90% for *Passenger Cars*, 10% for *Trucks*, and 0% for *HOV*. Next, in the [User Classes] data block, enter 80% for *Unresponsive* (Class 1) and 20% for *VMS-Responsive* (Class 5). Notice the [File List] data block, which indicates the input files requiring modification when the corresponding feature or capability is selected.

In the [Capacity Reduction] data block, check the <<Incident>> option and click on the <<Input>> button to launch the <Incident Input> dialog box.

Specify the incident information as shown below (Figure 3-17). Experiment with the <<Add>>, <<Delete>>, and <<Change>> buttons. In the end, you should have one incident with a *Severity* of 0.6 (i.e. the incident reduces the link capacity by 60%) on link 82, starting at minute 60 and ending at minute 85. Note that the time here refers to the simulation time and not actual clock time. Click <<OK>> to revert back to the <Capabilities Selection> dialog box.

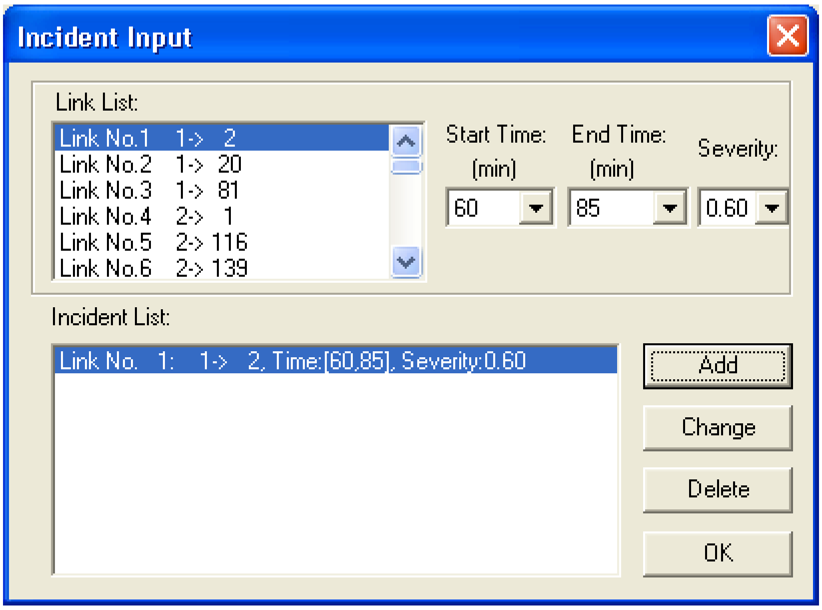


Figure 3-17. *Incident Input* dialog box

Finally, click on the <<Finish>> button to save information and exit the <Capabilities Selection> dialog box.

Step 5: Specify Advanced Settings

Select the Scenario | Advanced Settings… menu command (Figure 3-18). Doing so will launch the <Advanced Settings> dialog box (Figure 3-19).

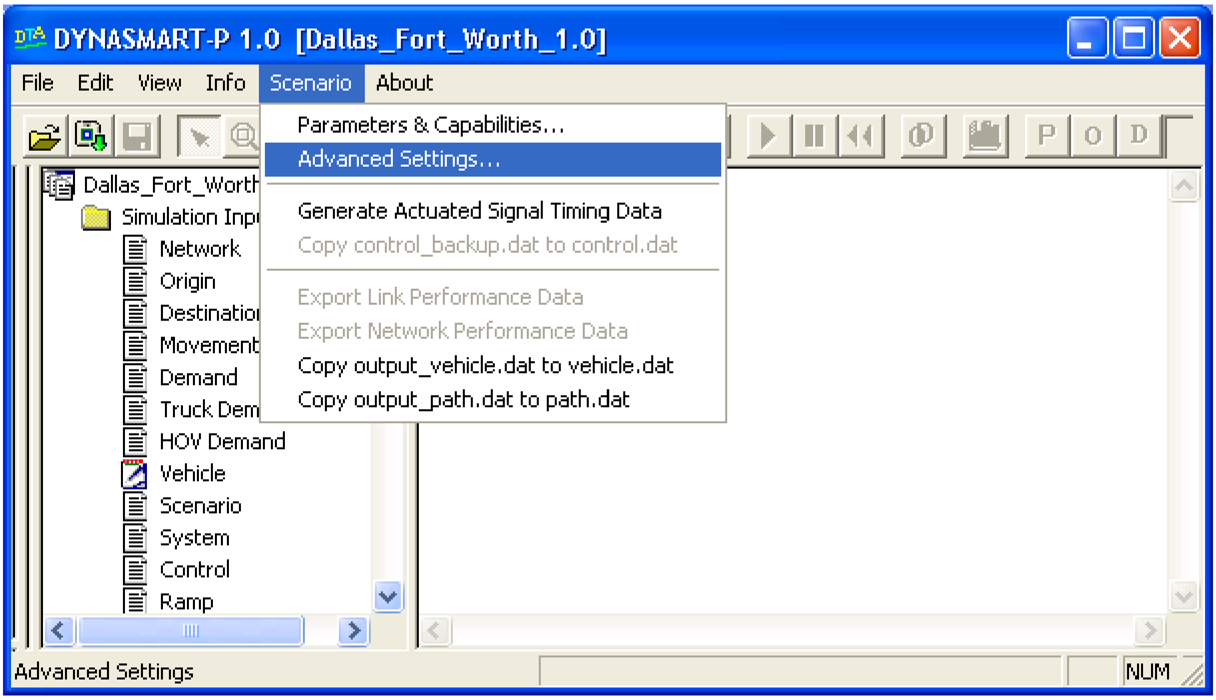


Figure 3-18. *Advanced Settings* command in Scenario menu

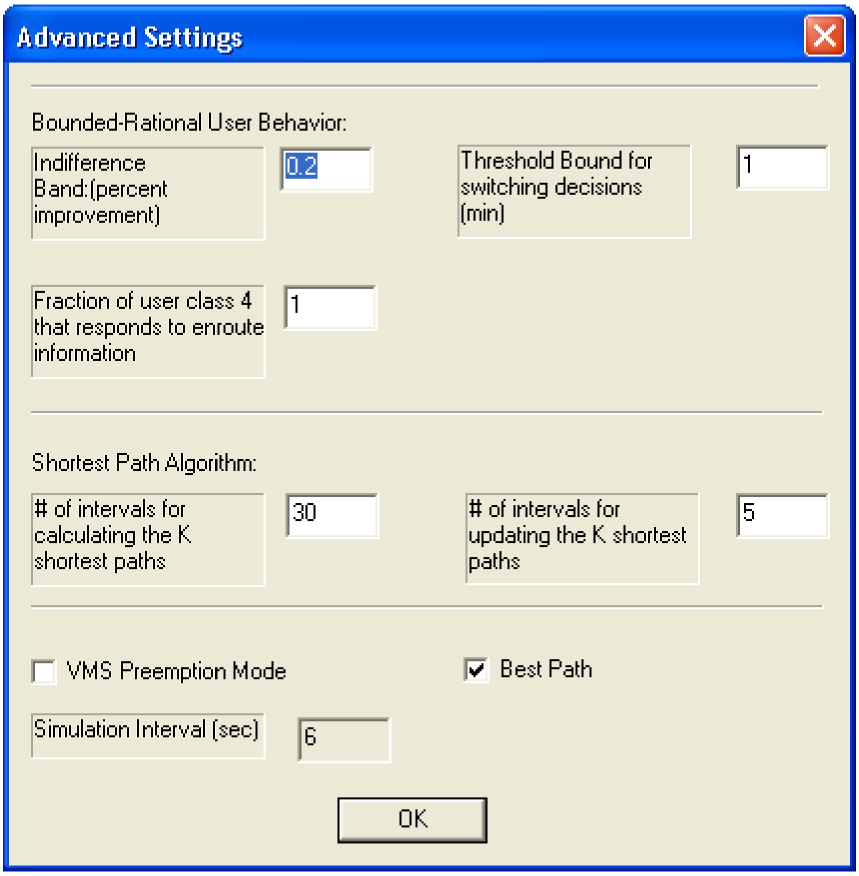


Figure 3-19. *Advanced Settings* dialog box

Of note are values of the *Indifference Band* (20%) and the *Threshold Bound* for *Switching Decisions* (1 min). This means that trip-makers who receive en-route information will switch if the new path yields a 20% or greater travel time savings, and if the timesaving is at least 1 minute. Accept the default values and click <<OK>> to proceed. Refer to Section 6.2.5 for more information regarding the Scenario menu.

Step 6: Execute DYNASMART-P Simulation-Assignment Model

Click on the ! icon on the toolbar to run DYNASMART-P. A warning message console window, as shown below (Figure 3-20), will pop up.

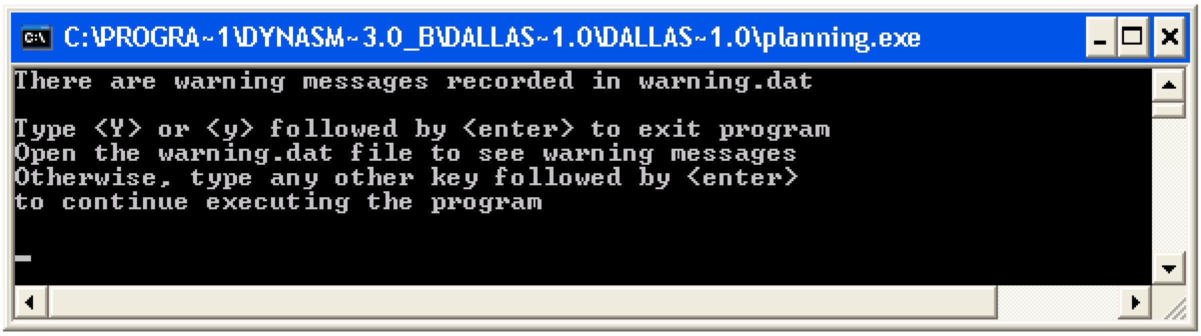


Figure 3-20. Warning messages console window

Follow the instructions on the console window to view the warning messages. Otherwise, enter any key such as <<k>> and hit <<Return>> key. Another console window will pop up, as shown below, showing the simulation in progress (Figure 3-21).

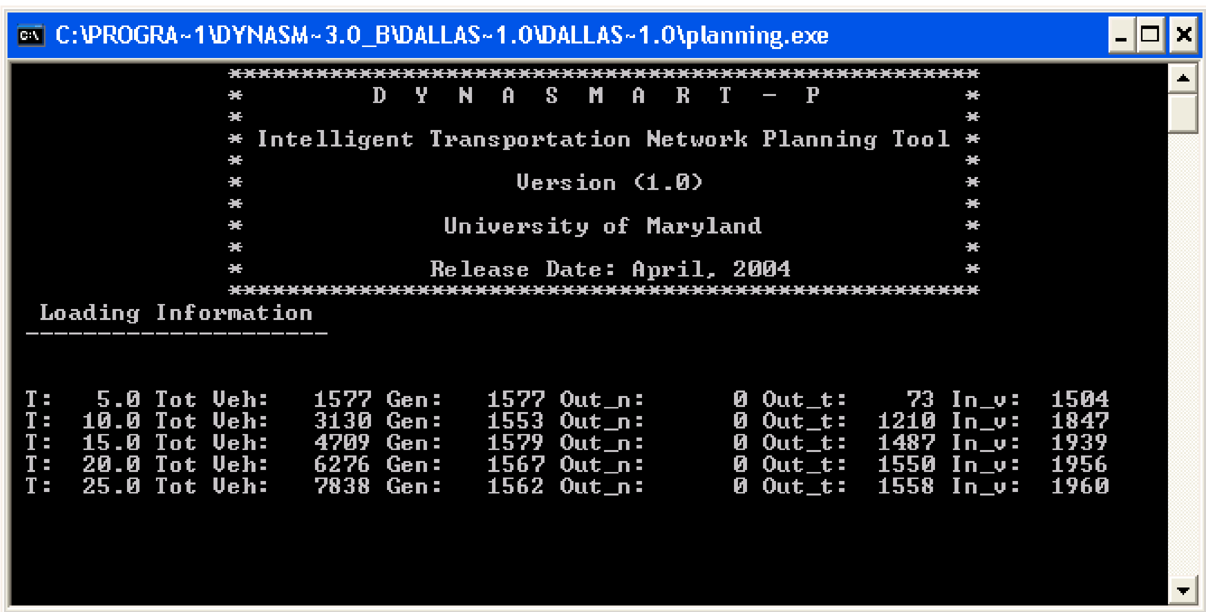


Figure 3-21. Execution window

Upon completion, a <DYNASMART-P> dialog box (Figure 3-22) will appear indicating completion of the simulation run, and showing the program execution time. Click on the <<Yes>> button to immediately load the animation results.

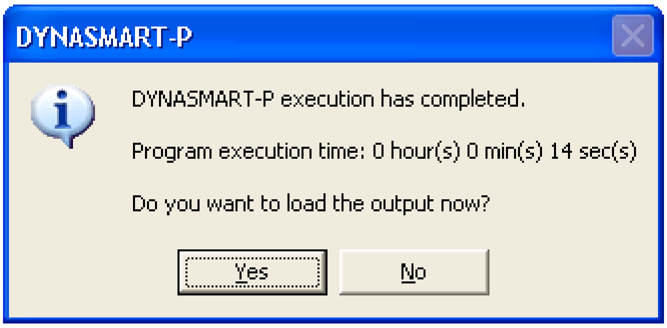


Figure 3-22. *Output Loading Confirmation* dialog box

Users should see the output view as shown below (Figure 3-23).

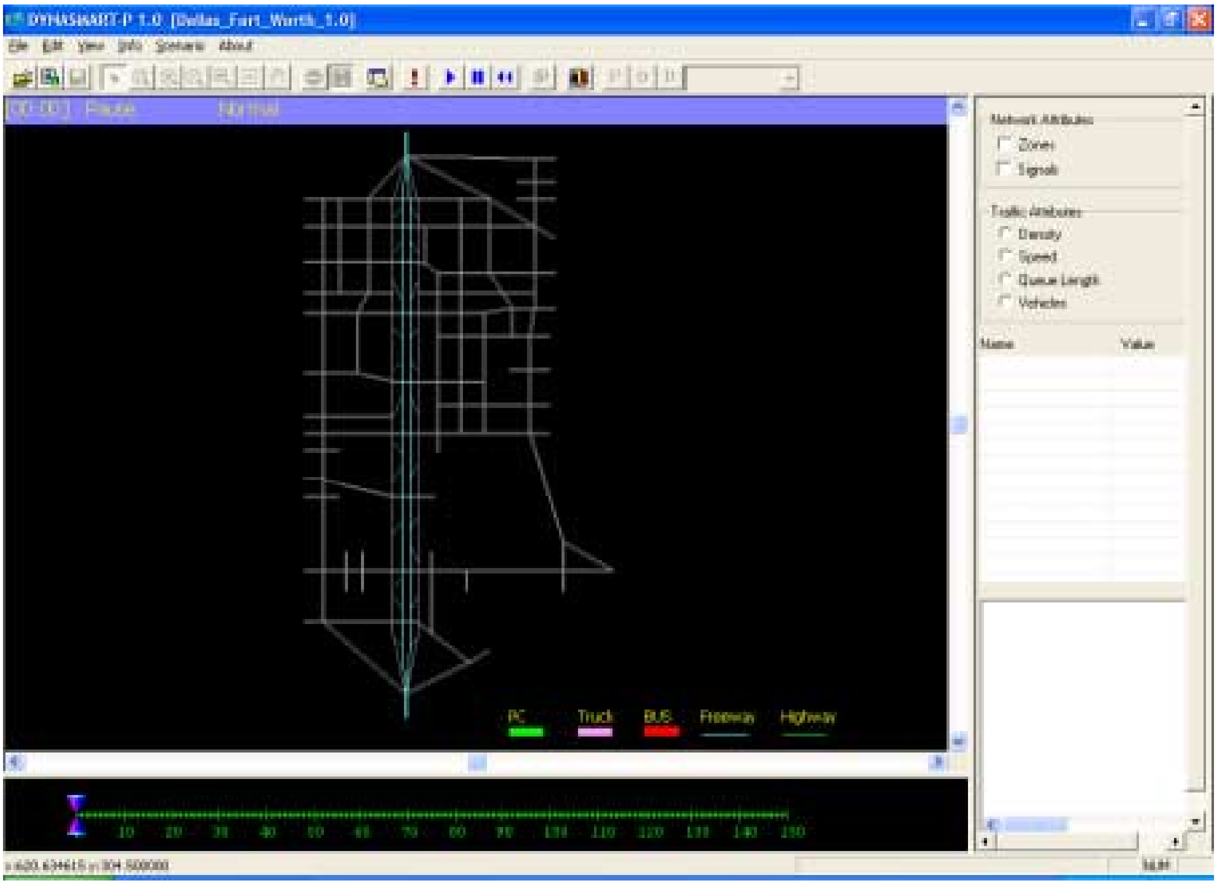


Figure 3-23. Output view

__Step 7: View Simulation Results__

In the [Traffic Attributes] block of the output view window, check the <<Vehicles>> option and then click on the icon on the toolbar to view the post-execution simulation results (Figure 3-24). Note here that users are simply viewing the stored simulation results as generated from the earlier run. Hence, users may view it as many times as necessary. At the users' disposal are the (pause) and (rewind) buttons. The user can also slide the clock button back and forth to see how traffic evolves over time. Users may want to examine other traffic attributes such as density, speed and queue lengths as well.

Figure 3-24. Vehicle animation of the simulation results

Step 8: Interpret Simulation Results

Click on the  icon (or the **F2** button on the keyboard) on the toolbar to switch to the input view. Double-click on the *Output Files* folder to view its contents. Click on the *Summary Statistics* file to view a summary of statistics for the simulation run (Figure 3-25). This file provides the following categories of information:

- ❑ Network characteristics
- ❑ Input parameters
- ❑ Vehicle loading and exiting information
- ❑ HOT/HOV statistics
- ❑ Simulation statistics

The first part of this file provides information about the network characteristics, which include the number of nodes, number of links and number of zones. Next is information on the intersection control data, followed by the number of ramp controls and VMS in the network. The next set of data pertains to the inputs specified for the simulation run. It classifies the inputs into the following categories:

- ❑ Network data
- ❑ Intersection control data
- ❑ Ramp data
- ❑ Solution mode
- ❑ Time periods
- ❑ Congestion pricing
- ❑ Vehicle loading mode
- ❑ MUC class percentages
- ❑ Vehicle type percentages
- ❑ Traffic management strategies
- ❑ Capacity reduction
- ❑ Loading information
- ❑ Vehicle information
- ❑ HOT lane(s) information
- ❑ Overall statistics report

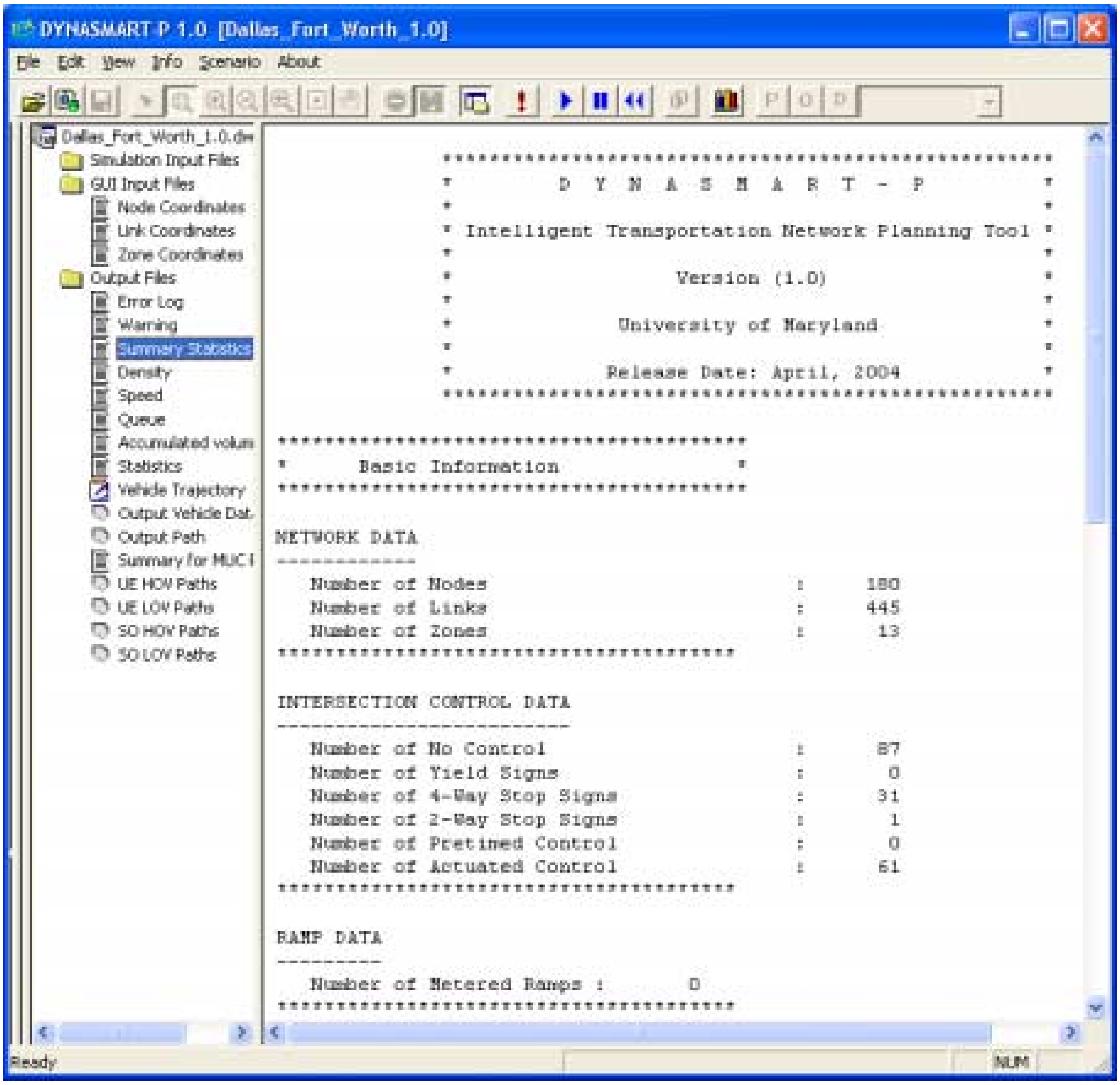


Figure 3-25. DYNASMART-P window showing *SummaryStatistics.dat*

Loading information is provided in 5-minute increments (Figure 3-26). The user has the flexibility to specify the loading information interval (refer to Section 4.33, *output_option.dat*). The first column (T) indicates the simulation time. The second column (Tot Veh) indicates the cumulative number of vehicles generated. The third column (GEN) indicates the number of vehicles generated in the last five minutes. The fourth column (Out_n) indicates the number of non-tagged vehicles that exited the network in the last five minutes. The fifth column (Out_t) indicates the number of tagged vehicles that exited the network, and the last column (In_v) indicates the number of vehicles in the network. Note that, for the Summary Statistics file, only the vehicles entering the network after the specified start-up time will be tagged. Vehicles entering the network prior to the specified start-up time will not be tagged and hence will not contribute to the overall statistics. Refer to Section 4.25 – *scenario.dat* – for further information.

```
****************************************
 *      Loading Information            *
 ****************************************

 T:   5.0 Tot Veh:   1970 Gen:   1970 Out_n:      0 Out_t:   158 In_v:  1812
 T:  10.0 Tot Veh:   3959 Gen:   1989 Out_n:      0 Out_t:   691 In_v:  3110
 T:  15.0 Tot Veh:   6037 Gen:   2078 Out_n:      0 Out_t:   958 In_v:  4230
 T:  20.0 Tot Veh:   8088 Gen:   2051 Out_n:      0 Out_t:  1106 In_v:  5175
 T:  25.0 Tot Veh:  10044 Gen:   1956 Out_n:      0 Out_t:  1113 In_v:  6018
 T:  30.0 Tot Veh:  12015 Gen:   1971 Out_n:      0 Out_t:  1047 In_v:  6942
 T:  35.0 Tot Veh:  14006 Gen:   1991 Out_n:      0 Out_t:   971 In_v:  7962
 T:  40.0 Tot Veh:  14006 Gen:      0 Out_n:      0 Out_t:   899 In_v:  7063
 T:  45.0 Tot Veh:  14006 Gen:      0 Out_n:      0 Out_t:   892 In_v:  6171
 T:  50.0 Tot Veh:  14006 Gen:      0 Out_n:      0 Out_t:   706 In_v:  5465
FRACTION WITH INFO = 0.600  AVG.IB-FRACTION = 0.20   BOUND = 1.00

 NOTE : There are        5465   target vehicles still in the network
```

Figure 3-26. Loading information block within the Summary Statistics file

Following the vehicle loading information is the overall vehicle information (Figure 3-27), which includes the total number of vehicles generated, the number of non-tagged vehicles, the number of tagged vehicles in the network and the number of tagged vehicles that exited the network. Non-tagged vehicles are those generated prior to the specified start-up time. Only vehicles generated after the start-up time will be used in computing statistics. The start-up time can be specified by the user.

```
  ******* VEHICLE INFORMATION *******
       TOTAL VEHICLES        :       19471
       NON-TAGGED VEHICLES   :           0
       TAGGED VEHICLES (IN)  :        5465
       TAGGED VEHICLES (OUT) :       14006
       OTHERS                :           0
```

Figure 3-27. Vehicle information block within the Summary Statistics file

Next is HOT lane information (Figure 3-28). The first piece of information is the number of toll links in the network, followed by four numbers: 1) LOV using HOT lanes; 2) LOV not using HOT lanes; 3) HOV using HOT lanes; and 4) HOV not using HOT lanes. In each case, the average travel time is given for each category.

```
 ******* HOT LANE(S) INFORMATION  **********
   Number of Links with Toll                  :       0

   For the Vehicles Exit the Network

   Number of LOV in HOT lanes                 :       0
   Avg travel time for LOV in the HOT lane    :       N/A

   Number of LOV not in HOT lanes             :    8541
   Avg travel time for LOV not in the HOT lane :      12.8919

   Number of HOV in HOT lanes                 :       0
   Avg travel time for HOV in the HOT lane    :       N/A

   Number of HOV not in HOT lanes             :       0
   Avg travel time for HOV not in the HOT lane :       N/A
```

Figure 3-28. Vehicle information block within the Summary Statistics file

The following simulation statistics are provided next:

- ❑ Maximum simulation time: the planning horizon (minutes) specified in the input
- ❑ Simulation interval: 0.1 minute (6 seconds)
- ❑ Simulation time: duration of time that was modeled
- ❑ Start-up time: the start time to collect statistics
- ❑ End of observation time of interest: the end time to collect statistics
- ❑ Total vehicles: total number of vehicles generated, both tagged and non-tagged

The remaining data are particularly useful for evaluating different scenarios. These statistics are discussed below. Overall statistics are produced for each user class separately. For example, here they are presented for two classes: info (VMS) and no-info. As mentioned previously, info here refers to those vehicles that receive and respond to real-time en-route VMS information, whereas no-info pertains to vehicles that are not responsive for such information. The data shown here is for a single-stop trip. In cases of trip-chains with multiple destinations, statistics for those vehicles making 2-stops and 3-stops will also be provided.

- ❑ Total travel times (hours): total vehicle travel time, measured from the instance when the vehicle is physically loaded onto the network
- ❑ Average travel times (minutes): average travel time per vehicle
- ❑ Total trip times (hours): total vehicle travel time plus entry time
- ❑ Average trip times (minutes): average trip time (entry time + travel time) per vehicle
- ❑ Total entry queue times (hours): total vehicles waiting time before entering the network

- ❑ Average entry queue times (minutes): average waiting time before entering the network
- ❑ Total stop time (minutes): total vehicle stop time
- ❑ Average stop time (minutes): average stop time per vehicle
- ❑ Total trip distance (miles): total vehicle travel distance
- ❑ Average trip distance (miles): average travel distance per vehicle

The appropriate measures of performance to scrutinize will depend on the desired analysis. For example, if the analysis deals with vehicle delay, then stop time would be a good measure. Here, we will use average trip time, though other measures may be appropriate. First, to evaluate the impact or effectiveness of a certain strategy, one would compare the average trip time of one run versus another. In our case of evaluating the effectiveness of VMS, we would compare the average trip time from this particular run versus one that does not have VMS. If the average trip time from this run is significantly lower, then we can conclude that the use of VMS is effective in improving overall network performance. However, it is often also appropriate to examine impacts at a more localized level, especially when the affected area (by the measure under evaluation) is limited spatially.

4. WORKING WITH INPUT DATA

4.1 General Overview of DYNASMART-P Input Files

DYNASMART-P requires two classes of input files: traffic simulation and graphical representation input files. Traffic simulation files must be present in the project working space; however, their contents may be empty (blank) depending on the scenario settings. (Note that DYNASMART-P searches for all files before the start of any computation effort and will display an error message if one of the traffic simulation input files is missing). Table 4-1 provides a brief description of what each simulation input file is used for.

Graphical representation files (Table 4-2) are optional. Without these files, the software would still function properly, but no graphical representation and no animation of the network and its associated traffic pattern would be available. Nevertheless it is strongly recommended that the user supply these files so as to graphically view traffic simulation results. To display the network within the GUI, the user must at least specify the node coordinates (or more specifically, *xy.dat*). Note that in this document, graphical representation input files and GUI input files are used interchangeably to mean the same thing.

Table 4-3 provides an overview of which input files are required for implementing various functionalities provided by DYNASMART-P.

Table 4-1. Traffic simulation input files

Input File	*Description*	*Status*
ProjectName.dws	Contains information about the project name, DYNASMART-P version number, and location of the origin coordinates.	Required
bus.dat	Contains information regarding the buses, including the trajectories, location of stops, and dwell time.	May be empty
control.dat	Contains information regarding the type of traffic control at each node. If the control type is signal control, then phasing information for the signal is also included.	Required
demand.dat *demand_truck.dat* *demand_HOV.dat*	Contains information regarding the temporal and spatial distribution of demand for PCs, trucks, and HOVs.	Required
destination.dat	Specifies destination nodes.	Required
GradeLengthPCE	Contains the PCE values for heavy vehicles based on link upgrade, length and heavy vehicle percentage.	Required
incident	Contains information regarding incidents in the network.	May be empty
leftcap.dat	Contains information regarding the left-turn capacity at signalized intersections (empirical numbers – can be obtained from the Highway Capacity Manual).	Required
movement.dat	Contains information regarding the allowed movements for vehicles (right-turns, left-turns, through, etc.).	Required
network.dat	Contains information regarding the network configuration, including zone and link characteristics.	Required
origin.dat	Specifies generation links.	Required
output_option.dat	Allows users to indicate whether or not certain output files should be created.	Required
path.dat	Contains the vehicle trajectory, in case it is needed to simulate a specific scenario where the vehicle paths are known. This file should be used in conjunction with vehicle.dat.	May be empty
pricing.dat	Contains information regarding the pricing of HOT/HOV Lanes.	May be empty
ramp.dat	Contains information regarding ramp metering scenarios including ramp locations, detector locations, ramp meter timings, etc.	May be empty
scenario.dat	Contains information regarding en-route information availability and basic simulation parameters.	Required
SuperZone.dat	Allows for aggregating several original TAZ's to a single zone.	May be empty
system.dat	Contains information regarding selection of the solution mode, the length of planning horizon, aggregation interval and assignment interval.	Required
TrafficFlowModel.dat	Contains the parameters of the traffic flow model types.	Required
vehicle.dat	Contains information regarding the individual vehicles (an alternative method to load vehicles).	May be empty
vms.dat	Contains information regarding the locations of VMS signs.	May be empty
WorkZone.dat	Contains the number of work zones to be simulated, their starting time, location, lane closure, reduced speed limits and the corresponding queue discharge rate.	May be empty
StopCap2Way.dat *StopCap4Way.dat*	Contains information regarding the capacity at stop-controlled intersections (2-way and 4-way).	Required
YieldCap.dat	Contains information regarding the capacity at yield-controlled intersections.	Required

Table 4-2. Graphical representation and animation (GUI) input data files

Input File	*Description*	*Status*
linkname.dat	Describes the street names.	Optional
linkxy.dat	Provides horizontal alignment of links by specifying the coordinates of feature points that constitute those links.	Optional
xy.dat	Contains the coordinates of network nodes.	Optional
zone.dat	Contains the information needed to display zone boundaries.	Optional

Table 4-3. Input files required for implementing various functionalities in DYNASMART-P

DYNASMART-P Function	*Related Input Files*
❑ Network Data	❑ *network.dat* ❑ *xy.dat* ❑ *Linkxy.dat* ❑ *LinkName.dat* ❑ *movement.dat* ❑ *TrafficFlowModel.dat*
❑ Intersection Control	❑ *control.dat* ❑ *leftcap.dat* ❑ *yieldcap.dat* ❑ *StopCap2Way.dat* ❑ *StopCap4Way.dat* ❑ *GradeLengthPCE.dat*
❑ Demand Generation	❑ *zone.dat* ❑ *origin.dat* ❑ *destination.dat* ❑ *SuperZone.dat* ❑ *demand.dat (for O/D matrix based combined demand)* ❑ *demand_truck.dat (for O/D matrix based truck demand)* ❑ *demand_HOV.dat (for O/D matrix based HOV demand)* ❑ *vehicle.dat (for trip chains and vehicle-based demand)* ❑ *path.dat (for trip chains and vehicle-based demand)*
❑ Bus Operation	❑ *bus.dat*
❑ Ramp Metering	❑ *ramp.dat*
❑ VMS signs	❑ *vms.dat*
❑ Accidents and lane closures	❑ *incident.dat* ❑ *workzone.dat*
❑ HOV/HOT lanes	❑ *pricing.dat*
❑ Solution Mode ❑ Planning Horizon ❑ Aggregation Intervals ❑ Assignment Intervals ❑ En-route Information ❑ Path Switching	❑ *system.dat* ❑ *scenario.dat*

4.2 Preparing DYNASMART-P Input Files

There are four ways to create DYNASMART-P input files:

1. Using a text editor (both externally or within the GUI environment); and/or
2. Through GUI input dialog boxes; and/or
3. Through DYNABUILDER; and/or
4. Through DSPEd, a DYNASMART-P editor

Text editing techniques are only feasible for small sized traffic networks, whereas GUI data input is best for fine-tuning scenario and system settings. DYNABUILDER is well-suited to converting networks from GIS format into DYNASMART-P format. DYNABUILDER is not designed to create all of the input files, just the necessary and complicated ones. DSPEd, on the other hand, provides a user-friendly data entry environment for creating DYNASMART-P input files, but may be time consuming for certain input files.

Therefore, each of these methods has its own advantages and disadvantages. The recommended method to create the input files would be to integrate all of these techniques. Table 4-4 presents the methods available to prepare each of the input files required by DYNASMART-P.

> *Note: DSPEd was developed for the FHWA and is distributed along with the DYNASMART-P software package. DYNABUILDER is a research tool developed by Maryland Transportation Initiative, University of Maryland. The reader can contact the software developer at www.dynasmart.com for more information about DYNABUILDER.*

Table 4-4. Available method of preparation for each input file

Input File	*Manual*	*GUI*	*DYNABUILDER*	*DSPEd*
**.dws*	Yes			Yes
bus.dat	Yes			Yes
control.dat	Yes		Yes	Yes
demand.dat	Yes		Yes	Yes
demand_truck.dat	Yes		Yes	Yes
demand_HOV.dat	Yes		Yes	Yes
destination.dat	Yes		Yes	Yes
GradeLengthPCE	Yes		Yes[2]	Yes
Incident	Yes	Yes	Yes[2]	Yes
leftcap.dat	Yes		Yes[2]	Yes
movement.dat	Yes		Yes	Yes
network.dat	Yes		Yes	Yes
origin.dat	Yes		Yes	Yes
output_option.dat	Yes		Yes[2]	Yes
path.dat	Yes	Yes[1]		
pricing.dat	Yes	Yes	Yes	Yes
ramp.dat	Yes		Yes	Yes
scenario.dat	Yes	Yes	Yes	Yes
SuperZone.dat	Yes		Yes[2]	Yes
system.dat	Yes	Yes	Yes	Yes
TrafficFlowModel.dat	Yes		Yes[2]	Yes
vehicle.dat	Yes	Yes[1]		
vms.dat	Yes	Yes	Yes[3]	Yes
WorkZone.dat	Yes		Yes[3]	Yes
StopCap2Way.dat	Yes		Yes[2]	Yes
StopCap4Way.dat	Yes		Yes[2]	Yes
YieldCap.dat	Yes		Yes[2]	Yes

[1] *Only if copied from a previous DYNASMART-P run*
[2] *Default values only, the user has no control over these files*
[3] *Created but are empty*

The subsections below describe the various input files required to run DYNASMART-P.

4.3 Project Information (ProjectName.dws)

This file contains the DYNASMART-P version number, and the location of origin coordinates to be read by DSPEd for determining which format to apply when creating input files. A detailed description of this file and its format are provided in Table 4-5 and Figure 4-1, respectively. Note that ProjectName is arbitrary and refers to the project name of the data set.

Table 4-5. Description of the *ProjectName.dws* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Version number	1	Text	Free	DYNASMART-P version number VERSION = “1.0”
Origin location	2	Text	Free	Node Y-axis coordinate ORIGIN = “BOTTOM_LEFT’’ or ORIGIN = “TOP_LEFT’’

```
VERSION = "1.0"
ORIGIN = "BOTTOM_LEFT"
```

Figure 4-1. Sample *ProjectName.dws* input file

Figure 4-1 shows that the DYNASMART-P version number is 1.0, and that the location of the origin coordinates is in the bottom left corner. This file needs to be prepared manually or via DSPEd.

4.4 Node Coordinates Data (xy.dat)

This file contains the coordinates of network nodes that will be only used for graphical representation purposes (on the GUI). In this file, users need to specify the xy coordinates for each node. The node numbers specified in this file must exactly match those reported in *network.dat* (discussed later). A detailed description of this file and its format are provided in Table 4-6 and Figure 4-2, respectively. As stated earlier, the origin coordinates may be chosen to be in the lower-left corner (default), or in the upper-left corner.

Table 4-6. Description of the link *xy.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Node data	1	Integer	Free	1st node number
	2	Float	Free	x-axis coordinate for 1st node
	3	Float	Free	y-axis coordinate for 1st node
.....	.....	.....	.....	.....
	1	Integer	Free	Last node number
	2	Float	Free	x-axis coordinate for last node
	3	Float	Free	y-axis coordinate for last node

```
 1 538.1845785733  24.0801305600
 2 512.1501927841  31.6423546317
 3 536.6874947171  37.4746422278
 4 403.0483780779   0.0000000000
 5 404.7039480101  26.5122822645
 6 404.8612149624  50.2583729413
 7 389.6636193993  87.1844095215
 8 387.9982964779  92.8533345470
 9 387.5338103629  97.9370802151
10 387.5703840727  104.6422603528
11 391.5605758165  120.9846130339
12 391.8677949792  127.6629724511
```

Figure 4-2. Sample *xy.dat* input file

Figure 4-2 shows that node number 1 (field 1) has an x-value of 538.1845785733 (field 2) and a y-value of 24.0801305600 (field 3). Similarly, node number 10 (field 1) has an x-value of 387.5703840727 (field 2) and a y-value of 104.6422603528 (field 3).

This file may be prepared manually, or via DSPEd, or via DYNABUILDER. If the user chooses to input the coordinates manually, extra caution must be exercised to ensure that coordinates in other GUI input files (*linkxy.dat* and *zone.dat*) use the same coordinate system. Location of the origin may be specified by accessing the Scenario | Advanced Settings… menu option. Once the user enters coordinates for all nodes, the GUI will automatically center the network on screen for better display.

4.5 Link Coordinates Data (linkxy.dat)

This file, which is used for graphical representation purposes, provides horizontal alignment of links by specifying the coordinates of feature points that constitute those links. The user, at a minimum, must specify the xy coordinates of upstream and downstream nodes for each link. For a given link, the user can specify as many feature points as needed, starting from the upstream node to the downstream node. Note that this file is optional. If no *linkxy.dat* is provided, *xy.dat* will be used to display the network, with the GUI applying an offset to make sure the directional links don't overlap. Link horizontal alignment information is typically contained in the link geography layer database (*.geo) in most GIS software such as TransCAD. A detailed description of this file and its format are provided in Table 4-7 and Figure 4-3, respectively.

Table 4-7. Description of the *linkxy.dat* input file

Record Type	*Field*	*Format*	*Field Width*	*Description*
Link xy data [1]	1	Integer	Free	1st link starting node
	2	Integer	Free	1st link ending node
	3	Integer	Free	Number of link-associated feature points [2]
	4	Float	Free	x-coordinate of the 1st feature point
	5	Float	Free	y-coordinate of the 1st feature point
.....	.....	.....	.....	.....
	.....	Float	Free	x-coordinate of the last feature point
	.....	Float	Free	y-coordinate of the last feature point
.....	.....	.....	.....	.....
	1	Integer	Free	Last link starting node
	2	Integer	Free	Last link ending node
	3	Integer	Free	Number of link-associated feature points [2]
	4	Float	Free	x-coordinate of the 1st feature point
	5	Float	Free	y-coordinate of the 1st feature point
.....	.....	.....	.....	.....
	.....	Float	Free	x-coordinate of the last feature point
	.....	Float	Free	y-coordinate of the last feature point

[1] *This record must be repeated for all links in the network*
[2] *More than 2 feature points are used to show the curve feature of links*

```
1320 371  4 452.24, 185.59, 452.30, 185.67, 451.44, 189.06, 450.38, 190.53
1320 372  4 449.06, 192.24, 449.03, 192.14, 450.16, 190.57, 450.27, 190.55
1321 1236  2 677.21, 195.54, 668.08, 195.59
```

Figure 4-3. Sample *linkxy.dat* input file

The first record in Figure 4-3 represents a link with upstream node 1320 (field 1) and a downstream node 371 (field 2). This link has 4 feature points (field 3), the xy coordinates of which are given by (452.24, 185.59) (fields 4 & 5), (452.30, 185.67) (fields 6 & 7), (451.44, 189.06) (fields 8 & 9), and (450.38, 190.53) (fields 10 & 11). Note that any two consecutive numbers in a line should be separated by a space, comma or colon.

This file may be prepared manually, via DSPEd, or via DYNABUILDER. If the user chooses to input the coordinates manually, it is recommended that xy coordinates be non-negative. Again, extra caution must be exercised to ensure that coordinates in other GUI input files (*xy.dat* and *zone.dat*) use the same coordinate system. As previously mentioned, if this file is not provided, *xy.dat* will be used instead to display the links with the default offset to separate directional links.

4.6 Link Names (linkname.dat)

This file describes street names to be used by the GUI. In this input file, users can define the street name for as many links as needed. This information is normally contained in the link layer information database of GIS software packages such as TransCAD. If this file is empty, the GUI will not display any street names. Also note that there is no requirement for the sequence of listed links. A detailed description of this file and its format are provided in Table 4-8 and Figure 4-4, respectively.

Table 4-8. Description of the *linkname.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Link name data	1	Integer	Free	1st link starting node
	2	Integer	Free	1st link ending node
	3	String	Free	Link name
.....	.....	.....	.....	.....
	1	Integer	Free	Last link starting node
	2	Integer	Free	Last link ending node
	3	String	Free	Link name

```
  1    2  ROBERTS
 33 1098  E EMORY
 66  487  MAYNDVL
```

Figure 4-4. General format of the *linkname.dat* input file

In the above example (Figure 4-4), the first record shows that a link with upstream and downstream node numbers 1 and 2, respectively, is called “ROBERTS”. The second record indicates that a link with upstream and downstream node numbers 33 and 1098, respectively, is called “E EMORY”. This file may be prepared manually, via DSPEd, or via DYNABUILDER.

4.7 Network Data (network.dat)

This input file, which provides information regarding traffic network configuration, is an agglomeration of several types of data including zoning, node numbering, and link characteristics. A detailed description of this file and its format are provided in Table 4-9 and Figure 4-5, respectively. Note that a link must have a length L_m greater than or equal to:

$$L_m \geq \frac{V_m \times 528}{60}$$

where L_m is the minimum length for link *m* (feet) and V_m is the free-flow speed for link *m* (mph). Therefore, for a free-flow speed of 60 mph, the minimum link length would be 528 feet. If the user specifies a link length shorter than L_m, the above inequality is violated and a warning message (on the command prompt console screen) will prompt the user to either (1) stop the simulation and check the *warning.dat* file (which reports all sorts of violations including short links), or (2) continue simulation without the user adjusting the link length. In the latter case, DYNASMART-P will internally reset the length of short links to L_m. An excessive number of short links may distort the actual network representation. Users are encouraged to merge short links together to avoid such a problem.

Table 4-9. Description of the *network.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Basic data	1	Integer	Free	Number of zones in the network
	2	Integer	Free	Number of nodes in the network
	3	Integer	Free	Number of links in the network
	4	Integer	Free	Number of shortest paths to be calculated for each O-D pair
	5	Integer	Free	Zone aggregation flag 0: Without zonal aggregation 1: With zonal aggregation (users need to supply the aggregation information in *SuperZone.dat*)
Node data[1]	1	Integer	Free	Node number of the 1st node
	2	Integer	Free	Zone number to which the 1st node belongs
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Node data[1]	1	Integer	Free	Node number of the last node
	2	Integer	Free	Zone number to which the last node belongs
Link data[2]	1	Integer	7	Upstream node of 1st link (starting node)
	2	Integer	7	Downstream node of 1st link (ending node)
	3	Integer	5	Number of left-turn bays of 1st link[3]
	4	Integer	5	Number of right-turn bays of 1st link[3]
	5	Integer	7	Length of the 1st link (in feet)
	6	Integer	3	Number of lanes for 1st link
	7	Integer	7	Traffic flow model number for the 1st link (which corresponds to those specified in *TrafficFlowModel.dat*)
	8	Integer	4	Posted speed limit adjustment margin (mph)[4]
	9	Integer	4	Posted speed limit for the 1st link (mph)
	10	Integer	6	Maximum service flow rate for the 1st link (pcphpl or vphpl)[5]
	11	Integer	6	Saturation flow rate for the 1st link (vphpl)[5]
	12	Integer	3	1st link identification number 1: Freeway[6]; 2: Freeway segment with detector (for ramp metering); 3: On ramp; 4: Off ramp; 5: Arterial; 6: HOT 7: Highway[7]; 8: HOV[8]; 9: Freeway HOT; 10: Freeway HOV
	13	Integer	4	Grade of the 1st link (%)
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Link data[2]	1	Integer	7	Upstream node of last link (starting node)
	2	Integer	7	Downstream node of last link (ending node)
	3	Integer	5	Number of left-turn bays of last link[3]
	4	Integer	5	Number of right-turn bays of last link[3]
	5	Integer	7	Length of the last link (in feet)
	6	Integer	3	Number of lanes for last link

Record Type	*Field*	*Format*	*Width*	*Description*
	7	Integer	7	Traffic flow model number for the last link (which corresponds to those specified in *TrafficFlowModel.dat*)
	8	Integer	4	Posted speed limit adjustment margin (mph)[4]
	9	Integer	4	Posted speed limit for the last link (mph)
	10	Integer	6	Maximum service flow rate for the last link (pcphpl or vphpl)[5]
	11	Integer	6	Saturation flow rate for the last link (vphpl)[5]
	12	Integer	3	Last link identification number 1: Freeway[6]; 2: Freeway segment with detector (for ramp metering); 3: On ramp; 4: Off ramp; 5: Arterial; 6: HOT 7: Highway[7]; 8: HOV[8]; 9: Freeway HOT; 10: Freeway HOV
	13	Integer	4	Grade of the last link (%)

1 *This Record must be repeated for all nodes in the network. Note that the order of node numbers in this file must be ascending, but not necessarily continuous. The maximum allowed node number is 89999.*

2 *The link data should be defined in a forward star(*) representation; that is, starting from the smallest node number, all downstream nodes should be exhausted (in ascending order) before representing a new node. Upstream nodes need to be in ascending order.*

3 *Up to 4 bays may be specified.*

4 *Used to reflect the actual observed free-flow speed as opposed to the posted speed limit. A positive/negative margin indicates that actual speed is higher/lower than posted speed limit. That is, if a highway section has a posted speed limit of 65 mph, but speed measurements indicate that the actual free-flow speed is approximately 69 mph, then a +4 should be entered for that parameter. It can also be used to represent aggressive driver behavior.*

5 *The maximum service flow rate is the maximum capacity of moving vehicles along a given lane, and provides an upper bound on the flow rate through a section under any condition. The saturation flow rate applies to downstream vehicles discharging from a queue. For freeways, these flow rates are interpreted as pcphpl and vphpl, respectively. For all other link types, the unit of flow is vphpl.*

6 *Fully-controlled access highways, where entrance and exit are only allowed at interchanges, and all crossroads are grade-separated using overpasses or underpasses – not directly intersecting the highway.*

7 *Partially-controlled access highway that is usually divided by a median, or other non-crossable barrier, and has access at interchanges or at-grade road intersections.*

8 *DYNASMART-P treats HOV links exclusively. The user must code the link twice if an HOV link is concurrent with other network links.*

```
  356   1347   3004    2    1
      1   10
      2   10
      3   10
      4   11
      5   11
..................................................................................
..................................................................
    171   25
    172   25
    173   25
    174   26
    175   26
    176   26
    177   26
    178   26
..........................................................................
      4      5    2    0   8394  1      2  +1  45  1800  1800  5  +3
      4   1332    0    0   7618  2      2  +2  45  1800  1800  5  +3
      4   1333    0    0   4937  2      2  +2  45  1800  1800  5  +3
      5      4    0    0   8391  1      2  +2  45  1800  1800  5  +3
      5      6    0    1   7246  4      1  -2  70  2200  2200  1  +1
....................................................................
```

Figure 4-5. General format of the *network.dat* input file

Figure 4-5 shows that the *network.dat* input file has three distinct data blocks: header information (first record only), node data, and link data blocks. The first record in Figure 4-5 indicates 356 zones in the network (field 1), 1347 nodes (field 2), 3004 links (field 3), the top 2 shortest paths are to be solved between all origins and destinations (field 4), and the zonal aggregation flag is 1 (field 5), meaning that aggregation is desired. Zonal aggregation information must be provided in the *SuperZone.dat* input file (refer to Section 4.22 for a description of *SuperZone.dat*). The second block lists the node numbers in ascending order. For example, nodes 3 and 4 belong to zones 10 and 11, respectively. Similarly, nodes 173 and 174 belong to zones 25 and 26, respectively.

The third block deals with link characteristics. The first record in that block reveals that link 1 starts at upstream node 4 (field 1), ends at downstream node 5 (field 2), has two left-turn bays (field 3), no right-turn bays (field 4), is 8394 feet long (field 5), has 1 lane (field 6), is governed by traffic flow model type 2 (field 7), has a free-flow speed one mph (+1) (field 8) above the posted speed limit of 45 mph (field 9), has a maximum service flow rate of 1800 vphpl (field 10), has a saturation flow rate of 1800 vphpl (field 11), is of type 5 (arterial) (field 12), and has a +3% grade (field 13). The fifth record reveals that the fifth link has an upstream node number 5 (field 1), downstream node number 6 (field 2), has no left-turn bay (field 3), 1 right-turn bay (field 4), is 7246 feet long (field 5), has 4 lanes (field 6), is governed by traffic flow model type 1 (field 7), has a free-flow speed two mph (-2) (field 8) below the posted speed limit of 70 mph (field 9), has a maximum service flow rate of 2200 pcphpl (field 10), has a saturation flow rate of 2200 vphpl (field 11), is of type 1 (freeway) (field 12), and has a +1% grade (field 13). As stated in Table 4-9, freeway maximum service flow rates and saturation flow rates are expressed in pcphpl. For arterials, the maximum service flow rate and saturation flow rate are expressed in vphpl.

This file can be prepared either manually, or via DSPEd or DYNABUILDER.

Further Discussion

- ❑ The number of shortest paths to be specified depends on the planning application. For pure UE or SO runs, a value of 1 (one path) is recommended for this entry. For en-route information planning applications, a value of 3 (three paths) is recommended (to provide alternate paths). For a general planning application with ATIS strategies, a value of 2 (two paths) is recommended.
- ❑ Freeways generally differ with arterials in that the former have higher service flow rates and follow a different traffic flow model (typically a dual-regime modified Greenshields model vs. single-regime models). Moreover, with freeways, traffic is modeled in units of passenger-car equivalents whereas on arterials, traffic is modeled in units of vehicles. Therefore, the user must be careful when specifying HOV/HOT links that are freeway links. They will inherently

behave differently than non-freeway HOV/HOT links, even if they have the same traffic model.

- ❑ In coding HOV links, the user typically needs to create duplicate links, one for regular lanes and the other for HOV lanes as DYNASMART-P does not model lane movement explicitly. That is, if a 4-lane freeway link has an HOV lane, the way to model it in DYNASMART-P would be to create two links, one freeway link (type 1) with 3 lanes, and another freeway HOV link (type 10) with one lane. The freeway link must then be split into two links to avoid having the same link (1 → 2) twice as shown in Figure 4-6. Note that the network.dat and movement.dat files need to be slightly modified in response to these changes.

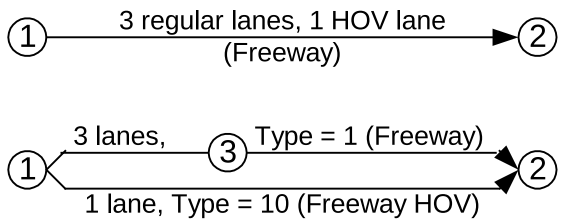


Figure 4-6. Modeling an HOV lane in DYNASMART-P

4.8 Movement Data (movement.dat)

The *movement.dat* file relates the various geometrically available movements associated with a given link. The purpose of this file is to specify allowed turning movements (due to geometrical and topological configuration) at each node. The previously discussed “forward star” representation is used; that is, the sequence of the listed links in this file should be identical to those specified in the link data record types of *network.dat*. A detailed description of this file and its format are provided in Table 4-10 and Figure 4-7, respectively.

Table 4-10. Description of the *movement.dat* input file

Record Type	*Field*	*Format*	*Field Width*	*Description*
Nodes	1	Integer	7	Upstream node of 1st link
	2	Integer	7	Downstream node of 1st link
	3	Integer	7	Downstream node number that a left-turn movement[1] leads to
	4	Integer	7	Downstream node number that a straight movement[1] leads to
	5	Integer	7	Downstream node number that a right movement[1] leads to
	6	Integer	7	Other node number that a movement[1] other than left, straight, or right leads to
	7	Integer	7	Other node number that a movement[1] other than left, straight, right or other movement 1 leads to
	8	Binary	7	U-turn flag 0: U-turn prohibited 1: U-turn allowed
.....	....	.....	.....	.....
Nodes	1	Integer	7	Upstream node of last link
	2	Integer	7	Downstream node of last link
	3	Integer	7	Left turn node number that a left-turn movement[1] leads to
	4	Integer	7	Straight node number that a straight movement[1] leads to
	5	Integer	7	Right node number that a right movement[1] leads to
	6	Integer	7	Other movement 1 node number that a movement[1] other than left, straight, or right leads to
	7	Integer	7	Other movement 2 node number that a movement[1] other than left, straight, right or other movement 1 leads to
	8	Binary	7	U-turn flag 0: U-turn prohibited 1: U-turn allowed

[1] *The movement is from the link defined by upstream node → downstream node*

```
      2    740      0     17    739    620      0      1
      3      1      2      0      0    746      0      0
      3    720    719    730    721      0      0      0
      4      5      0      6      0      0      0      0
      4   1332      0      0      0      0      0      0
      4   1333      0      0      0      0      0      0
```

Figure 4-7. General format of the *movement.dat* input file

Each record (line) contains data for one link (i.e. link 1 movements are described in the first line, link 2 movements are described in the second line and so on). Note that by default, u-turns are allowed on arterials, collectors, and surface streets, but are prohibited on freeways. The first record (first link) indicates that a vehicle traveling from upstream node 2 of the first link (field 1) to downstream node 740 of that link (field 2), cannot perform (0) a left-turning movement (field 3), can go straight (through) to node 17 (field 4), right to node 739 (field 5), can go "diagonally" (other-1 movement) to node 620 (field 6), no other-2 movement exists (field 7), and u-turns are allowed (field 8).

The third record (3rd link) of the file indicates that a vehicle on that link traveling from upstream node 3 (field 1) to downstream node 720 (field 2) can perform a left-turn to node 719 (field 3), a straight movement to node 730 (field 4) and a right-turn to node 721 (field 5). No other movements (fields 6 and 7) or u-turns (field 8) are allowed.

This file can be prepared either manually, or via DSPEd or DYNABUILDER.

4.9 Traffic Flow Model (TrafficFlowModel.dat)

This file provides parameters of the traffic flow model types specified within *network.dat*. As discussed earlier, DYNASMART-P uses a modified Greenshields model for traffic propagation. In the current version, two types of the modified Greenshields family models are available. Type one is a dual-regime model in which constant free-flow speed is specified for the free-flow conditions (1st regime) and a modified Greenshields model is specified for congested-flow conditions (2nd regime) (Figure 4-8).

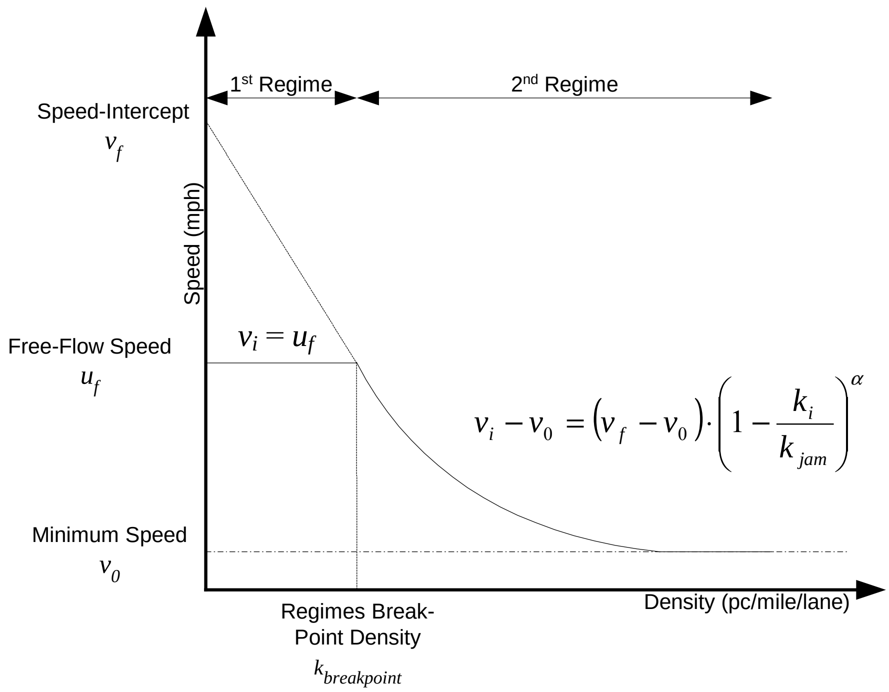


Figure 4-8. Type 1 modified Greenshields model

In mathematical terms, the type 1 modified Greenshields is expressed as follows:

$$v_i = u_f \qquad 0 \le k_i \le k_{breakpoint}$$

$$v_i - v_0 = (v_f - v_0) \cdot \left(1 - \frac{k_i}{k_{jam}}\right)^{\alpha} \qquad k_{breakpoint} \le k_i \le k_{jam}$$

where v_i = speed on link *i*

v_f = speed-intercept

u_f = free-flow speed on link *i*

v_0 = minimum speed on link *i*

k_i = density on link *i*

k_{jam} = jam density on link *i*

α = power term

$k_{breakpoint}$ = breakpoint density

Type two uses a single-regime to model traffic relations for both free- and congested-flow conditions (Figure 4-9), i.e.

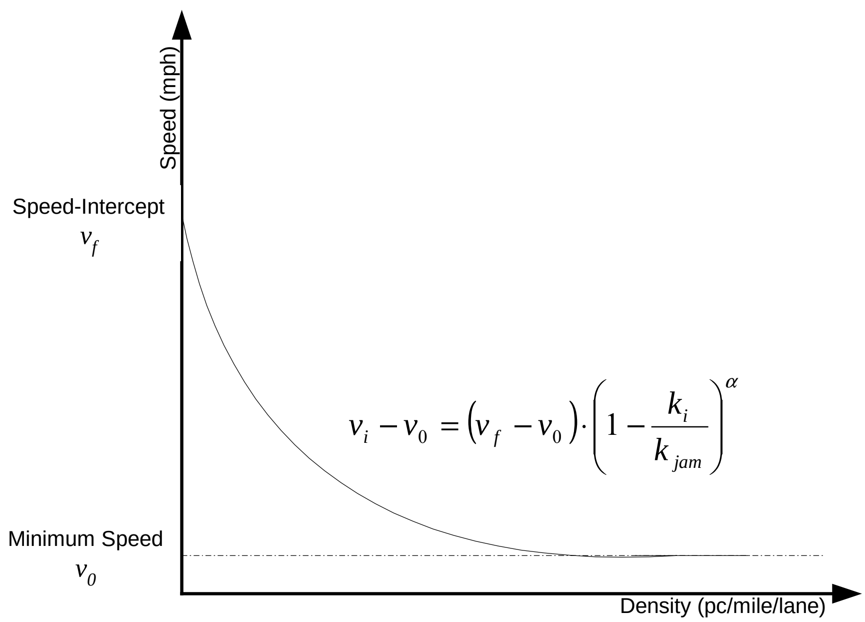


Figure 4-9. Type 2 modified Greenshields model

In mathematical terms, the type 2 modified Greenshields is expressed as follows:

$$v_i - v_0 = (v_f - v_0) \cdot \left(1 - \frac{k_i}{k_{jam}}\right)^{\alpha}$$

Dual-regime models are generally applicable to freeways, whereas single-regime models apply to arterials. The reason why a two-regime model is applicable for freeways in particular is that freeways have typically more capacity than arterials, and can accommodate dense traffic (up to 2300 pc/hr/ln) at near free-flow speeds. On the other hand, arterials have signalized intersections, meaning that such a phenomenon may be short-lived, if present at all. Hence, a slight increase in traffic would elicit more deterioration in prevailing speeds than in the case of freeways. Therefore, arterial traffic relations are better explained using a single-regime model.

Parameters for the dual-regime Greenshields model (in DYNASMART-P) were calibrated for the San Antonio (Texas) freeway system, whereas the single-regime parameters were calibrated for the Irvine (California) surface street network. No calibration studies have been performed on other areas due to the general lack of time-dependent traffic data. The user is encouraged to consult the available body of literature in that regard.

Table 4-11. Description of the *TrafficFlowModel.dat* input file

Record Type	*Field*	*Format*	*Field Width*	*Description*
Number of Traffic Flow Models	1	Integer	Free	Total number of traffic models specified in this file
Model type	1	Integer	Free	Model number
	2	Integer	Free	Traffic flow model type: 1: Two-regime modified Greenshields model 2: Single-regime modified Greenshields model
Model parameters	1	Integer	Free	Type 1: Density breakpoint between regimes (pc/mile/lane) Type 2: 0 (ignored by DYNASMART-P)
	2	Integer	Free	Type 1: Speed intercept for the two-regime model Type 2: 0 (ignored by DYNASMART-P)
	3	Integer	Free	All types: Minimum speed (mph)
	4	Integer	Free	All types: Jam density (pc/mile/lane)
	5	float	Free	All types: shape term α. The larger α is, the quicker the speed drop is with increasing density

```
4
1  1
30  97  15  200 3.09
2  2
 0   0  10   90 1.25
3  2
 0   0  10   90 1.25
4  2
 0   0  10   90 1.25
```

Figure 4-10. General format of the *TrafficFlowModel.dat* input file

The first record in Figure 4-10 indicates that four models are specified. The second record indicates that model 1 (field 1) is of type 1 – dual-regime modified Greenshields model (field 2). The third record indicates that the break point between regimes of the traffic model occurs at a density of 30 pc/mile/lane (field 1). The "speed intercept" for the second regime is 97 mph (field 2), the minimum speed is 15 mph (field 3), the jam density is 200 pc/mile/lane (field 4), and the shape parameter α is 3.09 (field 5).

Similarly, the sixth record indicates that model 3 (field 1) is of type 2 – single-regime modified Greenshields model (field 2). The next record indicates that a zero (field 1) break point (single-regime model). A zero "speed intercept" is (must be) specified (field 2), the minimum speed is 10 mph (field 3), the jam density is 90 pc/mile/lane (field 4), and the shape parameter α is 1.25 (field 5). Note that the speed intercept (or free-flow speed) for the single-regime model is estimated from the link speed limit and speed limit adjustment specified in *network.dat*.

This file can be prepared either manually, or via DSPEd or DYNABUILDER (default settings only).

4.10 Passenger Car Equivalency Data (GradeLengthPCE.dat)

This input file, which is based on Highway Capacity Manual 2000 Exhibit 21-9, contains PCE values for heavy vehicles based on link upgrade, length, and the percentage of heavy vehicles.

Table 4-12. Description of the *GradeLengthPCE.dat* input file

Record Type	*Field*	*Format*	*Field Width*	*Description*
Table Dimension	1	Integer	Free	Dimension for grade
	2	Integer	Free	Dimension for link length categories
	3	Integer	Free	Dimension for truck percentage categories
Truck Percentage	1	Float	Free	1st breakpoint for truck percentage categories
. . . . .	. . . .	. . . . .	. . . . .	. . . . .
	. . . .	Float	Free	Last breakpoint for truck percentage categories
Grade	1	Integer	Free	
Link Length category	1	Float	Free	1st breakpoint for link length categories
. . . . .	. . . .	. . . . .	. . . . .	. . . . .
	. . . .	Float	Free	Last breakpoint for link length categories

PCE values are used for adjusting the physical capacity of links (arterials and freeways), and the maximum service flow rate on freeways. The PCE values do not directly affect the maximum service flow rate on arterials as DYNASMART-P models vehicles on arterials in terms of vehicles and not passenger cars, which is the current practice. Also note that the effect of grade is only applicable to upgrades in DYNASMART-P. The reason behind such a design is that a downgrade is not expected to hinder vehicles from reaching their desired speed (prevailing speed on links), unlike when on an upgrade.

```
5   6   9
2   4   5   6   8  10  15  20  25
2
  0.00     1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5
  0.25     1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5
  0.50     1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5
  0.75     2.0  2.0  2.0  2.0  1.5  1.5  1.5  1.5  1.5
  1.00     2.5  2.5  2.5  2.5  2.0  2.0  2.0  2.0  2.0
  1.50     3.0  3.0  2.5  2.5  2.0  2.0  2.0  2.0  2.0
3
  0.00     1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5
  0.25     2.0  2.0  2.0  2.0  2.0  2.0  1.5  1.5  1.5
  0.50     2.5  2.5  2.0  2.0  2.0  2.0  2.0  2.0  2.0
  0.75     3.0  3.0  2.5  2.5  2.5  2.5  2.0  2.0  2.0
  1.00     3.5  3.5  3.0  3.0  3.0  3.0  2.5  2.5  2.5
  1.50     4.0  3.5  3.0  3.0  3.0  3.0  2.5  2.5  2.5
4
  0.00     1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5  1.5
  0.25     3.0  2.5  2.5  2.5  2.0  2.0  2.0  2.0  2.0
  0.50     3.5  3.0  3.0  3.0  2.5  2.5  2.5  2.5  2.5
  0.75     4.0  3.5  3.5  3.5  3.0  3.0  3.0  3.0  3.0
  1.00     5.0  4.0  4.0  4.0  3.5  3.5  3.0  3.0  3.0
  1.50     5.0  4.0  4.0  4.0  3.5  3.5  3.0  3.0  3.0
5
  0.00     2.0  2.0  1.5  1.5  1.5  1.5  1.5  1.5  1.5
  0.25     4.0  3.0  2.5  2.5  2.0  2.0  2.0  2.0  2.0
  0.33     4.5  4.0  3.5  3.0  2.5  2.5  2.5  2.5  2.5
  0.50     5.0  4.5  4.0  3.5  3.0  3.0  3.0  3.0  3.0
  0.75     5.5  5.0  4.5  4.0  3.5  3.0  3.0  3.0  3.0
  1.00     6.0  5.0  5.0  4.5  3.5  3.5  3.5  3.5  3.5
6
  0.00     4.0  3.0  2.5  2.5  2.5  2.5  2.5  2.0  2.0
  0.25     4.5  4.0  3.5  3.5  3.5  3.0  2.5  2.5  2.5
  0.33     5.0  4.5  4.0  4.0  3.5  3.0  2.5  2.5  2.5
  0.50     5.5  5.0  4.5  4.5  4.0  3.5  3.0  3.0  3.0
  0.75     6.0  5.5  5.0  5.0  4.5  4.0  3.5  3.5  3.5
  1.00     7.0  6.0  5.5  5.5  5.0  4.5  4.0  4.0  4.0
```

Figure 4-11. General format of the *GradeLengthPCE.dat* input file

No interpolation is used in determining the PCE factors. The specified link lengths act as breakpoints. For example, for a grade that is between 5 and 6% (say 5.5%) then the values corresponding to a 5% grade will be used (lower bracket). If the link length is between 0 and 0.25 miles, the following set of PCE factors (corresponding to 0 miles) are used:

```
2.0  2.0  1.5  1.5  1.5  1.5  1.5  1.5
```

If the length is between 0.33 and 0.50, the following PCE factors are used:

```
4.5  4.0  3.5  3.0  2.5  2.5  2.5  2.5  2.5
```

and so on. The same applies for truck percentages. If the link grade is 3%, then it falls between the 3% and 4% categories, and hence the set of values pertaining to the 3% category are used. As a final illustration, if the link length is 2000 ft (~ 0.4 miles) and the grade is 4.5%, then the following set of PCE values is used:

```
3.0  2.5  2.5  2.5  2.0  2.0  2.0  2.0  2.0
```

As a general rule, if the variable v (link length, fraction of trucks, or grade) is greater than or equal to x_1 and less than x_2 (i.e. $x_1 \leq v < x_2$), then the set of values corresponding to x_1 will apply.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER (default settings only).

4.11 Signal Control Data (control.dat)

This file describes the type of control associated with each node, namely whether it is no-control, stop or yield sign, or signalized. It also includes the offset, cycle lengths, phasing splits, and movements at any signalized node. The no-control feature applies to freeway and un-signalized highway nodes. Note that DYNASMART-P can generate default signal timing and phasing plans for signalized intersections, provided that the user codes these intersections as actuated (control type 5). To generate default signal timing plans, click the Scenario | Generate Actuated Signal Timing Data menu command. Also note that any phasing movement specified in this file will only be feasible if also specified in the *movement.dat* input file. *Movement.dat* will always prevail when there is a conflict between movements specified in *control.dat* and *movement.dat* files. A detailed description of *control.dat* and its format are provided in Table 4-13 and Figure 4-12, respectively.

Table 4-13. Description of the *control.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Number of plans[1]	1	Integer	Free	Number of signal timing plans
Start time of signal timing plan	1	Float	6(2)	Starting time (0.0) for 1st timing plan (minutes)
	2	Float	6(2)	Starting time for 2nd signal timing plan (minutes)
.....	....	.....	.....	.....
	....	Float	6(2)	Starting time for last signal timing plan (minutes).
Node data	1	Integer	Free	Node number
	2	Integer	Free	Control type: 1: no control; 2: yield sign; 3: 4-way stop sign; 4: pre-timed control; 5: actuated signal control;[2] 6: 2-way stop sign
	3	Integer	Free	Number of phases. Required for control types 4 and 5, otherwise a zero is entered.
	4	Integer	Free	Cycle length. Required for control types 4 and 5, otherwise a zero is entered[3].
Phasing data[4]	1	Integer	Free	Node number
	2	Integer	Free	Phase number

Record Type	Field	Format	Width	Description
	3	Integer	Free	Offset (if pre-timed), or maximum green (G-max) time (if actuated) for this phase[5]
	4	Integer	Free	Green time (if pre-timed) or minimum green (G-min) time (if actuated) for this phase
	5	Integer	Free	Amber time for this phase
	6	Integer	Free	Number of inbound links in this phase (maximum of 4 inbound links)
	7 – 10	Integer	Free	Upstream nodes of the inbound links, zero otherwise
Phasing movements[4]	1	Integer	Free	Upstream node of the inbound link
	2	Integer	Free	Downstream node of the inbound link (signalized node)
	3	Integer	Free	Phase number (must be the same as field 2 in the Phasing Data record type)
	4	Integer	Free	Number of movements allowed out of the inbound link during this phase
	5 –	Integer	Free	Associated downstream nodes that are reached from the inbound link for corresponding allowed movements
2-way stop and yield	1	Integer	Free	Node number
signs data	2	Integer	Free	Number of links specified as major approaches
	3	Integer	Free	Number of links specified as minor approaches
Major approach	1	Integer	Free	Upstream node of 1st major approach
	2	Integer	Free	Downstream node of 1st major approach
	1	Integer	Free	Upstream node of 2nd major approach
	2	Integer	Free	Downstream node of 2nd major approach
Minor approach	1	Integer	Free	Upstream node of 1st minor approach
	2	Integer	Free	Downstream node of 1st minor approach
	1	Integer	Free	Upstream node of 2nd minor approach
	2	Integer	Free	Downstream node of 2nd minor approach

1 *If more than one timing plan is specified, the process must be repeated (node data, phasing data, phasing movement, and 2-way stop and yield signs data record types) for other plans in a sequential manner.*

2 *DYNASMART-P emulates the behavior of actuated signals. The green time is extended, as long as vehicles are detected, until G-max is reached..*

3 *The cycle length is read but ignored by DYNASMART-P. The green and amber times provided in the phasing data are used by the model.*

4 *The node data and phasing movement records must be repeated for all phases.*

5 *Offset is only specified for phase 1. A zero must be entered in this field for remaining phases. DYNASMART-P does not explicitly model coordinated actuated signals.*

```
  2
  0.00   30.00
      1 5 3 120
      2 5 3 120
      3 5 3 120
      4 5 3 120
      5 5 3 120
      6 5 3 120
      7 5 3 120
      8 5 3 120
      9 5 3 120
     10 5 3 120
     11 5 3 120
     12 5 3 120
     13 6 0   0
     14 3 0   0
.
.
```

```
.
    176 3 0   0
    177 2 0   0
    178 3 0   0
.
.
.
      1       1      25      10       5       1      81       0       0       0
     81       1       1       2       2      20
      1       2      25      10       5       1     116       0       0       0
    116       1       2       3       2      20      81
      1       3      55      10       5       1       2       0       0       0
      2       1       3       2      20      81
      2       1      55      10       5       1       1       0       0       0
      1       2       1       2     116     139
      2       2      25      10       5       1     139       0       0       0
    139       2       2       2       1     116
      2       3      25      10       5       1      22       0       0       0
     22       2       3       3       1     116     139
      3       1      25      10       5       1      82       0       0       0
     82       3       1       2       4      24
      3       2      25      10       5       1      20       0       0       0
     20       3       2       3       4      24      82



    144       1      25      10       5       2      97     145       0       0
     97     144       1       2     145      91
    145     144       1       2      97      96
    144       2      25      10       5       2      97     145       0       0
     97     144       2       2      96      91
    145     144       2       2      91      96
    144       3      25      10       5       2      91      96       0       0
     91     144       3       2      96     145
     96     144       3       2      91      97
    144       4      25      10       5       2      91      96       0       0
     91     144       4       2      97     145
     96     144       4       2     145      97
=======Two Way Stop Signs/Yield Signs Below =======
     13       2       1
     14      13      76      13
     46      13


      1 5 3 120
      2 5 3 120
      3 5 3 120
      4 5 3 120
      5 5 3 120
      6 5 3 120
      7 5 3 120
      8 5 3 120
      9 5 3 120
     10 5 3 120
     11 5 3 120
     12 5 3 120
     13 6 0   0
     14 3 0   0
.
.
.
    176 3 0   0
    177 2 0   0
    178 3 0   0
.
.
.
      1       1      25      10       5       1      81       0       0       0
```

```
     81       1       1       2       2      20
      1       2      25      10       5       1     116       0       0       0
    116       1       2       3       2      20      81
      1       3      55      10       5       1       2       0       0       0
      2       1       3       2      20      81
      2       1      55      10       5       1       1       0       0       0
      1       2       1       2     116     139
      2       2      25      10       5       1     139       0       0       0
    139       2       2       2       1     116
      2       3      25      10       5       1      22       0       0       0
     22       2       3       3       1     116     139


    144       2      25      10       5       2      97     145       0       0
     97     144       2       2      96      91
    145     144       2       2      91      96
    144       3      25      10       5       2      91      96       0       0
     91     144       3       2      96     145
     96     144       3       2      91      97
    144       4      25      10       5       2      91      96       0       0
     91     144       4       2      97     145
     96     144       4       2     145      97
=======Two Way Stop Signs/Yield Signs Below =======
     13       2       1
     14      13      76      13
     46      13
```

Figure 4-12. General format of the *control.dat* input file

The first record in Figure 4-12 indicates that 2 control plans are provided. The second record indicates that plan 1 starts at time 0 (field 1) minutes, and plan 2 starts at time 30 (field 2) minutes of simulation. The node data block follows. One record from this block shows that node 1 (field 1) has a control type 5 (actuated) (field 2), 3 phases (field 3), and a cycle length of 120 sec (field 4). Note that this cycle length may be different during simulation because in the actuated signal, only the minimum and the maximum greens determine the length of each phase. Another record shows that node 14 (field 1) is of control type 3 (4-way stop sign) (field 2). Similarly node 176 (field 1) has a control type 3 (4-way stop sign) (field 2). Number of phases and cycle length are not required; hence a zero is provided in both fields 3 and 4. The node data must be completed before proceeding to the phasing data.

The phasing data and phasing movement blocks reveal that for node 1 (actuated – see corresponding record in the node data block) (field 1), and phase 1 (field 2), the maximum green time is 25 seconds (field 3), the minimum green time is 10 seconds (field 4), and the amber time is 5 seconds (field 5). Also, the same record indicates that vehicles from 1 inbound link (field 6) are allowed to use the intersection during this phase, namely vehicles arriving from upstream node 81 (of the inbound link) (field 7). The next record shows that vehicles traveling from upstream node 81 (field 1) to downstream node 1 (the signalized node) (field 2), are allowed to use the intersection in phase 1 (field 3), where movements are permitted from this upstream node (field 4) to downstream nodes 2 (field 5) and 20 (field 6).

The user only needs to provide phasing data and phasing movement data for those nodes specified with pre-timed or actuated control in the node information record type. The user needs to complete the phasing and movement data for a given signalized node before coding data for the next signalized node. The phasing data record type is a single line for every phase followed by the phasing movement data block, which consists of as many lines as inbound links for each phase. Zeros are used for placeholders when a phase has less than four inbound links.

The next block of data input is for major/minor approaches at two-way stop signs or yield signs. The first record indicates that node 13 is a two-way stop sign (field 1), two major approaches (field 2) are specified, and one minor (field 3) approach is specified. The next record specifies the upstream and downstream nodes of the major approaches. In the example, the two major approaches are (14, 13) and (76, 13). The next record specifies the upstream and downstream nodes for the minor approach. In the example, the minor approach is link (46, 13). The next block is applicable for timing plan number 2 (which starts at time = 30 minutes of simulation as indicated by the start time of the signal timing plans record type). The remaining records follow the same description as for plan 1.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER.

4.11.1 Coding a signalized intersection in DYNASMART-P

DYNASMART-P models both pre-timed and actuated signals, but not at the microscopic level. DYNASMART-P has been compared against CORSIM with favorable results, and has been shown to exhibit reasonable and robust control logic. For pre-timed control, the user needs to specify the offset, number of phases, and the green and yellow periods as well as permissive movements for each phase. Should there be un-protected left-turns, then the model adjusts the capacity for these movements based on the presence of turn bays, according to the HCM 2000. The same logic is followed for actuated control, except the user needs to specify the maximum and minimum green times for each phase. In this implementation, the green time is extended, as long as vehicles are detected, until G-max is reached.

To model coordinated pre-timed control, the user needs to specify an offset for the first phase of each cycle relative to the start-time of the plan, which is 0 sec by default. For “fully-actuated” signals, DYNASMART-P will keep extending the green (beyond G-min) up to G-max as along as vehicles are detected at the stop bar. Because DYNASMART-P does not explicitly model coordinated actuated signals, it may be preferable to model such intersections as pre-timed, to guarantee a certain amount of green time on the major street.

Figure 4-13 depicts a typical signalized intersection in an urban network. To code such a signalized intersection for DYNASMART-P, the user can declare node 555 to be a pre-timed signal (control type = 4), with 5 phases and a cycle length of 90 seconds in the node data block as follows:

```
....555.4.5..90
```

where `'.'` represents an empty space.

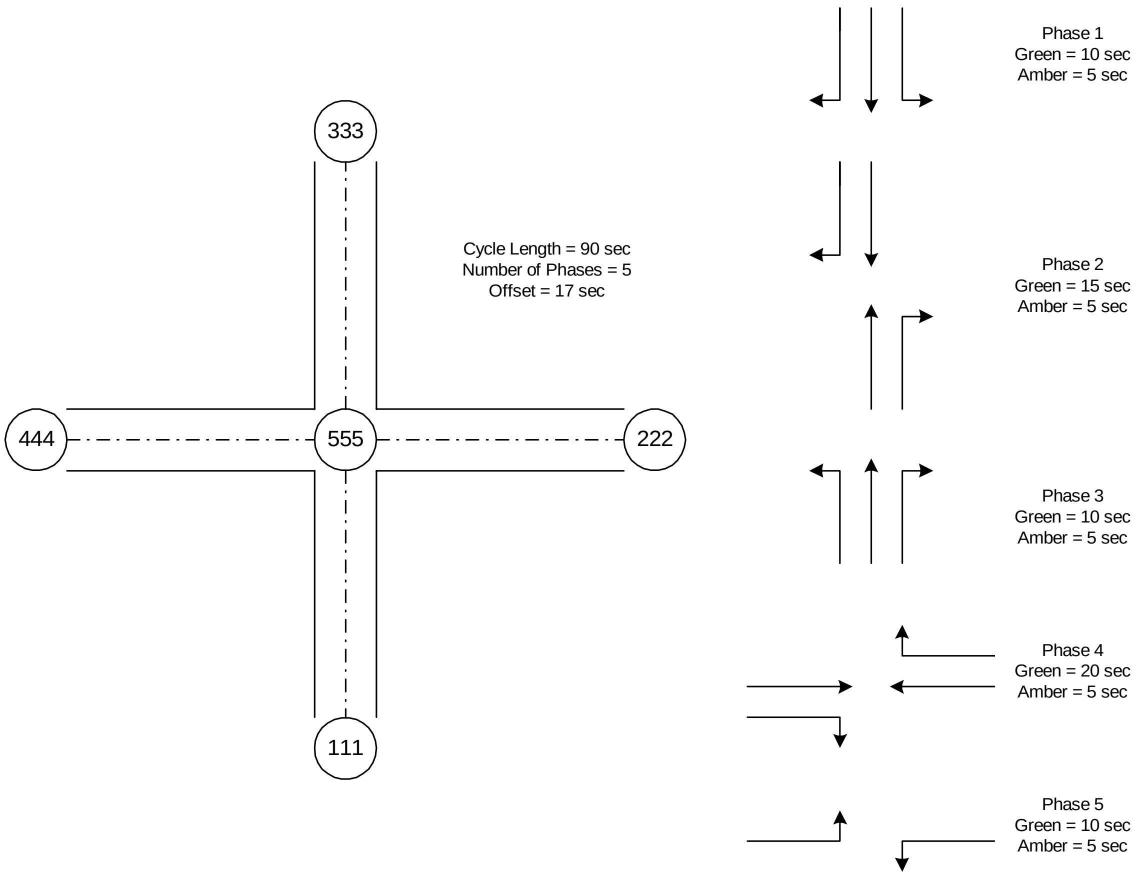


Figure 4-13. Typical signalized intersection with phasing and movement data

Then, the user must enter the phasing and movement data for each phase of this signal:

For the first phase, the offset is 17 sec, the green time is 10 sec, the amber time is 5 sec, the number of in-bound links is 1 (link 333 → 555), and the upstream node of the in-bound link is 333. This information is written as:

```
....555......1.....17.....10......5......1....333
```

The movement data for this phase are as follows. Vehicles traveling from node 333 (upstream node of in-bound link for this phase) to node 555 (node where signal is located) in phase 1 are allowed to complete three turning movements, namely to nodes 444 (right-turn), 111 (through), and 222 (left-turn). The movement data are written as follows:

```
....333....555......1....444....111....222
```

For the second phase, the offset is zero (no offset is specified for phases other than the first phase), the green time is 15 sec, the amber time is 5 sec, the number of in-bound links is 2 (links 333 → 555 and 111 → 555), and the upstream nodes of the in-bound links are 333 and 111. This information is written as:

```
....555......2......0.....15......5......2....333....111
```

The movement data for this phase are as follows. Vehicles traveling from node 333 (upstream node of the first in-bound link for this phase) to node 555 (node where signal is located) in phase 2 are allowed to complete two turning movements, namely to nodes 444 (right-turn) and 111 (through). Vehicles traveling from node 111 (upstream node of the second in-bound link for this phase) to node 555 (node where signal is located) in phase 2 are allowed to complete two turning movements, namely to nodes 222 (right-turn) and 333 (through). The movement data are written as follows:

```
....333....555......2....444....111
....111....555......2....222....333
```

For the third phase, the offset is zero (no offset is specified for phases other than the first phase), the green time is 10 sec, the amber time is 5 sec, the number of in-bounding links is 1 (link 111 → 555), and the upstream node of the in-bounding link is 11. This information is written as:

```
....555......3......0.....10......5......1....111
```

The movement data for this phase are as follows. Vehicles traveling from node 111 (upstream node of the in-bound link for this phase) to node 555 (node where signal is located) in phase 3 are allowed to complete three turning movements, namely to nodes 222 (right-turn), 333 (through), 444 (left). The movement data are written as follows:

```
....111....555......3....222....333....444
```

For the fourth phase, the offset is zero (no offset is specified for phases other than the first phase), the green time is 20 sec, the amber time is 5 sec, the number of in-bound links is 2 (links 222 → 555 and 444 → 555), and the upstream nodes of the in-bound links are 222 and 444. This information is written as:

```
....555......4......0.....20......5......2....222....444
```

The movement data for this phase are as follows. Vehicles traveling from node 222 (upstream node of the first in-bound link for this phase) to node 555 (node where signal is located) in phase 4 are allowed to complete two turning movements, namely to nodes 333 (right-turn) and 444 (through). Vehicles traveling from node 444 (upstream node of the second in-bound link for this phase) to node 555 (node where signal is located) in phase 4 are allowed to complete two turning movements, namely to nodes 111 (right-turn) and 222 (through). The movement data are written as follows:

```
....222....555......4....333....444
....444....555......4....111....222
```

For the fifth phase, the offset is zero (no offset is specified for phases other than the first phase), the green time is 10 sec, the amber time is 5 sec, the number of in-bound links is 2 (links 222 → 555 and 444 → 555), and the upstream nodes of the in-bound links are 222 and 444. This information is written as:

```
....555......5......0.....10......5......2....222....444
```

The movement data for this phase are as follows. Vehicles traveling from node 222 (upstream node of the first in-bound link for this phase) to node 555 (node where signal is located) in phase 5 are allowed to complete one turning movement, namely to node 111 (left). Vehicles coming from node 444 (upstream node of the second in-bound link for this phase) to node 555 (node where signal is located) in phase 5 are allowed to complete one turning movement, namely to node 333 (left). The movement data for this phase are written as follows:

```
....222....555......5....111
....444....555......5....333
```

Combining all of the data records, we have the phasing and movement data block for this signal to be entered in *control.dat*:

```
....555......1.....17.....10......5......1....333
....333....555......1....444....111....222
....555......2......0.....15......5......2....333....111
....333....555......2....444....111
....111....555......2....222....333
....555......3......0.....10......5......1....111
....111....555......3....222....333....444
....555......4......0.....20......5......2....222....444
....222....555......4....333....444
....444....555......4....111....222
....555......5......0.....10......5......2....222....444
....222....555......5....111
....444....555......5....333
```

Note that, for coding actuated signals, the user must replace the offset and green times with the maximum green and minimum green times, respectively.

4.12 Left-Turn Capacity (leftcap.dat)

This file specifies permitted left-turn capacities, as a function of lane channelization (presence of left-turn bays) and available green time. These values, which are the default values used in DYNASMART-P, were obtained from the HCM 2000 (Exhibit C16-9). The model parameter values within this file should probably not be changed by the user, unless field data are available to warrant permitted left-turn calibration. A detailed description of this file and its format are provided in Table 4-14 and Figure 4-14, respectively.

Table 4-14. Description of the *leftcap.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
		With left-turn bays		
Volume on opposing links[1]	1 – 7	Integer	Free	Seven different values for the total volume on the opposing link (vehicles/hr)
g/c indicator	1	Text/Float	4X/F3.1[2]	The ratio of the green time to the cycle length
Left-turn bay capacities	1	Integer	1	Number of lanes on the opposing link
	2	Free	3X	Empty spaces, ignored by DYNASMART-P
	2 – 8	Integer	5	Left-turn capacities (veh/hr) corresponding to the 7 volume categories specified in *volume on opposing links* record
		Without left-turn bays		
g/c indicator	1	Text/Float	7	The ratio of the green to the cycle length
Left-turn w/o bay capacities	1	Integer	1	Volume on the current link in hundreds (veh/hr)
	2	Integer	4	Number of lanes on the opposing link
	3-9	Integer	5	Left-turn capacities (veh/hr) corresponding to the 7 volume categories specified in *volume on opposing links* record

[1] *This record is not read by DYNASMART-P, and is intended to show the data in a tabularized format.*
[2] *The first 4 spaces are text and the remaining 3 spaces are numerical with one decimal point.*

Record 1 in Figure 4-14 refers to the volume on opposing links in vehicles/hr. Record 2 indicates that the g/c ratio = 0.3. Record 3 indicates that, in the case where the approach g/c ratio is 0.3 (record 2), for 1 (field 1) opposing link, the left-turn capacities are 135 (field 2) if the volume on opposing links is 200 veh/hr or less, 71 (field 2) if the volume on opposing links is 300 veh/hr or less, and 60 (field 3) if the volume on opposing links is 400 veh/hr or less. The left-turn capacity is zero for higher volumes. Record 4 indicates that, in the case where the approach g/c ratio is 0.3 (record 2), for 2 (field 1) opposing lanes, the left-turn capacities are 177 (field 2) if the volume on opposing links is 200 veh/hr or less, 126 (field 2) if the volume on opposing links is 300 veh/hr or less, and 92 (field 3) if the volume on opposing links is 400 veh/hr or less, and so on. The left-turn capacity is zero for higher opposing volumes, 1000 vehicles/hour.

```
       200  300  400  500  600  800 1000                           Record 1
g/c=0.3                                                            Record 2
1      135   71   60                                               Record 3
2      177  126   92   60   60   60                                Record 4
3      189  143  114   83   72   60   60                           Record 5
g/c=0.4                                                            Record 6
1      223  159   94   62                                          Record 7
2      270  219  168  134   84   60   60                           Record 8
3      282  236  191  162  118   95   73                           Record 9
g/c=0.5                                                            Record 10
1      317  252  183  121   80                                     Record 11
2      353  316  256  218  175   97   63                           Record 12
3      375  330  284  239  210  142  119                           Record 13
g/c=0.6                                                            Record 14
1      400  335  270  206  142   76                                Record 15
2      457  406  355  303  252  183  109                           Record 16
3      468  423  377  332  286  229  166                           Record 17
g/c=0.7                                                            Record 18
1      487  422  358  294  229  135                                Record 19
2      550  499  448  397  346  261  156                           Record 20
3      561  516  470  425  380  307  213                           Record 21
=======left turn capacity w/o bay ==                               Record 22
g/c=0.3                                                            Record 23
1   1  120   60   31                                               Record 24
1   2  161  112   79   46   31   16                                Record 25
1   3  172  128  101   71   61   41   26                           Record 26
2   1   90   43   21                                               Record 27
2   2  125   83   57   32   21   11                                Record 27
2   3  134   97   74   51   43   28   18                           Record 29
3   1   52   23   12                                               Record 30
3   2   75   48   32   17   11    6                                Record 31
3   3   82   56   42   28   24   15   10                           Record 32
g/c=0.4                                                            Record 33
1   1  210  147   85   55                                          Record 34
1   2  257  206  156  123   75   44   28                           Record 35
1   3  268  223  179  151  108   86   65                           Record 36
2   1  181  123   69   44                                          Record 37
2   2  224  177  132  102   61   35   22                           Record 38
2   3  235  193  152  126   89   70   52                           Record 39
3   1  141   93   51   32                                          Record 40
3   2  179  138  100   76   44   25   16                           Record 41
3   3  188  151  116   96   66   51   38                           Record 42
4   1   92   59   31   19                                          Record 43
4   2  120   90   63   47   27   15   10                           Record 44
4   3  127  100   75   61   41   32   23                           Record 45
```

Figure 4-14. General format of the *leftcap.dat* input file

Now consider record #34. It indicates that, for a g/c ratio of 0.4 (Record #33), if the volume on the current link is less than 100 (field 1 is in hundreds), then for 1 (field 2) opposing links, the left-turn capacity is 210 (field 3) if the opposing volume is less than 200 veh/hr, 147 (field 4) if the opposing volume is less than 300 veh/hr, 85 (field 5) if the opposing volume is less than 400 veh/hr, and 55 (field 6) if the opposing volume is less than 500 veh/hr. The left-turn capacity is zero for higher opposing volumes.

Similarly, Record 39 indicates that, for a g/c ratio of 0.4 (Record #33), if the volume on the current link is less than 200 (field 1 is in hundreds), then for 3 (field 2) opposing links, the left-turn capacity is 235 (field 3) if the opposing volume is less than 200 veh/hr, 193 (field 4) if the opposing volume is less than 300 veh/hr, 152 (field 5) if the opposing volume is less than 400 veh/hr, 126 (field 6) if the opposing volume is less than 500 veh/hr, 89 (field 7) if the opposing volume is less than 600 veh/hr, 70 (field 8) if the opposing volume is less than 700 veh/hr, and 52 (field 9) if the opposing volume is less than 800 veh/hr. The left-turn capacity is zero for higher opposing volumes.

Note that, for a given volume of opposing traffic, left-turning vehicles will have additional gaps to complete their movement as the number of opposing lanes increases, hence the higher left-turn capacity.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER (default settings only).

4.13 Two-Way Stop Sign Capacity (StopCap2Way.dat)

DYNASMART-P discharges vehicles at Two-Way Stop-Controlled (TWSC) intersections according to three types of turning movements (LT, TH, and RT) and the flow rate on the major approach. For each simulation interval, the control logic checks the flow rate on the major approach of a TWSC intersection and assigns an appropriate saturation flow rate for the given type of turning movement. The saturation flow rate is obtained from a lookup table provided by the user. In the event where no data regarding traffic flows at a two-way stop-controlled intersection are available, the user can accept the default values incorporated in DYNASMART-P, which are obtained from NCHRP[1]. These values are presented in Table 4-15.

---

[1] NCHRP – Capacity and Level of Service at Unsignalized Intersections. Final Report Volume 2 – All-Way Stop-Controlled Intersections, April 1996.

Table 4-15. DYNASMART-P default discharge rates at TWSC intersections

Flow on Major Approach (veh/hr/lane)	*Saturation Flow (veh/hr)*			*Flow on Major Approach (veh/hr/lane)*	*Saturation Flow (veh/hr)*		
	Left Turn	*Through*	*Right Turn*		*Left Turn*	*Through*	*Right Turn*
0	899	1027	1090	1100	214	191	260
100	794	886	961	1200	187	163	228
200	699	763	846	1300	163	140	199
300	616	656	744	1400	142	119	174
400	541	564	654	1500	123	101	152
500	476	484	575	1600	107	86	132
600	417	416	505	1700	93	74	115
700	366	357	443	1800	81	63	100
800	320	306	388	1900	70	53	87
900	280	262	340	2000	61	45	76
1000	245	224	298				

The model is fundamentally different than the common analytical or microscopic simulation models, which use critical gap acceptance theory and car following techniques for estimating the capacity at TWSC intersections. However, DYNASMART-P can be easily calibrated to produce similar results by appropriately adjusting the discharge flow rate for various traffic flow rates (on major approaches) and turning movement combinations. The format of *StopCap2Way.dat* is provided in Table 4-16. The user provides a look-up table, or accepts the default look-up table, as illustrated in Figure 4-15.

Table 4-16. Description of the *StopCap2Way.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General	1	Integer	Free	Total number of flow rate categories on major approach
	2	Integer	Free	Total number of traffic movements modeled
Flow rate[1]	1	Integer	Free	Average flow on major approach for category 1[2] (vphpl)
	2	Integer	Free	Saturation flow rate for left-turning vehicles (vphpl)
	3	Integer	Free	Saturation flow rate for through vehicles (vphpl)
	4	Integer	Free	Saturation flow rate for right-turning vehicles (vphpl)
.....	.....	.....	.....	.....
Flow rate	1	Integer	Free	Average flow on major approach for category n (vphpl)
	2	Integer	Free	Saturation flow rate for left-turning vehicles (vphpl)
	3	Integer	Free	Saturation flow rate for through vehicles (vphpl)
	4	Integer	Free	Saturation flow rate for right-turning vehicles vphpl)

[1] *This record must be repeated for all categories of flow rate modeled*
[2] *The flow rate categories must be entered in increasing order*

```
  21    3
   0  899 1027 1090
 100  794  886  961
 200  699  763  846
 300  616  656  744
 400  541  564  654
 500  476  484  575
 600  417  416  505
 700  366  357  443
 800  320  306  388
 900  280  262  340
1000  245  224  298
1100  214  191  260
1200  187  163  228
1300  163  140  199
1400  142  119  174
1500  123  101  152
1600  107   86  132
1700   93   74  115
1800   81   63  100
1900   70   53   87
2000   61   45   76
```

Figure 4-15. General format of the *StopCap2Way.dat* input file

In the above example, when the average flow rate on the major approach (for both directions) is less than 400 vphpl but greater than 300 vphpl, the minor approach saturation rate is 541 vphpl for left-turn movements, 564 vphpl for through movements, and 654 vphpl for right-turn movements.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER (default settings only).

4.14 Four-Way Stop Sign Capacity (StopCap4Way.dat)

DYNASMART-P discharges vehicles at All-Way Stop-Controlled (AWSC) intersections according to the type of turning movement and degree of traffic conflict. For each simulation interval, the control logic checks the number of active conflicting approaches of an AWSC intersection to determine the degree of conflict, and assigns the appropriate discharge rate for type of turning movement be it Left-Turn (LT), Through (TH), or Right-Turn (RT). An active approach is one that has at least one vehicle stopped at the stop line waiting to make a turn. In the event where no data regarding traffic flows at a four-way stop-controlled intersection are available, the user can accept the default values incorporated in DYNASMART-P, which are obtained from NCHRP[2]. These values are presented in Table 4-17. The format of *StopCap4Way.dat* is provided in Table 4-18. The user provides a look-up table, or accepts the

[2] NCHRP – Capacity and Level of Service at Unsignalized Intersections. Final Report Volume 2 – All-Way Stop-Controlled Intersections, April 1996.

default look-up table, as illustrated in Figure 4-16. Note that *StopCap4Way.dat* is applicable to all-way stop controlled intersections, including two-way, three-way and four-way stop-controlled intersections. That is, *StopCap4Way.dat* is applicable to any stop-controlled intersection at which there are no uncontrolled approaches.

Table 4-17. DYNASMART-P default discharge rates at AWSC intersections

Degree of Conflict[1]	*No of Conflicting Approaches*	*Description*	*Discharge Rate (*vphpl)		
			TH	*LT*	*RT*
0	0	No vehicles are present at the stop line on conflicting or opposing approaches	923	878	1091
1	1	At least one vehicle is present at the stop line of a particular conflicting or opposing approach	766	735	878
2	2	At least one vehicle is present at the stop lines of two conflicting or opposing approaches	621	600	692
3	> 3	At least one vehicle is present at the stop lines of three conflicting or opposing approaches	514	500	563

[1] *With respect to the subject approach*

Table 4-18. Description of the *StopCap4Way.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General	1	Integer	Free	Number of conflict cases modeled[1]
	2	Integer	Free	Number of movements modeled[2]
Conflict case 1	1	Integer	3	Number of active conflicting approaches (=0)
	2	Character	9	Ignored (only used for formatting)
	3	Integer	Free	Discharge rate for through movements for case 1
	4	Integer	Free	Discharge rate for left-turns for case 1
	5	Integer	Free	Discharge rate for right-turns for case 1
Conflict case 2	1	Integer	3	Number of active conflicting approaches (=1)
	2	Character	9	Ignored (only used for formatting)
	3	Integer	Free	Discharge rate for through movements for case 2
	4	Integer	Free	Discharge rate for left-turns for case 2
	5	Integer	Free	Discharge rate for right-turns for case 2
Conflict case 3	1	Integer	3	Number of active conflicting approaches (=2)
	2	Character	9	Ignored (only used for formatting)
	3	Integer	Free	Discharge rate for through movements for case 3
	4	Integer	Free	Discharge rate for left-turns for case 3
	5	Integer	Free	Discharge rate for right-turns for case 3
Conflict case 4	1	Integer	3	Number of active conflicting approaches (=3)
	2	Character	9	Ignored (only used for formatting)
	3	Integer	Free	Discharge rate for through movements for case 4
	4	Integer	Free	Discharge rate for left-turns for case 4
	5	Integer	Free	Discharge rate for right-turns for case 4

[1] *Must be set to 4*
[2] *Must be set to 3*

```
  4  3
  0 conflicts    923    878   1091
  1 conflict     766    735    878
  2 conflicts    621    600    692
  3 conflicts    514    500    563
```

Figure 4-16. General format of the *StopCap4Way.dat* input file

In the above example (which depicts a full-length typical *StopCap4Way.dat* file), when there are zero active conflicting approaches, the saturation flow rate on the subject approach is 923 vphpl (field 3) for left-turn movements, 878 vphpl (field 4) for through movements, and 1091 vphpl (field 5) for right-turn movements.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER (default settings only).

4.15 Yield Sign Capacity (yieldcap.dat)

DYNASMART-P discharges vehicles at Yield Sign-controlled intersections according to three types of turning movements (LT, TH, and RT), and the flow rate on the major approach. For each simulation interval, the control logic checks the major approach flow rate, and assigns an appropriate saturation flow rate for the given type of turning movement. The saturation flow rate is obtained from a lookup table provided by the user. The model is fundamentally different than the common theoretical or microscopic simulation models, which use the critical gap acceptance theory and car following techniques for estimating the capacity at yield-controlled intersections. However, DYNASMART-P may be easily calibrated to produce similar results by appropriately adjusting the discharge flow rate for various traffic flow rates (on major approaches) and turning movement combinations.

Yield signs are modeled exactly as TWSC intersections, except that the user needs to specify the appropriate discharge rates. In the event where no data regarding traffic flows at yield-controlled intersections are available, the user can accept the default values incorporated within DYNASMART-P. These values (Table 4-15) were obtained from NCHRP[3] for TWSC intersections, for use within *YieldCap.dat*. Since it is generally believed that discharge rates at a yield-controlled intersection are higher than TWSC intersections at low volumes, modeling the yield signs using the TWSC discharge rates should provide an acceptable yet conservative approach. The format of *YieldCap.dat* is provided in Table 4-19. The user provides a look-up table, or accepts the default table, as illustrated in Figure 4-17.

[3] NCHRP – Capacity and Level of Service at Unsignalized Intersections. Final Report Volume 1 – Two-Way Stop-Controlled Intersections, April 1996.

Table 4-19. Description of the *YieldCap.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General	1	Integer	Free	Total number of flow rate categories on major approach
	2	Integer	Free	Total number of traffic movements modeled
Flow rate[1]	1	Integer	Free	Average flow on major approach for category 1[2] (vphpl)
	2	Integer	Free	Saturation flow rate for left-turning vehicles (vphpl)
	3	Integer	Free	Saturation flow rate for through vehicles (vphpl)
	4	Integer	Free	Saturation flow rate for right-turning vehicles (vphpl)
.....	.....	.....	.....	.....
Flow rate[1]	1	Integer	Free	Average flow on major approach for category n (vphpl)
	2	Integer	Free	Saturation flow rate for left-turning vehicles (vphpl)
	3	Integer	Free	Saturation flow rate for through vehicles (vphpl)
	4	Integer	Free	Saturation flow rate for right-turning vehicles (vphpl)

[1] *This record must be repeated for all categories of flow rate modeled*
[2] *The flow rate categories must be entered in increasing order*

```
  21    3
   0  899 1027 1090
 100  794  886  961
 200  699  763  846
 300  616  656  744
 400  541  564  654
 500  476  484  575
 600  417  416  505
 700  366  357  443
 800  320  306  388
 900  280  262  340
1000  245  224  298
1100  214  191  260
1200  187  163  228
1300  163  140  199
1400  142  119  174
1500  123  101  152
1600  107   86  132
1700   93   74  115
1800   81   63  100
1900   70   53   87
2000   61   45   76
```

Figure 4-17. General format of the *YieldCap.dat* input file

In the above example, if the average flow rate from major approaches is less than 1000 vphpl, but greater than 900 vphpl, then the saturation flow rate from this minor approach is 245 vphpl for left-turn movements, 224 vphpl for through movements, and 298 vphpl for right-turn movements.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER (default settings only).

4.16 Zone Coordinates Data (zone.dat)

This file contains the information needed to display zone boundaries. In this file, the user defines the coordinates of feature points along the zone boundaries. In the event that this file is not provided, DYNASMART-P will approximate the zone locations for display purposes. Note that the feature points listed in this file can be the same feature points specified in *linkxy.dat*, the physical nodes defined in *network.dat* or a set of new feature points. A detailed description of this file and its format are provided in Table 4-20 and Figure 4-18, respectively. Figure 4-18 shows the general format for the *zone.dat* file.

Table 4-20. Description of the *zone.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General Information	1	Integer	Free	Total number of feature points to be used in defining the boundaries for all zones.
	2	Integer	Free	Total number of zones in the network[1]
Feature points[2]	1	Integer	Free	1st feature point[3]
	2	Float	Free	X-coordinate for 1st feature point
	3	Float	Free	Y-coordinate for 1st feature point
.....	.....	.....	.....	.....
Feature points	1	Integer	Free	Nth feature point
	2	Float	Free	X-coordinate for last feature point
	3	Float	Free	Y-coordinate for last feature point
Zone boundary	1	Integer	Free	1st zone
	2	Integer	Free	Number of feature points used to define the boundary of zone 1
	3	Integer	Free	List of points that define the boundary of zone 1
.....	.....	.....	.....	.....
Zone boundary	1	Integer	Free	Last zone
	2	Integer	Free	Number of feature points used to define the boundary of last zone
	3	Integer	Free	List of points that define the boundary of the last zone

[1] *Must be the same number as defined in network.dat (basic data record type, field 1 – 5)*
[2] *Must be repeated sequentially for as many times as there are feature points*
[3] *Must start from 1 and continue without skipping numbers*

```
this file defines zone regions
 number of nodes, number of zones
38639 350
feature #, x-coordinate, y-coordinate
    1 426.096342,  50.920919
    2 425.771194,  51.171205
    3 424.723121,  52.229334
zone #, number of nodes, node #'s
  190     4      2     13     40      5
  187     5    608    609    610    611    612
  194     3    831    832    833
```

Figure 4-18. General format of the *zone.dat* input file

In the above example, there are a total of 38639 feature points (typically imported from GIS/CAD files and not manually prepared) and 350 zones. The xy coordinates of feature points 1 and 2 are (426.096342, 50.920919) and (425.771194, 51.171205), respectively. The boundary of Zone 190 is described by 4 feature points, namely, 2, 13, 40, and 5. Zone 194 includes 3 boundary nodes, 831, 832, and 833.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER.

4.17 Combined Demand Data (demand.dat)

This file is used to load the demand using a time dependent O-D demand matrix. For this purpose, the user needs to define the number of loading intervals, a demand multiplication factor, starting time of each loading interval, and the end of the vehicle loading period. Note that for each loading interval, an O-D matrix[4] needs to be prepared. A detailed description of this file and its format are provided in Table 4-21 and Figure 4-19, respectively.

Depending on the *scenario.dat* specification or the vehicle type proportions specified in Scenario | Parameters & Capabilities…(see Figure 3-14), *demand.dat* may be used to load 1) PCs, 2) passenger cars and trucks, 3) PCs and HOVs, or 4) passenger cars and trucks and HOVs.

Table 4-21. Description of the *demand.dat* input file

Record Type	*Field*	*Format*	*Field Width*	*Description*
General	1	Integer	5	Number of O-D matrices (n)[1]
	2	Float	5	Multiplication factor[2]
Start-Times[3]	1 – n+1	6(1)	6(1)	Start times for all (n) O-D matrices, sequentially
Starting time[4]	1	Float	6(1)	Starting time for 1st O-D matrix (min)[5]
O-D matrix	1 – N	Array of floats	10(4)	Entries of 1st O-D matrix (pertaining to 1st time interval)[6]
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Starting time[4]	1	Float	6(1)	Starting time for last O-D matrix (min)[5]
O-D matrix	1 – N	Array of floats	10(4)	Entries of last O-D matrix (pertaining to last time interval)[6]

1 *The actual number of O-D matrices in the "O-D matrix" record type must be greater or equal to this number.*
2 *This factor uniformly increases or decreases the overall network loading level.*
3 *Need (n+1) starting times for (n) O-D matrices. The starting time of the (n+1)th O-D matrix is the ending time of the nth O-D matrix. Therefore, DYNASMART-P expects an ending time for the last O-D matrix.*
4 *These records need to be repeated as many times as the number of O-D matrices specified in the Settings record. This line is for the user's convenience (to indicate O-D start time) and is read but completely ignored by DYNASMART-P. Nonetheless, a record (may be empty) should be present.*
5 *Time milestones define the starting and ending time of O-D matrices. The start time of a loading interval is the end of the preceding interval. May be left blank.*
6 *Use 6 entries per line.*

4 *The size of the OD matrix should depend on the original number of zones, even if zone aggregation (superzone.dat) is used*

```
  7  30.0
   0.0   5.0  10.0  15.0  20.0  25.0  30.0  35.0
Start Time = 0.0
    0.0000    9.9167    0.0023    0.0033    0.0041    0.0096
    0.0053    0.0063    0.0080    0.2594    0.0088    0.0093
    0.0456
    9.0000    0.0001    0.1263    0.0014    0.0014    0.0000
    0.0000    0.0679    0.0000    0.5969    0.0029    0.2317
    0.7000
```

Figure 4-19. General format of the *demand.dat* input file

The first record in Figure 4-19 indicates that there are 7 O-D demand matrices (field 1), with a multiplication factor of 30.0 (field 2). The second record indicates that the first O-D demand matrix specifies conditions from min 0.0 (field 1) until just before min 5 (field 2). The second O-D demand matrix specifies conditions from min 5.0 (field 2) until just before min 10 (field 3), and so on. Note that for 7 O-D matrices, 8 starting times have been provided (to define 7 O-D demand-loading intervals). The final O-D demand matrix starts at 30.0 minutes (field 7) and ends at 35.0 minutes (field 8). A 13-zone network with 7 O-D demand matrices would require 7 (13x13) matrices. The third record indicates that the following O-D demand matrix starts at 0.0 min (this record is completely ignored by DYNASMART-P). The next few records (also typed in bold) describe the demand data for zone 1. They show that 0 trip (field 1) originates from zone 1 and is destined for zone 1, 297.501 (9.9167*30.0) trips (field 2) originate from zone 1 and are destined for zone 2, 0.069 (0.0023*30.0) trips (field 3) originate from zone 1 to zone 3, and so on.

The user can input either the number of trips for entries of the O-D demand matrix, or other entries that reflect certain scaling. If the user specifies the number of trips for each entry, then the multiplication factor should be specified as 1. The total number of loaded vehicles is obtained by summing up all the entries across all O-D matrices, and multiplying that sum by the multiplication factor.

This file can be prepared either manually, or via DSPEd.

4.18 Truck Demand Data (demand_truck.dat)

This file is similar to *demand.dat*, except that it is used exclusively to load trucks onto the network. This file is required, but may be left empty by specifying zero O-D matrices to be loaded in the *demand_truck.dat* file (record 1, field 1). In this case, trucks may still be loaded by specifying a fraction of *demand.dat* (either in *scenario.dat* or Scenario | Parameters & Capabilities… menu command) (see Figure 3-14) to be loaded as trucks. A detailed description of this file and its format are provided in Table 4-22 and Figure 4-20, respectively.

Table 4-22. Description of the *demand_truck.dat* input file

Record Type	*Field*	*Format*	*Field Width*	*Description*
General	1	Integer	5	Number of O-D matrices (n)[1]
	2	Float	5	Multiplication factor[2]
Start times[3]	1 – n+1	6(1)	6(1)	Start times for all (n) O-D matrices, sequentially
Starting time[4]	1	Float	6(1)	Starting time for 1st O-D matrix (min)[5]
O-D matrix	1 – N	Array of floats	10(4)	Entries of 1st O-D matrix (pertaining to 1st time interval)[6]
.....	.....	.....	.....	.....
Starting time[4]	1	Float	6(1)	Starting time for last O-D matrix (min)[5]
O-D matrix	1 – N	Array of floats	10(4)	Entries of last O-D matrix (pertaining to last time interval)[6]

[1] *The actual number of O-D matrices in the "O-D matrix" record type must be greater or equal to this number.*

[2] *This factor uniformly increases or decreases the overall network loading level.*

[3] *Need (n+1) starting times for (n) O-D matrices. The starting time of the (n+1)th O-D matrix is the ending time of the nth O-D matrix. Therefore, DYNASMART-P expects an ending time for the last O-D matrix.*

[4] *These records must be repeated as many times as the number of O-D matrices specified in the Settings record. This line is for the user's convenience (to indicate O-D start time) and is read but completely ignored by DYNASMART-P. Nonetheless, a record (may be empty) should be present.*

[5] *Time milestones define starting and ending time of O-D matrices. The start time of a loading interval is the end of the preceding interval. May be left blank.*

[6] *Use 6 entries per line.*

```
  7  30.0
   0.0   5.0  10.0  15.0  20.0  25.0  30.0  35.0
Start Time = 0.0
    0.0000    9.9167    0.0023    0.0033    0.0041    0.0096
    0.0053    0.0063    0.0080    0.2594    0.0088    0.0093
    0.0456
    9.0000    0.0001    0.1263    0.0014    0.0014    0.0000
    0.0000    0.0679    0.0000    0.5969    0.0029    0.2317
    0.7000
```

Figure 4-20. General format of the *demand_truck.dat* input file

The first record in Figure 4-20 indicates that there are 7 O-D demand matrices (field 1), with a multiplication factor of 30.0 (field 2). The second record indicates that the first O-D demand matrix specifies conditions from min 0.0 (field 1) until just before min 5 (field 2). The second O-D demand matrix specifies conditions from min 5.0 (field 2) until just before min 10 (field 3), and so on. Note that for 7 O-D matrices, 8 starting times have been provided (to define 7 O-D demand-loading intervals). The final O-D demand matrix starts at 30.0 minutes (field 7) and ends at 35.0 minutes (field 8). A 13-zone network with 7 O-D demand matrices would require 7 (13x13) matrices. The third record indicates that the following O-D demand matrix starts at 0.0 min (this record is completely ignored by DYNASMART-P). The next few records (also typed in bold) describe the demand data for zone 1. They show that 0 trip (field 1) originates from zone 1 and is destined for zone 1, 297.501 (9.9167*30.0) trips (field 2) originate from zone 1 and are destined for zone 2, 0.069 (0.0023*30.0) trips (field 3) originate from zone 1 to zone 3, and so on.

The user can input either the number of trips for entries of the O-D matrix, or other entries that reflect certain scaling. If the user specifies the number of trips for each entry, then the multiplication factor should be specified as 1. The total number of loaded vehicles is obtained by summing up all the entries across all O-D matrices, and multiplying that sum by the multiplication factor.

This file can be prepared either manually, or via DSPEd.

4.19 HOV Demand Data (demand_HOV.dat)

This input file is similar to *demand.dat*, except that it is used exclusively to load HOV vehicles onto the network. This file is required, but may be left empty by specifying zero O-D matrices to be loaded in *demand_HOV.dat* file (record 1, field 1). In this case, HOV vehicles can still be loaded onto the network by specifying a fraction of *demand.dat* (either in *scenario.dat* or Scenario | Parameters & Capabilities… menu command) (see Figure 3-14) to be loaded as HOV vehicles. A detailed description of this file and its format are provided in Table 4-23 and Figure 4-21, respectively.

Table 4-23. Description of the *demand_HOV.dat* input file

Record Type	*Field*	*Format*	*Field Width*	*Description*
General	1	Integer	5	Number of O-D matrices (n)[1]
	2	Float	5	Multiplication factor[2]
Start times[3]	1 – n+1	6(1)	6(1)	Start times for all (n) O-D matrices, sequentially
Starting time[4]	1	Float	6(1)	Starting time for 1^{st} O-D matrix (min)[5]
O-D matrix	1 – N	Array of floats	10(4)	Entries of 1^{st} O-D matrix (pertaining to 1^{st} time interval)[6]
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Starting time[4]	1	Float	6(1)	Starting time for last O-D matrix (min)[5]
O-D matrix	1 – N	Array of floats	10(4)	Entries of last O-D matrix (pertaining to last time interval)[6]

1 *The actual number of O-D matrices in the "O-D matrix" record type must be greater or equal to this number.*

2 *This factor uniformly increases or decreases the overall network loading level.*

3 *Need (n+1) starting times for (n) O-D matrices. The starting time of the (n+1)th O-D matrix is the ending time of the nth O-D matrix. Therefore, DYNASMART-P expects an ending time for the last O-D matrix.*

4 *These records need to be repeated as many times as the number of O-D matrices specified in the Settings record. This line is for the user's convenience (to indicate O-D start time) and is read but completely ignored by DYNASMART-P. Nonetheless, a record (may be empty) should be present.*

5 *Time milestones define starting and ending time of O-D matrices. The start time of a loading interval is the end of the preceding interval. May be left blank.*

6 *Use 6 entries per line.*

```
  7  30.0
   0.0   5.0  10.0  15.0  20.0  25.0  30.0  35.0
Start Time = 0.0
    0.0000    9.9167    0.0023    0.0033    0.0041    0.0096
    0.0053    0.0063    0.0080    0.2594    0.0088    0.0093
    0.0456
    9.0000    0.0001    0.1263    0.0014    0.0014    0.0000
    0.0000    0.0679    0.0000    0.5969    0.0029    0.2317
    0.7000
```

Figure 4-21. General format of the *demand_HOV.dat* input file

The first record in Figure 4-21 indicates that there are 7 O-D demand matrices (field 1), with a multiplication factor of 30.0 (field 2). The second record indicates that the first O-D demand matrix specifies conditions from min 0.0 (field 1) until just before min 5 (field 2). The second O-D demand matrix specifies conditions from min 5.0 (field 2) until just before min 10 (field 3), and so on. Note that for 7 O-D matrices, 8 starting times have been provided (to define 7 O-D demand-loading intervals). The final O-D demand matrix starts at 30.0 minutes (field 7) and ends at 35.0 minutes (field 8). A 13-zone network with 7 O-D demand matrices would require 7 (13x13) matrices. The third record indicates that the following O-D demand matrix starts at 0.0 min (this record is completely ignored by DYNASMART-P). The next few records (also typed in bold) describe the demand data for zone 1. They show that 0 trip (field 1) originates from zone 1 and is destined for zone 1, 297.50 (9.9167*30.0) trips (field 2) originate from zone 1 and are destined for zone 2, 0.069 (0.0023*30.0) trips (field 3) originate from zone 1 to zone 3, and so on.

The user can input either the number of trips for entries of the O-D matrix, or other entries that reflect certain scaling. If the user specifies the number of trips for each entry, then the multiplication factor should be specified as 1. The total number of loaded vehicles is obtained by summing up all the entries across all O-D matrices, and multiplying that sum by the multiplication factor.

This file can be prepared either manually, or via DSPEd.

4.20 Generation Links Data (origin.dat)

A distinctive feature of DYNASMART-P is that vehicles are generated on links. This represents actual traffic dynamics better than conventional planning tools, where centroids generate and attract traffic simultaneously, resulting in possibly unrealistic flow patterns around entry (generation) and exit (destination) nodes. DYNASMART-P, on the other hand, allows the user to specify generation (physical) links for each traffic analysis zone (TAZ), on which demand will be loaded. Generation links are specified in the *origin.dat* input file. The use of freeway links as generation links is not recommended except for those at the boundary of the network study area, to account for traffic generated outside the study area. The user has the flexibility to specify generation links for a specific zone that may not necessarily physically belong to that zone. A link may exist along the boundary of zones, but can only be physically contained in one zone, However, this link can be specified to receive demand from both zones.

A generation link can be specified for as many zones as desired, and the number of vehicles generated on each link is proportional to its lane-miles. Alternatively, the user may specify the share of demand that each generation link within a TAZ will generate. A detailed description of this file and its format are provided in Table 4-24 and Figure 4-22, respectively.

Table 4-24. Description of the *origin.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Zone Information	1	Integer	5	1st zone number
	2	Integer	5	Number of generation links in 1st zone
	3	Integer	5	Loading mode 0: default loading mode[1] 1: user-specified loading weights[2,3]
Generation Links	1	Integer	7	Upstream node of the 1st generation link in zone 1
	2	Integer	7	Downstream node the 1st of generation link in zone 1
	3	Float	7(3)	Loading weight for the 1st generation link in zone 1
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Generation Links	1	Integer	7	Upstream node of the last generation link in zone 1
	2	Integer	7	Downstream node the last generation link in zone 1
	3	Float	7(3)	Loading weight for the last generation link in zone 1
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Zone Information	1	Integer	5	Last zone number
	2	Integer	5	Number of generation links in last zone
	3	Integer	5	Loading mode 0: default loading mode[1] 1: user-specified loading weights[2,3]
Generation Links	1	Integer	7	Upstream node of the 1st generation link in last zone
	2	Integer	7	Downstream node the 1st of generation link in last zone
	3	Float	7(3)	Loading weight for the 1st generation link in last zone
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Generation Links	1	Integer	7	Upstream node of the last generation link in last zone
	2	Integer	7	Downstream node the last generation link in last zone
	3	Float	7(3)	Loading weight for the last generation link in last zone

[1] *Default loading weights are proportional to physical link capacities (lane-miles) within a zone.*
[2] *Must have loading mode = 1 (field 3 in the zone information record type) for these weights to be used. The sum of link weights for a given zone must be 1.0.*
[3] *The loading weights will have absolutely no effect if vehicles are to be loaded onto the network via the vehicle.dat and path.dat files.*

```
1   2    0
167    420  0.000
172    171  0.000

2   3    1
161    160  0.350
161    162  0.250
162    152  0.400
```

Figure 4-22. General format of *origin.dat* input file

The first record in Figure 4-22 indicates that zone 1 (field 1) has 2 generation links (field 2) and the default (Flag = 0) loading mode is desired (field 3). The first generation link is represented (next record) by upstream node 167 (field 1) and downstream node 420 (field 2). A zero is specified for the loading weight (field 3). The second generation link (next record) is from upstream node 172 (field 1) to downstream node 171 (field 2). A zero is specified for the loading weight (field 3). In the next block, zone 2 (field 1) has 3 generation links (field 2) specified in the next record, and user-specified (Flag = 1) loading weights are desired (field 3). The first generation link is from upstream node 161 (field 1) to downstream node 160 (field 2), and the loading weight is 35 percent (field 3). The next record describes the second generation link, which is from upstream node 161 (field 1) to downstream node 162 (field 2), and has a loading weight of 25 percent (field 3). The next record indicates that the third generation link is from upstream node 162 (field 1) to downstream node 152 (field 2), and has a loading weight of 40 percent (field 3).

This file can be prepared either manually, or via DSPEd or via DYNABUILDER.

4.21 Destination Data (destination.dat)

In DYNASMART-P, vehicles exit the network via destination nodes, in much the same way as in conventional planning models. The difference in DYNASMART-P is that they are connected to virtual centroids created and handled internally (refer to the *SuperZone.dat* section for more discussion of centroids). By default, one virtual centroid will be created for each zone. If zone aggregation is specified by the user, only one centroid will be created for each aggregated zone (super zone).

DYNASMART-P allows the user to identify destination nodes for each zone in the network. Furthermore, the user is allowed to specify the same destination node (such as borderline destination nodes) for more than one zone (a maximum of two zones are allowed). In the case that a destination is specified for more than two zones, an error message will prompt the user to modify the *destination.dat* input file accordingly. A detailed description of this file and its format are provided in Table 4-25 and Figure 4-23, respectively.

Table 4-25. Description of the *destination.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Zone Information	1	Integer	5	1st zone number
	2	Integer	5	Number of destinations in zone 1
	3	Integer	7	1st destination node number for zone 1
.....	.....	.....	.....	.....
	N	Integer	7	Last destination node number for zone 1
.....	.....	.....	.....	.....
Zone Information	1	Integer	5	Last zone number
	2	Integer	5	Number of destinations in last zone
	3	Integer	7	1st destination node number in last zone
.....	.....	.....	.....	.....
	N	Integer	7	Last destination node number in last zone

```
    1    1    199
    2    1    200
    3    9      3     20     23     24     67     69    119    131      2
    4    2    139    199
    5    3     96    104    162
```

Figure 4-23. General format of the *destination.dat* input file

The first record in Figure 4-23 indicates that zone 1 (field 1) has 1 destination (field 2), namely node number 199 (field 3). The fourth record indicates that Zone 4 (field 1) has 2 (field 2) destinations, nodes 21 (field 3), and 199 (field 4). Node 199 is a destination for both Zones 1 and 4.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER.

4.22 Zone Aggregation Data (SuperZone.dat)

DYNASMART-P also has an option that allows for the aggregation of TAZs into a single SuperZone (i.e. destinations are linked to the same centroid). Each aggregated zone will have a centroid, which is created internally by DYNASMART-P. Actual connections between the destination nodes and the centroids are handled internally as well. Essentially, DYNASMART-P allows the user to specify which zones are to be aggregated. It then creates a centroid for each super zone, and connects all of the destination nodes in the super zone to its centroid. An illustration of this concept is provided in Figure 4-24.

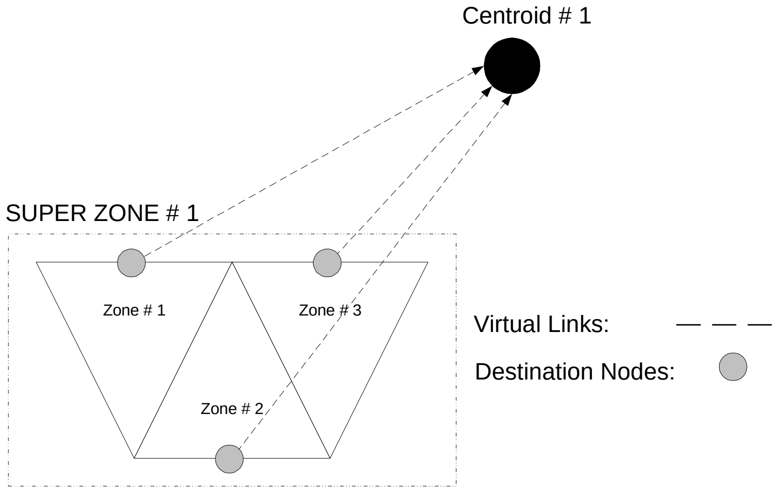


Figure 4-24. Illustration of a super zone

Figure 4-24 depicts that zones 1, 2 and 3 are being aggregated into one zone, designated as super zone #1. A corresponding centroid is then created and associated with super zone #1. Note that this centroid is a virtual node; it is not an actual physical node in the network and hence, is not visible to users. Next, the destination nodes (specified within *destination.dat*) in zones 1, 2 and 3 are linked to this centroid through virtual, non physical links. In the above illustration, all vehicles going to zones 1, 2 and 3 will be assigned to super zone #1, and therefore centroid #1 will resume the role of the final destination.

The ability to aggregate zones into larger zones (i.e. the ability to connect destination nodes from different zones to a single centroid) is intended as a modeling capability. It is useful for applications where travelers are considered to have finished their trip once they have reached certain exit points. With proper specification of destinations, advantages of this capability include a reduction in memory requirements, and faster computation, without significantly altering the traffic flow pattern. Like all real network modeling, the aggregation of zones is more of an art than science, and thus it is important to exercise careful engineering judgment.

The user must make sure that zonal aggregation will result in minimal adverse disruption of the original traffic pattern. For example, the user is discouraged from aggregating zones that are not in proximity to each other, as this will result in a loading pattern that is different from actual conditions. Another case would be to not aggregate zones of high demand attraction, as this would also disrupt the nature of actual traffic patterns. The user must try to aggregate medium to low demand attraction zones around high demand attraction zones, as this has been shown to result in minimal disruption of the original traffic pattern.

SuperZone.dat is a strictly optional input file, required only when the aggregation flag in *network.dat* (basic data, field 5) is set to 1. This file allows for aggregating several original TAZ's to a single zone. Such a capability provides the flexibility for users to reduce the required computational resources without compromising traffic representation details. The user should load vehicles via the O-D table to observe any changes due to zonal aggregation. A detailed description of this file and its format are provided in Table 4-26 and Figure 4-25, respectively.

Table 4-26. Description of the *SuperZone.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Parameters	1	Integer	Free	Total number of aggregated zones.
Delimiter line				Ignored by DYNASMART-P
Original zones[1]	1	Integer	5	1st zone number
.....	.....	.....	.....	.....
	N	Integer	5	Last zone number
Delimiter line				Ignored by DYNASMART-P
Zonal aggregation[1]	1	Integer	5	Super zone number for 1st zone number
.....	.....	.....	.....	.....
	N	Integer	5	Super zone number for last zone number

[1] *A maximum of 15 entries per line may be used*

```
  4
Original Zones
  1  2  3  4  5  6  7  8  9  10  11  12  13
Mapping of Original Zones to Aggregated zones
  1  1  1  2  2  2  3  3  4  4  4  4  4
```

Figure 4-25. General format of the *SuperZone.dat* input file

Figure 4-25 shows that there are 4 aggregated zones (1st record). The original zones are numbered sequentially from 1 to 13 (third record). Zones 1, 2, 3 are mapped into SuperZone 1. Zones 4, 5, 6 are mapped into SuperZone 2. Zones 7 and 8 are mapped to SuperZone 3. Zones 9 through 13 are mapped to SuperZone 4. Note that GIS-based transportation software packages, such as TransCAD, are convenient for mapping individual zones to superzones.

This file can be prepared either manually, or via DSPEd or via DYNABUILDER.

4.23 Vehicle Trip Data (vehicle.dat)

The purpose of this file is to specify vehicle characteristics and travel plans. A detailed description of this file and its format are provided in Table 4-27 and Figure 4-26, respectively. Note that it is important to list vehicles in the order of their departure time. Vehicles departing at identical time intervals should be listed in the order of their generation links.

Table 4-27. Description of the *vehicle.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Basic data	1	Integer	Free	Number of vehicles to be loaded[1]
	2	Integer	Free	Maximum number of destinations for all vehicles[2]
	3	Text	Free	Optional description of the data
Header	1	Text	Free	Header for each field
Vehicle characteristics[6]	1	Integer	7	1^{st} vehicle
	2	Integer	7	Upstream node of the generation link
	3	Integer	7	Downstream node of the generation link
	4	Float	8(2)	Starting time of 1^{st} vehicle (minutes)[3]
	5	Integer	6	User class 1: unresponsive, 2: SO, 3: UE, 4: Enroute info, 5: VMS[4]
	6	Integer	6	Type of 1^{st} vehicle 1: cars, 2: trucks, 3: HOV
	7	Integer	6	Occupancy level of 1^{st} vehicle 1: LOV, 2: HOV
	8	Integer	6	Number of nodes in the path of 1^{st} vehicle (enter 1 if *path.dat* will not be used)
	9	Integer	6	Number of destinations along the path of the 1^{st} vehicle including intermediate stops and final destination
	10	Integer	6	En-route information indicator for 1^{st} vehicle: 0: no info is available, 1: En-route info available
	11	Float	8(4)	Indifference band (minutes) for switching 1^{st} vehicle
	12	Float	8(4)	Response percentage (applies only to class 4 users, specify 0 for all other class users)
	13	Integer	5	Origin zone for 1^{st} vehicle
Destinations[5,6]	1	Integer	12	Zone number of the destination
	2	Float	7(2)	The activity duration (min) at the destination. The activity duration for the final destination should always be zero.
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .

[1] *This number should be no more than actual number of vehicles listed in this file. DYNASMART-P will load vehicles until this number is reached, even if more vehicles are specified in the file.*

[2] *Includes all intermediate destinations and the final destination. There is no limit on the number of intermediate destinations but only up to 3 destinations will be reported in SummaryStat.dat.*

[3] *This number needs to be sequentially ascending.*

[4] *Vehicle.dat retains the MUC class for each vehicle, and hence vehicles loaded via vehicle.dat remain responsive to enroute or VMS information if originally coded as MUC classes 4 or5, respectively.*

[5] *The Destinations record type must be repeated for each intermediate destination.*

[6] *Must be repeated for all vehicles.*

```
  28378          2   # of vehicles in the file, Max # of stops
 #   usec   dsec   stime usrcls vehtype ioc #ONode #IntDe info ribf   comp    OZ
 1    199    116    0.00     1     1     1    15     2     0  0.0000  0.0000    1
      2   5.00
     10   0.00
 2    199    116    0.00     1     1     1    15     1     0  0.0000  0.0000    1
      2   0.00
 3    199    116    0.00     1     1     1    15     1     0  0.0000  0.0000    1
      2   0.00
```

Figure 4-26. General format of the *vehicle.dat* input file

The first record in Figure 4-26 shows that there are 28378 (field 1) vehicles to be loaded. The maximum number of destinations in a vehicle path is 2 (field 2). The third line (second record) shows that vehicle 1 (field 1) is generated on a link with upstream node number 199 (field 2) and downstream node number 116 (field 3). It begins its journey time at 0.00 min (field 4). The vehicle belongs to user class 1 (unresponsive – more on user classes later) (field 5), of vehicle type 1 (passenger car – more on vehicle types later) (field 6) and is of occupancy type 1 (LOV) (field 7). The number of nodes in the path is 15 (field 8). This vehicle has 2 destinations (field 9), and does not have access to en-route information (Flag = 0) (no-info) (field 10); therefore zeros need to be provided for indifference band (field 11), and compliance rate (field 12). The origin zone for this vehicle is 1 (field 13). See Section 4.25 (*scenario.dat*) for more information regarding user classes and vehicle types.

The next record indicates that one of the two previously specified destinations is located in zone 2 (field 1), which is an intermediate destination with activity duration of 5 minutes (field 2). The next record indicates that the second destination (final destination) is located in zone 10 (field 1) and has a 0 duration (final destination) (field 2).

This file can be prepared either manually, or via the GUI (if using a previous simulation run). To prepare this file using the GUI, a simulation run (with the network loaded using an O-D demand matrix) is first submitted. At the end of the run, an output file named *output_vehicle.dat* (which has the same format as *vehicle.dat*) is generated. The user can rename this file to *vehicle.dat* manually, or by simply clicking the Scenario | Copy output_vehicle.dat to vehicle.dat menu command.

4.24 Path Information (path.dat)

The purpose of this file is to specify the itinerary of each vehicle in *vehicle.dat*. For each vehicle, nodes in the vehicle path are specified starting with the upstream node of the generation link. The number of nodes listed for each vehicle path must match the number of nodes specified in *vehicle.dat* (Record type: vehicle characteristics, field 8). Even if a user wishes to use only the vehicle file (*vehicle.dat*), *path.dat* must still be present in the working directory, although it can be an empty file. A detailed description of this file and its format are provided in Table 4-28 and Figure 4-27, respectively.

Table 4-28. Description of the *path.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Path for 1st vehicle	1	Integer	7	1st node along the path of the 1st vehicle
	2	Integer	7	2nd node along the path of the 1st vehicle
.....	.....	.....	.....	.....
	N	Integer	7	Last node along the path of the 1st vehicle
.....	.....	.....	.....	.....
Path for last vehicle	1	Integer	7	1st node along the path of the last vehicle
	2	Integer	7	2nd node along the path of the last vehicle
.....	.....	.....	.....	.....
	N	Integer	7	Last node along the path of the last vehicle

```
  9   86   25  10   98
 65   84   83   5    6   90   89
 68   67  130  81  116   19   23
 69   80   83   5    6   90   89
 71   70   71  85    7   31   32
 73   72   86   9   10   38   37
 74   11   12  42   41   37   34
 76   13   14  47   12   42   41
 84   85   7    8   66   29   6
```

Figure 4-27. General format of the *path.dat* input file

The first record (line) in Figure 4-27 indicates that the first vehicle (1st line) is loaded on a link with upstream node number 9 (field 1), the second node in the path is node 86 (field 2), the third node in the path is node 25 (field 3), the fourth node in the path is node 10 (field 4), and the final destination is node 98 (field 5). This format is then repeated for all remaining vehicle-paths (each vehicle is represented by a record) until the desired number of vehicle-paths is reached.

This file can be prepared either manually, or via the GUI (if using a previous simulation run). To prepare this file using the GUI, a simulation run (with the network loaded using an O-D demand matrix) is first submitted. At the end of the run, an output file named *output_path.dat* (which has the same format as *path.dat*) is generated. The user can rename this file to *path.dat* manually, or by simply clicking the Scenario | Copy output_path.dat to path.dat menu command. Note that this file must be used in conjunction with *vehicle.dat*.

4.25 Scenario Data (scenario.dat)

This file includes information about general settings of the traffic assignment module in DYNASMART-P, statistics collection period, proportions of user classes, and vehicle fleet composition. A detailed description of this file and its format are provided in Table 4-29 and Figure 4-28, respectively.

Table 4-29. Description of the *scenario.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General settings	1	Float	Free	Relative indifference band[1]
	2	Float	Free	Threshold bound for switching decisions (minutes)[1]
	3	Integer	Free	Random number (positive) generation seed[2]
	4	Integer	Free	Path index (for initial paths) 0: randomly assign a path (from K-paths) to vehicles 1: assign the best path to vehicles
	5	Integer	Free	VMS preemption mode 0: Only class 5 (VMS responsive) responds to VMS (default) 1: User classes 2 to 5 respond to VMS.
Compliance	1	Float	Free	Fraction of compliant vehicles[1]
Simulation step	1	Integer	Free	The basic simulation time step interval (6 seconds)
KSP	1	Integer	Free	No. of simulation intervals in which the KSP calculation algorithm is executed (default = 30)
	2	Integer	Free	No. of simulation intervals in which the KSP updating algorithm is updated (default =5)
Statistics	1	Float	Free	Start-up time to collect statistics
collection period	2	Float	Free	End time to collect statistics
No. Veh Types	1	Integer	Free	Number of vehicle types (other than bus) modeled in the network. (Range: 1 – 3)
Veh Type /MUC Proportions	1	Integer	5	1st vehicle type (must be a PC) in the network (must specify “1”)
	2	Integer	5	Demand mode for PC (must specify “0”: using *demand.dat*)
	3	Float	6(3)	Fraction of *demand.dat* to be loaded as PC
	4	Integer	3	MUC mode for PC (must specify 0)
	5	Float	6(3)	Proportion of PC to be non-responsive (Class 1)[7]
	6	Float	6(3)	Proportion of PC to be SO[7]
	7	Float	6(3)	Proportion of PC to be UE[7]
	8	Float	6(3)	Proportion of PC to be enroute info[7]
	9	Float	6(3)	Proportion of PC to be VMS-responsive[7]
Veh Type /MUC Proportions	1	Integer	5	2nd vehicle type in the network (if applicable) 2: Truck; 3: HOV
	2	Integer	5	Demand mode for the 2nd vehicle type[3] 0: using *demand.dat* 1: using separate demand file[4]
	3	Float	6(3)	Fraction of *demand.dat* to be loaded as the 2nd vehicle type. Must have demand mode = 0 (field 2 of this record)

Record Type	Field	Format	Width	Description
	4	Integer	3	MUC mode for the 2nd vehicle type 0: default MUC proportions[5,6] 1: using separate MUC proportions
	5	Float	6(3)	Proportion of 2nd vehicle type to be non-responsive (Class 1)[7]
	6	Float	6(3)	Proportion of 2nd vehicle type to be SO[7]
	7	Float	6(3)	Proportion of 2nd vehicle type to be UE[7]
	8	Float	6(3)	Proportion of 2nd vehicle type to be enroute info[7]
	9	Float	6(3)	Proportion of 2nd vehicle type to be VMS-responsive[7]
Veh Type /MUC Proportions	1	Integer	3	3rd vehicle type in the network (if applicable) 2: Truck; 3: HOV
	2	Integer	3	Demand mode for the 3rd vehicle type[3] 0: using *demand.dat* 1: using separate demand file[4]
	3	Float	6(3)	Fraction of *demand.dat* to be loaded as the 3rd vehicle type. Must have demand mode = 0 (field 2 of this record)
	4	Integer	3	MUC mode for the 3rd vehicle type 0: default MUC proportions[5,6] 1: using separate MUC proportions
	5	Float	6(3)	Proportion of 3rd vehicle type to be non-responsive (Class 1)[7]
	6	Float	6(3)	Proportion of 3rd vehicle type to be SO[7]
	7	Float	6(3)	Proportion of 3rd vehicle type to be UE[7]
	8	Float	6(3)	Proportion of 3rd vehicle type to be enroute info[7]
	9	Float	6(3)	Proportion of 3rd vehicle type to be VMS-responsive[7]

1 *Applies for user class 4 only (enroute info).*
2 *If this parameter is 0 then the system will reset the seed for each run.*
3 *The first vehicle type must be PC.*
4 *If vehicle type is PC, "0" must be specified in this field.*
5 *Corresponds to the MUC proportions specified for PC.*
6 *If vehicle type is PC, "0" must be specified in this field.*
7 *Must have MUC mode = 1 (field 4 of this record) unless vehicle type is PC.*

```
0.20 1.00 1234    1     1
1.00
   6
  30     5
30.00  105.00
3
  1  0 0.800  0 0.200 0.300 0.100 0.250 0.150
  2  1 0.000  1 0.150 0.100 0.050 0.600 0.100
  3  0 0.200  0
```

Figure 4-28. General format of the *scenario.dat* input file

The first record in Figure 4-28 indicates that the relative indifference band for switching paths (for user class 4 only) is 0.2 (or 20 percent) (field 1), the threshold bound for switching paths is 1 minute (field 2), the vehicle generation random number seed is set to 1234 (field 3), the best path is desired for all vehicles (field 4), and user classes 2 – 5 will respond to VMS (Flag = 1) (field 5).

The second record indicates that a proportion of 1 (or 100 percent) of user class 4 will respond to real time en-route information.

The third record indicates that the simulation interval is 6 seconds (field 1). The simulation interval is fixed at six seconds in this version of DYNASMART-P. The fourth record shows that the k-shortest paths calculation algorithm is executed every 30 simulation intervals (or 30×6 seconds = 3 minutes) (field 1), and the k-shortest paths updating algorithm is executed every 5 simulation intervals (or 5 × 6 seconds = 0.5 minutes) (field 2). The fifth record shows that simulation statistics will be collected starting from 30 minutes (field 1) until 105 minutes (field 2).

The sixth record indicates that 3 vehicle types are modeled in this network. From this point forward, the software will expect as many records as the number vehicle types indicated in record 6. The seventh record indicates that the vehicle type is 1 (field 1), and that it is a PC. The demand mode is 0 (field 2), that is, *demand.dat* will be used to load this vehicle type onto the network. The fraction of *demand.dat* to be loaded as PCs is 0.8 (field 3). The MUC mode for this vehicle type must be 0 (field 4). Since this is a PC, we must input the MUC proportions (these will be the default MUC proportions for other vehicle types whose MUC modes equal 0). For this vehicle type the proportion of vehicles is 0.2 non-responsive (field 5), 0.3 SO (field 6), 0.1 UE (field 7), 0.25 enroute info (field 8), and 0.15 VMS-responsive (field 9).

The eighth record indicates that the vehicle type ID is 2 (field 1), and that is it is a truck. The demand mode is 1 (field 2); that is, *demand_truck.dat* will be used to load this vehicle type onto the network. The fraction of *demand.dat* to be loaded as PCs is 0.0 (field 3). The MUC mode is 1 (field 4); that is, MUC proportions specific to this vehicle type are needed. For this vehicle type the proportion of vehicles is 0.15 non-responsive (field 5), 0.1 SO (field 6), 0.05 UE (field 7), 0.6 enroute info (field 8), and 0.1 VMS-responsive (field 9).

The ninth record indicates that the vehicle type ID is 3 (field 1), and that it is an HOV. The demand mode is 0 (field 2); that is, *demand.dat* will be used to load this vehicle type onto the network. The fraction of *demand.dat* to be loaded as PCs is 0.2 (field 3). The MUC mode is 0 (field 4); that is, default MUC proportions will be used. There is no need to input the default MUC proportions again.

This file can be prepared manually, or via the GUI (if using a previous simulation run), or via DSPEd, or via DYNABUILDER (default settings only).

4.25.1 Discussion of Selected Entries

- ❑ The relative indifference band (percent improvement above which user will change paths) only applies to user class 4 (en-route info).

- Tripmakers will not change paths unless travel time-savings are greater than the bound. This parameter only applies to user class 4 (en-route info).
- Identical scenarios with identical random number seeds will yield the same results.
- Positions of vehicles in the network are updated for each simulation time step (6 seconds). In other words, the system states evolve every simulation interval. The current version of DYNASMART-P fixes the simulation interval at 6 seconds.
- Although it may seem counterintuitive, assigning best paths to vehicles when they are generated does not necessarily guarantee that these paths will remain optimal at the end of "one-shot" simulation. Note that the one-shot simulation only simulates user classes 1, 4 and 5. Such a procedure merely assigns a path to each vehicle once it is generated, and unless this vehicle receives enroute information or encounters a VMS, this vehicle will be forced to maintain its assigned path for the complete simulation. These paths may cease to become the shortest paths as the simulation progresses. Such an assignment procedure (unless running UE or SO) does not take into account traffic evolution in the network at future time intervals. Therefore, it may not result in the best overall network-wide travel times, unless the network congestion level is extremely light.
- The number of simulation intervals (6 seconds each) for calculating the K-shortest path refers to "how often" the KSP routine is executed. For example, if 30 simulation intervals were specified, this means the KSP routine will be executed every 30*6 sec = 3 minutes. DYNASMART-P will actually solve for the K-shortest paths tree every 3 minutes. This is different than the number of simulation intervals for updating the shortest path, a process that does not solve for a new shortest paths tree. Instead, the current shortest paths tree travel times will be updated based on prevailing link travel times. Increasing the number of simulation intervals for calculating the shortest path means that the shortest path tree will be calculated less frequently, and this usually results in a shortest path tree that is not best reflective of the actual conditions. Hence, during certain assignment intervals, some vehicles will be assigned a path that would not necessarily correspond to the actual time-varying shortest path. Some vehicles might be assigned non-optimal paths as though they were optimal. In any case, it is advisable to keep the number of simulation intervals for calculating the shortest path at 30 simulation intervals (or 3 min). This number was obtained after extensive sensitivity analysis.

4.25.2 Multiple User Classes

A central feature in DYNASMART-P is the notion of multiple user classes (MUC). DYNASMART-P is capable of simultaneously modeling different classes of users with different choice and assignment rules under different information levels. Currently, DYNASMART-P handles 5 classes of users, namely:

Class 1 – Unresponsive

This class of users is not responsive to any type of information, and is used to model pre-trip information. These users receive path assignments at the beginning of simulation, and adhere to these paths throughout the entire simulation. This class only responds to detours (VMS type 2).

Class 2 – System Optimal (SO)

This class of users follows the system optimal (SO) assignment rule, in which travel times are minimized from the system's perspective. The general idea of this assignment rule is to force a small fraction of users to follow sub-optimal routes from their perspective (not UE) for the benefit of the majority. Such a class is only available if the iterative consistent assignment is chosen. Similar to the UE class, this user class is only responsive to VMS types 2 (mandatory detour) and 4 (optional detour) unless the VMS preemption mode is deselected (or unchecked), whereby this user class will also respond to VMS information. The total network-wide travel time resulting from this assignment is less than or equal to that generated from the UE assignment rule.

Class 3 – User Equilibrium (UE)

This class of users follows the user equilibrium (UE) assignment rule, in which travel times are minimized from the user's (traveler's) perspective. Such a class is only available if the iterative consistent assignment is chosen, and is used to model travelers who are familiar with the network. This user class is only responsive to VMS types 2 (mandatory detour) and 4 (optional detour) unless the VMS preemption mode is deselected (or unchecked), whereby this user class will also respond to VMS information. Note that this assignment rule provides an upper bound for the network-wide travel time relative to the system optimal assignment rule.

Class 4 – Enroute Info (Boundedly Rational Behavior)

This class of users updates its paths at each intersection based on the prevailing shortest path tree. It is designed to reflect enroute information, and is based on "boundedly rational behavior." Two criteria are used for route choice, namely the indifference band and the threshold bound for switching decisions. The indifference band reflects a fraction of travel time improvement below which the user will not switch routes. The threshold bound reflects a time improvement (in minutes) below which the user will not switch routes. Should any of these two criteria be exceeded, the user will switch routes at the next intersection. This class of users is only responsive to detours (VMS type 2), and generally does not respond to VMS information unless the VMS preemption mode is deselected (or unchecked).

Class 5 – VMS Responsive

This class of users responds to VMS information. There are four types of VMS information: congestion warning, optional and mandatory detours, and speed advisory. VMS responsive users receive path assignments at the beginning of simulation, which they adhere to unless they encounter a VMS, and possibly decide to change their paths as a result.

Because DYNASMART-P is an offline-planning model, it lacks the ability to predict and forecast future traffic conditions (given current traffic conditions), and is ill-suited for such applications. Moreover, the boundedly rational behavior is greedy in nature, and does not guarantee that Class 4 users will have the best overall path at the end of simulation. They will not have perfect information as in the SO case. The mechanism is highly sensitive to the values of indifference band, and the threshold bound for switching decisions. This does not mean that en-route info is always worse than no-info. Careful selection of the threshold for switching decisions might actually result in improvement in travel times. For example, increasing the threshold from 1 min to 5 min might lead to vehicles switching routes less frequently, and at the same time provide a savings of at least 5 min over their current path. This could be more beneficial than switching routes whenever the travel savings in travel time is 1 min. Consequently, there is no guarantee that enroute info will achieve better travel times than pre-trip info, but it is possible.

Users may be assigned the best path, or a randomly selected path (from k-shortest paths), depending on whether the best path option is selected in the Advanced Setting menu. Again, there is no guarantee that assigning best paths at the beginning of simulation (one-shot scenario) would result in the best overall network-wide travel times. Optimal paths selected at the start of the simulation may not remain optimal towards the end of the simulation.

Also, for an iterative run, some vehicles must be coded as either UE or SO. During an iterative run, the other MUC classes will be assigned their shortest paths based on prevailing conditions obtained from the last assignment iteration. That is, classes 1, 4, and 5 will make use of the iterative assignment procedure to be assigned more realistic paths. If no vehicles were coded as UE or SO, then the iterative assignment procedure is reduced to a one-shot simulation assignment.

4.25.3 Demand Loading Options

As mentioned earlier, there are two ways of loading vehicles in DYNASMART-P. The first method is to specify time-dependent O-D matrices for Traffic Analysis Zones (TAZs). The second method is to specify trip information for all vehicles, and their corresponding paths. The distinct features and implications for loading vehicles under the two different methods are explained next.

Time-Dependent O-D Demand Loading

When time-dependent O-D matrices are used for network loading, all vehicles are individually generated from the *demand.dat* file (and *demand_truck.dat* and *demand_HOV.dat*). DYNASMART-P assigns each vehicle a path based on the path assignment setting from *scenario.dat*. Vehicles are loaded only on generation links as specified in *origin.dat*. Within a given zone, the loading intensity of a given generation link is either proportional to the link's lane-miles, or based on the loading weight specified in *origin.dat* (refer to Section 4.20 for a description of *origin.dat*).

Vehicle-Path Loading

There will sometimes be instances where a user needs to load vehicles via path files (*vehicle.dat* and *path.dat* input files). This type of loading scheme is particularly needed when a user intends to evaluate different traffic management strategies, requiring specific network loading patterns and/or vehicle paths to be fixed across experiment scenarios. When vehicles are loaded through the vehicle file with a path file, no O-D matrix will be used. *Vehicle.dat* specifies the total number of vehicles to be loaded, along with detailed vehicle attributes (origin, destination, vehicle type, class, etc.) of these vehicles; and DYNASMART-P assigns their paths. If the user chooses to use *path.dat* in conjunction with *vehicle.dat*, vehicles will then be assigned with itineraries specified in *path.dat*. *Path.dat* should contain exactly the same number of records (lines) as *vehicle.dat* because each line represents a path that will be assigned to a vehicle in a corresponding line from *vehicle.dat*.

Loading vehicles via the *vehicle.dat* ("activity chain") input file, or via *vehicle.dat+path.dat* (activity chain with path file), is not allowed if the user specifies multiple user class (MUC) percentages, because these percentages will be determined directly from *vehicle.dat*. Therefore, vehicles will remain responsive to enroute or VMS info if they have been specified as MUC class 4 (enroute info) or 5 (VMS responsive), respectively, within *vehicle.dat*.

4.26 Variable Message Signs Data (vms.dat)

This file describes the underlying VMS configuration. Four types of VMS or Dynamic Message Signs (DMS) are supported by DYNASMART-P. Type 1 VMS is the speed advisory VMS that allows users to increase/decrease speed by a certain percentage when below/above a certain threshold. Type 2 VMS is the mandatory detour VMS that advises drivers of lane closures, and mandates all vehicles to follow some user-specified sub-path in the vicinity. Type 3 VMS is the congestion warning VMS, which allows users to specify percentages of VMS-responsive vehicles (user class 5) to evaluate the VMS information and divert if a better path exists. Therefore, the user is advised to select VMS type 3 on links that would provide diversion points. Finally, type 4 VMS is the optional detour VMS. Similar to type 2, it also advises drivers with lane closure information. However, type 4 gives drivers the option to follow the detour path or keep their original path, based on the boundedly rational decision rule.

These VMS signs can be specified at any locations in the network. In the current version of DYNASMART-P, the diversion behavior is modeled through the response rate, a user-specified parameter that indicates the percentage of VMS drivers who may switch routes due to a VMS. In general (General Settings Record Type, Field 5 in Scenario.dat or Scenario | Advanced Settings menu command), only user class 5 (VMS responsive) drivers will respond (and evaluate) to VMS types 1 and 3, whereas all drivers will respond to types 2 and 4 VMS. Should the user select the VMS preemption mode (General Settings Record Type, Field 5 in Scenario.dat or Scenario | Advanced Settings menu command), then user classes 2-5 will also respond to VMS types 1 and 3. A detailed description of this file and its format are provided in Table 4-30 and Figure 4-29, respectively.

Table 4-30. Description of the *vms.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Number of signs	1	Integer	Free	Number of Variable Message Signs
Sign description	1	Integer	Free	Type of VMS according to the following description 1: speed advisory; 2: mandatory detour; 3: congestion warning; 4: optional detour
	2	Integer	Free	Upstream node of the 1st VMS link
	3	Integer	Free	Downstream node of the 1st VMS link
	4	Integer	Free	Type 1: speed threshold (+ or -) (mph)[1] Type 2: 100[2] Type 3: percentage of user class 5[3] who will actually evaluate and respond to the VMS information Type 4: 100[2]
	5	Integer	Free	Type 1: percentage reduction or increase in VMS link speed Type 2: number of nodes in detour sub-path Type 3: path preference (0 or 1) for diversion 1: current best path; 0: a random path among K-paths Type 4: number of nodes in detour sub-path
	6	Float	Free	Start time for the 1st VMS (minutes)
	7	Float	Free	End time for the 1st VMS (minutes)
Subpath[4]	1	Float	Free	1st node in the detour sequence for the 1st VMS (if applicable)
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
	N			Last node in the detour sequence for the 1st VMS (if applicable)
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Sign description	1	Integer	Free	Type of VMS according to the following description 1: speed advisory; 2: mandatory detour; 3: congestion warning; 4: optional detour
	2	Integer	Free	Upstream node of the last VMS link
	3	Integer	Free	Downstream node of the last VMS link
	4	Integer	Free	Type 1: speed threshold (+ or -) (mph)[1] Type 2: 100[2] Type 3: percentage of user class 5[3] who will actually evaluate and respond to the VMS information Type 4: 100[2]
	5	Integer	Free	Type 1: percentage reduction or increase in VMS link speed Type 2: number of nodes in detour sub-path Type 3: path preference (0 or 1) for diversion 1: current best path; 0: a random path among K-paths Type 4: number of nodes in detour sub-path
	6	Float	Free	Start time for the last VMS (minutes)
	7	Float	Free	End time for the last VMS (minutes)
Subpath[4]	1	Float	Free	1st node in the detour sequence for the last VMS
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
	N			Last node in the detour sequence for the last VMS

[1] *If positive (+), link speed will be increased (if link speed is lower than the threshold). If negative (-), link speed will be decreased (if actual link speed is higher than the threshold).*

[2] *This entry is read but ignored by DYNASMART-P. It is used to keep the same number of fields for VMS types.*

[3] *If the VMS preemption mode is set to 1 (in scenario.dat), then this fraction applies to user classes 2-5.*

[4] *For VMS types 2 and 4 only.*

```
3
      1      1      20      40      10  10.0  30.0
      2     53      52     100       3  10.0  80.0
     52     51      14
      3     48      41      15       1   0.0  20.0
```

Figure 4-29. General format of the *vms.dat* input file

The first record in Figure 4-29 indicates that there are 3 VMS locations or sites. The second record states that a type 1 (speed advisory) VMS (field 1) is located between upstream node 1 (field 2) and downstream node 20 (field 3). A +40 mph threshold is given (field 4). The positive sign indicates that if the link speed is less than 40 mph, VMS-responsive vehicles will attempt to increase their speed to reach this speed. If their speed is already above 40 mph, then no action is taken. The next field indicates that VMS responsive vehicles (user class 5) will increase their speed by 10 percent to achieve the recommended speed threshold. The VMS is activated from time 10.0 (field 6) until time 30.0 minutes (field 7).

The third record (2nd VMS link in network) shows that there is a detour type VMS (type 2) (field 2) located between upstream node 53 and downstream node 52. All vehicles (irrespective of MUC class) need to divert (100%) and there are three nodes in the specified sub-path for detouring. The next immediate record specifies the node sequence of the sub-path for detouring. The first node is 52, which is required to be the downstream node of the VMS (there is no requirement for the last node on detour sub-path); the remaining two nodes on sub-path are 51 and 14. This VMS is activated between minutes 10.0 and 80.0 of simulation (field 7). Note that the detour-type VMS is of particular importance for work zone operational management strategies; however, it need not be used in conjunction with a work zone or an incident. Vehicles will simply follow the detour sub-path irrespective of whether a work zone (or an incident) is present or not.

The fourth record (3rd VMS link in network) shows that there is a congestion warning VMS (type 3) (field 1) located between upstream node 48 (field 2) and downstream node 41 (field 3), and a response rate of 15 percent (field 4) is specified. After diversion, vehicles will be assigned the current best (1) path (field 5) starting from the downstream node of the VMS link. The VMS will be activated from minute 0.0 (field 6) until minute 20.0 (field 7).

This file can be prepared either manually, or via the GUI, or via DSPEd or via DYNABUILDER (empty file). To prepare this file using the GUI, click on the Scenario | Parameters & Capabilities… menu command. Then click on <<Next>> in the <Parameter Settings> dialog box. Once in the <Capability Selection> dialog box, check the <<Variable Message Sign>> check box and click on <<Input…>> button in the [Traffic Management] data block. This launches the <VMS Input> dialog box. Enter the VMS data and click <<OK>> to proceed.

Further Discussion

- *Percentage of VMS-responsive vehicles that evaluate and respond to VMS information*: this percentage refers to class 5 users (and classes 2-5 if the VMS preemption mode is activated) that will evaluate (consider) the VMS information and divert if a better path exists. Otherwise, they will keep their original paths. Vehicles that do not evaluate the VMS information will keep their original paths.
- *Path preference for congestion warning VMS (type 3)*: if "1" is specified, the corresponding best path will be assigned to diverted vehicles, which implies that tripmakers who actually divert have a priori knowledge or reasonable familiarity with the network and corresponding traffic dynamics. If a "0" is specified, diverted vehicles will be assigned paths at random, which implies tripmakers may not necessarily have perfect network and traffic information, and hence might take inferior paths. This situation is used to model general situations where tripmakers are regular commuters or moderately familiar with the traffic network.
- When using VMS type 2 (mandatory detour) in an iterative consistent assignment solution mode (UE/SO), unless the user blocks (by specifying an incident with a severity of 1.0) the links being avoided by the detour, the iterative MUC procedure will lead to an inconsistent and unstable solution (equilibrium paths).
- In VMS type 4 (optional detour), vehicles would first have to decide between keeping their original paths and using the detour sub-path (based on the boundedly rational decision rule). Once on the detour sub-path, user classes 1 (unresponsive) and 5 (VMS-responsive) will stay on the sub-path, unless they encounter another VMS. On the other hand, user class 4 (enroute info) vehicles can still switch their paths at any node along the sub-path if the travel time savings are reasonable (according to the boundedly rational decision rule).
- The user may specify more than one VMS on the same link, although this practice is not recommended. When more than one active VMS is specified simultaneously on same link, the mandatory detour (VMS type 2) will always govern, followed by the optional detour (VMS type 4) and congestion warning VMS (type 3). The speed advisory VMS can coexist with any other VMS type.

4.27 Ramp Metering Data (ramp.dat)

Ramp metering in DYNASMART-P is modeled by adjusting on-ramp flow rates based on the flow and downstream capacity of mainline freeway lanes. The logic implemented is similar to Papageorgiou's ALINEA[5], which is a relatively simple feedback-control mechanism. The procedure measures the flow on freeway mainline lanes downstream of the ramp, and determines

[5] Papageorgiou, M., Blossville, J. M., and Haj-Salem, H. ALINEA: A Local Feedback Control for on-ramp Metering. *Transportation Research Record*, 1320, pp 58 – 64, 1991.

the remaining freeway capacity available based on occupancy values. Then the on-ramp flow rate is adjusted to meet the available capacity. This model is formulated as follows:

$$q_t = q_{t-1} + \alpha(\beta - OCC)$$

where q_t = Ramp flow rate (vehicles/lane/hr) for the t^{th} period

q_{t-1} = Ramp flow rate (vehicles/lane/hr) for the $(t\text{-}1)^{th}$ period

OCC = Measured downstream occupancy (percent time)

α = Occupancy-to-flow conversion rate (vehicles/lane/hr/percent time)

β = Maximum freeway downstream occupancy (percent time)

and

$$q_t = \begin{cases} Saturation\ flow rate(SFR) & if\ \ q_t \geq\ SFR \\ 288\ veh/hr/ln & if\ \ q_t < 288 \end{cases}$$

The term $(\beta$ - $OCC)$ represents the excess downstream capacity (in terms of occupancy) available for entering vehicles. Therefore, the higher β is, the more capacity is available for entering vehicles. The term α may be regarded as a control factor, which controls the number of vehicles entering the freeway via the on-ramp. Therefore, the higher α is, the more vehicles are able to enter the freeway.

This input file describes the ramp metering configuration including the number of metered ramps, location of loop detectors (delineated by the position of the edges with respect to the downstream link of the ramp), saturation flow rate, and the metering update interval. Note that occupancy, in DYNASMART-P, is averaged over a freeway section delineated by the edges of the loop detector. A detailed description of this file and its format are provided in Table 4-31 and Figures 4-32 and 4-33, respectively.

Table 4-31. Description of the *ramp.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General	1	Integer	Free	Number for metered ramps
	2	Integer	Free	Ramp metering updating interval (min)
Ramp data[1]	1	Integer	6	1st metered ramp
	2	Integer	6	Upstream node of the freeway link for the 1st metered ramp
	3	Integer	6	Downstream node of the freeway link for the 1st metered ramp
	4	Integer	6	Position of the first detector edge on the freeway link (in feet) measured from the downstream node of that link for the 1st ramp
	5	Integer	6	Position of the second detector edge on the freeway link (in feet) measured from the downstream node of that link for the 1st ramp
	6	Integer	6	Upstream node of the 1st metered ramp
	7	Integer	6	Downstream node of the 1st metered ramp
	8	Float	7(3)	Parameter (α) of the 1st ramp (default=0.32)
	9	Float	6(2)	Parameter (β) of the 1st ramp (default=0.2)
	10	Float	6(2)	Saturation flow rate for the 1st ramp (default=0.5 veh/sec/ln or 1800 vphpl)
Operation times	1	Float	8(2)	The starting time for metering at the 1st ramp (min)
	2	Float	8(2)	The ending time for metering at the 1st ramp (min)
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
Ramp data[1]	1	Integer	6	Last metered ramp
	2	Integer	6	Upstream node of the freeway link for the last metered ramp
	3	Integer	6	Downstream node of the freeway link for the last metered ramp
	4	Integer	6	Position of the 1st detector edge on the freeway link (in feet) measured from the downstream node of freeway for last ramp
	5	Integer	6	Position of the 2nd detector edge on the freeway link (in feet) measured from the downstream node of freeway for last ramp
	6	Integer	6	Upstream node of the last metered ramp
	7	Integer	6	Downstream node of the last metered ramp
	8	Float	7(3)	Parameter (α) of the last ramp (default=0.32)
	9	Float	6(2)	Parameter (β) of the last ramp (default=0.2)
	10	Float	6(2)	Saturation flow rate for the last ramp (default=0.5 veh/sec/ln or 1800 vphpl)
Operation times	1	Float	8(2)	The starting time for the metering at the last ramp (min)
	2	Float	8(2)	The ending time for the metering at the last ramp (min)

[1] *Refer to Figure 4-30 for a better understanding of this input file*

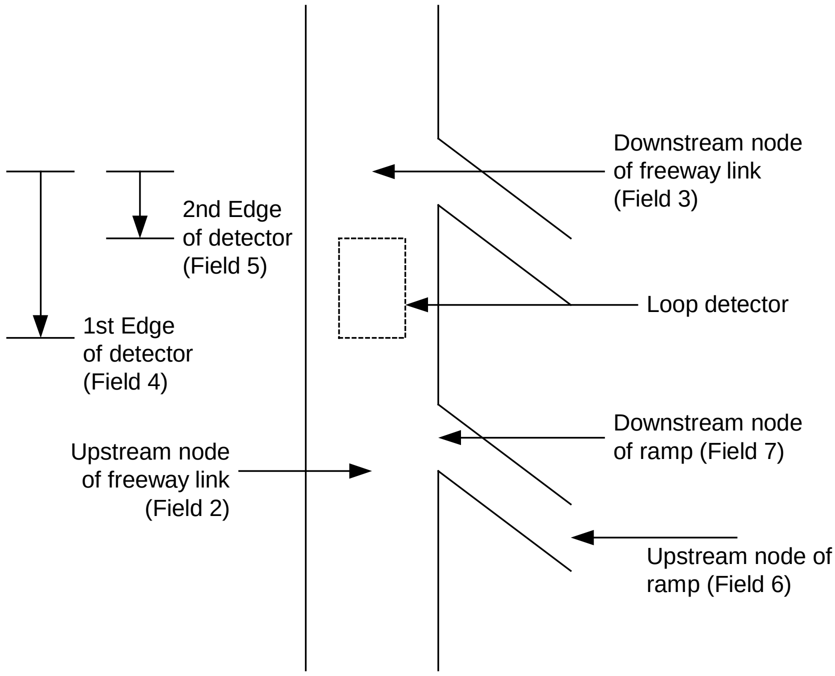


Figure 4-30. Ramp metering input description

```
    7     1
    1    25    21   260   250    26    25 0.320  0.20   0.50
  5.00   30.00
    2    37    34   260   250    38    37 0.320  0.20   0.50
  5.00   30.00
    3    41    37   260   250    42    41 0.320  0.20   0.50
  5.00   30.00
    4    53    52   260   250    54    53 0.320  0.20   0.50
  5.00   30.00
    5    28    32   260   250    27    28 0.320  0.20   0.50
  5.00   30.00
    6    32    35   260   250    31    32 0.320  0.20   0.50
  5.00   30.00
    7    44    45   260   250    43    44 0.320  0.20   0.50
  5.00   30.00
```

Figure 4-31. General format of the *ramp.dat* input file

The first record in Figure 4-31 indicates that there are 7 metered ramps (field 1), for which the metering rate is updated every 1 minute (field 2). The second record pertains to the first ramp (field 1), and defines the downstream link of the ramp to be from upstream node 25 (field 2) to downstream node 21 (field 3). The edges of the loop detector are located 260 (field 4) and 250 (field 5) feet upstream of node 21. The ramp is located between upstream node 26 (field 6) and downstream node 25 (field 7), and has ramp metering parameters of 0.320 (field 8) and 0.20 (field 9). The ramp saturation flow rate is 0.5 veh/sec/ln or 1800 vphpl (field 10). The next record states that ramp metering will be effective only between minutes 5.0 (field 1) and 30.0 (field 2).

This file can be prepared either manually, or via DSPEd, or via DYNABUILDER (empty file).

4.28 Incident Data (incident.dat)

The purpose of this file is to specify the number of incidents to be simulated, their starting and ending times (duration), location, and severity. A detailed description of this file and its format are provided in Table 4-32 and Figure 4-32, respectively.

Table 4-32. Description of the *incident.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General	1	Integer	Free	Total number of incidents in network
Incident description	1	Integer	Free	Upstream node of the 1st incident link
	2	Integer	Free	Downstream node of the 1st incident link
	3	Float	Free	Start time of the 1st incident (minutes)
	4	Float	Free	End time of the 1st incident (minutes)
	5	Float	Free	Severity[1] of the 1st incident
.....	.....	.....	.....	.....
Incident description	1	Integer	Free	Upstream node of the last incident link
	2	Integer	Free	Downstream node of the last incident link
	3	Float	Free	Start time of the last incident (minutes)
	4	Float	Free	End time of the last incident (minutes)
	5	Float	Free	Severity[1] of the last incident

[1] *The fraction of link capacity lost due to the incident (remaining capacity becomes one minus the severity)*

```
2
48 41  5.0 20.0 0.6
39 44 10.0 25.0 0.8
```

Figure 4-32. General format of the *incident.dat* input file

The first record in Figure 4-32 reveals that there are 2 incidents. The first incident (next record) is located between upstream node 48 (field 1) and downstream node 41 (field 2). The incident will take place between minutes 5 (field 3) and 20 (field 4) of simulation. The severity of the incident is specified to be 0.6 or 60 percent (field 5). That is, the remaining available capacity of the incident link (defined by nodes 48 and 41) is 0.4 or 40 percent of the original link capacity.

This file can be prepared either manually, or via the GUI, or via DSPEd, or via DYNABUILDER (empty file). To prepare this file using the GUI, click on the Scenario | Parameters & Capabilities… menu command. Then click on the <<Next>> button in the <Parameter Settings> dialog box. Once in the <Capability Selection> dialog box, check the <<Incident>> check box, and click on the <<Input…>> button in the [Capacity Reduction] data block. This launches the <Incident Input> dialog box. Enter the incident data and click <<Add>> to add the incident data to *incident.dat*. Click <<OK>> to proceed.

Further Discussion

Multiple incidents may be specified on a link. DYNASMART-P will pick the highest severity of all active incidents to reduce the physical capacity (lane-miles) and maximum flow rate of the incident link.

4.29 Work Zone Data (WorkZone.dat)

WorkZone.dat contains the number of work zones to be simulated, their start and end times, location, lane closure, reduced speed limits and queue discharge rate (i.e., maximum flow rate on the specified link, which also acts as an upper bound to the effective rate at which upstream queued vehicles may discharge into a work zone link). A detailed description of this file and its format are provided in Table 4-33 and Figure 4-33 respectively.

Table 4-33. Description of the *WorkZone.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General	1	Integer	Free	Total number of work zones in network
Work zone description	1	Integer	Free	Upstream node of the 1st work zone link
	2	Integer	Free	Downstream node of the 1st work zone link
	3	Float	Free	Start time of the 1st work zone (minutes)
	4	Float	Free	End time of the 1st work zone (minutes)
	5	Float	Free	Capacity reduction rate[1] for the 1st work zone
	6	Integer	Free	Posted speed limit for the 1st work zone
	7	Integer	Free	Queue discharge rate for the 1st work zone (vphpl)
.....	.....	.....	.....	.....
Work zone description	1	Integer	Free	Upstream node of the last work zone link
	2	Integer	Free	Downstream node of the last work zone link
	3	Float	Free	Start time of the last work zone (minutes)
	4	Float	Free	End time of the last work zone (minutes)
	5	Float	Free	Capacity reduction rate[1] for the last work zone
	6	Integer	Free	Posted speed limit for the last work zone
	7	Integer	Free	Queue discharge rate for the last work zone (vphpl)

[1] *The fraction of physical link capacity (lane closure) lost due to the work zone*

```
5
     52     48  10.0  120.0 0.6  50 1300
     53     52  10.0  120.0 0.3  50 1500
     45     49  10.0  120.0 0.0  65 1500
     41     37  10.0  120.0 0.3  50 1600
     35     39  10.0  120.0 0.3  50 1400
```

Figure 4-33. General format of the *WorkZone.dat* input file

The first record in Figure 4-33 reveals that there are 5 work zones. The first work zone (next record) is located between upstream node 52 (field 1) and downstream node 48 (field 2). The work zone activity will take effect between minutes 10.0 (field 3) and 120.0 (field 4) of simulation. The percentage of lane closure is specified to be 0.6 or 60 percent (field 5). That is, the remaining available capacity for the work zone link (defined by nodes 52 and 48) is 0.4 or 40 percent of the original link capacity. The posted speed limit is 50 mph (field 6), and the (upstream) queue discharge rate for this work zone link is 1300 vphpl.

This file can be prepared either manually, or via the GUI, or via DSPEd, or via DYNABUILDER (empty file). To prepare this file using the GUI, click on the Scenario | Parameters & Capabilities… menu command. Then click on <<Next>> in the <Parameter Settings> dialog box. Once in the <Capability Selection> dialog box, check the <<Work Zone>> check box, and click on the <<Input…>> button in the [Capacity Reduction] data block. This launches the <Work Zone Input> dialog box. Enter the incident data and click <<OK>> to proceed.

Note that users cannot specify multiple active work zones on the same link. DYNASMART-P will output an error message in this regard.

Discussion

Generally, DYNASMART-P supports modeling of the “partial closure” and “crossover” types of roadway work zones. As shown in Figure 4-34 through Figure 4-38, two partial closure types of work zone can be modeled: 1) partial lane closure in one direction with solid barrier median, and 2) partial lane closure in one direction with temporary channelizing devices (e.g., cones) placed along the median. The first type of work zone has minimal impact on the opposite direction of traffic. For the second type of work zone, queue discharge rates in the opposite direction could be significantly impacted.

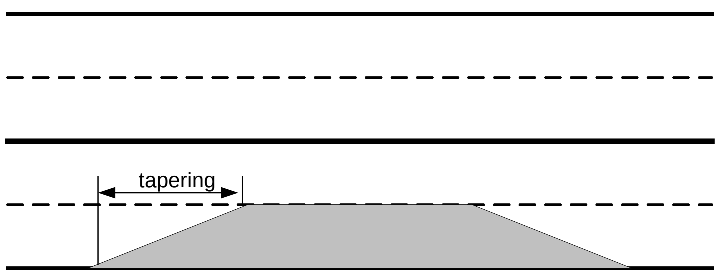


Figure 4-34. Partial lane closure with barrier median

An example of modeling the above work zone is illustrated in Figure 4-35, in which the work zone is located on freeway link (7,6), and tapering is on links (8,7) and (6,5). In the upstream tapering link (8,7), the lane closure is approximated as a 25% reduction of physical capacity (due to lane closure); the speed limit is reduced to 50 mph, and the queue discharge rate is 1,500 vphpl. The queue discharge rate provides an upper bound on the number of upstream queued vehicles that can discharge into a downstream work zone link in any given time interval. Work zone link (7,6) has a lane closure causing 50% capacity reduction, a speed limit of 50 mph, and a queue discharge rate of 1,300 vphpl. In the downstream tapered link (6,5), the lane closure is approximated at 25% capacity reduction, the speed limit is 50 mph, and the queue discharge rate is 1,800 vphpl. Because there is a barrier median, traffic in the opposite direction is not affected by the work zone.

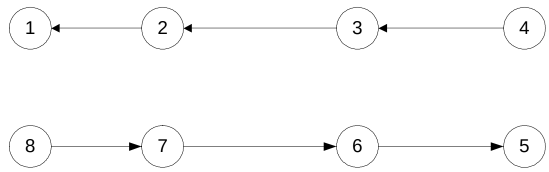


Figure 4-35. DYNASMART-P representation of work zone

```
3
      8      7  10.0  120.0 0.25  50 1500
      7      6  10.0  120.0 0.50  50 1300
      6      5  10.0  120.0 0.25  50 1800
```

Figure 4-36. Coding example of partial lane closure with barrier median

In the case of a temporary control device median, coding for the work zone direction remains the same, but the maximum service flow rate of links in the opposite direction is to be reduced appropriately. Hence, link (3,2) is assumed to experience zero capacity (physical) reduction, but its maximum service rate needs to be reduced to 1,500 vphpl in *network.dat*.

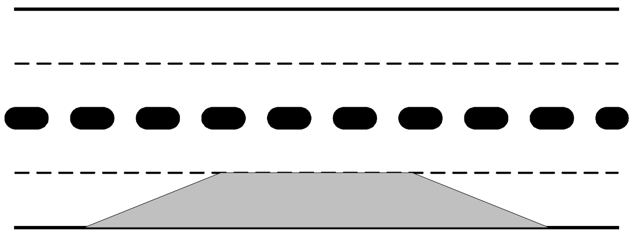


Figure 4-37. Partial lane closure with temporary control device median

For the "crossover" type of work zone, all lanes in one direction are totally closed. One or more lanes in the opposite direction are used to accommodate traffic in the work zone direction. In this scenario, vehicles traveling in both directions (work zone direction and opposite direction) are impacted by the work zone. As such, the upstream tapering link (8,7) is assumed to have 40%

capacity reduction, a speed limit of 50 mph, and a queue discharge rate of 1,400 vphpl. Work zone link (7,6) is assumed to have a capacity reduction of 50%, and a queue discharge rate of 1,300 vphpl. The downstream tapered link (6,5) is assumed to have 40% capacity reduction, and a queue discharge rate slightly higher than in the work zone, at 1,400 vphpl.

The opposite direction links are modeled as follows: the upstream tapering link (4,3) is assumed to have 25% capacity reduction (due to lane closure), and a queue discharge rate of 1,500 vphpl. The crossover section link (3,2) is assumed to have 50% capacity reduction, and a queue discharge rate of 1,300 vphpl. The downstream tapering link is assumed to have a 25% capacity reduction, and a queue discharge rate of 1,500 vphpl.

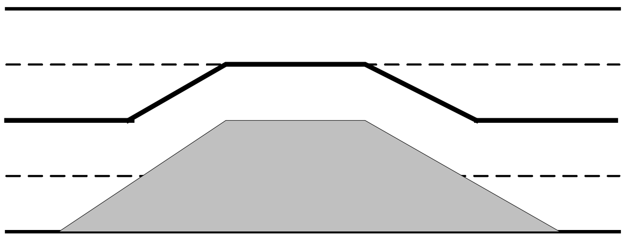


Figure 4-38. Crossover lane closure

```
6
      8      7  10.0  120.0 0.40  50 1400
      7      6  10.0  120.0 0.50  50 1300
      6      5  10.0  120.0 0.40  50 1400
      4      3  10.0  120.0 0.25  50 1500
      3      2  10.0  120.0 0.50  50 1300
      2      1  10.0  120.0 0.25  50 1500
```

Figure 4-39. Coding example of crossover lane closure

In summary, by properly specifying *WorkZone.dat*, one could use DYNASMART-P to model any of the above three types of work zones. Note that the capacity reduction is by default applied to the entire link. That is, the current version of DYNASMART-P does not explicitly consider the length of areas where capacity will be reduced. The user needs to carefully review the number of links that should be included in this file. If, for example, a work zone extends across several miles, several consecutive links may need to be included. On the other hand, if the work zone or accident incurs capacity reduction over a short distance, and the location of the work zone happens to be on a long link, then it might be more appropriate to segment the long link into several shorter links. This file may be entered manually or via DSPEd, or using the GUI as described in Section 6.2.5.

4.30 Congestion Pricing (pricing.dat)

The purpose of this file is to specify the cost for low and high occupancy vehicles (LOV and HOV) using high occupancy toll (HOT) links. The user can also set the cost of using standard (non HOT or HOV) links. These costs are subsequently converted to travel times (using a generalized cost function), and utilized in the shortest path calculations. As previously mentioned, this file is optional and need not contain any data. Nevertheless, it should be present in the working directory. A detailed description of this file and its format are provided in Table 4-34 and Figure 4-40, respectively.

Table 4-34. Description of the *pricing.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
HOT/HOV pricing	1	Float	Free	The toll value on every link in the general-purpose network (use 0 as default)
	2	Float	Free	The toll value (dollars) for LOV vehicles on HOT links
	3	Float	Free	The toll value (dollars) for HOV vehicles on HOT links
	4	Float	Free	Monetary value of time in $/hr (cannot be zero)

```
0.0   1.5   0.0   5.0
```

Figure 4-40. General format of the *pricing.dat* input file

Figure 4-40 shows that there is no (or $ 0) toll on the general-purpose network links (field 1). Low Occupancy Vehicles are charged $1.50 (field 2) on HOT links. No charges (or $ 0) are applied to High Occupancy Vehicles on those links (field 3). A monetary value of $5.00 per hour is specified (field 4). If LOV vehicles are to be denied access to HOT-dedicated links, then a toll of $9999 (or higher) is recommended for the cost of LOV vehicles on HOT links.

This file can be prepared either manually, or via the GUI, or via DSPEd, or DYNABUILDER (default settings only). To prepare this file using the GUI, click on the Scenario | Parameters & Capabilities… menu command. Then click on <<Next>> in the <Parameter Settings> dialog box. Once in the <Capability Selection> dialog box, check the <<Activated>> check box in the [Congestion Pricing] data block and enter the pricing data.

Discussion

- ❑ If no link is specified as an HOV or HOT link (refer to Section 4.7 – *network.dat*), then pricing data in *pricing.dat* will not be used. Moreover, specifying a zero cost for LOV vehicles on HOT links should give the same result as the case with no HOT links.

- There are two possible implementations for HOT links (the user needs to set the cost of appropriate fields in *pricing.dat*): (1) HOV vehicles can use HOT link for free, LOV vehicles for a user-specified toll; or (2) both HOV and LOV vehicles can use HOT links for a user-specified toll (may be different for each category).
- LOV vehicles cannot use HOV links.

4.31 Bus Data (bus.dat)

The purpose of this file is to specify bus operational characteristics such as the number of buses to be loaded, start time of operation, bus routes, dwell time, and the types and locations of bus stops. A detailed description of this file and its format are provided in Table 4-35 and Figure 4-41, respectively.

Table 4-35. Description of the *bus.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General	1	Integer	Free	Number of buses to be loaded
Bus data	1	Integer	Free	Upstream node of the starting link for the 1st bus
	2	Integer	Free	Downstream node of the starting link for the 1st bus
	3	Float	Free	Starting time (in minutes) for the 1st bus
	4	Float	Free	Average dwell time (in minutes) for the 1st bus
	5	Integer	Free	Number of nodes in the route for the 1st bus
Node Sequence	1	Integer	Free	First node[1] in the route for the 1st bus
.....	.....	.....	.....	.....
	N	Integer	Free	Last node[2] in the route for the 1st bus
Stop locations	1	Integer	Free	Stop mode for the 1st node[3] along the route of the 1st bus 0: no stop 1: stop at the near block (downstream node of the link) 2: stop at the mid-block (in the middle of the link) 3: stop at the mid-block bus bay
.....	.....	.....	.....	.....
	N	Integer	Free	Stop mode for the last node along the route of the 1st bus 0: no stop 1: stop at the near block (downstream node of the link) 2: stop at the mid-block (in the middle of the link) 3: stop at the mid-block bus bay
.....	.....	.....	.....	.....
Bus data	1	Integer	Free	Upstream node of the starting link for the last bus
	2	Integer	Free	Downstream node of the starting link for the last bus
	3	Float	Free	Starting time (in minutes) for the last bus
	4	Float	Free	Average dwell time (in minutes) for the last bus
	5	Integer	Free	Number of nodes in the route for the last bus
Node Sequence	1	Integer	Free	First node[1] in the route for the last bus
.....	.....	.....	.....	.....
	N	Integer	Free	Last node[2] in the route for the last bus
Stop locations	1	Integer	Free	Stop mode for the 1st node[3] along the route of the last bus 0: no stop 1: stop at the near block (downstream node of the link) 2: stop at the mid-block (in the middle of the link) 3: stop at the mid-block bus bay
.....	.....	.....	.....	.....
	N	Integer	Free	Stop mode for the last node along the route of the last bus 0: no stop 1: stop at the near block (downstream node of the link) 2: stop at the mid-block (in the middle of the link) 3: stop at the mid-block bus bay

[1] *Downstream node of the starting link*

[2] *Must be a valid destination node (as specified in the destination.dat input file)*

[3] *Must be set to "0", because the downstream node of the bus starting link must not have a stop*

```
3
86  72 1.0  1.0 10
72  73  74  11  12  94 149  95 110 168
0  0  0  2  0  0  1  0  2  1
169 112 1.0  1.0  8
112 113 114  16  15  88  87 135
0  2  0  0  0  3  0  1
78  77 1.0  1.0  9
77  76  75  74  73  72  86  85  84
0  0  0  2  0  2  0  1  1
```

Figure 4-41. General format of the *bus.dat* input file

The first record in Figure 4-41 shows that 3 buses are present. Each bus operation requires three records. The second bus (5th record) starts at the link between upstream node 169 (field 1) and downstream node 112 (field 2). The start time is 1.0 minute (field 3) after the start of simulation, the dwell time for this bus is 1.0 minute (field 4), and its route is defined by a sequence of 8 nodes (field 5). The next record (6th record) specifies those 8 nodes (or equivalently, the bus route) sequentially starting from node 112 (field 1), to node 113 (field 2), and so on until node 135 (field 8).

The next record (record 7) indicates that there is no stop (0 in field 1) between nodes [169 & 112], a type 2 stop (mid block stop) (field 2) between nodes [112 & 113], and no stop between nodes [113 & 114] (a zero is indicated in field 3 of the sixth record, which refers to the link described by nodes 113 and 114). Similarly, no stops exist between [114 & 16], and [16 & 15]. A type 3 stop (3 is specified in field 6 of the sixth record) – stop at mid block of bus bay – is also specified between nodes [15 & 88], no stop (stop type 0) (field 7) between nodes [88 & 87], and finally, a type 1 stop (1 is specified in field 8 of this record) – stop at the near block – between nodes [87 & 135]. Note that the capacity reduction due to buses is implicitly modeled in DYNASMART-P, in accordance with HCM 2000 procedures.

This file can be prepared either manually, or via the GUI, or via DSPEd, or DYNABUILDER (empty file).

4.32 System Data (system.dat)

This file allows the user to specify operational settings within DYNASMART-P. A detailed description of this file and its format are provided in Table 4-36 and Figure 4-42, respectively.

Table 4-36. Description of the *system.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
General	1	Float	Free	Planning Horizon
Assignment & generation parameters	1	Integer	Free	Maximum number of iterations to be used in the iterative consistent procedure 0: one-shot 1+: iterative consistent assignment
	2	Integer	Free	Vehicle generation mode 0: from vehicle file *vehicle.dat* 1: from O-D demand matrix *demand.dat* 2: from vehicle and path files *vehicle.dat* & *path.dat*
MUC parameters	1	Integer	Free	Number of simulation intervals (6 seconds) per aggregation interval[1] (default = 10)
	2	Integer	Free	Number of simulation intervals (6 seconds each) per assignment interval[2] (default = 50)
	3	Float	Free	MUC threshold[3] (default = 0.50)
	4	Integer	Free	Convergence threshold[4] (default = 100)

[1] *The aggregation interval pertains to the time interval over which the MOE are averaged. These traffic measures are used by the time-dependent shortest path algorithm to calculate the shortest path tree.*

[2] *The assignment interval pertains to the time interval for which the MUC procedure solves the shortest path tree problem, and assigns vehicles generated within that interval to a path from this shortest path tree. For example, if an assignment interval of 5 minutes is specified, then the MUC (making use of the already stored k-shortest paths) will solve the shortest path tree for time intervals [0,5], [6,10], and so on. Then each vehicle that is generated within interval [0,5] will be assigned a path from the shortest path tree generated for time interval [0,5] and so on. Hence the smaller the interval, the more accurate the MOE (and hence traffic assignment), and the larger the memory requirements. Note that this parameter is only applicable for the iterative consistent assignment procedure (UE and/or SO).*

[3] *The minimal difference (in vehicles) of assignment levels between two consecutive iterations, for all O-D pairs for all departure time intervals. If the difference is greater than the MUC threshold, a violation is counted. The lower this value is, the better the traffic assignment results are.*

[4] *The total number of MUC threshold violations accumulated over all O-D for all departure time intervals. The lower this value is, the better traffic assignment results are.*

```
120.00
3 1
10 50 0.5 100
```

Figure 4-42. General format of the *system.dat* input file

The first record in Figure 4-42 depicts that the planning horizon is 120 minutes. The second record indicates that a maximum of 3 iterations is desired (field 1), and that vehicles are to be generated from the O-D demand table (1 is specified in field 2). In specifying a non-zero number for the number of iterations, it is implicitly known that an SO or UE assignment is desired. The third record indicates that the number of simulation intervals per aggregation interval is 10 – equivalent to 10 * 6 = 60 sec = 1 min – (field 1). The number of simulation intervals per assignment interval is 50, or 3 minutes (field 2). The MUC threshold is 0.5 (field 3), and the convergence threshold is set at 100 violations (field 4).

In specifying parameters for the *system.dat* file, the default values reported in Table 4-36 are recommended. These values were obtained after an extensive sensitivity analysis. The lower the number of simulation intervals per aggregation interval is, the more accurate the link travel times are, and the better the traffic assignment is (although additional memory is required). Also, the lower the number of simulation intervals per assignment interval is, the better the traffic assignment is (and more memory requirements). The lower the MUC threshold, the better the assignment is, as it places a stricter requirement on traffic assignment consistency. Finally, the lower the convergence threshold, the harder it is to reach UE or SO convergence (more iterations are required – more memory) and hence better traffic assignment.

This file can be prepared either manually, or via the GUI, or via DSPEd, or DYNABUILDER (default settings only). To prepare this file using the GUI, click on the Scenario | Advanced Settings… menu command. Enter the system data and click <<OK>> to proceed.

To select the vehicle generation mode within the GUI, click on the Scenario | Parameters & Capabilities… menu command. This will launch the <Parameter Settings> dialog box. Click the <<Next>> button and proceed to the <Capability Selection> dialog box. Check the appropriate loading option in the [Demand] data block, namely the <<OD Trip Table>> check box (loading via the *demand.dat*, *demand_truck.dat*, and *demand_HOV.dat* files), <<Activity Chain>> check box (loading via the *vehicle.dat* input file), and the <<With Path File>> check box (loading via the *vehicle.dat* and *path.dat* input files).

4.33 Optional Output Data (output_option.dat)

This file allows users to indicate whether or not certain output files will be created. Users can also specify the time interval over which the statistics are averaged. In addition, users can specify the time interval in which vehicle loading information is displayed on the console window at runtime. A detailed description of this file and its format are provided in Table 4-37 and Figure 4-43, respectively.

Table 4-37. Description of the *output_option.dat* input file

Record Type	*Field*	*Format*	*Width*	*Description*
Out_LinkGen.dat[1] (number of generated vehicles)	1	Integer	Free	1 to print the file; 0 otherwise
	2	Integer	Free	Number of simulation intervals over which number of vehicles on links will be averaged
OutLinkVeh.dat[1] (number of vehicles)	1	Integer	Free	1 to print the file; 0 otherwise
	2	Integer	Free	Number of simulation intervals over which number of vehicles on links will be averaged[2]
OutLinkQue.dat[1] (vehicle queue length)	1	Integer	Free	1 to print the file; 0 otherwise
	2	Integer	Free	Number of simulation intervals over which vehicle queue on links will be averaged
OutLinkSpeedAll.dat[1] (link speed)	1	Integer	Free	1 to print the file; 0 otherwise
	2	Integer	Free	Number of simulation intervals over which link speed will be averaged
OutLinkDent.dat[1] (link density)	1	Integer	Free	1 to print the file; 0 otherwise
	2	Integer	Free	Number of simulation intervals over which link density will be averaged
OutLinkSpeedFree.dat[1] (speed of moving vehicles)	1	Integer	Free	1 to print the file; 0 otherwise
	2	Integer	Free	Number of simulation intervals over which speed of moving vehicles will be averaged
OutLinkDentFree.dat[1] (density of moving vehicles)	1	Integer	Free	1 to print the file; 0 otherwise
	2	Integer	Free	Number of simulation intervals over which density of moving vehicles will be averaged
OutLeftFlow.dat[1] (number of left-turning vehicles)	1	Integer	Free	1 to print the file; 0 otherwise
	2	Integer	Free	Number of simulation intervals over which number of left-turning vehicles will be averaged
OutGreen.dat[1]	1	Integer	Free	1 to print the file; 0 otherwise
(green time at intersections)	2	Integer	Free	Number of simulation intervals over which green time at intersections will be averaged
OutFlow.dat[1]	1	Integer	Free	1 to print the file; 0 otherwise
(number of vehicles crossing intersections)	2	Integer	Free	Number of simulation intervals over which number of vehicles crossing intersections will be averaged
GUI updating interval	1	Integer	Free	Number of simulation intervals (set at 6 seconds) for which the GUI updates vehicle position and loading information on the network

[1] *Detailed information about these files is provided in Table 5-1*

```
1 10
1 10
1 10
1 10
1 10
1 10
1 10
1 10
1 10
1 10
50
```

Figure 4-43. General format of the *output_option.dat* output file

Figure 4-43 shows that all possible optional output files are to be generated for an aggregation interval of 10 simulation intervals (or 10 × 6 seconds = 1 minute). Also, vehicle positions and loading information on the network are updated in the GUI every 50 simulation intervals (or 50 × 6 seconds = 300 seconds = 5 minutes).

This file can be prepared either manually, or via DSPEd, or via DYNABUILDER (default settings only).

5. OUTPUT DATA DESCRIPTION

5.1 General Description

DYNASMART-P collects travel information for every vehicle in the network, which enables it to generate statistics (such as vehicle trajectories, system performance, and many more) at essentially any desired level of aggregation. Furthermore, network-wide averages are also readily available for several descriptors such as overall and basic trip times, entry queue times, stop times, and trip distances. Given the abundance and level of detail of output statistics in DYNASMART-P, the user may easily compute statistics for composite descriptors such as fraction of stopped time per trip time, and many others. The DYNASMART-P output files are briefly described in Table 5-1. More detailed descriptions of output files are provided in subsequent sub-sections.

Table 5-1. Description of the main output files of DYNASMART-P

Output File	*Description*
SummaryStat.dat	This is the main output file for DYNASMART-P. It summarizes network performance for the given planning horizon. Overall vehicle statistics including trip times, travel times, stop times, entry queues, and travel distances are reported. It also includes vehicle loading and exiting information, statistics regarding HOT/HOV lanes, and a summary of the primary inputs.
VehTrajectory.dat	This file provides trajectories for individual simulated vehicles. Each trajectory is associated with a set of nodes (describing the path), the cumulative travel time, the travel time on each link in the path, the stop time at each node, and the cumulative stop time. This file is also used by the GUI to display animation of traffic simulation.
OutLinkGen.dat	This file contains the number of vehicles generated on each link during each simulation interval.
OutLinkVeh.dat	This file contains the number of vehicles (volume) on each link. It is averaged over the number of simulation intervals specified in output_option.dat.
OutLinkQue.dat	This file contains the number of vehicles in the queue on each link. It is averaged over the number of simulation intervals specified in output_option.dat.
OutLinkSpeedAll.dat	This file contains the average speed (mile/hr) on each link. It is averaged over the number of simulation intervals specified in output_option.dat.
OutLinkDent.dat	This file contains the average density (pc/mile-lane) on each link. It is averaged over the number of simulation intervals specified in output_option.dat.
OutLinkSpeedFree.dat	This file contains the average speed (mile/hr) for the moving vehicles on each link. It is averaged over the number of simulation intervals specified in output_option.dat. This file is similar to OutLinkSpeed.dat, but it excludes stopped vehicles.
OutLinkDentFree.dat	This file contains the average density (pc/mile-lane) for moving vehicles on the free-moving section of each link. It is averaged over the number of simulation intervals specified in output_option.dat.
OutLeftFlow.dat	This file contains the number of left-turning vehicles that are discharged from links. It is averaged over the number of simulation intervals specified in output_option.dat.
OutGreen.dat	This file contains the green time (seconds) for each approach. It is averaged over the number of simulation intervals specified in output_option.dat.
OutFlow.dat	This file contains the number of vehicles that have been discharged by the link including left-turning vehicles. It is averaged over the number of simulation intervals specified in output_option.dat.
OutMUC.dat	This file summarizes certain iterative consistent equilibrium statistics for each user

Output File	Description
	class.
OutAccuVol.dat	This file contains the number of accumulated vehicles, measured at mid-points of links and reported for every minute of simulation.
BusTrajectory.dat	This file provides trajectories for the buses. The information given for each vehicle consist of: nodes in the path, cumulative travel time, travel time on each link in the path, stop time at each node, and cumulative stop time.
Fort.600[1]	This file provides the percentage of link length that has a queue at the end of each pre-specified interval (default value = 1 min).
Fort.700[1]	This file provides the average concentration (pc/mile/lane) on each link during each pre-specified interval.
Fort.800[1]	This file provides overall network statistics such as average network travel time, number of vehicles generated, number of vehicles remaining in the network, and information regarding incidents.
Fort.900[1]	This file provides the average speed (miles/min) on each link during each pre-specified interval.
ErrorLog.dat	This file contains any messages that indicate fatal program errors due to input data or resource deficiencies.
Warning.dat	This file contains warning messages.
RPUELOV	This file outputs the user equilibrium (UE) routing policy for LOVs. It is generated only if there are UE LOV class vehicles.
RPUEHOV	This file outputs the user equilibrium (UE) routing policy for HOVs. It is generated only if there are UE HOV class vehicles.
RPSOLOV	This file outputs the system optimal (SO) routing policy for LOVs. It is generated only if there are SO LOV class vehicles.
RPSOHOV	This file outputs the system optimal (SO) routing policy for HOVs. It is generated only if there are SO HOV class vehicles.
Output_vehicle.dat	This file contains information for every generated vehicle, such as its ID, generation link, start time, vehicle class and number of stops. This file will be generated only if the O-D demand matrix is used to load vehicles on the network.
Output_path.dat	This file contains the path (sequence of nodes) for every generated vehicle.

[1] *Different format for GUI purposes*

5.2 SummaryStat.dat

This file summarizes all information used and generated during the simulation run such as:

- ❑ Network characteristics
- ❑ Summary of signal settings
- ❑ Input parameters
- ❑ Traffic management scenarios
- ❑ Assignment mode
- ❑ Vehicle loading and exiting information
- ❑ HOT/HOV statistics
- ❑ Simulation statistics

- Impacted vehicle statistics
- Summary of MUC statistics

Impacted vehicles are defined as those vehicles that have initial paths passing through an incident or a work zone link. These statistics are based on incident/work zone locations specified by the user in *incident.dat* or *WorkZone.dat*. In the event that vehicles change their path midway through their trip (due to VMS or enroute information), they will be reported as "diverted" in the summary statistics. "Non-diverted" vehicles are those that stick to their initial paths or do not respond to VMS (or enroute info). In the case that no VMS or user class 4 vehicles are specified, all impacted vehicles are reported as "non-diverted vehicles". The statistics for each incident location are reported, as well as the overall statistics for all impacted vehicles. Figure 5-1 presents a sample *SummaryStat.dat* output file.

```
                ****************************************************
                *         D Y N A S M A R T - P                    *
                *                                                  *
                * Intelligent Transportation Network Planning Tool *
                *                                                  *
                *                  Version (1.0)                   *
                *                                                  *
                *             University of Maryland               *
                *                                                  *
                *            Release Date: April, 2004             *
                ****************************************************

 ****************************************
 *      Basic Information               *
 ****************************************

 NETWORK DATA
 ------------
    Number of Nodes                        :     180
    Number of Links                        :     445
    Number of Zones                        :      13
 ***************************************

 INTERSECTION CONTROL DATA
 -------------------------
    Number of No Control                   :      87
    Number of Yield Signs                  :       0
    Number of 4-Way Stop Signs             :      31
    Number of 2-Way Stop Signs             :       1
    Number of Pretimed Control             :       0
    Number of Actuated Control             :      61
 ***************************************

RAMP DATA
 ---------
    Number of Metered Ramps :       2

    Ramp Meter No.          1
    Metering Start Time     0.000
    Metering End Time     120.000
    Ramp Link                   42   -->     41
```

```
   Freeway Detector Link      41   -->     37
   Alpha                   0.320
   Beta                    0.200
   Saturation Flow Rate    1800.000   veh/hr/ln

   Ramp Meter No.          2
   Metering Start Time    45.000
   Metering End Time      90.000
   Ramp Link                  27   -->     28
   Freeway Detector Link      28   -->     32
   Alpha                   0.320
   Beta                    0.200
   Saturation Flow Rate    1800.000   veh/hr/ln
 ***************************************

 SOLUTION MODE
 -------------
   Execute Iterative Consistency Algorithm(Equilibrium)
   Max. Number of Iterations                :       5
   Current Iteration                        :       5
 ***************************************

 TIME PERIODS
 ------------
   Planning Horizon(min)                    :     120.0
   Aggregation Interval(# of Sim Int)       :      50
   Assignment Interval(# of Sim Int)        :      50
   Max # of Iterations                      :       5
   MUC Threshold (# of Vehicles)            :       0.5
   Convergence Threshold(# of Violation)    :     100
 ***************************************

 CONGESTION PRICING
 ------------------
   Cost on Regular Links($)                 :       0.0
   Cost of LOV on HOT Links($)              :       0.0
   Cost of HOV on HOT Links($)              :       0.0
   Value of Time($/hr)                      :       1.0
 ***************************************

VARIABLE MESSAGE SIGNS
 ----------------------
   Number of Variable Message Signs:    1

   VMS #     1    Type:  Optional Detour
   Location   52  --   48   From min   0.0 To min 120.0
   Vehicles will switch to detour sub-path based on the
   boundedly rational decision rule
***************************************

 CAPACITY REDUCTION
 ------------------
    -- Incident  --
      Location   34  --   30   From min  30.0 To min  60.0,   50.0 % Capacity
Reduction
    -- Work Zone --
      Location   48  --   41   From min   0.0 To min 120.0,   33.0 % Capacity
Reduction

 ****************************************
 *      Loading Information             *
 ****************************************

 T:   5.0 Tot Veh:   1577 Gen:   1577 Out_n:      0 Out_t:   110 In_v:  1467
```

```
 T:  10.0 Tot Veh:   3130 Gen:   1553 Out_n:      0 Out_t:   965 In_v:  2055
 T:  15.0 Tot Veh:   4709 Gen:   1579 Out_n:      0 Out_t:  1462 In_v:  2172
 T:  20.0 Tot Veh:   6276 Gen:   1567 Out_n:      0 Out_t:  1562 In_v:  2177
 T:  25.0 Tot Veh:   7838 Gen:   1562 Out_n:      0 Out_t:  1606 In_v:  2133
 T:  30.0 Tot Veh:   9412 Gen:   1574 Out_n:      0 Out_t:  1604 In_v:  2103
 T:  35.0 Tot Veh:  10969 Gen:   1557 Out_n:      0 Out_t:  1470 In_v:  2190
 T:  40.0 Tot Veh:  12556 Gen:   1587 Out_n:      0 Out_t:  1371 In_v:  2406
 T:  45.0 Tot Veh:  14130 Gen:   1574 Out_n:      0 Out_t:  1400 In_v:  2580
 T:  50.0 Tot Veh:  15694 Gen:   1564 Out_n:      0 Out_t:  1391 In_v:  2753
 T:  55.0 Tot Veh:  17273 Gen:   1579 Out_n:      0 Out_t:  1528 In_v:  2804
 T:  60.0 Tot Veh:  18842 Gen:   1569 Out_n:      0 Out_t:  1477 In_v:  2896
 T:  65.0 Tot Veh:  20440 Gen:   1598 Out_n:      0 Out_t:  1588 In_v:  2906
 T:  70.0 Tot Veh:  22018 Gen:   1578 Out_n:      0 Out_t:  1749 In_v:  2735
 T:  75.0 Tot Veh:  23585 Gen:   1567 Out_n:      0 Out_t:  1516 In_v:  2786
 T:  80.0 Tot Veh:  25155 Gen:   1570 Out_n:      0 Out_t:  1518 In_v:  2838
 T:  85.0 Tot Veh:  26745 Gen:   1590 Out_n:      0 Out_t:  1630 In_v:  2798
 T:  90.0 Tot Veh:  28325 Gen:   1580 Out_n:      0 Out_t:  1704 In_v:  2674
 T:  95.0 Tot Veh:  29912 Gen:   1587 Out_n:      0 Out_t:  1724 In_v:  2537
 T: 100.0 Tot Veh:  31503 Gen:   1591 Out_n:      0 Out_t:  1645 In_v:  2483
 T: 105.0 Tot Veh:  33079 Gen:   1576 Out_n:      0 Out_t:  1600 In_v:  2459
 T: 110.0 Tot Veh:  34663 Gen:   1584 Out_n:      0 Out_t:  1674 In_v:  2369
 T: 115.0 Tot Veh:  36221 Gen:   1558 Out_n:      0 Out_t:  1713 In_v:  2214
 T: 120.0 Tot Veh:  37829 Gen:   1608 Out_n:      0 Out_t:  1579 In_v:  2243
 ***************************************

 VEHICLE LOADING MODE
 --------------------
    O-D Demand Table
 ***************************************

MUC CLASS PERCENTAGES
 ---------------------
    Pre-Specified (Non-Responsive)          :    20.42 %
    Boundedly-Rational(En-route Information) :    20.16 %
    VMS Responsive                          :    19.74 %
    System Optimal                          :    19.92 %
    User Equilibrium                        :    19.76 %

 ***************************************
 VEHICLE TYPE PERCENTAGES
 ------------------------
    PC                                     :      90.0 %
    TRUCK                                  :      10.0 %
    HOV                                    :       0.0 %
    BUS                                    :       1 Buses
AVG.IB-FRACTION = 0.20   BOUND = 1.00

 NOTE : There are        2243  target vehicles still in the network

  ******* VEHICLE INFORMATION *******
      TOTAL VEHICLES        :        37829
      NON-TAGGED VEHICLES   :            0
      TAGGED VEHICLES (IN)  :         2243
      TAGGED VEHICLES (OUT) :        35586
      OTHERS                :            0


******* HOV/LOV VEHICLE INFORMATION *******
    Avg travel time for LOV                    :      22.3023

    Avg travel time for HOV                    :       9.5077

 ***************************************
 *  OVERALL STATISTICS REPORT          *
```

```
****************************************

   Max Simulation Time (min)                  :      120.0
   Actual Sim. Intervals                      :     1200
   Simulation Time     (min)                  :      120.0
   Start Time in Which Veh Stat are Collected :        0.0
   End   Time in Which Veh Stat are Collected :      120.0
   Total Number of Vehicles of Interest       :    37829
                        With    Info          :        0
                        Without Info          :    37829
------------------------------------------------
TOTAL TRAVEL TIMES (HRS)
   OVERALL    :    4772.2290
   NOINFO     :    4772.2290
   1 stop     :    4772.2290
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000

AVERAGE TRAVEL TIMES (MINS)
   OVERALL    :       7.5692
   NOINFO     :       7.5692
   1 stop     :       7.5692
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000

------------------------------------------------
TOTAL TRIP TIMES (INCLUDING ENTRY QUEUE TIME) (HRS)
   OVERALL    :    4843.4473
   NOINFO     :    4843.4473
   1 stop     :    4843.4473
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000
AVERAGE TRIP TIMES (INCLUDING ENTRY QUEUE TIME) (MINS)
   OVERALL    :       7.6821
   NOINFO     :       7.6821
   1 stop     :       7.6821
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000

------------------------------------------------
TOTAL ENTRY QUEUE TIMES (HRS)
   OVERALL    :      71.2586
   NOINFO     :      71.2586
   1 stop     :      71.2586
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
```

```
   2 stops    :       0.0000
   3 stops    :       0.0000
AVERAGE ENTRY QUEUE TIMES (MINS)
   OVERALL    :       0.1130
   NOINFO     :       0.1130
   1 stop     :       0.1130
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000

-------------------------------------------------
TOTAL STOP TIME ( HRS )
   OVERALL    :    1141.7427
   NOINFO     :    1141.7427
   1 stop     :    1141.7427
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000
AVERAGE STOP TIME ( MINS )
   OVERALL    :       1.8109
   NOINFO     :       1.8109
   1 stop     :       1.8109
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000

-------------------------------------------------
TOTAL TRIP DISTANCE ( MILES )
   OVERALL    :  162453.0469
   NOINFO     :  162453.0469
   1 stop     :  162453.0469
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000
AVERAGE TRIP DISTANCE ( MILES )
   OVERALL    :       4.2944
   NOINFO     :       4.2944
   1 stop     :       4.2944
   2 stops    :       0.0000
   3 stops    :       0.0000
   INFO       :       0.0000
   1 stop     :       0.0000
   2 stops    :       0.0000
   3 stops    :       0.0000

-------------------------------------------------

*******************************************************

  The following block is for incident impacted vehicle statistics

*******************************************************
```

```
 ---------------------------------------------
 Incident Location            =             1
 Incident Link             34    ->        30
 -Diverted---------------------
Number of vehicles            =          2047
Total Trip Times(min)         =     20372.982
Total Trip Distance(ml)       =     12190.560
Total Stop Time(min)          =      2571.059
Average Trip Times(min)       =         9.953
Average Stop Time(min)        =         1.256
Average Trip Distance(ml)     =         5.955
 -Sub stats--------------------
Number of vehicles            =          2047
Total Trip Times(min)         =     20372.982
Total Trip Distance(ml)       =     12190.560
Total Stop Time(min)          =      2571.059
Average Trip Times(min)       =         9.953
Average Stop Time(min)        =         1.256
Average Trip Distance(ml)     =         5.955



 ==========================================
   Overall Incident Impacted Vehicle Statistics
 ==========================================
Number of vehicles            =          9948
Total Trip Times(min)         =     20372.982
Total Trip Distance(ml)       =     12190.560
Total Stop Time(min)          =      2571.059
Average Trip Times(min)       =         2.048
Average Stop Time(min)        =         0.258
Average Trip Distance(ml)     =         1.225


 *******************************************************

   The following block is for Work Zone impacted vehicle statistics

 *******************************************************
 ---------------------------------------------
 Work Zone Location            =             1
 Work Zone Link             48    ->        41
 -Non-Diverted-----------------
Number of vehicles            =          6821
Total Trip Times(min)         =     58317.535
Total Trip Distance(ml)       =     38884.891
Total Stop Time(min)          =      6926.280
Average Trip Times(min)       =         8.550
Average Stop Time(min)        =         1.015
Average Trip Distance(ml)     =         5.701
 -Diverted---------------------
Number of vehicles            =          1176
Total Trip Times(min)         =     12271.345
Total Trip Distance(ml)       =      6560.721
Total Stop Time(min)          =      2183.058
Average Trip Times(min)       =        10.435
Average Stop Time(min)        =         1.856
Average Trip Distance(ml)     =         5.579
 -Sub stats--------------------
Number of vehicles            =          7997
Total Trip Times(min)         =     70588.883
Total Trip Distance(ml)       =     45445.613
Total Stop Time(min)          =      9109.338
Average Trip Times(min)       =         8.827
```

```
Average Stop Time(min)        =          1.139
Average Trip Distance(ml)     =          5.683


 ==========================================
    Overall Work Zone Impacted Vehicle Statistics
 ==========================================
Number of vehicles            =           7997
Total Trip Times(min)         =      70588.883
Total Trip Distance(ml)       =      45445.613
Total Stop Time(min)          =       9109.338
Average Trip Times(min)       =          8.827
Average Stop Time(min)        =          1.139
Average Trip Distance(ml)     =          5.683

------------------------------------------------
 Best MUC Solution (Please refer to outMUC.dat)
 Best Iteration                                  :       2
 Average Trip Time for vehicles reaching destinations:       9.2024
 ------------------------------------------------
```

Figure 5-1. *SummaryStat.dat* output file

5.2.1 Description of Selected Blocks within SummaryStat.dat

Network Data

This block provides information on the number of nodes, links, and zones in the network.

Intersection Control Data

This block provides information on the intersection control data in the network.

Ramp Data

This block provides information on the number of metered ramps, their location, their start and end times, the location of detectors, ramp saturation flow rate, and other ramp-specific variables.

Solution Mode

This block provides information about the solution mode of the traffic-assignment problem (one-shot simulation-assignment or consistent-iterative assignment), the maximum number of iterations (if iterative) and the current iteration number (at which the program terminated).

Time Periods

This block provides information about the solution-specific parameters such as the planning horizon, aggregation and assignment intervals, the maximum number of iterations, and the MUC and convergence thresholds.

Congestion Pricing

This block provides information on the cost of using regular links, the cost of LOV and HOV vehicles using HOT links, and the value of time.

Variable Message Signs

This block provides information regarding the number of variable message signs specified in the network as well as the type, location, and specific parameters pertaining to each VMS.

Capacity Reduction

This block provides the location, start and end times, and reduction in capacity for all incidents and work zone in the network.

Loading Information

The loading and exiting of vehicles in the network is reported in the *SummaryStat.dat* output file under the "loading information" block. An explanation of this block is presented in Table 5-2.

Table 5-2. Description of the loading information block within the *SummaryStat.dat* output file

Term	*Description*
T	Time when this statistic is reported up to time T (min)
Tot Veh	Total number of generated vehicles
Gen	Number of vehicles generated for each time interval
Out_n	Number of non-tagged vehicle that exit the network
Out_t	Number of tagged vehicles that exit the network
In_v	Total number of vehicles that are still in the network

Vehicle Loading Mode

This block provides information on the vehicle loading mode used, whether it is OD demand table, vehicle file, or vehicle + path (activity chain) files.

MUC Class Percentages

This block provides information regarding the fraction of each MUC class in the network at the end of the simulation. Note that due to the inherent randomness of DYNASMART-P, these values will not exactly match those specified in *scenario.dat* (or under Scenario | Parameter and Capabilities…); however, they should be very similar. In this regard, MUC percentages specified in *scenario.dat* or under Scenario | Parameter and Capabilities… must be treated as mean values.

Vehicle Type Percentages

This block provides information regarding the fraction of each vehicle type in the network. Note that due to the inherent randomness of DYNASMART-P, these values will not exactly match those specified in *scenario.dat* (or under Scenario | Parameter and Capabilities…); however, they should be very similar. In this regard, vehicle type percentages specified in *scenario.dat* or under Scenario | Parameter and Capabilities… must be treated as mean values.

Vehicle Information

This block provides information regarding the total number of vehicles loaded onto the network, and the number of tagged and non-tagged vehicles.

HOV/LOV Information

This block provides information regarding the average travel times of all LOV and HOV vehicles in the network. That is, they account for vehicles that remain in the network (did not reach their destination), unlike in the *Overall Simulation Statistics* block, where statistics are computed for completed trips only. Note that buses contribute to HOV statistics as well.

Overall Simulation Statistics Block

Each MOE is reported in terms of groups of vehicles with or without travel information and with different number of intermediate and final destinations (or stops) (refer to Section 4.21 for a description of *destination.dat*). There is no limit to the number of destinations for vehicles, but statistics are reported for only up to 3 destinations. Only MUC class 4 (Enoute Info) contributes to the "info" statistics. It is important to note that MUC class 4 (VMS Responsive) vehicles do not contribute to the "info" statistics even though they receive information via the VMS signs. Moreover, loading must be done via the O-D demand matrix to observe any "info" statistics in the overall statistics block. That is, if loading is done via the vehicle+path files (activity chain), no statistics are reported for the "info" section.

Impacted Statistics Block

This block provides information for impacted vehicles (vehicles that have their paths passing through an incident or a work zone). Traffic MOE are computed for two categories of vehicles, namely diverted and non-diverted for each incident or work zone location.

MUC Solution Information

This block provides the best iteration number when running the iterative consistent assignment procedure with SO vehicles (with or without UE class). It also provides the average trip time for vehicles reaching their destination. Therefore, the user can run the model for the same number of iterations again to obtain the routing policy (assignment) that would minimize system trip time. Detailed information for the MUC procedure is provided in OutMUC.dat. Note that when running the iterative consistent assignment with no SO vehicles (all classes except SO), DYNASMART-P will not provide the best iteration number in *SummaryStat.dat*, as UE assignment should not result in the minimum system trip time. The final iteration (i.e. when the procedure terminates) should provide the routing policy (assignment) for this multiple user class problem.

5.3 VehTrajectory.dat

This file describes the traffic information and itinerary associated with each vehicle in the network. Information regarding vehicles that exited the network is listed first, followed by information for those that are still in the network at the end of simulation. The format of this output is presented in Figure 5-2. A description of file parameters is also provided in Table 5-3. Vehicles that are still in the network when simulation ends have the exact same output as those that exited, except that the associated statistics are reported up to the downstream node of the currently traveled link.

```
****  Output file for vehicles tranjectories ****
=================================================
This file provides all the vehicles trajectories

Veh #  16645 Tag= 2 OrigZ=  2 DestZ=  1 Class= 1 Ustm=    200 OrigN=    117
DestN=    116 STime=  52.90 Total Travel Time=  63.17 # of Nodes=  13
VehType 1 LOO 1
    117     64     60     53     52     48     41     37     34     30
     25     21    116
 ==>Node Exit Time Point
  36.20  40.90  41.20  42.00  42.20  42.70  52.80  59.50  61.20  61.70
  62.40  62.60  63.10
 ==>Link Travel Time
  36.20   4.70   0.30   0.80   0.20   0.50  10.10   6.70   1.70   0.50
   0.70   0.20   0.50
 ==>Accumulated Stop Time
  28.62  28.62  28.62  28.62  28.62  28.62  35.20  37.26  37.26  37.26
  37.26  37.26  37.26
```

Figure 5-2. General format of the *VehTrajectory.dat* output file

In Figure 5-2, the first block pertains to vehicle number 16645. This vehicle is a tagged vehicle, and has exited the network by the time this file has been generated (Tag = 2). The origin zone for this vehicle is 2 and the destination zone is 1. This vehicle does not respond to any information (Class = 1). The upstream node of its generation link is 200. The downstream node of the generation link is node 117, and the destination node is 116. The departure time is 52.90 minutes, and the total travel time is 63.17 minutes. The vehicle has 13 nodes in its path, is of vehicle type 1 (passenger car), and has occupancy level 1 (LOV). The next line lists the complete path from the origin to the destination (excluding the upstream node of the generation link), namely node numbers 117, 64, 60, 53, 52, 48, 41, 37, 34, 30, 25, 21, and 116.

The next line shows the time instance, relative to the departure time, at which the vehicle exited nodes 117, 64, 60, 53, 52, 48, 41, 37, 34, 30, 25, 21, and 116 which are 36.20, 40.90, 41.20, 42.00, 42.20, 42.70, 52.80, 59.50, 61.20, 61.70, 62.40, 62.60, and 63.10, respectively. The next line shows the travel times on links 117→64, 64→60, 60→53, 53→52, 52→48, 48→41, 41→37, 37→34, 34→30, 30→25, 25→21, and 21→116 which are 36.20, 4.70, 0.30, 0.80, 0.20, 0.50, 10.10, 6.70, 1.70, 0.50, 0.70, 0.20, and 0.50 minutes, respectively. The next line shows accumulated stop times at nodes 117, 64, 60, 53, 52, 48, 41, 37, 34, 30, 25, 21, and 116 which are 28.62, 28.62, 28.62, 28.62, 28.62, 28.62, 35.20, 37.26, 37.26, 37.26, 37.26, 37.26, and 37.26 minutes, respectively, and so on.

Table 5-3. Description of the parameters in *VehTrajectory.dat* output file

Parameter	*Description*
Veh #	Vehicle ID number
Tag	Type of tagging. Tagged vehicles are vehicles that have recorded characteristics. Those tagged vehicles are used in calculating the average characteristics of vehicles in the network. 0: not tagged 1: tagged vehicle that did not reach its destination before the end of simulation 2: tagged vehicle that reached its destination
OrigZ	Origin zone number
DestZ	Destination zone number
Class	Vehicle user class 1: non-responsive; 2: SO; 3: UE; 4: enroute info; 5: VMS-responsive
Ustm	Upstream node of the generation link
OrigN	Downstream node of the generation link
DestN	Destination node
Stime	Departure time (min)
Total Travel Time	Total travel time from the origin to the destination (min)
# of Nodes	Number of nodes in the traversing path
Vehicle Type	Vehicle type 1: Passenger car 2: Truck 3: HOV
Node Exit Time Point	Time instant when the vehicle leaves the node (min)
LOO	Level of occupancy 1: LOV; 2: HOV
Link Travel Time	Link travel times reported when this vehicle reaches the downstream node of a link (min)
Accumulated Stop Time	Accumulated stop time at each node along the path plus the activity duration at the downstream node of the link if any (min)

5.4 Link Statistics Output Files

Link statistics are captured in 11 output files:

- *OutLinkGen.dat* – vehicles generated on each generation link (optional)
- *OutLinkVeh.dat* – number of vehicles on each link (optional)
- *OutLinkQue.dat* - number of queued vehicles on each link (optional)
- *OutLinkSpeedAll.dat* – average speed of vehicles on each link (optional)
- *OutLinkDent.dat* – average density of vehicles on each link (optional)
- *OutLinkSpeedFree.dat* – average speed of moving vehicles on each link (optional)
- *OutLinkDentFree.dat* – average density of moving vehicles on each link (optional)
- *OutLeftFlow.dat* – number of left-turning vehicles on each link (optional)
- *OutGreen.dat* – average green time for each approach (optional)
- *OutFlow.dat* – number of vehicles that pass through the link (optional)
- *OutAccuVol.dat* – cumulative number of vehicles that pass the mid point of links (every min – always generated)

To generate one or more of these output files, the associated flag in *output_option.dat* needs to be set to 1 (see Table 4-37). The format and structure of these files are very similar. Each file shows the simulation time followed by the output link descriptor (speed, volume, etc.) value for each link at that specific time. A more detailed description of each of these output files is provided in the subsequent sections.

5.4.1 OutLinkGen.dat

This file reports the number of vehicles generated on each link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The averaging period is also the reporting period. The general format of this file is presented Figure 5-3. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (or one minute) is desired. The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, it shows that zero vehicles were generated on links 1 (field 1), 1 vehicle was generated on links 2 (field 2) and 3 (field 3), and so on. The process is repeated for all averaging time intervals.

```
****** Output file for vehicle generation ******
 ==================================================
 This file provides the average number of vehicles
 per sim. int., averaged over          10 sim. int.

     1.0
   0.000   1.000   1.000   0.000   0.000   1.000   0.000   0.000   0.000
   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000


   2.0
   0.000   0.000   0.000   0.000   0.000   1.000   0.000   0.000   0.000
   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

Figure 5-3. General format of the *OutLinkGen.dat* output file

5.4.2 OutLinkVeh.dat

This file contains the number of vehicles present on each link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The general format of this file is presented in Figure 5-4. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (or one minute) is desired. The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, its shows that zero vehicles (field 1) are currently present on link 1, 1 vehicle (field 2) is present on link 2, and so on. The process is repeated for all averaging time intervals.

```
****** Output file for link volumes    ******
 ==================================================
 This file provides the average number of vehicles
 per sim. int. averaged over          10 sim. int.

     1.0
   0.000   1.000   1.000   0.000   0.000   1.000   0.000   0.000   0.000
   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000

   2.0
   0.000   0.000   0.000   0.000   0.000   1.000   0.000   0.000   0.000
   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000
```

Figure 5-4. General format of the *OutLinkVeh.dat* output file

5.4.3 OutLinkQue.dat

This file contains the number of vehicles in the queue on each link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The reporting period is again identical to the averaging interval. The general format of this file is presented in Figure 5-5. In this figure, the first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, it shows that 2 vehicles (field 1) are queued on link 1, 0 vehicles (field 2) are queued on link 2, 3 vehicles (field 2) are queued on link 3, and so on. The process is repeated for all averaging time intervals.

```
****** Output file for vehicle queue   ******
 ==================================================
 This file provides the average number of vehicles
 in the queues on links per sim. int. averaged over          10 sim. int.

     1.0
   2.000   0.000   3.000   0.000   0.000   1.000   0.000   0.000   0.000
   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000   0.000

   2.0
   0.000   0.000   0.000   0.000   0.000   1.000   0.000   0.000   0.000
```

Figure 5-5. General format of the *OutLinkQue.dat* output file

5.4.4 OutLinkSpeedAll.dat

This file contains the speed (miles/hr) prevailing on each link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The general format of this file is presented in Figure 5-6. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (or one minute) is desired. The first record indicates the time interval in minutes (minute 1 is this example). The next record provides link information. In this example, it shows that link 1 has an average speed of 40.000 mph (field 1), link 2 has an average speed of 60 mph (field 2), link 3 has an average speed of 39.631 mph (field 3), and so on. The process is repeated for all averaging time intervals.

```
****** Output file for link speed     ******
 ==================================================
 This file provides the average speed
 on links per sim. int. averaged over           10 sim. int.

   1.0
 40.000 60.000 39.631 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000
```

Figure 5-6. General format of the *OutLinkSpeedAll.dat* output file

5.4.5 OutLinkDen.dat

This file contains the density (pc/mile/lane) prevailing on each link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The general format of this file is presented in Figure 5-7. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (or one minute) is desired.

```
****** Output file for link density   ******
 ==================================================
 This file provides the average density
 on links per sim. int. averaged over          10 sim. int.

    1.0
  0.629   3.550   0.000   0.322   0.000   2.200   0.000
  0.000   0.000   0.000   0.000   0.000   0.000   0.000

    2.0
  0.000   1.331   1.449   0.629   0.374   0.220   0.000
  0.000   0.000   3.000   0.754   0.546   2.250   0.440
```

Figure 5-7. General format of the *OutLinkDen.dat* output file

The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, it shows that link 1 has an average density of 0.629 pc/mile/lane (field 1), link 2 has an average density of 3.550 pc/mile/lane (field 2), link 4 has an average density of 0.322 pc/mile/lane (field 4), and so on. The process is repeated for all averaging time intervals.

5.4.6 OutLinkSpeedFree.dat

This file contains the average speed (mph) for the moving vehicles on each link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The general format of this file is presented in Figure 5-8. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (or one minute) is desired.

```
Speed on the queue-free portion of the link
 ==================================================
This file provides the average speed on
 the queue-free portion on links every
 sim. int. averaged over          10 sim. int.

   1.0
 40.000 60.000 39.631 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000


   2.0
 40.000 40.000 39.877 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 30.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 40.000 40.000 40.000 40.000 65.000 40.000 65.000 40.000 40.000
```

Figure 5-8. General format of the *OutLinkSpeedFree.dat* output file

The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. This example shows that moving vehicles on link 1 have an average speed of 40.000 mph (field 1), moving vehicles on link 2 have an average speed of 60.000 mph (field 2), moving vehicles on link 3 have an average speed of 39.631 mph (field 3), and so on. The process is repeated for all link averaging time intervals. Note that this file is similar to *OutLinkSpeedAll.dat*, except it excludes stopped vehicles.

5.4.7 OutLinkDenFree.dat

This file contains the prevailing density (pc/mile/lane) for moving vehicles on each link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The general format of this file is presented in Figure 5-9. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (or one minute) is desired.

```
Density on the queue-free portion of the link
 ==================================================
This file provides the average density on
 the queue-free portion on links per
 sim. int. averaged over          10 sim. int.

    1.0
  0.629   3.550   0.322   1.002   0.000   2.200   0.000
  0.000   0.000   0.000   0.000   0.000   0.000   0.000

    2.0
  0.000   1.331   1.449   0.629   0.374   0.220   0.000
  0.000   0.000   3.000   0.754   0.546   2.250   0.440
```

Figure 5-9. General format of the *OutLinkDenFree.dat* output file

The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, it shows that moving vehicles on link 1 have an average density of 0.629 pc/mile/lane (field 1), moving vehicles on link 2 have an average density of 3.550 pc/mile/lane (field 2), moving vehicles on link 3 have an average density of 0.322 pc/mile/lane (field 3), and so on. The process is repeated for all averaging time intervals. Note that this file is similar to *OutLinkDen.dat*, except it excludes stopped vehicles.

5.4.8 OutLeftFlow.dat

This file contains the number of left-turning vehicles on the link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The general format of this file is presented in Figure 5-10. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (one minute) is desired.

```
Output file for left turning out flow
 ==================================================
This file provides the average number of
 left turning vehicles on links per
 sim. int. averaged over          10 sim. int.

    1.0
  1.500   4.000   0.200   0.000   0.000   0.000
  0.000   0.000   0.100   0.000   0.000   0.100

    2.0
  1.000   0.000   0.500   0.000   0.100   0.000
  2.200   0.000   0.000   0.000   0.000   0.000
```

Figure 5-10. General format of the *OutLeftFlow.dat* output file

The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, it shows that link 1 has an average of 1.500 turning vehicles (field 1), link 2 has an average of 4.000 turning vehicles (field 2), link 3 has an average of 0.200 turning vehicles (field 3), and so on. The process is repeated for all averaging time intervals.

5.4.9 OutGreen.dat

This file contains the green time (seconds) for each approach per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. The general format of this file is presented in Figure 5-11. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (or one minute) is desired.

```
Output file for green time
 ==================================================
 This file provides the average green time
 for each link every per sim. int. averated over          10 sim. int.

   1.0
  14  0  11  10  60  60  14  0  21  10
   2.0
  10  0  10  16  60  60  10  0  20  16
```

Figure 5-11. General format of the *OutGreen.dat* output file

The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, link 1 has an average green time of 14 seconds (field 1), link 2 has an average green time of 0 seconds (field 2), link 3 has an average green time of 11 seconds (field 3), and so on. The process is repeated for all link averaging time intervals.

5.4.10 OutFlow.dat

This file contains the number of vehicles that pass through the link per simulation interval, averaged over the number of simulation intervals specified in *output_option.dat*. It includes through, left-turning, and right-turning vehicles. The general format of this file is presented in Figure 5-12. In this figure, the top text lines indicate that an averaging and reporting period of 10 simulation intervals (or one minute) is desired.

```
Output file for out flow
 ==================================================
 This file provides the average number of vehicles
 out of each link per sim. int. averaged over          10 sims ints

     1.0
   0.200   0.500   0.300   0.100   0.200   0.300   0.100
   0.000   0.100   0.300   0.600   0.200   0.500   0.000


     2.0
   0.000   0.300   0.200   0.100   0.200   0.200   0.100
   0.600   0.700   0.900   0.100   0.500   0.000   0.100
```

Figure 5-12. General format of the *OutFlow.dat* output file

The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, it shows that an average of 0.200 vehicles (field 1) pass through link 1, an average of 0.500 vehicles (field 2) pass through link 2 (field 2), an average of 0.300 vehicles (field 3) pass through link 3, and so on. The process is repeated for all averaging time intervals.

5.4.11 OutAccuVol.dat

This file contains the cumulative number of vehicles that pass through the mid point of the link, reported every minute. The general format of this file is presented in Figure 5-13. Note that this file is always generated.

```
Output file for accumulated volume
 ==================================================
 This file provides the accummulated number of veh.
 on of each link           every 10 sims ints

  1.0
  1.00    0.00    0.00    0.00    1.00    0.00    0.00    0.00    0.00
  0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00    0.00

  2.0
  9.00   30.00    0.00    6.00   95.00   50.00   17.00  134.00    8.00
  2.00   31.00   23.00  239.00   32.00    6.00   32.00   26.00   36.00
```

Figure 5-13. General format of the *AccuVol.dat* output file

In this figure, the top text lines indicate that a reporting period of 10 simulation intervals (or one minute) is desired. The first record indicates the time interval in minutes (minute 1 in this example). The next record provides link information. In this example, it shows that at min 20.0, 9 vehicles (field 1) pass through link 1, 30 vehicles (field 2) pass through link 2 (field 2), 0 vehicles (field 3) pass through link 3, and so on. The process is repeated for all averaging time intervals.

5.5 BusTrajectory.dat

This file contains the exact same information as *VehTrajectory.dat*, except that the output information here pertains only to buses.

5.6 ErrorLog.dat

This file provides the current error message that halted the run of the program. The error message generally will indicate the cause of the error and possible reason(s) for that error.

5.7 Warning.dat

This file provides the list of warning messages to alert the user of some (not recommended) poor network modeling practices that might result in undesirable model results. Such warning messages will not cause DYNASMART-P to terminate prematurely.

5.8 Routing Policies for UE/SO LOV/HOV

The effects of routing policies are captured in the following four files:

- ❑ *RPUELOV.dat* – routing policy for UE-LOV vehicles
- ❑ *RPUEHOV.dat* – routing policy for UE-HOV vehicles
- ❑ *RPSOLOV.dat* – routing policy for SO-LOV vehicles
- ❑ *RPSOHOV.dat* – routing policy for SO-HOV vehicles

For each assignment interval and for each destination zone, DYNASMART-P outputs the following information: (See Table 5-4)

- ❑ Number of paths generated from each origin zone to the destination zone, routing policy (assignment percentage), and the number of generated vehicles assigned to this O-D pair.

- Number of vehicles assigned to this path (the sum of this value across all paths should be the number of vehicles assigned to this O-D pair), percentage of assigned vehicles to this path (regardless of whether the number of vehicles allocated to this O-D pair is zero), number of nodes on this path, and node sequence starting from the origin node to the destination node.

(Note that the "origin node" is the upstream node of a generation link (physical node), which connects to the origin zone centroid. Similarly, the "destination node" is a physical node and connects to the destination zone centroid.)

Table 5-4 Description of routing policy output files
(applies to *RPUELOV.dat*, *RPUEHOV.dat*, *RPSOLOV.dat* and *RPSOHOV.dat*)

Record Type	*Field*	*Format*	*Width*	*Description*
Assignment	1	Float	Free	1st assignment interval number
Destination zone	1	Integer	Free	1st destination (super) zone number
Vehicle-path Data[1]	1	Integer	Free	1st origin zone number
	2	Integer	Free	Number of generated paths
	3	Integer	Free	Number of vehicles assigned between the first origin zone and the destination (super) zone indicated in second record
Routing Policy[2]	1	Float	Free	Number of vehicles assigned to this path
	2	Float	Free	Assignment percentage of this path
Path (Node Sequence)	1	Integer	Free	Number of nodes on this path
	2 - N	Integer	Free	Path in terms of the node sequence from the origin node (upstream of generation link connecting to origin zone centroid) to the destination node connecting to the destination (super) zone centroid specified in second record

1 *When no more paths can be specified in fourth record, the origin zone number is incremented. These records are repeated sequentially for as many times as there are origin zones in the network, starting with the first origin zone through the last origin zone. When no more origin zones can be specified, the destination zone number in second record is incremented, and the process is repeated again, until no more destination (super) zones may be specified. At that point, the assignment interval in the first record is incremented and the process is performed all over again, until no assignment intervals may be specified.*

2 *Routing Policy record is repeated for as many as the number of generated paths specified in third record*

The general format of these four files is presented in Figure 5-14.

```
 Time           1
 Destination           1
 ---------
 origin, # of paths and Veh           1    1    0
     0  1.0000
   2    199    116
 ---------
 origin, # of paths and Veh           2    1   75
    75  1.0000
  14    200    117     64     60     53     52     48     41     37     34
30     25     21    116
 ---------
 origin, # of paths and Veh           3    2    0
     0  0.5000
   9     69     80     83      5      6     26     25     21    116
     0  0.5000
   8     68    131     82      3      4     22     21    116
```

Figure 5-14. General format of the routing policy output files

The first record in Figure 5-14 indicates the output that follows is for the 1st assignment interval. The second record indicates that the output pertains to destination (super) zone 1. The next record indicates that for origin zone 1 (field 1) there is 1 (field 2) path generated between this origin zone (zone 1) in the network and destination (super) zone 1, with no vehicles (0 is indicated in field 3 of this record) assigned to it (no vehicles are generated between this origin zone and destination (super) zone pair in the simulation). The next record shows that zero vehicles are generated on this path (a zero is indicated in field 1), 100 percent of vehicles are assigned to this path (1 is indicated in field 2). The next record indicates that the path is comprised of 2 nodes (field 1), and these nodes are 199 and 116. Note that node 116 is a destination node that connects to the centroid of destination (super) zone 1. The next block of data is for the next origin (node 2) to destination (super) zone 1, and so on.

DYNASMART-P calculates paths based on super zone centroids, not destinations. In other words, the desired path from a given origin node to a given destination node is based on the super zone containing the destination node. The reported path's node sequence starts with the origin node, and terminates at a destination node adjacent to the (super) zone centroid. Therefore, in the above example, the path containing node sequence 1-2-116 implies that 116 is connected via a virtual link to the super zone centroid (which governs the destination node).

5.9 OutMUC.dat

This file (Figure 5-15) provides a summary for the MUC assignment procedure in DYNASMART-P.

```
*********************************************
**  Summaries for MUC Iteration Procedures  **
*********************************************

 ====================================================
 BASIC PARAMETERS
 ----------------------------------------------------
 Planning Horizon:                      120.0000
 Iterations Limit:                             5
 OD Demand Loading Factor:          30.00000
 Start Time of Collecting Stats:  0.0000000E+00
 End Time of Collecting Stats:          120.0000
 Iteration Number                              0
 Current time:                          119.9000
 ====================================================

 ====================================================
 Vehicles Still in the Network
 ----------------------------------------------------
 Number of Vehicles             =           1484
 Total Travel Time w/o queuing  =       4981.409
 Total Trip Distances           =       3716.155
 Total Stop Time                =          0.000
 Average Travel Time            =          3.357
 Average Trip Distance          =          2.504
 Average Stop Time              =          0.000
 Average travel Speed           =         44.760
 ====================================================

 ====================================================
 Vehicles Outside the Network
 ----------------------------------------------------
 Number of Vehicles             =          26909
 Total Travel Time w/o queuing  =     159641.312
 Total Travel Time w queuing    =     162159.578
 Total Trip Distances           =     125766.320
 Total Stop Time                =      20212.936
 Average Travel Time            =          5.933
 Average Trip Time              =          6.026
 Average Trip Distance          =          4.674
 Average Stop Time              =          0.751
 Average travel Speed           =         47.268
 ====================================================

 ====================================================
  For All Vehicles in the Network
 ----------------------------------------------------
 Number of Vehicles             =          28393
 Total Travel Time w/o queuing  =     164622.719
 Total Trip Distances           =     129482.477
 Total Stop Time                =      20212.936
 Average Travel Time            =          5.798
 Average Trip Distance          =          4.560
 Average Stop Time              =          0.712
 Average travel Speed           =         47.192
 ====================================================

 ====================================================
 For vehicles that have reached their destinations
```

```
 ----------------------------------------------------

 LOV Vehicles
 ----------------------------------------------------

 Non-Responsive Vehicles
 -----------------------
 Number of Vehicles            =          5639
 Total Overall Travel Time(min)=     34228.434
 Total Trip Times(min)         =     33680.539
 Total Entry Queue Time(min)   =       547.912
 Total Trip Distance(ml)       =     26275.230
 Total Stop Time(min)          =      4395.356
 Average Overall Trip Time(min)=         6.070
 Average Trip Times(min)       =         5.973
 Average Entry Q Time(min)     =         0.097
 Average Stop Time(min)        =         0.779
 Average Trip Distance(ml)     =         4.660

 System Optimal Vehicles
 -----------------------
 Number of Vehicles            =          4625
 Total Overall Travel Time(min)=     27878.086
 Total Trip Times(min)         =     27458.271
 Total Entry Queue Time(min)   =       419.806
 Total Trip Distance(ml)       =     21634.268
 Total Stop Time(min)          =      3483.547
 Average Overall Trip Time(min)=         6.028
 Average Trip Times(min)       =         5.937
 Average Entry Q Time(min)     =         0.091
 Average Stop Time(min)        =         0.753
 Average Trip Distance(ml)     =         4.678


User Equilibrium Vehicles
 -------------------------
 Number of Vehicles            =          8038
 Total Overall Travel Time(min)=     48358.914
 Total Trip Times(min)         =     47594.555
 Total Entry Queue Time(min)   =       764.056
 Total Trip Distance(ml)       =     37621.617
 Total Stop Time(min)          =      5964.874
 Average Overall Trip Time(min)=         6.016
 Average Trip Times(min)       =         5.921
 Average Entry Q Time(min)     =         0.095
 Average Stop Time(min)        =         0.742
 Average Trip Distance(ml)     =         4.680

 En-Route Info Vehicles
 ----------------------
 Number of Vehicles            =          2257
 Total Overall Travel Time(min)=     13490.625
 Total Trip Times(min)         =     13271.928
 Total Entry Queue Time(min)   =       218.766
 Total Trip Distance(ml)       =     10619.482
 Total Stop Time(min)          =      1547.827
 Average Overall Trip Time(min)=         5.977
 Average Trip Times(min)       =         5.880
 Average Entry Q Time(min)     =         0.097
 Average Stop Time(min)        =         0.686
 Average Trip Distance(ml)     =         4.705
```

```
VMS-Responsive Vehicles
-----------------------
Number of Vehicles            =          2306
Total Overall Travel Time(min)=     13812.455
Total Trip Times(min)         =     13589.332
Total Entry Queue Time(min)   =       223.203
Total Trip Distance(ml)       =     10692.377
Total Stop Time(min)          =      1744.603
Average Overall Trip Time(min)=         5.990
Average Trip Times(min)       =         5.893
Average Entry Q Time(min)     =         0.097
Average Stop Time(min)        =         0.757
Average Trip Distance(ml)     =         4.637


----------------------------------------------------
HOV Vehicles
----------------------------------------------------

Non-Responsive Vehicles
-----------------------
Number of Vehicles            =           962
Total Overall Travel Time(min)=      5799.157
Total Trip Times(min)         =      5713.801
Total Entry Queue Time(min)   =        85.363
Total Trip Distance(ml)       =      4498.766
Total Stop Time(min)          =       739.249
Average Overall Trip Time(min)=         6.028
Average Trip Times(min)       =         5.940
Average Entry Q Time(min)     =         0.089
Average Stop Time(min)        =         0.768
Average Trip Distance(ml)     =         4.676

System Optimal Vehicles
-----------------------
Number of Vehicles            =           824
Total Overall Travel Time(min)=      4898.274
Total Trip Times(min)         =      4830.306
Total Entry Queue Time(min)   =        67.976
Total Trip Distance(ml)       =      3806.892
Total Stop Time(min)          =       606.539
Average Overall Trip Time(min)=         5.945
Average Trip Times(min)       =         5.862
Average Entry Q Time(min)     =         0.082
Average Stop Time(min)        =         0.736
Average Trip Distance(ml)     =         4.620

User Equilibrium Vehicles
-------------------------
Number of Vehicles            =          1402
Total Overall Travel Time(min)=      8537.619
Total Trip Times(min)         =      8421.260
Total Entry Queue Time(min)   =       116.362
Total Trip Distance(ml)       =      6671.328
Total Stop Time(min)          =      1054.686
Average Overall Trip Time(min)=         6.090
Average Trip Times(min)       =         6.007
Average Entry Q Time(min)     =         0.083
Average Stop Time(min)        =         0.752
Average Trip Distance(ml)     =         4.758
```

```
En-Route Info Vehicles
----------------------
Number of Vehicles            =          425
Total Overall Travel Time(min)=     2531.811
Total Trip Times(min)         =     2496.527
Total Entry Queue Time(min)   =       35.284
Total Trip Distance(ml)       =     1953.811
Total Stop Time(min)          =      310.551
Average Overall Trip Time(min)=        5.957
Average Trip Times(min)       =        5.874
Average Entry Q Time(min)     =        0.083
Average Stop Time(min)        =        0.731
Average Trip Distance(ml)     =        4.597

VMS-Responsive Vehicles
-----------------------
Number of Vehicles            =          431
Total Overall Travel Time(min)=     2623.810
Total Trip Times(min)         =     2587.075
Total Entry Queue Time(min)   =       36.735
Total Trip Distance(ml)       =     1997.043
Total Stop Time(min)          =      365.717
Average Overall Trip Time(min)=        6.088
Average Trip Times(min)       =        6.002
Average Entry Q Time(min)     =        0.085
Average Stop Time(min)        =        0.849
Average Trip Distance(ml)     =        4.634

-----------------------------------------------------
Total Violation=   2586.000
-----------------------------------------------------
```

Figure 5-15. General format of the *OutMUC.dat* output file

DYNASMART-P computes MUC MOE statistics for all vehicles and vehicles that have reached their destinations. The latter refers to MOE statistics averaged for vehicles that have reached their destinations (completed trips), whereas the former refers to MOE statistics for all vehicles that have been loaded onto the network. They include those that reached their destinations (completed trips) as well as those that did not reach their destination at the end of simulation.

5.10 Output_vehicle.dat and Output_path.dat

These two files contain vehicle characteristics and path trajectories for the generated vehicles. The *output_vehicle.dat* and *output_path.dat* file formats are identical to the *vehicle.dat* and *path.dat* input file formats, respectively. As mentioned earlier, these files may be used to prepare the *vehicle.dat* and *path.dat* input files. To accomplish this, a trial run must be submitted, and the *output_vehicle.dat* and *output_path.dat* output files from this trial run must be renamed to *vehicle.dat* and to *path.dat*, respectively. This can be done either manually, or by clicking the Scenario | Copy output_vehicle.dat to vehicle.dat and Scenario | Copy output_path.dat to path.dat menu commands. Note that to use these files in loading the network, the demand mode must be specified as activity chain with or without the path file, as described in Sections 4.23 and 4.24.

5.11 GUI Output Files

Four output files are generated in DYNASMART-P solely for animation purposes within the GUI. These files include:

- ❑ Fort.600 – average fraction of link length that has a queue
- ❑ Fort.700 – density of vehicles
- ❑ Fort.800 – network information
- ❑ Fort.900 – speed

5.11.1 Fort.600

This output file contains the average fraction of link length having a queue at the end of each pre-specified interval (e.g., 1 minute). Figure 5-16 presents the general format of this file. The first record indicates the time interval (1 minute). The next record, which provides link information, describes a queue amounting to a fraction of 0.200 (field 1) of link 1 length. Similarly, a fraction of 0.100 (field 2) of link 2 length is queued, and so on.

```
    1.0
  0.200   0.100   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000   0.000


   2.0
0.000   0.000   0.021   0.000   0.000   0.000   0.014
0.000   0.019   0.000   0.000   0.000   0.028   0.000
```

Figure 5-16. General description of the Fort.600 GUI output file

5.11.2 Fort.700

This file presents the average density (pc/mile/lane) on each link during each pre-specified interval (e.g., 1 minute). Figure 5-17 presents the general format of this file. The first record indicates the time interval (1 minute). The next record (which provides link information) shows that link 1 has an average density of 0.600 pc/mile/lane (field 1), link 2 has an average density of 1.125 pc/mile/lane (field 2), and so on. The process is repeated for all simulation intervals.

```
    1.0
  0.600   1.125   0.000   0.000   0.000   0.000   0.000
  0.000   0.000   0.000   0.000   0.000   0.000   0.000

   2.0
0.000   0.000   0.021   0.000   0.000   0.000   0.014
0.000   0.019   0.000   0.000   0.000   0.028   0.000
```

Figure 5-17. General description of the Fort.700 GUI output file

5.11.3 Fort.800

This file provides overall network statistics such as average network travel time, number of vehicles generated, number of vehicles remaining in the network, and information regarding incidents. Figure 5-18 shows the general format for a section of this file.

```
   1.0 ← time
   177 ← total number of vehicles generated
     7 ← number of vehicles that have exited the network
   163 ← number of vehicles still in the network
     5 ← the average travel time for all vehicles
     6 ← the average travel time for vehicles that went out of the network
  37.0 ← the average speed for all links in the network
  51.0 ← the average speed for freeway links in the network
  36.0 ← the average speed for arterial links in the network
```

Figure 5-18. General description of the Fort.800 GUI output file

5.11.4 Fort.900

This file contains the average speed (mph) on each link during each pre-specified interval (1 minute). Figure 5-19 presents the general format of this file. The first record indicates the time interval (1 minute). The next record (which provides link information) shows that link 1 has an average speed of 40.000 mph (field 1), link 2 has an average speed of 39.631 mph (field 2), and so on. The process is repeated for all simulation intervals.

```
   1.0
 40.000 39.631 25.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000


   2.0
 40.000 40.000 39.877 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 30.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000 40.000
 40.000 40.000 40.000 40.000 40.000 65.000 40.000 65.000 40.000 40.000
```

Figure 5-19. General description of the Fort.900 GUI output file

6. DYNASMART-P GRAPHICAL USER INTERFACE

6.1 Input and Output views

The DYNASMART-P graphical user interface (GUI) consists of two main views: input and output. The input view (Figure 6-1) is composed of the file tree on the left and the text panel on the right. The text panel is a built-in editor that allows users to make changes to the input files before running the model. The user can switch between the file tree and the text editing area, and vice-versa by pressing the **F5** and **F6** buttons, respectively.

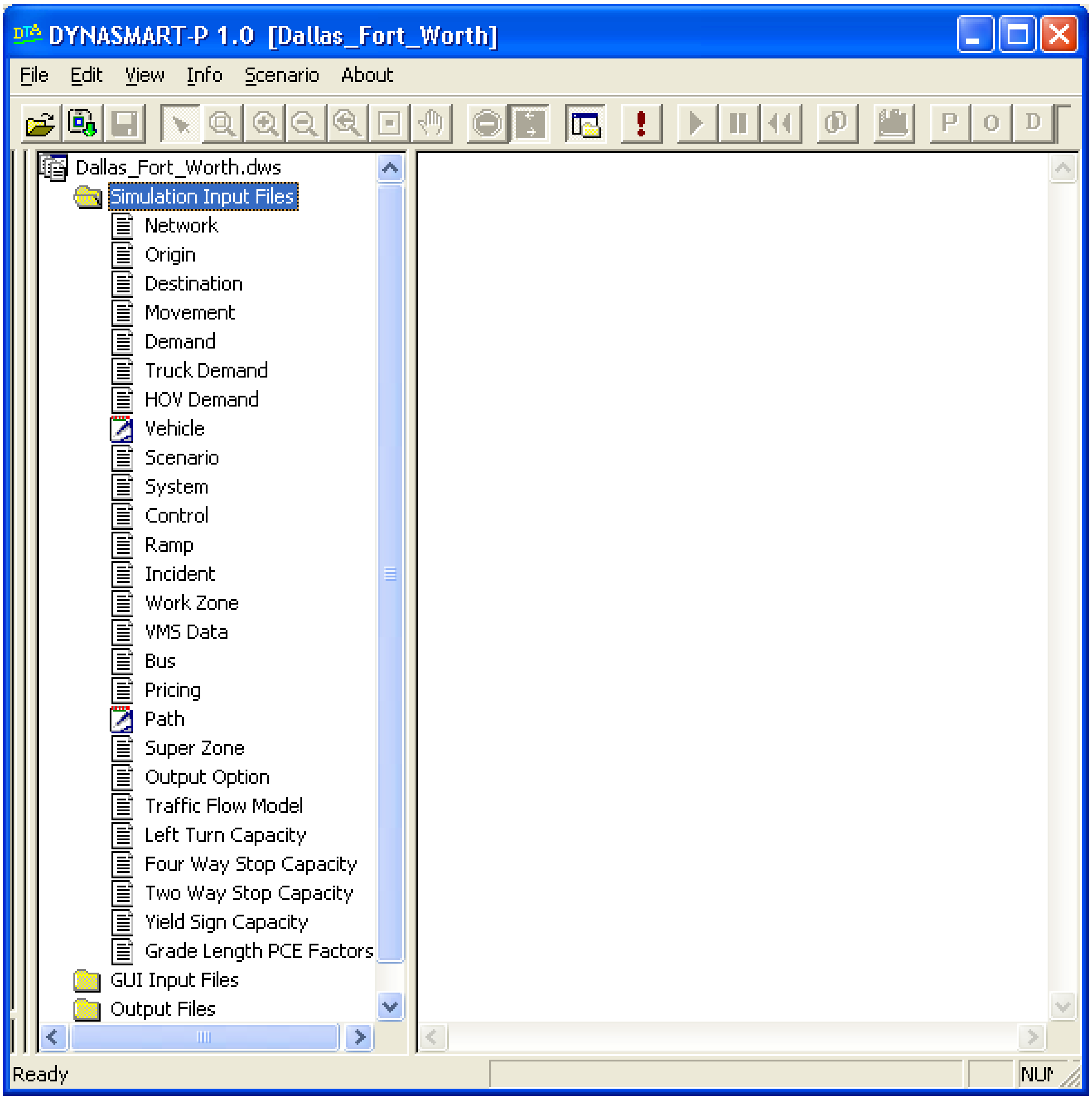


Figure 6-1. GUI input view

To switch back and forth between the input view and the output view, press the **F2** button or simply click the icon on the DYNASMART-P toolbar. The output view (Figure 6-2) is composed of the simulation panel in the middle, clock panel on the bottom, and the information panel on the right. This view allows users to examine simulation results and other characteristics pertaining to the scenario being investigated.

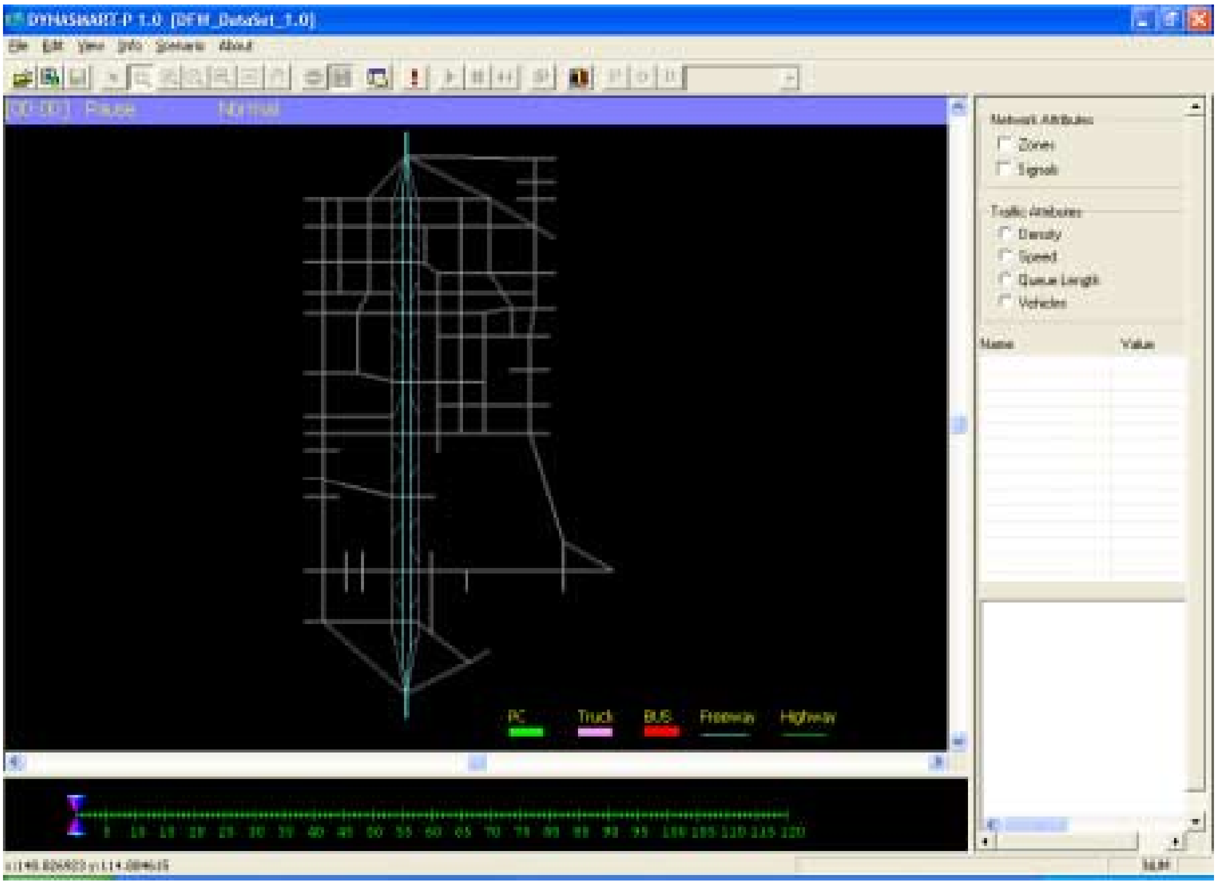


Figure 6-2. GUI output view

In both views, the toolbar and pull-down menus are located at the top of the screen, and the status bar is located at the bottom of the screen.

6.2 Pull-Down Menus

The menu bar consists of five main pull-down menus: File, Edit, View, Info, and Scenario. The File and Edit pull-down menus provide standard project workspace options and text editing capabilities, respectively. The View pull-down menu allows for viewing the various network features. The Info pull-down menu enables users to view information about the network. Finally, the Scenario pull-down menu provides dialog boxes for specifying different system, scenario and simulation parameters. Detailed descriptions of these menus are provided below.

6.2.1 The File Menu

The File menu (Figure 6-3) commands allow users to create a new project workspace, open an existing project workspace, load network data, load simulation results, save individual files, and save the entire project workspace. It also allows for retrieval of the most recently opened project workspaces.

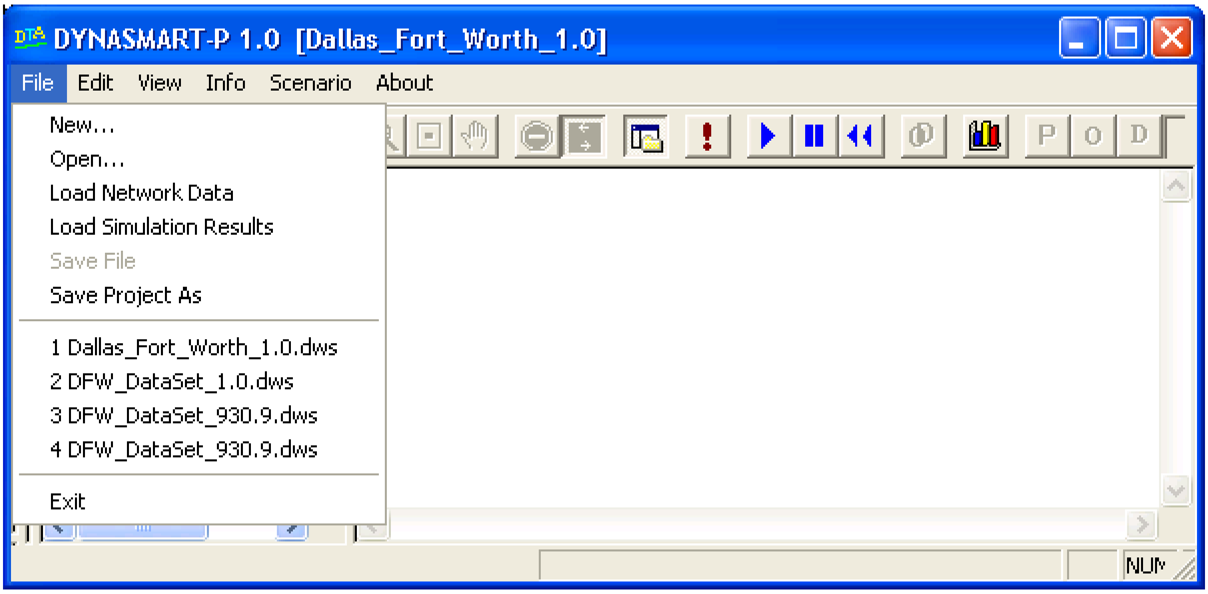


Figure 6-3. The *File* pull-down menu

To create a new project workspace (a new set of input files), click the File | New menu command. This will launch the <New Project> dialog box (Figure 6-4).

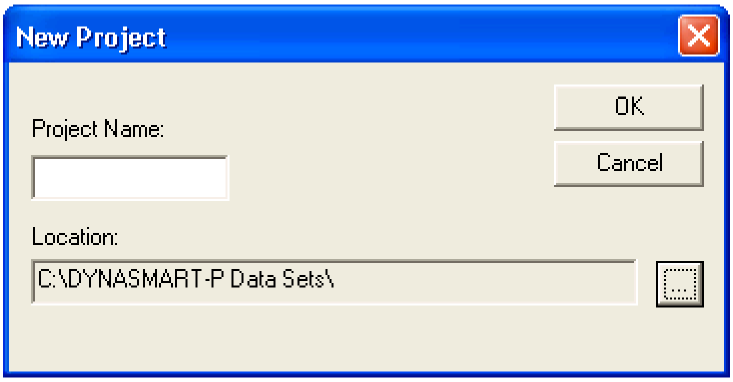


Figure 6-4. *New Project* dialog box

The GUI will create a template project workspace with empty input files. The project name can be specified in the <<New Project>> text box (Figure 6-4). To change the location, specify the desired folder by clicking . Doing so will launch the <Choose Directory> dialog box (Figure

6-5). To simplify data management, users are encouraged to assemble all DYNASMART-P input files in a data folder. Users can either type the name of the new folder in the <<Directory Name>> field, or browse the list to select the desired folder. After creating the new project, users may enter the necessary input information either manually, through the GUI, or by using DSPEd.

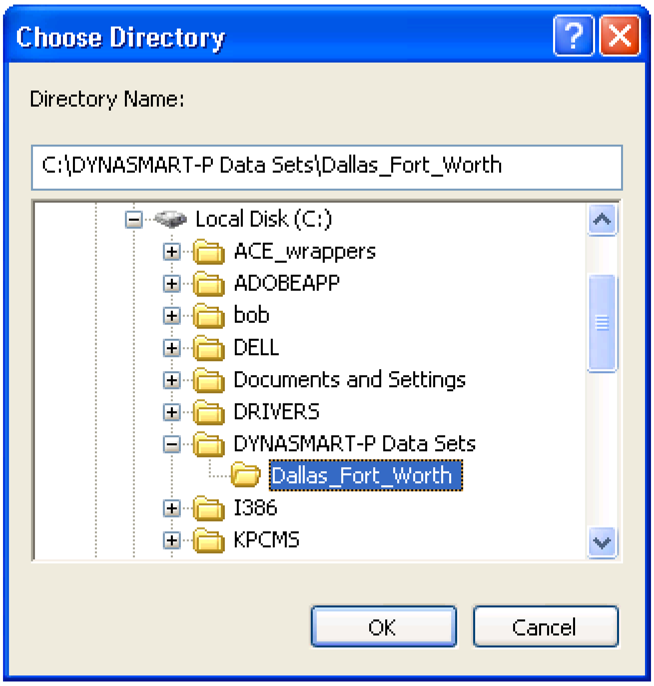


Figure 6-5. *Choose Directory* dialog box

If a project workspace has already been created, users may open it via the File | Open menu command, or by clicking the  icon on the DYNASMART-P toolbar. Doing so will launch the <Open Project> dialog box (Figure 6-6).

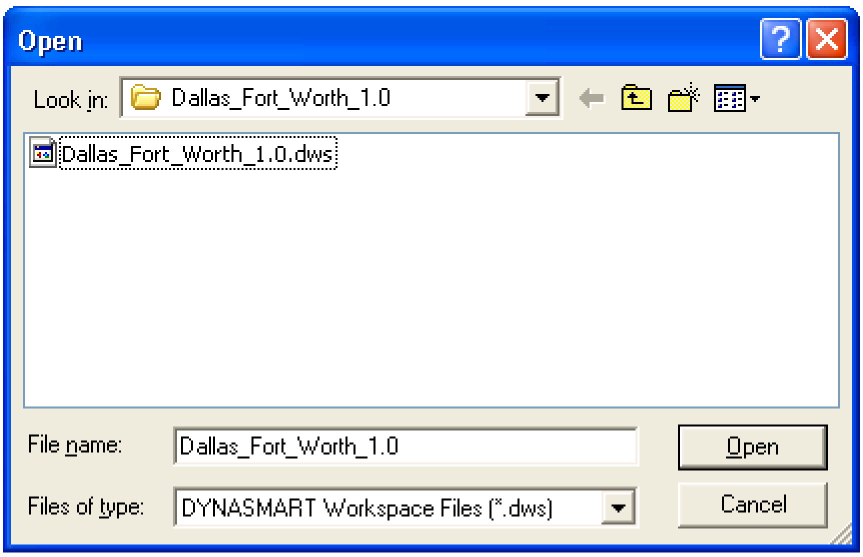


Figure 6-6. *Open Project* dialog box

To simply load the physical network, click the File | Load Network Data menu command. To load the physical network and the latest simulation results, click the File | Load Simulation Results menu command (or the icon on the DYNASMART-P toolbar). The user may then click the icon to view animation. The icon (or **F2** keyboard button**)** can be used to switch to the output view mode, to view numerical simulation results. Note that the user may also load network data by clicking the icon. Doing so will invoke the following dialog box (Figure 6-7):

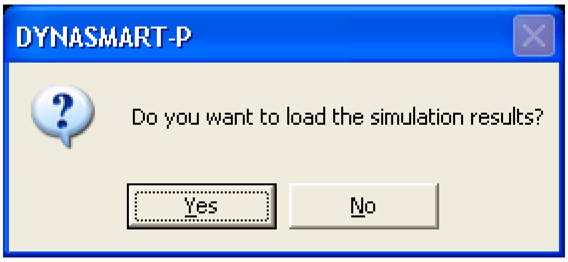


Figure 6-7. *Load Simulation Results* dialog box

If the user clicks the <<No>> button, then only the network data will be loaded. If the user clicks the <<Yes>> button, then both the network and simulation data will be loaded.

To save an input file that has been edited within the GUI, click the File | Save File menu command (or the icon on the DYNASMART-P toolbar). In either case, the GUI would still prompt the user to save changes when switching between input files, if warranted (Figure 6-8).

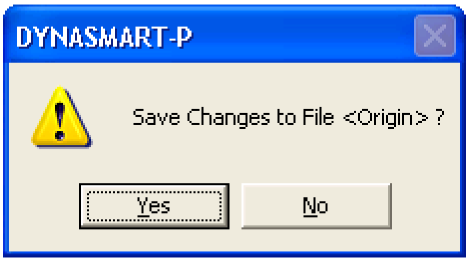


Figure 6-8. *Save Changes to File* dialog box

To save a DYNASMART-P project, click the File | Save Project As menu command. Doing so launches the <Save Project As> dialog box (Figure 6-9).

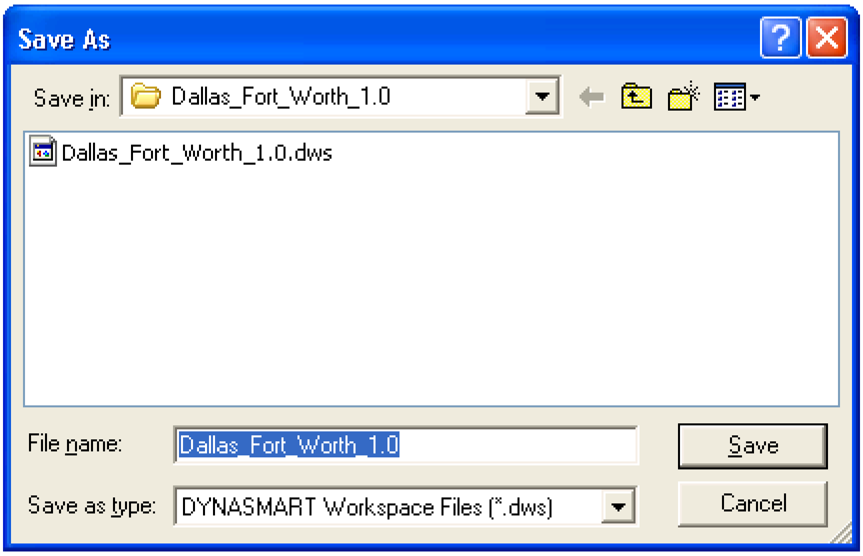


Figure 6-9. *Save Project As* dialog box

Finally, to exit the program, simply click on the  icon in the top right corner, or click on the File | Exit menu command.

6.2.2 The Edit Menu

The Edit menu (Figure 6-10) provides various text editing capabilities. Their functionalities are self-explanatory, and are identical to those provided in standard text editors such as Microsoft WordPad.

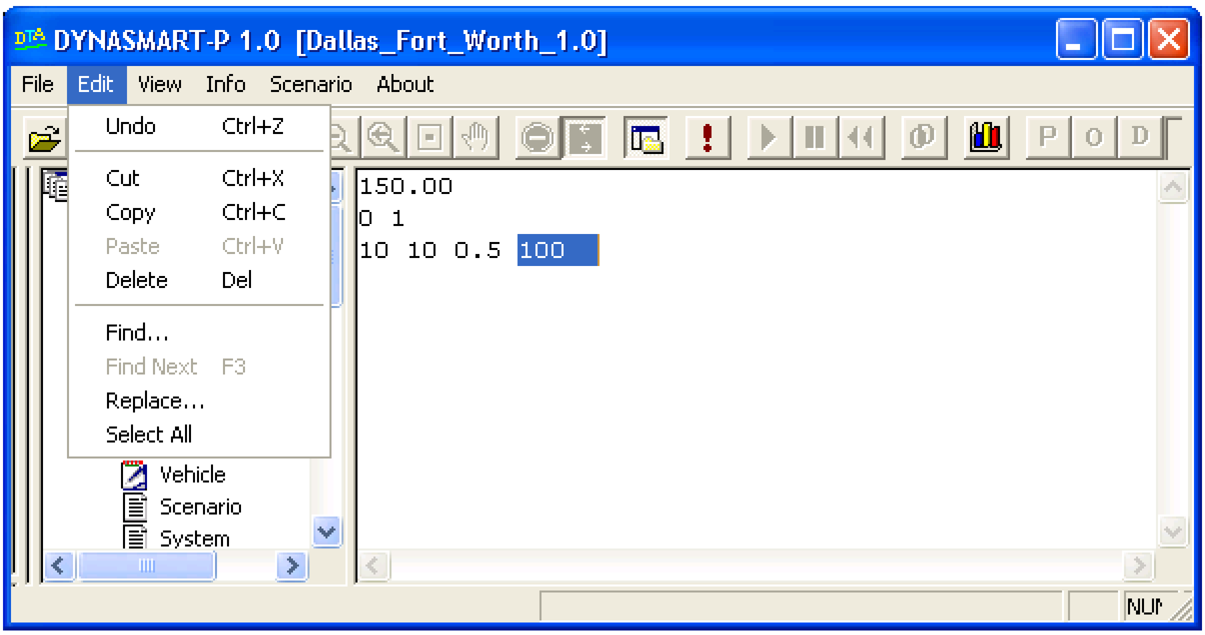


Figure 6-10. *Edit* menu

6.2.3 The View Menu

The View menu (Figure 6-11) commands provide options for viewing network features. For example, selecting the View | Toolbar menu option makes the toolbar icons visible on the screen. Similarly, selecting the View | Status Bar menu option makes the status bar appear. The View menu also includes options used to highlight network features. These features include nodes, node numbers, destination nodes, signals, stop signs, yield signs, link names, number of lanes, generation links, highways and freeways, ramps, left-turn bays, detectors, short links, zone boundaries, zone numbers, super zones, vehicle types, bus routes, VMS, and work zones. For example, checking the View | Highway & Freeway menu option will trigger the GUI to highlight freeways and highways in the network (Figure 6-12), and so on. An example for each of the View options is provided below. Note that the GUI does not update its views on the fly in response to changes in data files. In this case, the user needs only to load the network data again (using the File menu).

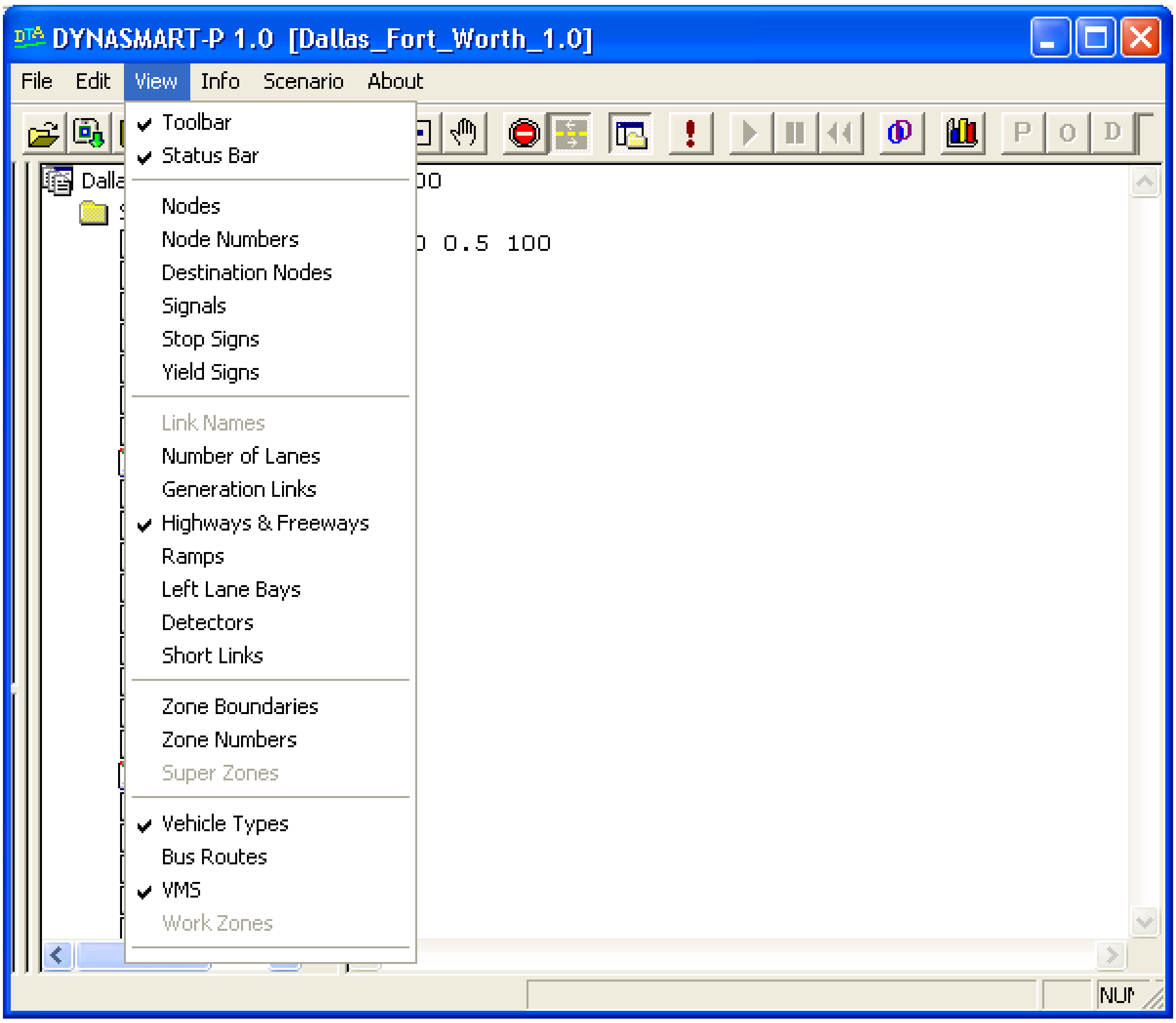


Figure 6-11. The *View* menu

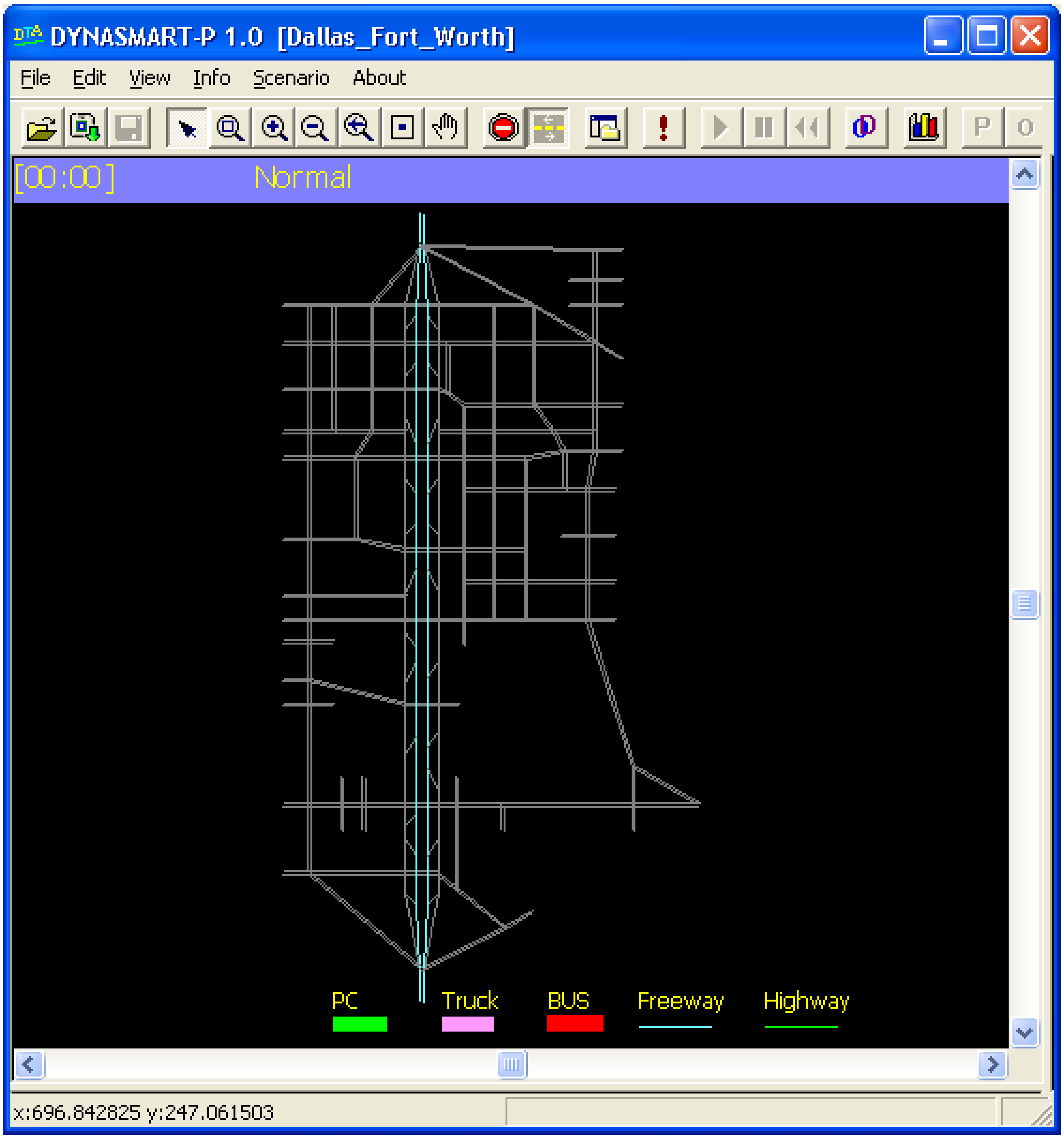


Figure 6-12. Freeways and highways as shown on GUI

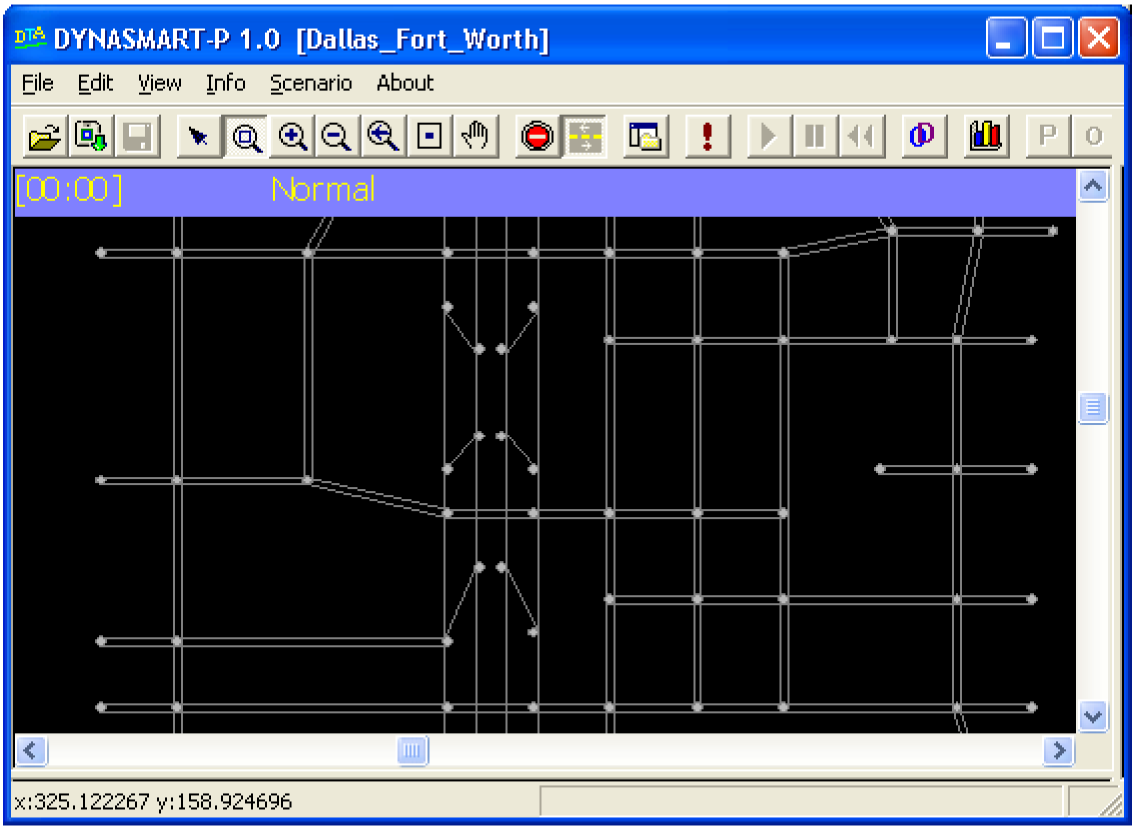


Figure 6-13. Nodes as shown on GUI

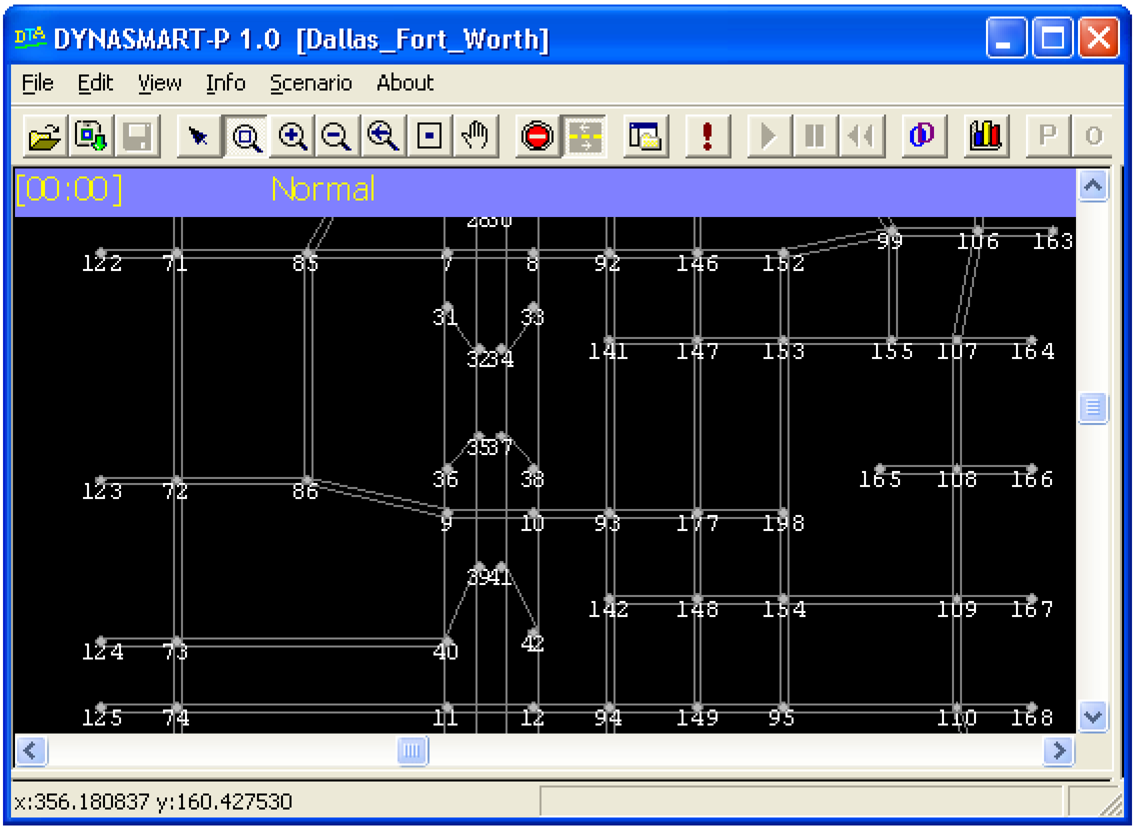


Figure 6-14. Node numbers as shown on GUI

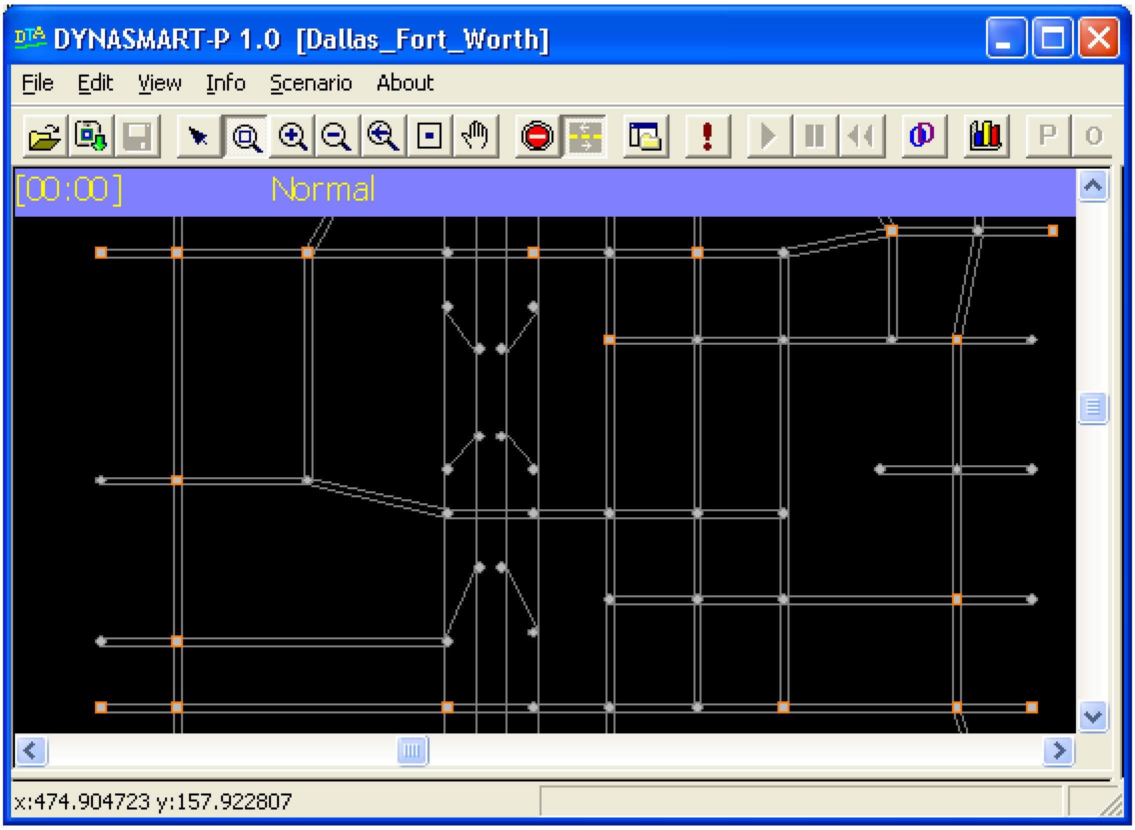


Figure 6-15. Destination nodes as shown on GUI

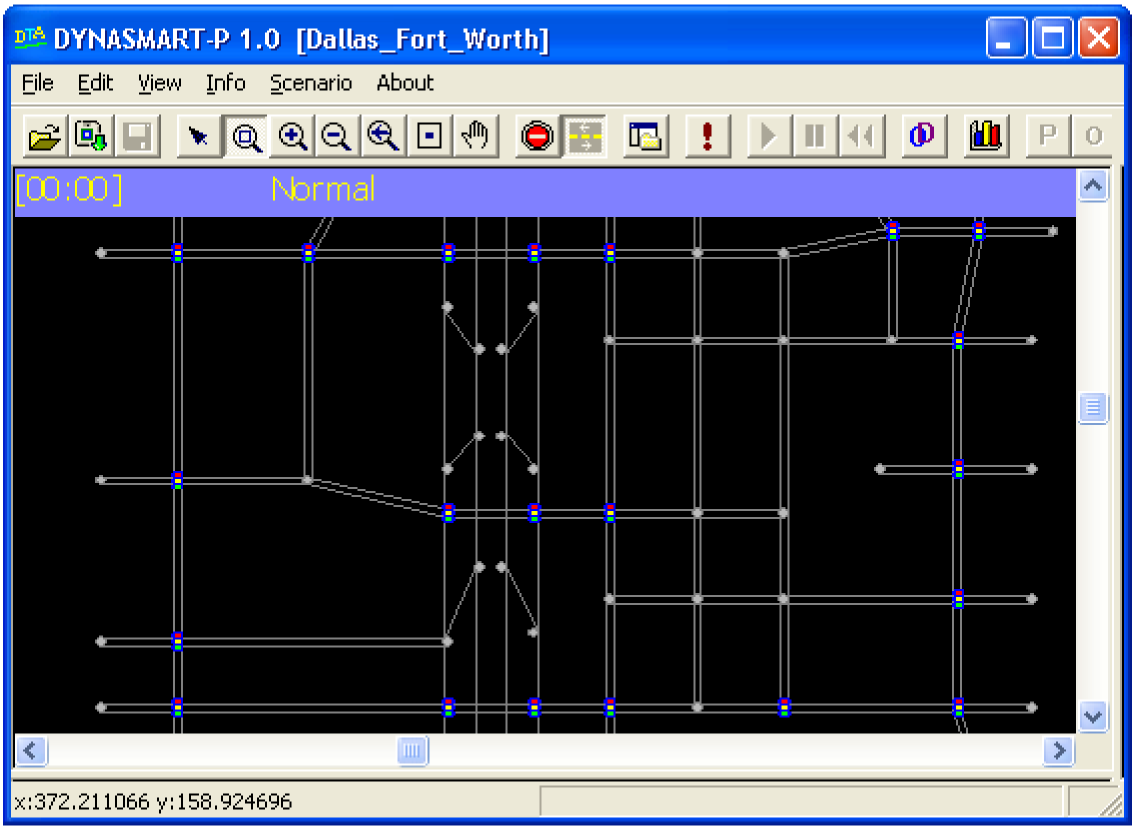


Figure 6-16. Signals as shown on GUI

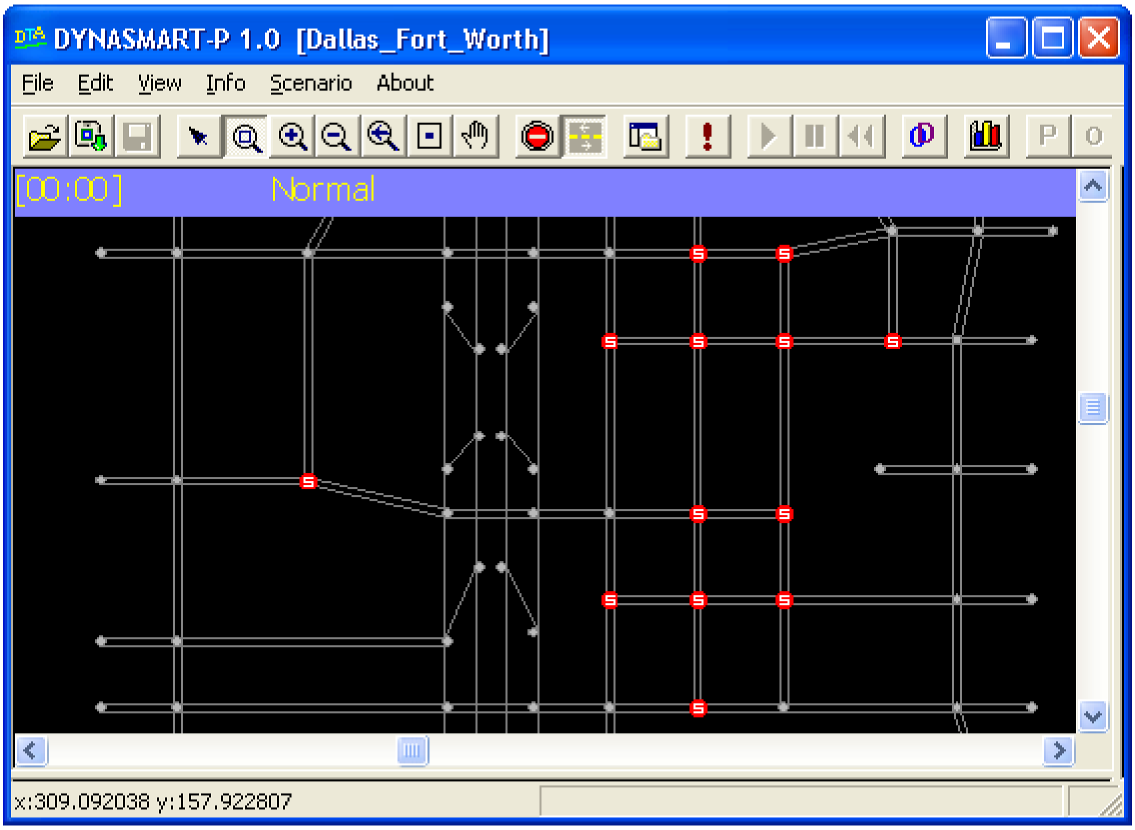


Figure 6-17. Stop signs as shown on GUI

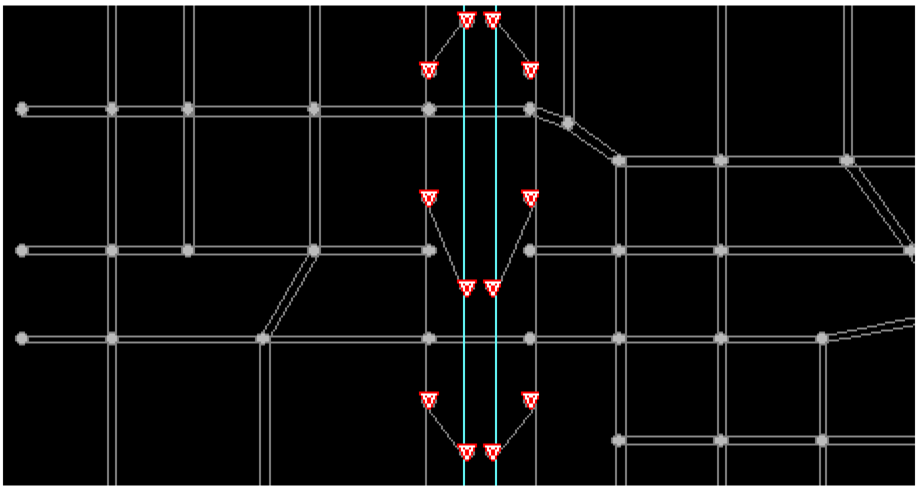


Figure 6-18. Yield signs as shown on GUI

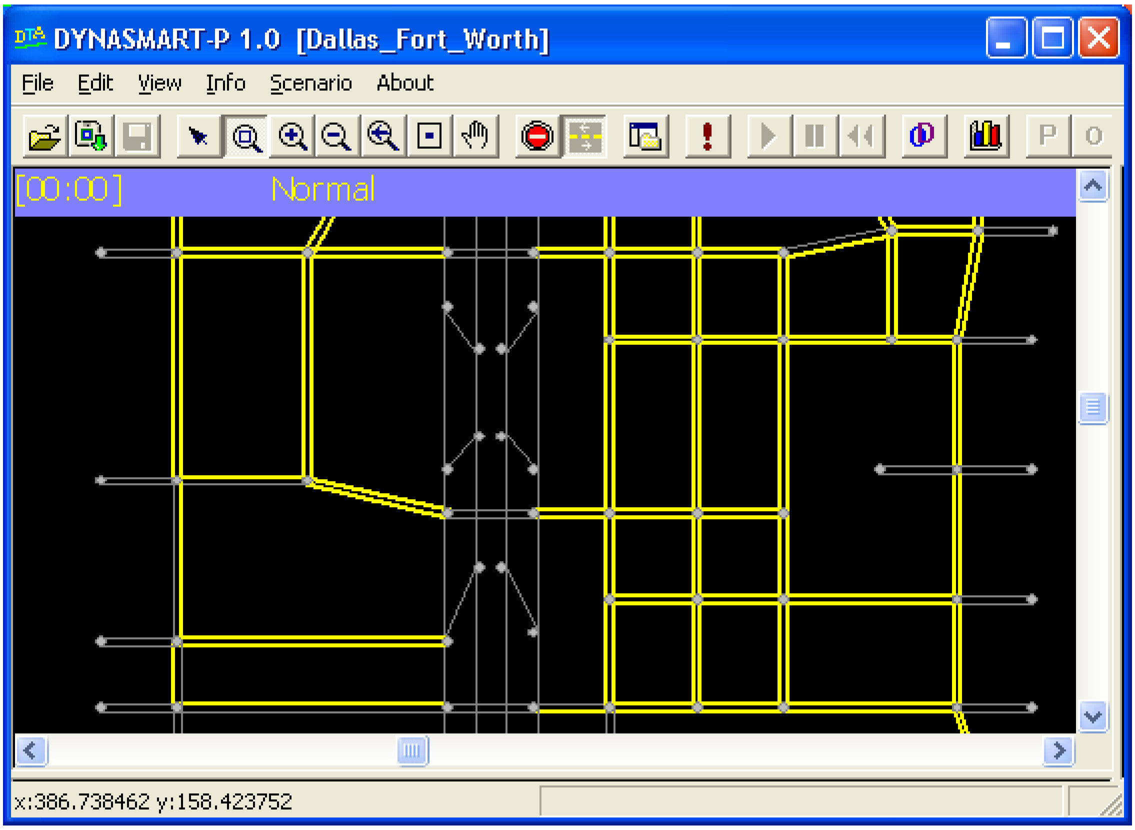


Figure 6-19. Generation links as shown on GUI

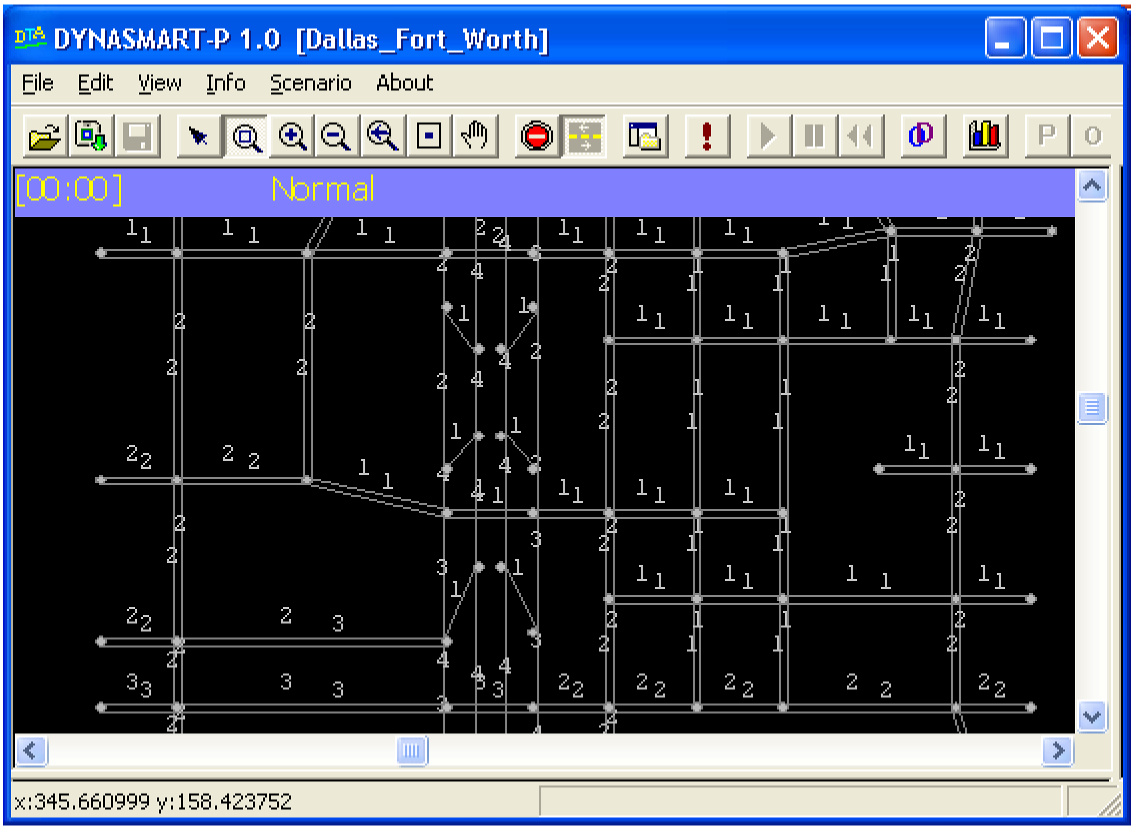


Figure 6-20. Number of lanes as shown on GUI

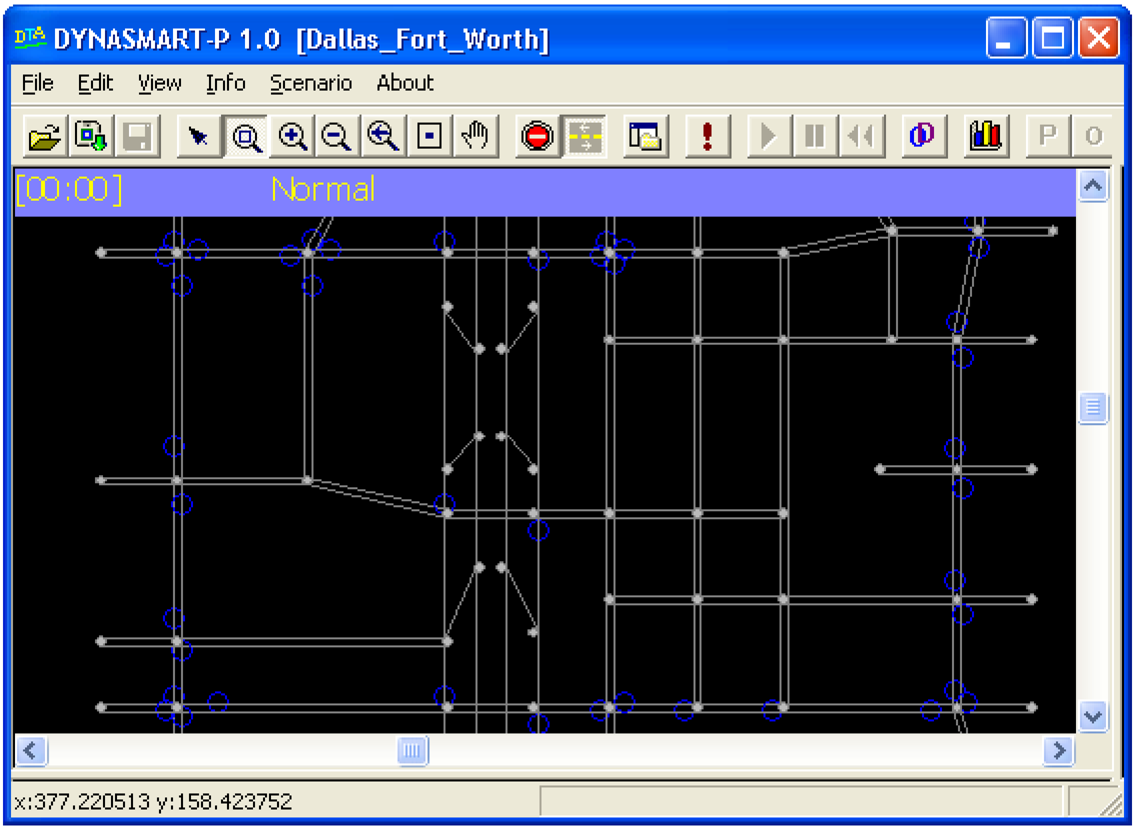


Figure 6-21. Left-turn bays as shown on GUI

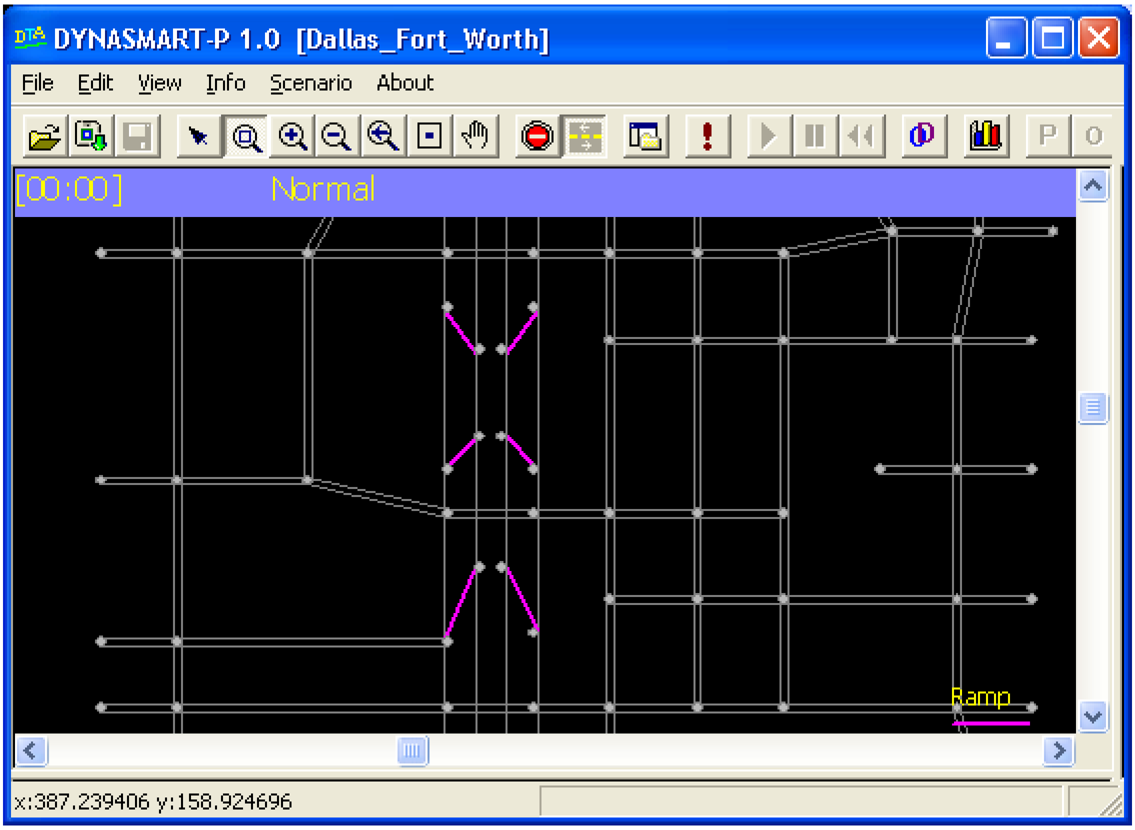


Figure 6-22. Ramps as shown on GUI

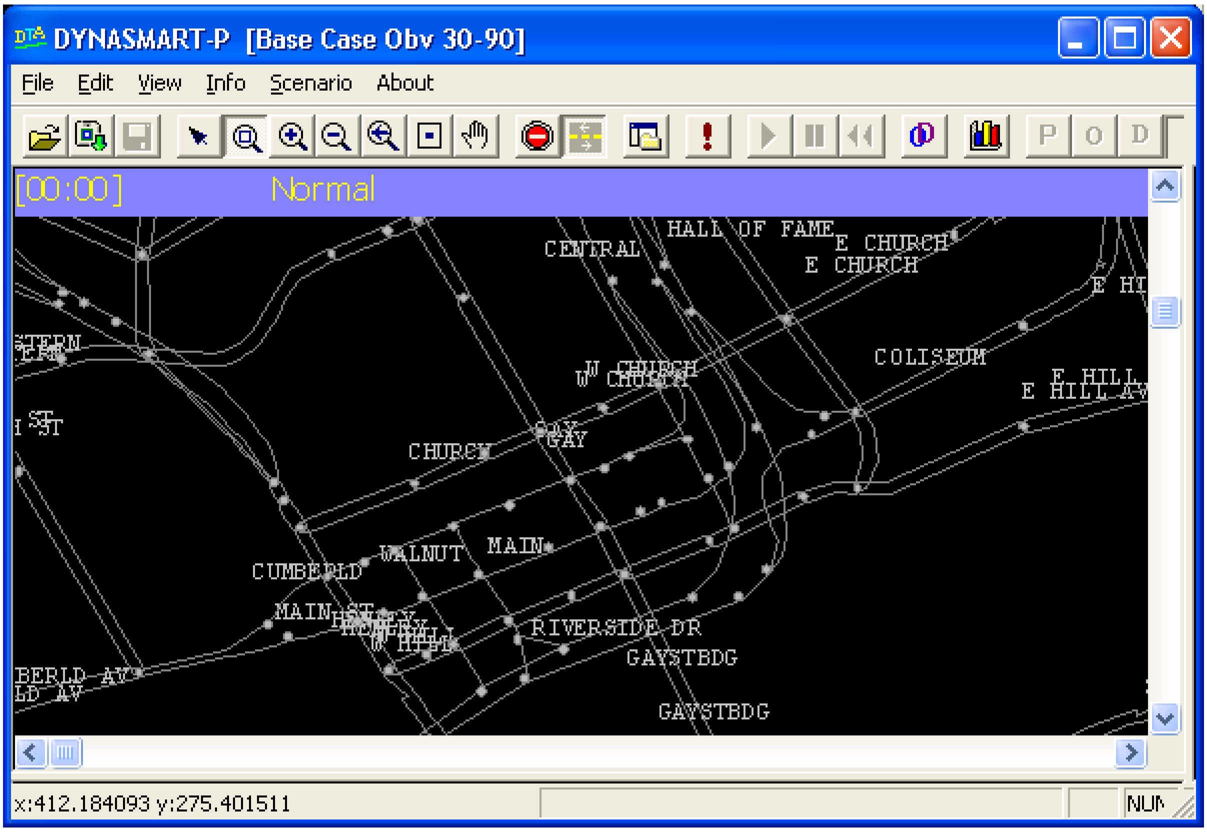


Figure 6-23. Link names as shown on GUI

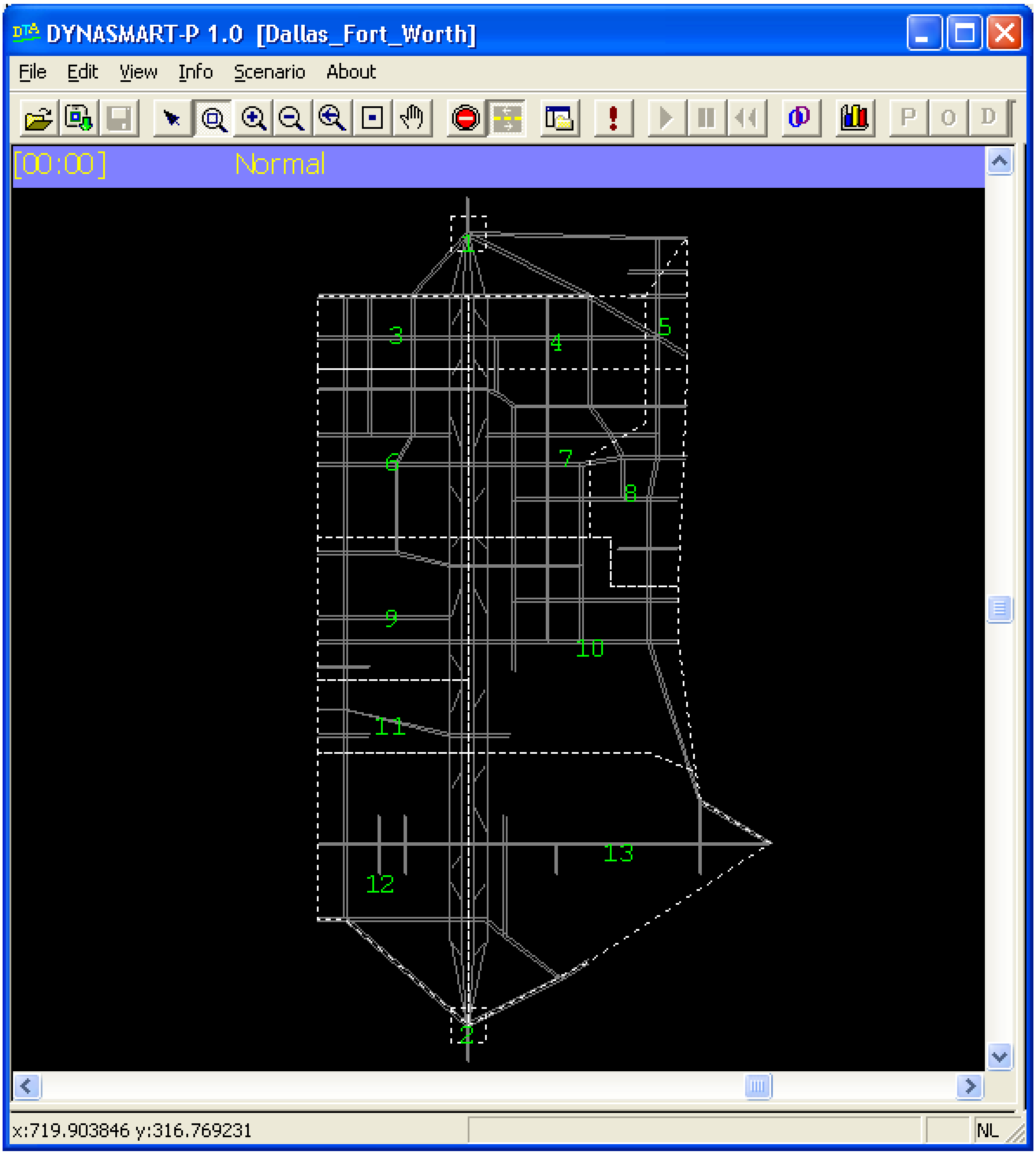


Figure 6-24. Zone numbers and boundaries as shown on GUI

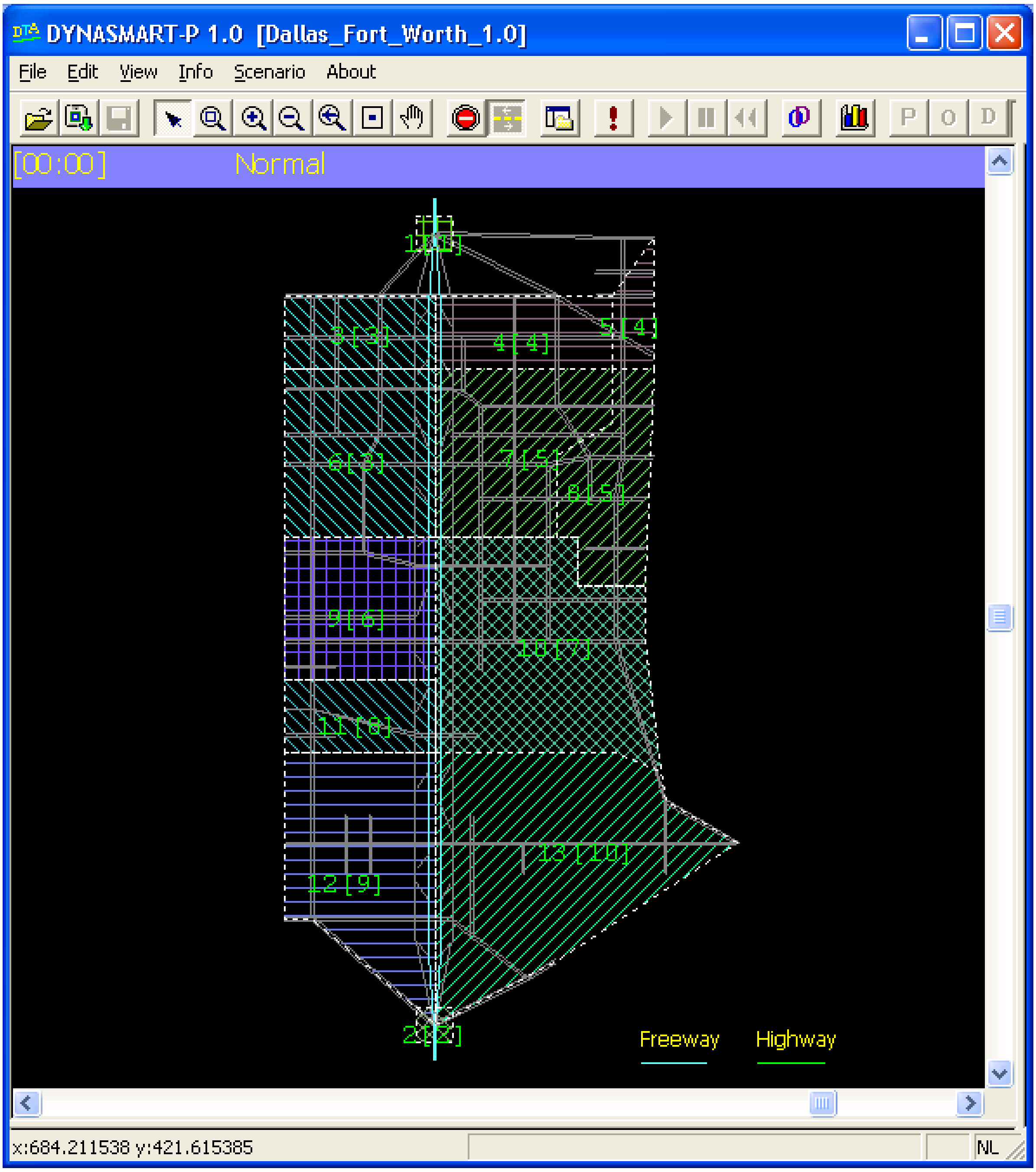


Figure 6-25. Super zones, marked by hatching patterns, as shown on GUI

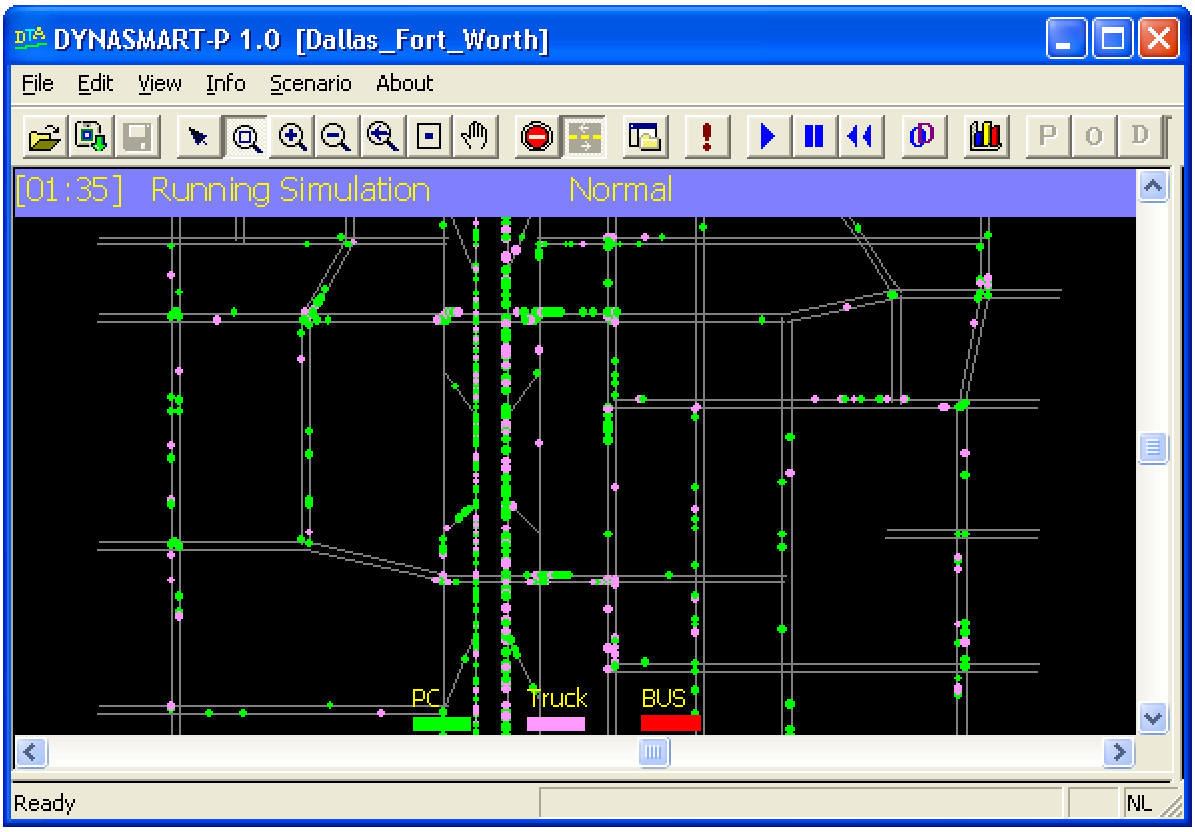


Figure 6-26. Vehicle types as animated on GUI

6.2.4 The Info Menu

The Info menu (Figure 6-27) enables users to view node and link information in the output view (this menu is not available in the input view mode). It also allows the user to search for nodes and links.

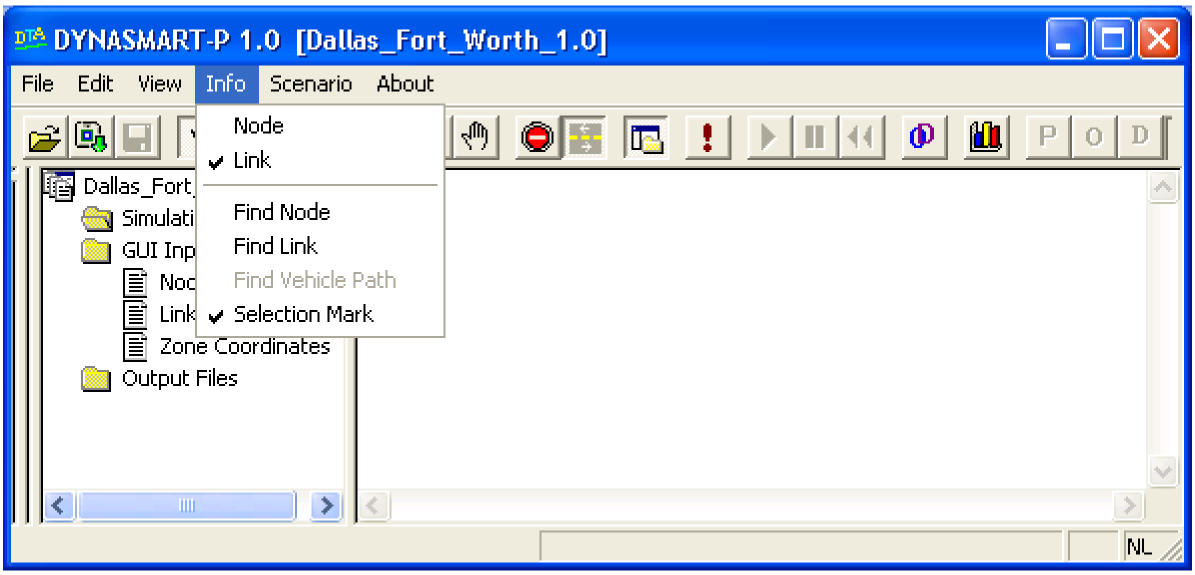


Figure 6-27. The *Info* menu

For example, select the Info | Node menu option (or click the icon on the DYNASMART-P toolbar), and double click a node in the network. The corresponding node information is displayed in the [Information] data block (Figure 6-29).

Name	Value
Node ID	97
Control Type	No Control
Zone No.	4
Super Zone No.	4

Figure 6-28. Node attributes information data block

Alternatively, select the Info | Link menu option (or click the icon on the DYNASMART-P toolbar), and double click a link in the network. The corresponding node information is displayed in the [Information] data block (Figure 6-29).

Name	Value
Link ID	376
From Node	146
To Node	92
Type	Arterial
Numbers of Lanes	1
Length (mi)	0.17
Sat Rate (veh/hr/ln)	1800.00
Density (veh/mi/ln)	--
Speed (mi/hr)	--
Volume (veh/hr/ln)	--

Figure 6-29. Node/link attributes shown in right column of *Information* window

To find a particular node in the network, click the Info | Find Node menu option. Doing so will invoke the <Find A Node> dialog box (Figure 6-30).

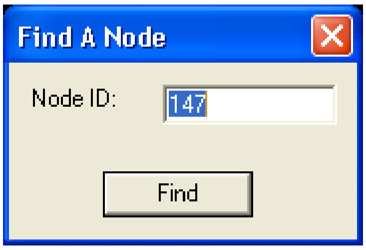


Figure 6-30. *Find A Node* dialog box

Enter the node number in question, and click the <<Find>> button to highlight that node within the GUI (Figure 6-31).

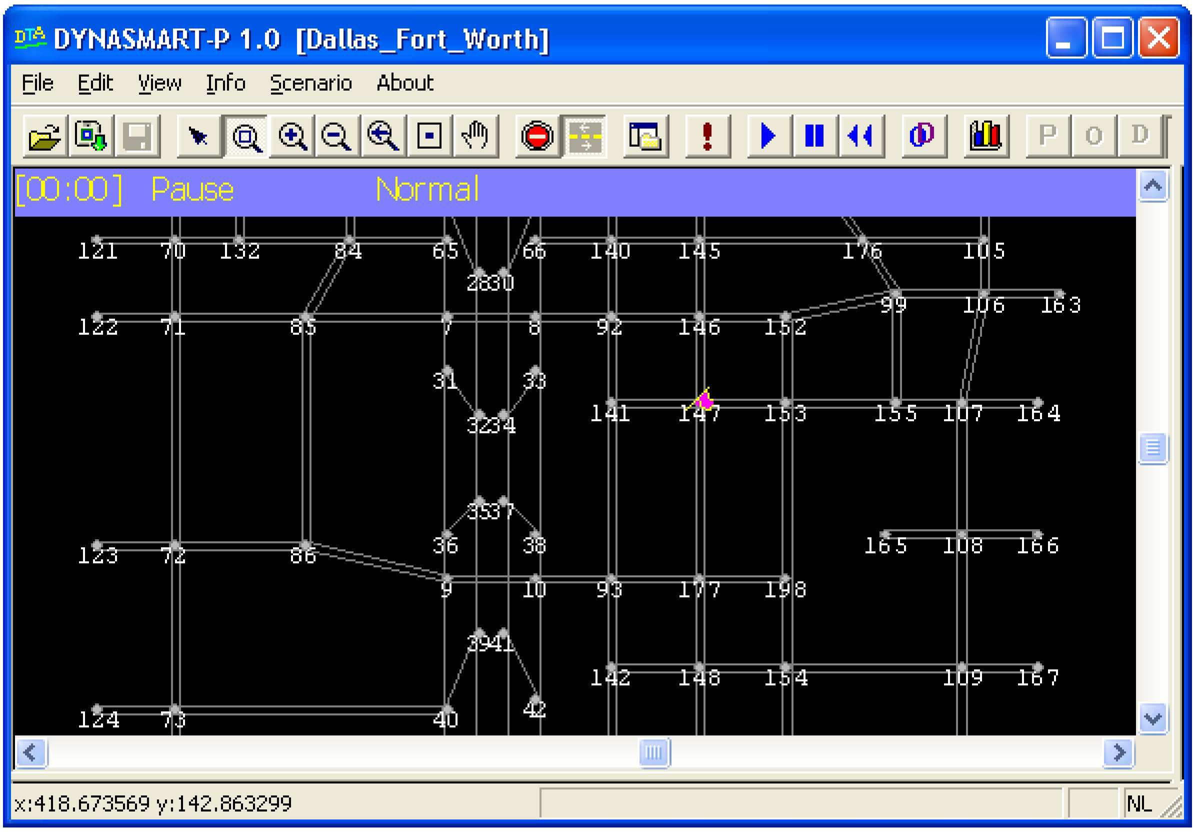


Figure 6-31. Highlighted node in the GUI

Similarly, to find a link in the network, click the Info | Find A Link menu option. Doing so will invoke the <Find A Link> dialog box (Figure 6-32).

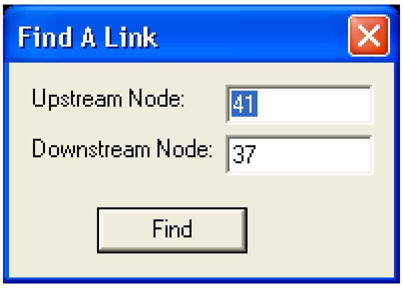


Figure 6-32. *Find A Link* dialog box

Enter the node number in question, and click the <<Find>> button to highlight that link within the GUI (Figure 6-33).

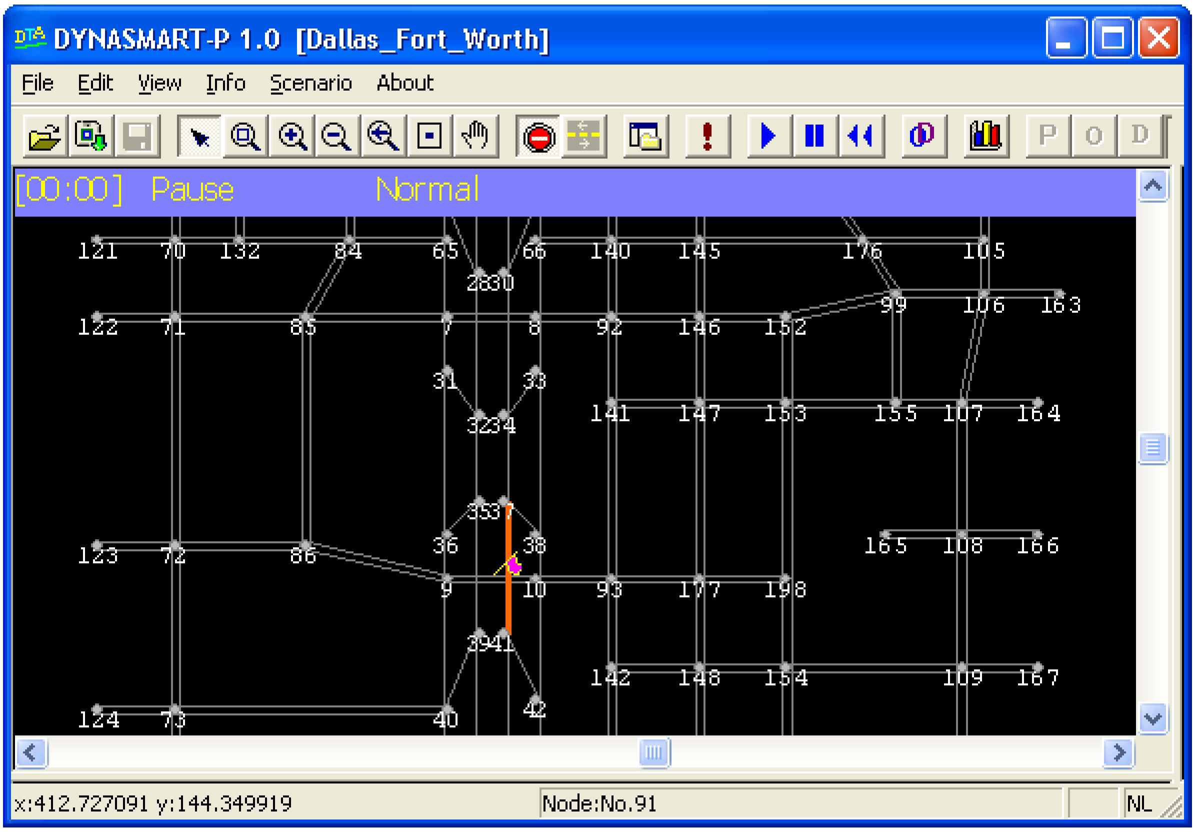


Figure 6-33. Highlighted link in the GUI

Finally, by selecting or de-selecting the Info | Selection Mark menu option, the user has the choice of placing a red flag on selected nodes or links.

6.2.5 The Scenario Menu

The Scenario menu (Figure 6-34) commands allow users to specify system parameters and construct different experiments. It also allows the user to export link and network performance data to separate text files.

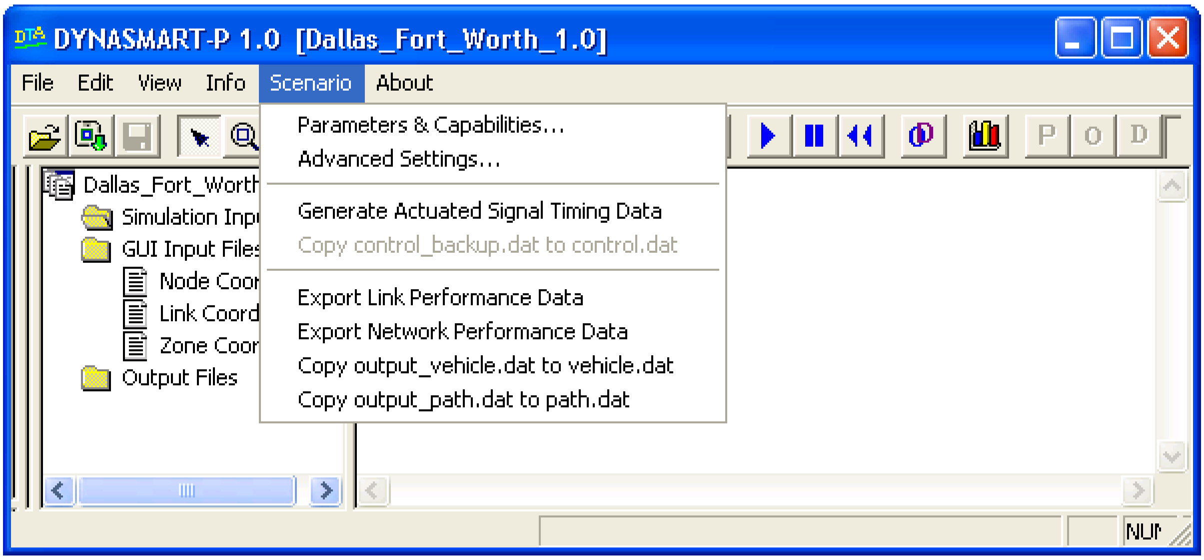


Figure 6-34. The *Scenario* menu

Selecting the Scenario | Parameters & Capabilities menu command will launch the <*Parameter Settings*> dialog box (Figure 6-35), which allows the user to specify general scenario parameters, including solution modes and time periods.

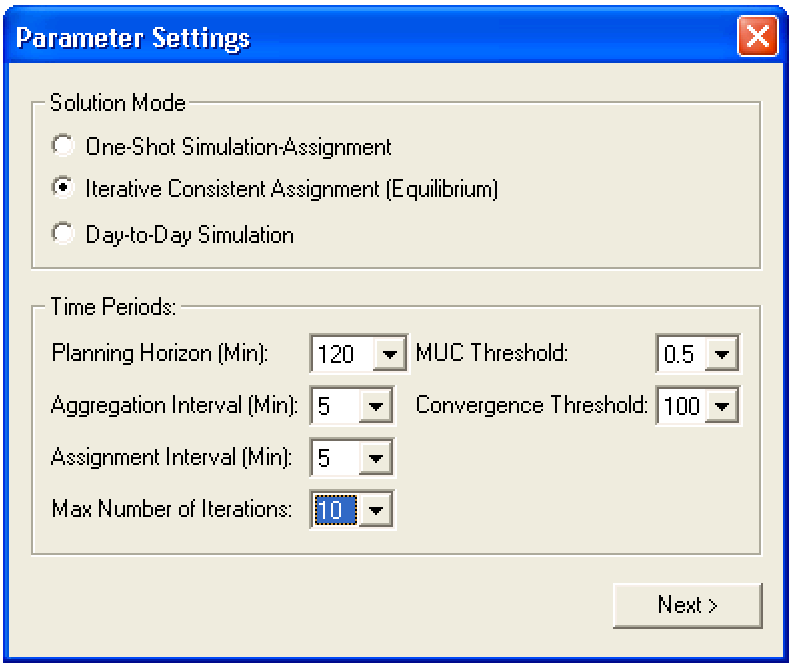


Figure 6-35. *Parameter Settings* dialog box

As the names imply, the *One-Shot Simulation-Assignment* solution mode performs one iteration of the simulation-assignment procedure, while the *Iterative Consistent Assignment (Equilibrium)* solution mode performs an iterative MUC equilibrium procedure. When users select one of these modes, corresponding parameters in the [Time Periods] data block are enabled, and can be varied within the given ranges. Definitions of these parameters are provided below. The third solution mode, *Day-to-Day Simulation*, is not operational in the current version of the software. This mode is a day-to-day system evolution-modeling framework that interfaces the within-day simulation assignment with day-to-day behavior adjustment rules.

If users select the *One-Shot Simulation-Assignment* procedure, only the *Planning Horizon* parameter will be enabled. The planning horizon represents the length of simulation in minutes. On the other hand, if users select the *Iterative Consistent Assignment* procedure, the following parameters will be enabled:

- *Planning Horizon:* The length of simulation in minutes.
- *Aggregation Interval:* The time interval (minutes) over which MOE are averaged. These traffic measures are used by the *Time-Dependent Shortest Path* algorithm to calculate the shortest path. A default value of 1 minute is recommended.
- *Assignment Interval:* The time interval (minutes) over which traffic assignment is performed. Each assignment interval is given a routing policy (a set of paths and the number of vehicles assigned to each path). A default value of 5 minutes is recommended.
- *Max Number of Iterations*: Maximum number of iterations desired.
- *MUC Threshold*: A threshold (percentage) for differences in the number of assigned vehicles on each path. For each assignment interval, for each O-D pair, and for two successive iterations below which the user is indifferent between these two vehicle assignment results, equilibrium is reached for this path. If the actual difference in the number of vehicles on each path (for two successive iterations) exceeds this threshold, then it is considered as a "violation". The lower the value of this threshold, the higher the number of iterations. A default value of 0.5 percent is recommended.
- *Convergence Threshold*: a threshold (vehicles) below which convergence is reached. The lower the value of this threshold, the higher the number of iterations. A default value of 100 is recommended.

Click <<Next>> to proceed to the <Capability Selection> dialog box (Figure 6-36), which allows users to select from an array of analysis capabilities. These capabilities are grouped into seven categories: *demand*, *network characteristics*, *congestion pricing*, *traffic management strategies*, *vehicle types*, *user classes*, and *capacity reduction*. Note that, at any time, the user can click the

<<Cancel>> and <<Back>> buttons to cancel the input process and return to the <*Parameter Settings*> dialog box, respectively.

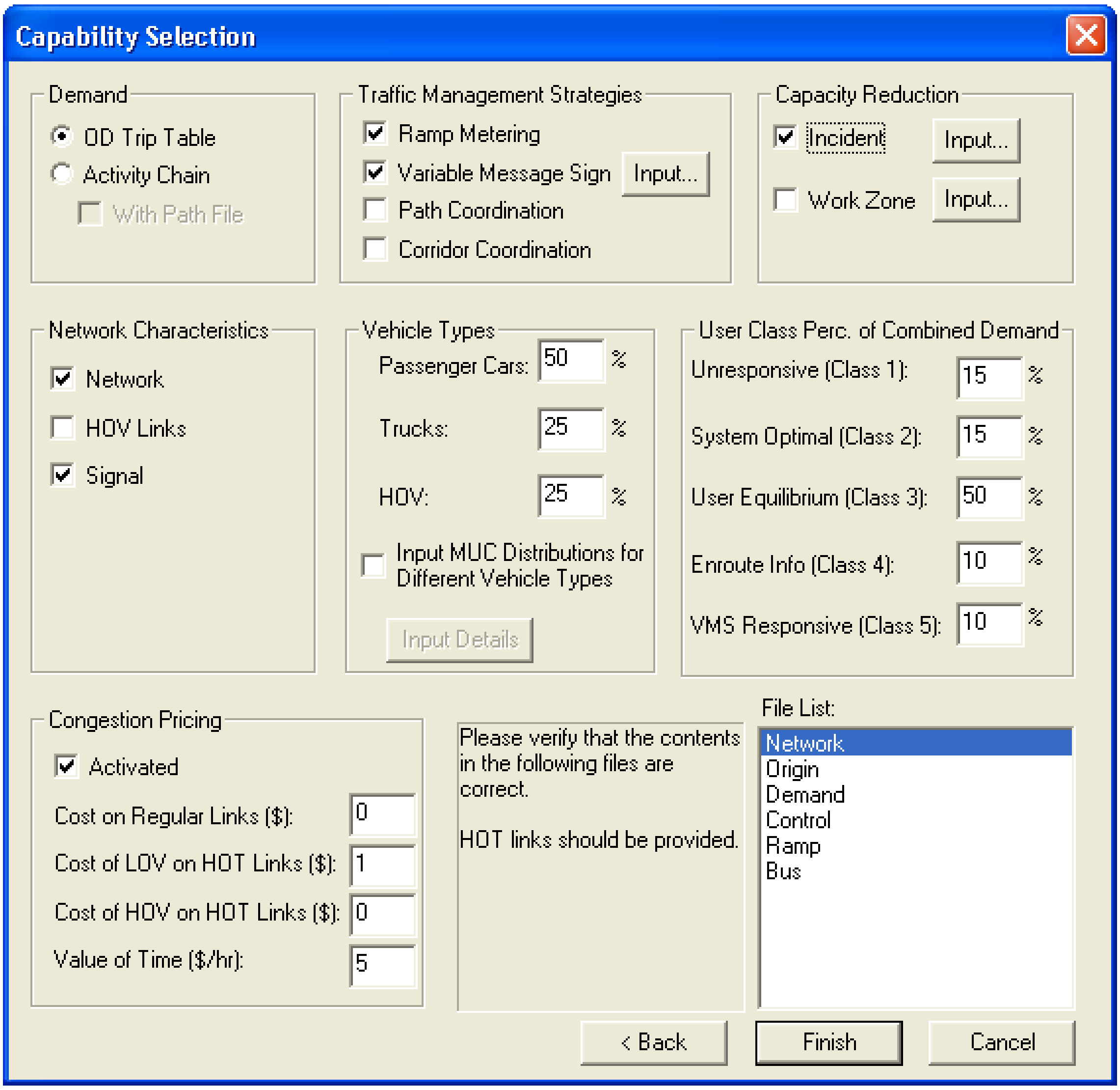


Figure 6-36. *Capability Selection* dialog box

Demand Data Block

By selecting the <<O-D Trip Table>> option, vehicles will be generated from the O-D demand matrices (*demand.dat*, *demand_truck.dat*, and *demand_HOV.dat* files). On the other hand, by selecting the <<Activity Chain>> option, vehicles will be generated according to information provided in the vehicle file (*vehicle.dat*). The *vehicle.dat* file contains information regarding vehicle type, user class, and origin-destination nodes for each vehicle. In this case, paths for these vehicles will be generated by DYNASMART-P. If the <<With Path File>> option is selected, vehicles will follow the paths specified in *path.dat*. For detailed information on *demand.dat*, *vehicle.dat* and *path.dat*, refer to Sections 4.17, 4.23, and 4.24, respectively.

Network Characteristics Data Block

By default, the network and signal files will be checked. This is because users must always provide the network and signal information. Users can also model HOV and bus routes. To model HOV links, *network.dat* must be modified accordingly. To model bus operations, users will need to supply relevant information in *bus.dat*. For information on creating the *network.dat* and *bus.dat* input files, refer to Sections 4.7 and 4.31, respectively.

Traffic Management Strategies Data Block

To model ramp metering, the <<Ramp Metering>> check box needs to be selected, although users still need to enter ramp data manually (within *ramp.dat*). To delete all of the ramp metering information, simply de-select the <<Ramp Metering>> check box. A dialog box will pop out to confirm the user's decision (Figure 6-37).

Figure 6-37. Erase ramp metering warning dialog box

To model VMS signs in the network, the <<Variable Message Sign>> check box needs to be selected. De-selecting any check box will erase all existing data. To add or edit existing VMS data, click on the <<Input…>> button next to the <<Variable Message Sign>> check box, which will launch the following dialog box (Figure 6-38).

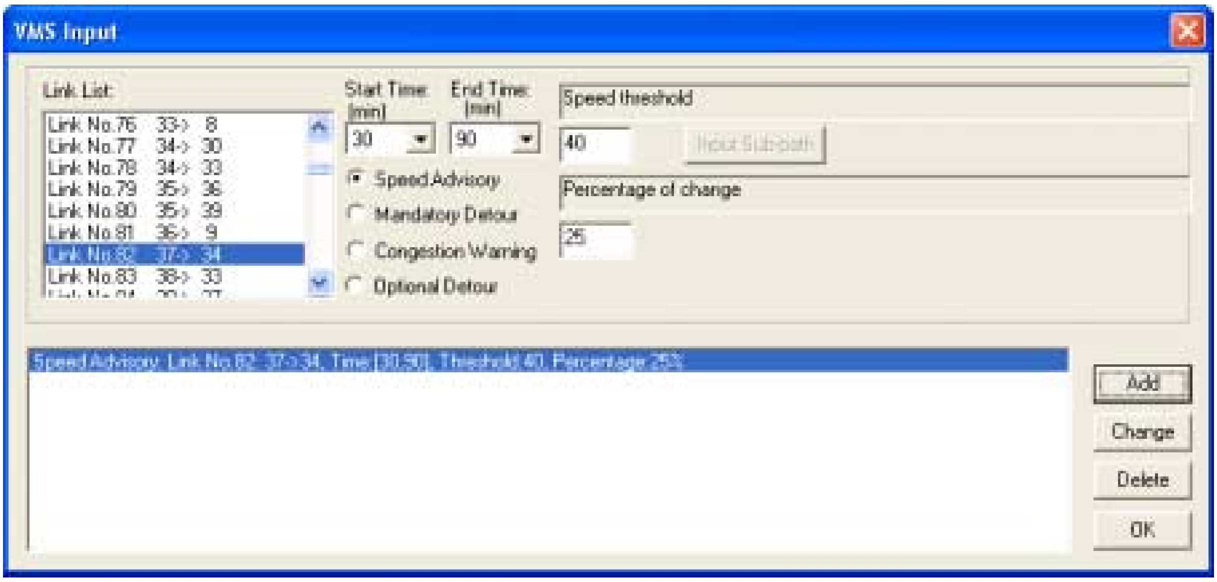


Figure 6-38. *VMS Input* dialog box – speed advisory

The procedure for entering VMS data is to first select the desired link from the <<Link List>>, and to specify the <<Start Time>> and <<End Time>> for that VMS. Next, select the type of VMS desired. Four types of VMS are available in DYNASMART-P: 1) speed advisory, 2) mandatory detour, 3) congestion warning, and 4) optional detour.

- ❑ In the case of speed advisory VMS (Figure 6-38), users will then need to specify the <<Speed Threshold>> (+ or -). If positive (+), the program will increase link speed by a percentage specified in the next input (if link speed is lower than the threshold). If negative (-), the program will decrease link speed by a percentage (if link speed is higher than the threshold). Lastly, users will need to specify the <<Percentage of Change>> desired for reducing or increasing VMS link speed. Click on the <<Add>> button to add the VMS information. To remove an existing VMS record, select it from the VMS list and click on the <<Delete>> button. To make changes to the VMS information, select the VMS record to be edited (this would highlight its parameter values in the dialog box), make the changes, and click on the <<Change>> button to lock in the changes. Finally, press the <<OK>> button to save the VMS information into *vms.dat*, and exit the <<VMS Input>> dialog box. Note that the **ESC** button on the keyboard can be pressed to exit any dialog box.
- ❑ In the case of mandatory detour VMS (Figure 6-39), users will then need to click <<Input Sub-Path>> to specify a sub-path on which vehicles will divert. The user must specify a sequence of links comprising the path that detoured vehicles will follow (Figure 6-40). Once done selecting the detour links, click the <<Add>>, <<Remove>> or <<Clear>> buttons to add, delete, or clear the detour VMS information. Click the <<OK>> button to return to the <<VMS Input>> dialog box. Once in the <<VMS Input>> dialog box, click <<OK>> to add this information to *vms.dat*.

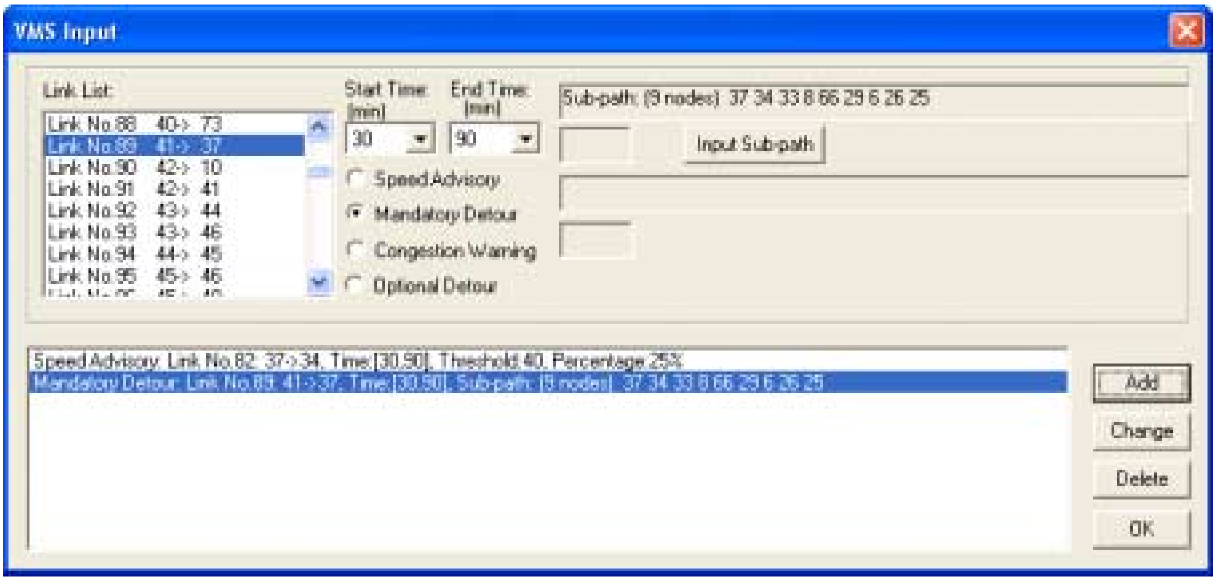


Figure 6-39. *VMS Input* dialog box – mandatory detour VMS

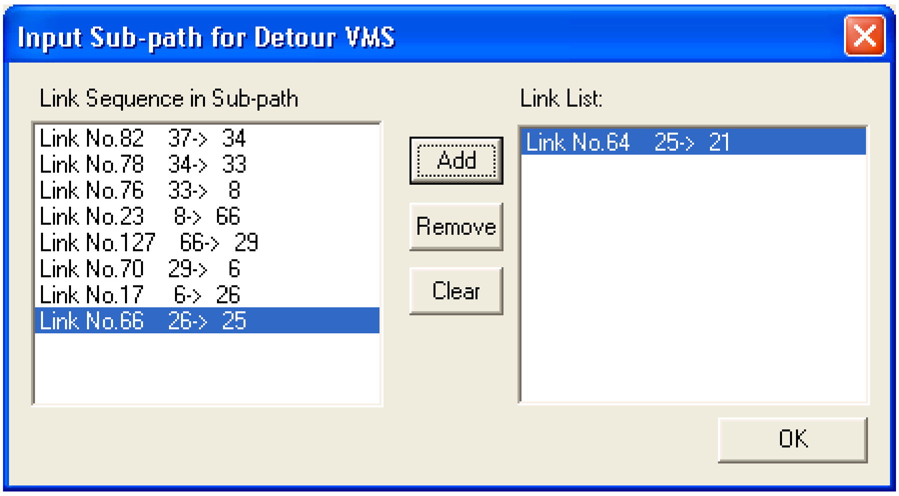


Figure 6-40. *Input Sub-Path for Detour VMS* dialog box

- ❑ In the case of congestion warning VMS (Figure 6-41), users will then need to specify the percentage of class 5 users (VMS Responsive) to be diverted. Classes 2 through 5 (SO, UE, Enroute, and VMS-Responsive) can be diverted if the VMS preemption mode (see Scenario | Advanced Settings menu command) is selected. Vehicles will be re-routed according to the path preference specified. A value of 1 selects the current best path (i.e. shortest path given prevailing travel times), and a value of 0 selects a random path among the K-paths. The K-paths parameter is specified in *network.dat*. Click on the <<Add>> button to add the VMS information. To remove an existing VMS record, select it from the VMS list and click on the <<Delete>> button. To make changes to the VMS information, select the VMS record to be edited (this would highlight its parameter values in the dialog box), make the changes, and click on the <<Change>> button to lock in the changes. Finally, press the <<OK>> button to save the VMS information into *vms.dat*, and exit the <<VMS Input>> dialog box.

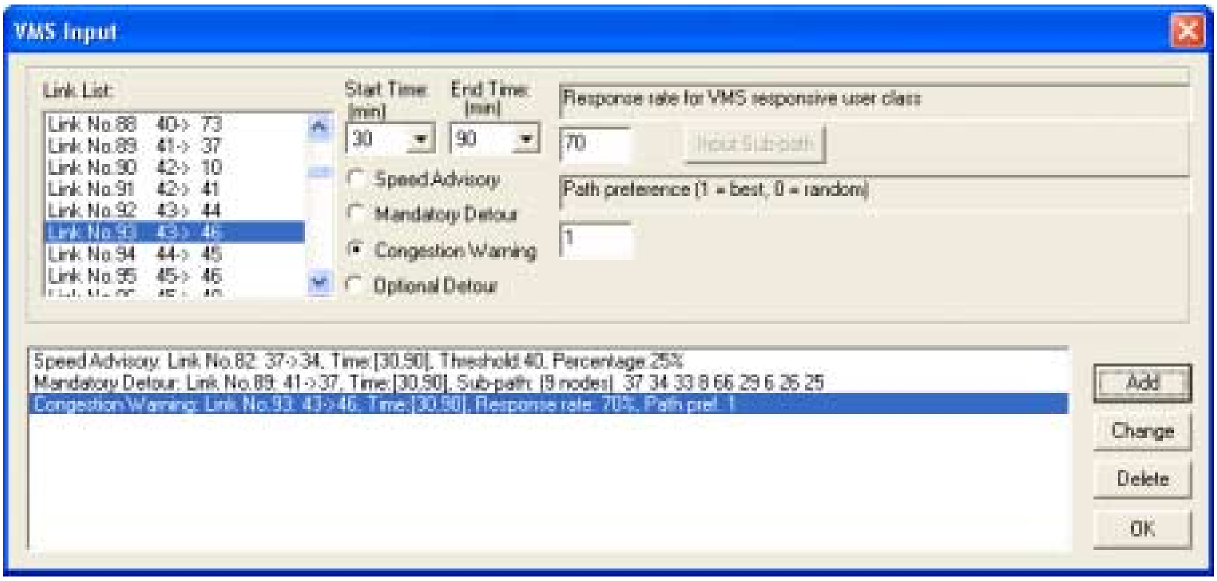


Figure 6-41. *VMS Input* dialog box – congestion warning

- ❑ In the case of optional detour VMS, users will need to follow the same instructions for the mandatory detour; the only difference being that in optional detour, drivers need not follow the detour path if their original path has a better travel time. The boundedly rational decision rule will be used to determine whether drivers keep their original paths or use the detour sub-path.

To delete all VMS information, simply uncheck the <<Variable Message Sign>> check box. A dialog box will appear to confirm the user's decision (Figure 6-42).

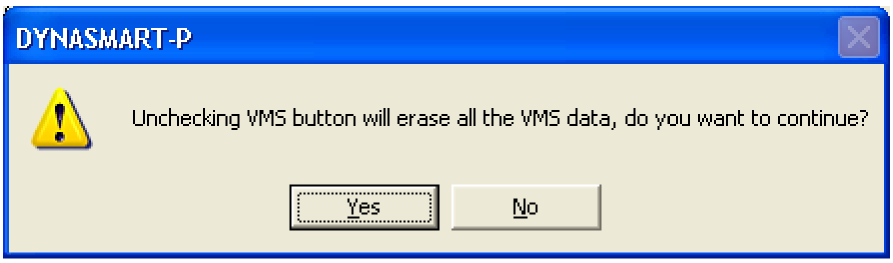


Figure 6-42. Erase VMS information warning dialog box

Note that users may specify more than one active VMS on the same link; however, this is not recommended. The mandatory detour VMS (type 2) will always govern, followed by the optional detour VMS (type 4) and the congestion warning VMS (type 3). The speed advisory VMS can co-exist with any of the above VMS types.

The last items in the [Traffic Management Data Block] are the <<Corridor Coordination>> and <<Path Coordination>> check boxes. These are not functional yet, and are intended for future development of the software.

Vehicle Types Data Block

Users may specify the percentage of vehicle types for any given scenario. The summation of percentages must equal exactly 100 percent. If HOV vehicles are specified, then the network must have at least one HOT or HOV link. These fractions are ultimately applied to *demand.dat*. Alternatively, by selecting the <<Input MUC Distributions for Different Vehicle Types>> check box and clicking the <<Input Details>> button, the <<MUC Distribution & Vehicle Percentages>> dialog box will appear (Figure 6-43). The user can choose to load trucks and/or HOV from their respective separate O-D demand files (*demand_truck.dat* and *demand_HOV.dat*), and can specify different MUC distributions for each vehicle type. Note that <<Combined Demand>> refers to the standard *demand.dat* file.

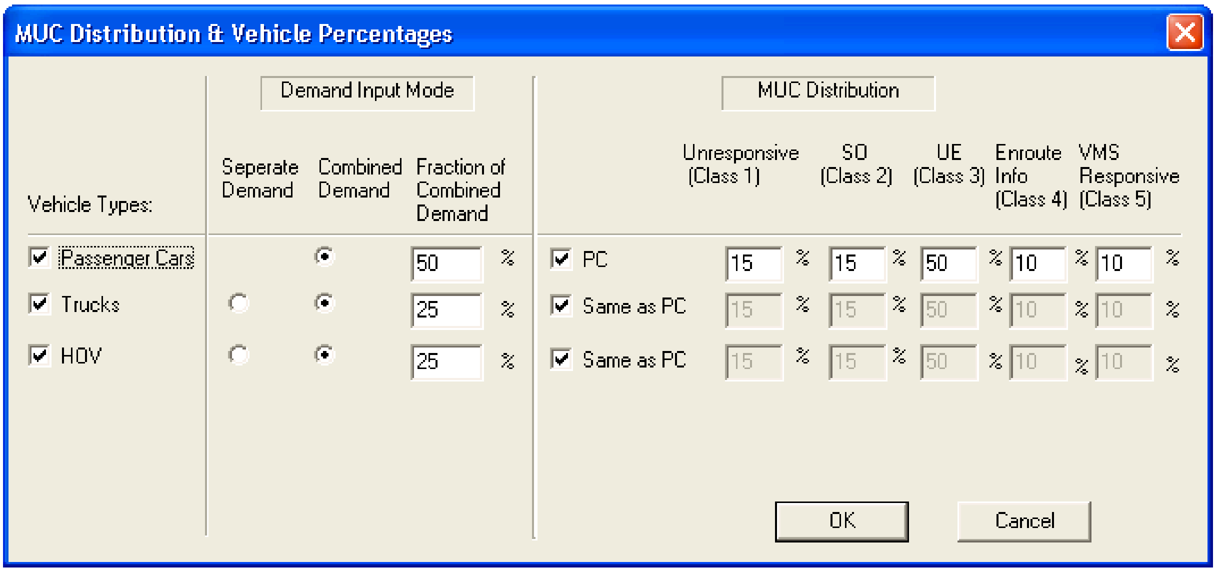


Figure 6-43. *MUC Distribution & Vehicle Percentages* dialog box

User Class Percentages of Combined Demand Data Block

There are five different user classes modeled in DYNASMART-P. They are unresponsive, system optimal (SO), user equilibrium (UE), en-route info, and VMS-responsive. When running the *One-Shot Simulation-Assignment* procedure, the SO and UE user classes are not available. The sum of percentages for the different user classes should equal exactly 100 percent. The definition of these user classes is provided below (Table 6-1). By default, only class 5 (VMS responsive) will respond to VMS. However, by selecting the VMS preemption mode parameter in the Scenario |

Advanced Settings dialog box (described later in this guide), user classes 2 through 5 will also respond to VMS.

Table 6-1. Definition of multiple user classes

User Class Number	*User Class Name*	*Description*
1	Unresponsive	Vehicles that follow their given paths and do not respond to en-route guidance devices such as VMS
2	System Optimal (SO)	Vehicles following paths with SO objective
3	User Equilibrium (UE)	Vehicles following paths with UE objective
4	En-route info	Vehicles that receive real-time en-route information via in-vehicle equipment, and are allowed to re-route at any intersection. Re-routing is based on the boundedly rational behavior mechanism.
5	VMS-responsive	Vehicles that follow their given paths; however, they are capable of receiving real-time en-route information via external guidance devices such as VMS. Re-routing is possible at the VMS link.

MUC fractions entered in this dialog box apply (across the board) to the combined demand file (*demand.dat*). To specify different MUC distributions for each vehicle type, select the <<Input MUC Distributions for Different Vehicle Types>> check box, and click the <<Input Details>> button. The <<MUC Distribution & Vehicle Percentages>> dialog box will appear (Figure 6-43). It is now possible to select types of vehicles in the network, the source of their demand (either separate demand files such as *demand_truck.dat* or demand_HOV.dat, or combined demand), and specify the different MUC.

Congestion Pricing Data Block

DYNASMART-P has the capability of modeling basic congestion pricing schemes. To do this, users can select the <<Activated>> check box, and then enter values for four parameters: (1) the cost for traversing typical links in the network, (2) the cost of low occupancy vehicles using HOT lanes (links), (3) the cost of HOV vehicles using the HOT lanes (links), and finally (4) the dollar value of time. As mentioned previously in this guide (Section 4.30), pricing schemes are not effective unless there are HOT links in the network. Also, note that un-checking the <<Activated>> check box will not delete any value in pricing.dat, except for the price on regular links (set back to zero). That is, *pricing.dat* will retain the latest values entered, and link pricing will remain fully functional as long as there are HOT links in network. This holds true even if the <<Activated>> check box is not selected, and even if the price on regular links is zero. To modify the current values in *pricing.dat*, the <<Activated>> check box can be used to enter the link pricing values.

Capacity Reduction Data Block

Users can model events such as incidents and work zones using the capacity reduction capability. To add an incident, select <<Incident>>, and click on the <<Input…>> button to reach the <Incident Input> dialog box (Figure 6-44)

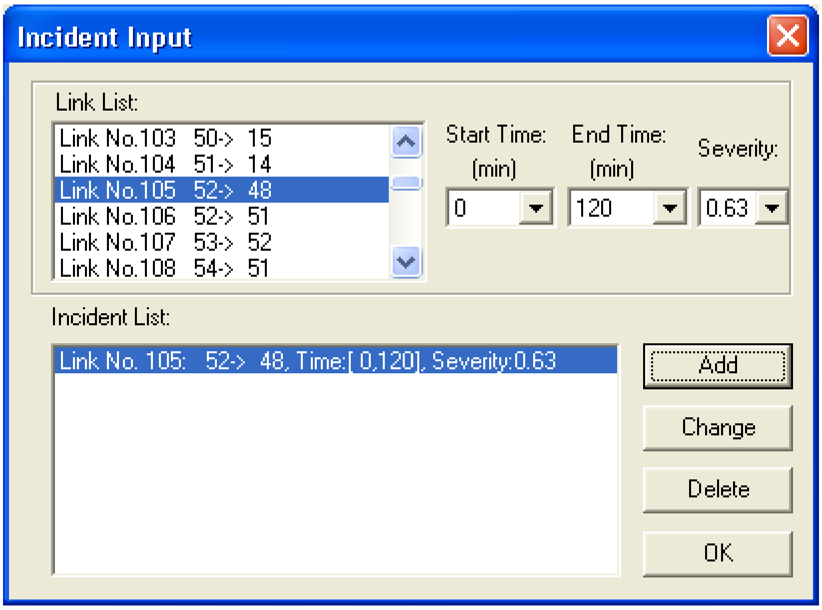


Figure 6-44. *Incident Input* dialog box

The procedure for entering incident data is to first select the desired link from the <<Link List>>, and then select the <<Start Time>> and <<End Time>> of the incident. Next, users can choose the <<Severity>> level, which refers to the fraction of capacity lost due to the incident. Click on the <<Add>> button to add the incident information. To remove an existing incident record, select it from the incident list, and click on the <<Delete>> button. To make changes to the incident information, select the incident record to be edited (this would highlight its parameter values in the dialog box), make the changes, and click on the <<Change>> button to lock in the changes. Finally, press the <<OK>> button to save the incident information into *incident.dat*, and exit the <<Incident Input>> dialog box. To delete all incident information, simply de-select the <<Incident>> check box. A dialog box will appear to confirm the user's decision (Figure 6-45)

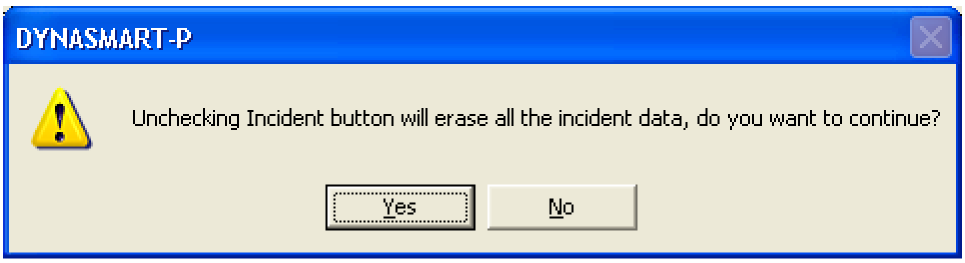


Figure 6-45. Erase incident information warning dialog box

Users can specify multiple incidents on the same link. DYNASMART-P will pick the highest severity of all active incidents to reduce the physical link capacity (lane-miles), and the maximum flow rate.

To add a work zone, select the <<Workzone>> check box, and click on the <<Input…>> button to invoke the <Work Zone Input> dialog box (Figure 6-46).

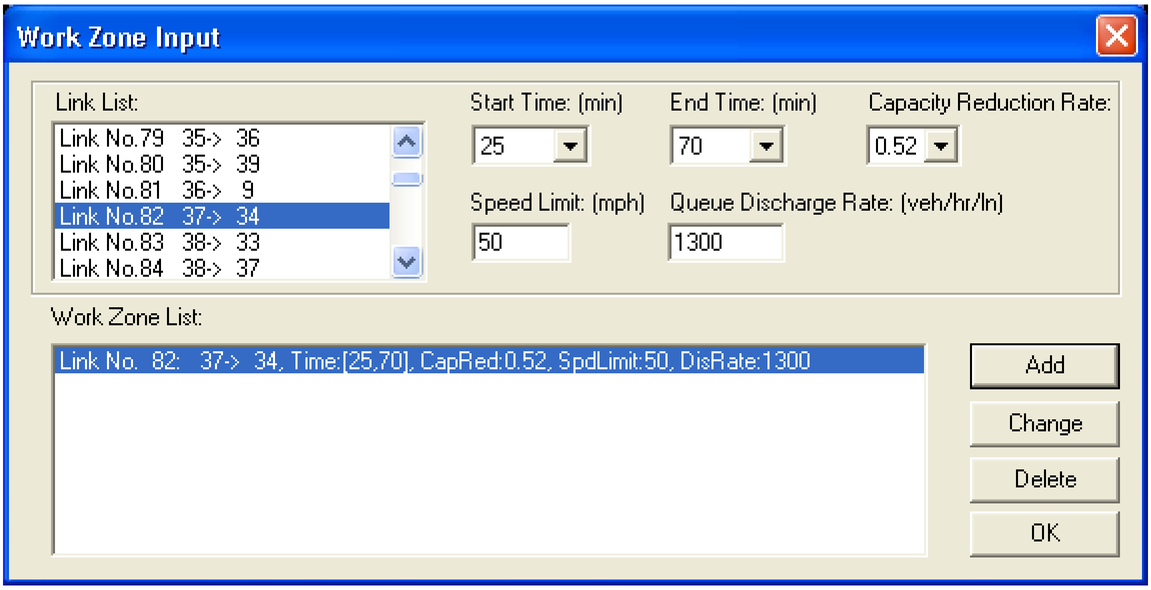


Figure 6-46. *Work Zone Input* dialog box

The procedure for entering work zone data is to first select the desired link from the <<Link List>>, and then select the <<Start Time>> and <<End Time>> of the work zone. Next, users can choose the <<Capacity Reduction Rate>> level, which refers to the fraction of capacity lost due to the work zone. Select the newly posted <<Speed Limit>> and the <<Queue Discharge Rate>>. Click on the <<Add>> button to add the work zone information. To remove an existing work zone record, select it from the Work Zone List, and click on the <<Delete>> button. To make changes to the work zone information, select the work zone record to be edited (this would highlight its parameter values in the dialog box), make the changes, and click on the <<Change>> button to lock in the changes. Finally, press the <<OK>> button to save work zone information into *WorkZone.dat*, and exit the <<Work Zone Input>> dialog box. To delete all work zone information, simply de-select the <<Work Zone>> check box. A dialog box will appear to confirm the user's decision (Figure 6-47).

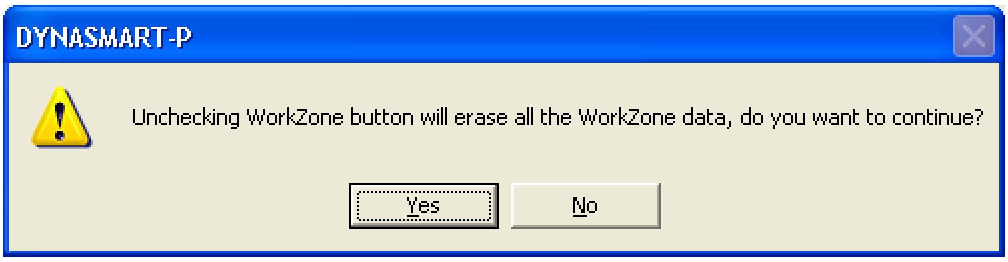


Figure 6-47. Erase work zone information warning dialog box

Users cannot specify multiple active work zones on the same link. DYNASMART-P will output an error message in this regard.

Additional parameters can be specified under Scenario | Advanced Settings, which launches the <Advanced Settings> dialog box (Figure 6-48). These variables are related to user classes, traffic management strategies and simulation-assignment parameters. Below is a brief explanation of these parameters.

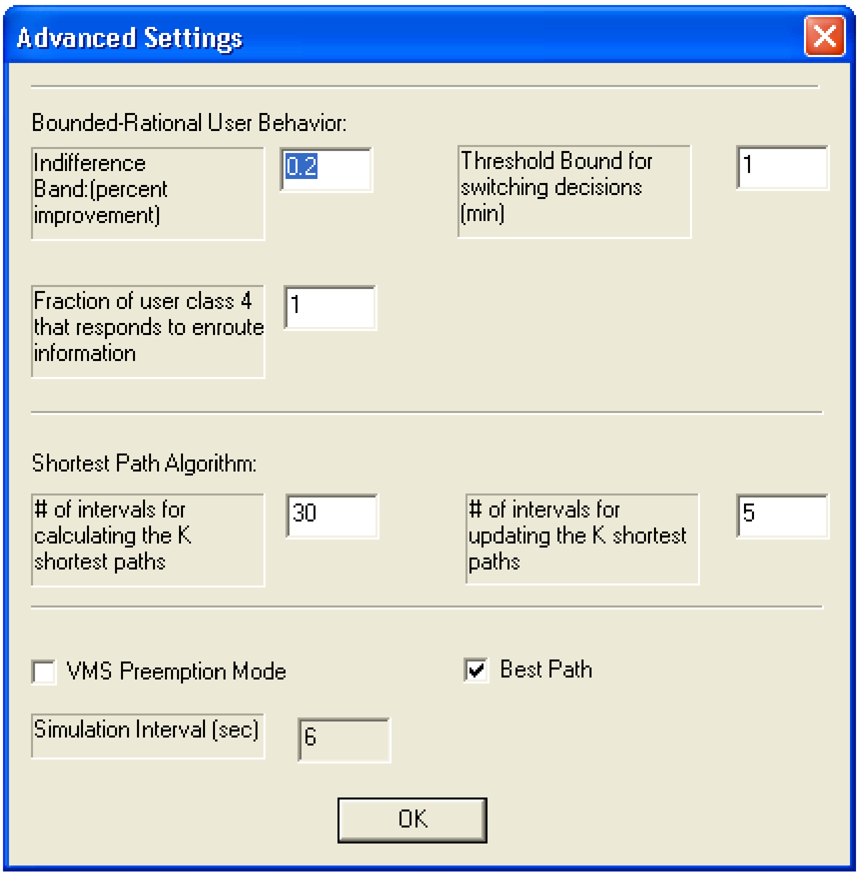


Figure 6-48. *Advanced Settings* dialog box

- *Indifference Band* (only applies user class 4): Denotes the percentage of improvement in travel time for which trip-makers will change paths.
- *Threshold bound for switching decisions* (only applies to user class 4): A threshold (in minutes) above which users will switch paths if it saves at least the bound specified.
- *Best Path (for initial assignment)*: A check box to control pre-trip information. If the box is checked, trip-makers will be assigned to the best path at their time of departure. Such a scenario is intended to model pre-trip information. If the box is left unchecked, trip makers will be randomly assigned to one of the k-shortest paths (the number of available shortest paths specified in *network.dat*). Such a scenario is intended to model the condition where trip makers are not familiar with network traffic conditions. This logic applies to all user classes.
- *Fraction of user class 4 vehicles that respond to en-route information*: The fraction of user class 4 vehicles that will undertake suggested guidance, provided it is beneficial and satisfies the requirements of *Indifference Band* and *Threshold bound for switching decisions*.
- *VMS Preemption Mode*: A check box to control ITS information supply strategy via VMS. If this box is checked, then user classes 2 – 5 will respond to VMS information. If the box is left unchecked, then only user class 5 (VMS-responsive) will respond to VMS information.
- *Simulation Interval*: Interval at which vehicle positions in the network are updated (i.e. the system state evolves every simulation interval). In the current version of DYNASMART-P, the simulation interval is restricted to 6 seconds.
- *Number intervals for calculating K-shortest paths*: The number of simulation intervals (where each simulation interval is 6 seconds) in which the k-shortest paths algorithm is executed. A default value of 30 simulation intervals (or 3 minutes) is recommended.
- *Number intervals for updating K-shortest paths*: The time interval (in terms of the number of simulation intervals) in which the k-shortest paths are updated. That is, the previously identified k-paths (from the shortest path solution algorithm) will have their travel time updated based on the current state of the system. These paths will also be re-ranked once travel time is updated. A default value of 10 simulation intervals (or 1 minute) is recommended.

Clicking the Scenario | Generate Actuated Signal Timing Data menu command will create default actuated signal phasing movements if the control type is specified as actuated (field 2 of the node data record type in *control.dat* – see section 4.11). That is, in the absence of phasing information, the user can select this option to provide default phasing information and complete *control.dat*, provided that the control type of signals without phasing information is actuated. The software will simply provide any missing phasing information in *control.dat*, and copy the original *control.dat* to *control_backup.dat* for convenience. The user will be prompted to enter the default settings in the <Actuated Signal Settings> dialog box (Figure 6-49).

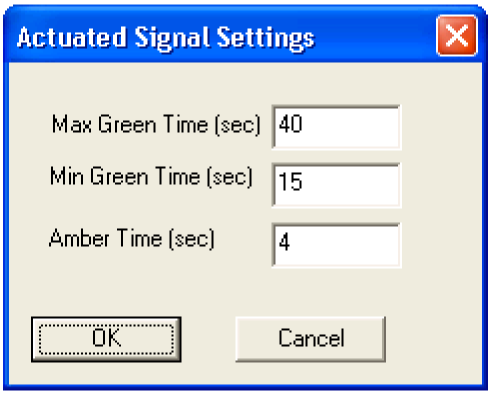


Figure 6-49. *Actuated Signal Settings* dialog box

Finally, the user can export network and link MOE to a set of text files. To perform this process, first select (by clicking) a particular link in the network (after simulation is over), and then select the Scenario | Export Link Performance Data or Scenario | Export Network Performance Data menu command. The nature and format of the exported text files are presented in Figure 6-50 and Figure 6-50, respectively.

Link 147 ->177   120 mins

Time(min)	Density(veh/ml/ln)	Speed(ml/hr)	Flow(veh/hr/ln)	Queue length(%)
1	0.00	40.00	0.00	0.00
2	2.76	39.14	60.00	0.00
3	1.38	39.57	60.00	0.00
4	2.76	39.14	0.00	0.00
5	9.65	37.02	300.00	0.00
6	6.89	37.65	360.00	0.00
7	5.51	38.07	120.00	0.00
8	9.65	36.80	180.00	0.00
9	9.65	37.02	480.00	0.00
10	1.38	39.57	60.00	0.00
11	2.76	39.14	60.00	0.00

Figure 6-50. Format of the Export Link Performance Data text file

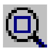
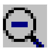
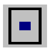
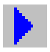
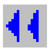
Time	AvgTravelTime	AvgTraveTimeOut	LinkSpeed	FreewaySpeed	ArterialSpeed
1	0.50	0.00	39.70	65.00	37.90
2	1.00	1.20	39.50	65.00	37.70
3	1.50	1.70	39.20	65.00	37.40
4	2.00	2.40	38.90	65.00	37.10
5	2.50	3.10	38.60	64.80	36.80
6	2.90	3.80	38.40	64.80	36.60
7	3.30	4.80	38.40	64.80	36.60
8	3.60	5.00	38.30	64.00	36.50
9	3.80	5.20	38.30	64.30	36.50

Figure 6-51. Format of the Export Network Performance Data text file

6.3 Toolbar

The Toolbar contains the most commonly used functions for easy access. The function of each toolbar button is described in Table 6-2. Tool tips are also provided for each button, for clarification. To view the tool tips, rest the mouse pointer over the button for one or two seconds.

Table 6-2. Description of Toolbar command buttons

Tool	*Meaning*	*Description*
	Open project	Click this icon to open an existing project file.
	Load results	Click this icon to load the network data (if the *linkxy.dat* and *xy.dat* files are available) and simulation results.
	Save text file	Save the active file in the text window by clicking on this icon. This button is active only if the file in the text window has been modified and not saved.
	Selection pointer	Use this tool to select a specific entity (node or link) in the output view.
	Zoom in on focus area	The zoom icon is used to zoom into the focus area. Use the selection pointer to specify the rectangular view.
	Zoom in	Click this icon to zoom in.
	Zoom out	Click this icon to zoom out.
	Previous view	Click this icon to return to the previous view.
	Restore view	Click this icon to restore the view.
	Pan	Click this icon to pan the view.
	Node Selection	Click this icon to switch to node selection mode.
	Link Selection	Click this icon to switch to link selection mode.
	Switch view	Click this icon to switch between the input (text editor) and output (graphical) views.
	Execute simulation	Click this icon to run the DYNASMART-P simulation-assignment model.
	Play simulation	Click this icon to graphically view the simulation results.
	Pause simulation	Click this icon to pause the simulation.
	Rewind simulation	Click this icon to rewind the simulation back to the very beginning.
	Temporal demand	Click this icon to view the temporal demand pattern between O-D zones. Use the pointer selection to click and drag the rubber line to select the desired two zones.
	Plot Window	Click this icon to activate the plot window. Information about the plot window is described in a later section.
	View UE/SO paths	Click this icon to view UE/SO paths[1].
	Specify origin	Click this icon to specify the origin node. First, use the selection pointer to select a node, and then click on this tool to mark it as an origin node[1].
	Specify destination	Click this icon to specify the destination node. First, use the selection pointer to select a node, and then click on this tool to mark it as a destination node[1].
UE+LOV	Vehicle Class - Path type	Use this list box to select the desired vehicle class-path type[1]. UE+LOV = UE LOV paths; UE+HOV = UE HOV paths; SO+LOV = SO LOV paths; SO+HOV = SO HOV paths.

[1] *This feature is only available when the iterative consistent assignment procedure is performed.*

6.3.1 Viewing UE/SO Paths

The user must make sure that the output view is in the node selection mode by clicking on the button. Use this tool to select the routing policy (path assignment, whether UE or SO) and vehicle occupancy (whether LOV or HOV) combination. This selector is active only if the solution mode is iterative consistent assignment. After submitting an iterative consistent assignment run and loading the results, click to activate the path feature. To select an origin zone, double click on any node in that zone, and then click . To select a destination zone, double click any destination node in that zone, and then click . DYNASMART-P will then show the equilibrium paths (routing policy), using different colors that exist between the selected O-D zones combination. DYNASMART-P will also show on the MUC paths legend (bottom-left of screen) the fraction of vehicles assigned to each path. The user may click on the MUC path color legend (in the bottom-left of screen) to highlight a particular path. This feature will become useful with overlapping paths. Note that destination nodes are those marked by (see Figure 6-15). Users may close the UE/SO paths view any time by clicking on again.

Actual paths might not necessarily terminate at the selected destination node, because shortest paths are actually calculated with respect to zone (or super zone if applicable) centroids, which are virtual nodes and cannot be shown in the GUI. Instead, the path may terminate at a different destination node that belongs to the same destination zone (or super zone) to which the selected destination node belongs. Therefore, displayed paths in the GUI are shown to terminate at destinations that may be different than the desired destination (Figure 6-52). The user may want to view the zone (or super zone) boundaries to visually identify destinations that belong to same zone (or super zone).

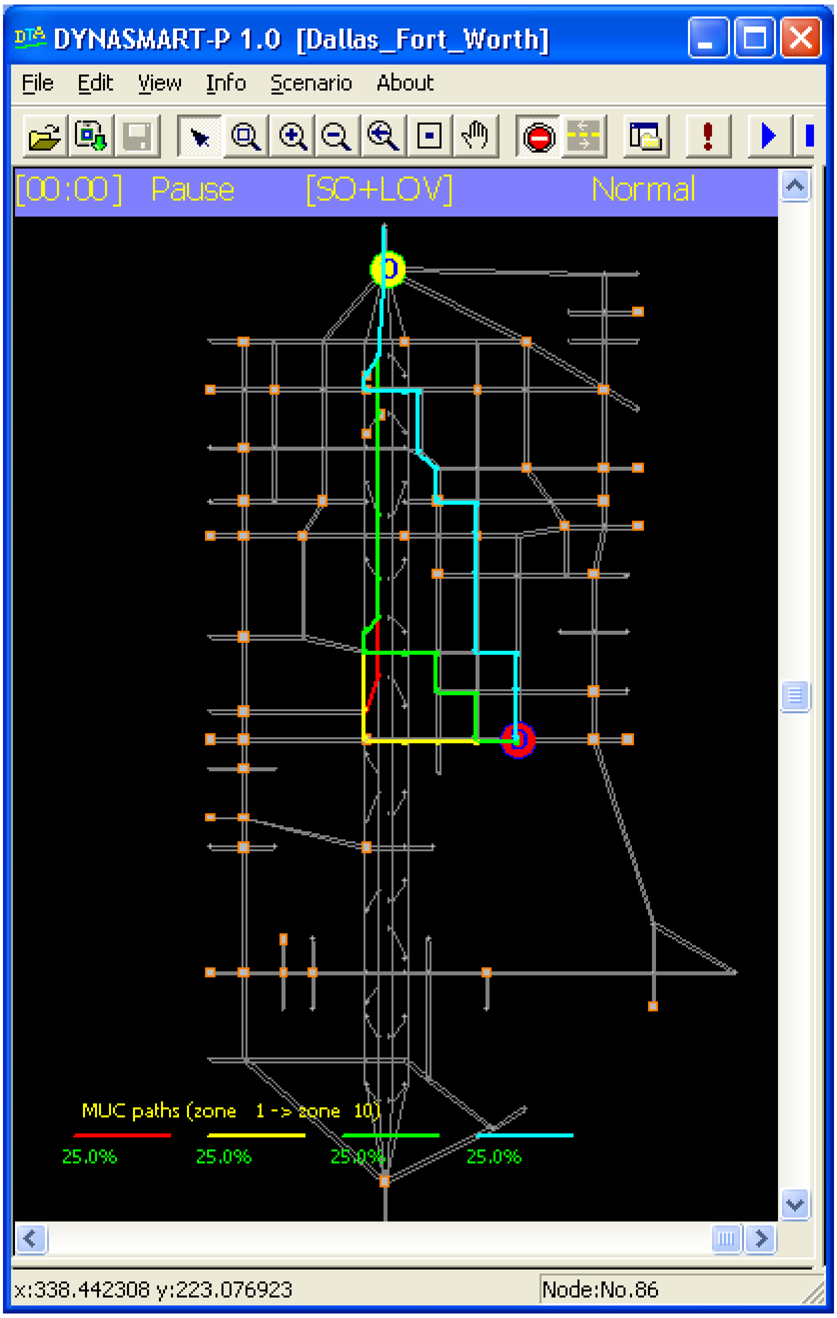


Figure 6-52. Viewing UE or SO paths on GUI

6.4 Information Window

In the output view, the information window aims at highlighting certain network characteristics and traffic conditions. The components in this window are described below.

6.4.1 Network Attributes

In this block (Figure 6-53), users may select any of the network attribute options to see information graphically, provided that relevant information is entered. For example, users can see bus routes and signalized intersections (see Figure 6-16).

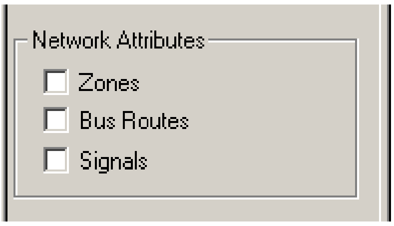


Figure 6-53. *Network Attributes* settings

6.4.2 Traffic Attributes

Upon completion of the simulation, users can examine a set of traffic attributes (Figure 6-54). That is, users can see the density (pc/mile/lane) (Figure 6-55), speed (mph) (Figure 6-56), queue lengths (Figure 6-57) and vehicles (Figure 6-58) for each network link.

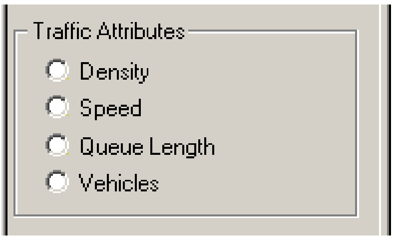


Figure 6-54. *Traffic Attributes* settings

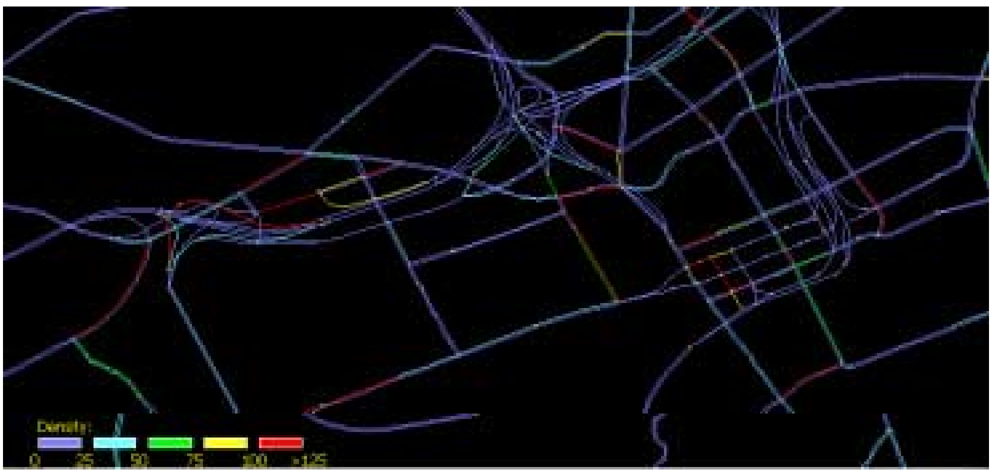


Figure 6-55. Density is shown with different colors and legend is provided

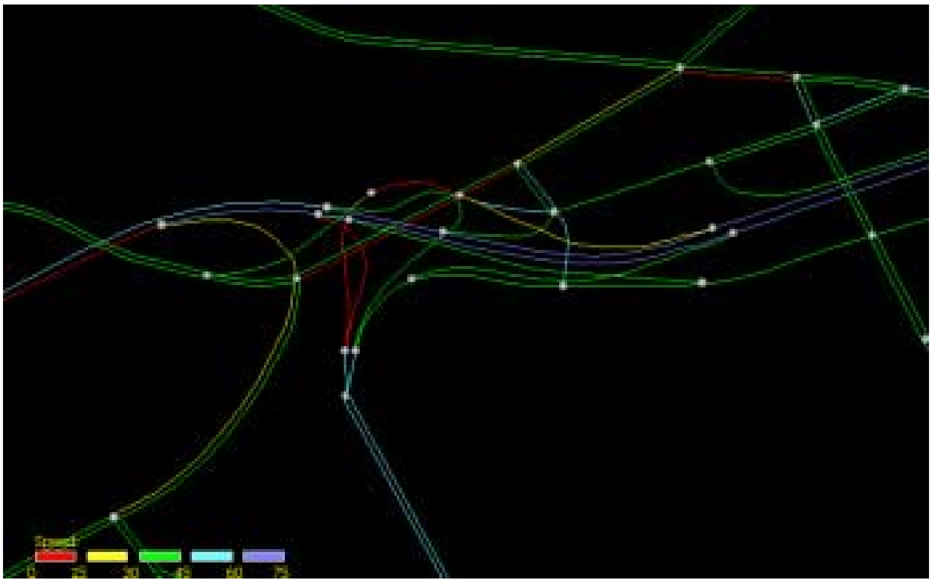


Figure 6-56. Link speeds as shown on the GUI

Figure 6-57. Queue lengths as shown on the GUI

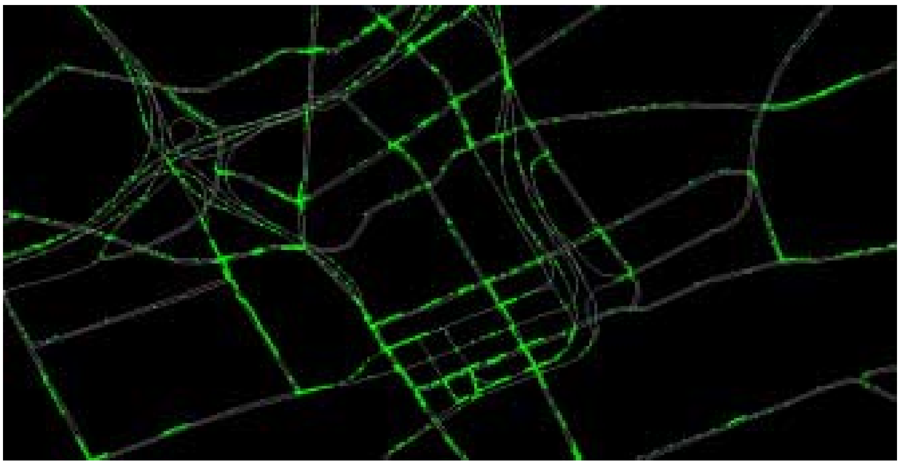


Figure 6-58. Vehicles as shown on the GUI

The GUI depicts newly generated vehicles (each vehicle is represented by a dot) starting from the downstream node of their respective generation links. That is why, for boundary generation links receiving no upstream traffic, the GUI will not show vehicle animation on that link, even though there are actually newly generated vehicles traversing that link. Also, DYNASMART-P assumes the average length of a PC to be 21.12 ft. If the link length is not a perfect divisor of 21.12 (as is the case in general), then there will always be "empty space" in the link into which DYNASMART-P will be unable to physically move a vehicle. Trucks are assigned PCE factors greater than one, so even if the link length is a perfect divisor of 21.12 ft, the presence of trucks will almost always result in empty space that is too small for DYNASMART-P to move an additional vehicle into. That is why, in some cases where congestion levels are high, the GUI will not show a solid queue line extending across intersections.

6.4.3 Node/Link Attributes

Node or link characteristics are displayed in the table shown below (Figure 6-59). To obtain the information shown in this table, the user can click on the link or node in the network diagram.

Name	Value
Link ID	2935
From Node	1294
To Node	221
Type	Arterial
Numbers of Lanes	2
Length (mi)	0.04
Sat Rate (veh/hr/ln)	1800.00
Density (veh/mi/ln)	--
Speed (mi/hr)	--
Volume (veh/hr/ln)	--

Figure 6-59. Node/Link Attributes display view

6.4.4 Message Box

Relevant information pertaining to the scenario being simulated is automatically displayed in the message box (e.g. incident status, VMS status, etc.).

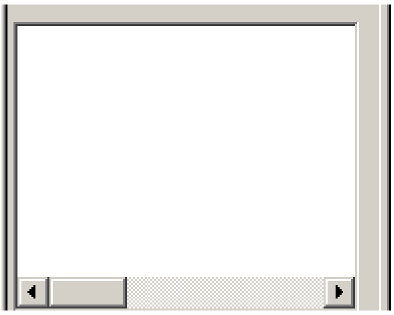
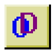


Figure 6-60. Message Box

6.5 Plot Window

The plot window is activated via the  button in the toolbar. It consists of a window with three tabs showing the temporal demand, link characteristics, and overall network performance. A scaling selection option is provided for all three tabs.

The <<Temporal Demand>> tab (Figure 6-61) can also be activated via the  toolbar button. O-D pairs may be specified using the provided lists or using the pointer selection tool. Starting and ending time can also be specified.

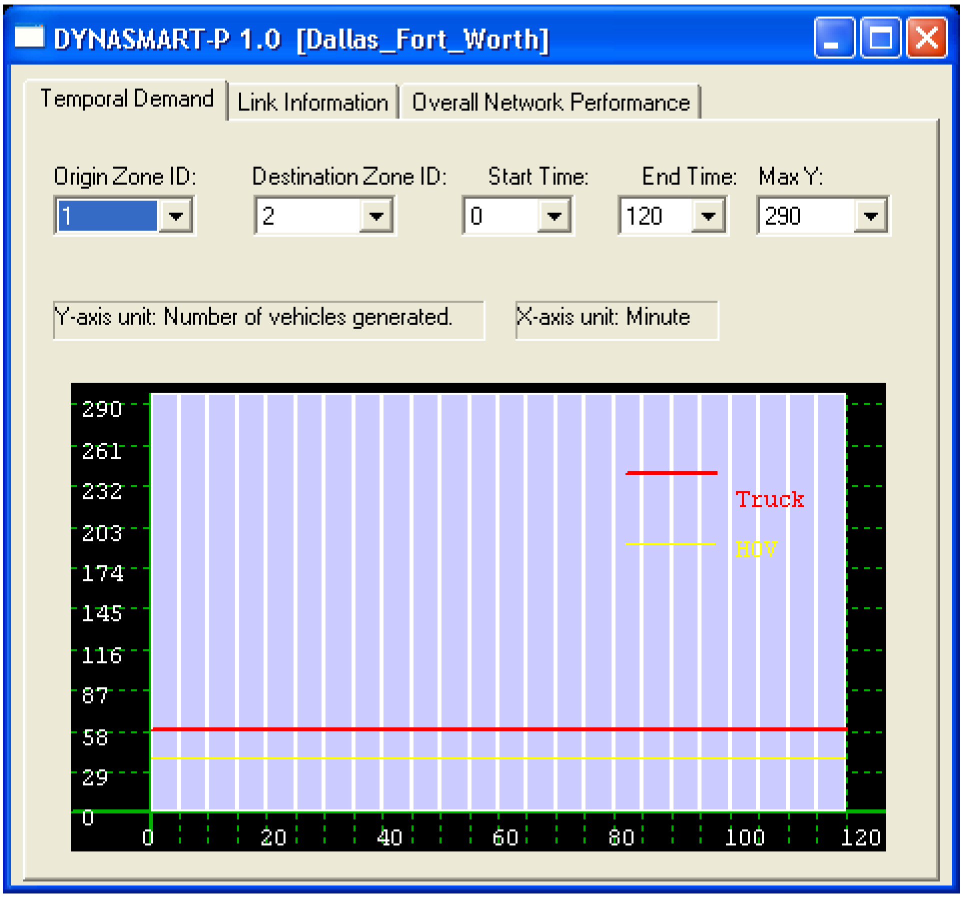


Figure 6-61. *Temporal Demand* plot window

The <<Link Information>> tab (Figure 6-62) can also be activated by double-clicking on any link in the network. Links may be selected using the list provided, or using the pointer selection tool.

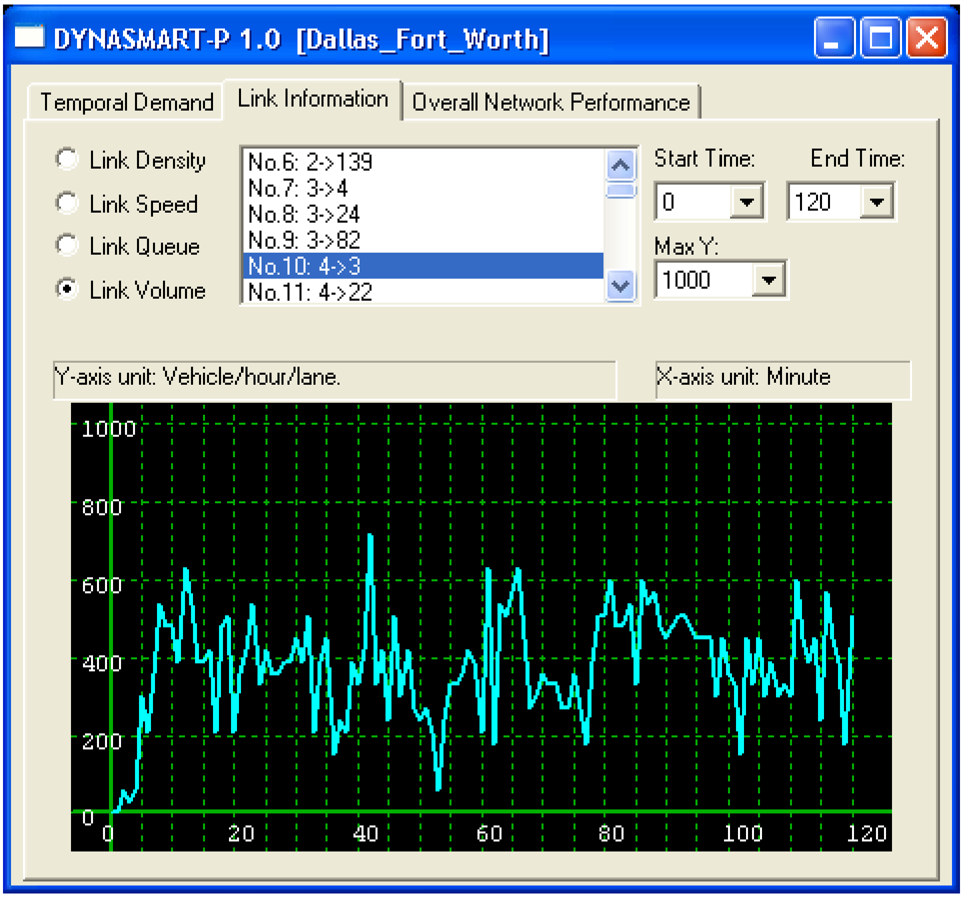


Figure 6-62. *Link Information* tab - showing link volume

The <<Overall Network Performance>> tab (Figure 6-63) shows relevant statistics over the given planning horizon; namely, number of vehicles in the network, number of vehicles out of the network, average travel time and average speed.

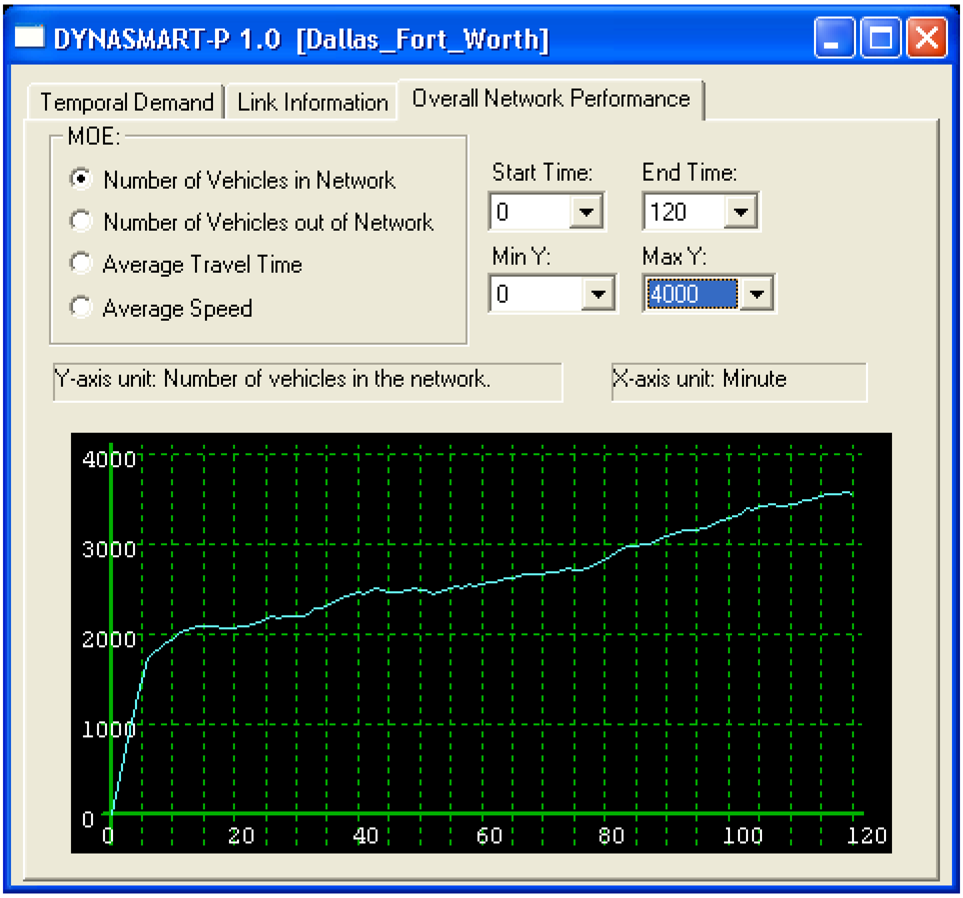
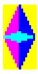
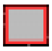
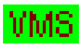
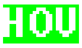
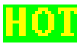
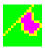
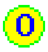
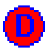
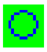


Figure 6-63. *Overall Network Performance* tab – showing number of vehicles in network

6.6 Network Symbols

The symbols shown in the simulation and clock window are described below (Table 6-3):

Table 6-3. Description of network symbols

Symbol	*Description*
	Clock indicator. Click and drag the clock indicator to the desired time instance to view a snap shot of the network state
	Incident link
	Destination node
	Four-way stop sign node
	Two-way stop sign node
	Yield sign node
	VMS link
	HOV link
	HOT link
	Signalized node
	Bus route node
	Node or link selection mark
	Origin node for UE/SO paths
	Destination zone for UE/SO path
	Left-turn bay
	Passenger car
	Truck
	Network node

6.7 Keyboard Support

The GUI has the following keyboard support (Table 6-4):

Table 6-4. Keyboard support in GUI

Keyboard	*Description*
F2	To switch between the input (text editor view) and output (network) view in the same manner as  button
F3	Find next (must be in input view – text editor)
F5	Switch the cursor from the input file (in input files tree) to the body of text of this file
F6	Switch the cursor from the body of text of an input file to the input file itself (in the input files tree)
ESC	To close a window or dialog box
DEL	Delete (must be in text editor window)
CTRL+Z	Undo last action (must be in text editor window)
CTRL+X	Cut (must be in text editor window)
CTRL+C	Copy (must be in text editor window)
CTRL+V	Paste (must be in text editor window)
CTRL+O	Open project
ALT+P	Play animation (must be in network view window to see animation)
ALT+R	Rewind animation (must be in network view window to see animation)
ALT+SpaceBar	Pause animation (must be in network view window to see animation)
→ **(right arrow)**	Opens a folder if in the input file tree Advances animation one step ahead, if in output (network) view (the user needs to click on the time bar first)
← **(left arrow)**	Opens a folder if in the input file tree Rewinds animation one step backwards, if in output (network) view (the user needs to click on the time bar first)

7. CREATING A NEW PROJECT IN DYNASMART-P

7.1 General

To create a project, the following data categories are needed:

- ❑ Project data
- ❑ Network data
- ❑ Control data
- ❑ Demand data
- ❑ Scenario data
- ❑ System data

Six major steps must be followed to create a project in DYNASMART-P, as depicted in Figure 7-1. These steps need not be executed in that order; however, doing so will facilitate typical preparation of the input files and hence smooth execution of the project.

As mentioned earlier in this guide, there are four ways to create the input files:

1. Manually, using a text editor (both externally or within the GUI environment),
2. Through GUI dialog boxes,
3. Through DYNABUILDER, and/or
4. Through DSPEd (DYNASMART-P editor).

Each of these methods has its own advantages and disadvantages; however, the recommended method for creating these input files would be to integrate all of these techniques. Manual text editing techniques are only feasible for small sized traffic networks, whereas GUI data input is best for fine-tuning scenario and system settings. DYNABUILDER is well-suited for converting networks from GIS format into DYNASMART-P format. It is also effective if link and node infomation are available in an MS Excel or Access database format. DSPEd, on the other hand, provides a user-friendly data entry environment for creating DYNASMART-P input files.

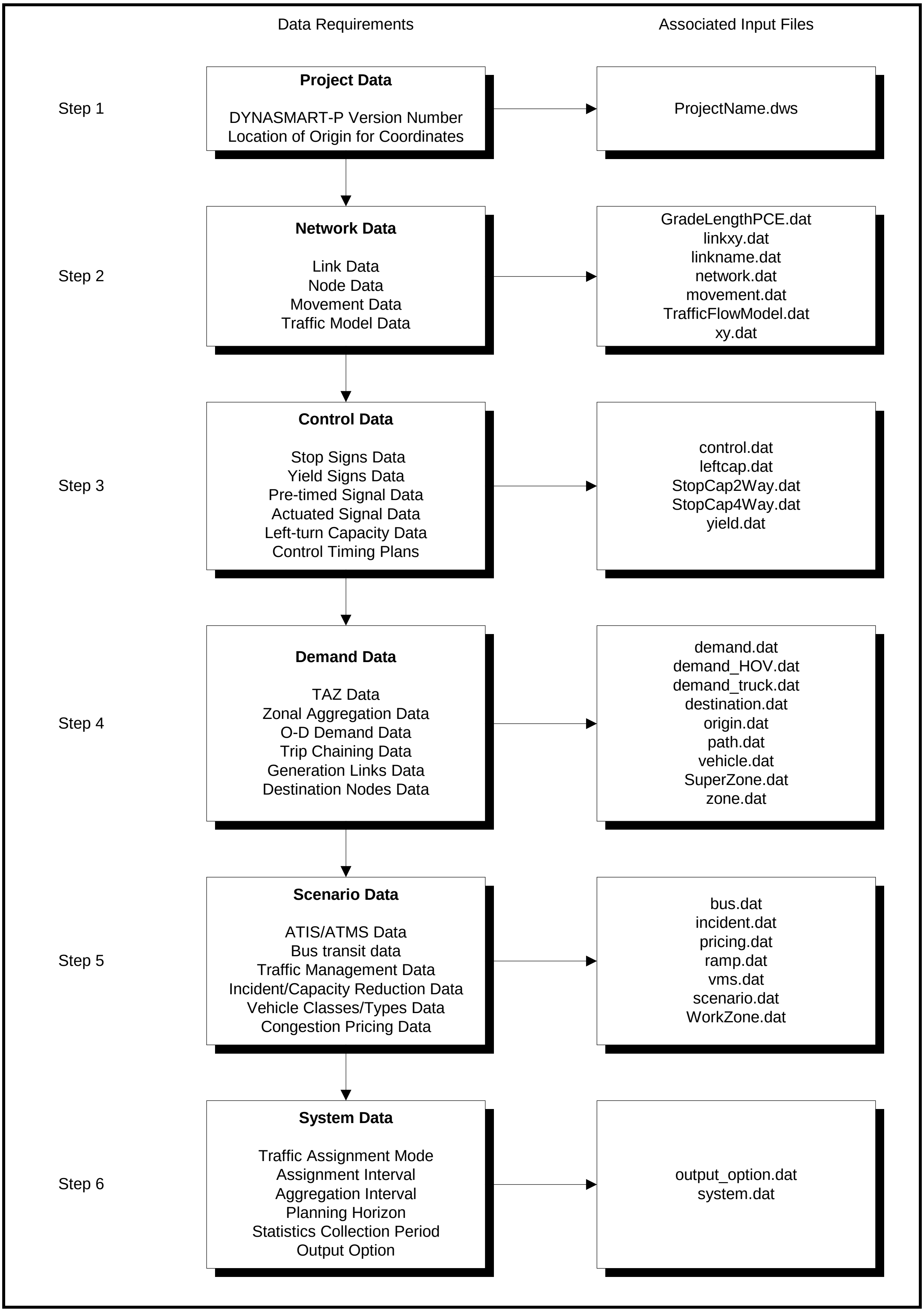


Figure 7-1. Data requirements for DYNASMART-P

7.2 Step 1 – Project Data

In this step, the user only needs to prepare the *ProjectName.dws* (where *ProjectName* is the name of the project or application to be modeled in DYNASMART-P) input file to specify the DYNASMART-P version number, and the location of the origin for the xy coordinates (see Section 4.3).

7.3 Step 2 – Network Data

To fully describe the network, three types of data are required: node, link, and movement data (Table 7-1).

Table 7-1. Required data to model and describe the traffic network

Type	*Required Data*	*Input File*
Node data	Node number	*network.dat*
	Total number of nodes	*network.dat*
	Node coordinates	*xy.dat*
	Link coordinates	*linkxy.dat*
Traffic Flow Model data	Parameters for modified Greenshields model	*TrafficFlowModel.dat*
Link data	Total number of links	*network.dat*
	Link horizontal alignment	*linkxy.dat*
	Saturation flow	*network.dat*
	Speed limit	*network.dat*
	Free-flow speed adjustment parameter	*network.dat*
	Traffic flow model type	*network.dat*
	Link type	*network.dat*
	Link name	*linkname.dat*
	Link grade	*network.dat*
Movement data	Allowed movements from all links	*movement.dat*

7.4 Step 3 – Control Data

Control data deals primarily with the node-transfer mechanism for vehicles. It dictates the movement of a vehicle for a given type of control present at an intersection (or equivalently, a node). Intersection control types modeled in DYNASMART-P include no control, stop and yield signs, pre-timed signals and actuated signals. Each of these control types requires specific data as presented in Table 7-2. DYNASMART-P can also generate default signal timing plans for signalized intersections with no phasing plans, for actuated signals only. To have DYNASMART-P generate default signal timing plans, click the Scenario | Generate Actuated Signal Timing Data menu command (see Section 6.2.5).

Table 7-2. Control data requirements and their associated input files for DYNASMART-P

Control Type	*Required Data*	*Input File*
No-control	Node number	*control.dat*
Stop signs	Node number	*control.dat*
	Approach capacities for 4-way stop signs	*StopCap4Way.dat*
	Approach capacities for 2-way stop signs	*StopCap2Way.dat*
Yield signs	Node number	*YieldCap.dat*
Pre-timed signals	Node number	*control.dat*
	Offset	*control.dat*
	Cycle length	*control.dat*
	Number of phases	*control.dat*
	Phasing splits	*control.dat*
	Phasing movements	*control.dat*
Actuated signals	Node number	*control.dat*
	Minimum green	*control.dat*
	Maximum green	*control.dat*
	Phasing splits	*control.dat*
	Phasing movements	*control.dat*

7.5 Step 4 – Demand Data

Demand data are used to load traffic on the network. DYNASMART-P has two methods to load vehicles on the network: (1) using a time-dependent O-D demand matrix notation, albeit a dynamic one, and (2) using predefined vehicle-path information, which is ideal for modeling trip chaining, and for providing a controlled environment to assess the short-term impacts of several traffic management strategies. The user also needs to specify generation links plus destination nodes for traffic analysis zones. Additionally, TAZs may be aggregated to create a coarser O-D representation. Table 7-3 represents the various requirements needed to fully describe demand loading onto the network.

Table 7-3. Required data to model and describe traffic demand

Type	*Required Data*	*Input File*
Zone data	Zone configuration	*zone.dat*
O-D demand matrix	Number of trips for each O-D pair, for each demand loading interval	*demand.dat* *demand_truck.dat* *demand_HOV.dat*
Generation links	Set of links for each zone, where demand will be loaded	*origin.dat*
Destination nodes	Nodes where vehicles exit the network after reaching the destination zone	*destination.dat*
Vehicle loading	Complete attributes for vehicles including O-D, generation time, vehicle type, user class, and intermediate destinations of each vehicle	*vehicle.dat*
Path information	The itinerary for each vehicle	*path.dat*

7.6 Step 5 – Scenario Data

Scenario data are central to the execution of the traffic simulation component of DYNASMART-P. They include information about the simulation period (planning horizon), loading time, traffic management strategies, incident management, vehicle types and composition, Multiple User Classes (MUCs), and congestion pricing (Table 7-4). Most of the scenario data can be entered through the dialog windows (Scenario | Parameter and Capabilities… menu command).

Table 7-4. Required data to model and describe the traffic network

Type	*Required Data*	*Input File*	*Used For*
Traffic management strategies	Ramp metering	*ramp.dat*	Traffic simulation
	Variable message signs	*vms.dat*	Traffic simulation
MUC	Proportion of user classes Trip information availability	*scenario.dat*	Traffic simulation
Congestion pricing	Money value of time	*pricing.dat*	Traffic simulation
Vehicle types	Fleet composition	*scenario.dat*	Traffic simulation
Capacity reduction	Incidents	*incident.dat*	Traffic simulation
Work zone	Work zones	*WorkZone.dat*	Traffic simulation

7.7 Step 6 – System Data

The final step in creating a project is to specify the *system.dat* and *output_option* input files.

8. FREQUENTLY ASKED QUESTIONS

8.1 Why don't I ever see any difference between the "noinfo" and "overall" results from the Summary Statistics output file, even after changing the percentage of VMS responsive vehicles?

The reason why there is no difference between the "noinfo" and "overall" results in the Summary Statistics output file is that MUC class 5 (VMS-responsive) does not contribute to the "info" statistics. Only MUC class 4 (Enroute Info) contribute to the info statistics. As an illustration, consider the Dallas Fort Worth sample data set. Three scenarios were conducted with loading done via the O-D demand table.

1. 100% En-route info (MUC Class 4)
2. 100% VMS-responsive (MUC Class 5)
3. 50% En-route info (MUC Class 4) and 50% VMS-responsive (MUC Class 5)

In Scenario 1, the average travel time is 35.38, and reflects vehicles receiving info. In Scenario 2, the average travel time for VMS-responsive vehicles is 21.83 minutes, and is regarded as no-info. The third scenario indicates both info and noinfo statistics.

```
AVERAGE TRAVEL TIMES (MINS)
    OVERALL    :      35.5822
    NOINFO     :       0.0000
    1 stop     :       0.0000
    2 stops    :       0.0000
    3 stops    :       0.0000
    INFO       :      35.5822
    1 stop     :      35.5822
    2 stops    :       0.0000
    3 stops    :       0.0000
```

Scenario 1: 100% En-route info

```
AVERAGE TRAVEL TIMES (MINS)
    OVERALL    :      21.8385
    NOINFO     :      21.8385
    1 stop     :      21.8385
    2 stops    :       0.0000
    3 stops    :       0.0000
    INFO       :       0.0000
    1 stop     :       0.0000
    2 stops    :       0.0000
    3 stops    :       0.0000
```

Scenario 2: 100% VMS responsive

```
AVERAGE TRAVEL TIMES (MINS)
    OVERALL    :      17.2985
    NOINFO     :      13.8708
    1 stop     :      13.8708
    2 stops    :       0.0000
    3 stops    :       0.0000
    INFO       :      20.6922
    1 stop     :      20.6922
    2 stops    :       0.0000
    3 stops    :       0.0000
```

Scenario 3: 50% Enroute info and 50% VMS-responsive

8.2 Do I have to run the model to be able to view the network graphically (nodes, links, zones, traffic controls, work zones, VMS, etc)?

You can view the physical network without actually executing the model, as long as the following files are present: *xy.dat* and *linkxy.dat*. Simply click the upload button  located in the DYNASMART-P toolbar, or click File | Load Network Data menu command.

8.3 How can I export time-dependent performance data for a given link, or for the network?

You can extract link performance data for any link or the network by selecting Scenario | Export Link Performance Data, or Scenario | Export Network Performance Data.

8.4 Why doesn't the speed profile show speeds above 65 mph, when I specified an 80 mph VMS speed advisory on the link?

The reason why the time-dependent speed remained at 65 mph is that the speed limit for that link is probably 65 mph to begin with. Therefore, a vehicle cannot physically move at a speed higher than 65 mph.

8.5 Why does assigning random paths to vehicles (instead of the best path) result in a reduced network travel time?

While it may seem puzzling, assigning the best path to vehicles when they are generated does not guarantee that these paths will remain optimal at the end of simulation, in the one-shot simulation-assignment. Such a procedure merely assigns a path to each vehicle once it is generated, and unless this vehicle receives enroute information or encounters a VMS, this vehicle will be forced to maintain its assigned path for the complete simulation. These paths will invariably cease to become the shortest paths as the simulation progresses. Such an assignment procedure (without running UE or SO) does not take into account traffic evolution in the network at future time intervals. Hence it may not result in the best overall network-wide travel times, unless the network congestion level is extremely light.

8.6 Why does increasing the number of simulation intervals for calculating shortest paths cause severe congestion?

Increasing the number of simulation intervals for calculating the shortest path means that the shortest path tree will be calculated less frequently, and this usually results in a shortest path tree that is not best reflective of actual conditions. Therefore, during certain assignment intervals, some vehicles will be assigned a path that would not necessarily correspond to the actual time-varying shortest path. Some vehicles might be assigned non-optimal paths as though they were optimal. In any case, it is advisable to keep the number of simulation intervals for calculating the shortest path at 30 simulation intervals (or 3 min). This number was obtained after an extensive sensitivity analysis.

8.7 Why does specifying all vehicles to receive enroute info sometimes result in a greater network-wide travel time than when specifying all vehicles to be non-responsive?

Enroute information operations are complex, and difficult to analyze. It takes into account several parameters such as the Threshold Bound for Switching Decisions (minutes) and the Indifference Band (% improvement). Vehicles receiving en-route information attempt path switching at every intersection based on the boundedly rational decision (both of the above mentioned criteria). Therefore, route switching might be a disadvantage if the Threshold Bound for Switching Decisions or the Indifference Band (% improvement) were at very low settings. Moreover, the boundedly rational behavior algorithm is greedy in nature, and does not look into the future when assigning new paths to vehicles.

8.8 Do all user classes respond to VMS information, or just VMS-Responsive vehicles?

If the user selects <VMS Preemption Mode> within Scenario | Advanced Settings…, then all user classes except the non-responsive class will respond to VMS. If <VMS Preemption Mode> is not selected, then only VMS-responsive vehicles will respond to VMS information.

8.9 Why are the vehicle type proportions in *SummaryStat.dat* different than what I have entered in *Scenario.dat,* or the Scenario | Parameters & Capabilities… window?

Vehicle type proportions entered in *scenario.dat* or the Scenario | Parameters & Capabilities… window only reflect average (mean) values. Due to the inherent randomness in DYNASMART-P, simulated values are often slightly different than what have been specified.

8.10 Why did the total number of loaded vehicles increase when I increased the capacities in Y*ieldCap.dat* (which has nothing to do with the demand level)?

Demand.dat specifies the total number of vehicles to be ultimately loaded. However, DYNASMART-P loads vehicles in the middle of "generation" links. If these "generation" links are congested, or have no physical capacity to accommodate additional vehicles for a given loading time, then these vehicles will be stored in a virtual entry queue. They will only be discharged onto the physical network if enough downstream capacity exists. Increasing the capacities in *YieldCap.dat* might have created instances where the capacity on certain generation links was increased relative to the original scenario, resulting in more vehicles actually loaded onto the network.

8.11 Why do I need to include vehicle + path files for operational planning analysis runs (for example, when evaluating the impact of an incident or any other scenario on traffic patterns)?

Incidents are characterized by relatively short durations that typically would not allow traffic to react (by changing routes, unless they receive some kind of traffic info) in response to the incident. Therefore, by running subsequent scenarios using the vehicle + path files obtained from the base case run with O-D demand, the exact impact of the incident on the network becomes evident. Without including the path file, DYNASMART-P would simply re-assign vehicles to better paths (which may be different than the original paths) reflecting prevailing network supply and information conditions, which for operational planning purposes, would not capture the desired impact. Additionally, statistics for incident impacted vehicles are provided in the SummaryStat.dat file. The same reasoning applies for all other scenarios, such as assessing the impact of work zones, grade length, saturation flow rates, discharge rates, left-turn capacities, etc.

8.12 The documentation for *origin.dat* mentions that "freeway links should not be modeled as generation links". Why doesn't coding a freeway link as a generation link generate any error message?

Freeways are not recommended to be generation links, as vehicles generally start their trip on surface streets before reaching the freeway. However, there is nothing to preclude using freeway links as generation links. In particular, those on the boundary of the network may be used to generate inter-state traffic demand. Nevertheless, DYNASMART-P outputs a warning message to *warning.dat* in this situation.

8.13 How can I get impacted statistics (local statistics) for a link that has no work zone and no incident?

It is possible to specify a "dummy" incident (or a work zone), but with a very small severity (such as 0.01) on the link in question. DYNASMART-P will generate statistics for those vehicles impacted by this link, due to the presence of this "dummy" incident (or work zone).

8.14 Why am I observing counterintuitive results?

1. Double check whether loading was done via the vehicle + path files instead of the O-D demand table.
2. Double check to see if the best path option was selected (Scenario | Advanced Settings…).

8.15 When loading via *vehicle.dat,* why am I not observing different results than when loading with the O-D demand?

Loading via *vehicle.dat* only is exactly the same as loading via *demand.dat* in that DYNASMART-P will assign a path to each vehicle. To see this, one can easily load via *demand.dat* and perform a one-shot simulation, then compare the results to loading via the *vehicle.dat* only.

8.16 Why do I see no vehicle particles (animation) moving on a link, but the GUI shows a significant queue on that link?

This only happens if the link is a generation link and does not receive upstream traffic from any other link. This is due to the fact that vehicles generated on this link start their journey at the downstream end of this link, from the GUI perspective. And since this link does not receive traffic from other links, no vehicles will be shown traversing that link. Nonetheless, from a DYNASMART-P perspective, vehicles are loaded on mid-links such that the queue calculations are correct.

8.17 Why does specifying different values of K (for shortest paths calculations) result in a different number of vehicles loaded on the network?

This is due to the inherent randomness in DYNASMART-P. However, the number of vehicles to be loaded for different values of K remains very similar.

8.18 How does changing the zone aggregation affect results?

Zonal aggregation actually has an effect on travel time. However, to observe any changes, loading must be done via the O-D demand table, and the aggregation flag must be set to 1 in *network.dat*.

8.19 Why does changing the link identification from 5 (arterial) to 1 (freeway) change the network travel time?

This is because on arterials, DYNASMART-P uses units of vehicles to discharge traffic at intersections. On freeways, PCEs are used, as is the norm in traffic engineering.

8.20 Why do I not observe any changes when I specify downgrades in the network?

In DYNASMART-P, only upgrades affect the ability of vehicles to quickly reach their desired free-flow speed. Downgrades have no effect on this.

8.21 I specified a K=3 in network.dat. Why am I getting 4 paths between a given O-D when I run iterative consistent assignment procedure, and activate the "show path" feature?

The number of shortest paths to be solved for (k) only applies for the one-shot simulation-assignment procedure. When an iterative assignment procedure is used, DYNASMART-P will add a new path between a given O-D at every iteration, according to the method of successive averages (MSA).

8.22 Why do I see a u-turn when displaying the equilibrium paths (routing policy assignment) for a given O-D?

DYNASMART-P, in general, deletes cycles in paths. However, there are 2 cases where DYNASMART-P allows a u-turn, namely: 1) to circumvent a prevented movement such as a prevented left-turn, and 2) when a vehicle is generated on an origin link but needs to go in the other direction to reach its destination. In these two cases, DYNASMART-P keeps the cycle in the path. Note that, at signalized intersections where a left-turn phase is specified, it is conceivable that the phase might not be active for a given time interval, Therefore, for this duration of time, the left-turn movement would be prevented. Hence, DYNASMART-P would allow a vehicle to make a u-turn to avoid waiting for the left-turn phase to be active. This is also a realization of the 1st case described above.

8.23 I specified an origin node and a destination node using the UE/SO display path utility (P). However, I observe paths that start far away from the origin node and do not terminate at the selected destination node. Why?

DYNASMART-P calculates the routing policy (equilibrium paths for iterative consistent procedure – UE/SO) from the centroids of an origin zone to that of a destination zone. The user would pick any node to locate an origin zone (DYNASMART-P would know which zone this node belongs to), and similarly would pick a destination node to locate a destination zone. However, DYNASMART-P does not show centroids on the network (as they are virtual). DYNASMART-P would only show the part of the path that starts from a generation link (downstream of the origin zone centroid) in the selected origin zone to a destination node (upstream of the destination zone centroid) in the selected destination zone. This destination node may not be the destination node selected by the user, as is the case for the origin node.

8.24 How does DYNASMART-P load vehicles onto the network?

DYNASMART-P loads vehicles on links. However, when a given link is congested or has little residual capacity, vehicles not yet generated are stored in a virtual entry queue until enough capacity is available. That is, not all vehicles to be generated might actually make it on to the network. The way DYNASMART-P loads vehicles is as follows. For each demand interval, DYNASMART-P computes the total demand. Furthermore, DYNASMART-P computes the demand generation rates in vehicles/second for each demand interval (say [0-5], [5-10], etc…) by dividing the total demand for that interval by the interval length. Then the fraction of total demand generated and attracted from and to each zone, respectively, is computed for all demand intervals. Then, the total number of lane-miles for all generation links within a zone is computed, and the fraction of lane-miles for each generation link is determined. This represents the probability that a link would generate a vehicle in its zone. Therefore, for each vehicle, DYNASMART-P determines probabilistically (via the use of random numbers) its origin zone, generation link, and destination zone. Finally, since DYNASMART-P adopts a simulation time step of six seconds, fractional vehicles might be generated. Here too, the fractional values are rounded off via the use of random numbers.

APPENDIX A – DYNASMART-P OPERATIONAL MODES: ALGORITHMIC ASPECTS

DYNASMART-P can be deployed to operate in three distinct modes. These modes differ mainly in the assignment component applied. In the first mode, vehicles are assigned to current-best-paths, random paths or any pre-determined paths (e.g. historical paths). In the second mode, a consistent iterative assignment procedure (UE and/or SO) is applied. The third mode is a day-to-day system evolution modeling framework. The first mode represents a one-step simulation-assignment procedure, while the second mode represents an iterative user equilibrium (UE) procedure. The third mode is a day-to-day system evolution modeling framework that interfaces the within-day simulation assignment with day-to-day behavior adjustment rules. Because the latter is still largely in the research realm, it is not provided in the current version of the software. A prototype implementation is described in Hu and Mahmassani (1997). In this section, the algorithmic aspects and modeling considerations of the first two modes are presented. The way in which each mode is activated in DYNASMART-P is described in detail in the user interface section of this guide.

Mode 1 (One-Step Simulation-Assignment Procedure)

This section introduces DYNASMART-P when executed as a one-step simulation-assignment. In this mode, DYNASMART-P operates as a fixed time step mesoscopic simulation-assignment model. It is designed to model traffic patterns and evaluate overall network performance, possibly under real-time information systems, for a given network configuration (including traffic control system) and given time-dependent demand pattern. The modeling approach integrates a traffic flow simulator, a network path processing component, user behavior rules, and information supply strategies.

In mode 1, DYNASMART-P can utilize two demand configurations: (1) the time-dependent O-D vehicular desires, and (2) disaggregate trip plans for each traveler. In the first case, DYNASMART-P loads vehicles based on the time-dependent O-D vehicular desires, and moves these vehicles until they reach their respective destinations. In the second case, DYNASMART-P moves vehicles according to their travel plans in a trip chain until they reach their final destinations. When any vehicle is at its intermediate destination, DYNASMART-P temporarily removes this vehicle from the network so that it no longer affects prevailing network conditions. When a vehicle is generated at its origin, or at any of its intermediate destinations, it is assigned based on user behavior rules to either the current best path, or a random path among a set of superior paths.

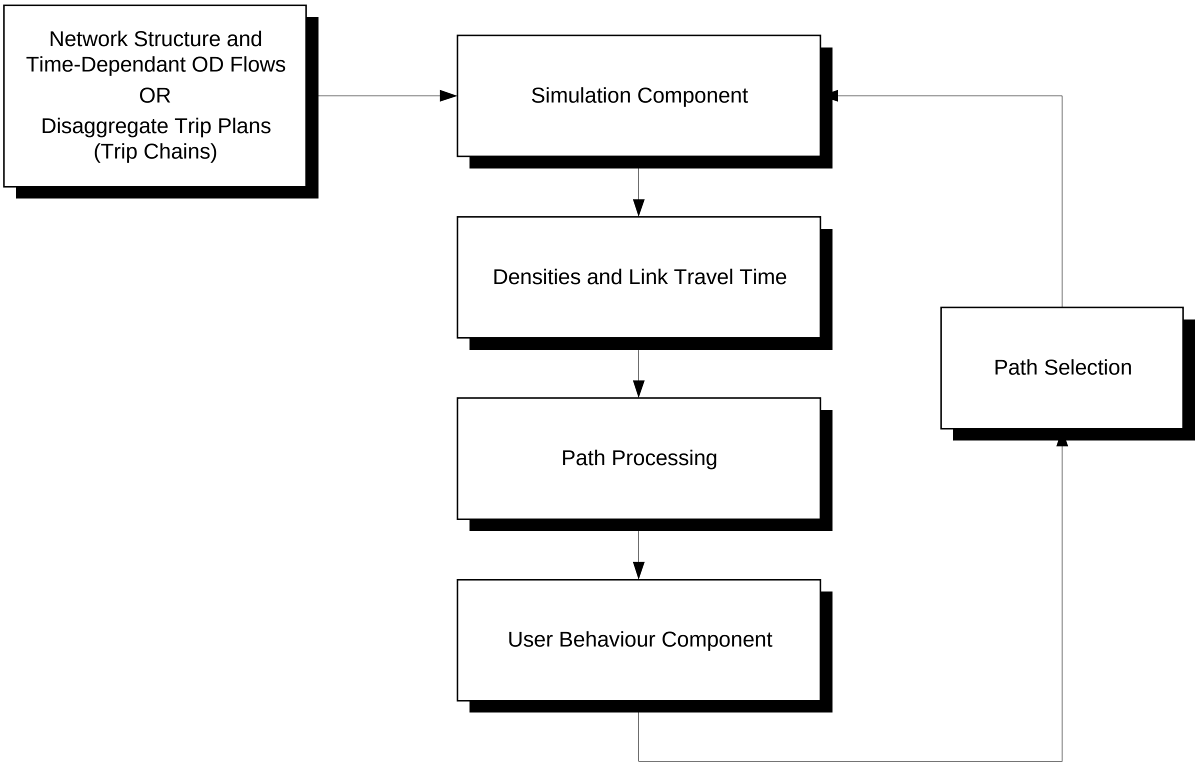


Figure A-1. DYNASMART-P (One-Step Simulation-Assignment Procedure)

Figure A-1 illustrates the overall structure of DYNASMART-P in mode 1. DYNASMART-P essentially relies on the same basic theory and offers the same core capabilities as the earlier DYNASMART, except that it can simulate activity/trip chains. A comprehensive discussion on these aspects of DYNASMART is presented in Mahmassani, Hu and Jayakrishnan (1992) and Mahmassani, Hu, Peeta and Ziliaskopoulos (1993).

Mode 2 (Iterative Simulation-Assignment)

As mentioned earlier, DYNASMART-P allows the user to solve for an equilibrium time-dependent flow pattern in the network. This section describes the algorithmic procedures for this second mode of operation.

Definition of Variables and Notations

The following notation is used to represent variables in the formulation:

i = subscript for origin node, $i \in I$,

j = subscript for destination node, $j \in J$,

t = superscript denoting current time interval, $t = 1,...,T$,

h = subscript denoting a travel pattern for a group of travelers at their origin, i.e., travelers who have the same intermediate and final stops, preferred arrival times, and activity duration (sojourn time), $h \in H$,

τ = superscript denoting departure time interval, $\tau = 1,...,T1$,

k = subscript for a path in the network that starts at trip origin i,

r_{ih}^{τ} = number of trips with travel pattern h generated at origin node i during departure time interval τ,

r_{ijk}^{τ} = number of travelers who depart from origin node i to destination j assigned to departure time interval τ and path k,

y_{ijk}^{τ} = auxiliary number of travelers who depart from origin node i to destination j assigned to departure time interval τ and path k, (number of travelers assigned to path k based on all-or-nothing assignment)

T^{ta} = travel time on link a at the beginning of period t, and

x^{ta} = total number of travelers on link a at the beginning of period t.

Problem Statement

Consider a traffic network with multiple origins $i \in I$ and destinations $j \in J$ represented by a directed graph G(N,A), where N is the set of nodes and A is the set of directed links. A node, in this network, can represent a trip origin, an intermediate destination, a final destination, and/or a junction of physical links. The analysis period of interest or the planning horizon T′ is discretized into small intervals t = 1,...,T and τ = 1,...,T1, where t is a superscript denoting current time interval and τ is a superscript denoting departure (or start) time interval.

Given the number of motorized travelers that have the same travel pattern h for the planning horizon at each origin i, r_{ih}^{τ} $\forall\ i \in I$, $\forall\ h \in H$ and $\forall\ \tau$. Travelers are defined to have the same origin, intermediate and final destinations, departure time, and activity duration (sojourn time) at each stop. The objective is to determine a time-dependent assignment of vehicles to the different network paths so as to minimize the travel time (or least generalized travel cost in case of link pricing consideration) for each individual traveler. Hence, the objective is to find the number of vehicles r_{ijk}^{τ} with travel pattern h that depart along path $k=1,...,k_{ih}$ at departure time interval τ, $\forall i \in I$, $\forall\ j \in J$, and τ=1,...,T1.

Solution Algorithm

This section presents the solution algorithm for the activity-based travel demand assignment problem. The solution algorithm is illustrated in Figure A-2. It is a heuristic iterative procedure in which a special purpose traffic simulation model is used to model activity-based travel, represent traffic interactions in the network, and evaluate system performance under a given assignment. For this purpose, DYNASMART has been modified to represent trip chains. In this modification, vehicles are permitted to exit the transportation network at intermediate destination(s) along their travel path to perform a particular activity for a time that is equal to the activity duration (sojourn time). While the vehicle is out of the network at any intermediate destination, it has no effect on traffic in the network. Upon completion of an activity, the tripmaker resumes its trip again from this destination to complete the trip according to its pre-specified travel pattern. Once the vehicle reaches its final destination, it exits the network. The steps of the algorithm are described below.

Step 0. Initialization. Set the iteration counter $\iota = 0$. Assign the activity-based demand, r_{ih}^{τ} $\forall$ i, τ, and h to initial set of feasible paths $k \in k_{ij,}$ where j is the first destination in the travel plan h. Accordingly, the initial solution is given by $r_{ijk}^{\tau,0}$, $\forall$ i, h, τ, and k.

Step 1. Under the set of departure time and path assignments $r_{ihk}^{\tau,\iota}$, perform traffic network simulation (using the modified DYNASMART) to obtain the corresponding network performance including link travel times, T^{ta}, $\forall$ t, a. Calculate also the new demand at each node, which is equal to $r_{ij}^{\tau,\iota} = \sum_k r_{ijk}^{\tau,\iota}$ $\forall$ i, j, and τ.

Step 2. For each departure time interval τ, compute the set of least travel time (or least generalized travel cost in case of link pricing consideration) paths between each origin-destination pair.

Step 3. Perform all or nothing assignment for all travel desires $r_{ij}^{\tau,\iota}$. This gives an auxiliary number of vehicles on paths for each departure time interval $y_{ijk^*}^{\tau^*,\iota}$, $\forall$ i, j and τ.

Step 4. Update the path by checking if $k^* \in k_{ij}$, and include it if it does not, $\forall$ i and h. Assignments for the next iteration $r_{ijk}^{\tau,\iota+1}$ are obtained using the method of successive averages, $\forall$ i, h, τ, and k:

$$r_{ijk}^{\tau,\iota+1} = \frac{1}{(\iota+1)} \cdot [y_{ijk}^{\tau,\iota}] + \left(1 - \frac{1}{(\iota+1)}\right) \cdot [r_{ijk}^{\tau,\iota}]$$

Step 5. Check the convergence criterion that is based on the difference in numbers of vehicles assigned to various departure time intervals and paths over two successive iterations. Hence, the assignments to the next iterations $r_{ihk}^{\tau,\iota+1}$ are compared with the current path assignments $r_{ijk}^{\tau,\iota}$, $\forall$ i, j, τ, and k:

$$\left| r_{ijk}^{\tau,\iota+1} - r_{ijk}^{\tau,i} \right| \le \varepsilon \qquad \text{where } \varepsilon \text{ is a predefined threshold.}$$

Step 6. The number of cases, N(ε), in which the above absolute value is greater than ε is recorded.

Step 7. Specify a pre-set upper bound, Ω, on the number of violations, N(ε), terminate the algorithm if the number N(ε)≤ Ω, and output the joint departure time-path assignments

$r_{ijk}^{\tau,\iota}$ as the solution to the assignment problem. On the other hand, if N(ε)>Ω, the convergence criterion is not satisfied. Update the iteration counter (ι=ι+1) and go to step 1 with the new path assignments $r_{ijk}^{\tau,\iota+1}$.

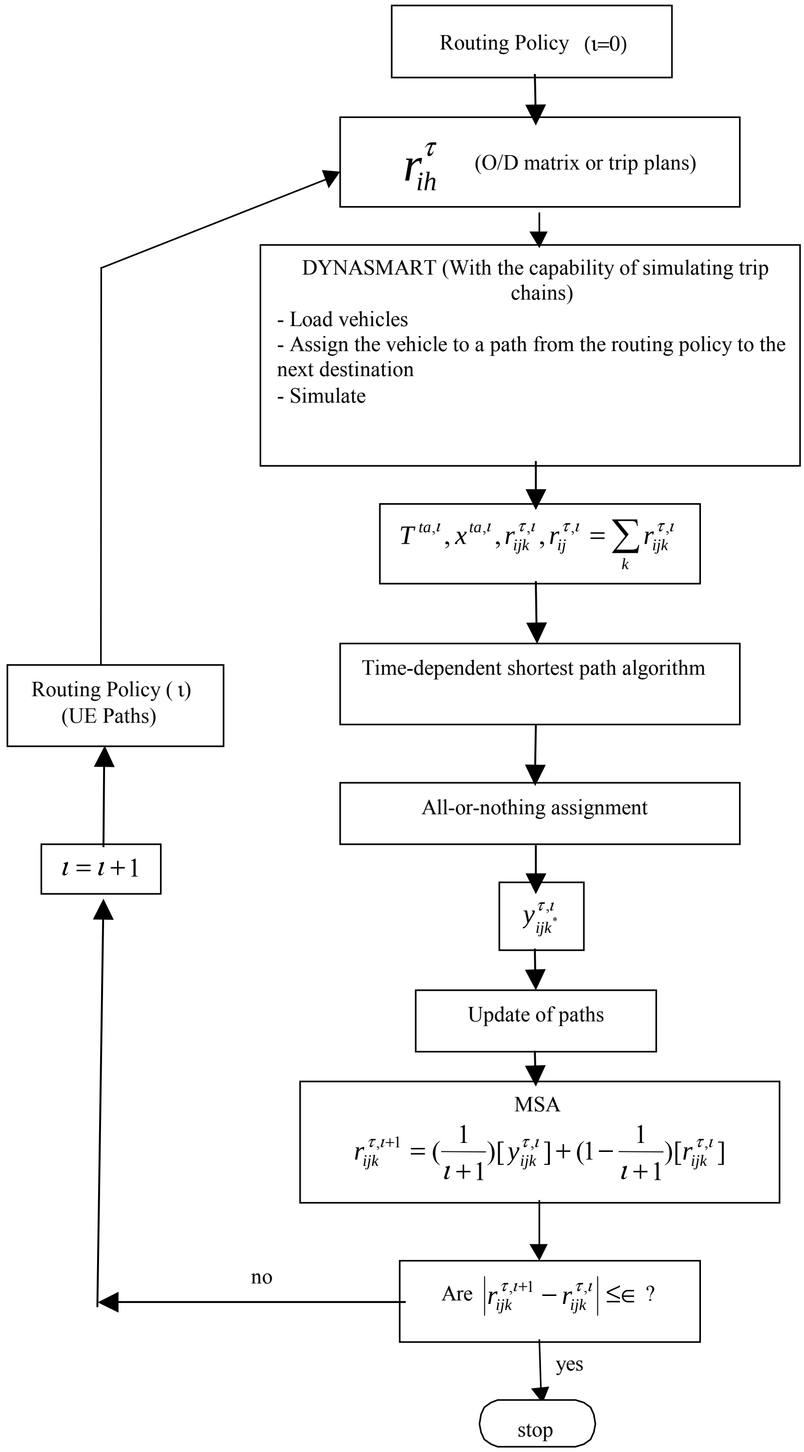


Figure A-2. The solution algorithm for DYNASMART-P (Iterative UE Procedure)

APPENDIX B – TROUBLESHOOTING

Error Message	allocate **** error - insufficient memory
Explanation	The program stops because there is insufficient memory to run the program
Possible Solutions	❑ Reduce the K-shortest path (general setting record type, field 4, network.dat) ❑ Reduce the network size ❑ Aggregate several TAZ to single super zone ❑ Reduce demand loading level by reducing the multiplication factor
Message	error in build muc path for vehicle a origin b destination c
Explanation	The program finds problematic paths when constructing initial path sets for MUC procedure
Possible Solutions	❑ When this error happens, it means the network topology has some problem. Two steps to proceed to solve the problem: ❑ Review network.dat and movement.dat, and make sure the network topology is correct ❑ If the error persists, record the error message and data sets, and contact technical support
Message	ERROR Number of vehicles in the network > nu_ve
Explanation	The number of generated vehicles exceeds the dynamic parameters specified by the program
Possible Solutions	This error should rarely occur, because the program usually provides sufficient resources for generating vehicles. Record the error message and data sets, and contact technical support.
Message	Error!! Possibly wrong setting in vehicle type in scenario.dat
Explanation	Mistakes in fleet composition in *scenario.dat* cause this error message
Possible Solutions	Review the vehicle fleet composition in *scenario.dat*
Message	Error in bus generation Check the destination for bus: a
Explanation	The last node in the bus paths is not a valid destination
Possible Solutions	1. Revise destination.dat to make the last node of the bus path a destination 2. Modify the bus path
Message	deallocate *** error
Explanation	Error happens when deallocating memory for *** array

Possible Solutions	Please record the error message and data sets and contact technical support
Message	Found invalid generation for zone a Please check *origin.dat*
Explanation	All of the generation links in zone a are isolated and cannot reach any destination
Possible Solutions	1. review network.dat, movement.dat and control.dat to make sure the network topology is correct 2. If the problem persists, please record the error message and data sets and contact technical support
Message	error in get_veh_path for vehicle j origin a destination b
Explanation	Vehicle j's path is not a valid path to reach its destination
Possible Solutions	1. Review the network.dat, movement.dat to make sure the network topology is correct 2. If the problem persists, please record the error message and data sets and contact technical support
Message	INPUT ERROR : Total number of vehicles to be loaded is zero Please check the following files depending on the demand generation mode *demand.dat* *vehicle.dat* *bus.dat*
Explanation	No vehicles are generated
Possible Solutions	Check *demand.dat*, *vehicle.dat* and *bus.dat* files

Message	Error in *network.dat* Check the destination settings for zone m
Explanation	Errors in *SuperZone.dat*. The mappings between the original zones and the super zones are not correct.
Possible Solutions	Review *SuperZone.dat*
Message	Isolated Centroid Found i
Explanation	Zone i doesn't have any destination specified in *destination.dat*
Possible Solutions	Add at least one destination node to zone i in *destination.dat*
Message	Check Free-Flow Speed for link i
Explanation	Free-flow speed for link i is problematic
Possible Solutions	Check link i in *network.dat*
Message	Check Saturation Flow for link i
Explanation	Satuation flow for link I is problematic
Possible Solutions	Check saturation flow for link i in *network.dat*
Message	Check Number of Lanes for link i
Explanation	Number of lanes for link i is problematic
Possible Solutions	Check number of lanes for link i in *network.dat*
Message	INPUT ERROR in network.dat check the link identification for link number i upstream node: downstream node: the value must be between 1 and 10
Explanation	The link ID for link i is out of the valid range
Possible Solutions	Check the link id field for link i in *network.dat*
Message	Error in destination.dat Found zone a contains no destination
Explanation	Zone a is not specified with any destination node in *destination.dat*
Possible Solutions	Add at least one destination node for zone a
Message	Only max 2 centroids that a connector Can connect to Review zone j node i

	in your *destination.dat*
Explanation	The maximum number of zones that a destination node can connect to is 2
Possible Solutions	Review *destination.dat* and remove node i from zone j in *destination.dat*
Message	INPUT ERROR : scenario data file kupstep is greater or equal to kspstep kupstep should be < kspstep
Explanation	The interval for calculating the K-shortest-path algorithm should be longer than that for updating the K-shortest path
Possible Solutions	Review *scenario.dat*
Message	ERROR : scenario data file Warmup time is >= planning horizon
Explanation	Planning horizon is less than warm up time
Possible Solutions	Review *scenario.dat* and move the start time for collecting statistics earlier
Message	INPUT ERROR : Found *scenario.dat* with HOV vehicles, but no HOV/HOT lanes are specified in *network.dat* check the link identification for all links the ID for HOT lanes is 6 or 9 the ID for HOV lanes is 8 or 10
Explanation	The vehicle type setting in *scenario.dat* indicates that the user wants to model HOV/HOT; however, no links are specified as HOV lanes in network.dat
Possible Solutions	Review either *network.dat* or *scenario.dat* to ensure consistency
Message	INPUT ERROR : Oversaturation on generation link
Explanation	The generation link is receiving more demand than it can physically accommodate
Possible Solutions	Assign additional generation links for the same demand zone, or add more lanes