DYNASMART-P

Intelligent Transportation Network Planning Tool

User's Guide

v1.3.0

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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 Information Systems
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 DYNASMART-P Version 1.3 User's Guide (*DSP User's Guide 1.3.pdf*) in electronic format for quick access;
- An execution planning tool file (*Planning.exe*), which can only be accessed from within the DYNASMART-P GUI;
- The DSPEd execution file (*DSPEd.exe*) and the DSPEd Version 1.3 User's Guide (*DSPEdUsersGuide1.3.pdf*);
- Two data sets namely, Fort_Worth_Data_Set and Knoxville_Data_Set with all of the input and output files;
- DYNASMART-P and DSPEd end-user license agreements (DSPEdLicense.pdf and DYNASMART-PLicense.pdf);
- A word document template (Log_Report_Template.doc) to report any bugs or problems with DYNASMART-P; and
- A disclaimer showing a list of known issues for DSPEd when editing or creating DYNASMART-P networks.

1.4 Technical Assistance

Feedback may be submitted by filling out a DYNASMART-P log report (Figure 1-2) and emailing it to *mctrans@ce.ufl.edu*. An MS WORD document template has been provided with DYNASMART-P installation and is located under the DYNASMART-P directory.

DYNASMART-P PROBLEM REPORT[1]

Log No:________________________________ **Date:**____________

Name:________________________________ **Phone:**___________

Company:______________________________

Registration No:_________________________

City:__________________________________

E-Mail:________________________________

Operating System:_______________________

Processor:_____________________________

Display Resolution:______________________

RAM: _________________________________

Disk Storage: ___________________________

Version No.:____________________________

Data Set(s): ____________________________

Problem Type: *(Highlight one or more below)*

1. Malfunction	*2. Invalid*	*3. Deficiency*	*4. Installation*
5.Input/Output	*6. Documentation*	*7. Suggestion*	*8. Query Results*

Problem Severity *(Highlight one below)*

1. Fatal	*2. Fundamental*	*3. Serious*	*4. Minor*

Detailed Description:

Suggested Correction Action *(Optional):*

Figure 1-2. DYNASMART-P problem report template

[1] Email this report to: mctrans@ce.ufl.edu

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 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 microsimulation-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 must 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. 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, drivers' 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 is also capable of specifying time-dependent costs for different link types (HOV, HOT, or regular).

2.11 Network Familiarity and Information Strategies

DYNASMART-P does not explicitly model drivers' knowledge of the network. However, given that drivers' 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 Memory Usage

Five networks were used to test the memory usage requirements for DYNASMART-P (Table 2-1). Two assignment modes were considered, namely one-shot simulation assignment and iterative consistent assignment (100% UE in this case). Two path processing procedures were considered, namely the default and sequential loading modes. No super zones were used. The memory usage results are summarized in Table 2-1 and Table 2-2. Note that these results were obtained using DYNASMART-P version 1.3 on a Pentium 4, 2.8 GHz, 4GB RAM DELL DIMENSION 4700. These results are by no means a lower bound on memory requirements. Effort is still underway in the quest to minimize memory usage.

Table 2-1. DYNASMART-P test networks

Network	*No. of Nodes*	*No. of Links*	*No. of Zones*	*No. Vehicles*
Fort Worth, TX	180	445	13	47279
Irvine, CA	326	626	61	44756
Knoxville, TN	1347	3004	356	117016
CHART, MD	2182	3387	111	111565
Portland, OR	5823	14722	1244	342638

Table 2-2. DYNASMART-P memory usage

Network	*Assignment Mode*	*Aggregation Interval (min)*	*Assignment Interval (min)*	*Memory Usage*	
				Default Loading Mode	*Sequential Loading Mode*
Fort Worth, TX	One-shot	N/A	N/A	32 MB	30 MB
	100% UE	1	1	80 MB	67 MB
Irvine, CA	One-shot	N/A	N/A	48 MB	37 MB
	100% UE	1	1	140 MB	116 MB
Knoxville, TN	One-shot	N/A	N/A	400 MB	122 MB
	100% UE	1	1	842 MB	740 MB
CHART, MD	One-shot	N/A	N/A	383 MB	267 MB
	100% UE	1	1	752 MB	633 MB
Portland, OR	One-shot	N/A	N/A	N/A	342 MB
	100% UE	5	5	N/A	1.08 GB

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 or Windows 2000
- ❑ 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 versions of Windows, 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.

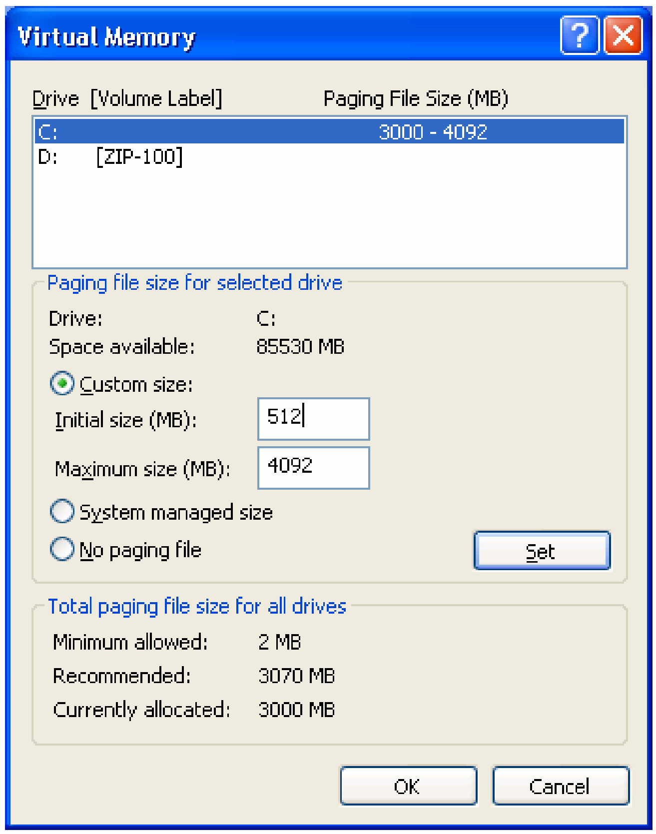

Figure 3-1. Virtual memory dialog box

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 CD into the CD-ROM drive.

2. The DYNASMART-P installation wizard will be launched automatically. If installation fails to start, locate and double-click the Setup.exe file in the DYNASMART-P CD.
3. Follow the instructions of the wizard.
4. Upon installation, a DYNASMART-P 1.3 folder in C:\Program Files\FHWA as well as a DYNASMART-P 1.3 shortcut folder in the Windows Start | All Programs Menu will be created.
5. The wizard will inform you when the install process is complete.
6. After DYNASMART-P installation, the DYNASMART-P Editor (DSPEd) installation program will be automatically launched. If installation fails to start, locate and double-click the DSPEdSetup.exe file in the DYNASMART-P CD.
7. Follow the instructions of the wizard.
8. Upon installation, a DSPEd folder (in C:\Program Files\FHWA) and a DSPEd shortcut folder (in the Windows Start | All Programs Menu) will be created.
9. You are now ready to use DYNASMART-P and DSPEd. Refer to the DSPEd user's guide for information on how to use DSPEd.

If the user does not have an administrator account or write-access to the folder Program Files, it may not be possible to install to the default folder under C:\Program Files. In this case it would be necessary to choose another folder where write-access is granted to install DYNASMART-P. Moreover, if DYNASMART-P is already installed to a folder accessible by the administrator (such as C:\Program Files), then limited user accounts are generally not allowed to access (modify) the DYNASMART-P input files. In this case, it is recommended to copy any input datasets to other folders where the user has complete write-access.

3.3.1 Large Address Allocation Switch

Under 32-bit Windows operating systems (Windows 2000, Windows XP, Windows 2003 server professional and enterprise version), regular 32-bit applications can only use up to 2GB of RAM memory. In fact, the maximum memory address range for a 32-bit processor is 4GB, and under normal settings a maximum of 2 GB is allocated for a single application. The remaining memory is reserved for the system kernel process. In order to allow DYNASMART-P 1.3 application to use up to 3 GB of RAM memory, users need to add "/3GB" switch in C:\boot.ini file to the following line as follows:

```
multi(0)disk(0)rdisk(0)partition(2)\WINDOWS="Microsoft Windows XP
Professional" /noexecute=optin /fastdetect /3GB
```

For earlier DYNASMART-P versions, in addition to the "/3GB" switch in C:\boot.ini file, users would need to add an "/Image_File_Large_Address_Aware" flag in the binary file of the user application. This can be done by modifying the existing binary file externally; by using **editbin.exe** or **imagecfg.exe** programs (provided by Microsoft) to add a "**/LARGEADDRESSAWARE**" flag to the executable through the command line. **Editbin.exe** is typically located in "**C:\Program Files\Microsoft Visual Studio\VC98\Bin**". **Imagecfg.exe** can be found in the server resource kit CD for Windows 2000 and Windows 2003 server versions. Microsoft provides detailed explanations for this large memory feature in the following URL: http://support.microsoft.com/default.aspx?scid=kb;EN-US;297812

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 | All Programs menu command.
2. Locate the <<DYNASMART-P 1.3>> program menu.
3. Click on the <<Uninstall DYNASMART-P 1.3>> option.
4. Follow the instructions.
5. 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 1.3 icon from the Start | All Programs Windows XP menu command (Figure 3-2).

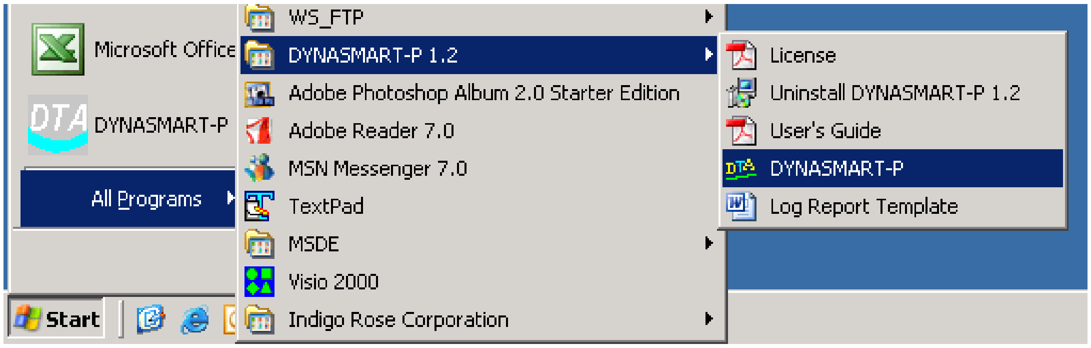

Figure 3-2. DYNASMART-P application menu

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.

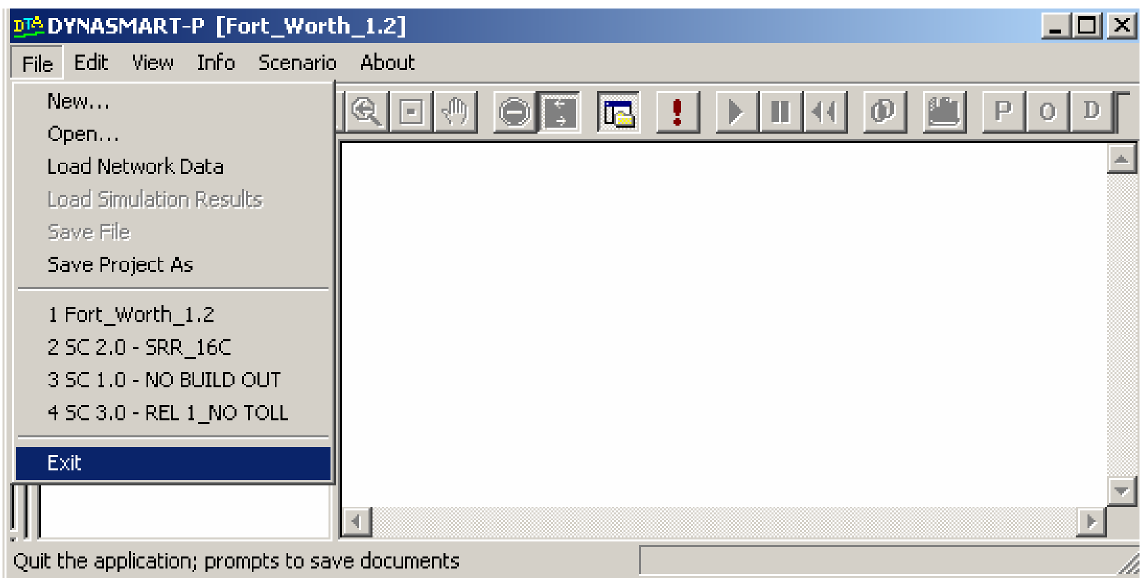

Figure 3-3. DYNASMART-P file menu

3.6 Sample Session

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).

3.6.1 Step 1: Launch the DYNASMART-P Application

Click on the DYNASMART-P 1.3 icon from the Start | All Programs menu (Figure 3-4.

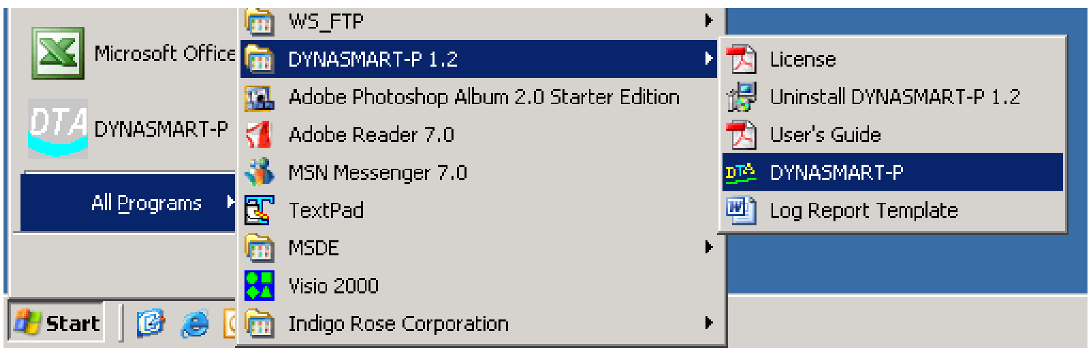

Figure 3-4. DYNASMART-P application menu

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

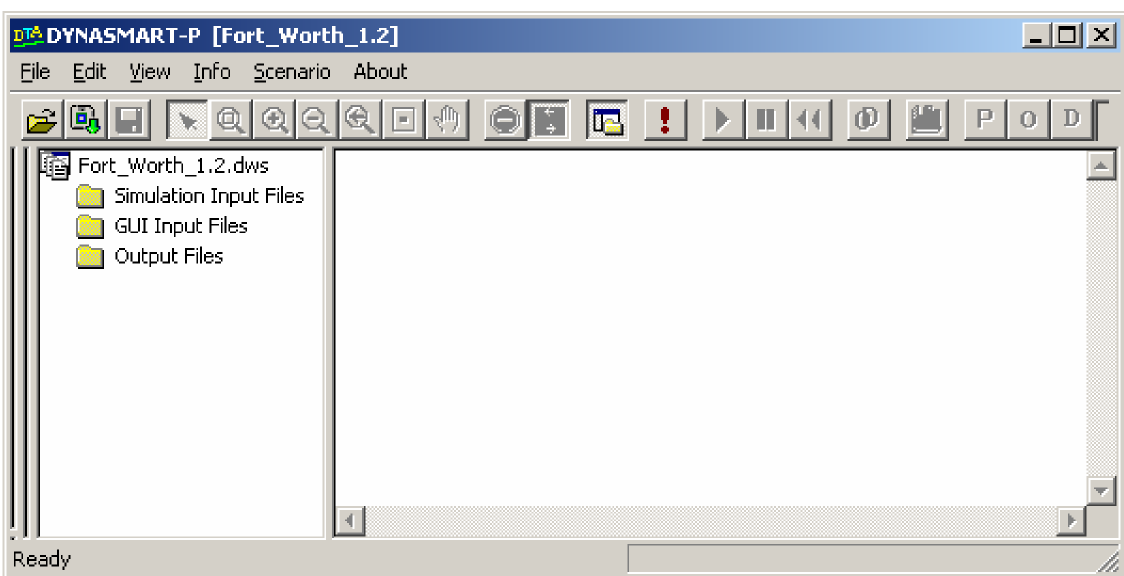

Figure 3-5. DYNASMART-P start-up window

3.6.2 Step 2: Open a Project Workspace

Select the File | Open… menu command (Figure 3-6) or select the open project button  on the DYNASMART-P tool bar):

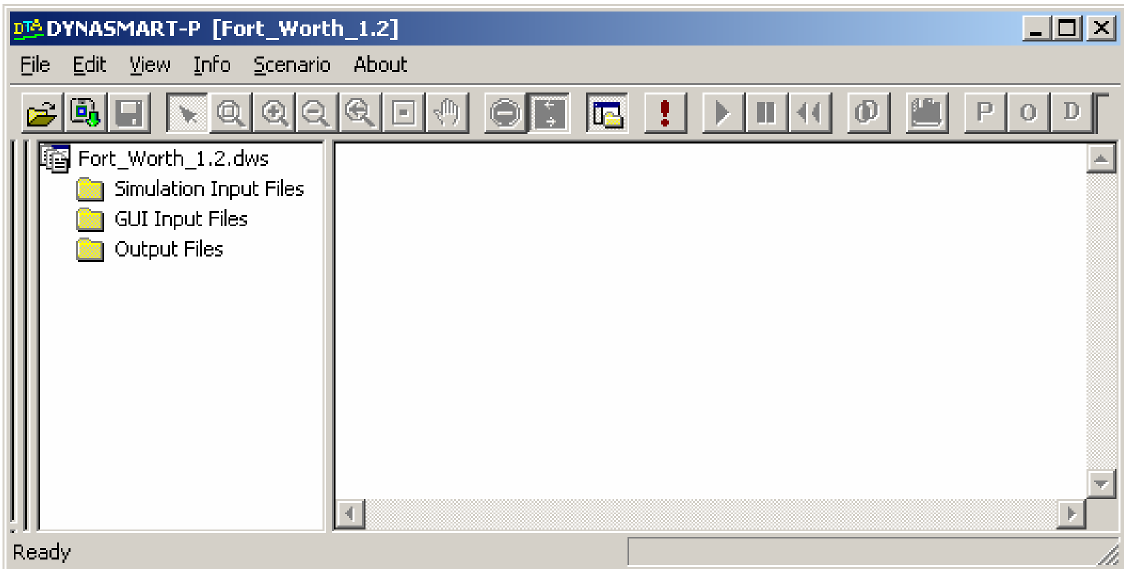

Figure 3-6. DYNASMART-P file menu

The <Open> dialog box will pop up. Locate and double-click on the folder C:\Program Files\FHWA\DYNASMART-P 1.2\Fort_Worth_Data_Set_1.2. Select the file *Fort_Worth_Data_Set_1.2.dws* and click <<Open>> (Figure 3-7).

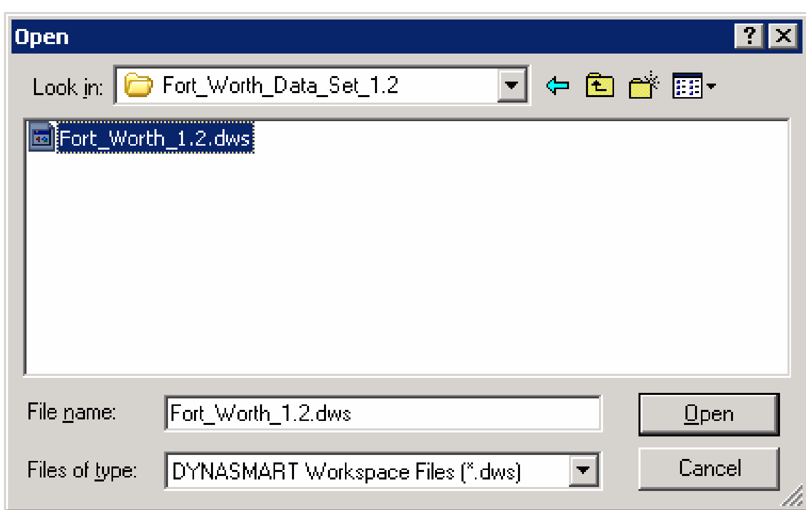

Figure 3-7. Fort_Worth_Data_Set_1.2.dws file

The Fort Worth data set will be loaded and the associated input files will be shown on the file tree window (Figure 3-8).

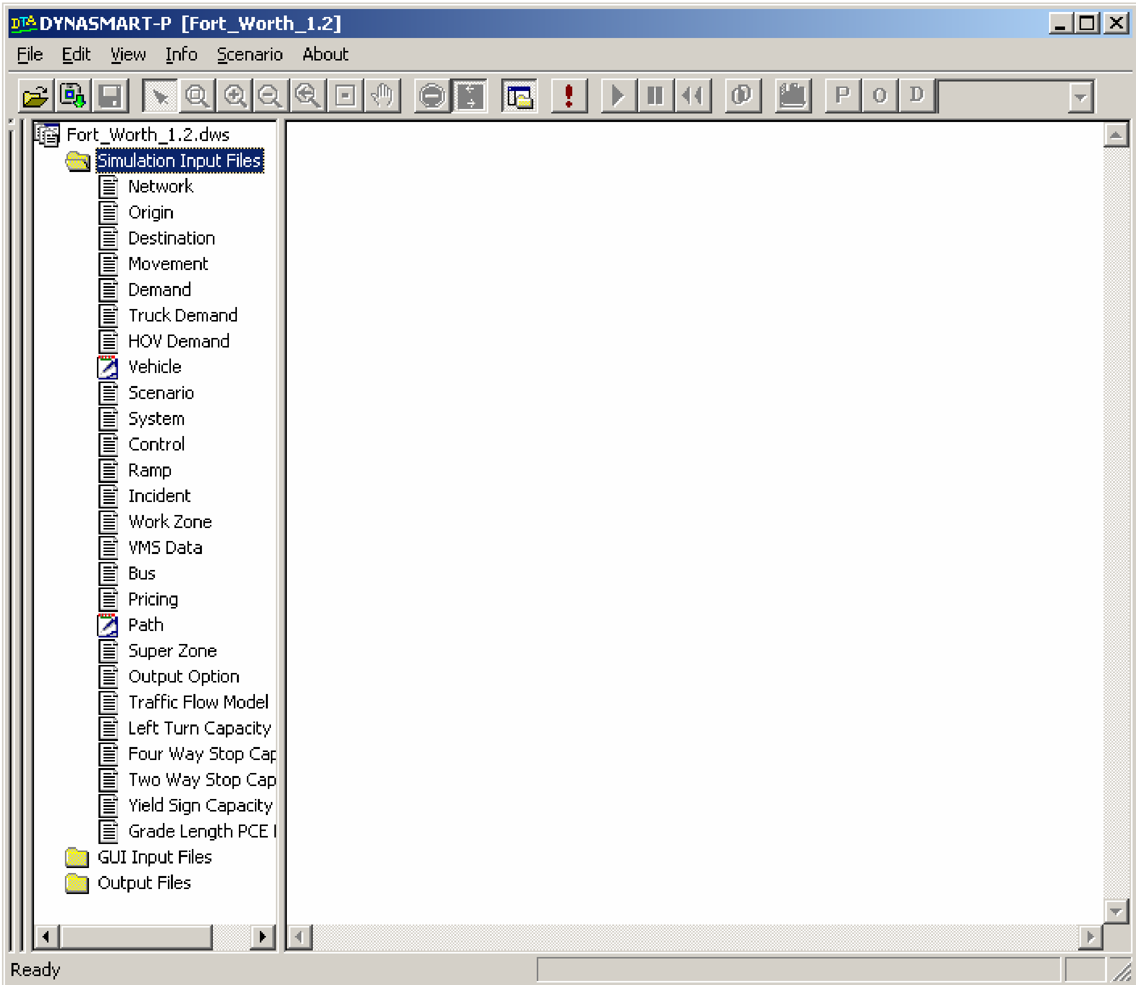

Figure 3-8. Fort_Worth_1.2 loaded data set

3.6.3 Step 3: Specify Scenario Parameters and Capabilities

Select the Scenario | Parameter and Capabilities… menu command (Figure 3-9).

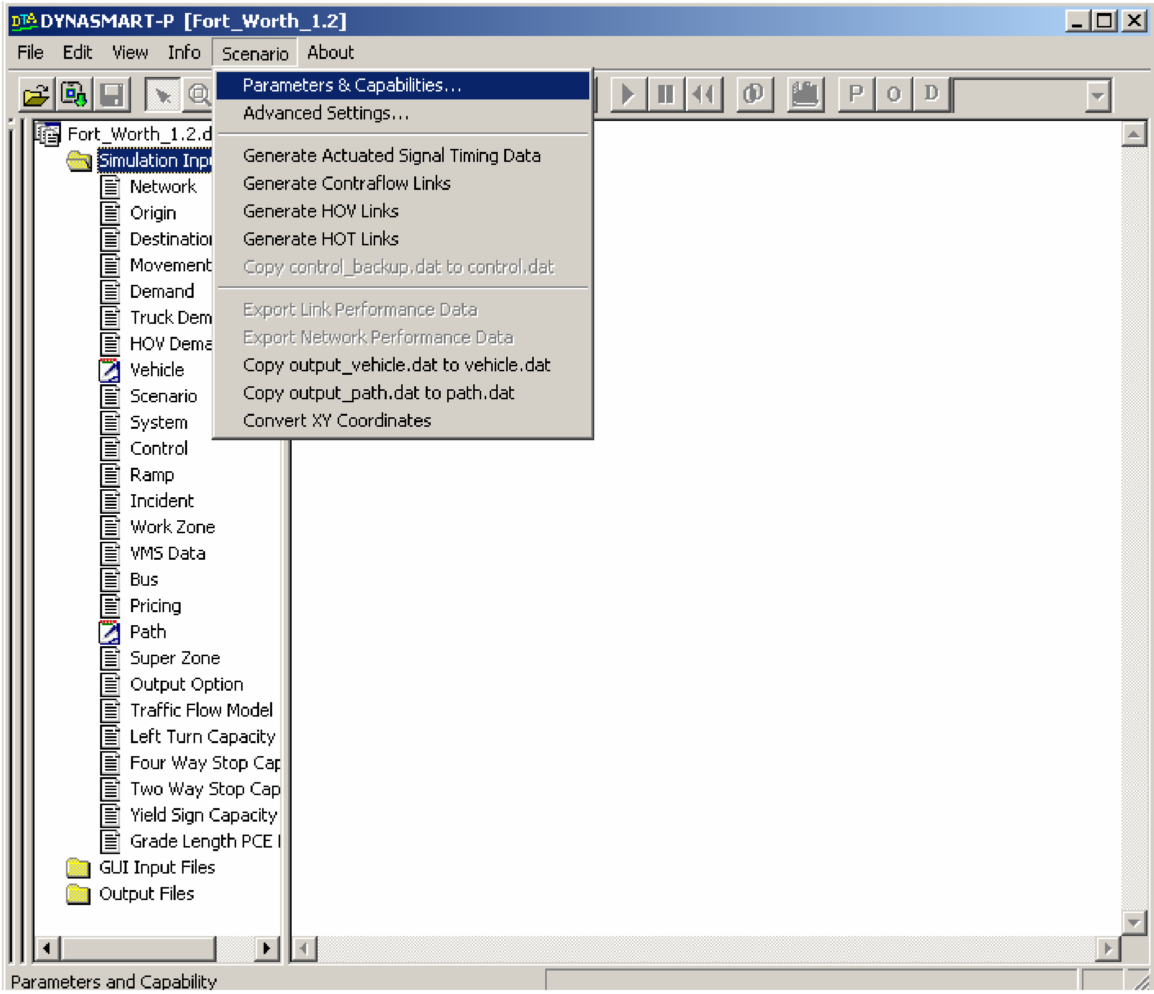

Figure 3-9. Parameter and capabilities menu command

This will launch the <Parameter Settings> dialog box (Figure 3-10). By default, the one-shot simulation-assignment solution mode is selected. As the name implies, 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.

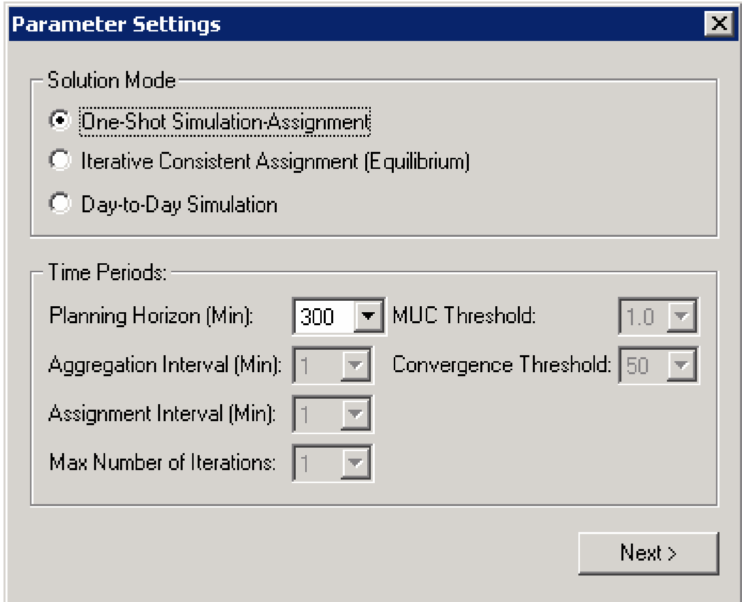

Figure 3-10. DYNASMART-P parameter settings dialog box

Click on <<Next>> to proceed to the <Capability Selection> dialog box (Figure 3-11).

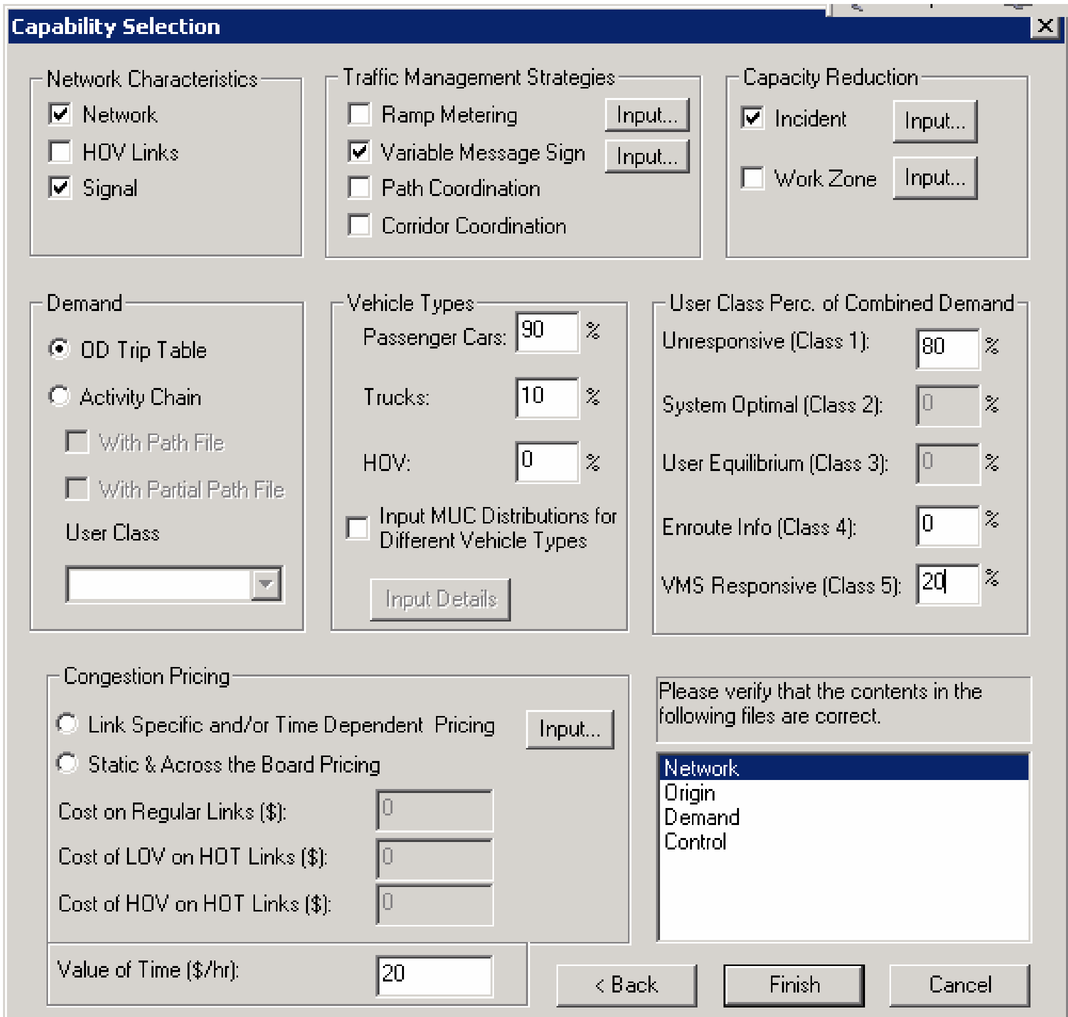

Figure 3-11. Capabilities selection dialog box

Input data should be specified 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. Experiment with the <<Add>> and <<Delete>> buttons. Specify a congestion warning type VMS on link 105, starting at minute 0 and ending at minute 300, 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 3-12). Click <<OK>> to proceed. This will cause DYNASMART-P to revert back to the <Capabilities Selection> dialog box.

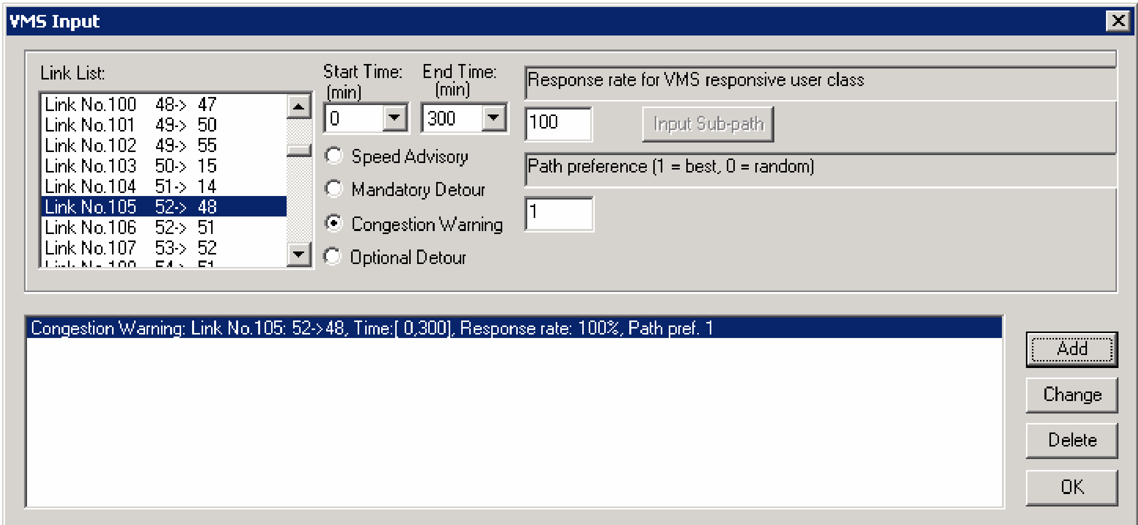

Figure 3-12. VMS input dialog box

In the [Vehicle Types] data block (Figure 3-11) 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 3-13). 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 link capacity by 60%) on link 99, starting at minute 20 and ending at minute 30. Note that the time here refers to simulation time and not actual clock time. Click <<OK>> to revert back to the <Capabilities Selection> dialog box.

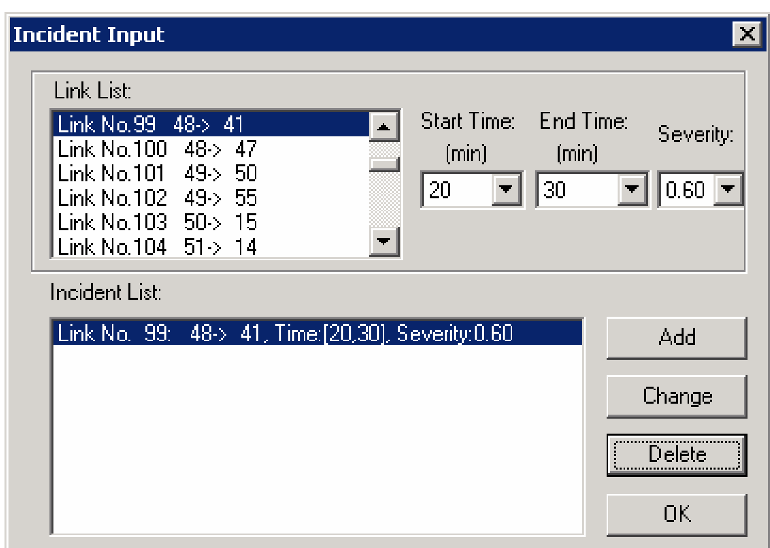

Figure 3-13. Incident input dialog box

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

3.6.4 Step 4: Specify Advanced Settings

Select the Scenario | Advanced Settings… menu command (Figure 3-14). Doing so will launch the <Advanced Settings> dialog box (Figure 3-15).

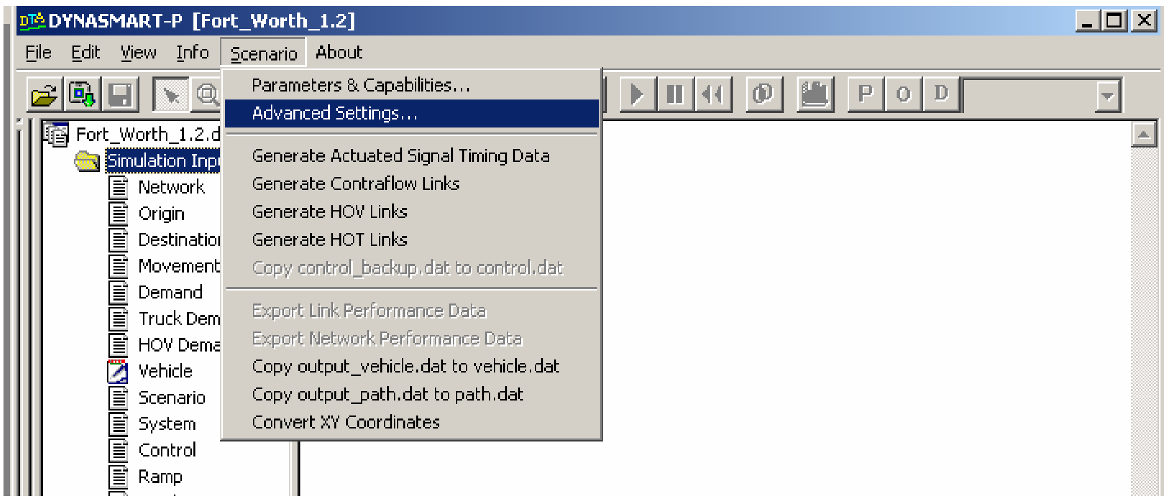

Figure 3-14. Advanced settings command in Scenario menu

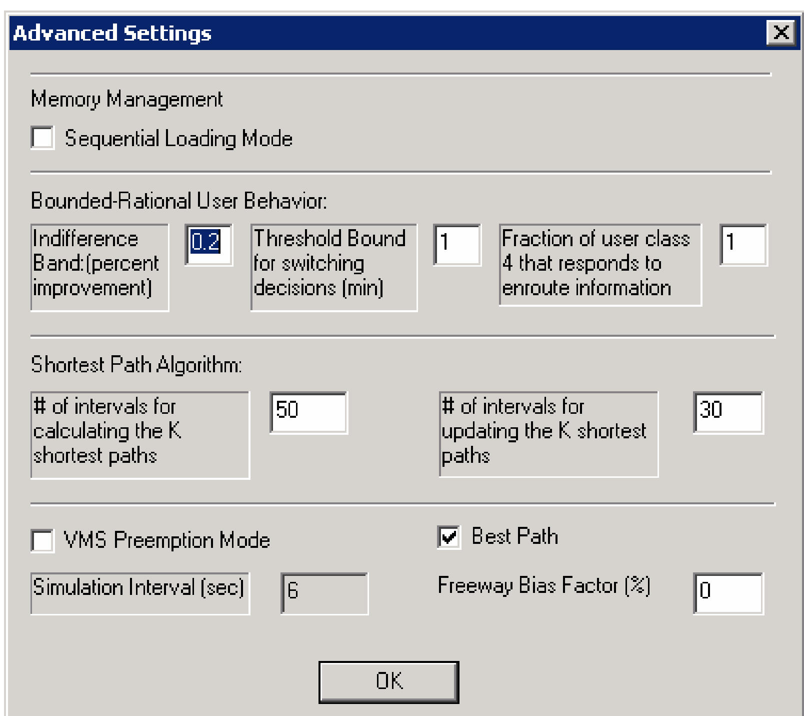

Figure 3-15. Advanced settings dialog box

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.

3.6.5 Step 5: 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 3-16) will pop up.

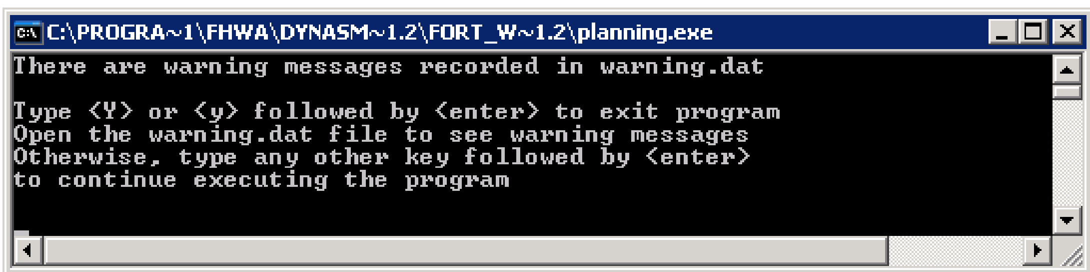

Figure 3-16. Warning messages console window

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 3-17).

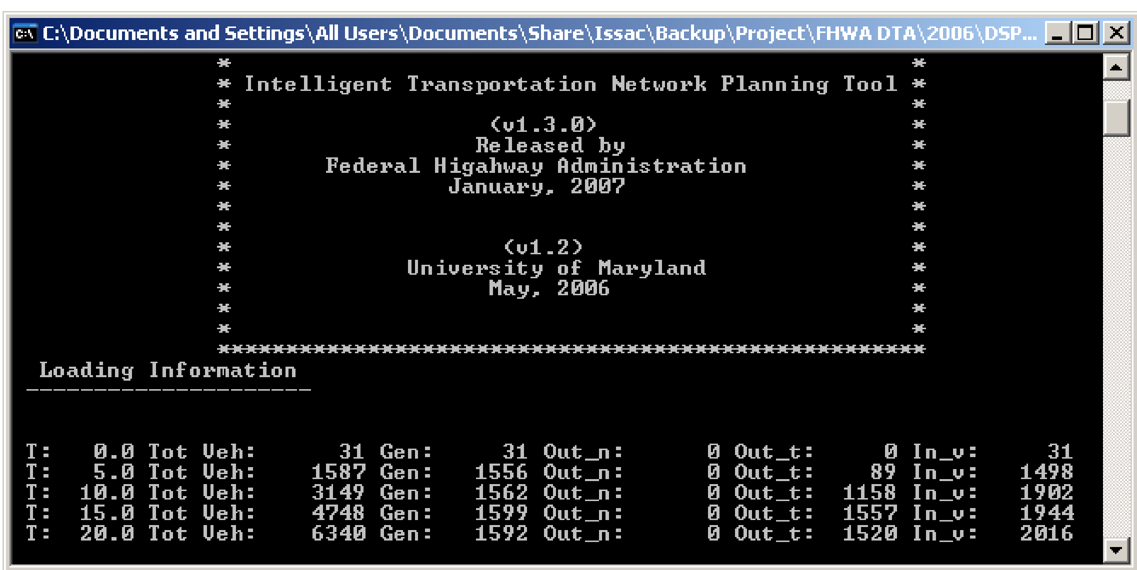

Figure 3-17. Execution window

Upon completion, a <DYNASMART-P> pop-up message (Figure 3-18) will appear indicating completion of the simulation run, and showing the program execution time. Click on the <<Yes>> button to immediately load animation results.

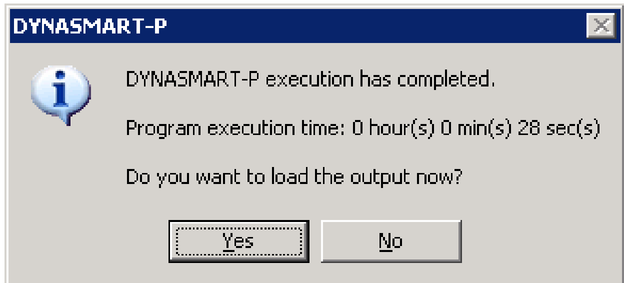

Figure 3-18. Output loading confirmation dialog box

Users should see the output view as shown below (Figure 3-19).

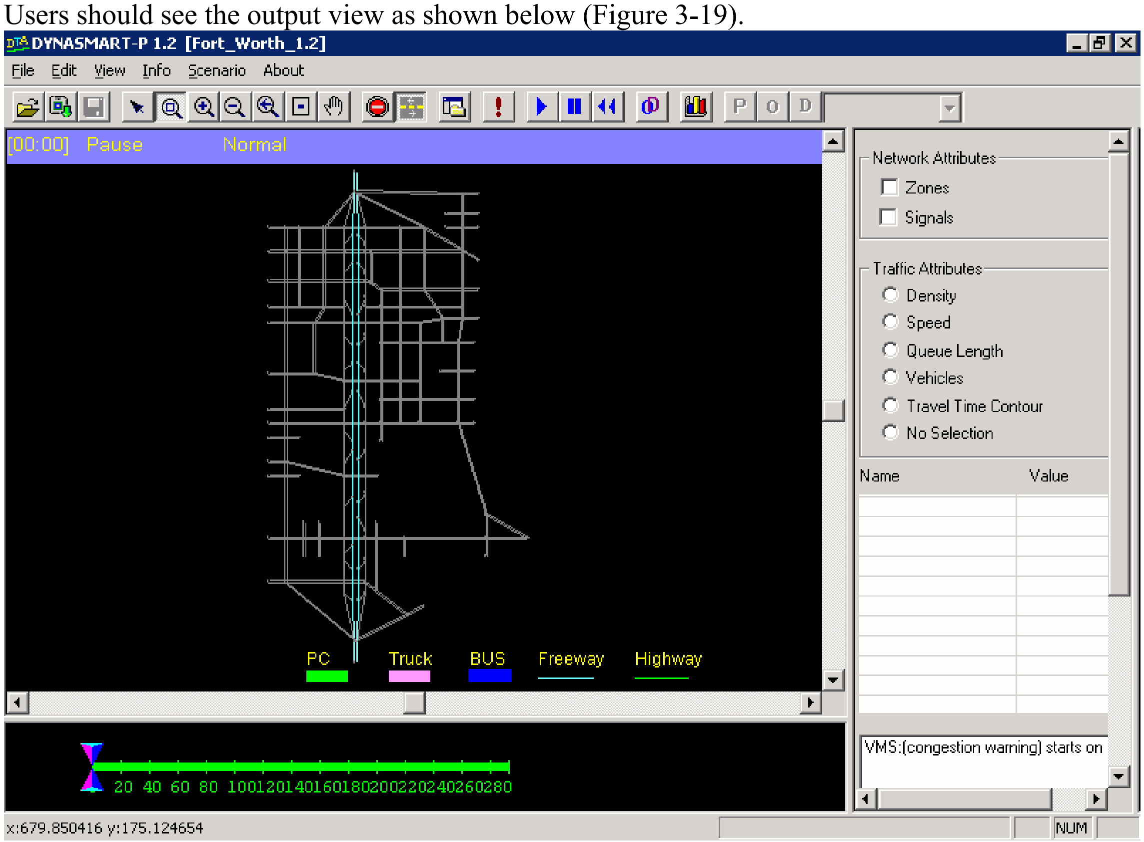

Figure 3-19. Output view

3.6.6 Step 6: View Simulation Results

In the [Traffic Attributes] section of the output view window, check the <<Vehicles>> option and then click the icon on the toolbar to view post-execution simulation results (Figure 3-20). 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.

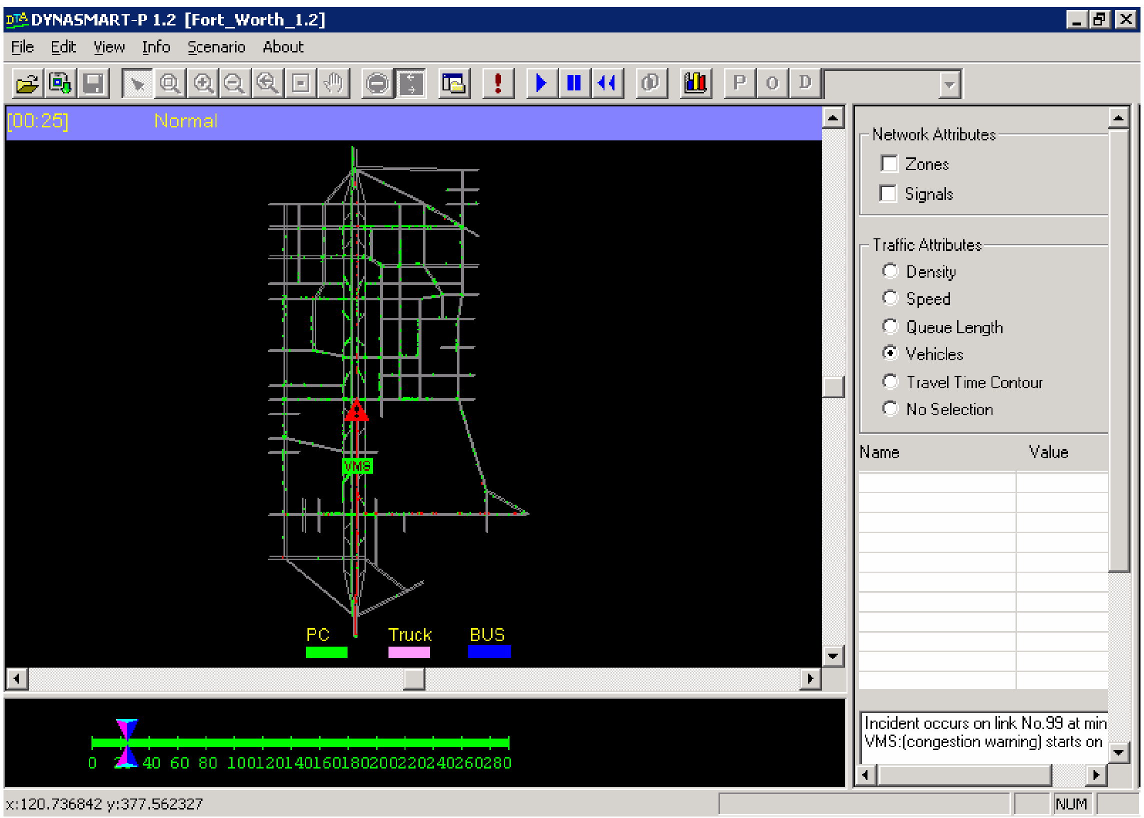

Figure 3-20. Vehicle animation of the simulation results

3.6.7 Step 7: 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 3-21). 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 inputs specified for the simulation run. Input data are subdivided 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

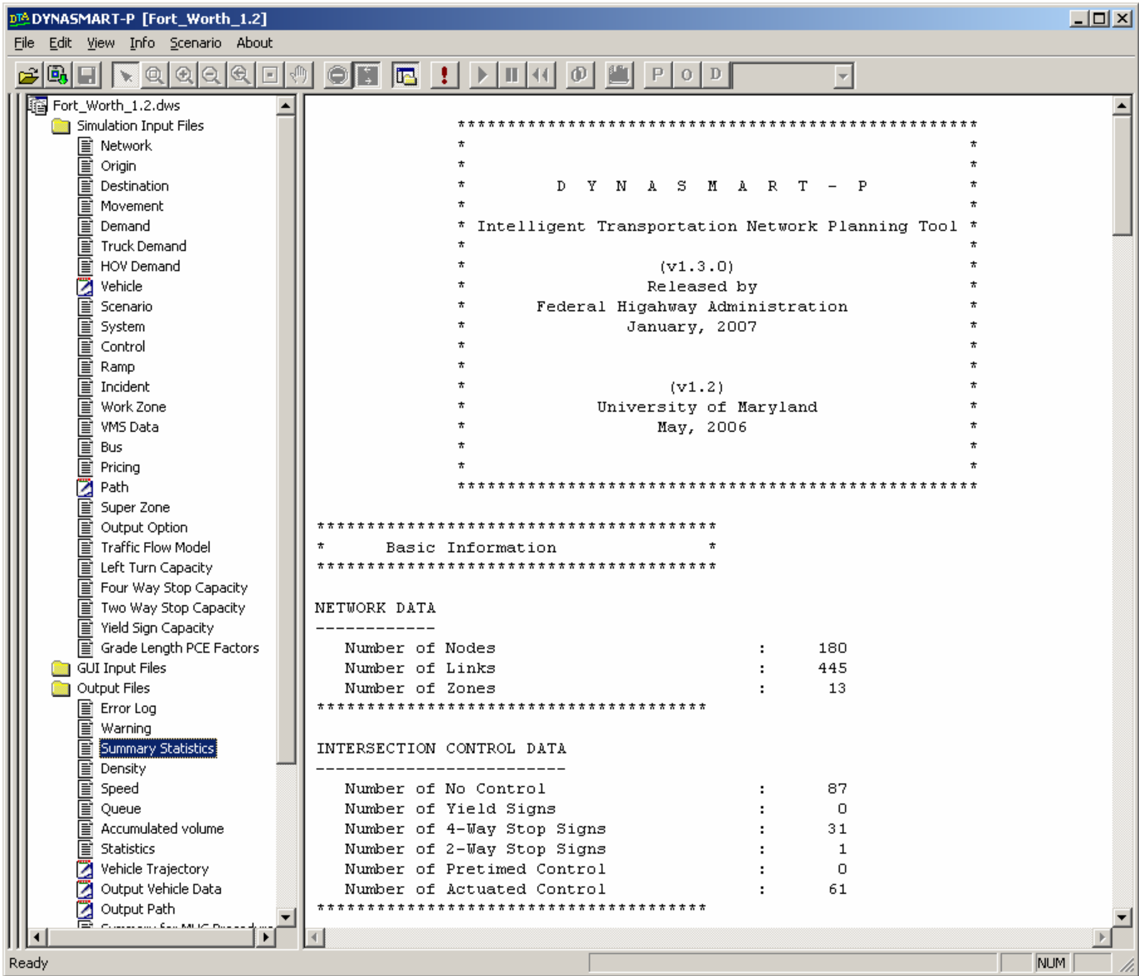

Figure 3-21. DYNASMART-P window showing SummaryStatistics.dat

Loading information is provided in 5-minute increments (Figure 3-22). 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:    1573 Gen:   1573 Out_n:      0 Out_t:    77 In_v:   1496
T:  10.0 Tot Veh:    3150 Gen:   1577 Out_n:      0 Out_t:  1100 In_v:   1973
T:  15.0 Tot Veh:    4731 Gen:   1581 Out_n:      0 Out_t:  1431 In_v:   2123
T:  20.0 Tot Veh:    6313 Gen:   1582 Out_n:      0 Out_t:  1599 In_v:   2106
T:  25.0 Tot Veh:    7886 Gen:   1573 Out_n:      0 Out_t:  1615 In_v:   2064
T:  30.0 Tot Veh:    9454 Gen:   1568 Out_n:      0 Out_t:  1602 In_v:   2030
T:  35.0 Tot Veh:   11031 Gen:   1577 Out_n:      0 Out_t:  1529 In_v:   2078
T:  40.0 Tot Veh:   12602 Gen:   1571 Out_n:      0 Out_t:  1550 In_v:   2099
T:  45.0 Tot Veh:   14176 Gen:   1574 Out_n:      0 Out_t:  1532 In_v:   2141
T:  50.0 Tot Veh:   15748 Gen:   1572 Out_n:      0 Out_t:  1622 In_v:   2091
T:  55.0 Tot Veh:   17321 Gen:   1573 Out_n:      0 Out_t:  1556 In_v:   2108
T:  60.0 Tot Veh:   18899 Gen:   1578 Out_n:      0 Out_t:  1571 In_v:   2115
T:  65.0 Tot Veh:   20471 Gen:   1572 Out_n:      0 Out_t:  1559 In_v:   2128
T:  70.0 Tot Veh:   22038 Gen:   1567 Out_n:      0 Out_t:  1595 In_v:   2100
T:  75.0 Tot Veh:   23620 Gen:   1582 Out_n:      0 Out_t:  1577 In_v:   2105
T:  80.0 Tot Veh:   25177 Gen:   1557 Out_n:      0 Out_t:  1605 In_v:   2057
T:  85.0 Tot Veh:   26752 Gen:   1575 Out_n:      0 Out_t:  1532 In_v:   2100
T:  90.0 Tot Veh:   28330 Gen:   1578 Out_n:      0 Out_t:  1472 In_v:   2206
T:  95.0 Tot Veh:   29915 Gen:   1585 Out_n:      0 Out_t:  1714 In_v:   2077
T: 100.0 Tot Veh:   31476 Gen:   1561 Out_n:      0 Out_t:  1613 In_v:   2025
T: 105.0 Tot Veh:   33048 Gen:   1572 Out_n:      0 Out_t:  1588 In_v:   2009
T: 110.0 Tot Veh:   34616 Gen:   1568 Out_n:      0 Out_t:  1476 In_v:   2101
T: 115.0 Tot Veh:   36200 Gen:   1584 Out_n:      0 Out_t:  1574 In_v:   2111
T: 120.0 Tot Veh:   37760 Gen:   1560 Out_n:      0 Out_t:  1646 In_v:   2025
T: 125.0 Tot Veh:   37760 Gen:      0 Out_n:      0 Out_t:  1469 In_v:    556
T: 130.0 Tot Veh:   37760 Gen:      0 Out_n:      0 Out_t:   525 In_v:     31
**************************************************
The program reached the end of simulation because:
all target vehicles have reached their destinations
**************************************************
****************************************
*****************************************
```

Figure 3-22. Loading information block within the Summary Statistics file

Following the vehicle loading information is the overall vehicle information (Figure 3-23), 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         :        37760
      NON-TAGGED VEHICLES    :            0
      TAGGED VEHICLES (IN)   :            0
      TAGGED VEHICLES (OUT)  :        37760
      OTHERS                 :            0
```

Figure 3-23. 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 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.dat	Contains the PCE values for heavy vehicles based on link upgrade, length and heavy vehicle percentage.	Required
Incident.dat	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 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 DSPEd, a DYNASMART-P editor (mainly for network, signal and demand data); and/or
3. Through GUI input dialog boxes (mainly for system and scenario data); and/or

Text editing techniques are only feasible for small sized traffic networks, whereas GUI data input is best for fine-tuning scenario and system settings. DSPEd is a fully click-and-drag graphical network editing software which provides a user-friendly data entry environment for creating DYNASMART-P input files. In addition to creating a network directly, the DSPEd also allows a user to import data files from GIS (through MS Excel) and CORSIM. For details about using DSPEd, please refer to the DSPED user's guide.

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.

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

Input File	*Manual*	*DSPGUI*	*DSPEd*
**.dws*	Yes		Yes
bus.dat	Yes		Yes
control.dat	Yes		Yes
demand.dat	Yes		Yes
demand_truck.dat	Yes		Yes
demand_HOV.dat	Yes		Yes
destination.dat	Yes		Yes
GradeLengthPCE	Yes		Yes
Incident	Yes	Yes	Yes
leftcap.dat	Yes		Yes
movement.dat	Yes		Yes
network.dat	Yes		Yes
origin.dat	Yes		Yes
output_option.dat	Yes		Yes
path.dat	Yes	Yes[1]	
pricing.dat	Yes	Yes	No
ramp.dat	Yes		Yes
scenario.dat	Yes	Yes	Yes
SuperZone.dat	Yes		Yes
system.dat	Yes	Yes	No
TrafficFlowModel.dat	Yes		Yes
vehicle.dat	Yes	Yes[1]	
vms.dat	Yes	Yes	Yes
WorkZone.dat	Yes	Yes	Yes
StopCap2Way.dat	Yes		Yes
StopCap4Way.dat	Yes		Yes
YieldCap.dat	Yes		Yes

[1] *Only if copied from a previous DYNASMART-P run*[2]

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 = "1.3"
Origin location	2	Text	Free	Node Y-axis coordinate ORIGIN = "BOTTOM_LEFT'' or ORIGIN = "TOP_LEFT''

```
VERSION = "1.3"
ORIGIN = "BOTTOM_LEFT"
```

Figure 4-1. Sample ProjectName.dws input file

Figure 4-1 shows that the DYNASMART-P version number is 1.3, and that the location of the origin coordinates is in the bottom left corner. This file can 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.. 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 or via DSPEd. 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 or via DSPEd.

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), one 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.

4.7.1 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.

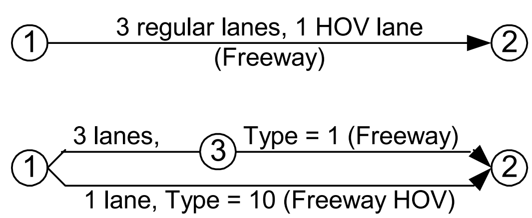

Figure 4-6. Modeling an HOV lane in DYNASMART-P

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-turn 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-turn 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.

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 free-flow conditions (1st regime). A modified Greenshields model is specified for congested-flow conditions (2nd regime) (Figure 4-8).

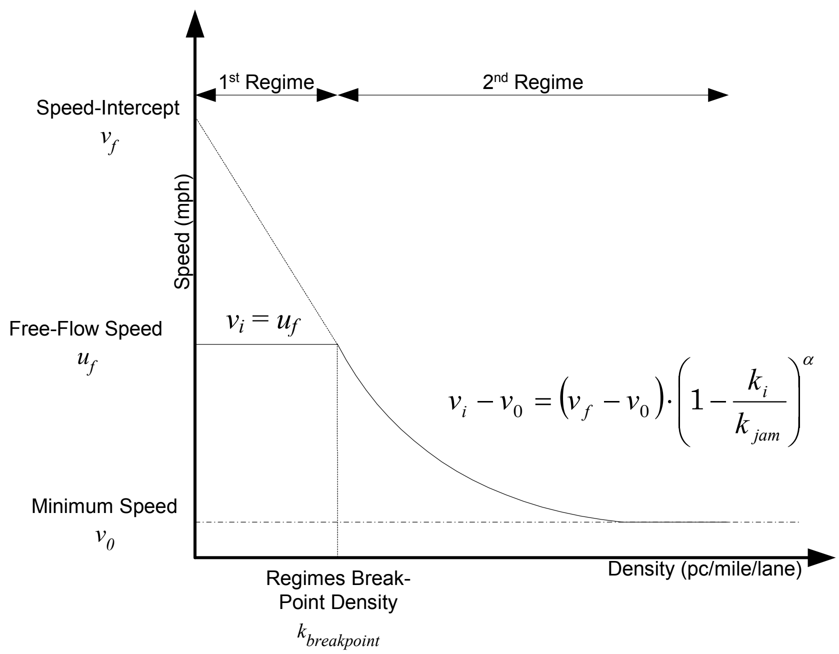

Figure 4-8. Type 1 modified Greenshields model

In mathematical terms, the type 1 modified Greenshields model 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-flow and congested-flow conditions (Figure 4-9), i.e.

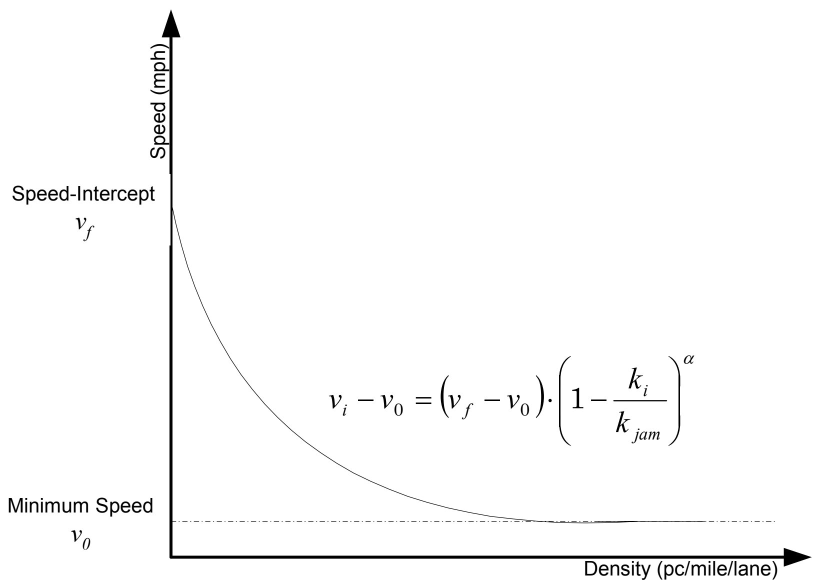

Figure 4-9. Type 2 modified Greenshields model

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. Two-regime models are applicable to freeways in particular because 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 (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 because 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%), 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 (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 actuated-controlled (control type 5) intersections. 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
	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

Record Type	*Field*	*Format*	*Width*	*Description*
				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 signs data	1	Integer	Free	Node number
	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), and plan 2 starts after 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 upstream and downstream nodes for the minor approach. In the example, the minor approach is link (46, 13). The next block is applicable to timing plan number 2 (which starts at time = 30 minutes of simulation, as indicated by the start time of the signal timing plan record type). The remaining records follow the same description as for plan 1.

This file can be prepared either manually or via DSPEd.

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, green and yellow interval durations, and 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 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 analysis, which is 0 seconds. 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.

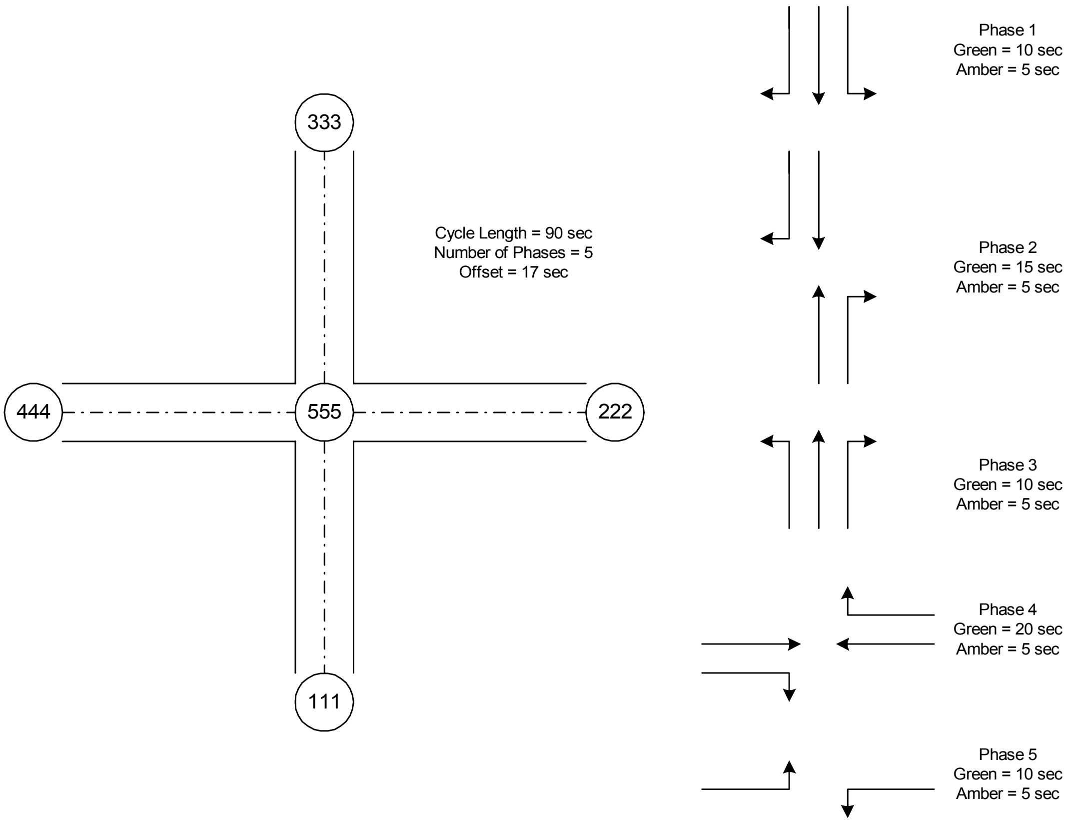

Figure 4-13. Typical signalized intersection with phasing and movement data

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 green time to 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, but 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 is 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, left-turn capacity is 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, left-turn capacity is 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   30   30   30   30                                  Record 3
2     177  126   92   60   60   60   30                                  Record 4
3     189  143  114   83   72   60   60                                  Record 5
g/c=0.4                                                                  Record 6
1     223  159   94   62   30   30   30                                  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   30   30                                      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   30                                      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   30                                      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   30   30   30   30                                      Record 24
1   2  161  112   79   46   31   16   30                                      Record 25
1   3  172  128  101   71   61   41   26                                      Record 26
2   1   90   43   21   30   30   30   30                                      Record 27
2   2  125   83   57   32   21   11   30                                      Record 27
2   3  134   97   74   51   43   28   18                                      Record 29
3   1   52   23   12   30   30   30   30                                      Record 30
3   2   75   48   32   17   11    6   30                                      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   30   30   30                                      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   30   30   30                                      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   30   30   30                                      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   30   30   30                                      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 link, 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 (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, control logic checks the flow rate on the major approach of a TWSC intersection and assigns appropriate saturation flow rates 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[2] These values are presented in Table 4-15.

[2] 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 to estimate TWSC intersection capacity. 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 major approach average flow rate (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 (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, control logic checks the number of active conflicting approaches of an AWSC intersection to determine the degree of conflict, and assigns appropriate discharge rates 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[3]. 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 default look-up table, as illustrated in Figure 4-16. Note that *StopCap4Way.dat* is applicable to all-way stop controlled

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

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 (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, control logic checks the major approach flow rate, and assigns appropriate saturation flow rates 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 critical gap acceptance theory and car following techniques to estimate yield-controlled intersection capacity. 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 in exactly the same manner 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[4] 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.

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

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

	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 (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 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.

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[5] 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 3-11, *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.*

```
  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
```

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

```
    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 10.0 (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 trips (field 1) originate from zone 1 destined for zone 1, 297.501 (9.9167*30.0) trips (field 2) originate from zone 1 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 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 3-11) 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 10.0 (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 trips (field 1) originate from zone 1 destined for zone 1, 297.501 (9.9167*30.0) trips (field 2) originate from zone 1 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 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* (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 3-11) 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 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 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 5.0 (field 2). The second O-D demand matrix specifies conditions from min 5.0 (field 2) until just before min 10.0 (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 trips (field 1) originate from zone 1 destined for zone 1, 297.50 (9.9167*30.0) trips (field 2) originate from zone 1 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 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.

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.

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 the centroid. An illustration of this concept is provided in Figure 4-24.

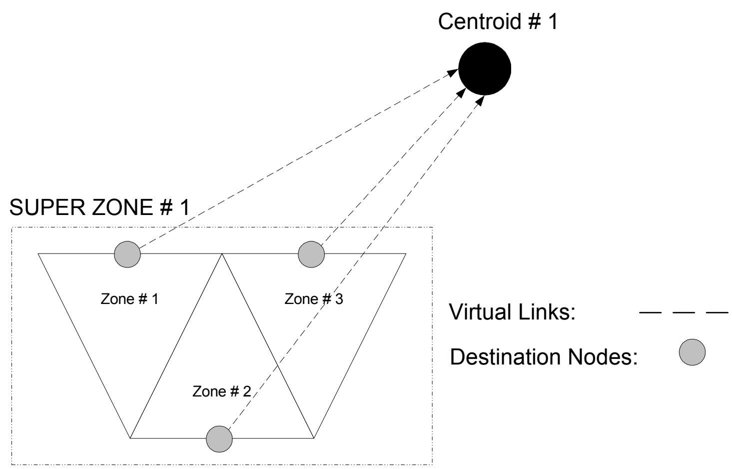

Figure 4-24. Illustration of a super zone

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 reduced 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 super zones.

This file can be prepared either manually or via DSPEd.

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[3]	1	Integer	7	1st 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 1st vehicle (minutes)[4]
	5	Integer	6	User class 1: unresponsive, 2: SO, 3: UE, 4: Enroute info, 5: VMS[5]
	6	Integer	6	Type of 1st vehicle 1: cars, 2: trucks, 3: HOV
	7	Integer	6	Occupancy level of 1st vehicle 1: LOV, 2: HOV
	8	Integer	6	Number of nodes in the path of 1st vehicle (enter 1 if *path.dat* will not be used)
	9	Integer	6	Number of destinations along the path of the 1st vehicle including intermediate stops and final destination
	10	Integer	6	En-route information indicator for 1st vehicle: 0: no info is available, 1: En-route info available
	11	Float	8(4)	Indifference band (minutes) for switching 1st vehicle
	12	Float	8(4)	Compliance rate (0 – 1.0)[6] (Class 4 users only, specify 0 for all other class users)
	13	Integer	5	Origin zone for 1st vehicle
Destinations[7]	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 the 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] *Must be repeated for all vehicles.*

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

[5] *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.*

[6] *Determines whether an enroute information vehicle (user class 4) will respond to enroute information or not.*

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

```
  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 0.0 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 4 (enroute info) and 5 (VMS responsive) 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)
	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]

Record Type	Field	Format	Width	Description
	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 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 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 (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 not more than 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. This user class is not responsive to VMS information, except for speed advisory (VMS type 1), since it receives better information. To force SO vehicles to detour a given link, this link must be blocked by specifying an incident with 100% capacity reduction. Allowing SO or UE vehicles to respond to VMS information will result in inconsistent, unstable, and non-convergent path assignments. This is because VMS will provide paths based on prevailing conditions that don't account for the future evolution of traffic, and as such are not guaraneteed to be optimal. 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 not responsive to VMS information, except for speed advisory (VMS type 1), since it receives better information. To force UE vehicles to detour a given link, this link must be blocked by specifying an incident with 100% capacity reduction. Allowing SO or UE vehicles to respond to VMS information will result in inconsistent, unstable, and non-convergent path assignments. This is because VMS will provide paths based on prevailing conditions that don't account for the future evolution of traffic, and as such are not guaraneteed to be optimal. Note that this assignment rule provides higher estimates for network-wide travel times, 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 selected.

<u>Class 5 – VMS Responsive</u>

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 improve 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*.

Vehicle Loading with Partial Path

In this demand loading mode, vehicles are loaded from the *vehicle.dat* file. Some of these vehicles (user specified user-classes) will get their paths from DYNASMART-P (simulator) as a result of some assignment mode, and others will have to follow their paths as specified in *path.dat*. The user will still have to provide a full *path.dat* file. However, vehicles (user classes) instructed to get their paths from the simulator will simply ignore their paths from *path.dat*. This is an excellent feature for modeling background traffic. Simply specify background traffic to be of user class 1 (non-responsive), and then instruct them to read their paths from *path.dat.* These vehicles will stick to their paths through out the simulation, unless there is an optional/ mandatory detour along their path. Specify all other vehicles to get their paths from the simulator.

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. All user classes respond to (and evaluate) the speed advisory VMS (type 1). Other VMS types advise select user classes about route diversion possibilities, which (in the current version of DYNASMART-P) are modeled through a user-specified response rate. This rate indicates the percentage of VMS drivers who may switch routes due to a VMS. In general, user class 5 (VMS responsive) responds to and evaluates all VMS types, whereas user classes 1 (non-responsive) and 4 (enroute info) respond to VMS types 1 (speed advisory) and 2 (mandatory detour). If the VMS preemption mode (General Settings Record Type, Field 5 in Scenario.dat or Scenario | Advanced Settings menu command) is selected, then user classes 4 and 5 will respond to all VMS types. User classes 2 (SO) and 3 (UE) do not respond to VMS information because they have superior information. Table 4-30 provides a summary of user class response behavior to the various VMS types. A detailed description of this file and its format are provided in Table 4-31 and Figure 4-29, respectively.

Table 4-30. User classes and their response to various VMS information

User Class	*VMS Type 1* Speed Advisory	*VMS Type 2* *Mandatory Detour*	*VMS Type 3* *Congestion Warning*	*VMS Type 4* *Optional Detour*
VMS Preemption Mode is Off (Default)				
1 – non responsive	Responds	Responds	Do not respond	Do not respond
2 – system optimal	Responds	Do not respond	Do not respond	Do not respond
3 – user equilibrium	Responds	Do not respond	Do not respond	Do not respond
4 – enroute info	Responds	Responds	Do not respond	Do not respond
5 – vms responsive	Responds	Responds	Responds	Responds
VMS Preemption Mode is On				
1 – non responsive	Responds	Responds	Do not respond	Do not respond
2 – system optimal	Responds	Do not respond	Do not respond	Do not respond
3 – user equilibrium	Responds	Do not respond	Do not respond	Do not respond
4 – enroute info	Responds	Responds	Responds	Responds
5 – vms responsive	Responds	Responds	Responds	Responds

Table 4-31. 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. 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.

4.26.1 Further Discussion

- *Percentage of VMS-responsive vehicles that evaluate and respond to VMS information*: this percentage refers to class 5 users (and classes 4, and 5 if the VMS preemption mode is selected) 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).
- VMS type 4 (optional detour) is optional, and as such, only user class 5 (VMS-responsive) vehicles will respond. That is, the preemption mode is needed to have user classes 4 and 5 respond to it. 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 class 5 (VMS-responsive) vehicles 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 difference between mandatory and optional VMS is that mandatory VMS will force all vehicles to take the detour sub-path (at least the first link) whereas in the optional detour VMS, vehicles will decide whether to switch or not. Once on the detour path, non-responsive vehicles (user class 1) will stay on it, VMS-responsive vehicles (user class 5) will stay on it unless they encounter another VMS, and enroute info vehicles (user class 4) will keep evaluating their paths at every diversion node along the sub-path. In short, the mandatory VMS (VMS type 2) only guarantees that user class 4 vehicles will use the first link of the sub-path. Therefore, to make sure user class 4 vehicles will traverse the sub-path in its entirety, provide a mandatory detour on each of the sub-path links.
- 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[6], which is a relatively simple feedback-control mechanism. The procedure measures the flow on freeway mainline lanes downstream of the ramp, and determines 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 metering update interval. Note that occupancy, in DYNASMART-P, is averaged over a freeway section delineated by edges of the loop detector. A detailed description of this file and its format are provided in Table 4-32 and Figures 4-32 and 4-33, respectively.

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[6] 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.

Table 4-32. 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*

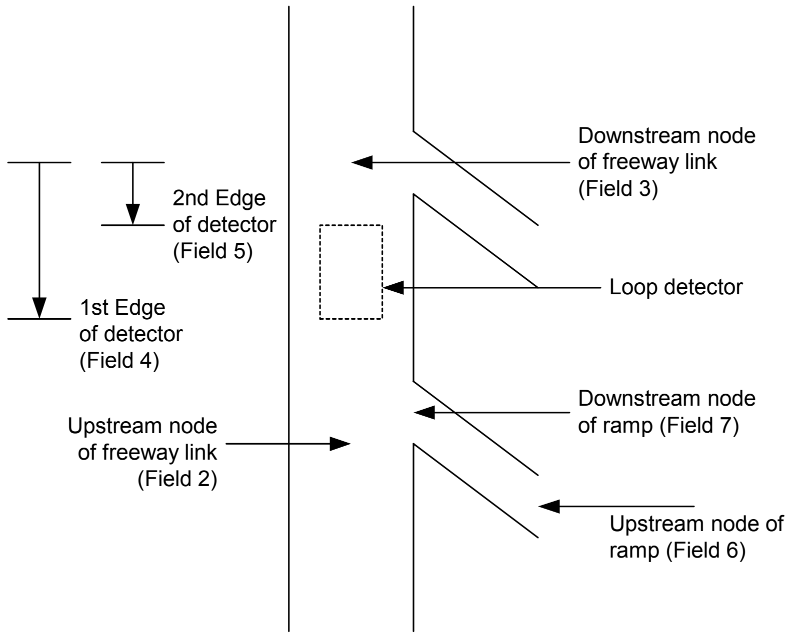


Figure 4-30. Ramp metering input description

```
  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 active only between minutes 5.0 (field 1) and 30.0 (field 2).

This file can be prepared either manually or via DSPEd.

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 4-33 and Figure 4-32, respectively.

Table 4-33. 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. 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.

4.28.1 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 4-34 and Figure 4-33 respectively.

Table 4-34. 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. 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.

4.29.1 Discussion

Capacity Reduction and Queue Discharge Rate

Capacity reduction refers to the reduction in physical storage capacity (lane miles). Queue discharge rate refers to the maximum flow rate vehicles are able to maintain when flowing out of the work zone link. DYNASMART-P uses the capacity reduction to compute available link storage capacity, and to determine whether an upstream vehicle can physically move into the work zone link. The queue discharge rate is used by DYNASMART-P to determine the rate at which vehicles can flow out of the work zone link. There is no relationship between these two parameters as far as DYNASMART-P is concerned. However, these parameters are correlated in a sense that reduction in physical space (due to barriers and medians) would affect the driving behavior of trip makers, and force them to flow at lower rates than normal. In the absence of flow rate measurements, the user is encouraged to adopt the recommended queue discharge rate values reported in Table 4-35. In short, vehicles in a work zone cannot possibly maintain free-flow conditions even at low densities, due to the presence of machinery and barriers.

Work Zone Closure Types

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 zones 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.

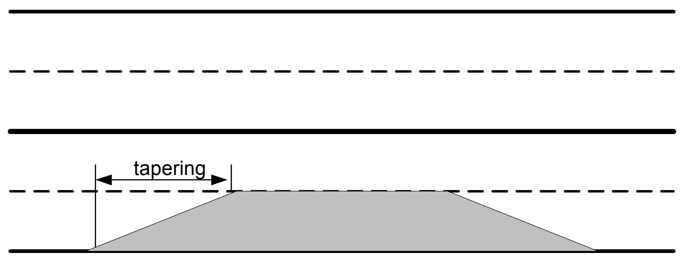


Figure 4-34. Partial lane closure with barrier median

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), lane closure is approximated as a 25% reduction in 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), lane closure causes 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.

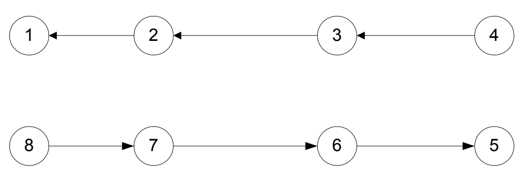


Figure 4-35. DYNASMART-P representation of work zone

```
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*.

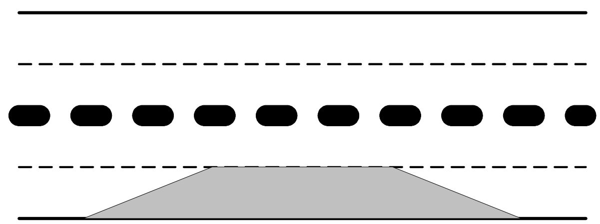


Figure 4-37. Partial lane closure with temporary control device median

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.

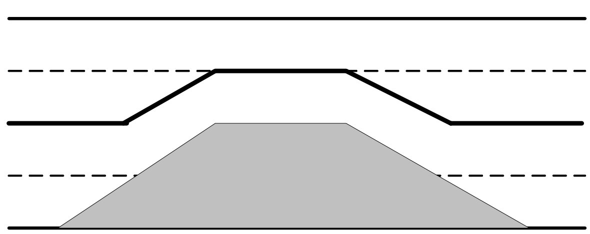


Figure 4-38. Crossover lane closure

```
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. Moreover, in the absence of flow rate measurements, the user is encouraged to adopt the recommended queue discharge rates values reported in Table 4-35. 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.

Table 4-35. Recommended parameter values for select work zone types

Work Zone Type	*Direction*	*Location*	*Capacity Reduction (Percent)*	*Speed Limit (mph)*	*Discharge Rate (veh/hr/lane)*
Partial closure with barrier median	Work zone	Initial tapering	25	50	1500
	Work zone	Mainline	50	50	1300
	Work zone	Final tapering	25	50	1800
	Opposite	Mainline	0	65	1800
Partial closure with temporary median	Work zone	Initial tapering	25	50	1500
	Work zone	Mainline	50	50	1300
	Work zone	Final tapering	25	50	1500
	Opposite	Mainline	0	65	1500
Crossover	Work zone	Initial tapering	40	50	1400
	Work zone	Mainline	50	50	1300
	Work zone	Final tapering	40	50	1400
	Opposite	Initial tapering	25	50	1500
	Opposite	Mainline	50	50	1300
	Opposite	Final tapering	25	50	1500

Work Zone Traffic Flow Model

The imposed work zone speed limit and capacity reduction introduces changes to the traffic flow model associated with the work zone link, which will no longer be applicable. Recall the shape of the modified Greenshields traffic flow model as depicted in Figure 6-65.

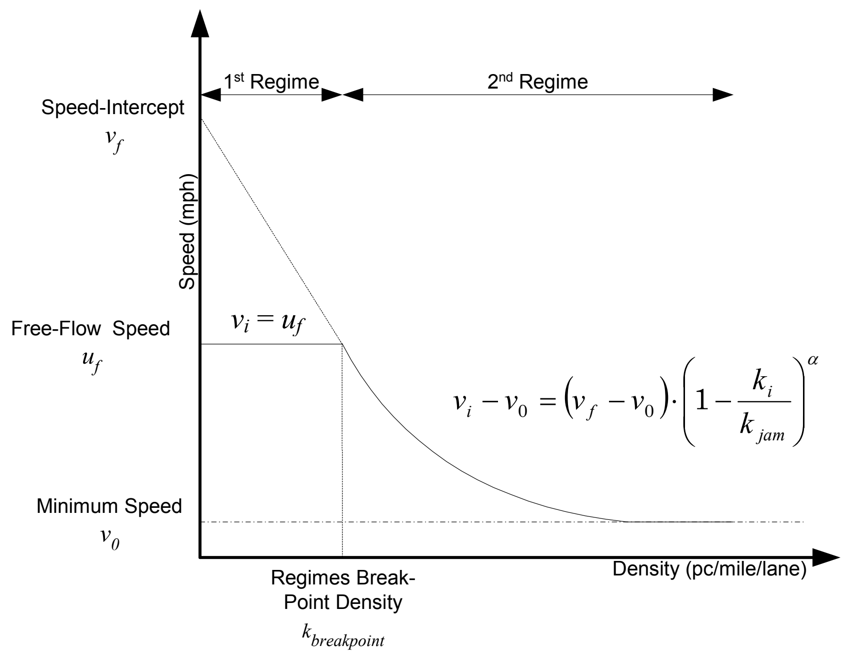


Figure 4-40. Type 1 modified Greenshields model

The free-flow speed u_f (speed limit) is directly related to the speed-intercept v_f. When the speed limit is reduced due to the presence of a work zone, the speed-intercept changes, and so does the traffic flow model. DYNASMART-P accounts for the change in speed intercept as depicted below (Figure 6-66):

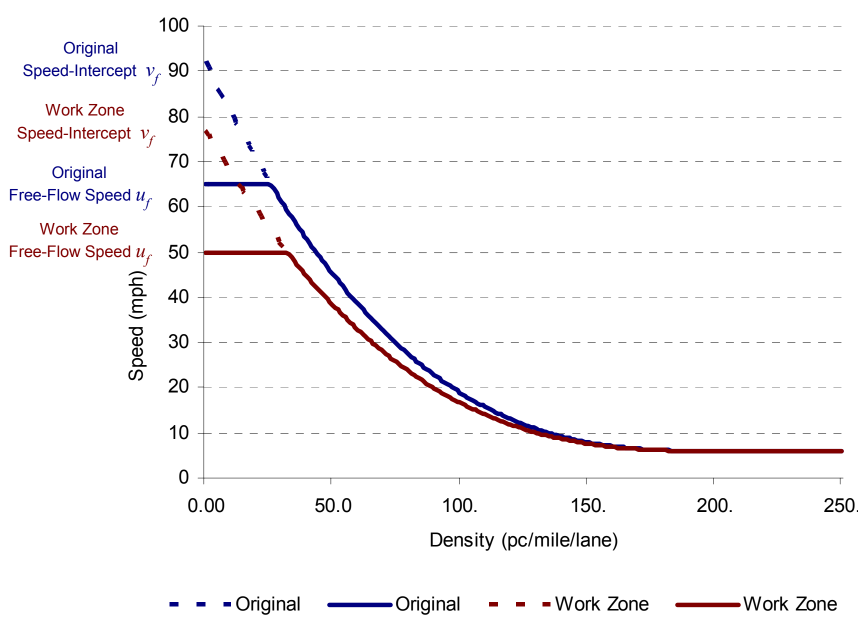


Figure 4-41. Traffic flow model change due to work zone

Therefore, DYNASMART-P adjusts the speed intercept proportionately to the reduction in the speed limit, all while keeping the other traffic flow parameters intact (jam density, minimum speed, shape parameter).

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. 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 4-36 and Figure 4-42, respectively.

Table 4-36. 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)
Freeway Bias	1	Float	Free	Freeway Bias Factor (fraction)
No. HOT Links	2	Integer	Free	Number links receiving time-dependent tolls
Link Information	1	Integer	Free	Link counter (1st link to receive a time-dependent toll)
	2	Integer	Free	Upstream node for the 1st link to receive a toll
	3	Integer	Free	Downstream node for the 1st link to receive a toll
	4	Integer	Free	Number of toll periods
Toll Information	1	Float	Free	Start time for the 1st toll period
	2	Float	Free	End time for the 1st toll period
	3	Integer	Free	Toll Type (0: regular links, 1: HOT links, 2: HOV links)
	4	Float	Free	Toll (in dollars)
. . . . .	. . . .	. . . . .	. . . .	. . . . .
Toll Information	1	Float	Free	Start time for the Nth toll period
	2	Float	Free	End time for the Nth toll period
	3	Integer	Free	Toll Type (0: regular links, 1: HOT links, 2: HOV links)
	4	Float	Free	Toll (in dollars)
. . . . .	. . . .	. . . . .	. . . .	. . . . .
Link Information	1	Integer	Free	Link counter (Nth link to receive a time-dependent toll)
	2	Integer	Free	Upstream node for the Nth link to receive a toll
	3	Integer	Free	Downstream node for the Nth link to receive a toll
	4	Integer	Free	Number of toll periods
Toll Information	1	Float	Free	Start time for the first toll period
	2	Float	Free	End time for the first toll period
	3	Integer	Free	Toll Type (0: regular links, 1: HOT links, 2: HOV links)
	4	Float	Free	Toll (in dollars)
. . . . .	. . . .	. . . . .	. . . .	. . . . .
	1	Float	Free	Start time for the Nth toll period
	2	Float	Free	End time for the Nth toll period
	3	Integer	Free	Toll Type (0: regular links, 1: HOT links, 2: HOV links)
	4	Float	Free	Toll (in dollars)

```
0.0 0.0 0.0 20.0
0.2 2
  1      52      48  2
    0   30 0 0.75
   31   60 0 1.0

  2      48      41  2
    0   30 0 0.75
   31   60 0 1.0
```

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

Figure 4-42 shows that there is no (or $0) toll on the general-purpose network links (field 1). Low Occupancy Vehicles (LOV) are not charged ($0 toll) (field 2) on HOT links. No charges (or $0 toll) are applied to High Occupancy Vehicles (HOV) on HOT links (field 3). A monetary value of $20.00 per hour is specified (field 4). If LOV vehicles are to be denied access to HOV-dedicated links (HOT links), then a toll of $9999 (or higher) is recommended for the cost of LOV vehicles on HOT links.

The first field in the second record indicates that a freeway bias factor of 20% (0.2) is specified. This means drivers will perceive freeway links travel times to be 20% shorter than in reality. The entry in field 2 indicates that there are 2 links that receive time-dependent link tolls. The third record indicates that the first link (field 1) is 52 -> 48, and it has 2 (field 4) time-dependent tolls. The fifth record indicates that the first period is from minute 0 (field 1) to minute 30 (field 2) with a toll type of 0 (field 3), meaning it is a regular link toll and applies to all vehicles. Finally, the toll charge is $0.75 per mile (field 4), which will be later converted to a time penalty when computing the shortest path trees.

The recommended way of preparing this file is as of follows. First, the user selects pertinent HOV or HOT links in DSPEd. Once DSPEd saves the project this file would be generated but with zero toll rate assigned to each link. The user will then modify the toll rate in DSP GUI. To modify this file using the GUI, click on the <u>Scenario</u> | <u>Parameters & Capabilities…</u> menu command. Then click on <<Next>> in the <<u>Parameter Settings</u>> dialog box. Once in the <<u>Capability Selection</u>> dialog box, select the <<Link Specific and/or Time Dependent Pricing>> or <<Across the Board Static Pricing>> radio buttons in the [<u>Congestion Pricing</u>] data block and enter the pricing data.

4.30.1 Further Discussion

Freeway Bias:

- ❑ Typical shortest path calculations assume that drivers have no preference to use freeways over arterials. Such an assumption may not hold when there is clear evidence that drivers are biased towards using freeway links. In such a case, to be able to replicate field conditions in planning and operational applications, the user will be able to account for such a bias by specifying a "freeway bias factor" as a percentage by which the drivers will perceive freeway link travel times to be shorter than reality. This way, the path processing component in DYNASMART-P will assign more vehicles to freeways, and will replicate field conditions more accurately.

General Pricing:

- ❑ An HOV toll is not really a monetary toll, but rather a modeling technique to forbid LOV vehicles from using an HOV link. The software will assign a very high cost for LOV vehicles using the HOV links that will eventually preclude the HOV links from any shortest path for LOV vehicles.
- ❑ HOV vehicles cannot be specified unless there is at least one HOV/HOT link specified in the network.
- ❑ LOV vehicles can never use HOV links. It does not make any difference if the user manually changes the HOV toll in *prcing.dat* as the program will discard this value. The program will internally specify a very large link cost to prohibit LOV vehicles from using HOV links.

Across the Board Static Pricing:

- ❑ 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 (as long as network geometry remains the same).
- ❑ 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).

Link Specific and/or Time-Dependent Pricing:

- ❑ A regular toll type means that all vehicles will pay the toll to traverse such a link during the specified duration. An HOT toll type means that only LOV vehicles will pay (HOV vehicles will not pay) the toll to traverse the HOT link (link types 6 and 9 in *network.dat*). The HOV toll type indicates that LOV vehicles will not be able to traverse the HOV link (link types 8 and 10 in *network.dat*) for the specified period. This feature is extremely helpful, as users can specify HOV links to be active during the peak period to deny LOV vehicles from traversing these links, and non-active during the off-peak period to allow all vehicles to traverse the HOV links.

- To apply static tolls on specific links, use the time dependent pricing to select a set of toll links, and set the toll period to be equal to the planning horizon (i.e. set start time equal to 0 and end time equal to the planning horizon).
- Unresponsive (user class 1) vehicles, which receive path assignments at the beginning of simulation and adhere to these paths throughout the entire simulation, do not recognize time-dependent tolls that will be activated after their departure times. Users might observe unresponsive LOV vehicles passing through an HOT link even when a high HOT cost has been specified.

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 4-37 and Figure 4-43, respectively.

Table 4-37. 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 4-43. General format of the bus.dat input file

The first record in Figure 4-43 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.

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 4-38 and Figure 4-44, respectively.

Table 4-38. 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
Loading Mode	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* 3: from vehicle file with partial path information *vehicle.dat* & *path.dat* (Partial Vehicle Path Loading)
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)
Partial Vehicle Path Loading Information	1	Integer	Free	Number of user classes who receive their paths from simulator
	2	Integer	Free	1st user class to receive path from simulator
	. . . .	. . . . .	. . . .	. . . . .
	N	Integer	Free	Nth (≤ 5) user class to receive path from simulator
Sequential Loading Flag	1	Integer	Free	0: Regular shortest path calculation and vehicle loading 1: Sequential shortest path calculation and vehicle loading

[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 MOEs (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 and 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
0
0
```

Figure 4-44. General format of the system.dat input file

The first record in Figure 4-44 specifies 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). The final record is simply not read since the loading mode is not done via the partial vehicle path loading mode.

In specifying parameters for *system.dat*, the default values listed in Table 4-38 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. If DSPEd loaded an exist project, then DSPEd won't modify the setting in system.dat. If a user is create a new project from scratch, then when saving the project DSPEd will generate system.dat based on default values. Users are suggested to modify this file in DSP GUI. To do so, click on the <u>Scenario</u> | <u>Advanced Settings…</u> menu command. Enter the system data and click <<OK>> to proceed.

To select the vehicle generation mode within the GUI, click on the <u>Scenario</u> | <u>Parameters & Capabilities…</u> menu command. This will launch the <<u>Parameter Settings</u>> dialog box. Click the <<Next>> button and proceed to the <<u>Capability Selection</u>> 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).

4.32.1 Discussion of Selected Entries

<u>Sequential Loading Mode</u>

In DYNASMART-P, vehicles can be loaded either from O-D demand tables (*demand.dat*) or from vehicle files (*vehicle.dat*). Unless a path file (*path.dat*) is provided, a complete path calculation is necessary in the path processing component in DYNASMART-P for every calculation interval. Shortest paths are assigned to each vehicle according to that vehicle's attributes, including origin, destination, departure time and occupancy level (HOV or SOV) etc. An efficient shortest path algorithm is implemented in DYNASMART-P, where a multi-dimensional array approach is adopted to store the node labels and link attributes. Dimensions of the arrays for storing shortest path nodes labels include: origin, destination, time interval, path index, and occupancy level. The multi-dimensional array implementation is computationally efficient, but memory-consuming in particular when the network size (numbers of nodes, links, destination nodes, and zones) is large or the planning horizon (number of time intervals) is long. In order for DYNASMART-P to be able to handle large-scale networks, a more memory efficient sequential shortest path tree calculation (and vehicle loading) was implemented, in addition to the regular shortest path calculation method.

The regular version of shortest path tree calculation and vehicle loading is an all (nodes) -to-all (destination zones) shortest path tree that is calculated for every shortest path calculation interval (typically 3 minutes) and stored in the multi-dimensional arrays. Generated vehicles are assigned to their respective shortest paths according to different vehicles' attributes. However, in the sequential version of the shortest path tree calculation and vehicle loading, every time an all (nodes) -to-one (destination) shortest path tree is calculated and stored in the arrays, vehicles going to that particular destination are assigned to their respective shortest paths. This process is repeated for every destination zone so that all vehicles with different destinations can obtain their shortest paths. Apparently, this sequential method of shortest path tree calculation and vehicle loading can save much more memory when compared with the regular version. Indeed, in the large scale network application with many traffic analysis zones (TAZ), the size of destination dimension is equal to 1 in the sequential version, but is equal to the total number of destination zones in the regular version. On the downside, because the shortest path tree is not available to all destinations at a given point in time, VMS signs cannot be specified. Moreover, user classes 4 (enroute info vehicles) and 5 (VMS info vehicles) cannot be specified either. Furthermore, the sequential loading mode cannot be used with vehicle loading modes (vehicle+path and vehicle+partial path).

Note that in the sequential loading mode, only the parameter "*no. of simulation intervals in which the KSP calculation algorithm is executed*" is applicable (see 4.25 and Table 4-29). This is because the KSP tree for each destination is calculated for every KSP recalculation interval, but is not updated in the interim. The reason is that a shorter KSP recalculation interval is usually set in the sequential loading mode, and there is no need to update the KSP trees in the interim. If the interval is too long, too many vehicles might be loaded on generation links at the same time, and this would result in large entry queue delays. On the other hand, if the calculation interval is too short, the speed of the sequential mode would be very slow. Therefore, the range of the KSP recalculation interval is recommended be between 5 and 30 simulation intervals, or between 0.5 and 3 minutes.

It is very important to note that the sequential loading mode and regular loading mode do not produce identical runs, nor do they produce identical information for the iterative assignment process applied to compute an approximate UE. Therefore, it is not meaningful to compare results after two iterations. The only meaningful comparison might be at convergence, if attained, and then only approximately. Moreover, we strongly recommend for the user to restrict the shortest path recalculation interval to be between 0.5 and 3 minutes in the sequential loading mode; using too large of a recalculation interval will create significant deviations from the regular (simultaneous) loading mode. Table 4-39 shows the impact of the KSP recalculation interval on solution quality, and memory usage for the Portland network (5823 nodes, 14722 links, and 1244 zones). This table reflects results from the sequential loading mode, using the one-shot simulation-assignment solution mode. A 2-hour demand was used to load 345,000 vehicles onto the network for a planning horizon of 500 minutes.

Table 4-39. Tradeoff between solution quality, KSP recalculation and memory usage for the Portland network

KSP Calculation Interval Min (No of simulation intervals)	*Average Trip Time (min)*	*Memory Usage (MB)*	*Execution Time (min)*
0.5 (5)	6.0480	242	180
1 (10)	6.1034	328	120
2 (20)	6.3691	347	70
3 (30)	6.7858	405	65
4 (40)	7.3261	407	46
5 (50)	7.9715	410	38

Vehicle Loading with Partial Path

In this demand loading mode, vehicles are loaded from the *vehicle.dat* file. Some of these vehicles (user-specified user-classes) will get their paths from DYNASMART-P (simulator) as a result of some assignment mode, and others will have to follow their paths as specified in *path.dat*. The user will still have to provide a full *path.dat* file, however the vehicles (user classes) instructed to get their paths from the simulator will simply ignore their paths from *path.dat*. This is an excellent feature for modeling background traffic. Simply specify background traffic to be of user class 1 (non-responsive) and instruct them to read their paths from *path.dat*. These vehicles will stick to their paths through out the simulation, unless there is an optional/mandatory detour along their path. Specify all other vehicles to get their paths from the simulator.

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. Users can also 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 4-40 and Figure 4-45, respectively.

Table 4-40. 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 loading information on output screen.

[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 4-45. General format of the output_option.dat output file

Figure 4-45 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.DSPEd.

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 subsections.

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.

Output File	*Description*
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 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 consists 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
- Summary of MUC statistics

SummaryStatistics.dat (Summary Statistics output file – GUI) only reports statistics for all vehicles, whether they are still in the network (did not reach their destinations by end of planning horizon) or are outside the network (reached their destinations by end of planning horizon). However, seperate statistics for both types of vehicles can be found in *OutMuc.dat* (Summary for MUC Procedure output file – GUI) even if one-shot simulation is selected. 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 *
*                                                 *
*                     (V1.3)                      *
*                   Released by                   *
*         Federal Higahway Administration         *
*                  January, 2006                  *
*                                                 *
*                                                 *
*                     (V1.2)                      *
*              University of Maryland             *
*                    May, 2006                    *
*                                                 *
*                                                 *
***************************************************

****************************************
*      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 One-Shot Simulation Mode
***************************************

TIME PERIODS
------------
   Planning Horizon(min)                    :     120.0
   Aggregation Interval(# of Sim Int)       :      10
   Assignment Interval(# of Sim Int)        :      10
   Max # of Iterations                      :       0
   MUC Threshold (# of Vehicles)            :       0.5
   Convergence Threshold(# of Violation)    :     100
***************************************

CONGESTION PRICING
------------------
   Cost on Regular Links($)                 :       0.0
   Cost of LOV on HOT Links($)              :       1.0
   Cost of HOV on HOT Links($)              :       0.0
   Value of Time($/hr)                      :       5.0
***************************************

VARIABLE MESSAGE SIGNS
-----------------------
   Number of Variable Message Signs:    2

   VMS #     1    Type:  Mandatory Detour
      Location   52  --   48   From min   0.0 To min 120.0
All vehicles will follow detour sub-path

   VMS #     2    Type:  Congestion Warning
   Location   34  --   30   From min  33.0 To min  50.0
   The Best Path is Assigned to Responded Vehicles
     100 % of Out-of-Vehicle Responsive Vehicles Respond to VMS
***************************************

CAPACITY REDUCTION
------------------
   -- Incident  --
```

```
       Location   30  --   25   From min  30.0 To min  50.0,   30.0 % Capacity
Reduction
    -- Work Zone --
       Location   48  --   41   From min   0.0 To min 120.0,   50.0 % Capacity
Reduction

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

 T:   5.0 Tot Veh:    1191 Gen:   1191 Out_n:      0 Out_t:    70 In_v:   1121
 T:  10.0 Tot Veh:    2376 Gen:   1185 Out_n:      0 Out_t:   650 In_v:   1656
 T:  15.0 Tot Veh:    3556 Gen:   1180 Out_n:      0 Out_t:   911 In_v:   1925
 T:  20.0 Tot Veh:    4739 Gen:   1183 Out_n:      0 Out_t:  1015 In_v:   2093
 T:  25.0 Tot Veh:    5933 Gen:   1194 Out_n:      0 Out_t:  1141 In_v:   2146
 T:  30.0 Tot Veh:    7134 Gen:   1201 Out_n:      0 Out_t:  1105 In_v:   2242
 T:  35.0 Tot Veh:    8315 Gen:   1181 Out_n:      0 Out_t:   968 In_v:   2455
 T:  40.0 Tot Veh:    9499 Gen:   1184 Out_n:      0 Out_t:   897 In_v:   2742
 T:  45.0 Tot Veh:   10676 Gen:   1177 Out_n:      0 Out_t:   938 In_v:   2981
 T:  50.0 Tot Veh:   11871 Gen:   1195 Out_n:      0 Out_t:  1032 In_v:   3144
 T:  55.0 Tot Veh:   13048 Gen:   1177 Out_n:      0 Out_t:  1088 In_v:   3233
 T:  60.0 Tot Veh:   14232 Gen:   1184 Out_n:      0 Out_t:  1028 In_v:   3389
 T:  65.0 Tot Veh:   15404 Gen:   1172 Out_n:      0 Out_t:  1062 In_v:   3499
 T:  70.0 Tot Veh:   16582 Gen:   1178 Out_n:      0 Out_t:  1068 In_v:   3609
 T:  75.0 Tot Veh:   17767 Gen:   1185 Out_n:      0 Out_t:  1066 In_v:   3728
 T:  80.0 Tot Veh:   18946 Gen:   1179 Out_n:      0 Out_t:  1180 In_v:   3727
 T:  85.0 Tot Veh:   20135 Gen:   1189 Out_n:      0 Out_t:  1145 In_v:   3771
 T:  90.0 Tot Veh:   21314 Gen:   1179 Out_n:      0 Out_t:  1092 In_v:   3858
 T:  95.0 Tot Veh:   22510 Gen:   1196 Out_n:      0 Out_t:  1112 In_v:   3942
 T: 100.0 Tot Veh:   23681 Gen:   1171 Out_n:      0 Out_t:  1064 In_v:   4049
 T: 105.0 Tot Veh:   24858 Gen:   1177 Out_n:      0 Out_t:  1022 In_v:   4204
 T: 110.0 Tot Veh:   26039 Gen:   1181 Out_n:      0 Out_t:   959 In_v:   4426
 T: 115.0 Tot Veh:   27203 Gen:   1164 Out_n:      0 Out_t:  1007 In_v:   4583
 T: 120.0 Tot Veh:   28379 Gen:   1176 Out_n:      0 Out_t:   915 In_v:   4844
 ***************************************

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

 MUC CLASS PERCENTAGES
 ---------------------
    Pre-Specified (Non-Responsive)           :     0.00 %
    Boundedly-Rational(En-route Information) :     0.00 %
    VMS Responsive                           :   100.00 %
    System Optimal                           :     0.00 %
    User Equilibrium                         :     0.00 %
 ***************************************

 VEHICLE TYPE PERCENTAGES
 ------------------------
    PC                                     :     100.0 %
    TRUCK                                  :       0.0 %
    HOV                                    :       0.0 %
    BUS                                    :       1 Buses
AVG.IB-FRACTION = 0.20   BOUND = 1.00

 NOTE : There are        4844   target vehicles still in the network

  ******* VEHICLE INFORMATION *******
      TOTAL VEHICLES        :        28379
      NON-TAGGED VEHICLES   :            0
      TAGGED VEHICLES (IN)  :         4844
```

```
     TAGGED VEHICLES (OUT) :        23535
     OTHERS                :            0


 ******* HOV/LOV VEHICLE INFORMATION *******
   Avg travel time for LOV                    :      11.1678

   Avg travel time for HOV                    :       8.5077


*************************************
*  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      :    28379
                        With    Info         :        0
                        Without Info         :    28379
----------------------------------------------
TOTAL TRAVEL TIMES (HRS)
   OVERALL    :    6188.3950
   NOINFO     :    6188.3950
   1 stop     :    6188.3950
   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    :      13.0837
   NOINFO     :      13.0837
   1 stop     :      13.0837
   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    :    6264.1636
   NOINFO     :    6264.1636
   1 stop     :    6264.1636
   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    :      13.2439
   NOINFO     :      13.2439
   1 stop     :      13.2439
   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    :      75.9075
   NOINFO     :      75.9075
   1 stop     :      75.9075
   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    :       0.1605
   NOINFO     :       0.1605
   1 stop     :       0.1605
   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    :    2695.2705
   NOINFO     :    2695.2705
   1 stop     :    2695.2705
   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    :       5.6984
   NOINFO     :       5.6984
   1 stop     :       5.6984
   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    :  118362.8984
   NOINFO     :  118362.8984
   1 stop     :  118362.8984
   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    :       4.1708
   NOINFO     :       4.1708
   1 stop     :       4.1708
   2 stops    :       0.0000
   3 stops    :       0.0000
```

```
    INFO       :       0.0000
    1 stop     :       0.0000
    2 stops    :       0.0000
    3 stops    :       0.0000

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

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 zones 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 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 simulation. Note that due to the inherent randomness of DYNASMART-P, these values will not exactly match those specified in *scenario.dat* (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* (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 numbers 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.

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 trajectories  ****
=================================================
This file provides all the vehicles trajectories
Veh #  16645 Tag= 2 OrigZ=    5 DestZ=    9 Class= 5 UstmN=     103 DownN=
102 DestN=      11 STime=  70.20 Total Travel Time=   8.49 # of Nodes=  18
VehType 1 LOO 1
    102    160    102    103    151     97     89      4      3     24
      5     27     28     32     35     39     40     11
```

```
==>Node Exit Time Point
  0.80   0.90   1.60   2.20   3.00   3.40   3.80   5.00   5.50   5.90
  6.00   6.30   6.70   7.10   7.30   7.60   8.20   8.40
==>Link Travel Time
  0.80   0.10   0.70   0.60   0.80   0.40   0.40   1.20   0.50   0.40
  0.10   0.30   0.40   0.40   0.20   0.30   0.60   0.20
==>Accumulated Stop Time
  0.60   0.60   1.20   1.36   1.42   1.44   1.47   2.22   2.57   2.57
  2.57   2.57   2.57   2.57   2.57   2.57   2.57   2.57
```

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 5 and the destination zone is 9. This vehicle responds to VMS information (Class = 5). The upstream node of its generation link is 103. The downstream node of the generation link is node 102, and the destination node is 11. The departure time is 70.20 minutes, and the total travel time is 8.49 minutes. The vehicle has 18 nodes in its path, is of vehicle type 1 (passenger car), and has an occupancy level (or level of occupancy LOO) of 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 102, 160, 102, 103, 151, 97, 89, 4, 3, 24, 5, 27, 28, 32, 35, 39, 40, and 11.

The next line shows the time instance, relative to the departure time, at which the vehicle exited nodes 102, 160, 102, 103, 151, 97, 89, 4, 3, 24, 5, 27, 28, 32, 35, 39, 40, and 11 which are 0.80, 0.90, 1.60, 2.20, 3.00, 3.40, 3.80, 5.00, 5.50, 5.90, 6.00, 6.30, 6.70, 7.10, 7.30, 7.60, 8.20, and 8.40, respectively. The next line shows the travel times on links 102→160, 160→102, 102→103, 103→151, 151→97, 97→89, 89→4, 4→3, 3→24, 24→5, 5→27, 27→28, 28→32, 32→35, 35→39, 39→40, and 40→11 which are 0.80, 0.10, 0.70, 0.60, 0.80, 0.40, 0.40, 1.20, 0.50, 0.40, 0.10, 0.30, 0.40, 0.40, 0.20, 0.30, 0.60, and 0.20 minutes, respectively. The next line shows accumulated stop times at nodes 102, 160, 102, 103, 151, 97, 89, 4, 3, 24, 5, 27, 28, 32, 35, 39, 40, and 11 which are 0.60, 0.60, 1.20, 1.36, 1.42, 1.44, 1.47, 2.22, 2.57, 2.57, 2.57, 2.57, 2.57, 2.57, 2.57, 2.57, 2.57, and 2.57, respectively, and so on.

Table 5-3. Description of parameters in the 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 4-40). 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 link 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, it 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 accumulated 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.

5.4.12 Output_td_linktraveltime.dat

This file presents the time-dependent link travel time (minute) on each link during each aggregation time interval. Figure 5-14 presents the general format of this file. The first record is the assignment mode (0 is one-shot mode; otherwise iterative MUC mode). The second record is the total number of aggregation time intervals. The third record is the planning horizon. The fourth record is the number of simulation time intervals per aggregation time interval for one-short mode. The fifth record is the number of simulation time intervals per aggregation time interval for iterative MUC mode. The seventh record is the aggregation time interval index. Records 8 and onwards pertain to the aggregation time index reported in record 7; they represent the time-dependent link travel time for each link. Field 1 is the link index; field 2 is the upstream node number; field 3 is the downstream node number; field 4 is the link type; and field 5 is the link travel time.

```
          0
         13
   60.00000
         40
         50

          1
          1           1           2           5  0.1193182
          2           1          20           5  0.3380682
          3           1          81           5  0.4659091
          4           2           1           5  0.1193182
          5           2         116           5  0.4005682
.
.
.
```

Figure 5-14. General format of the output_td_linktraveltime.dat output file

5.4.13 Output_td_turnpenalty.dat

This file presents the time-dependent turn penalty on each turn movement during each aggregation time interval. Figure 5-15 presents the general format of this file. The first record is the assignment mode (0 is one-shot mode; other wise, iterative MUC mode). The second record is the total number of aggregation time intervals. The third record is the planning horizon. The fourth record is the number of simulation time intervals per aggregation time interval for one-short mode. The fifth record is the number of simulation time intervals per aggregation time interval for iterative MUC mode. The seventh record is the aggregation time interval index.

Records 8 and onwards pertain to the aggregation time index reported in record 7, representing the time-dependent turn penalty for each turn movement for each link. Field 1 is the link index; field 2 is the upstream node number of inbound link; field 3 is the downstream node number of inbound link; field 4 is upstream node number of next link (to which the movement penalty will be computed); field 5 is the link type; and field 6 is the turn penalty for this turn movement.

```
           0
          13
   60.00000
          40
          50

           1
           1           2           1           2           5   9999.000
           1          81           1           2           5  1.0000000E-03
           1         116           1           2           5  3.0000000E-03
           2           2           1          20           5  3.0000000E-03
           2          81           1          20           5  1.0000000E-03
.
.
.
```

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

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 again, until no assignment intervals may be specified.*

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

The general format of these four files is presented in Figure 5-16.

```
 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 5-16. General format of the routing policy output files

The first record in Figure 5-16 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) 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-destination zone pair in the simulation). The next record shows that zero vehicles are generated on this path (a zero is indicated in field 1), and 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 5-17) provides a summary for the MUC assignment procedure in DYNASMART-P. This file is provided even if the one-shot solution mode is selected.

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

 ====================================================
 BASIC PARAMETERS
 ----------------------------------------------------
 Planning Horizon:                    105.0000
 Iterations Limit:                           1
 OD Demand Loading Factor:         1.000000
 Start Time of Collecting Stats:  0.0000000E+00
 End Time of Collecting Stats:        105.0000
 Iteration Number                            0
 Current time:                        66.10000
 ====================================================

 ====================================================
 Vehicles Still in the Network
 ----------------------------------------------------
 Number of Vehicles             =              0
 Total Travel Time w/o queuing  =          0.000
 Total Trip Distances           =          0.000
 Total Stop Time                =          0.000
 ====================================================
 Vehicles Outside the Network
 ----------------------------------------------------
 Number of Vehicles             =           6000
 Total Travel Time w/o queuing  =      35068.535
 Total Travel Time w queuing    =      35667.645
 Total Trip Distances           =      37742.047
 Total Stop Time                =          0.000
 Average Travel Time            =          5.845
 Average Trip Time              =          5.945
 Average Trip Distance          =          6.290
 Average Stop Time              =          0.000
 Average travel Speed           =         64.574
 ====================================================

 ====================================================
  For All Vehicles in the Network
 ----------------------------------------------------
 Number of Vehicles             =           6000
 Total Travel Time w/o queuing  =      35068.535
 Total Trip Distances           =      37742.047
 Total Stop Time                =          0.000
 Average Travel Time            =          5.845
 Average Trip Distance          =          6.290
 Average Stop Time              =          0.000
 Average travel Speed           =         64.574
 ====================================================

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

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

 Non-Responsive Vehicles
 -----------------------
```

```
Number of Vehicles            =          1208
Total Trip Time (min)         =      7181.511
Total Travel Time (min)       =      7060.361
Total Entry Queue Time (min)  =       121.203
Total Trip Distance (ml)      =      7598.406
Total Stop Time (min)         =         0.000
Average Trip Time (min)       =         5.945
Average Travel Time (min)     =         5.845
Average Entry Q Time (min)    =         0.100
Average Stop Time (min)       =         0.000
Average Trip Distance (ml)    =         6.290

System Optimal Vehicles
-----------------------
Number of Vehicles            =          1224
Total Trip Time (min)         =      7278.198
Total Travel Time (min)       =      7154.044
Total Entry Queue Time (min)  =       124.203
Total Trip Distance (ml)      =      7699.047
Total Stop Time (min)         =         0.000
Average Trip Time (min)       =         5.946
Average Travel Time (min)     =         5.845
Average Entry Q Time (min)    =         0.101
Average Stop Time (min)       =         0.000
Average Trip Distance (ml)    =         6.290

User Equilibrium Vehicles
-------------------------
Number of Vehicles            =          1192
Total Trip Time (min)         =      7087.011
Total Travel Time (min)       =      6966.648
Total Entry Queue Time (min)  =       120.403
Total Trip Distance (ml)      =      7497.766
Total Stop Time (min)         =         0.000
Average Trip Time (min)       =         5.945
Average Travel Time (min)     =         5.845
Average Entry Q Time (min)    =         0.101
Average Stop Time (min)       =         0.000
Average Trip Distance (ml)    =         6.290

En-Route Info Vehicles
----------------------
Number of Vehicles            =          1186
Total Trip Time (min)         =      7050.608
Total Travel Time (min)       =      6931.548
Total Entry Queue Time (min)  =       119.103
Total Trip Distance (ml)      =      7460.025
Total Stop Time (min)         =         0.000
Average Trip Time (min)       =         5.945
Average Travel Time (min)     =         5.844
Average Entry Q Time (min)    =         0.100
Average Stop Time (min)       =         0.000
Average Trip Distance (ml)    =         6.290

VMS-Responsive Vehicles
-----------------------
Number of Vehicles            =          1190
Total Trip Time (min)         =      7069.824
Total Travel Time (min)       =      6955.164
Total Entry Queue Time (min)  =       114.703
Total Trip Distance (ml)      =      7485.186
```

```
Total Stop Time (min)          =          0.000
Average Trip Time (min)        =          5.941
Average Travel Time (min)      =          5.845
Average Entry Q Time (min)     =          0.096
Average Stop Time (min)        =          0.000
Average Trip Distance (ml)     =          6.290


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

Non-Responsive Vehicles
-----------------------
Number of Vehicles          =               0

System Optimal Vehicles
-----------------------
Number of Vehicles          =               0

User Equilibrium Vehicles
-------------------------
Number of Vehicles          =               0

En-Route Info Vehicles
----------------------
Number of Vehicles          =               0

VMS-Responsive Vehicles
-----------------------
Number of Vehicles          =               0


----------------------------------------------------
Total Violation=  0.0000000E+00
----------------------------------------------------

====================================================
**********************************************
**  Summaries for MUC Iteration Procedures  **
**********************************************

====================================================
BASIC PARAMETERS
----------------------------------------------------
Planning Horizon:                      105.0000
Iterations Limit:                             1
OD Demand Loading Factor:          1.000000
Start Time of Collecting Stats:  0.0000000E+00
End Time of Collecting Stats:          105.0000
Iteration Number                              1
Current time:                          66.10000
====================================================

====================================================
Vehicles Still in the Network
----------------------------------------------------
Number of Vehicles              =              0
Total Travel Time w/o queuing  =          0.000
Total Trip Distances            =          0.000
Total Stop Time                 =          0.000
```

```
====================================================
Vehicles Outside the Network
----------------------------------------------------
Number of Vehicles              =           6000
Total Travel Time w/o queuing   =      34233.922
Total Travel Time w queuing     =      34833.648
Total Trip Distances            =      36818.562
Total Stop Time                 =          1.938
Average Travel Time             =          5.706
Average Trip Time               =          5.806
Average Trip Distance           =          6.136
Average Stop Time               =          0.000
Average travel Speed            =         64.530
====================================================

====================================================
 For All Vehicles in the Network
----------------------------------------------------
Number of Vehicles              =           6000
Total Travel Time w/o queuing   =      34233.922
Total Trip Distances            =      36818.562
Total Stop Time                 =          1.938
Average Travel Time             =          5.706
Average Trip Distance           =          6.136
Average Stop Time               =          0.000
Average travel Speed            =         64.530
====================================================

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

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

Non-Responsive Vehicles
-----------------------
Number of Vehicles             =          1208
Total Trip Time (min)          =      7187.043
Total Travel Time (min)        =      7063.444
Total Entry Queue Time (min)   =       123.603
Total Trip Distance (ml)       =      7598.406
Total Stop Time (min)          =         0.245
Average Trip Time (min)        =         5.950
Average Travel Time (min)      =         5.847
Average Entry Q Time (min)     =         0.102
Average Stop Time (min)        =         0.000
Average Trip Distance (ml)     =         6.290

System Optimal Vehicles
-----------------------
Number of Vehicles             =          1224
Total Trip Time (min)          =      6853.186
Total Travel Time (min)        =      6742.581
Total Entry Queue Time (min)   =       110.602
Total Trip Distance (ml)       =      7246.840
Total Stop Time (min)          =         0.670
Average Trip Time (min)        =         5.599
Average Travel Time (min)      =         5.509
Average Entry Q Time (min)     =         0.090
Average Stop Time (min)        =         0.001
```

```
Average Trip Distance (ml)    =          5.921

User Equilibrium Vehicles
-------------------------
Number of Vehicles            =           1192
Total Trip Time (min)         =       6648.182
Total Travel Time (min)       =       6536.478
Total Entry Queue Time (min)  =        111.702
Total Trip Distance (ml)      =       7026.618
Total Stop Time (min)         =          0.656
Average Trip Time (min)       =          5.577
Average Travel Time (min)     =          5.484
Average Entry Q Time (min)    =          0.094
Average Stop Time (min)       =          0.001
Average Trip Distance (ml)    =          5.895

En-Route Info Vehicles
----------------------
Number of Vehicles            =           1186
Total Trip Time (min)         =       7058.626
Total Travel Time (min)       =       6933.635
Total Entry Queue Time (min)  =        125.003
Total Trip Distance (ml)      =       7460.025
Total Stop Time (min)         =          0.189
Average Trip Time (min)       =          5.952
Average Travel Time (min)     =          5.846
Average Entry Q Time (min)    =          0.105
Average Stop Time (min)       =          0.000
Average Trip Distance (ml)    =          6.290

VMS-Responsive Vehicles
-----------------------
Number of Vehicles            =           1190
Total Trip Time (min)         =       7086.563
Total Travel Time (min)       =       6957.762
Total Entry Queue Time (min)  =        128.803
Total Trip Distance (ml)      =       7485.186
Total Stop Time (min)         =          0.177
Average Trip Time (min)       =          5.955
Average Travel Time (min)     =          5.847
Average Entry Q Time (min)    =          0.108
Average Stop Time (min)       =          0.000
Average Trip Distance (ml)    =          6.290


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

Non-Responsive Vehicles
-----------------------
Number of Vehicles           =               0

System Optimal Vehicles
-----------------------
Number of Vehicles           =               0

User Equilibrium Vehicles
-------------------------
Number of Vehicles           =               0
```

```
En-Route Info Vehicles
----------------------
Number of Vehicles           =              0

VMS-Responsive Vehicles
-----------------------
Number of Vehicles           =              0
----------------------------------------------------
Total Violation=   2586.000
----------------------------------------------------
```

Figure 5-17. General format of the OutMUC.dat output file

In this output file, DYNASMART-P reports MUC MOE statistics for 1) vehicles still in the network (not reaching their destinations during the planning horizon), 2) vehicles outside the network (having reached their destinations during the planning horizon), and 3) for all vehicles (those still in the network, plus those having reached their destinations).

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 5-18 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 0.200 fraction (field 1) of link 1 length. Similarly, a 0.100 fraction (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 5-18. 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 5-19 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 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 5-19. 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 5-20 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 5-20. 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 5-21 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 5-21. General description of the Fort.900 GUI output file

5.12 TollRevenue.dat

DYNSMART-P generates TollRevenue.dat if a user specifies the HOT/HOV links and rates in link_pricing.dat or from GUI. TollRevenue.dat displays the vehicle-mile-traveled (VMT) and toll revenue for each HOT/HOV link specified by the user. The total VMT and revenue are also displayed at the end of the file.

```
Statistics for Toll Links ==> Interation #            3
==========================================================================
Link      60->     178   VMT(ml) =     785.2  Toll Revenue($)=     157.0
Link     178->      52   VMT(ml) =     532.8  Toll Revenue($)=     106.6
Link      52->     179   VMT(ml) =      68.9  Toll Revenue($)=      13.8
Link     179->      48   VMT(ml) =      79.3  Toll Revenue($)=      15.9
Link      48->     180   VMT(ml) =     996.1  Toll Revenue($)=     199.2
Link     180->      34   VMT(ml) =    1044.5  Toll Revenue($)=     208.9
--------------------------------------------------------------------------
Total Revenue($) =    701.3512
Total VMT(mile)  =    3506.756
===========================================================================
```

Figure 5-22 General description of TollRevenue.dat

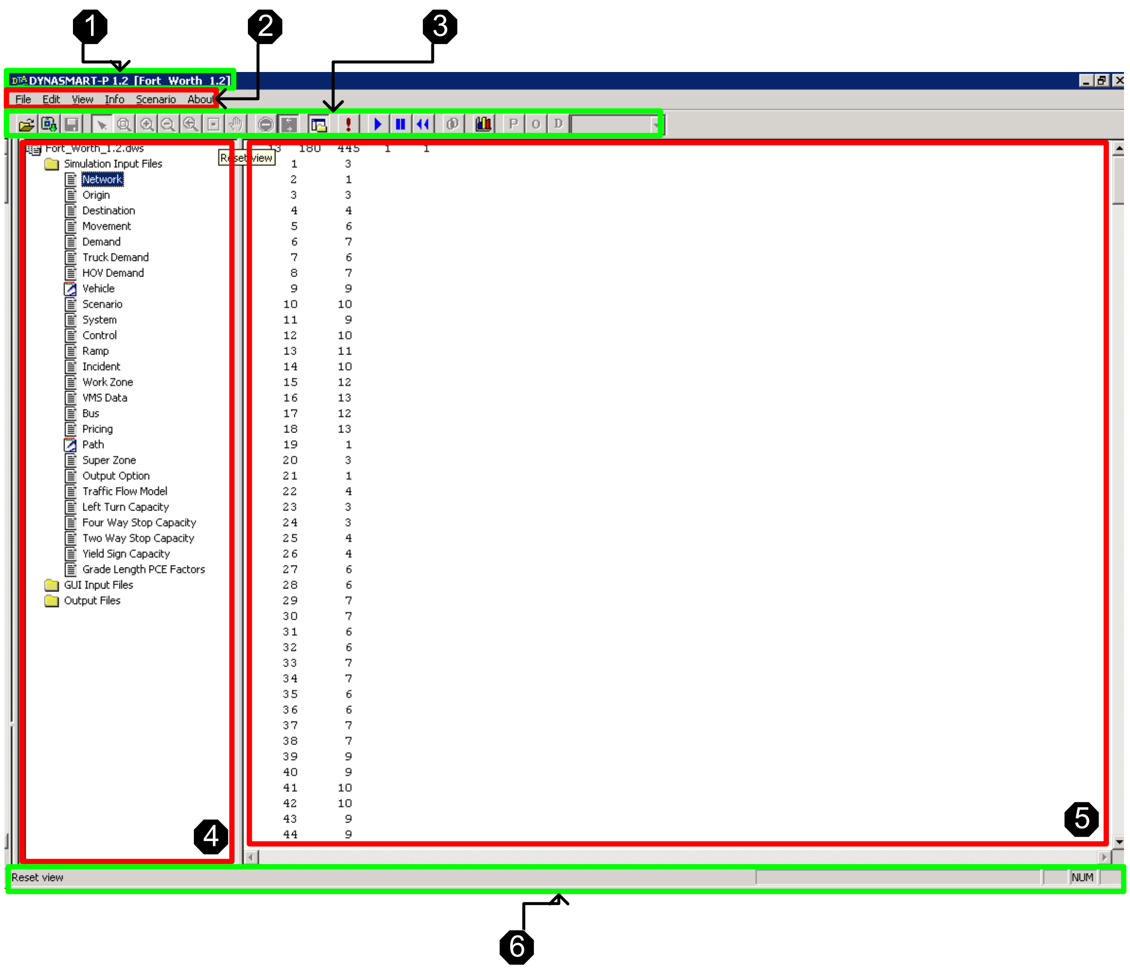
6. DYNASMART-P GRAPHICAL USER INTERFACE

6.1 Input and Output View Modes

The DYNASMART-P graphical user interface (GUI) consists of two main view modes: <Input> and <Output>.

6.1.1 Input View Mode

The <Input> view (Figure 6-1) is composed of the 1) <Version Number & Data Set Name> bar, 2) <Menu> bar, 3) <Toolbar>, 4) <Project File Tree>, 5) <Text Panel> window, and 6) <Status> bar. The text panel window is supported by a built-in editor that allows users to make changes to the input files before running the model. The user can switch between the <Project File Tree> and the <Text Panel> windows by pressing the **F5** and **F6** buttons, respectively.

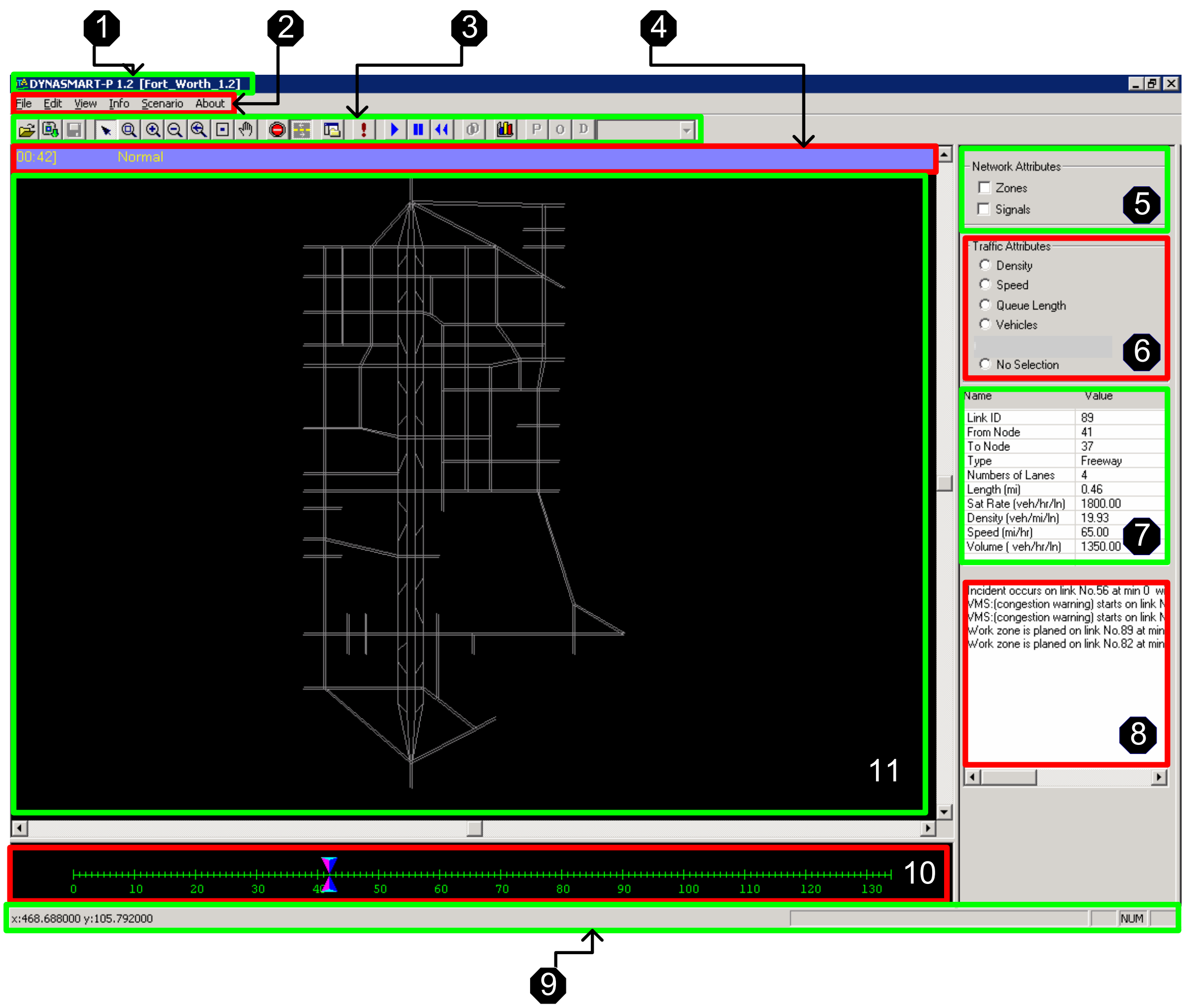


1: Version Number & Data Set Name bar
2: Menu bar
3: Tool bar
4: Project File Tree window
5: Text Panel window
6: Status bar

Figure 6-1. GUI input view

6.1.2 Output View Mode

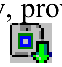
To switch between the <Input> and the <Output> views, press the **F2** button, or simply click the  icon on the <Toolbar>. The <Output> view (Figure 6-2) is composed of 1) <Version Number & Data Set Name> bar, 2) <Menu> bar, 3: <Toolbar>, 4) <Simulation Status> bar, 5) <Network Attributes> window, 6) <Traffic Attributes> window, 7) <Node & Link Attributes> window, 8) <Message> window, 9) <Status> bar, 10) <Simulation Clock Time> bar, and 11) <Network Display> window. This view allows users to examine simulation results and other characteristics pertaining to the scenario being investigated.



1: Version Number & Data Set Name bar
2: Menu bar
3: Toolbar
4: Simulation Status bar
5: Network Attributes window
6: Traffic Attributes window
7: Node & Link attributes window
8: Message window
9: Status bar
10: Simulation Clock Time bar
11: Network Display window

Figure 6-2. GUI output view

Network Attributes Window

In this window (Figure 6-3), users may select any of the network attribute options to see information graphically, provided that network data is loaded using the File | Load Network Data menu command or the  toolbar icon. For example, selecting the <<Zones>> check box will display zone boundaries and numbers on the network (Figure 6-4). Similarly, selecting the <<Signals>> check box will display signal locations on the network (Figure 6-5).

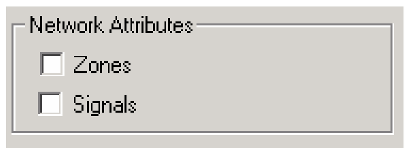


Figure 6-3. Network attributes window

Figure 6-4. Zone numbers and boundaries as shown on GUI

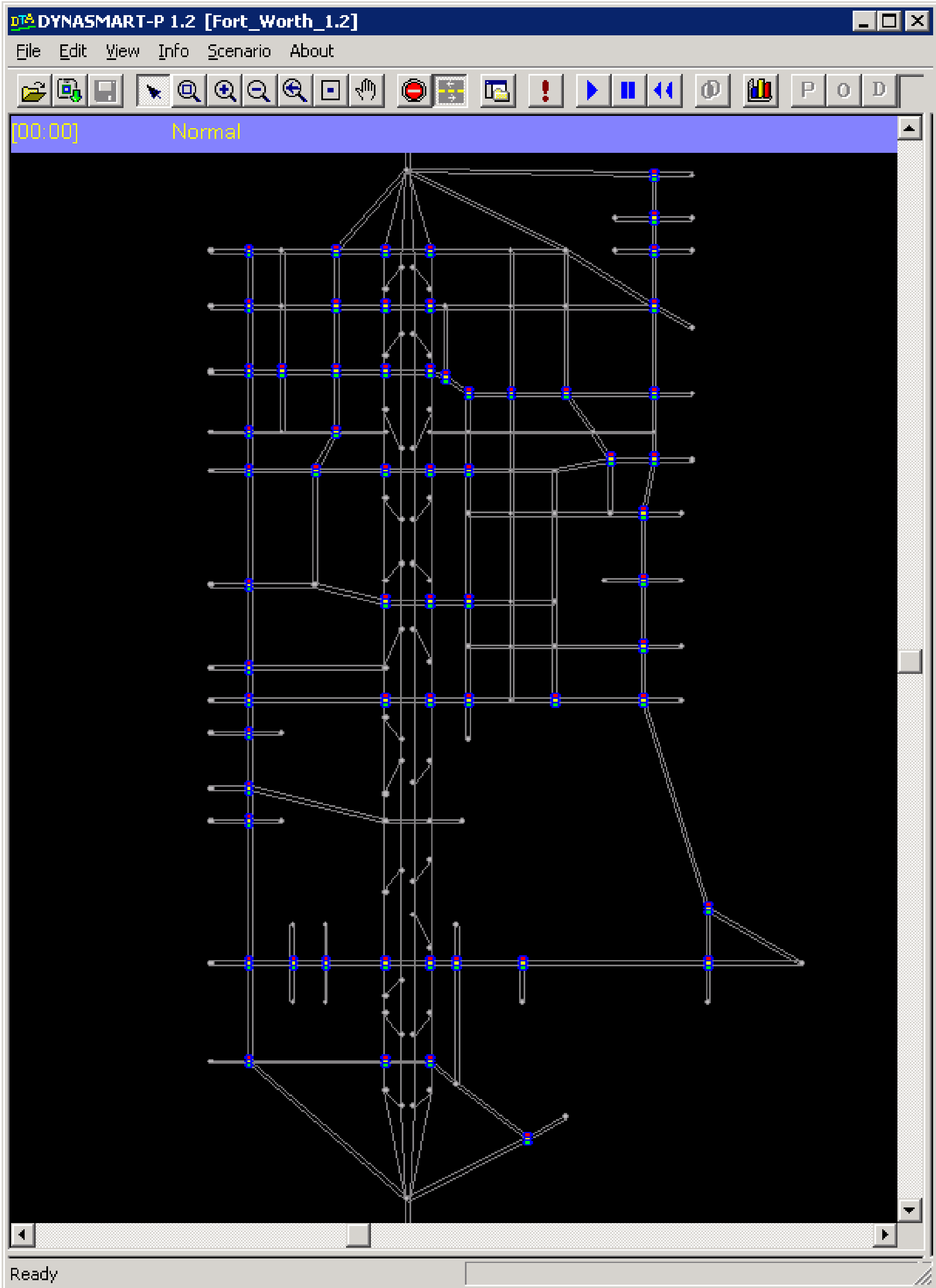


Figure 6-5. Signals as shown on GUI

Traffic Attributes Window

After loading simulation results (using the File | Load Simulation Results menu command or the  toolbar icon), select <<Density>>, <<Speed>>, <<Queue Length>>, or <<Vehicles>> to display time-dependent density (pc/mile/lane) (Figure 6-7), speed (mph) (Figure 6-8), queue lengths (Figure 6-9), vehicles (Figure 6-10). Slide the simulation clock time cursor  to display MOEs pertaining to different simulation time points. Finally, select the <<NO Selection>> option to clear the network.

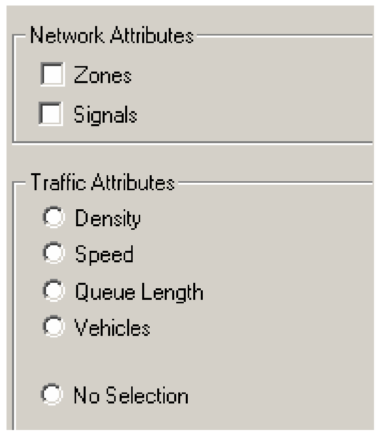


Figure 6-6. Traffic attributes window

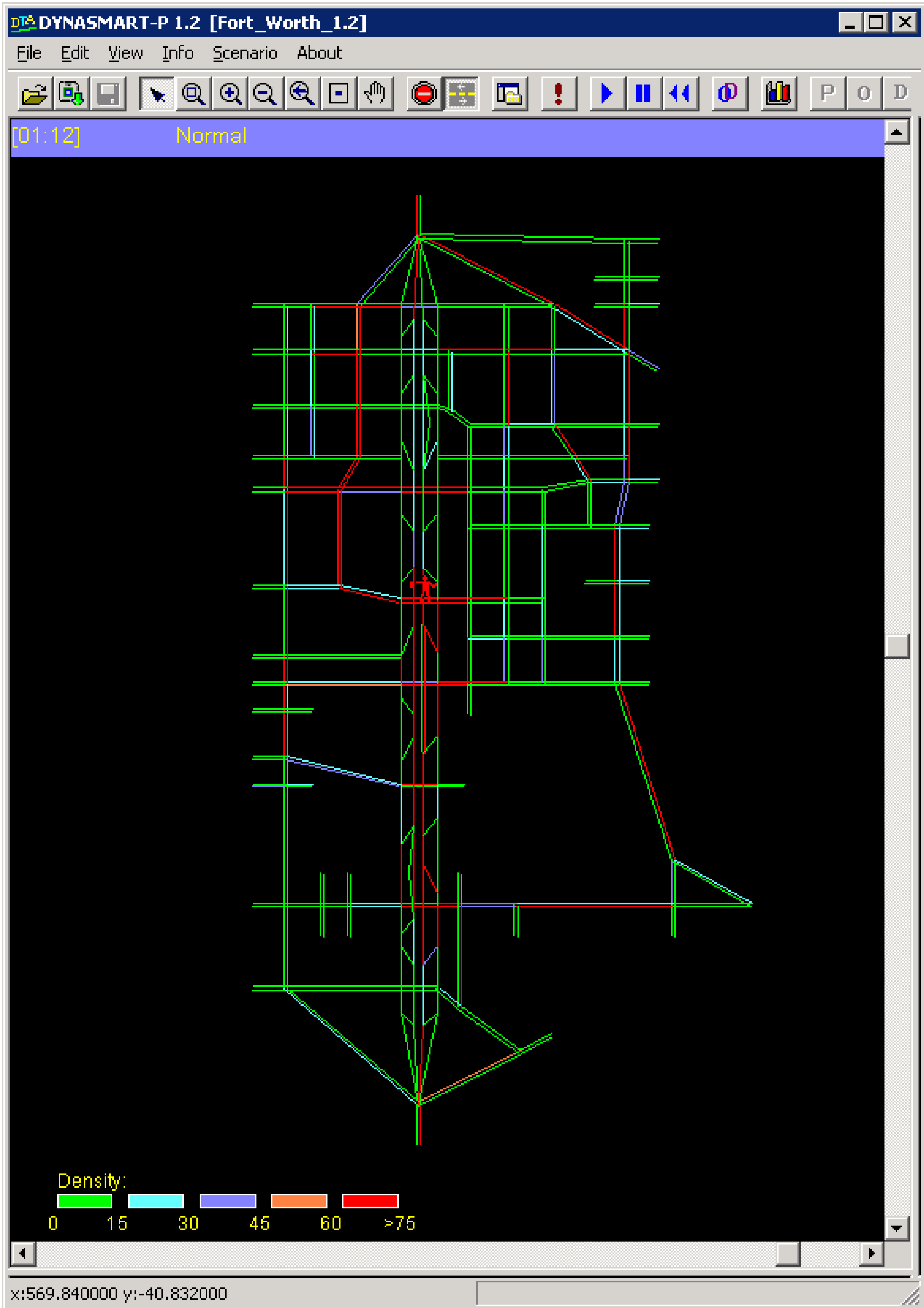


Figure 6-7. Density is shown with different colors and legend is provided

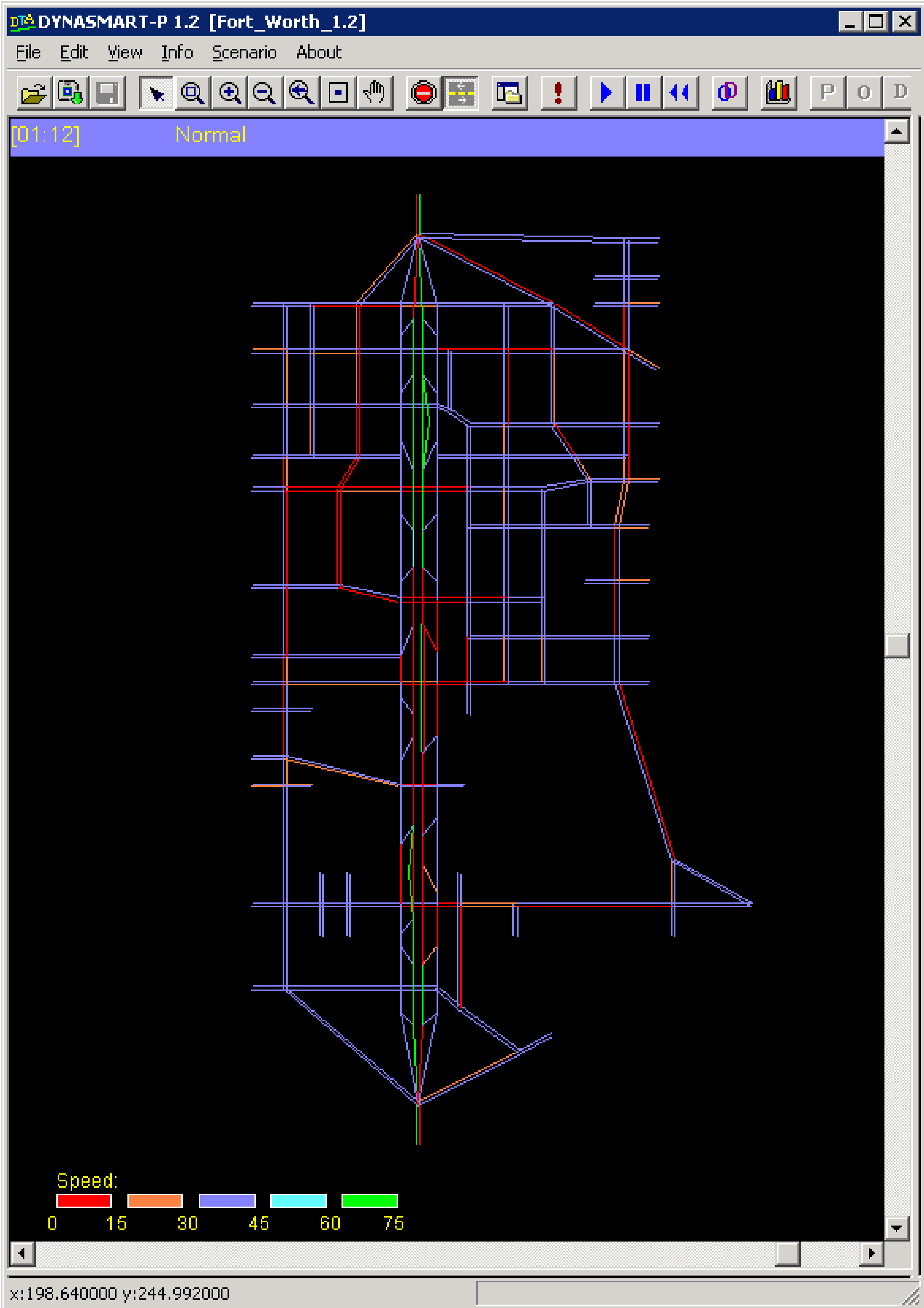


Figure 6-8. Link speeds as shown on the GUI

Figure 6-9. Queue lengths as shown on the GUI

Note that 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. This is why the GUI will usually not show a continuous solid queue line extending across intersections when conditions are oversaturated.

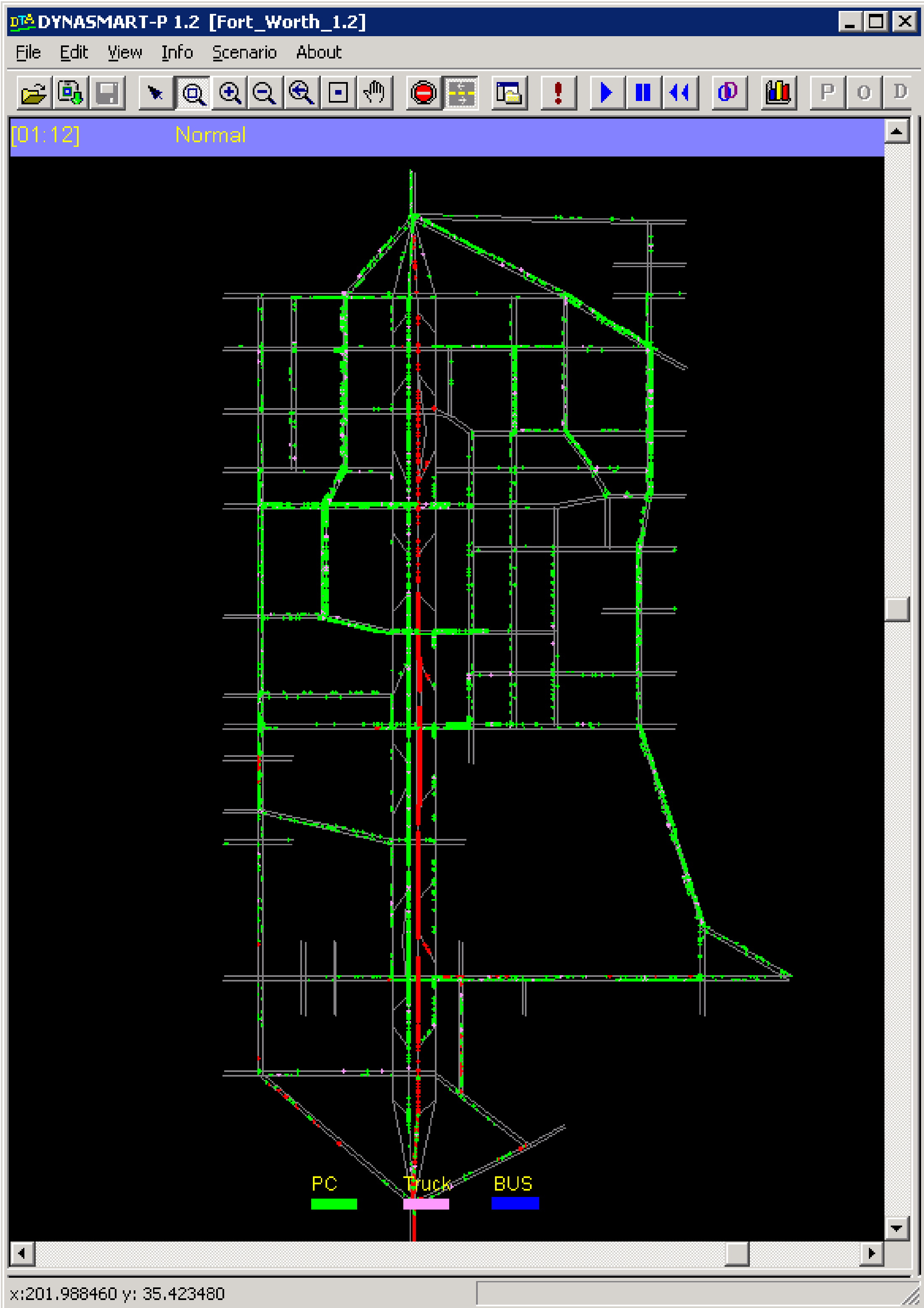


Figure 6-10. Vehicles as shown on the GUI

Note that PCs are shown as green dots, trucks as pink dots, buses as blue dots, and impacted vehicles are shown as red dots. Moreover, since the GUI depicts newly generated vehicles starting from the downstream node of their respective generation links, boundary generation links receiving no upstream traffic will not show vehicles (moving dots) on that link, even though there are in fact generated vehicles traversing that link.

Node and Link Attributes Information Window

Node or link characteristics are displayed in the table shown below (Figure 6-13). To obtain the information shown in this table, the user can click on the link or node in the network diagram.

Name	Value
Node ID	148
Control Type	Stop Sign
Zone No.	10
Super Zone No.	8

Figure 6-11. Node attributes information window

Name	Value
Link ID	99
From Node	48
To Node	41
Type	Freeway
Numbers of Lanes	4
Length (mi)	0.86
Sat Rate (veh/hr/ln)	1800.00
Density (veh/mi/ln)	20.15
Speed (mi/hr)	65.00
Volume (veh/hr/ln)	1230.00

Figure 6-12. Link attributes information window

Message Box

Relevant information pertaining to the scenario being simulated is automatically displayed in the message box (e.g., incident status, VMS status, etc.).

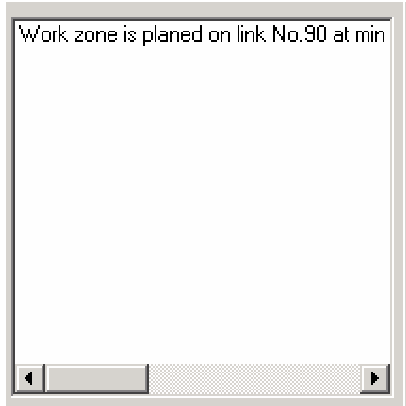


Figure 6-13. Message box

6.2 Menu Bar Items

The <Menu> bar consists of five main pull-down menus: File, Edit, View, Info, Scenario, and About. 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. The Scenario pull-down menu provides dialog boxes for specifying different system, scenario and simulation parameters. Detailed descriptions of these menus are provided below. Finally, the About menu provides version and copyright information.

6.2.1 The File Menu

The File menu (Figure 6-15) 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.

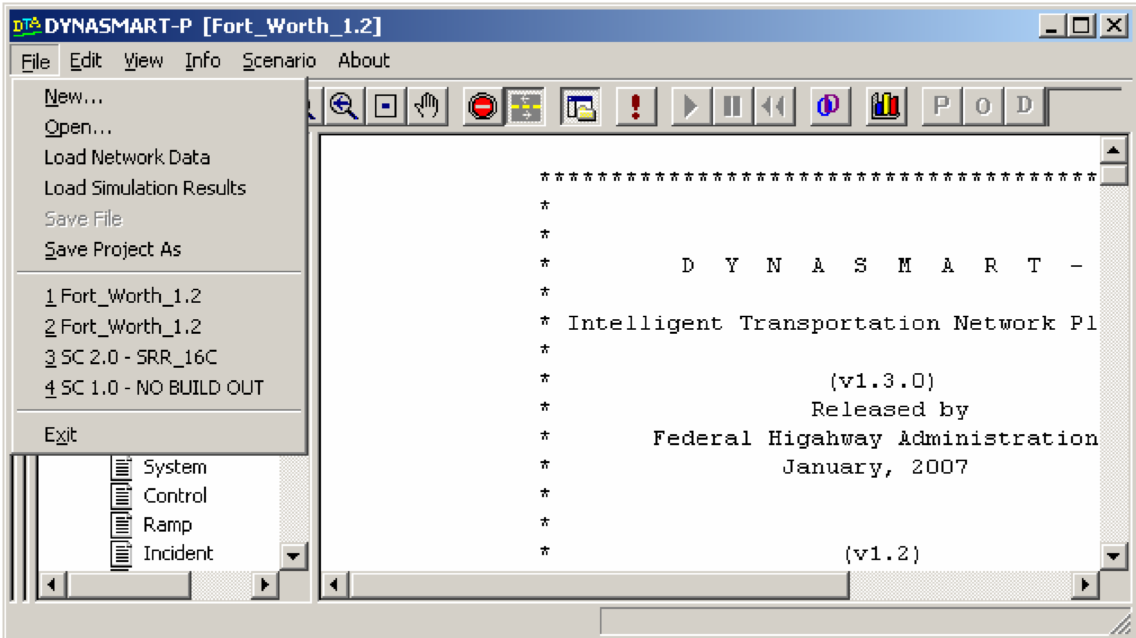


Figure 6-14. The file pull-down menu

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 6-16).

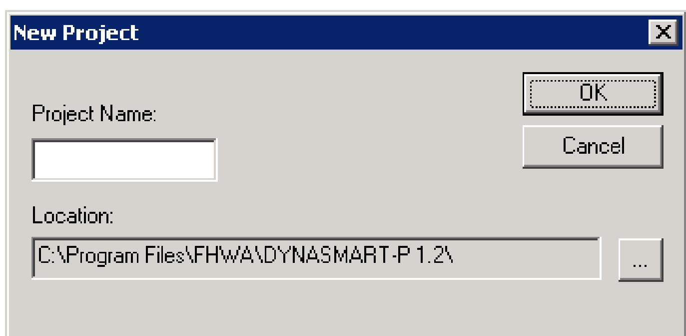


Figure 6-15. New project dialog box

The GUI will create a template project workspace with empty input files. The project name can be specified in the <<Project Name:>> text box (Figure 6-16). To change the location, specify the desired folder by clicking . Users with limited access rights should also use this button to select a folder where they have full write-access. Doing so will launch the <Choose Directory> dialog box (Figure 6-17). 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.

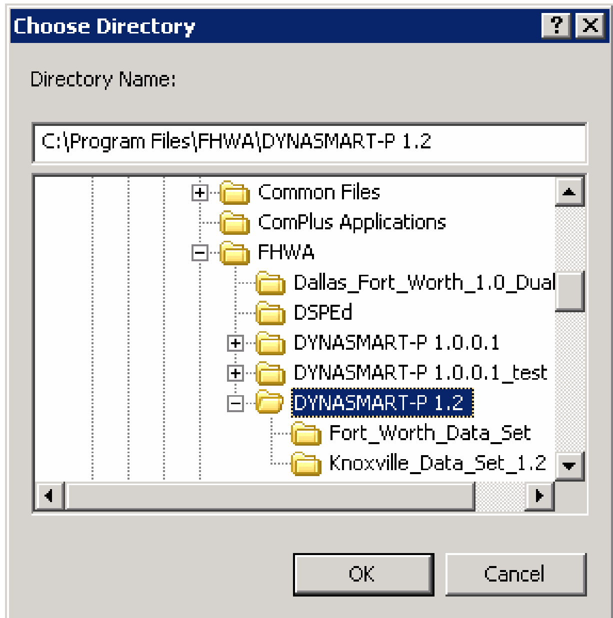


Figure 6-16. Choose directory dialog box

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 to launch the <Open Project> dialog box (Figure 6-18).

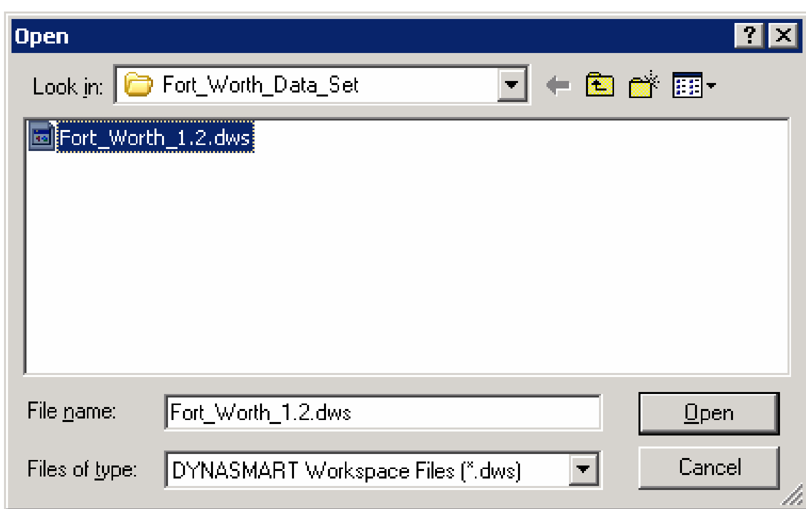


Figure 6-17. Open project dialog box

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 <Toolbar>icon). The user may then click the <Toolbar> icon to view animation. The <Toolbar>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 <Toolbar> icon. Doing so will invoke the following dialog box (Figure 6-19):

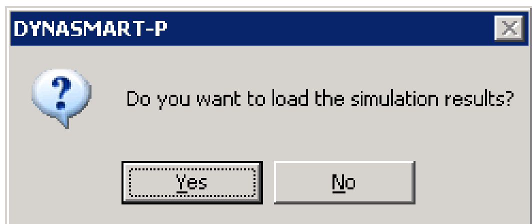
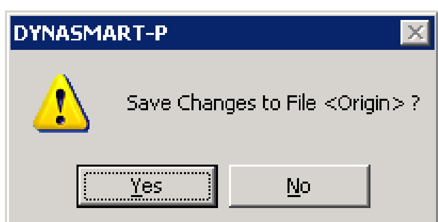


Figure 6-18. Load simulation results dialog box

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 <Toolbar> icon). In either case, the GUI would still prompt the user to save changes when switching between input files. Click <<Yes>> to save the file.



To save a DYNASMART-P project, click the File | Save Project As menu command. Doing so launches the <Save Project As> dialog box (Figure 6-20).

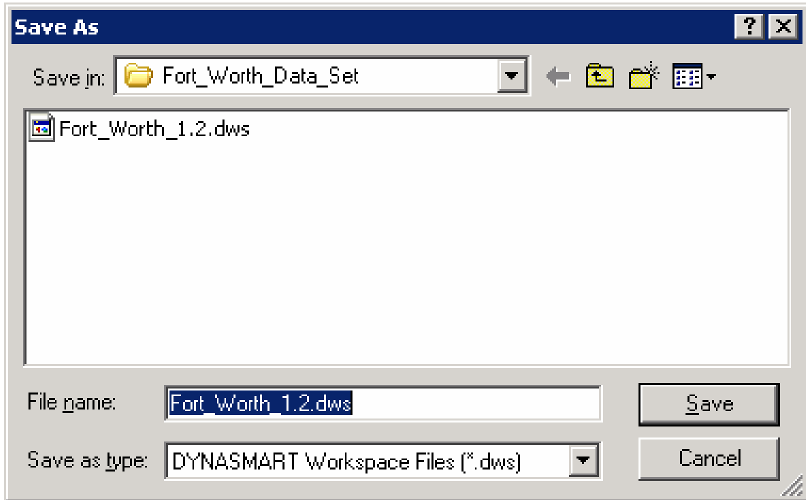


Figure 6-19. Save project as dialog box

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 6-21) provides various text editing capabilities. Their functionalities are self-explanatory, and are identical to those provided in standard text editors such as MS WORD and MS WORDPAD.

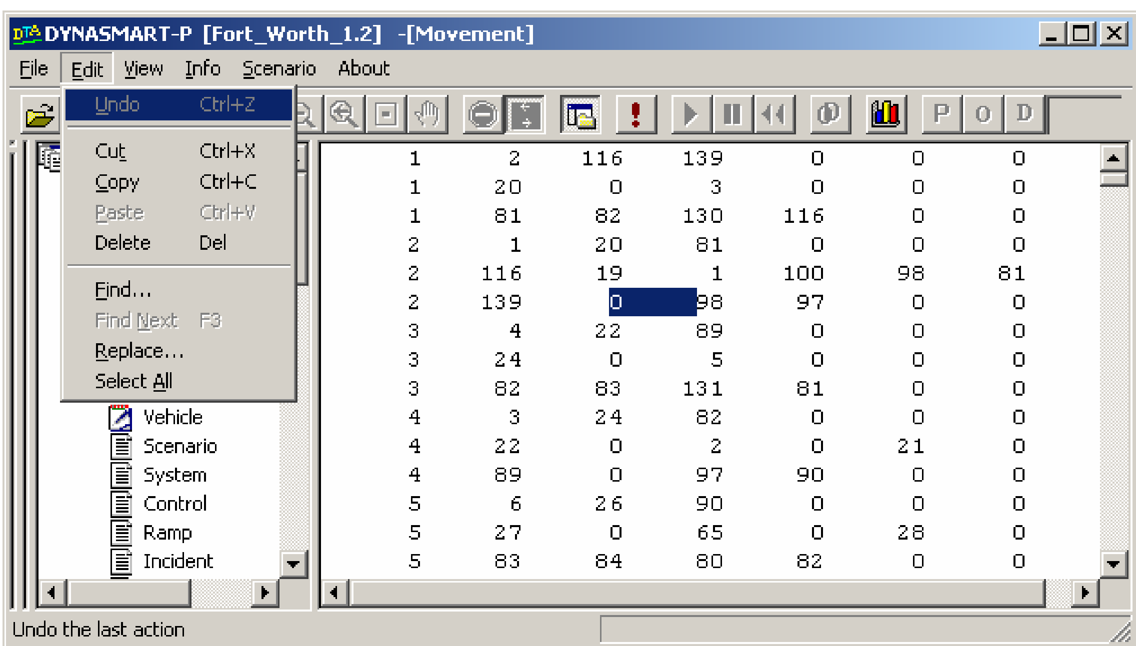
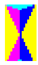
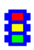
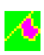
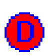
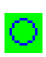
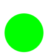


Figure 6-20. Edit menu

6.2.3 The View Menu

Before discussing the View menu options, it is helpful to take a look at network symbols used in DYNASMART-P (Table 6-1).

Table 6-1. Description of network symbols

Symbol	*Description*
	Simulation clock cursor. Click and drag the clock cursor 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
	Impacted vehicle
	Network node

The View menu (Figure 6-22) 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 6-32) and so on. An example for each of the View options is provided below. Note that the GUI does not update the display 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). Also note that, when in the <<Output>> view mode, the View menu commands may be disabled. To activate them, the user need only click on the <<Network Display>> window.

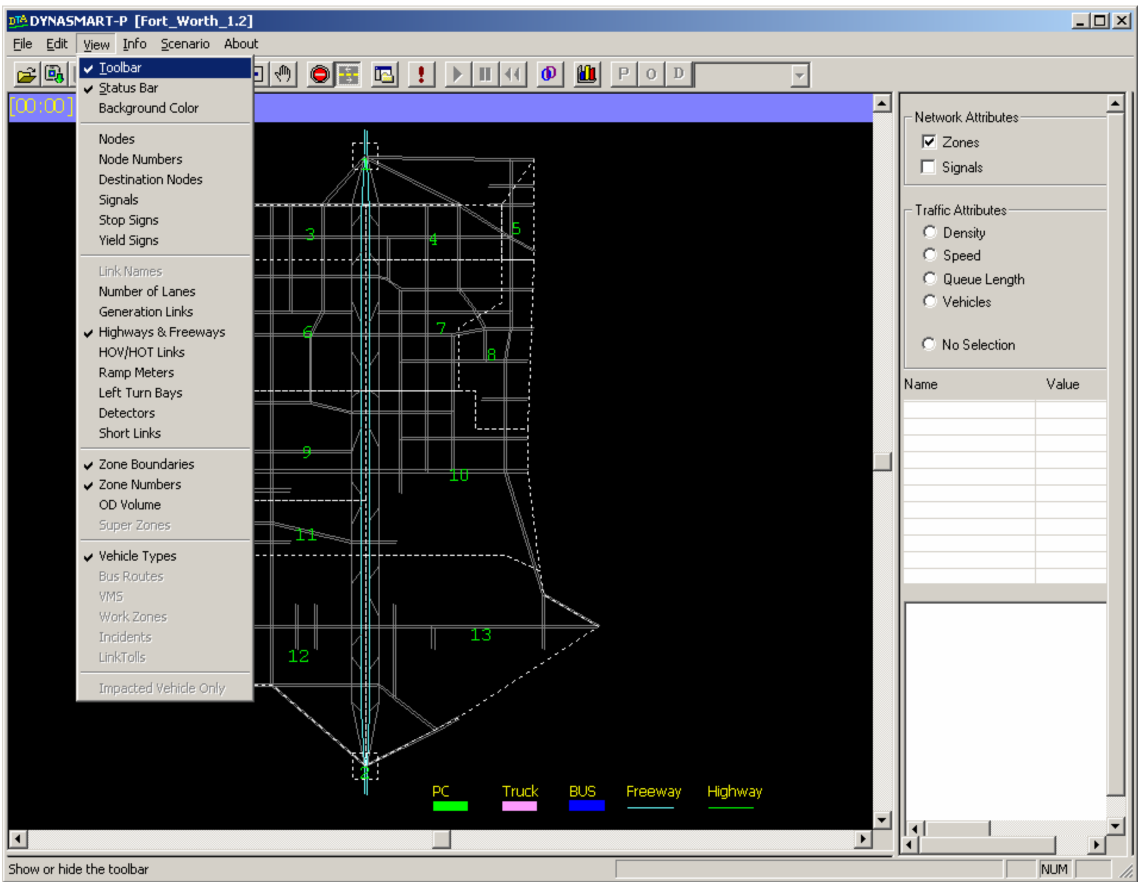


Figure 6-21. The view menu

View | Nodes Menu Command

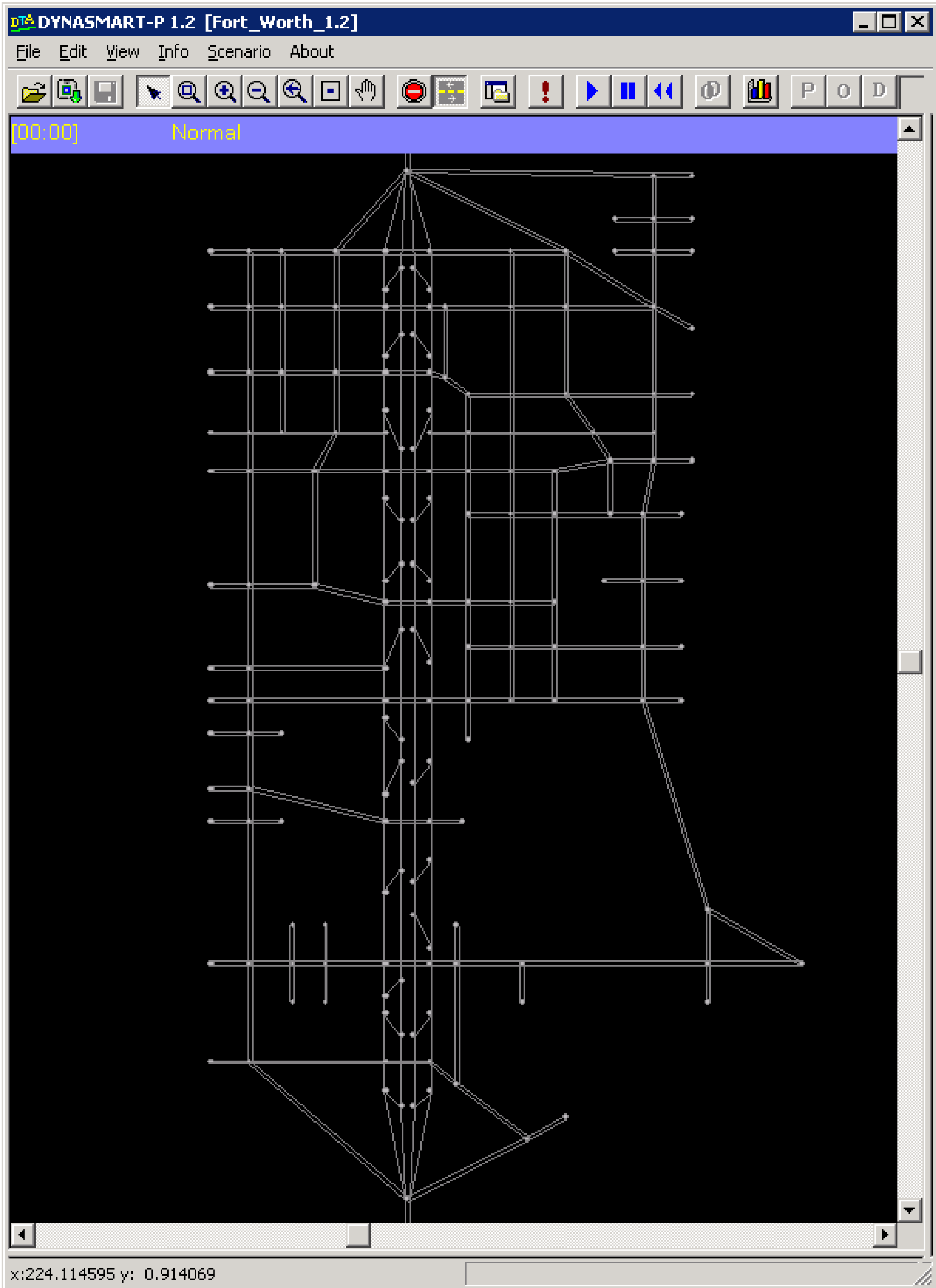


Figure 6-22. Nodes as shown on the GUI

***View* | *Node Numbers* Menu Command**

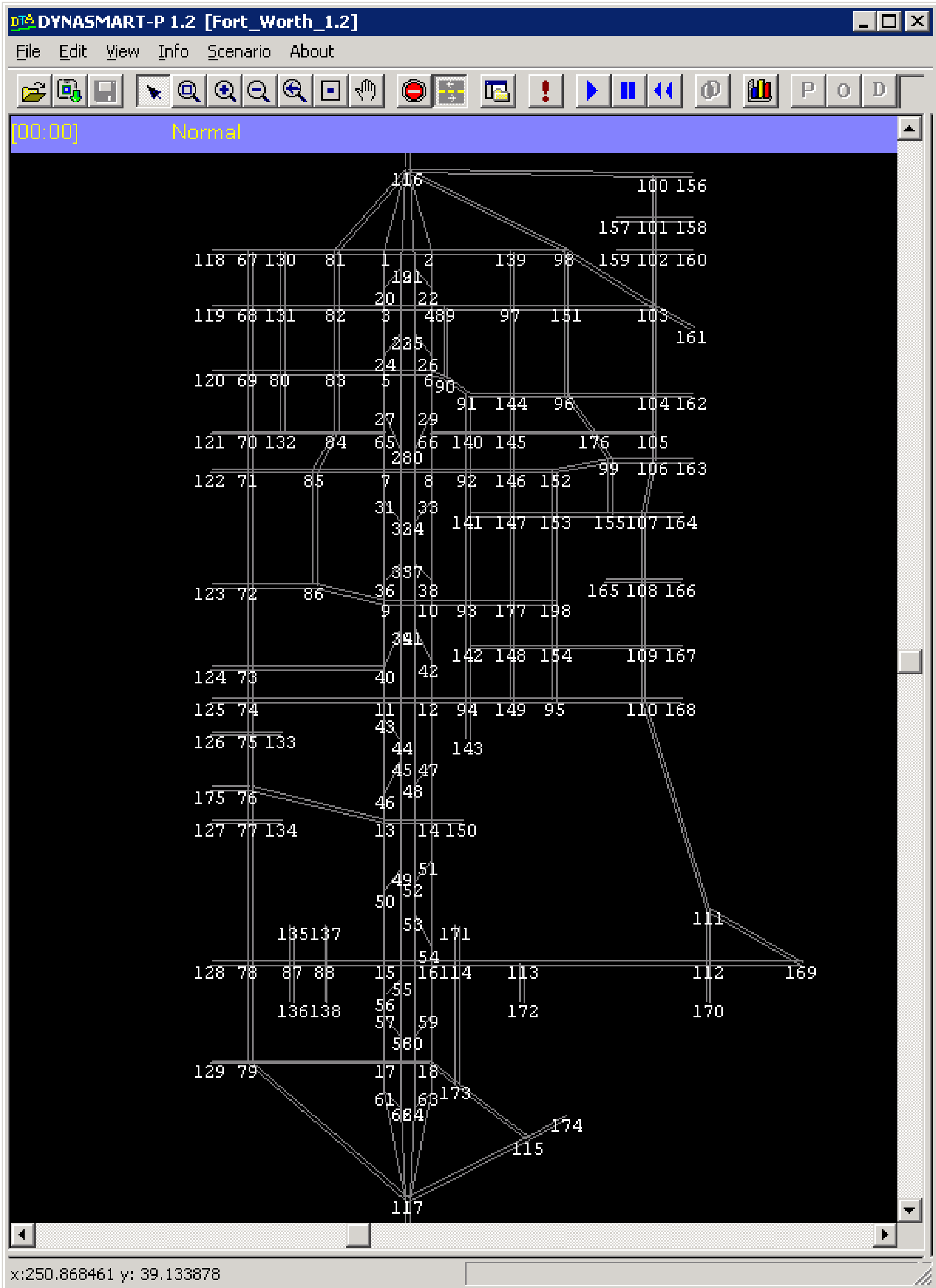


Figure 6-23. Node numbers as shown on GUI

***View* | *Destination Nodes* Menu Command**

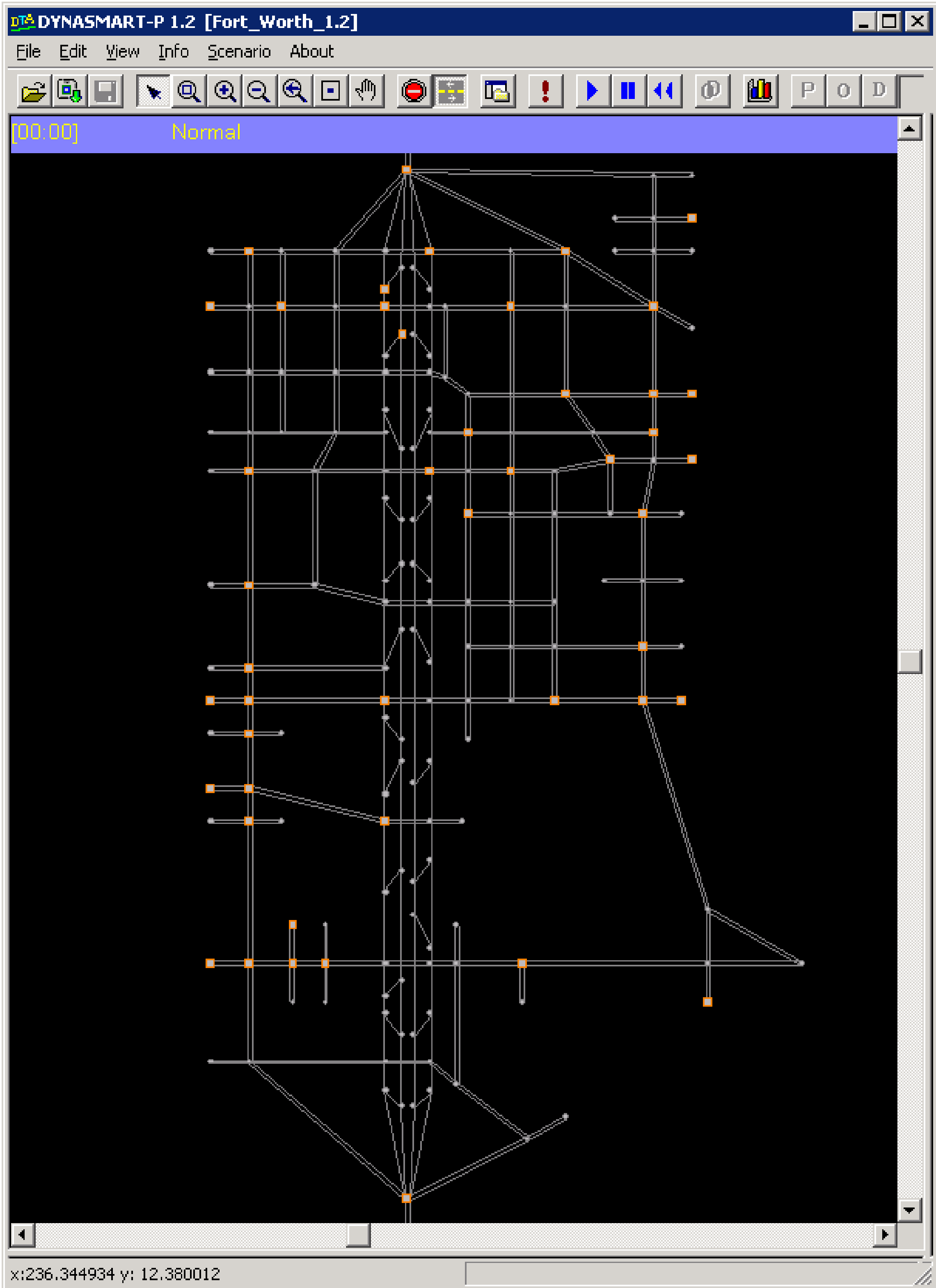


Figure 6-24. Destination nodes as shown on GUI

View | Signals Menu Command

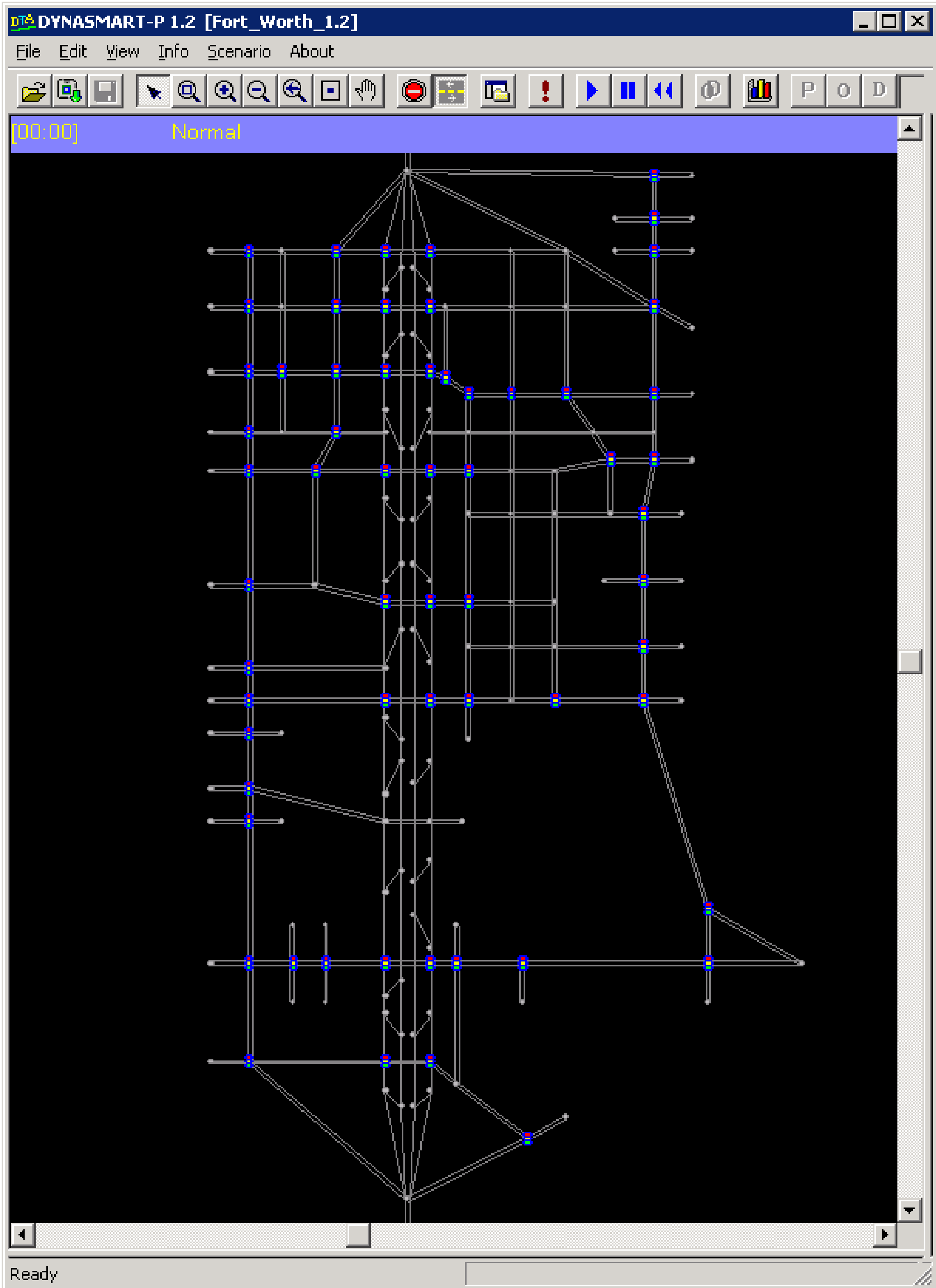


Figure 6-25. Signals as shown on GUI

***View* | *Stop Signs* Menu Command**

Figure 6-26. Stop signs as shown on GUI

***View* | *Yield Signs* Menu Command**

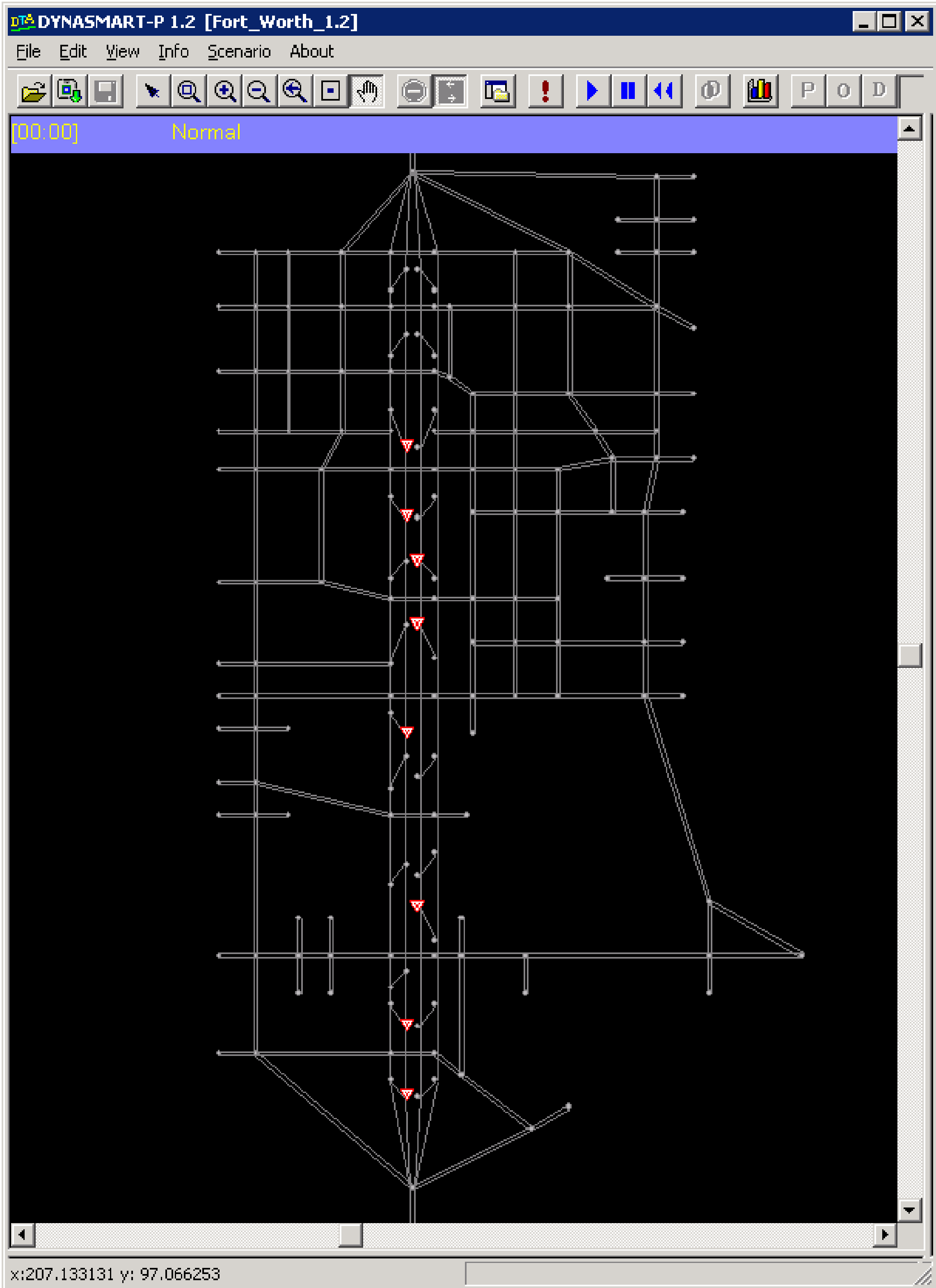


Figure 6-27. Yield signs as shown on GUI

***View* | *Link Names* Menu Command**

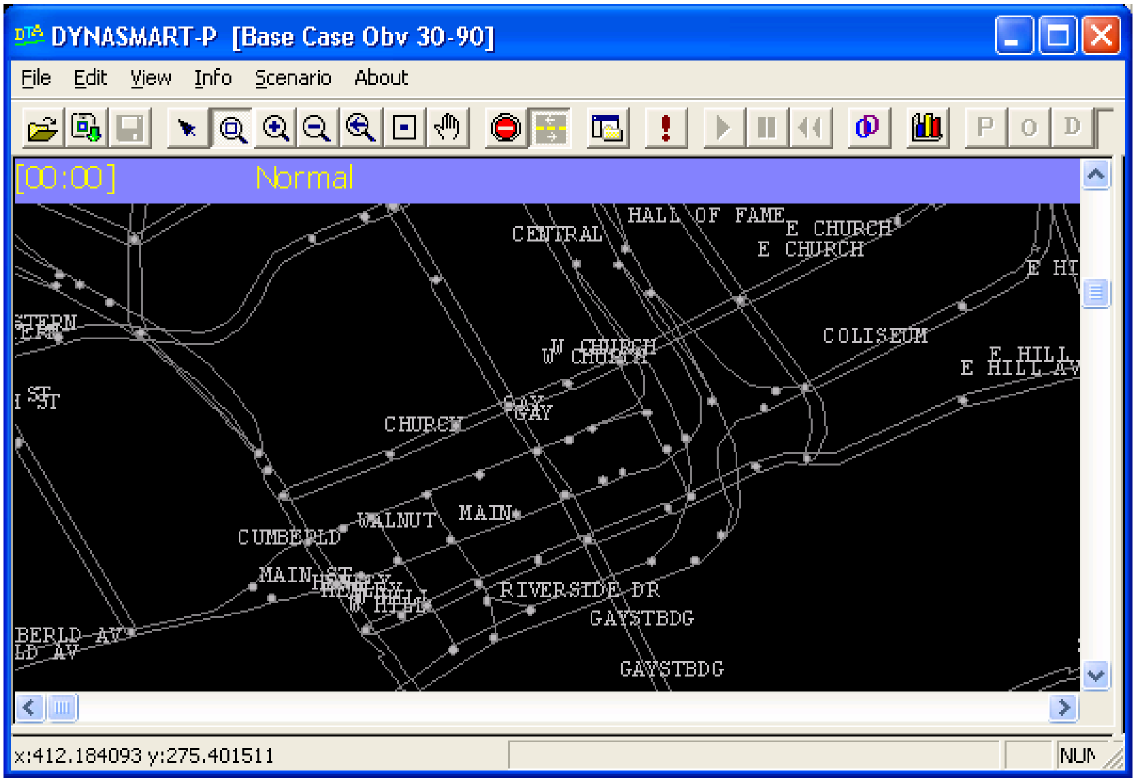


Figure 6-28. Link names as shown on GUI

***<u>View</u>* | *<u>Number of Lanes</u>* Menu Command**

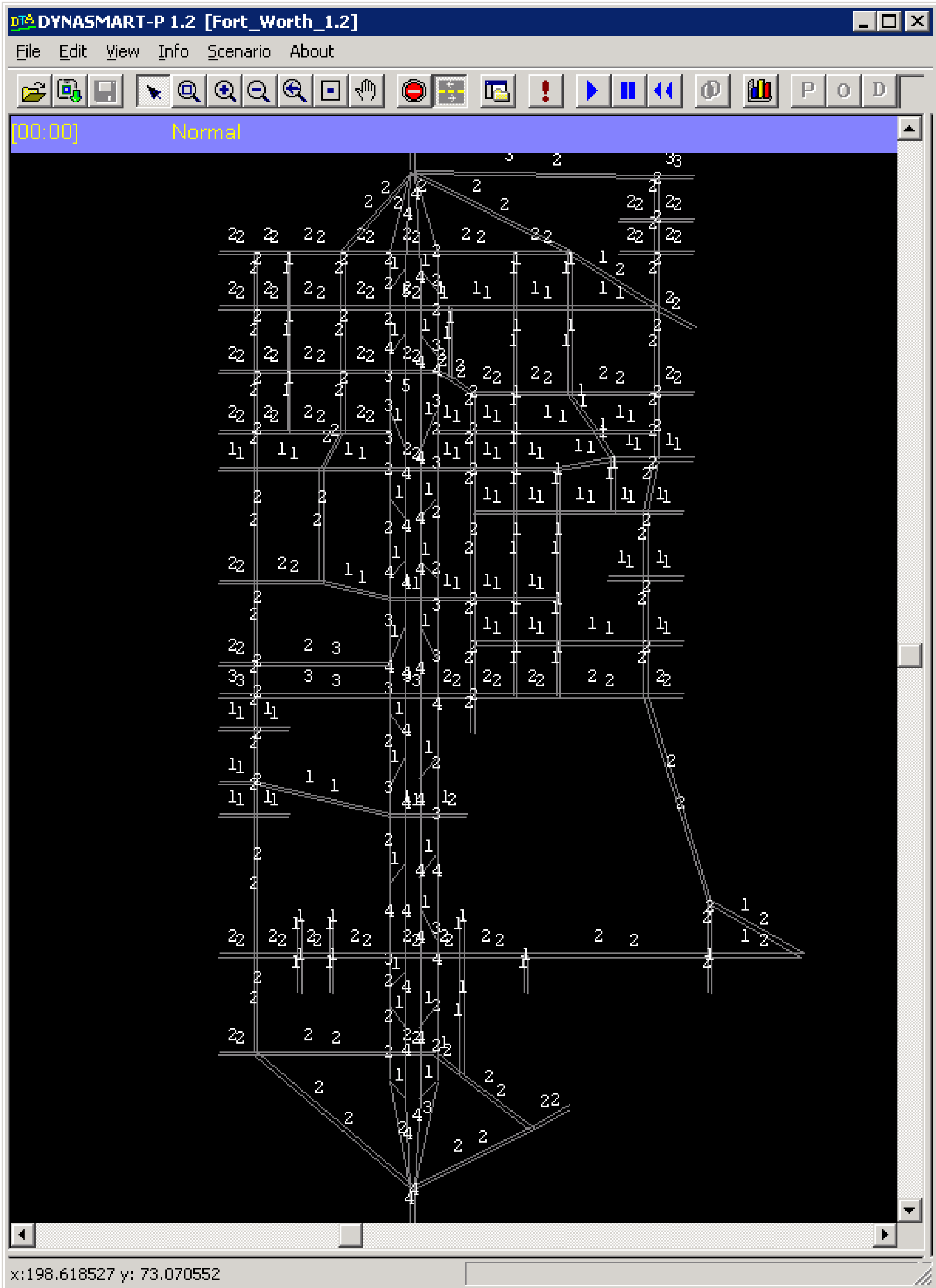


Figure 6-29. Number of lanes as shown on GUI

***View* | *Generation Links* Menu Command**

Figure 6-30. Generation links as shown on GUI

***View* | *Highways & Freeways* Menu Command**

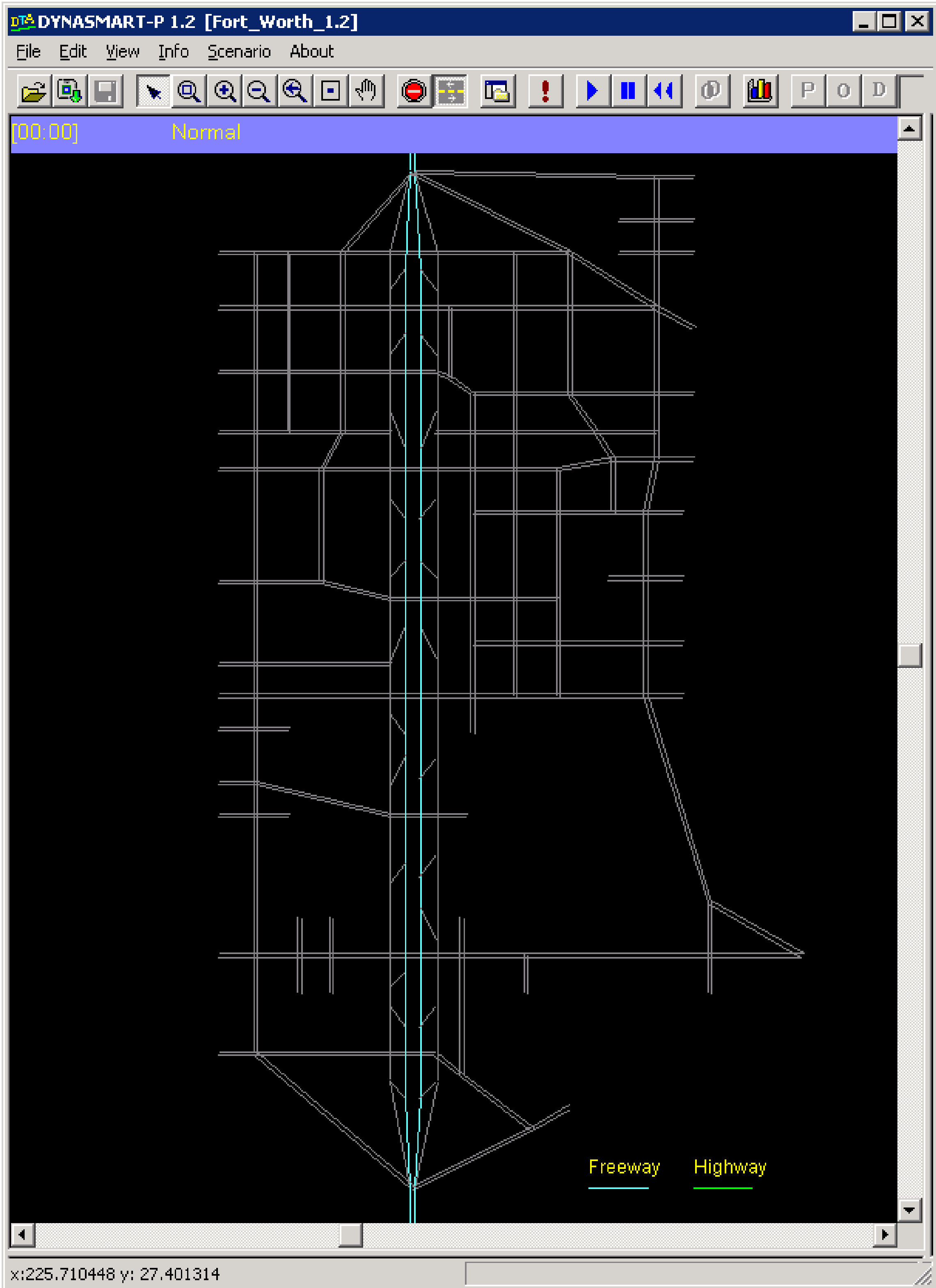


Figure 6-31. Freeways and highways as shown on GUI

***View* | *HOV/HOT Links* Menu Command**

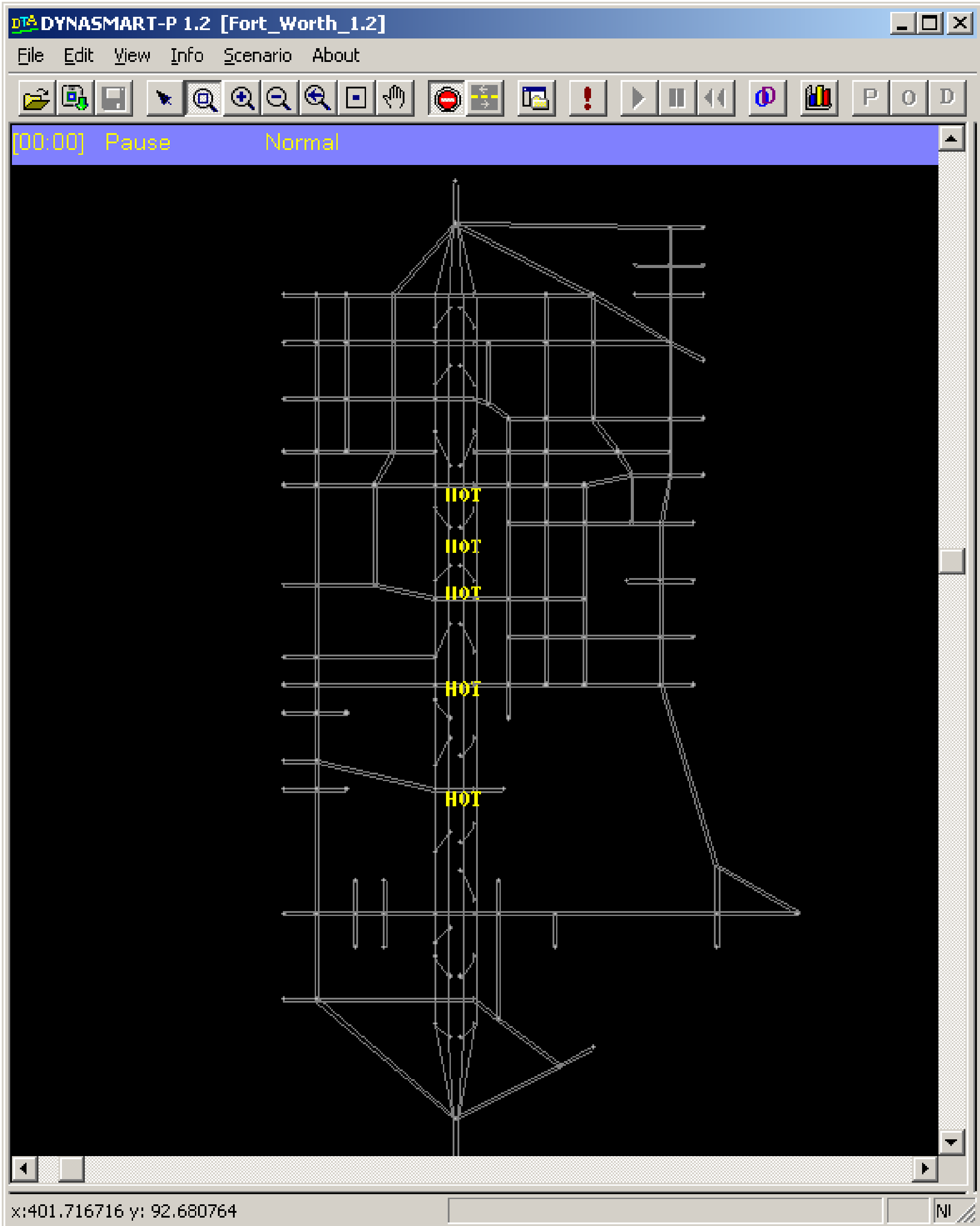


Figure 6-32. HOT links as shown on GUI

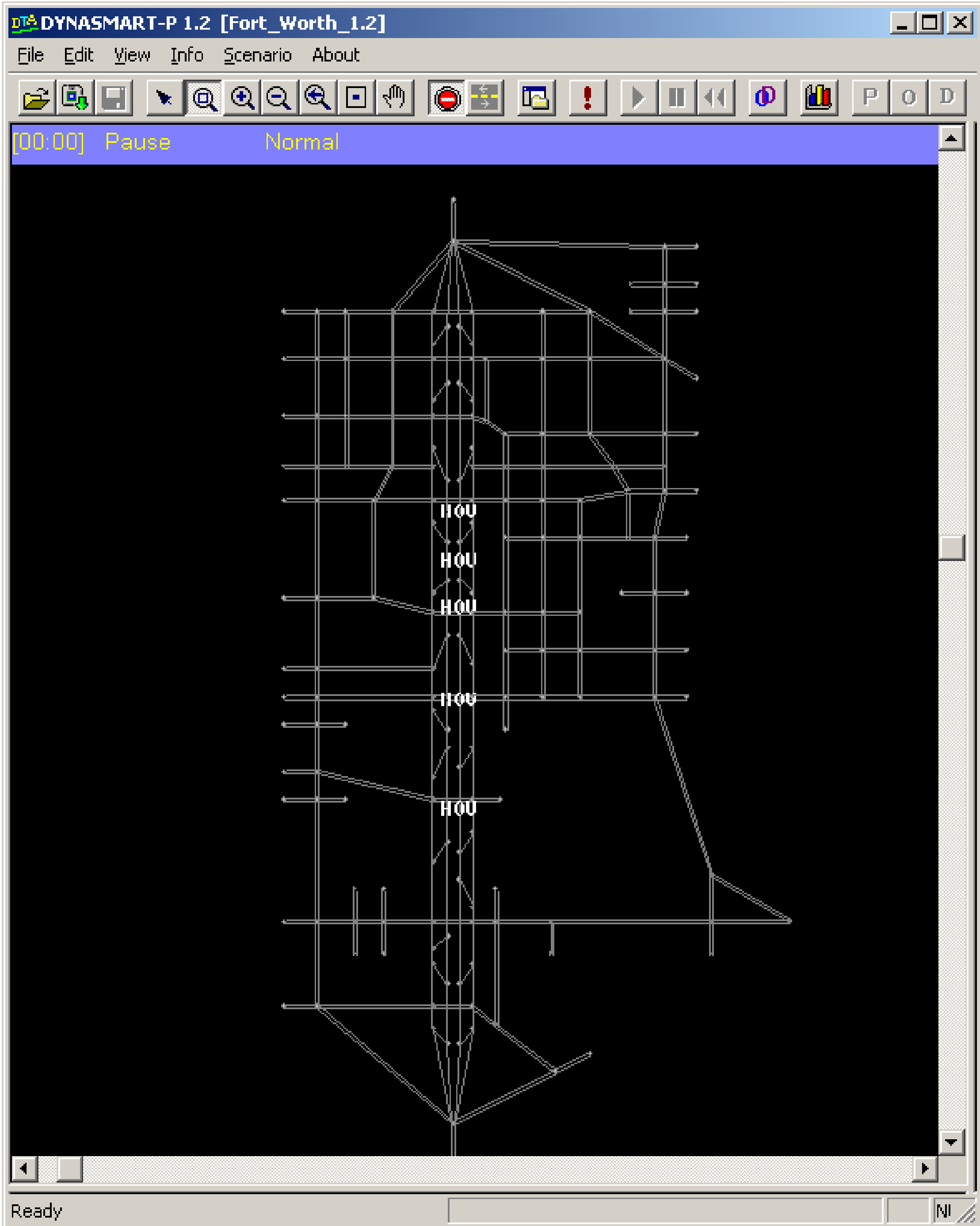


Figure 6-33. HOV links as shown on GUI

<u>View</u> | <u>Link Tolls</u> Menu Command

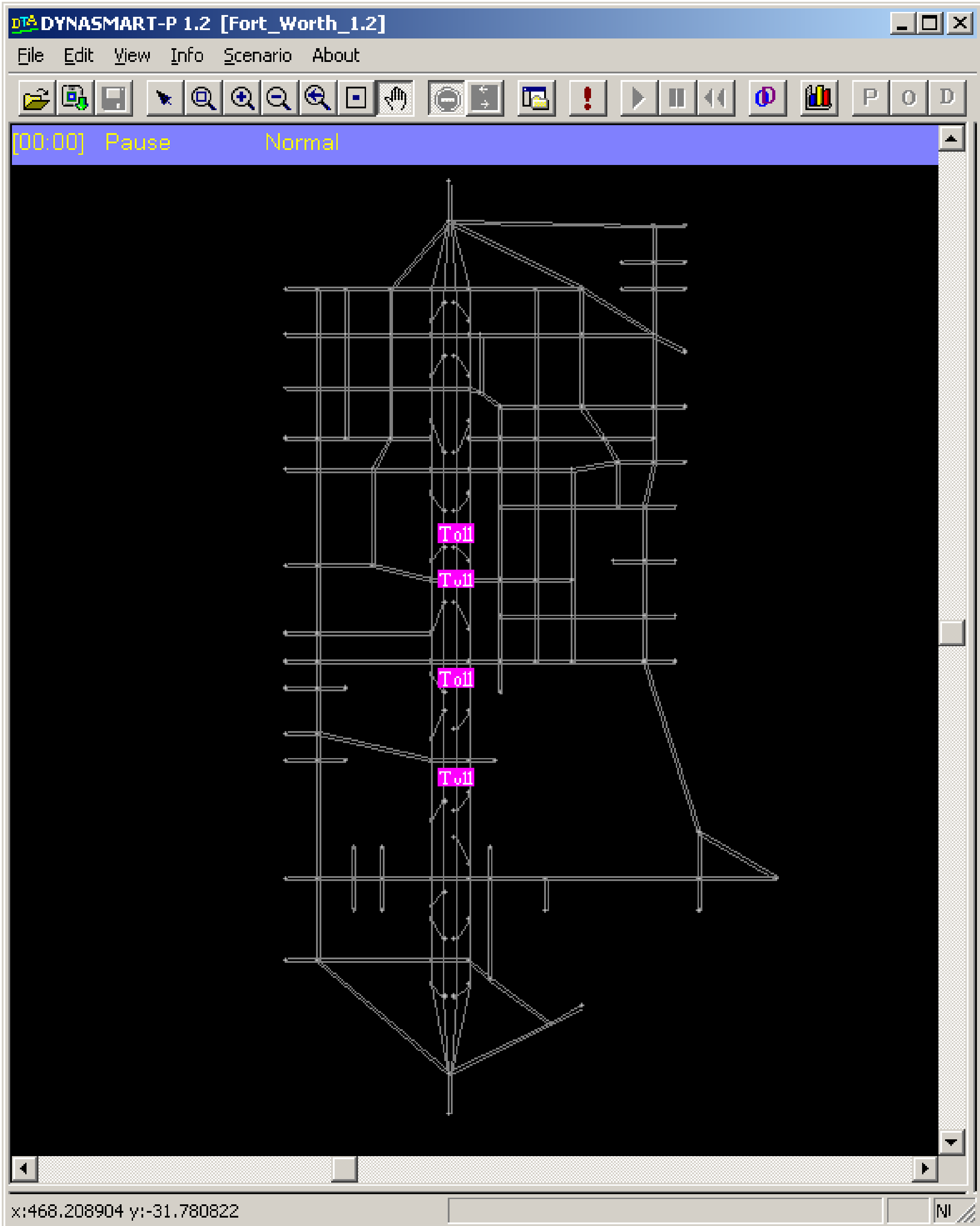


Figure 6-34. Link tolls lanes as shown on GUI

***View* | *Left Turn Bays* Menu Command**

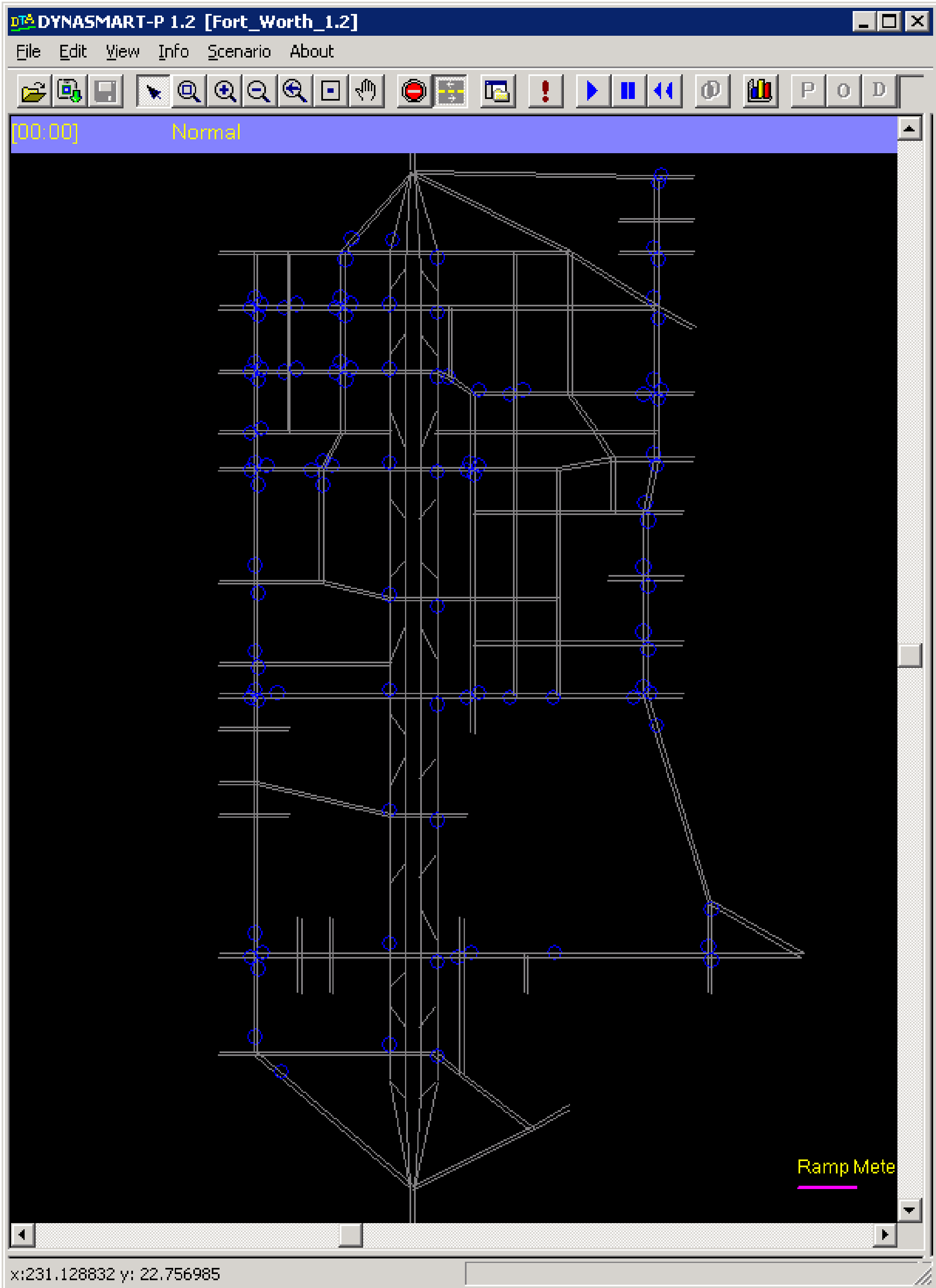


Figure 6-35. Left-turn bays as shown on GUI

***View* | *Short Links* Menu Command**

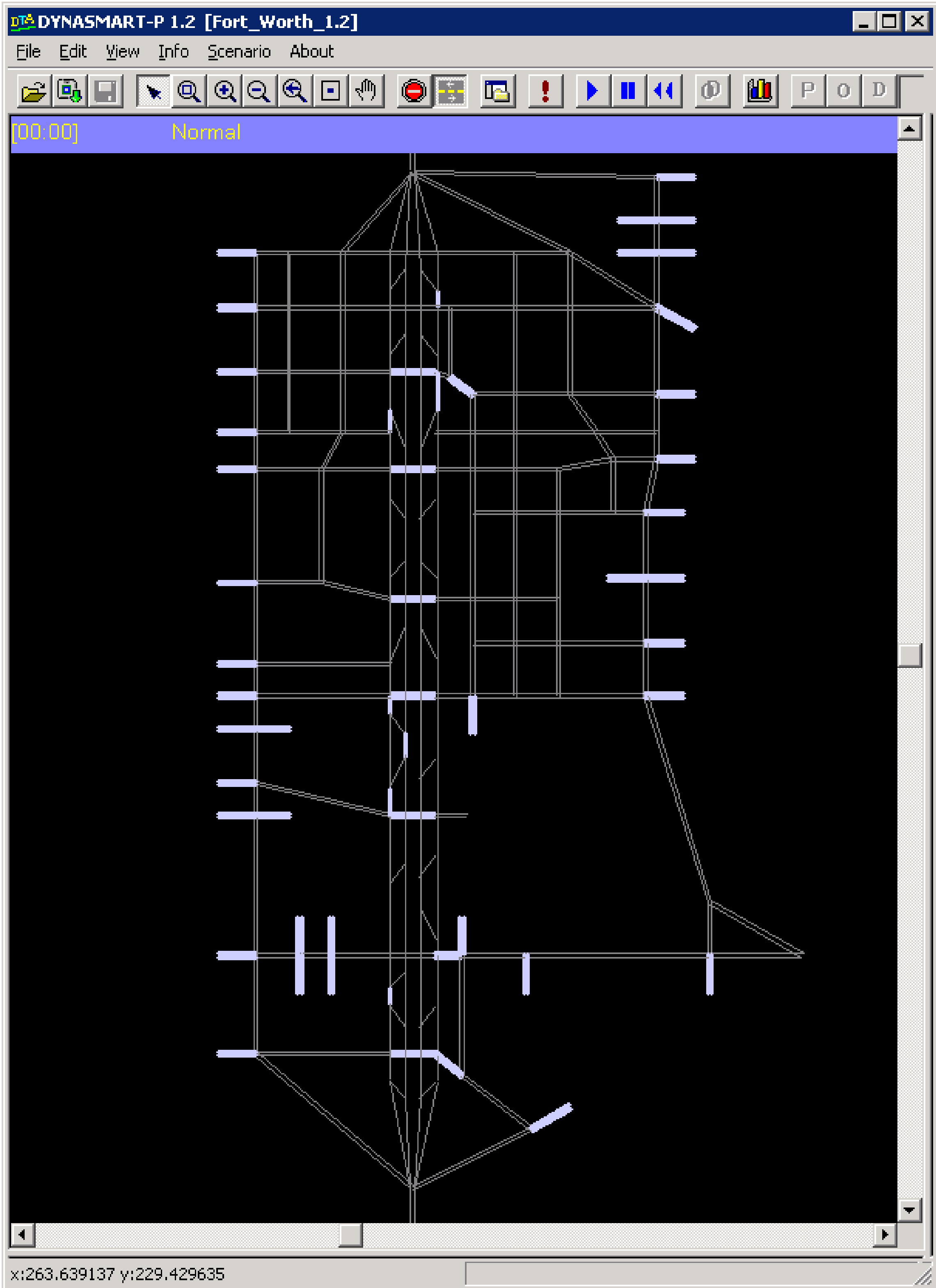


Figure 6-36. Short links as shown on GUI

***View* | *Ramp Meters* Menu Command**

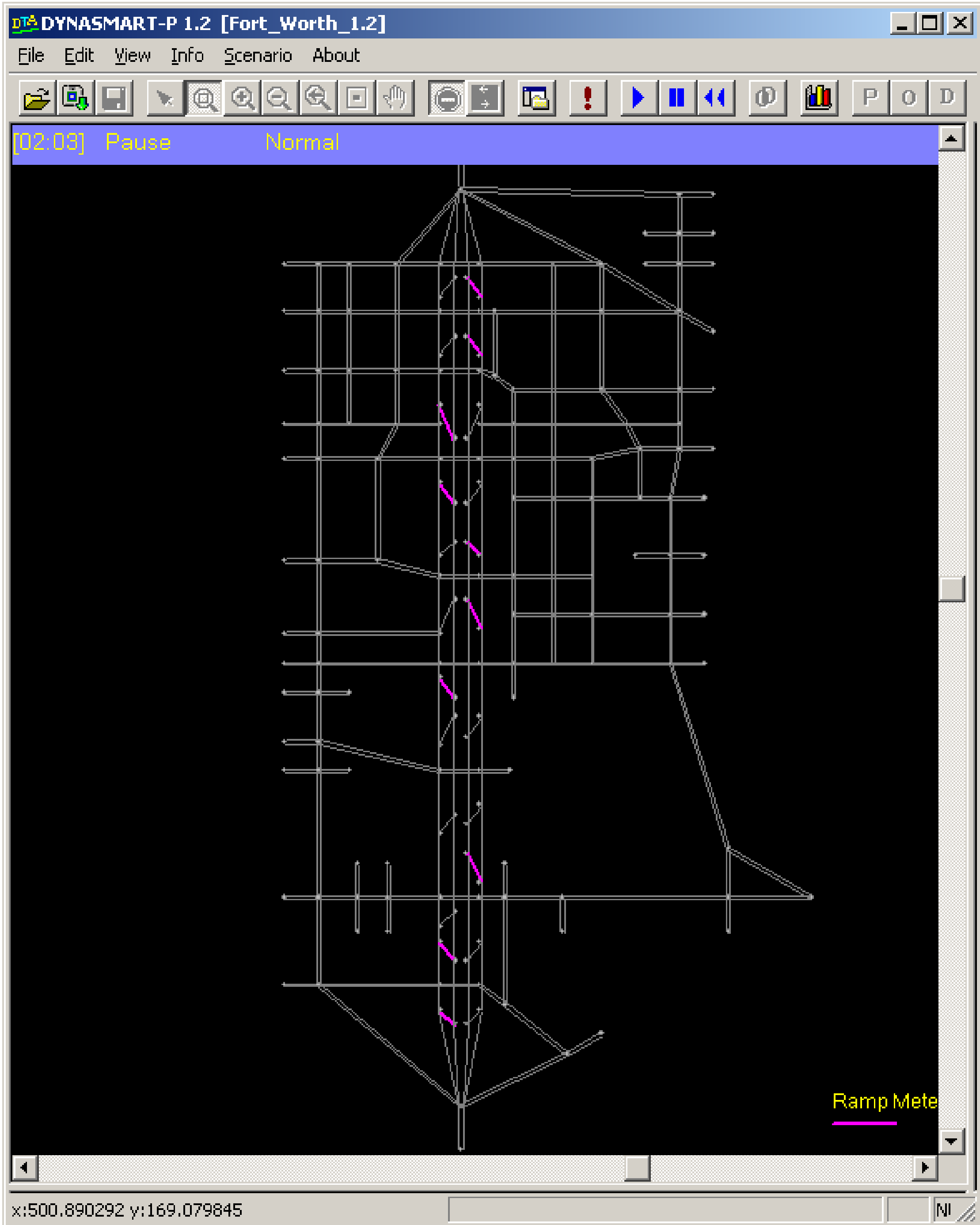


Figure 6-37. Ramps as shown on GUI

***View* | *Zone Boundaries* Menu Command**

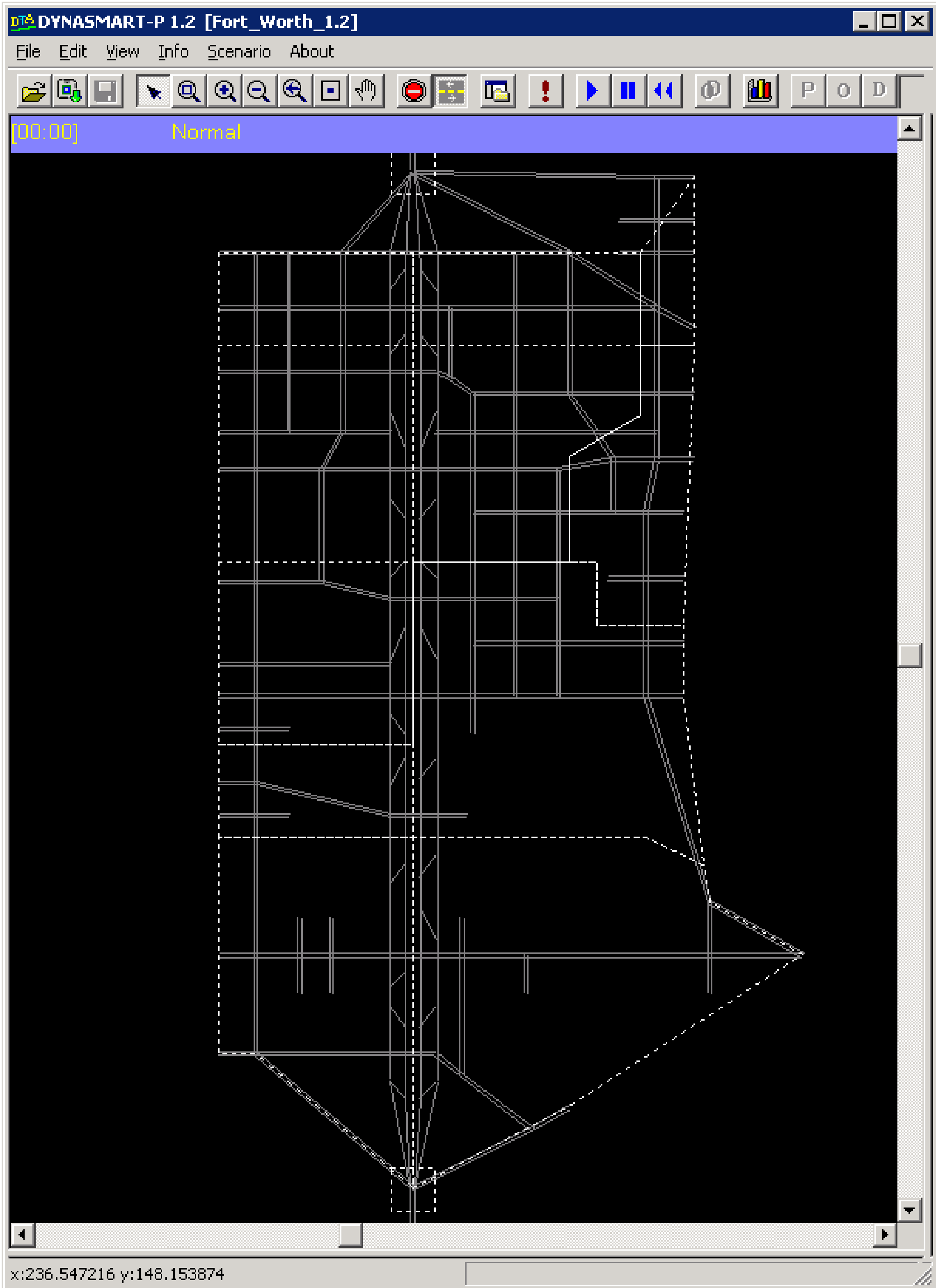


Figure 6-38. Zone boundaries as shown on GUI

***View* | *Zone Numbers* Menu Command**

Figure 6-39. Zone numbers and boundaries as shown on GUI

***View* | *Super Zones* Menu Command**

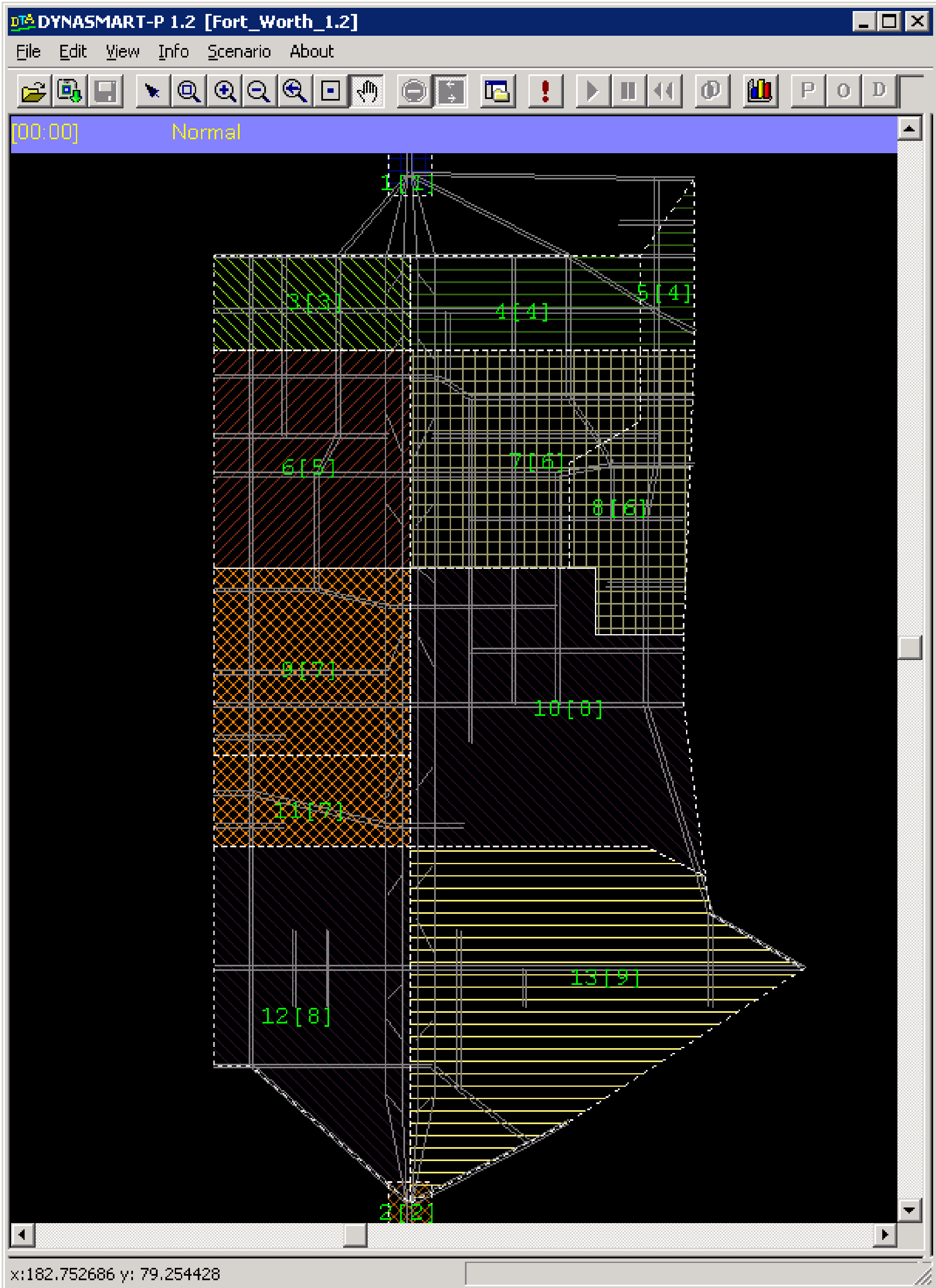


Figure 6-40. Super zones, marked by hatching patterns, as shown on GUI

***View* | *OD Volume* Menu Command**

Figure 6-41. OD volumes as shown on GUI

***View* | *VMS* Menu Command**

Figure 6-42. VMS signs as shown on GUI

***View* | *Work Zone* Menu Command**

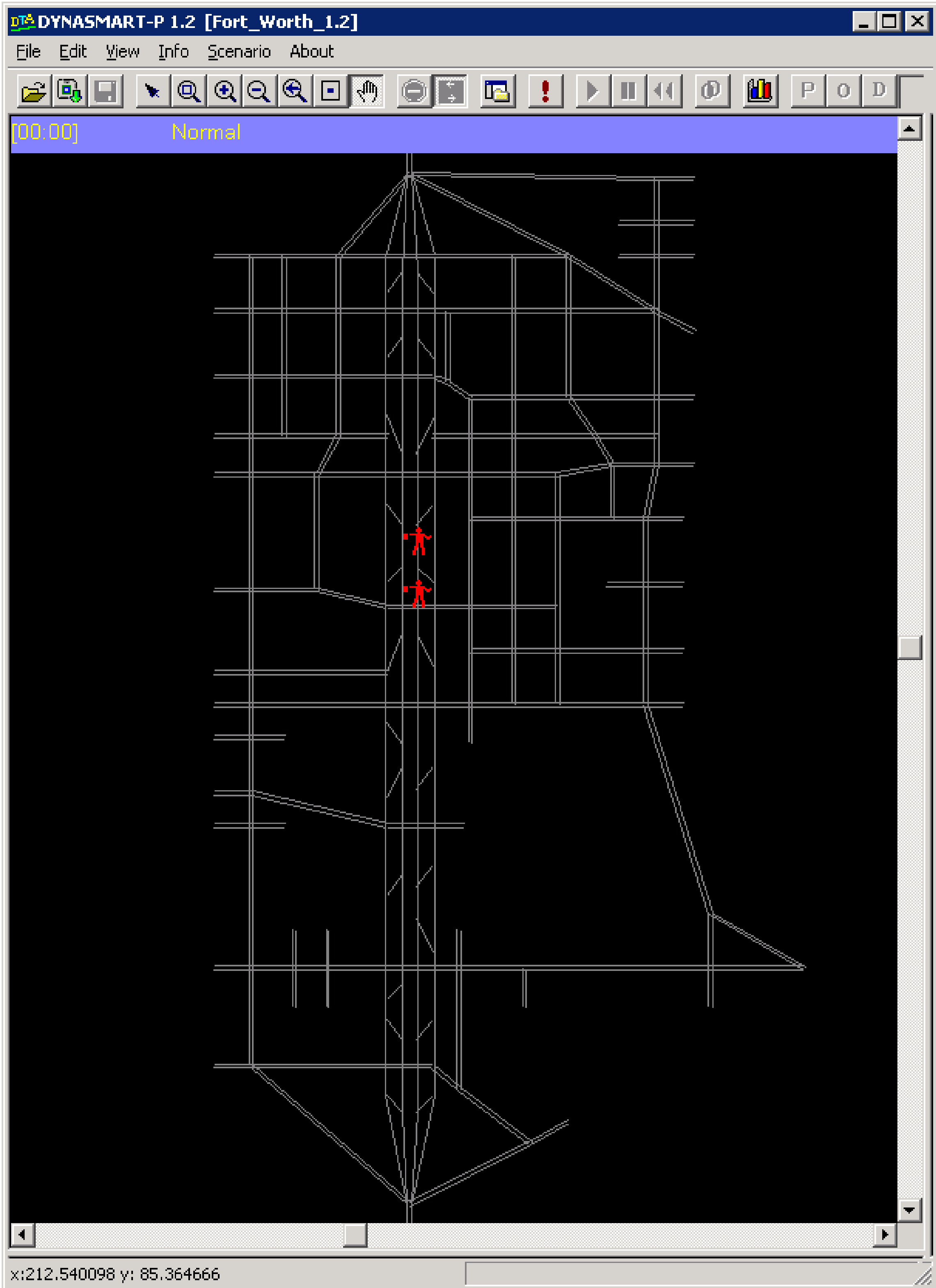


Figure 6-43. Work zone links as shown on GUI

View | Impacted Vehicles Only Menu Command

To use this feature, first select the <<Vehicles>> option from the <Traffic Attributes> window (Figure 6-6). Then click the View | Impacted Vehicles Only menu command to show only the impacted vehicles.

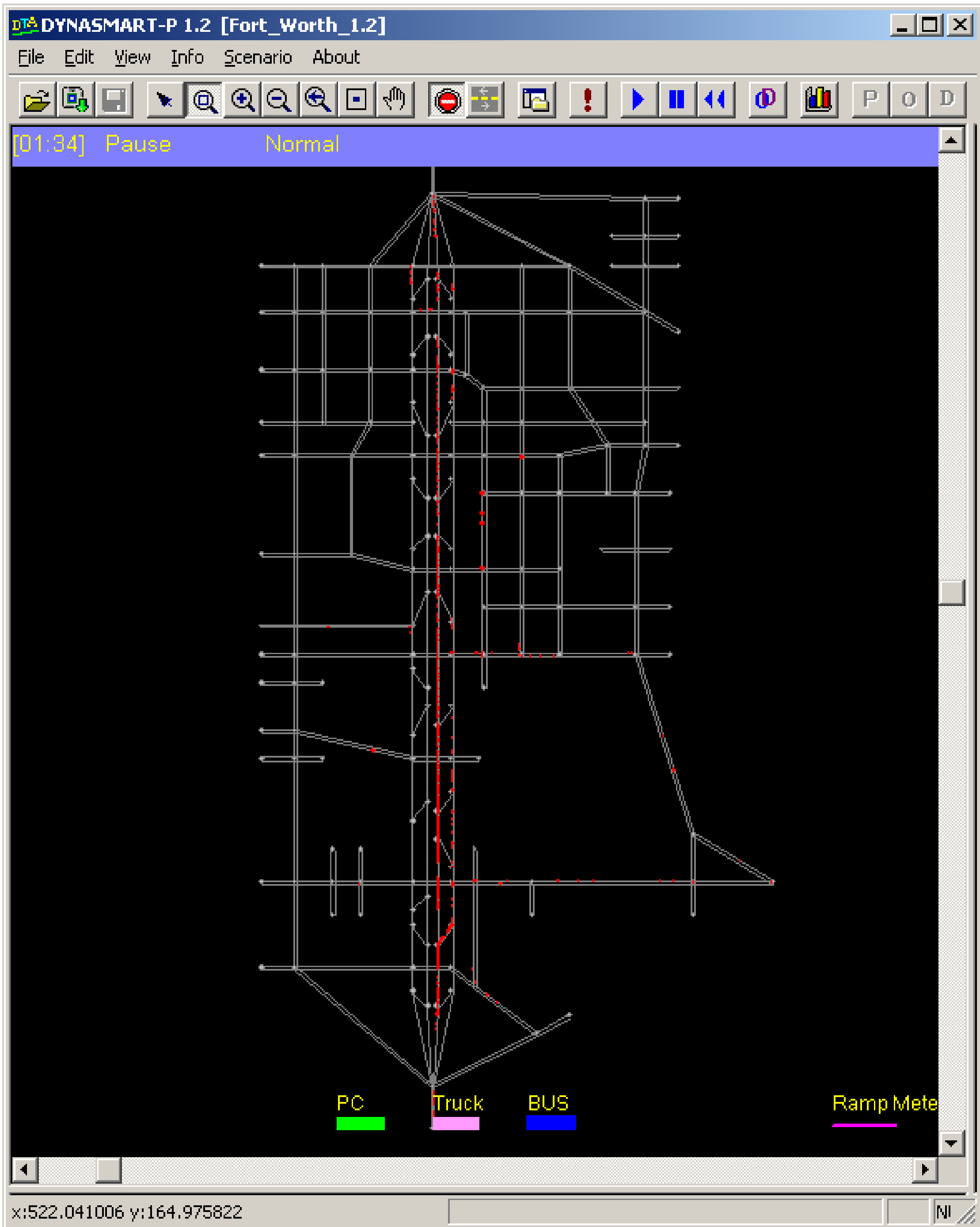


Figure 6-44. Impacted vehicles only as shown on GUI

6.2.4 The Info Menu

The Info menu (Figure 6-47) enables users to select a node or link and view its attributes in the <Node & Link Attributes> window, in the GUI <Output> view. It also allows the user to search for nodes and links, and to display individual vehicle paths.

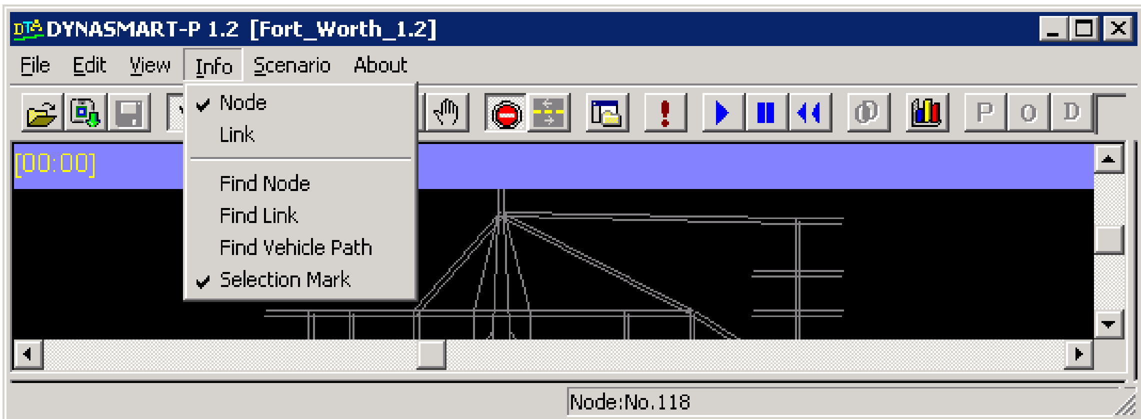


Figure 6-45. The info menu

***Info* | *Node* Menu Command**

This menu command allows the user to select nodes in the network using the selection pointer icon on the <DYNASMART-P Toolbar>. This command is similar to clicking the node selection <Toolbar> icon . Note that to be able to select a node in the network, the user must click the View | Nodes menu command to display nodes in the network.

When a node is selected in the network, it is highlighted by a pink flag ( ) selection mark, as depicted in Figure 6-48. To remove the selection mark, simply click outside the network, or click the Info | Selection Mark menu command. Note that the status bar dynamically traces the selection pointer and shows its XY coordinates.

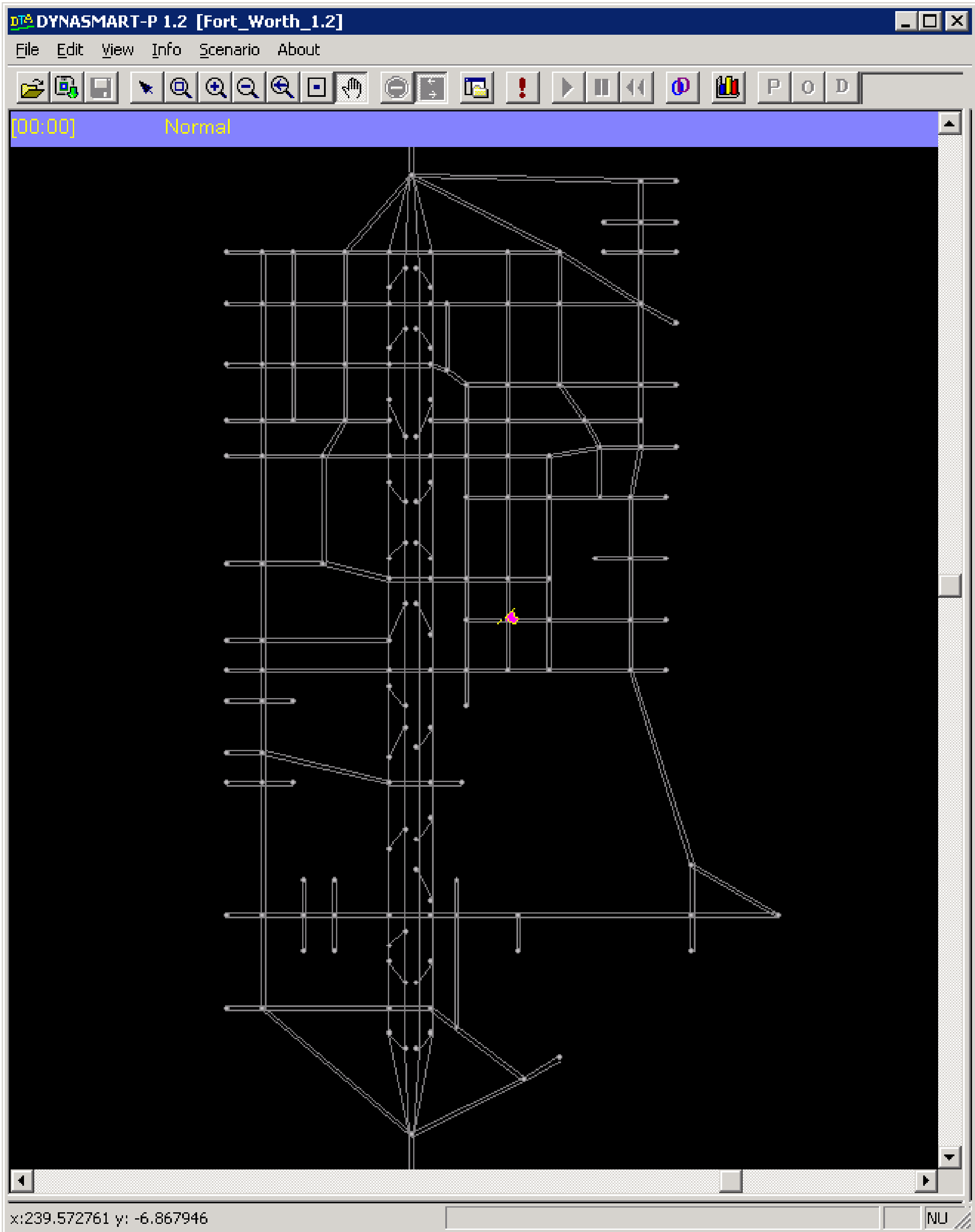


Figure 6-46. Selected node in DYNASMART-P

The corresponding node information is displayed in the <Node & Link Attributes> window, in the GUI <Output> view (Figure 6-51).

Name	Value
Node ID	148
Control Type	Stop Sign
Zone No.	10
Super Zone No.	8

Figure 6-47. Node attributes information window

Similarly, select the Info | Link menu option (or click the toolbar icon), and select a link in the network. The link will be highlighted, and a selection mark ( ) will be located at the mid point of the link.

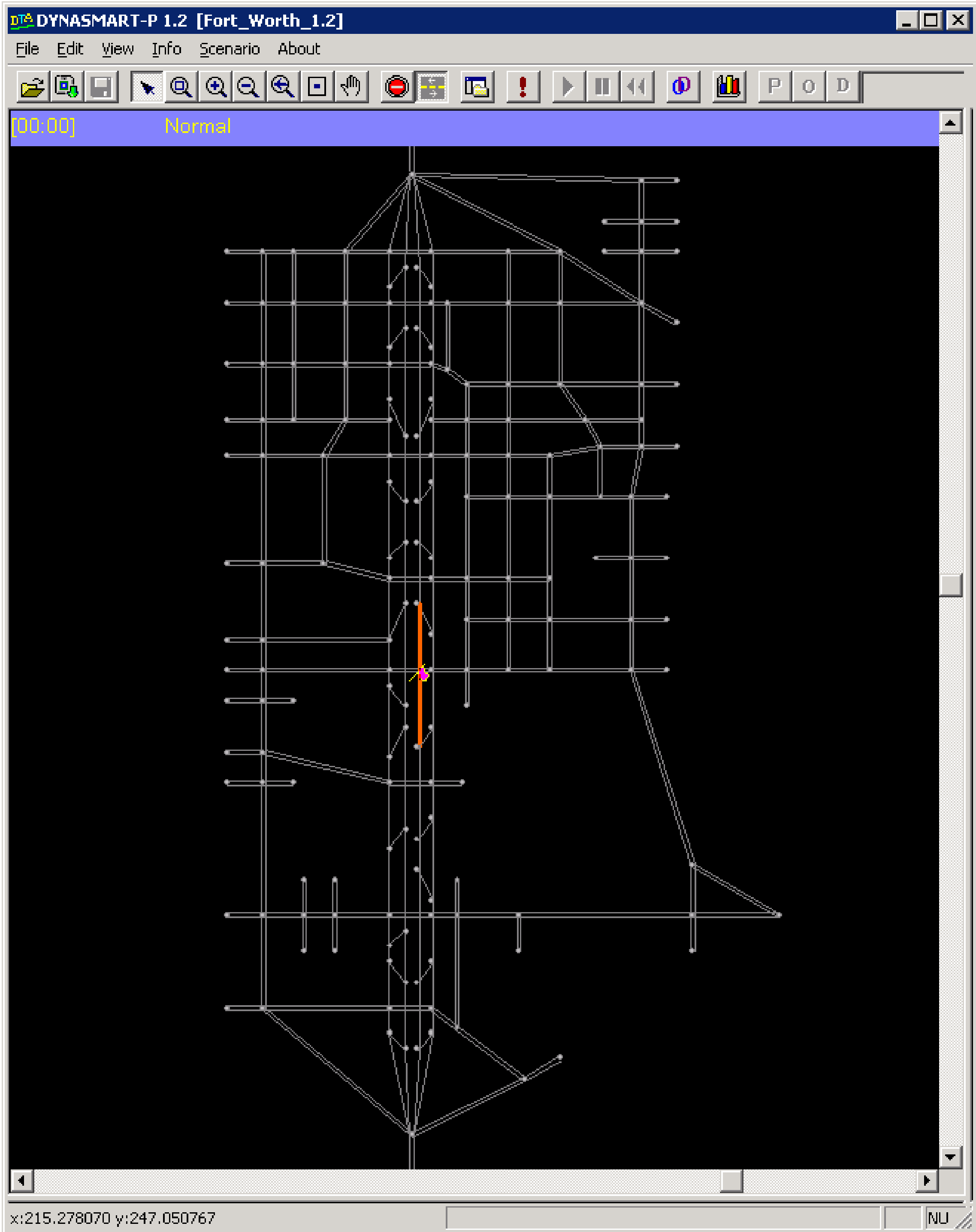
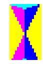


Figure 6-48. Selected link in DYNASMART-P

The corresponding node information is displayed in the <Node & Link Attributes> window in the GUI <Output> view (Figure 6-51). Note that if the simulation results are already loaded, then the density, speed, and volume MOEs pertaining to the current simulation time are displayed. The user can also slide the simulation time clock icon  to see the corresponding MOEs in the <Node & Link Attributes> window.

Name	Value
Link ID	99
From Node	48
To Node	41
Type	Freeway
Numbers of Lanes	4
Length (mi)	0.86
Sat Rate (veh/hr/ln)	1800.00
Density (veh/mi/ln)	20.15
Speed (mi/hr)	65.00
Volume (veh/hr/ln)	1230.00

Figure 6-49. 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 launch the <Find A Node> dialog box (Figure 6-52)

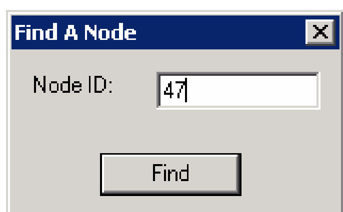


Figure 6-50. Find a node dialog box

Enter the node number in question, and click the <<Find>> button to highlight that node. Similarly, to find a link in the network, click the Info | Find A Link menu option. Doing so will launch the <Find A Link> dialog box (Figure 6-53)

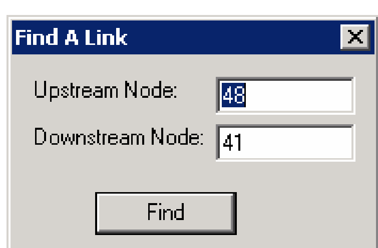
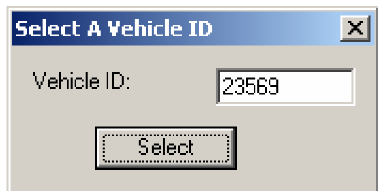


Figure 6-51. Find a link dialog box

Enter the node number in question, and click the <<Find>> button to highlight the link. Finally, by selecting or de-selecting the Info | Selection Mark menu option, the user has the choice of placing a pink flag  on selected nodes or links.

***Info* | *Find A Vehicle Path* Menu Command**

This menu command allows the user to display the path of a particular vehicle. Simply provide the vehicle id.



Click <<Select>> to display its path on the network (Figure 6-54)

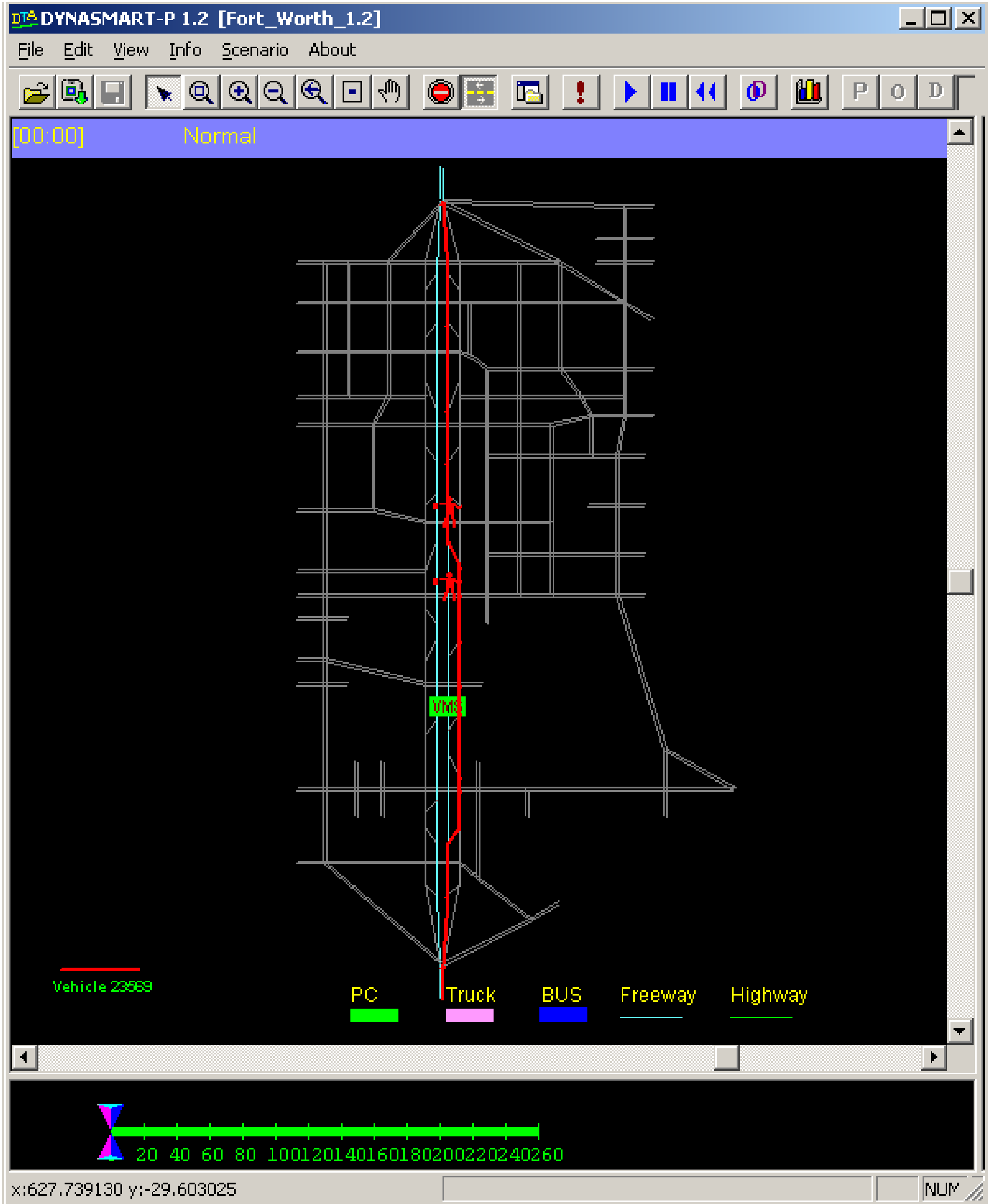


Figure 6-52. A vehicle's path as displayed on GUI

6.2.5 The Scenario Menu

The Scenario menu (Figure 6-55) 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.

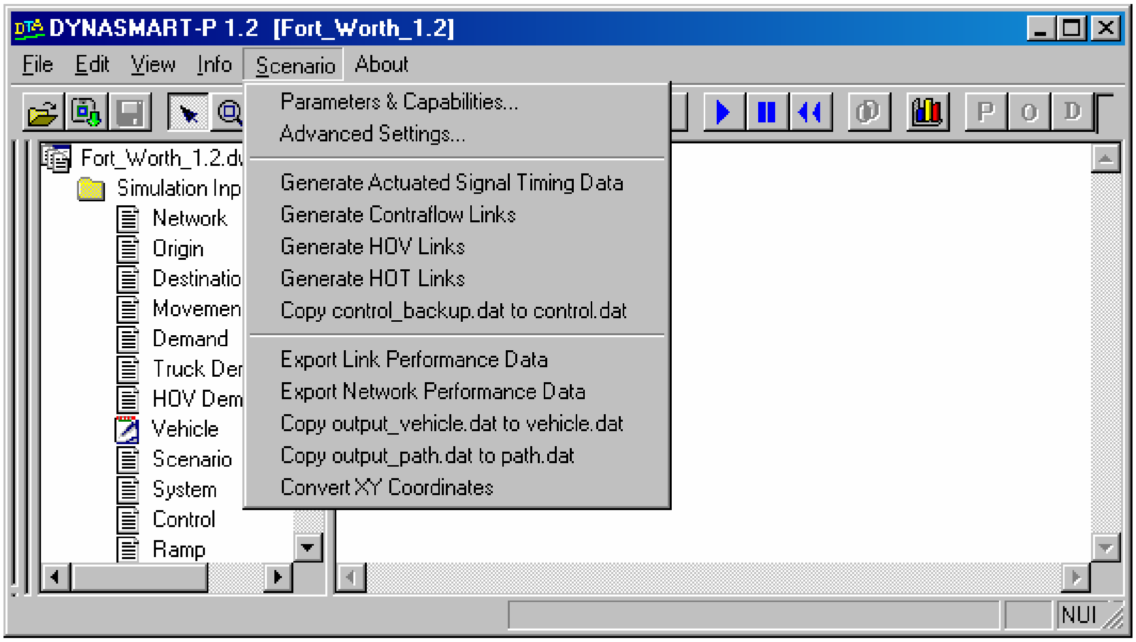


Figure 6-53. The scenario menu

***Scenario* | *Parameters & Capabilities* Menu Command**

Selecting the Scenario | Parameters & Capabilities menu command will launch the <*Parameter Settings*> dialog box (Figure 6-56), which allows the user to specify general scenario parameters, including solution modes and time periods.

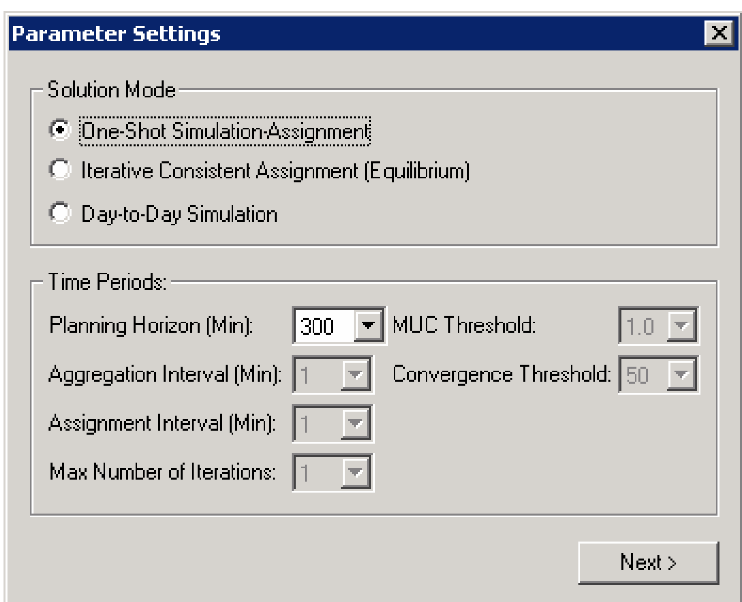


Figure 6-54. Parameter settings dialog box

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 in the [Time Periods] data block. 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 6-57), which allows users to select from an array of analysis capabilities. These capabilities are grouped into seven data blocks: [Network Characteristics], [Traffic Management Strategies], [Capacity Reduction], [Demand], [Vehicle Types], [User Classes Percentages of Combined Demand], and [Congestion

Pricing]. 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.

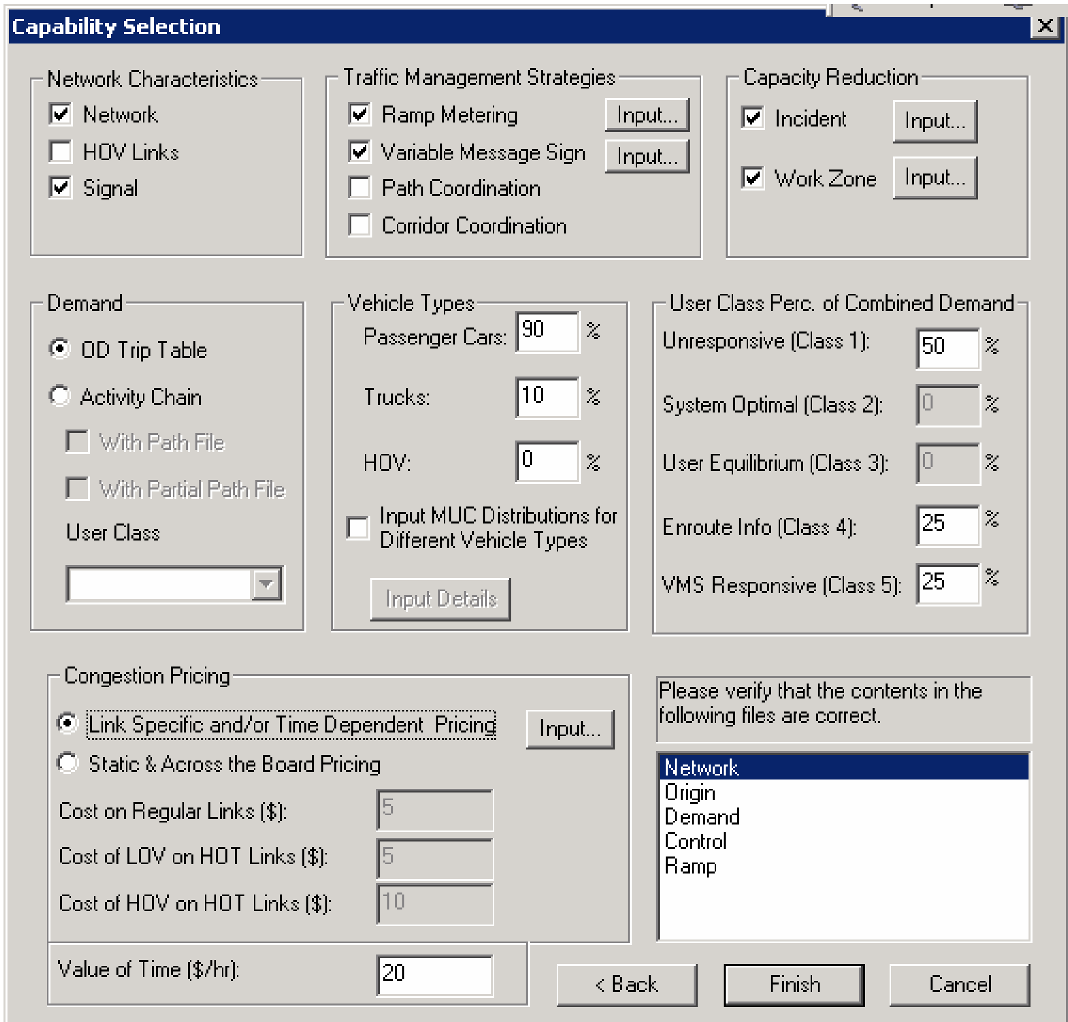


Figure 6-55. Capability selection dialog box

[Network Characteristics] Data Block

By default, the network and signal files will always 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 input ramp metering data, select the <<Ramp Metering>> check box, and then click the adjacent <<Input…>> button to launch the <Ramp Metering Input> dialog box (Figure 6-58).

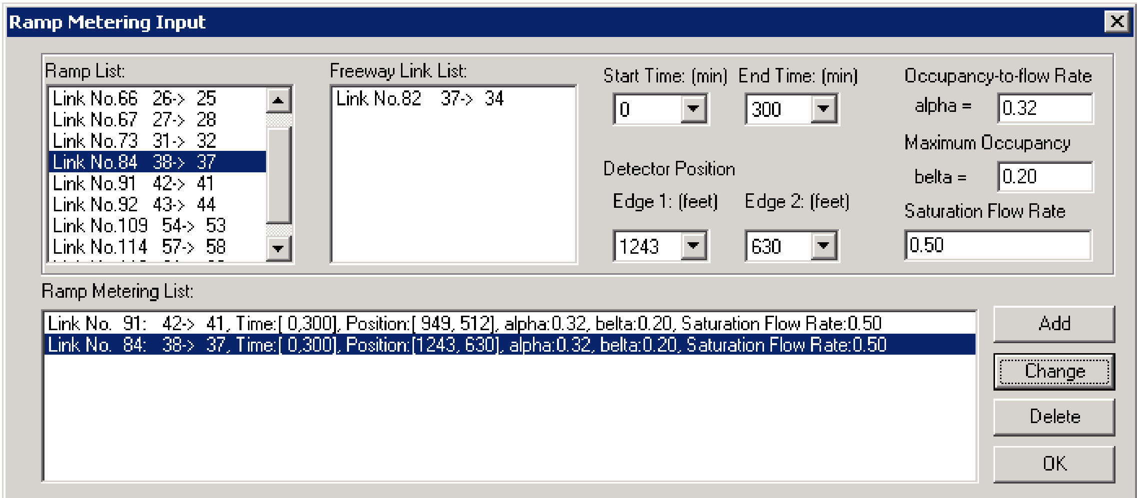


Figure 6-56. Ramp metering input dialog box

To add a ramp meter, select a link from the [Ramp List] data block, select a freeway link from the [Freeway Link List] data block, and specify the ramp parameters. To edit ramp parameters, select a ramp record from the [Ramp Metering List] data block, change its parameters, and then click the <<Change>> button to save these values. After adding all of the ramp meters, click <<OK>> to continue, and return to the <Capability Selection> dialog box. Note that users can specify two or more metering rates for the same ramp meter, provided that they are not active at the same time.

To delete a given ramp meter, simply select the ramp meter record from the [Ramp Metering List] data block in question, and click <<Delete>>. To delete all of the ramp metering information, simply de-select the <<Ramp Metering>> check box in the <Capability Selection> dialog box. Click <<Yes>> to confirm.

To specify VMS signs in the network, select the <<Variable Message Sign>> check box. 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 6-59).

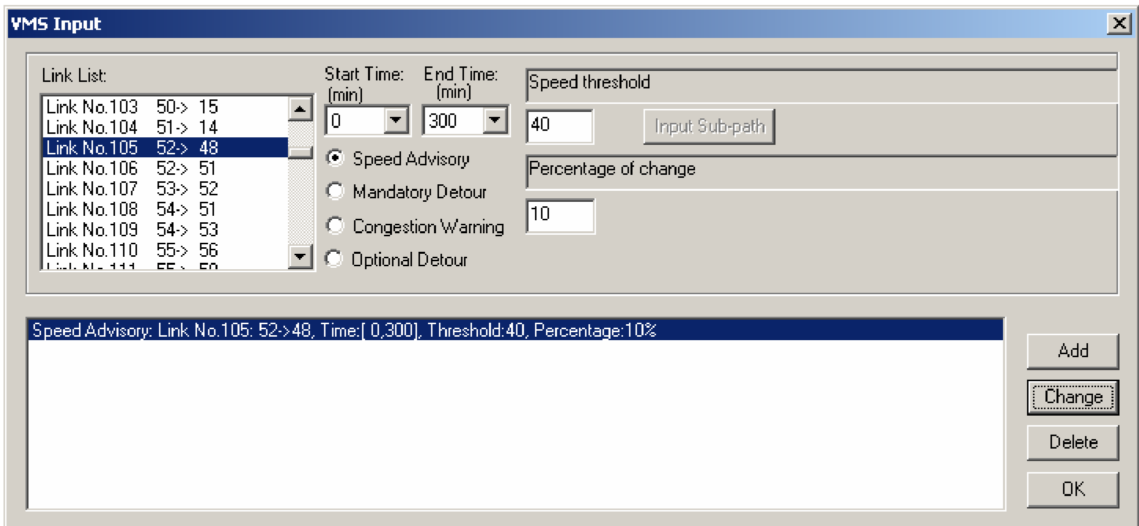


Figure 6-57. VMS input dialog box – speed advisory

The procedure for entering VMS data is to first select the desired link from the [Link List] data block, and to specify the <<Start Time>> and <<End Time>> for that VMS. Next, select the type of VMS desired: speed advisory, mandatory detour, congestion warning, or optional detour.

- ❑ In the case of speed advisory VMS (Figure 6-59), users will then need to specify the <<Speed Threshold>> (+ or -) and the <<Percentage of Change>>. If positive (+), the program will increase link speed (if lower than the specified threshold, by the percentage specified in the <<Percentage of Change>> text box). If negative (-), the program will decrease link speed (if higher than the specified threshold, by the percentage specified in the <<Percentage of Change>> text box). Click on the <<Add>> button to add the VMS information. To remove an existing VMS record, select it from the [VMS List] data block, and click on the <<Delete>> button. To change VMS information, select the VMS record from the [VMS List] data block (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 6-60), 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 6-61). Select a link from the [Link List] data block, and click <<Add>> to add the link to the [Link Sequence in Sub-path] data block. Similarly, select a link from the [Link Sequence in Sub-path] data block, and click <<Remove>> to remove it from the list. Click the <<Clear>> button to clear the [Link Sequence in Sub-path] data block. Once done selecting the detour links, click the <<OK>> button to return to the <VMS Input> dialog box. Once in the <VMS Input> dialog box, click <<OK>> to save this information into *vms.dat*.

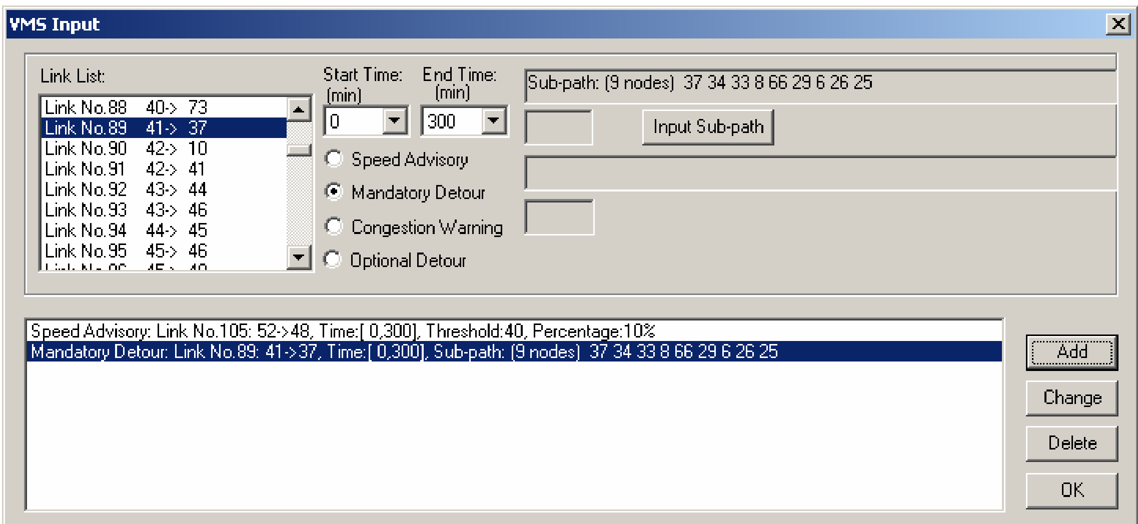


Figure 6-58. VMS input dialog box – mandatory detour VMS

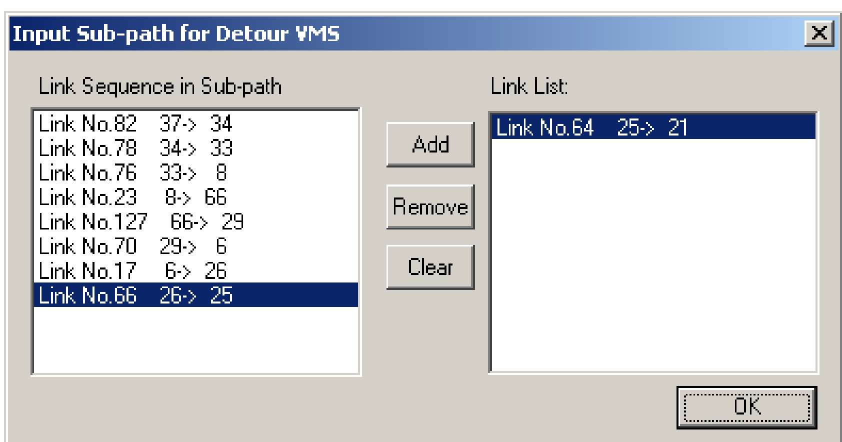


Figure 6-59. Input sub-path for detour VMS dialog box

- In the case of congestion warning VMS (Figure 6-62), users will then need to specify the <<Response Rate for VMS Responsive User Class>> and the <<Path Preference>>. The <<Response Rate for VMS Responsive User Class>> refers to the fraction of all user classes that have access to VMS information, and are willing to evaluate it (possibly switching their path, but not necessarily). Typically only user class 5 has access to VMS information. If the VMS preemption mode (see Scenario | Advanced Settings menu command) is selected, then Classes 4 (Enroute) and 5 (VMS-Responsive) will have access to VMS information. Vehicles will be re-routed according to the value specified in the <<Path Preference>> text box. A value of 1 means that vehicles will be diverted, if need be, to the current best path (i.e., shortest path given prevailing travel times), and a value of 0 means that vehicles will be diverted, if need be, among the K-paths. The K-paths parameter can be specified in *network.dat* (see Section 4.7). Click on the <<Add>> button to add the VMS information. To remove an existing VMS record, select it from the [VMS List] data block, and click on the <<Delete>> button. To make changes to the VMS information, select the VMS record from the [VMS List] data block (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.

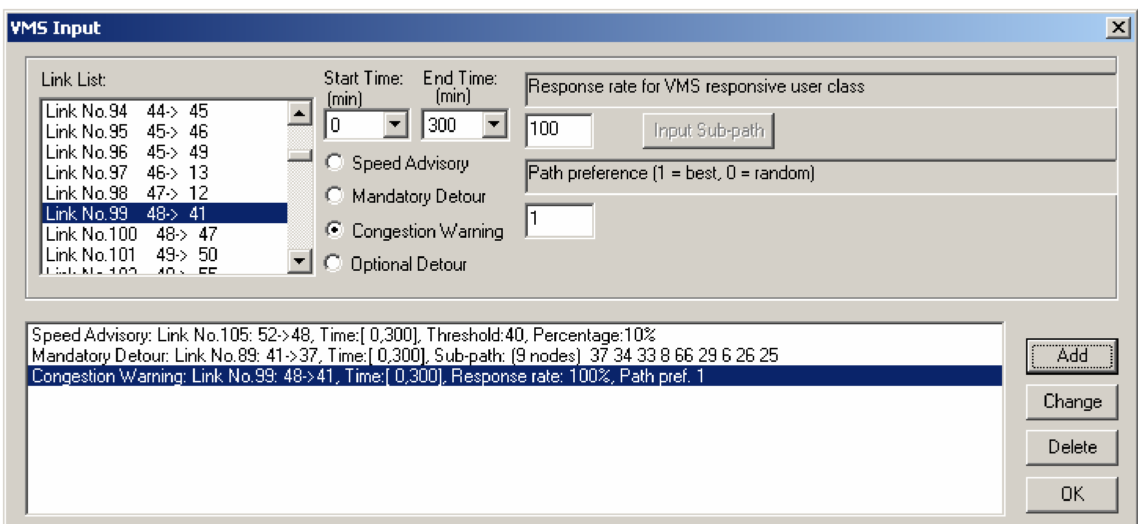
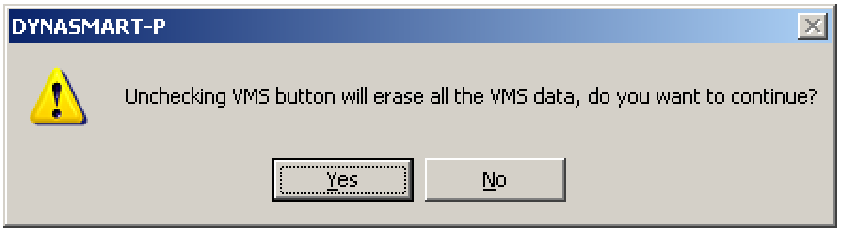


Figure 6-60. VMS input dialog box – congestion warning

- ❑ 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 the 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.

Finally, to delete all VMS information, simply de-select the <<Variable Message Sign>> check box in the <Capability Selection> dialog box. Click <<Yes>> to confirm.



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 remaining 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.

[Capacity Reduction] Data Block

Users can model events such as incidents and work zones using the capacity reduction capability. To add an incident, select the <<Incident>> check box, and click on the <<Input…>> button to launch the <Incident Input> dialog box (Figure 6-63).

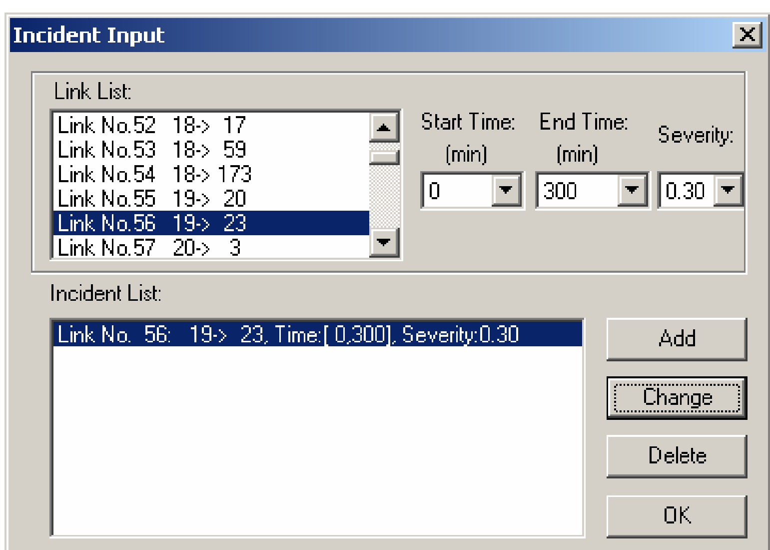
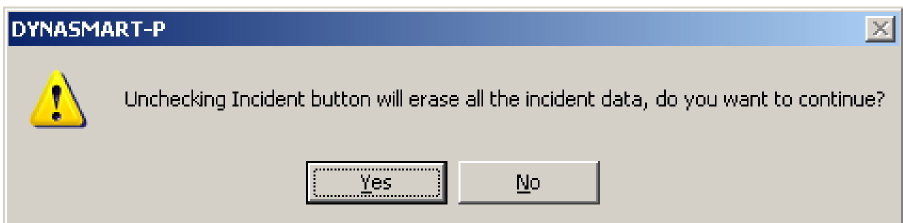


Figure 6-61. Incident input dialog box

The procedure for entering incident data is to first select the desired link from the [Link List] data block, and then select the <<Start Time>> and <<End Time>> of the incident. Next, choose the <<Severity>> level, which refers to the fraction of physical capacity (lanes) lost due to the incident. Click the <<Add>> button to add incident information to the [Incident List] data block. To remove an existing incident record, select it from the [Incident List] data block, and click the <<Delete>> button. To make changes to an existing incident, select the incident record from the [Incident List] (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 in the <Capability Selection> dialog box. Click <<Yes>> to confirm.



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 consequently the maximum flow rate.

To add a work zone, select the <<Workzone>> check box, and click on the <<Input…>> button to launch the <Work Zone Input> dialog box (Figure 6-64).

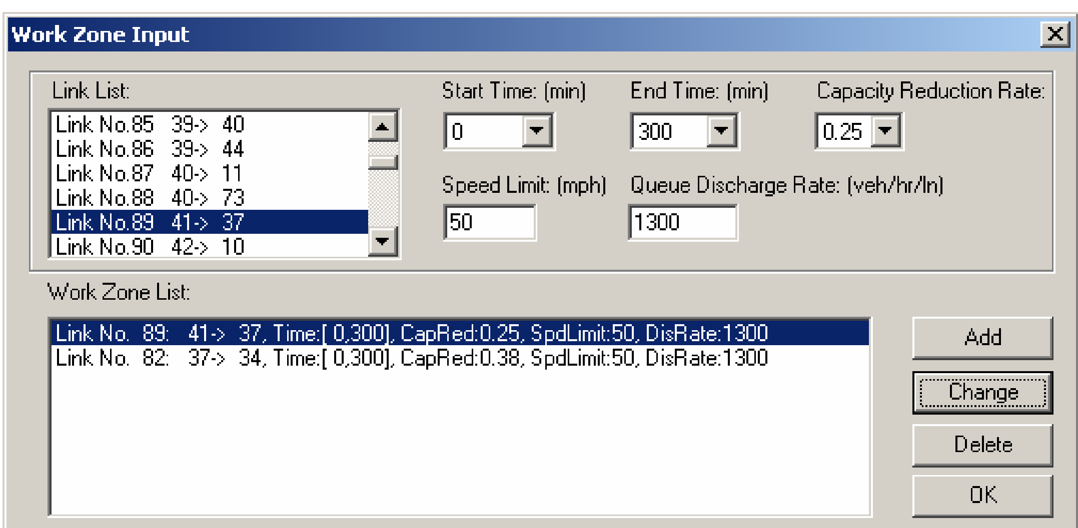


Figure 6-62. Work zone input dialog box

The procedure for entering work zone data is to first select the desired link from the [Link List] data block, and then select the <<Start Time>> and <<End Time>> of the work zone. Next, choose the <<Capacity Reduction Rate>> level, which refers to the fraction of physical capacity (lane-miles) lost due to the work zone. Select the newly posted <<Speed Limit>> and the <<Queue Discharge Rate>>, which refers to the maximum rate at which vehicles can exit the work zone link. 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] data block, and click on the <<Delete>> button. To make changes to the work zone information, select a work zone record from the [Work Zone List] data block (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, click 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 in the <Capability Selection> dialog box. Click <<Yes>> to confirm. Note that users can specify as many work zones on the same link provided they are not simultaneously active.

Work zone speed limits and capacity reductions introduce changes to the traffic flow model, which will no longer be applicable on the work zone link. Recall the shape of the modified Greenshields traffic flow model as depicted in Figure 6-65.

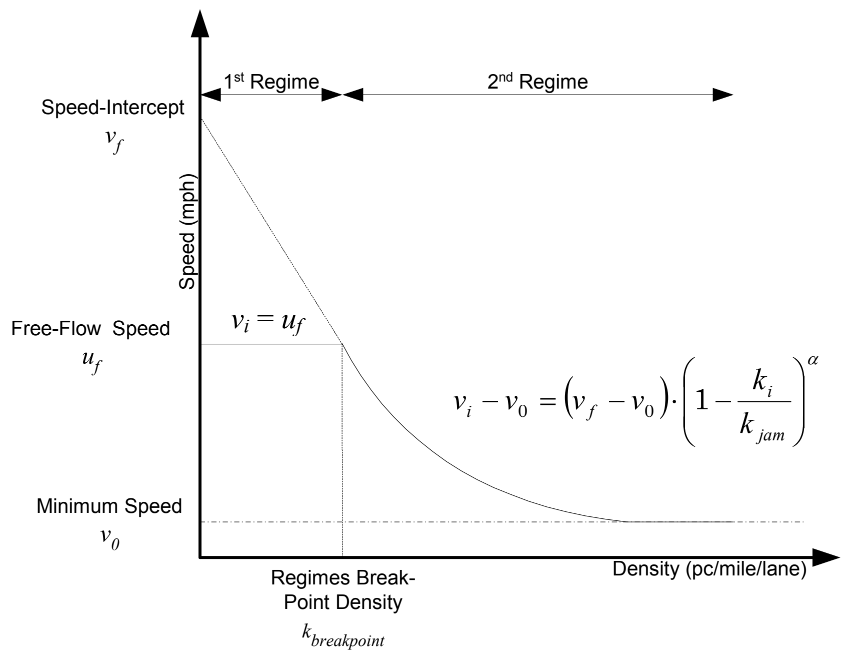


Figure 6-63. Type 1 modified Greenshields model

The free-flow speed u_f (speed limit) is directly related to the speed-intercept v_f. When the speed limit is reduced due to presence of a work zone, the speed-intercept changes, and so does the traffic flow model. DYNASMART-P accounts for changes in the speed intercept as depicted below (Figure 6-66).

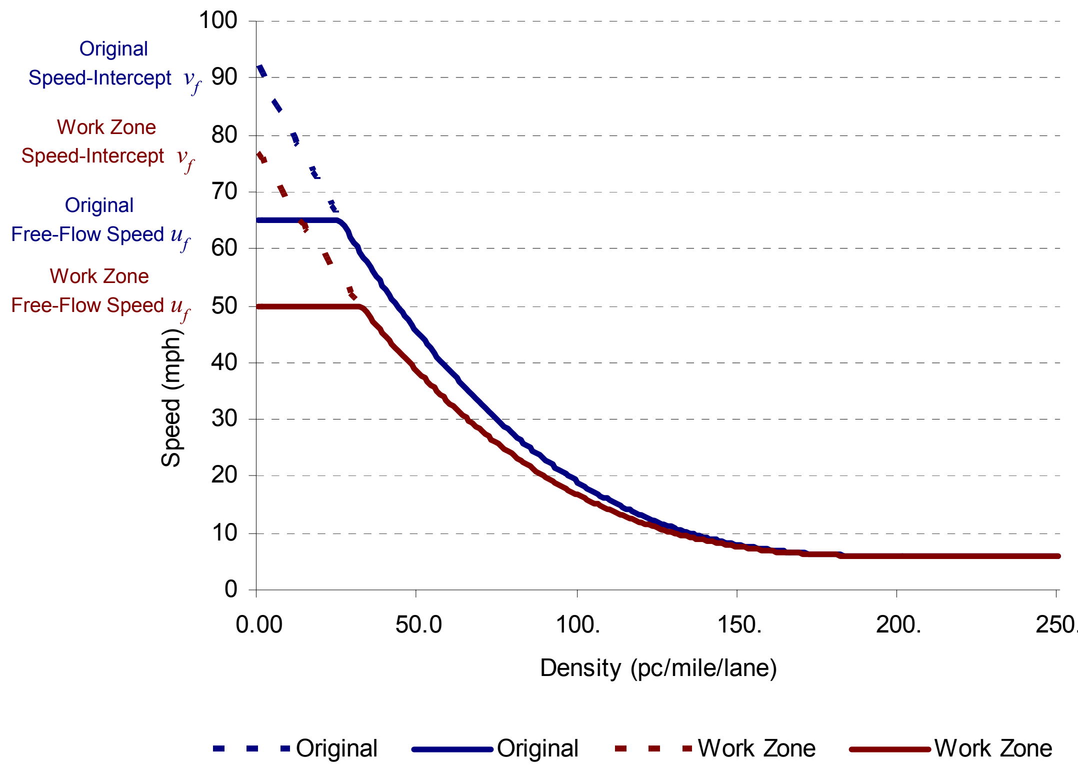


Figure 6-64. Traffic flow model change due to work zone

Therefore DYNASMART-P adjusts the speed intercept proportionately to the reduction in speed limit, all while keeping the other traffic flow parameters (jam density, minimum speed, shape parameter) intact.

[Demand] Data Block

By selecting the <<OD 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 only, 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. Note that the [Vehicle Types] and [User Class Percentages of Combined Demand] data blocks will be disabled and empty, indicating that one cannot specify these parameters when using the activity chain option as such information will be contained in *vehicle.dat*. If the <<With Path File>> option is selected, vehicles will follow the paths specified in *path.dat*. If the <<With Partial Path File>> option is selected, then the user needs to specify which user classes will get their paths from the simulator (instead of *path.dat*). All remaining user classes will still follow their paths as specified in the *path.dat*. This option is excellent for modeling background traffic. In this case, background traffic will follow their paths from *path.dat*, and others will get their paths from simulator. For detailed information on *demand.dat*, *vehicle.dat* and *path.dat*, refer to Sections 4.17, 4.23, and 4.24, respectively.

[Vehicle Types] Data Block

Users may specify the percentage of vehicle types for any given scenario. Vehicle type percentages must sum to 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 be launched (Figure 6-67). 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.

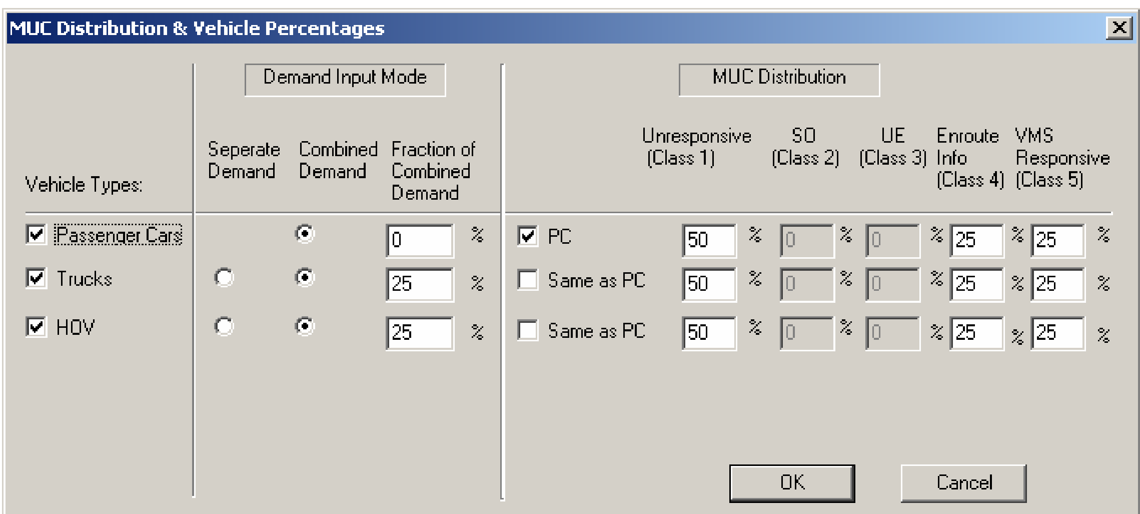


Figure 6-65. MUC distribution & vehicle percentages dialog box

[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 summation of user class percentages must be exactly 100 percent. The definition of these user classes is provided below (Table 6-2). By default, only class 5 (VMS responsive) will respond to VMS. However, by selecting the VMS preemption mode parameter in *scenario.dat*, or the

Scenario | Advanced Settings dialog box (described later in this guide), user classes 4 and 5 will also recognize and evaluate (not necessarily follow) VMS information.

Table 6-2. 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 6-67). It is now possible to specify the 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 the different MUC.

[Congestion Pricing] Data Block

DYNASMART-P has the capability of modeling static (across the board) or time-dependent link-specific congestion pricing schemes. To model static congestion pricing, it is suggested that a user user DSPEd to specify all the HOT/HOV links. After completing this step, the user come to DYNASMART-P GUI and select the "Link Pricing Input" window, the user could be able to input futher timing and toll rate data. To specify timing and toll rate information for each toll link, select the <<Static & Across the Board Pricing>> check box, and then enter values for the following three parameters: (1) <<Cost on Regular Links>> (the cost for traversing typical links in network), (2) <<Cost of LOV on HOT Links>> (the cost of LOV vehicles using HOT links), and (3) <<Cost of HOV on HOT Links>> (the cost of HOV vehicles using HOT links). As mentioned previously, (Section 4.30), pricing schemes are not effective unless there are HOT links in the network.

Alternatively, select the <<Link Specific and/or Time Dependent Pricing>> check box, and click the <<Input…>> button to specify time-dependent link-specific tolls. This will launch the <Link Pricing Input> dialog box (Figure 6-66).

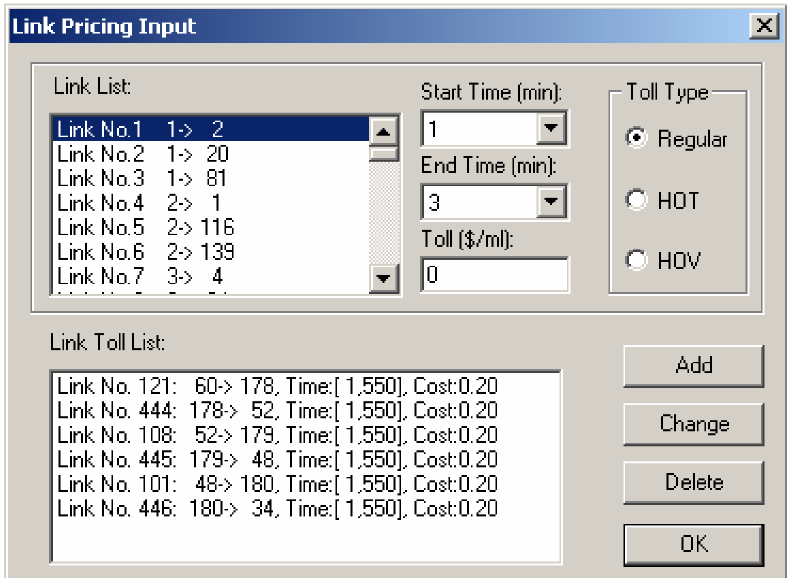
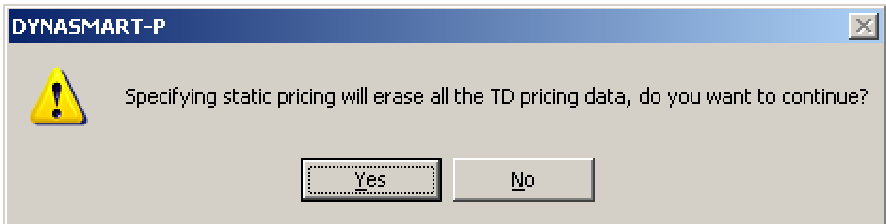


Figure 6-66.Link pricing input dialog box

To specify time-dependent link-specific tolls, first select a link from the [Link List] data block, then specify the <<Start Time>>, <<End Time>>, and <<Toll>> values. Select the toll type to be <<Regular>>, <<HOT>>, or <<HOV>>. A <<Regular>> toll type means that all vehicles will pay the toll to traverse the link during the specified duration. An <<HOT>> toll type means that only LOV vehicles will pay the toll to traverse the HOT link (link types 6 and 9 in *network.dat*). An <<HOV>> toll type means that LOV vehicles will not be able to traverse the HOV link (link types 8 and 10 in *network.dat*) for the specified period. This feature is extremely helpful, as users can specify HOV links to be active during the peak period to deny LOV vehicles from traversing these links, and to be non-active during the off-peak period, to allow all vehicles to traverse the HOV links.

After specifying the relevant pricing parameters, click <<Add>> to add the pricing information to the [Link Toll List] data block. To edit the pricing parameters of a particular link, select a record form the [Link Toll List]. This will highlight the corresponding pricing parameters. Edit these parameters and click <<Change>> to lock these changes. To delete pricing information, select a link from the [Link Toll List] and click <<Delete>>. Click <<OK>> to save the pricing information to *pricing.dat*, and return to the <Capability Selection> dialog box. Finally, specify the <<Value of Time>> (dollar value of time), which will be used to convert tolls to travel time-penalties in the shortest path calculations.

To delete the entire set of time-dependent pricing information, simply select the <<Static Pricing>> option. Click <<Yes>> to confirm.



Either <<Static Pricing>> or <<Link Specific and/or Time Dependent Pricing>> may be selected. However, the latter can be used to specify static link tolls on selected links, by specifying a single toll over all time periods. Note that switching between <<Static Pricing>> and <<Link Specific and/or Time Dependent Pricing>> will cause DYNASMART-P to ignore the static pricing parameters, but no warning message is generated.

***Scenario* | *Advanced Settings* Menu Command**

Additional parameters can be specified under Scenario | Advanced Settings, which launches the <Advanced Settings> dialog box (Figure 6-69). These variables are related to memory management, boundedly rational user behavior, shortest path algorithm, and other miscellaneous parameters. Below is a brief explanation of these parameters.

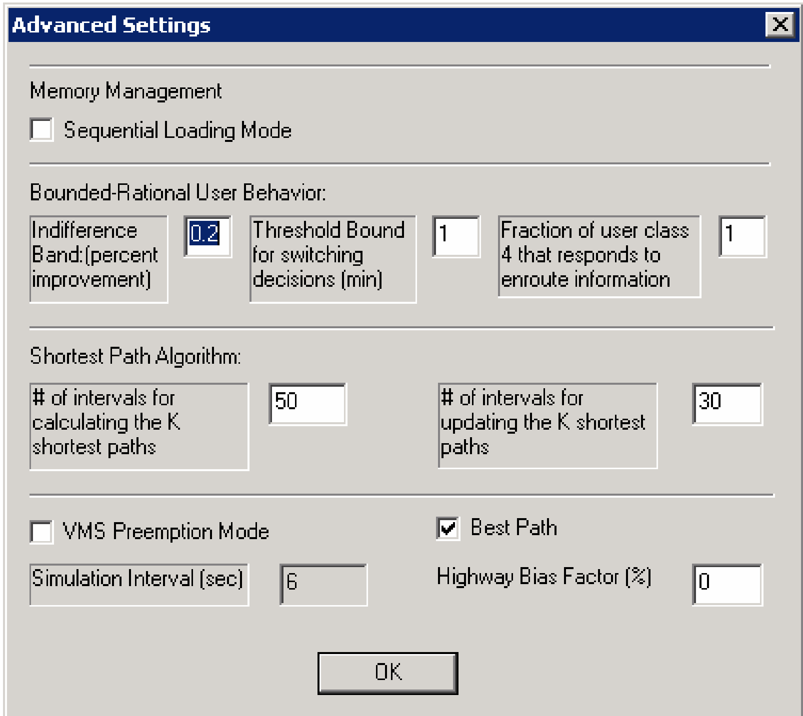


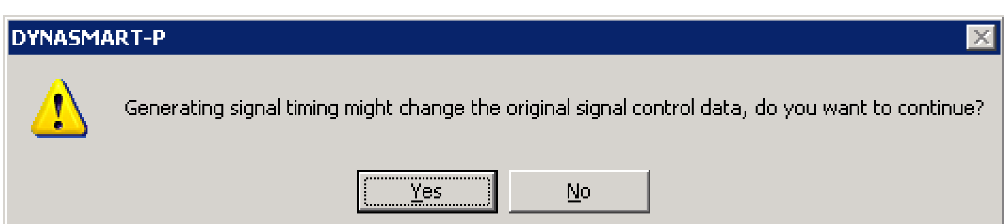
Figure 6-67. Advanced settings dialog box

- *Sequential Loading Mode*: Denotes a shortest path calculation procedure that computes the shortest path trees to all destination zones sequentially instead of all at once, thus saving memory requirements significantly. Use this mode when the memory requirements to run a given network are huge. The drawbacks for using this mode are that 1) the simulation may take much more time to run, and 2) that no VMS responsive (user class 5) and enroute information (user class 4) vehicles may be specified.
- *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 4 (enroute info) and 5 (VMS-responsive) will respond to VMS information. If the box is left unchecked, then only user class 5 (VMS-responsive) will respond to VMS information.
- *Freeway Bias Factor*: A percentage by which drivers perceive freeway link travel times to be shorter than reality. Use this parameter to force more vehicles to use the freeway links, if this would replicate field conditions.
- *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.

***Scenario* | *Generate Actuated Signal Timing Data* Menu Command**

Use this command, in the absence of phasing information, to create default actuated signal phasing movements. To use this feature, first the user needs to specify control type for those nodes with missing information to be actuated (control type 5 in *control.dat*, see Section 4.11. Then click on Scenario | Generate Actuated Signal Timing Data. Click <<Yes>> to continue.



DYNASMART-P will then copy the original *control.dat* file to *control_backup.dat*, as a backup. Click <<OK>> to continue.

You will then be prompted to enter the default settings in the <Actuated Signal Settings> dialog box (Figure 6-70).

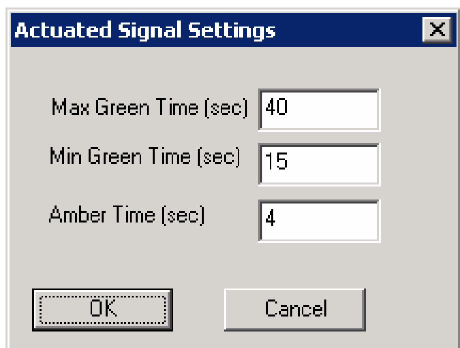
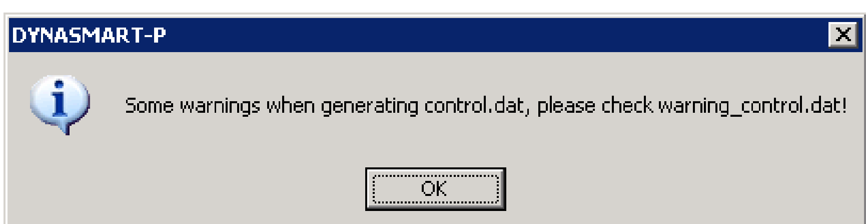


Figure 6-68. Actuated signal settings dialog box

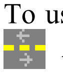
Should there be any warning messages from the phase generation step, they will be reported in *warning_control.dat*. Click <<OK>> to acknowledge.

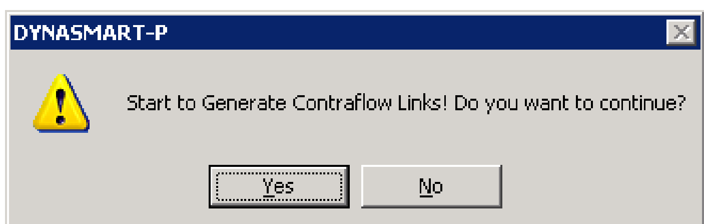


DYNASMART-P will then report the total number of signals for which default phasing information has been provided. Click <<OK>> to continue.

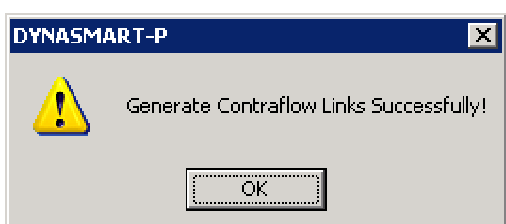
Finally, a dialog box pops out indicating that a new *control.dat* file has been successfully created. Click <<OK>> to finish.

***Scenario* | *Generate Contraflow Links* Menu Command**

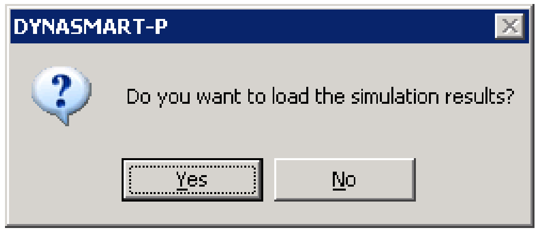
To use this feature, first load the network using the  toolbar icon, and select a link using the  toolbar icon. Select the Scenario | Generate Contraflow Links menu command. Click <<Yes>> to start generating Contraflow links.



Click <<OK>> to acknowledge that contraflow links have been created successfully.



Click <<Yes>> to load the simulation results to display the generated contraflow links (Figure 6-71).



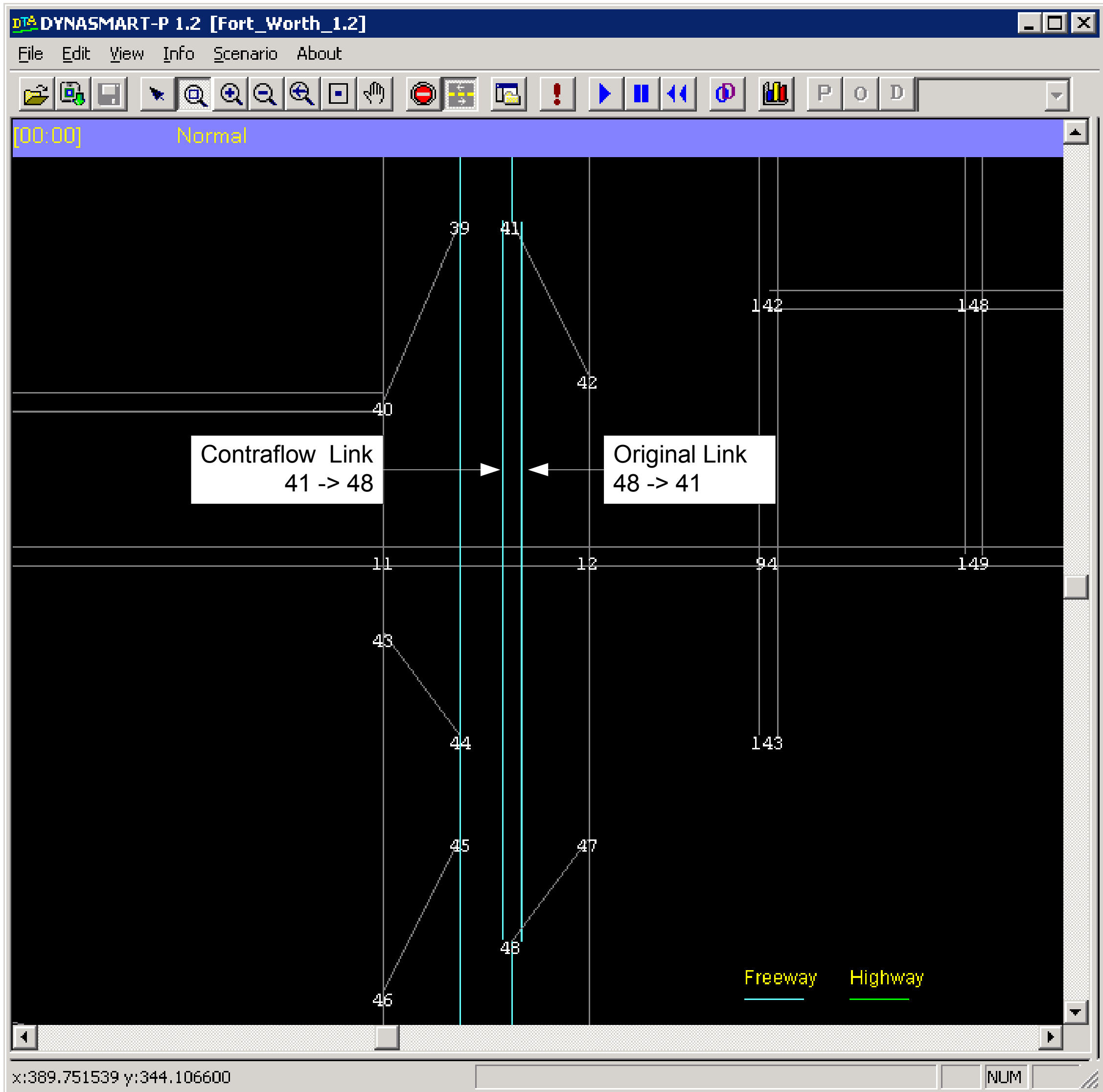
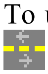
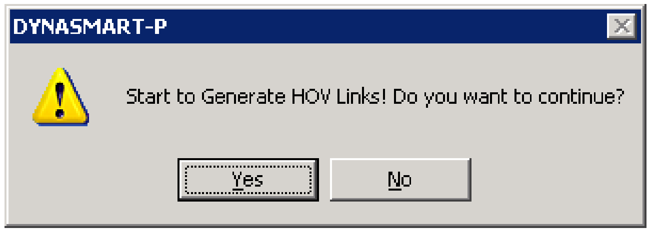


Figure 6-69. Contraflow link as generated by DYNASMART-P

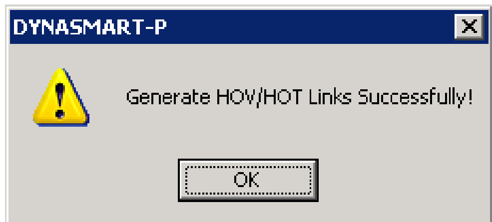
Note that contraflow links will be generated with the same number of lanes as the original link. The user, though, will have to use an incident with 100% capacity reduction on the original link to prevent vehicles from using it. Alternatively, the user can create an incident on each link such that the sum of capacity reductions is equal to 100%. This will model the case where not all lanes are to be reversed.

***Scenario* | *Generate HOV Links* Menu Command**

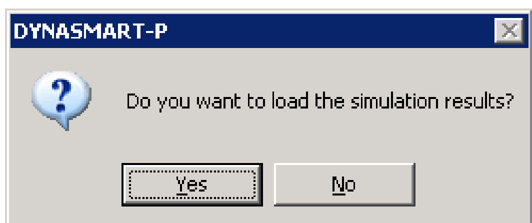
To use this feature, first load the network using the  toolbar icon, and select a link using the  toolbar icon. Click the Scenario | Generate HOV Links menu command. Click <<Yes>> to start generating HOV links.



Click <<OK>> to acknowledge that HOV links have been created successfully.



Click <<Yes>> to load simulation results and display generated HOV links (Figure 6-72).



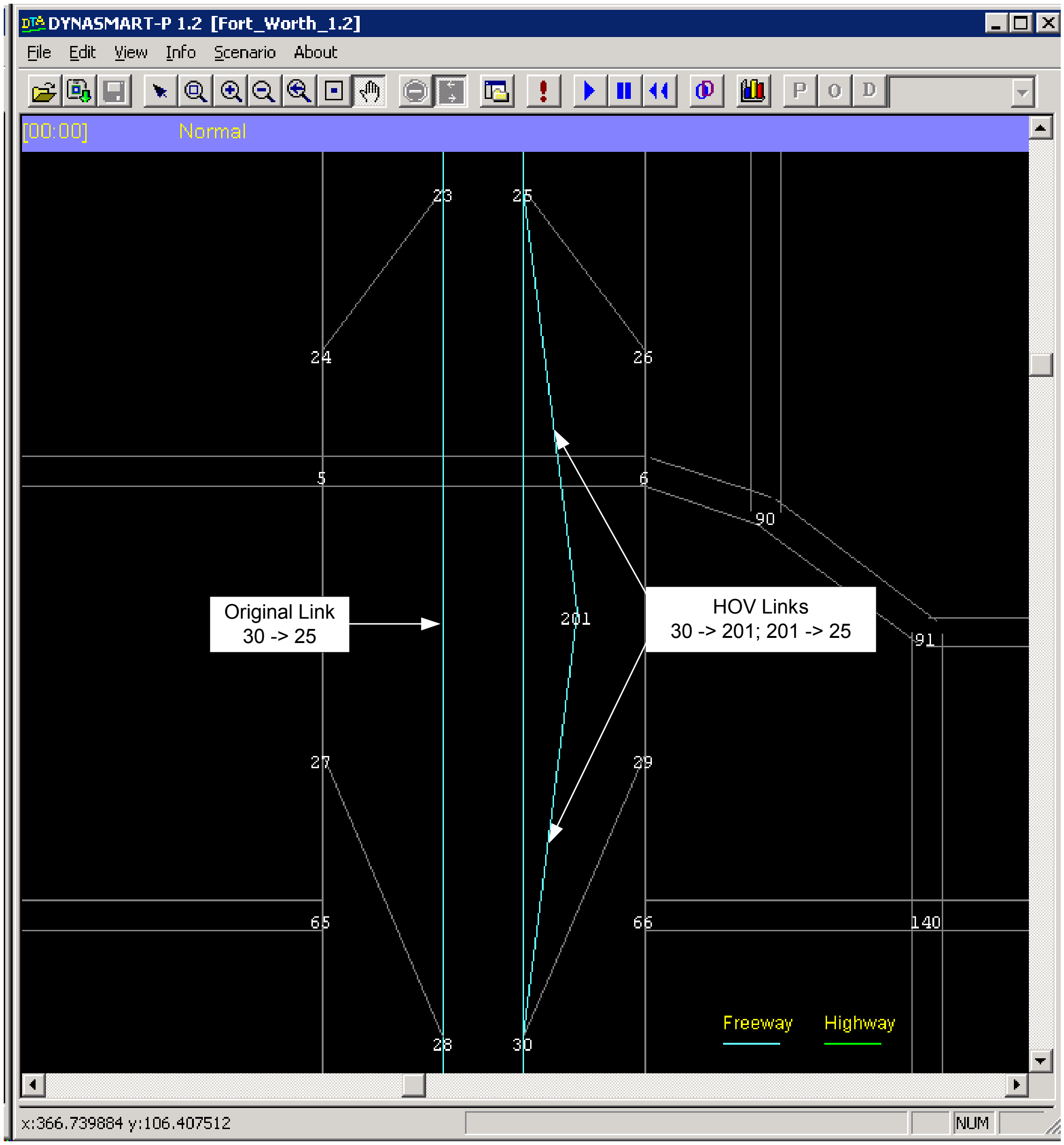
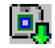


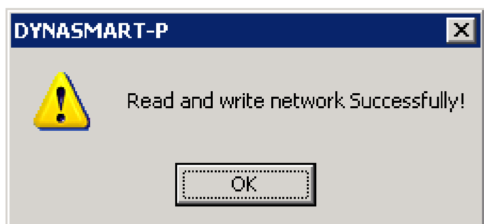
Figure 6-70. HOV links as generated by DYNASMART-P

Note that HOV links will be generated with only one lane, and that the number of lanes in the original link will be reduced by one. Therefore, users should be careful not to apply this feature on links with only one lane, unless they artificially increase the number of lanes within *network.dat*.

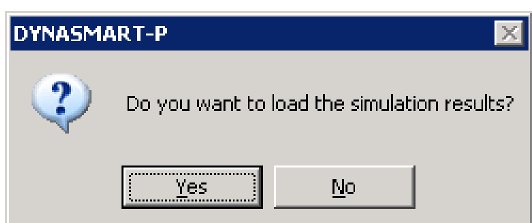
***Scenario* | *Generate HOT Links* Menu Command**

To use this feature, first load the network using the  toolbar icon, and select a link using the  toolbar icon. Click on the Scenario | Generate HOT Links menu command. Click <<Yes>> to start generating HOT links.

Click <<OK>> to acknowledge that HOV links have been created successfully.



Click <<Yes>> to load simulation results, and to display the generated HOT links (Figure 6-73).



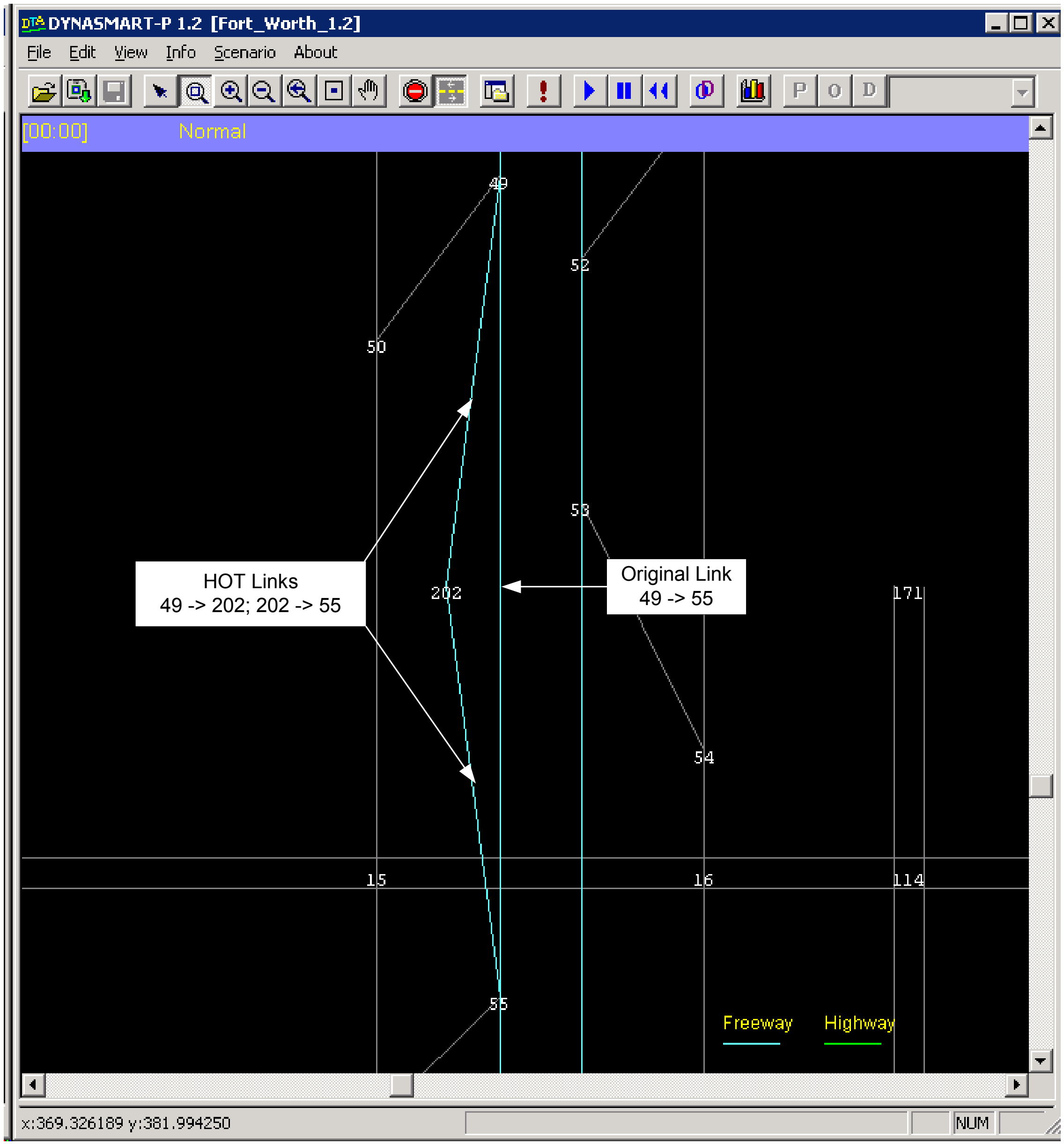


Figure 6-71. HOT links as generated by DYNASMART-P

Note that HOT links will be generated with only one lane, and that the number of lanes on the original link will be reduced by one. Therefore, users should be careful not to apply this feature on links with only one lane, unless the number of lanes in *network.dat* is artificially increased.

***Scenario* | *Copy control_backup.dat to control.dat* Menu Command**

Recall that in the Scenario | Generate Actuated Signal Timing Data command, the original *control.dat* file is copied to *control_backup.dat* before any phasing data is generated. This command, as the name suggests, copies the contents of *control_backup.dat* to *control.dat*, in case the user needs to revert to the original *control.dat* file.

***Scenario* | *Export Link Performance Data* Menu Command**

This feature exports MOEs for a given link to a user-specified text file. To use this feature, first load simulation results using the  toolbar icon (if no simulation results are available, then submit a simulation run prior to this step), and select a link using the  toolbar icon. Click the Scenario | Export Link Performance Data menu command. Specify the aggregation interval over which the link MOEs will be averaged (Figure 6-74).

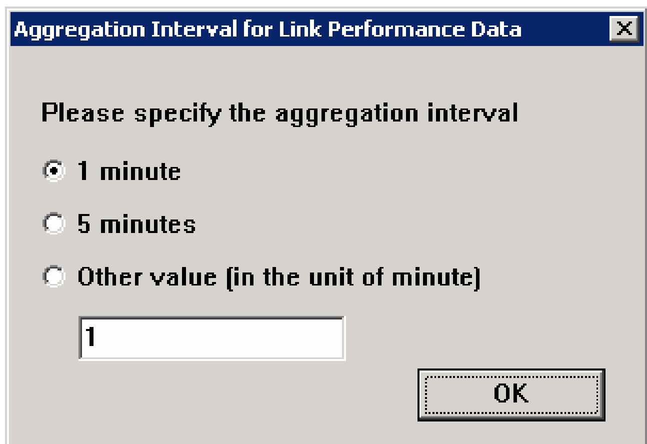


Figure 6-72. Aggregation interval for link performance data dialog box

Specify the name of the file to which the link performance data will be exported (Figure 6-76).

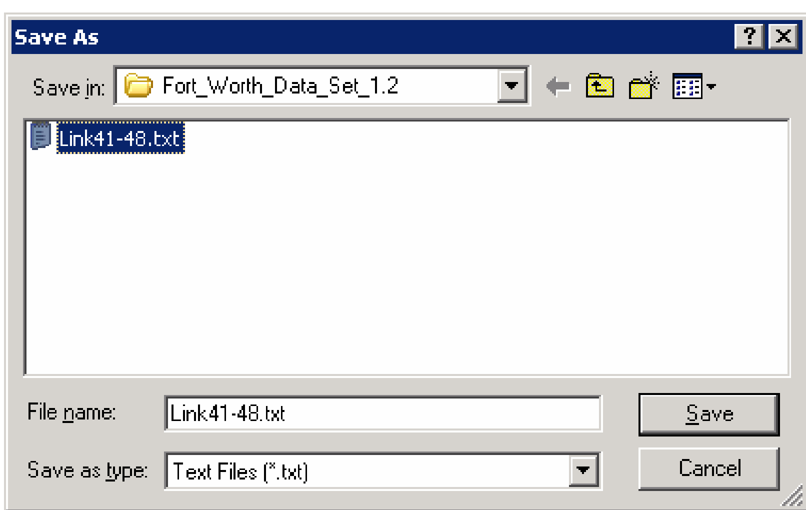


Figure 6-73. Save link performance data dialog box

The nature and format of the text file is presented in Figure 6-76 and is self explanatory.

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 6-74. Format of the exported link performance data text file

Scenario | ***Export Network Performance Data*** ***Menu Command***

This feature exports network MOEs to a user-specified text file. To use this feature, first load simulation results using the toolbar icon (if no simulation results are available, submit a simulation run prior to this step). Click the Scenario | Export Network Performance Data menu command. Specify the name of the text file to which the network performance data will be exported (Figure 6-77).

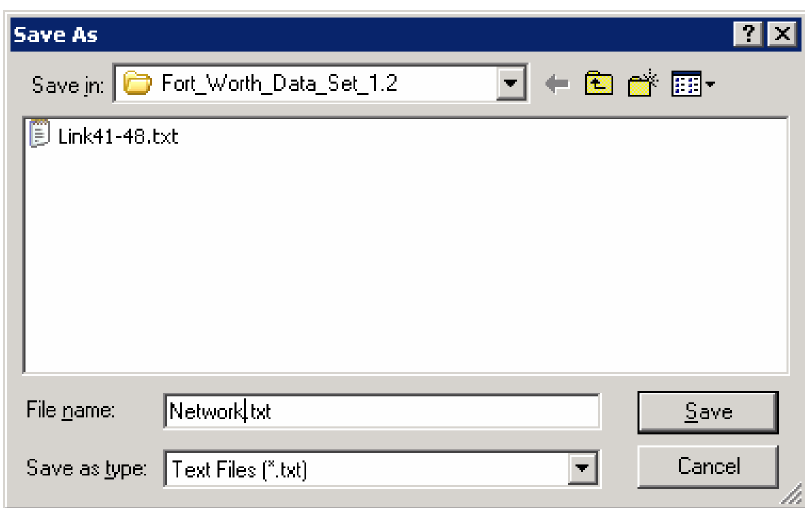


Figure 6-75. Save network performance data dialog box

The nature and format of the text file is presented in Figure 6-78 and is self explanatory.

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 6-76. Format of the exported network performance data text file

***Scenario* | *Copy output_vehicle.dat to vehicle.dat* Menu Command**

This command, as the name suggests, allows the user to copy the contents of *output_vehicle.dat* (generated after a simulation run) back to *vehicle.dat*. This feature is particular useful in several scenario contexts. For example, if one wishes to evaluate the effectivenss of VMS based on a UE flow pattern, he/she would first run through a UE equilibrium run, use this feature to reassign all the users from the User Equilibrium class to VMS Responsive Class, and then submit another run with new vehicle and path files plus appropriate VMS setting.

Once a user select a "Copy output_vehicle.dat to vehicle.dat" menu command, a dialogue box as shown in Figure 6-77 appears. If the user selects not to distribute the user class, then output_vehicle.dat will be copied to vehicle.dat without any change. Otherwise, the dialogue box as shown in Figure 6-78 will appear to allow the user to input the new user class distribution.

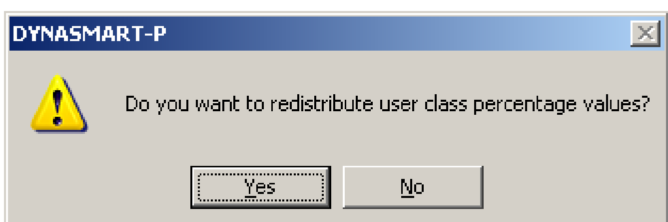


Figure 6-77 Dialogus box asking whether a user wants to re-distribute user classes

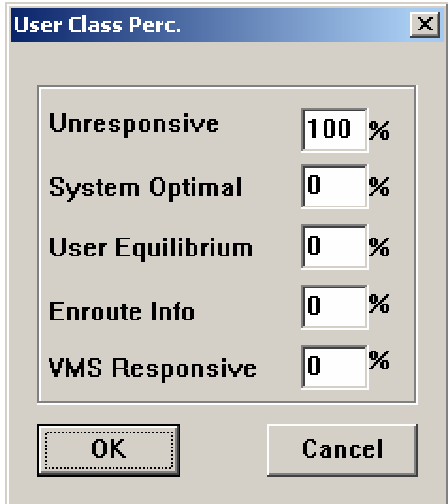


Figure 6-78 Re-distribute vehicle class dialogue box

***Scenario* | *Copy output_path.dat to path.dat* Menu Command**

This command, as the name suggests, allows the user to copy the contents of *output_path.dat* (generated after a simulation run) back to *path.dat*. This feature is handy when loading the demand using activity chain with path or partial path file.

***Scenario* | *Convert XY Coordinates* Menu Command**

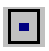
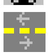
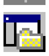
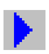
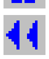
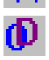
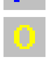
This menu command allows the user to to convert any given coordinate system in the original data set to a coordinate system with units of feet[7]. This function is designed to help users open an existing data set using DSPEd. For further information regarding the DSPEd coordinate system, please check the DSPEd technical assistance URL: http:// mctrans.ce.ufl.edu/technicalassistance/dynasmart/.

6.3 Toolbar

The Toolbar contains the most commonly used functions for easy access. The function of each toolbar button is described in Table 6-3. When switching to the <<Output>> view, the <<Toolbar>> buttons may be disabled. Simply click anywhere on the <<Network Display>> window to activate them. 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.

[7] *The default coordinate unit in DSPEd is feet, regardless of the original coordinate system in an existing DYNSMART-P project (e.g., longitude and latitude). Additionally, DSPEd only accepts the network data with its origin at the left-bottom corner of the screen. If a network data set has its origin at the left-top corner, please convert its coordinate origin to the left-bottom corner before modifying it with DSPEd. Specifically, the coordinates in files xy.dat, linkxy.dat and zone.dat should be converted.*

Table 6-3. Description of toolbar buttons

Tool	*Meaning*	*Description*
	Open project	Click this icon to open an existing project file.
	Load results	Click this icon to load 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 simulation results.
	Pause simulation	Click this icon to pause simulation.
	Rewind simulation	Click this icon to rewind 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].
	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 Plot Dialog Box Toolbar Icon

The <Plot> dialog box is activated via the button in the toolbar. It consists of a window with four tabs showing the <<Temporal Demand>>, <<Link Characteristics>>, <<Overall Network Performance>>, and <<Vehicle Paths>>.

<<Temporal Demand>> Tab

The <<Temporal Demand>> tab (Figure 6-79) can also be activated via the toolbar button. O-D pairs may be specified using the provided lists, or by using the pointer selection tool. Starting and ending time can also be specified. Total demand is always shown with the truck and HOV demand included as a part of the total.

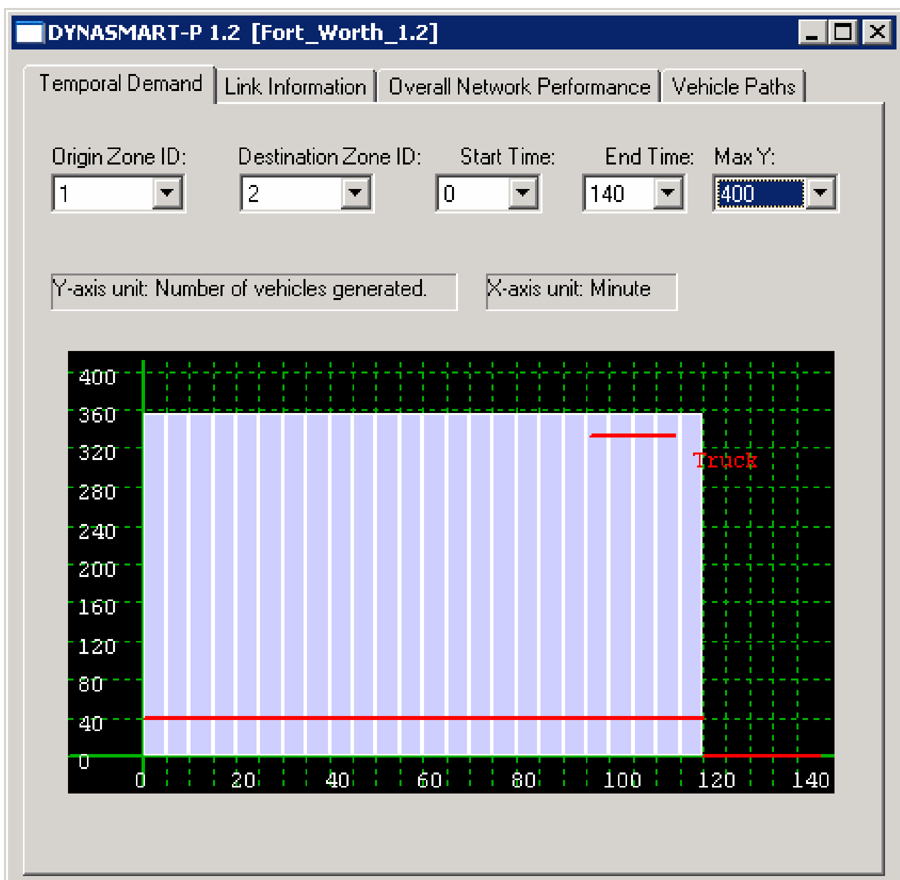


Figure 6-79. Temporal demand tab in the plot dialog box

<<Link Information>> Tab

The <<Link Information>> tab (Figure 6-80) can be activated by double-clicking on any link in the network (by activating the link selection toolbar icon and using pointer selection toolbar icon to double click a link). Alternatively, from the <Plot > dialog, select the <<Link

Information>> tab. Four MOEs can be displayed in the <<Link Information>> tab, namely link density (Figure 6-80), link speed (Figure 6-81), link queue (Figure 6-82), and link volume (Figure 6-83).

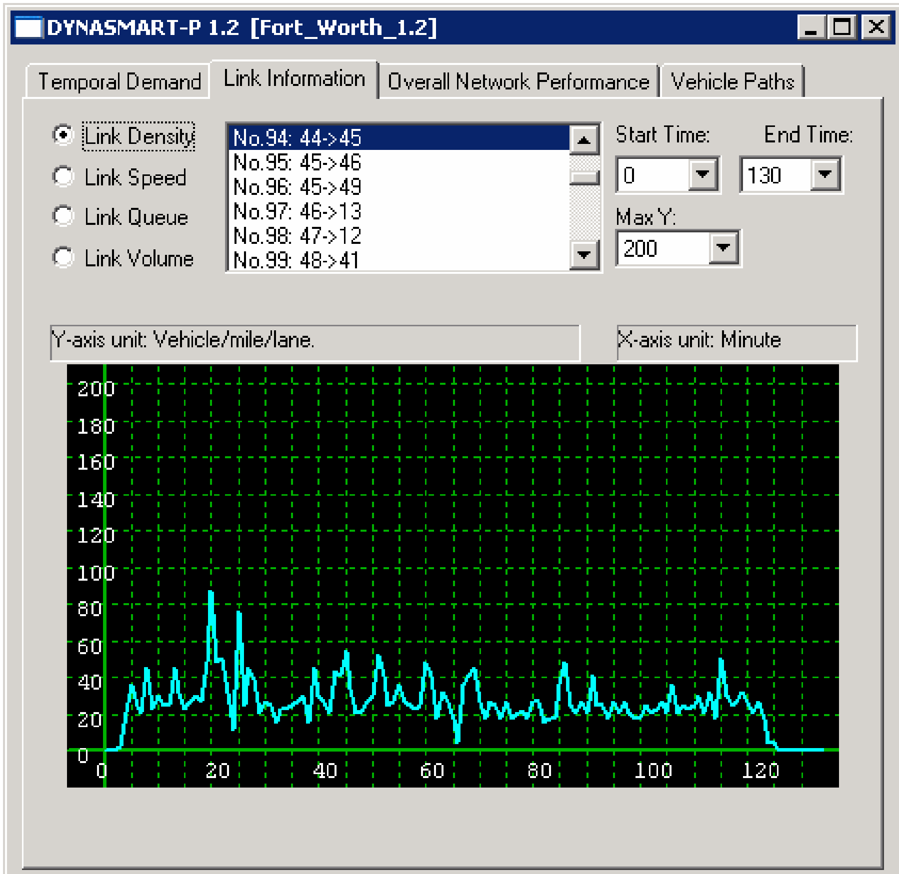


Figure 6-80. Link information tab in the plot dialog box – showing link density

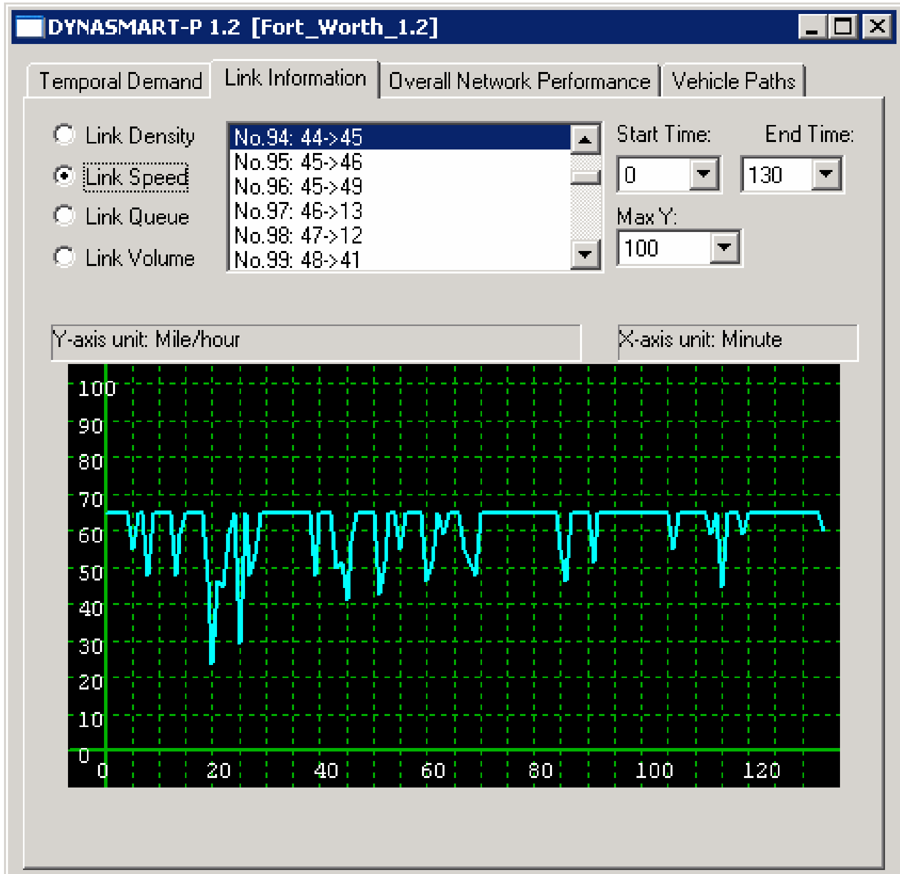


Figure 6-81. Link information tab in the plot dialog box – showing link speed

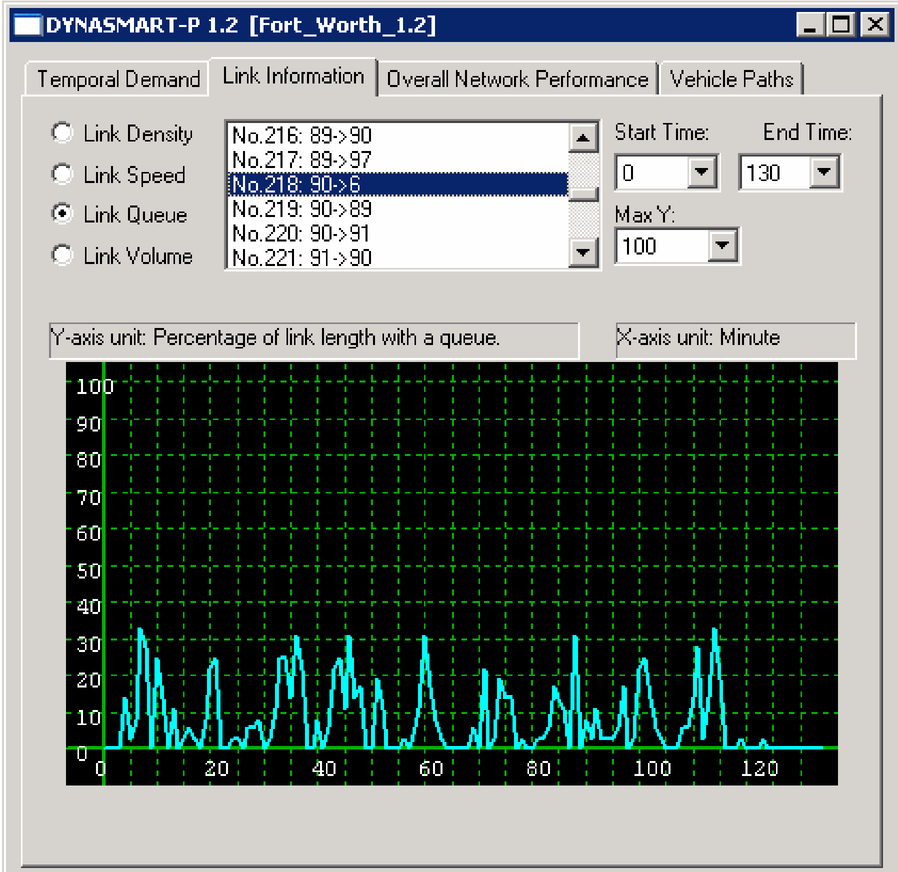


Figure 6-82. Link information tab in the plot dialog box – showing link queue

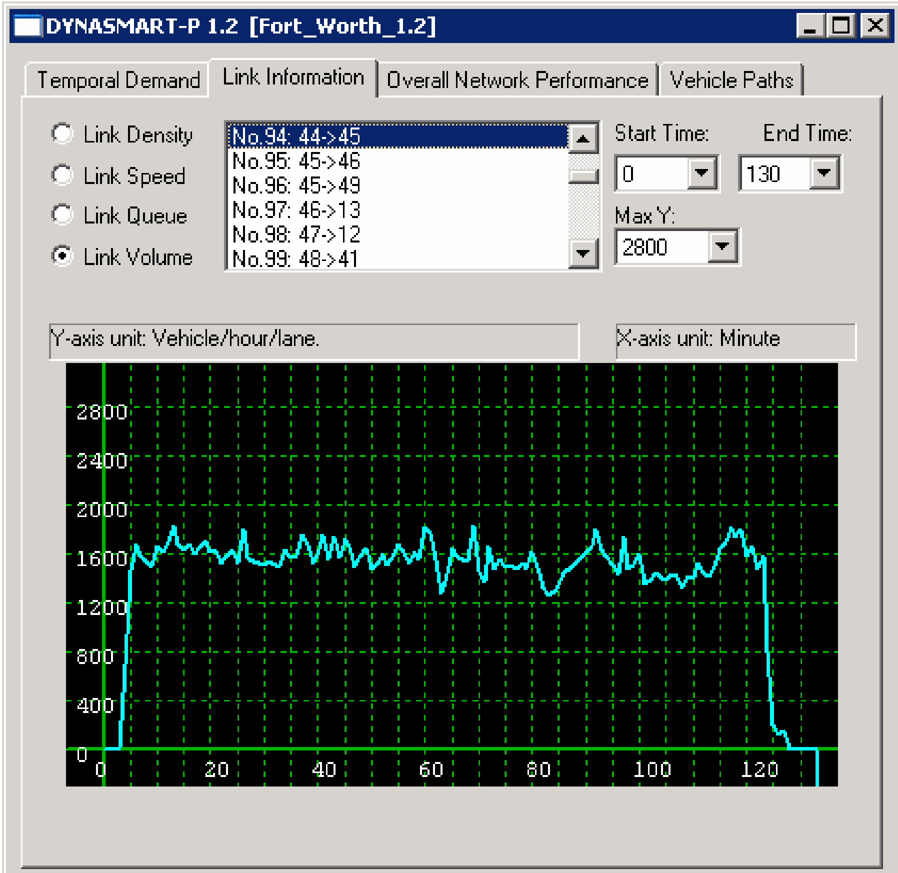


Figure 6-83. Link information tab in the plot dialog box – showing link volume

<< **<u>Overall Network Performance</u>** >> Tab

The <<<u>Overall Network Performance</u>>> tab (Figure 6-84) shows relevant network-wide statistics over the given planning horizon; specifically the number of vehicles in the network (Figure 6-84), number of vehicles out of the network (Figure 6-85), average travel time (Figure 6-86), and average speed (Figure 6-87).

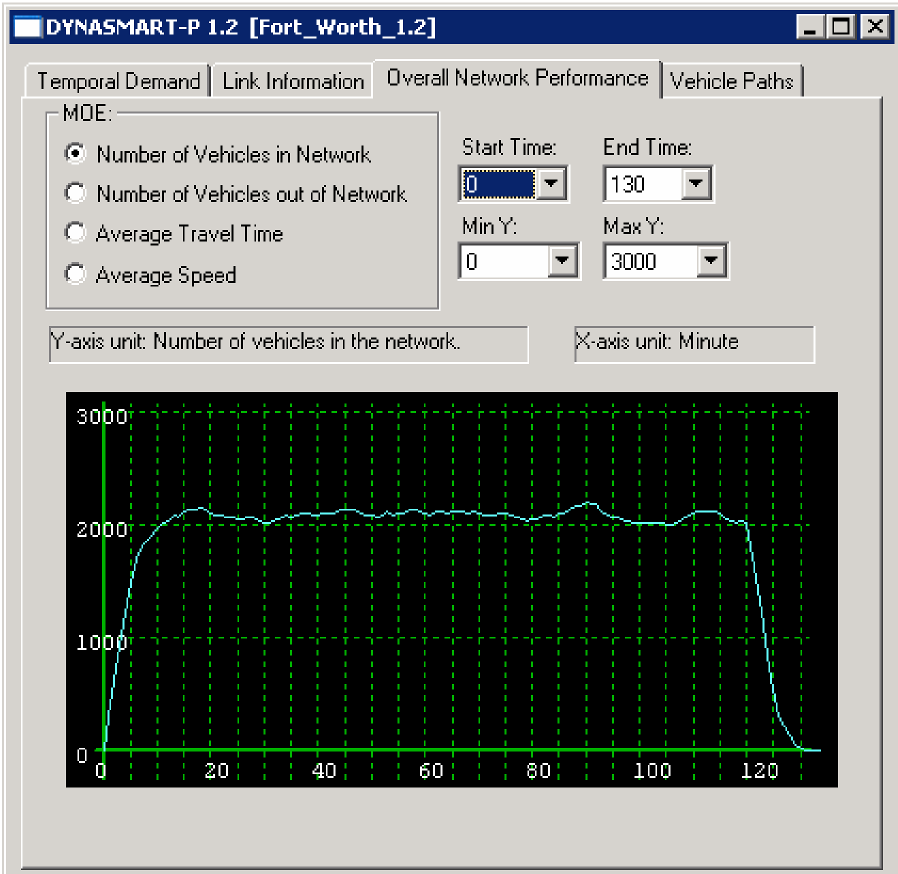


Figure 6-84. Overall network performance tab on plot dialog box– showing number of vehicles in network

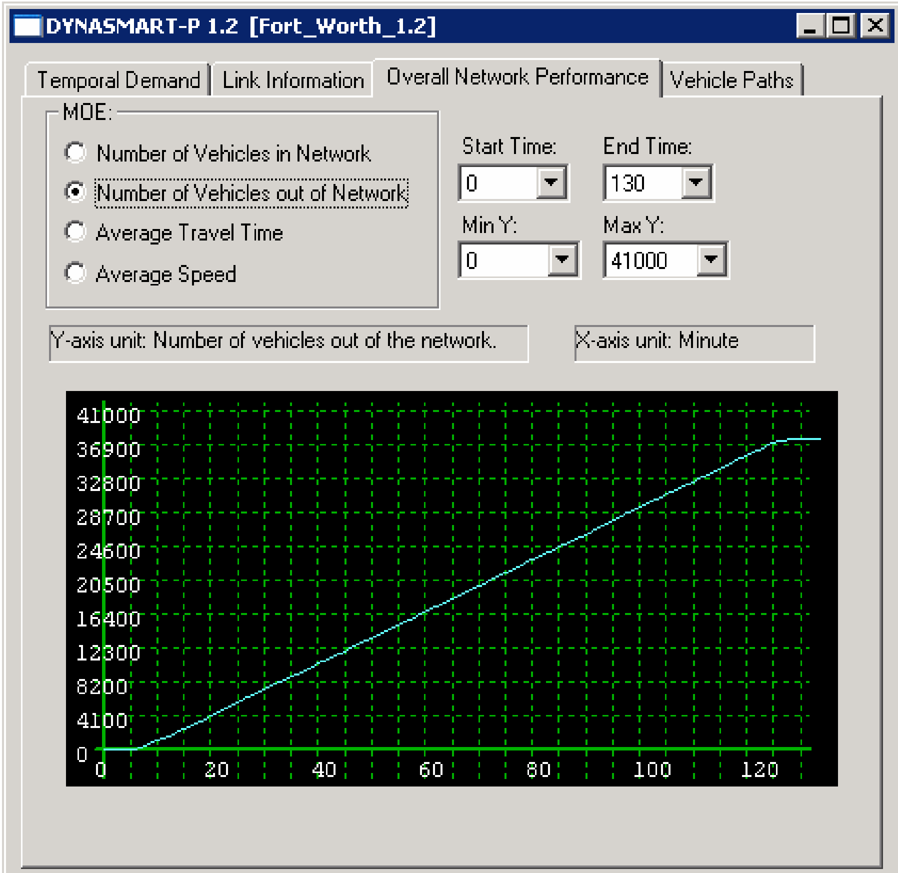


Figure 6-85. Overall network performance tab on plot dialog box– showing number of vehicles out of network

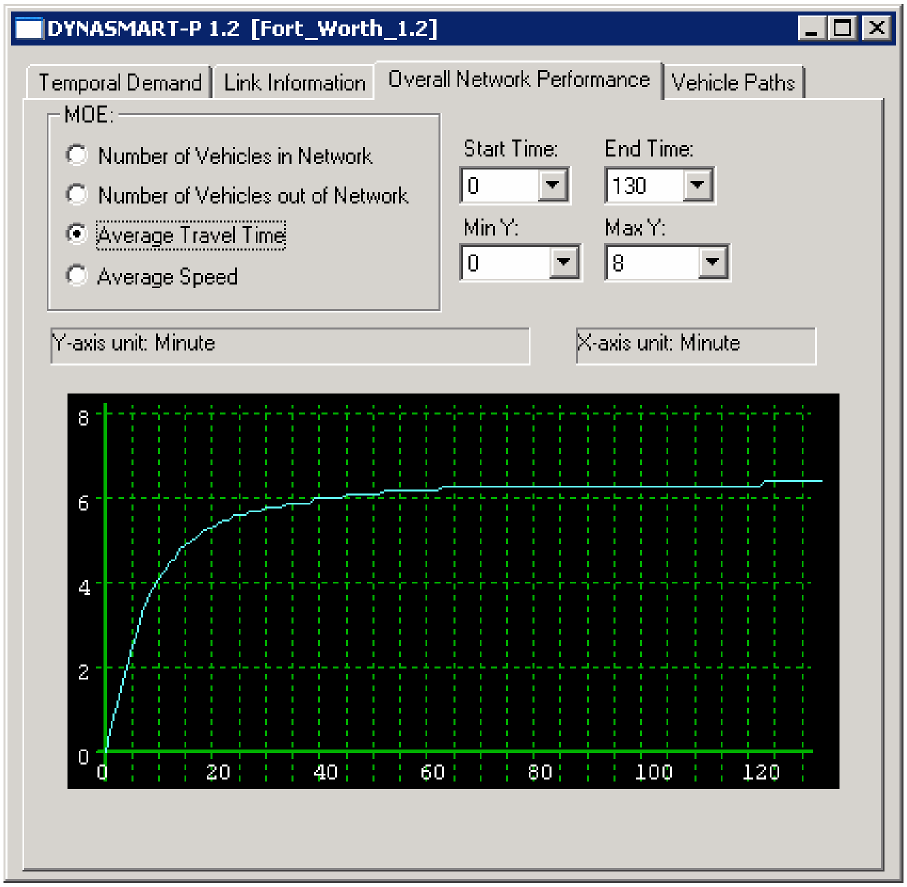


Figure 6-86. Overall network performance tab on plot dialog box– showing average travel time in network

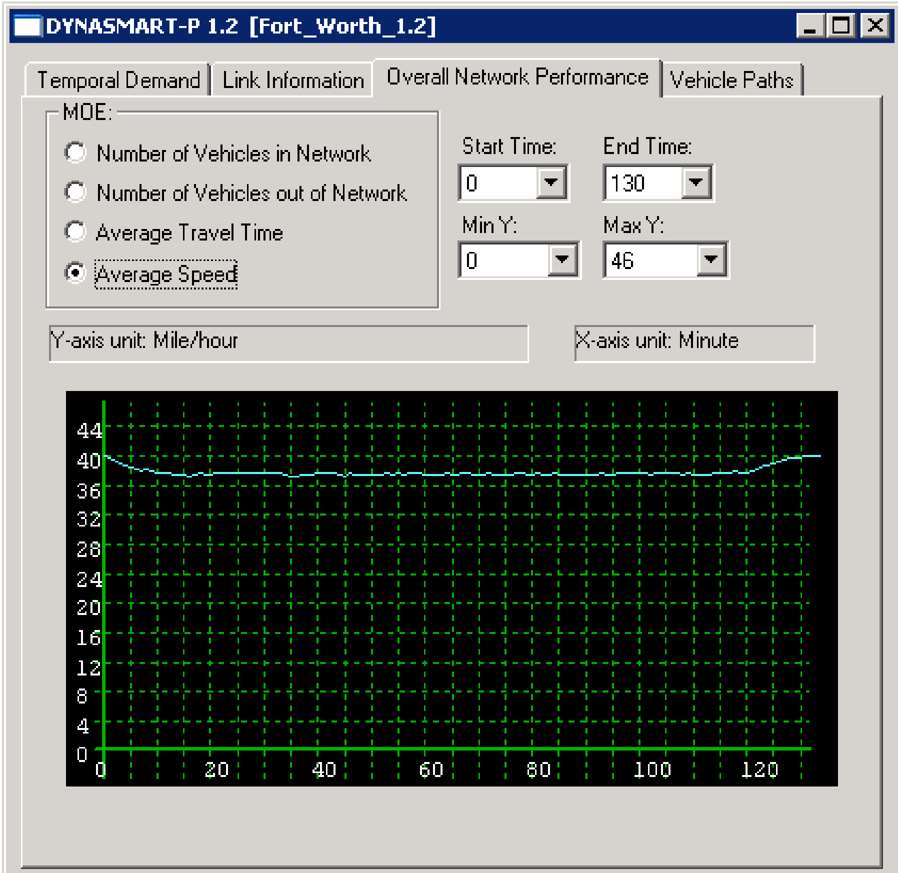
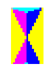


Figure 6-87. Overall network performance tab on Plot dialog box– showing average speed in network

<<Vehicle Paths>> Tab

The <<Vehicle Paths>> tab (Figure 6-88) may be used to display vehicle paths on the GUI, and/or output O-D travel time information. To display vehicle paths on the GUI, first specify the <<Origin Zone ID>> and <<Destination Zone ID>>. Then select a generation link from the [Generation Link List] data block, select a user class from the [User Class List] data block, and select a vehicle type from the [Vehicle Type] data block. Finally, select the aggregation interval from the [Aggregation Interval] data block which refers to the departure time period over which results are computed. Select one or more paths from the [Paths List] data block to display on the GUI (Figure 6-89. Alternatively, click on the path color legend in the GUI to highlight it (Figure 6-90. Note that, if the aggregation interval is chosen to be less than then planning horizon (e.g., a 5-minute interval), then slide the Simulation clock cursor  in the simulation time bar to display paths for different departure times.

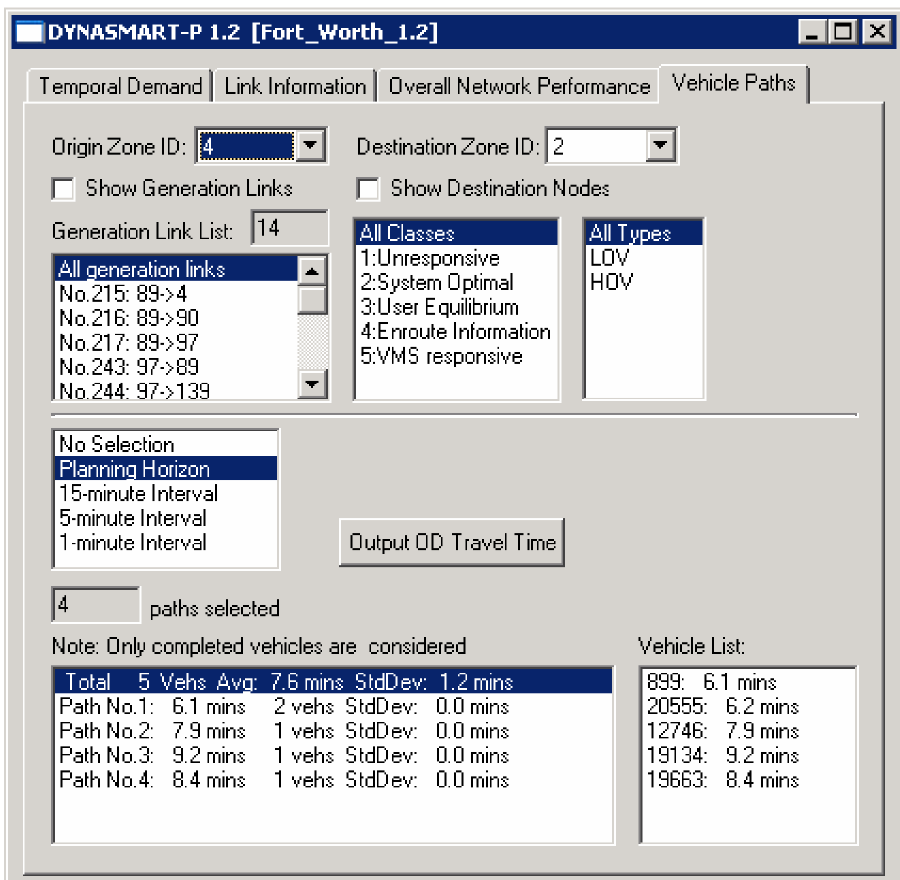


Figure 6-88. Vehicle paths tab on plot dialog box

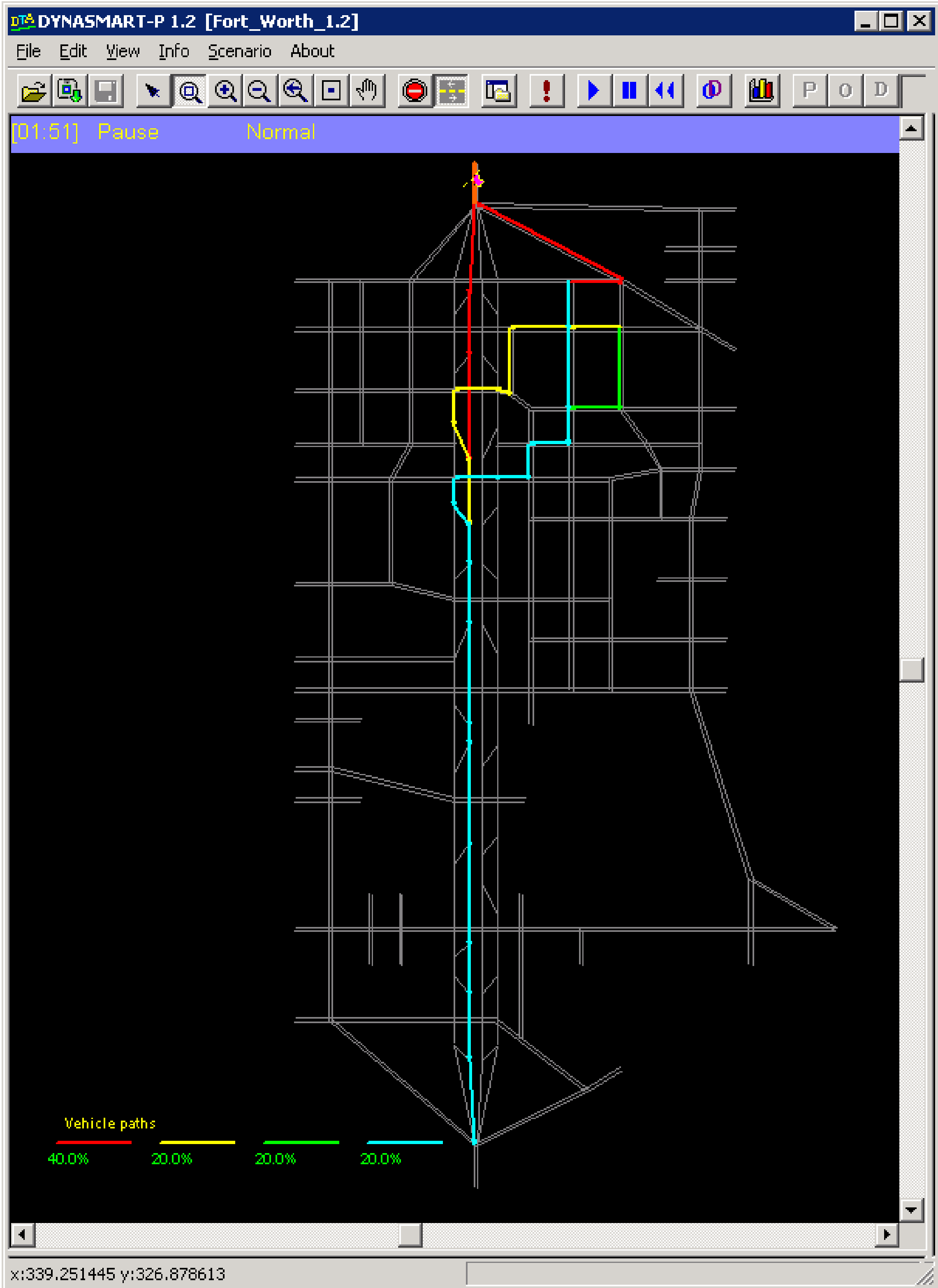


Figure 6-89. Vehicle paths as displayed on the GUI

Figure 6-90. Vehicle paths as displayed on the GUI after clicking the yellow path legend

To output the OD travel time information, click on the <<Output OD Travel Time>> button (Figure 6-88. Results are reported in the *ODTravelTime.dat* output file, which can be viewed in the GUI input view mode (Figure 6-91).

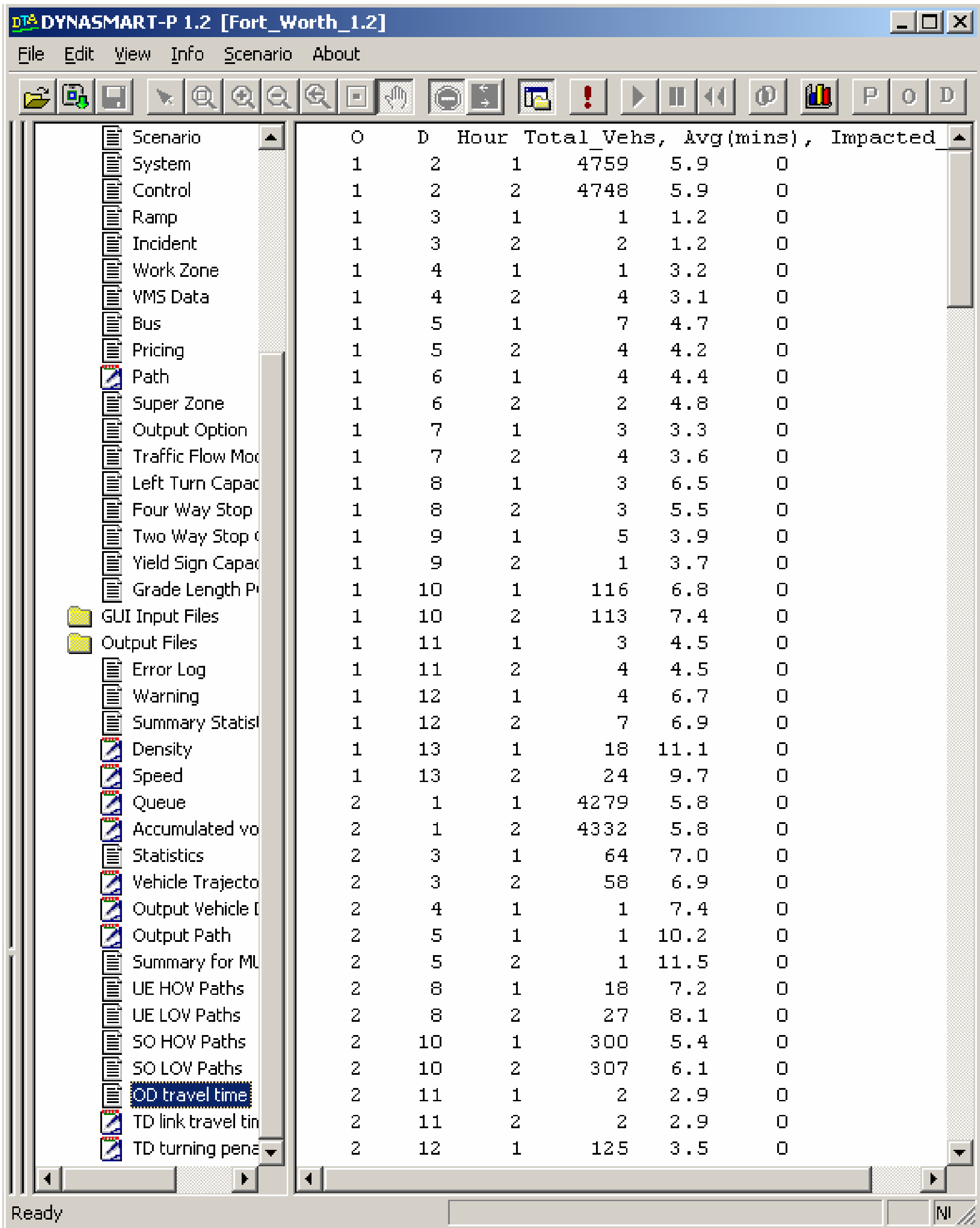


Figure 6-91. OD travel time information as displayed on the GUI input view

6.3.2 Viewing UE/SO Paths Toolbar Icon

To use this feature correctly, an iterative simulation-assignment run must be made. Load the simulation results, and the switch to the GUI output view mode. Activate the node selection mode by clicking the toolbar icon. Use the UE+LOV tool to select a routing policy (path assignment, whether UE or SO) and vehicle occupancy (LOV or HOV) combination. This selector is active only if the solution mode is iterative consistent assignment. Click P to activate the path feature. To select an origin zone, double click on any node in that zone, and then click O. To select a destination zone, double click any destination node in that zone, and then click D. DYNASMART-P will then show the equilibrium paths (routing policy) using different colors that exist between the selected O-D zone combinations. 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 (at the bottom-left of the screen) to highlight a particular path. This feature will become useful with overlapping paths. Note that destination nodes are those marked by (see Figure 6-25). Users may close the UE/SO paths view any time by clicking on P 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 6-92). The user may want to view the zone (or super zone) boundaries to visually identify destinations that belong to the same zone (or super zone).

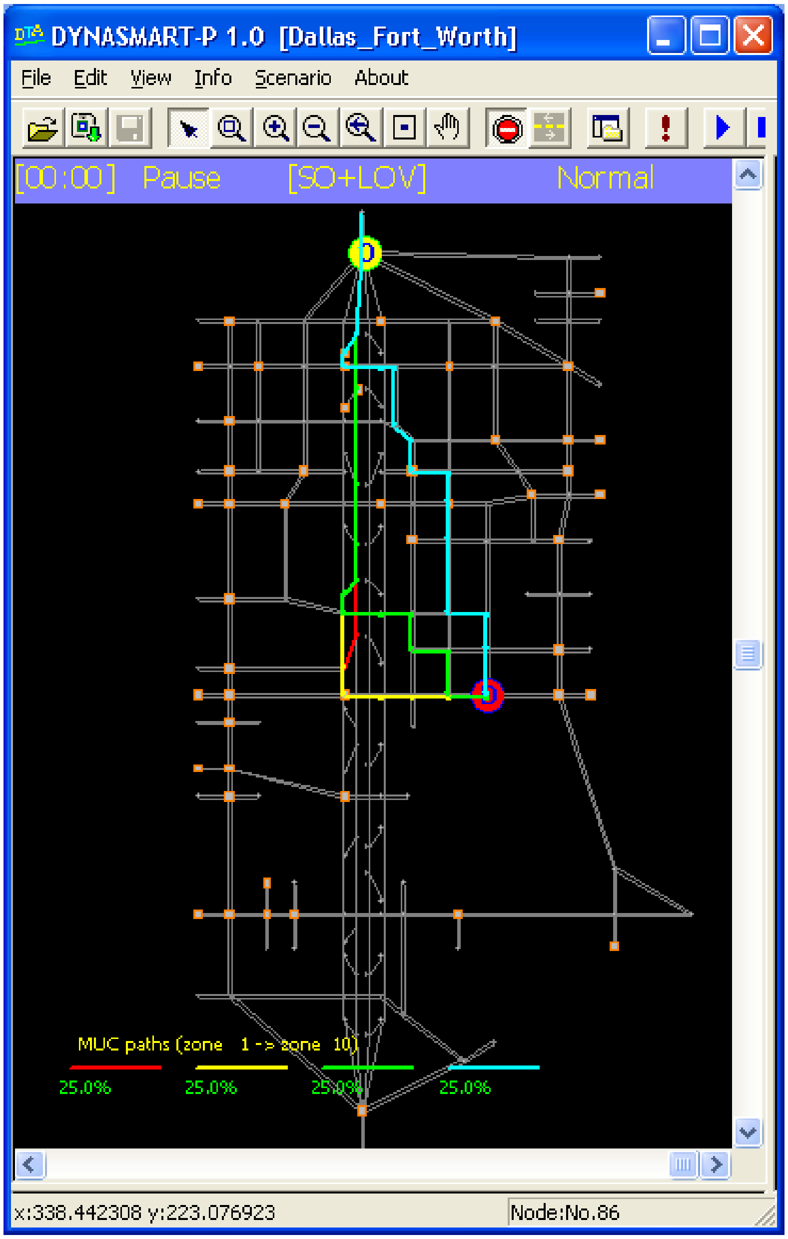
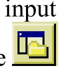


Figure 6-92. Viewing UE or SO paths on GUI

6.4 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 input (text editor view) and output (network) views in the same manner as the  button
F3	Find next (must be in input view – text editor)
F5	Switch the cursor from the input file (input files tree) to the body of text for this file
F6	Switch the cursor from the body text of an input file to the input file name itself (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 (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 (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. The 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 DSPEd (DYNASMART-P editor).

Each of these methods has its own advantages and disadvantages; therefore, the recommended method for creating input files would be to choose among any of these four 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.

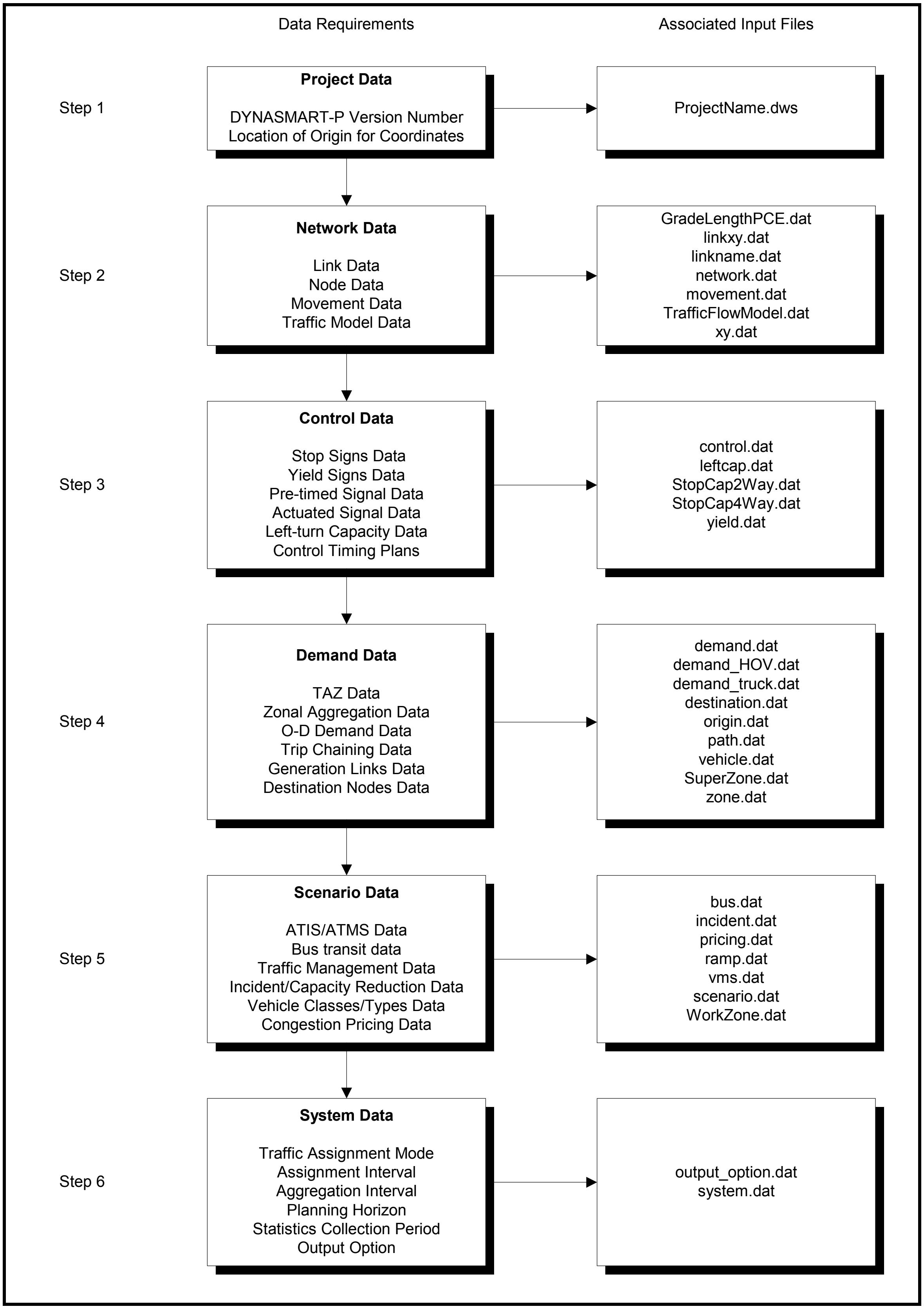


Figure 7-1. Data requirements for DYNASMART-P

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 xy coordinate origin (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 actuated signals. 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 for loading 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.dat* input files.

8. FREQUENTLY ASKED QUESTIONS

8.1 Why don't I 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) contributes 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 on the 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 user classes 4 and 5 will respond to and evaluate VMS. If <VMS Preemption Mode> is not selected, only VMS-responsive vehicles will respond to VMS information. Note that all user classes will respond to mandatory detour and speed advisory VMS.

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 a 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.

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 a boundary of the network may be used to generate interstate 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 (<u>Scenario</u> | <u>Advanced Settings…</u>).

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 *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?

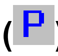
In DYNASMART-P, only upgrades affect the ability of vehicles to quickly reach their desired free-flow speed. Downgrades have no effect on this.

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, and activate the "show path" feature?

The number of shortest paths to be solved for (k) only applies to 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 (). 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 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[8] (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

[8] T-Y., Hu and H. S. Mahmassani. Day-to-day evolution of network flows under real-time information and reactive signal control. *Transportation Research Part C*, Vol. 5, No. 1, pp. 51 – 69, 1997.

based on user behavior rules to either the current best path, or a random path among a set of superior paths.

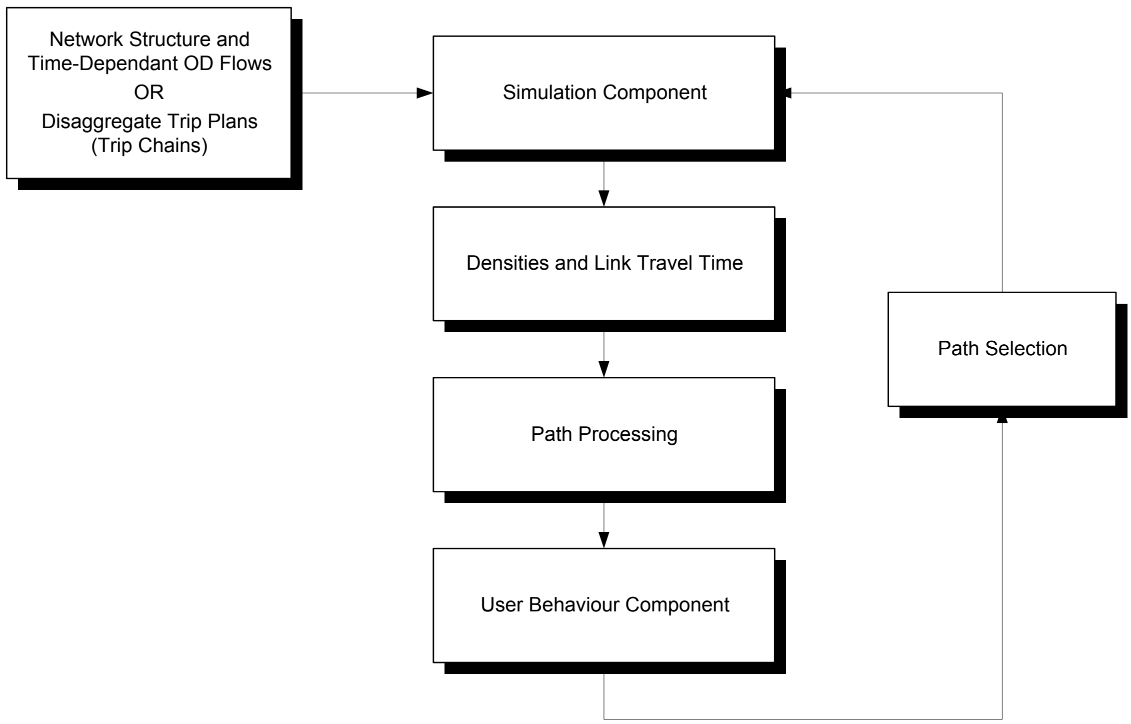


Figure A-1. DYNASMART-P (One-Step Simulation-Assignment Procedure)

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 et. al.[9] (1993) and Jayakrishnan et. al.[10] (1994).

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.

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[9] Mahmassani, H.S., Peeta, S., Hu, T-Y, and Ziliaskopoulos, A. Algorithm for dynamic route guidance in congested networks with multiple user information availability groups. *Proceedings of the 26th International Symposium on Automotive Technology and Automation*, pp.273-280, 1993.

[10] Jayakrishnan, R, Mahmassani, HS, and Hu, T-Y. An evaluation tool for advanced traffic information and management systems in urban networks. *Transportation Research Part C*, Vol. **2**, No. 3, pp. 129-147, 1994.

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 $\tau = 1,...,T1$, 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, ∀i ∈I, ∀ j ∈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 their trip again from this destination, to complete the trip according to their 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 ι = 0. Assign the activity-based demand, r_{ih}^{τ} ∀ i, τ, and h to initial set of feasible paths k∈$k_{ij,}$ where j is the first destination in the travel plan h. Accordingly, the initial solution is given by $r_{ijk}^{\tau,0}$, ∀ 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}, ∀ t, a. Calculate also the new demand at each node, which is equal to $r_{ij}^{\tau,\iota} = \sum_{k} r_{ijk}^{\tau,\iota}$ ∀ 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 $y_{ijk^*}^{\tau^*,\iota}$, ∀ i, j and τ.

Step 4. Update the path by checking if k^*∈k_{ij}, and include it if it does not, ∀ i and h. Assignments for the next iteration $r_{ijk}^{\tau,\iota+1}$ are obtained using the method of successive averages, ∀ 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, assignments to the next iterations $r_{ihk}^{\tau,\iota+1}$ are compared with current path assignments $r_{ijk}^{\tau,\iota}$, ∀ i, j, τ, and k:

$$\left| r_{ijk}^{\tau,\iota+1} - r_{ijk}^{\tau,i} \right| \leq \varepsilon \qquad \text{where } \varepsilon \text{ is a predefined threshold.}$$

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 $r_{ijk}^{\tau,\iota+1}$.

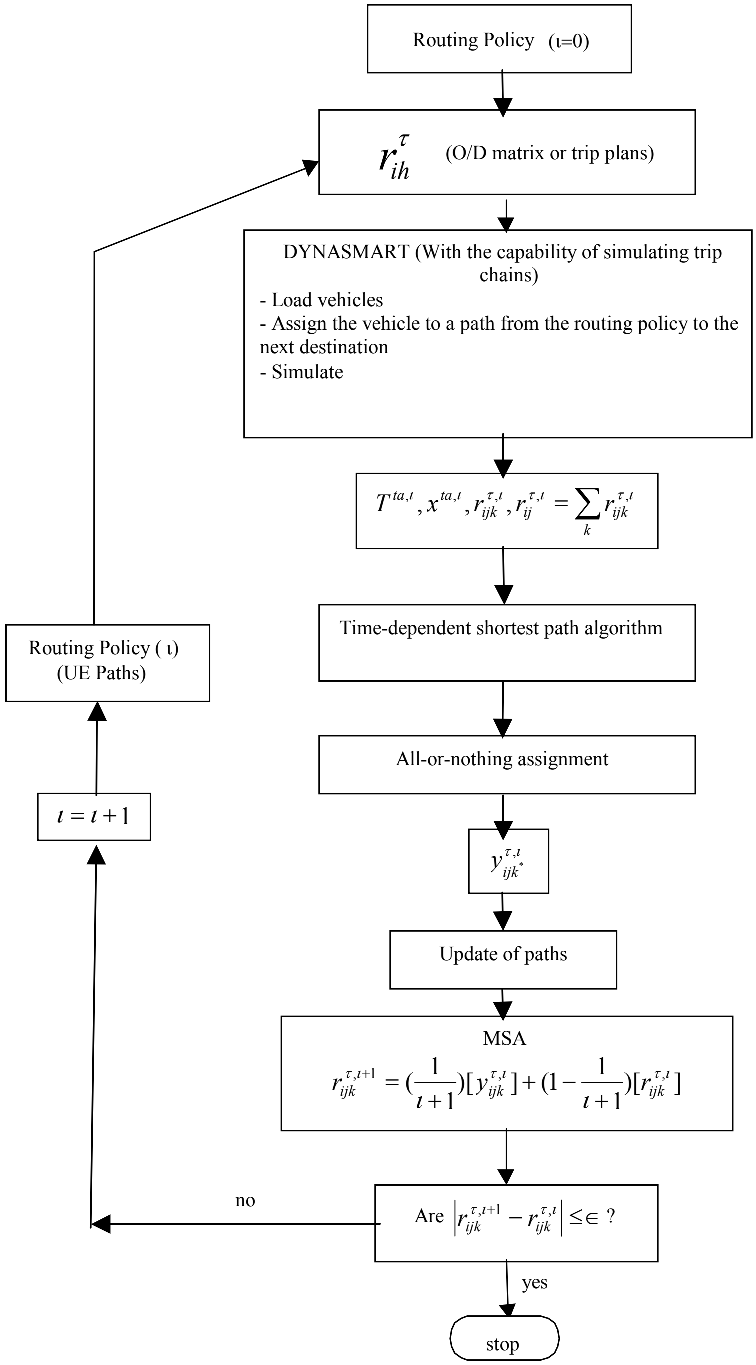

Figure A-2. The solution algorithm for DYNASMART-P (Iterative UE Procedure)

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 *network.dat* and *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 the *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*. Mappings between the original zones and 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	Saturation 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