DEVELOPMENT OF A METHODOLOGY TO INTERFACE TRANSPORTATION PLANNING AND TRAFFIC SIMULATION

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(ABSTRACT)

The purpose of this research is to develop a methodology to interface transportation planning and traffic simulation. Differences in representations of planning and traffic networks prohibits planners and engineers from sharing the input data for the same area being studied. Therefore the planning data need to be utilized to create data that the traffic engineers can use for traffic simulation, thus avoiding duplication of effort to collect data for the two purposes. The methodology developed specifically for the Urban Transportation Planning Software (UTPS) and Traffic Simulation Software (TRAF), can be modified to interface planning and simulation performed by other software as well. The methodology is demonstrated using a typical urban town network.

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Chapter 1. Introduction

1.1 Research objectives

One of the main aspects of transportation planning is travel forecasting for future conditions. These forecasts are based on forecasts of future development of the urban area. The future population and employment in an urban area is predicted using computerized urban growth models. These models are rigorous mathematical algorithms that allocate the total growth of the area according to criteria which affect development decisions. Current travel forecasting processes use a sequence of four major models, each representing a different aspect of the traveler's decisions. The trip generation model estimates how many trips will be made to and from individual analysis zones. The trip distribution model estimates where trips originating in various zones will be destined, linking the trip origins and destinations from the trip generation model. The mode choice model identifies whether each trip will be made by motor vehicle or mass transit. The traffic assignment model allocates the trips for each mode to the most likely route, whether a roadway or a transit line. Using these models the performance of the existing roadway and transit systems can be assessed under current and future development conditions.

Traffic Engineering on the other hand, mainly deals with the operational performance of the transportation system as determined by various measures of effectiveness (MOE). Measures such as vehicle speed under current demand, vehicle stops, delays, vehicle-hours of travel, vehicle-miles of travel, fuel consumption and pollutant emissions, transit service performance are some of the indices used to analyze the performance of the system. Testing various traffic control strategies such as changes in traffic signal timings, analyzing the effect of short term and long term events, testing the effect of increased traffic flow in the network are typical traffic engineering exercises.

Technology and practice in both transportation planning and traffic engineering have grown in parallel with the growth of computer technology. Processing of massive databases needed for even the smallest transportation planning studies would be virtually prohibitive without using a computer. Describing the transportation system and urban geography involves considerable effort which is simplified by the use of computer. The Urban Transportation Planning System (UTPS), developed by the U.S Department of Transportation is a mainframe program package used to perform comprehensive transportation planning. One of the most important analytical tools of traffic engineering is computer simulation. Traffic systems can be simulated on a computer by means of simulation models, thereby providing information on the effect of traffic engineering strategies on the system's performance. A family of traffic simulation models, referred to as TRAF, has been developed by the U.S Department of Transportation for simulating various traffic conditions on microscopic and macroscopic levels.

Thus planners and engineers use various mathematical and simulation tools to perform planning and simulation respectively. While the goals of a planner and an engineer are different, information used by them are interrelated, though indifferent form and data formats. This difference in the representation of the transportation system by planners and engineers prohibits them from sharing information for the same area being studied. Currently this not only requires duplicate effort to collect data for each system, but it also creates difficulties in integrating planning activities and traffic strategy analyses for the study area. Thus, the main objective of the research is to develop a methodology to convert the planning information into a form that can be utilized by the engineer for traffic simulation. This methodology would serve as an interface or a link between planning and traffic simulation. Though, the methodology has been developed specifically for the UTPS planning software package and the TRAF simulation package, it can be adapted easily to other software systems, since most software used for planning and simulation purposes have many fundamental similarities.

The objective is achieved by interfacing the UTPS planning information with both the macroscopic model for corridor analysis (CORFLO) and the microscopic simulation model for urban network analysis (NETSIM).

1.2 Organization

This thesis report is organized as follows :

The second chapter provides an overview of various features of the Urban Transportation Planning System. It also explains the format of the planning data that will be used by the methodology.

The third chapter provides an overview of various features of the TRAF family of simulation models. The records types used to represent traffic networks are discussed.

The fourth chapter explains the methodology developed to interface planning and simulation using UTPS and TRAF. The procedures to be followed to implement the methodology are also discussed.

The fifth chapter is intended to demonstrate the methodology on a typical urban town network. The input planning data, the sequence of operations to be followed to establish the interface with TRAF, and the results are explained.

The sixth chapter concludes the report with a discussion on the benefits of the research methodology and provides recommendations for future improvements of the methodology.

Chapter 2. Urban Transportation Planning System (UTPS)

2.1 Introduction

Local and state administrators facing complex transportation or land use issues frequently have little time to choose between alternative courses of action. Analytical support for decision making is often crucial; most decisions are reviewed by elected officials and the public, and may have to conform to federal regulations.

Information demands on decision makers are rapidly outpacing the ability of local planning staffs to produce answers. The Urban Transportation Planning System (UTPS) provides planning and impact forecasting tools to meet many of these demands. UTPS computerized methods can be used to provide answers to a wide variety of questions such as :

- Will present roads accommodate future travel demands ?
- What road improvements should have highest priority ?
- What ridership should be expected on a proposed busway ?
- How will traffic circulation be affected by a proposed mall ?

Maps, graphs and tables generated by UTPS help local officials compare alternative solutions.

UTPS was developed jointly by the Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA). It allows the planners to simulate the operation of a transportation system and thereby determine what would happen if changes were made in the roadway or transit networks. This simulation parallels the steps in the standard transportation planning process. This process involves four major steps: (1) representation of the roadway or transit system, (2) estimation of the number of future drivers and transit riders and their origins and destinations, (3) assignment of trips to appropriate roads and transit routes, and (4) preparation of maps, tables and graphs to display the results and compare different transportation alternatives.

UTPS is usually used to test different roadway or transit configurations and operating strategies to compare resulting levels of traffic congestion, transit ridership, air pollution, energy use and numerous other factors. For example, to determine how best to reduce congestion on a certain road, one might test alternatives such as adding lanes, building a new road, relocating a public building or reducing the zoned density of an undeveloped parcel. For each alternative UTPS could provide information about traffic accident levels, travel time reductions(or increases) and the geographic distribution of mobility improvements.

This chapter provides an overview of the Urban Transportation Planning System. Article 2.2 describes the functions of various program modules. Article 2.3 lists the computer requirements for using the UTPS system. Article 2.4 describes the procedure for representing transportation networks in UTPS. Article 2.5 describes the structure of the UTPS planning data that are used in the research methodology.

2.2 UTPS program modules

UTPS contains many modules to perform a variety of planning functions. The following paragraphs briefly describe the function of various program modules.

Land Use Forecasting

DRAM, EMPAL and CALIB are the names of the land use modeling programs in UTPS.

DRAM is used to forecast residential location based on zone-to-zone travel impedances, employment location, land use patterns, and zonal income distribution. Output files contain numbers of employed persons in each zone.

EMPAL, the employment allocation model, forecasts the spatial allocation of employment by type, based on residential location, travel impedance, and prior employment location.

CALIB estimates parameters and K-factors for both DRAM and EMPAL.

Highway Network Analysis

HNET, the highway network data collection program, creates or updates a highway network from link data cards. These data include link distances, travel times, facility type, number of lanes and other characteristics for input to the highway assignment program UROAD. Outputs include a data file describing the highway network for other programs and printer plots of network and its associated attributes.

UROAD, the highway analyzer and assignment program, finds the shortest paths based on any combination of time, distance or tolls. It also assigns trips to the highway network, using one of a variety of techniques selected by the user. It's inputs include the network and highway trip tables, such as those output by UMODEL or AGM. In addition to updating the network file from link volumes, UROAD outputs origin-destination trip matrices for selected links, impedance matrices, selected paths, link loadings and speeds, pollution emission and energy consumption estimates and plots describing any of the above.

NAG, the network windowing program, extracts network and travel demand information for a sub-area of a region. Called "windowing" this process facilitates micro-level planning. Inputs include the regional highway network and trip tables. Outputs include a subarea network file, subarea trip tables, and reports.

HNIP, the highway network improvement program, was designed to evaluate alternative network improvements, working either with capital investments or with dedicated transit and carpool lanes on specified links.

Demand Estimation

UMODEL, the demand model program, accommodates any user-specified travel demand model. Inputs include user-provided FORTRAN-coded subroutines, as well as zonal and matrix data. Outputs consist of trip tables or a calibration file that can be used by program ULOGIT.

ULOGIT, the logit calibration program, calibrates models for mode choice forecasting. Using a calibration file produced by UMODEL, it uses a maximum likelihood estimation technique to estimate parameters. Outputs include parameter estimates, plots and goodness-of-fit statistics.

AGM, the gravity model program is used to forecast trip distributions. Inputs may include zonal productions and attractions, zone-to-zone travel times and friction factors. Outputs may include calibration and forecasting results, with comparison plots of estimated and observed trip tables and trip length frequency distributions.

Matrix Operations and Evaluation

MBUILD, the matrix building program, constructs matrices from origin-destination survey cards or from calibration files, as output from UMODEL. Trip factoring or data recoding is accomplished through the use of user-specified lookup tables. Output consists of trip tables and edit summaries as well as detailed raw data.

UMATRIX, the transportation data manipulation program, performs arithmetic and functional operations on zone-zone matrix data and on zonal or link attribute data. Capabilities include addition, subtraction, multiplication, division as well as special functions such as transposition and square roots.

USQUEX, the matrix expander and compressor, is used to aggregate or disaggregate zone-to-zone data. By combining, breaking down, or rearranging matrix data, zones can be consolidated into districts or new smaller zones can be created. Inputs are matrices, and outputs include matrices and files readable by other programs.

UFMTR, the matrix formatting program has the capability to print or to plot the contents of zone-to-zone matrices. Outputs are reports and include row-by-row listings of table contents, selected row displays, plots of trip length frequency distributions.

UMCON, the matrix format conversion program, scales trip tables to forecasted zonal productions and attractions using Fratar-like scaling algorithm.

Transit Network Analysis

INET, the integrated network program, reads highway network and transit line data and writes a transit network description for use by the path building program (UPATH) and the passenger loading program (ULOAD) which can further analyze transit service options. Outputs include transit network plots and reports on transit characteristics such as route miles, travel times, energy consumption etc. In addition INET can be used in the determination of headways, construction of route schedules, and estimation of operating costs.

UPATH the transit path builder reads the network description from INET and outputs a description of shortest paths between all or selected zone pairs in the study area. The criteria for determining the shortest path include fare, distance, waiting times and transfer penalties. Output includes matrices of zone-to zone fares, distances or a combination of these and a transit path file for input to the minimum path summary program UPSUM.

UPSUM is the transit path analyzer which reads each minimum path from UPATH and outputs matrices providing information about trips on the minimum paths between all zone pairs in the system. This information includes transit running times by mode, walk time, out of vehicle time, transfers and total travel time, which are used as input to demand models in UMATRIX or UMODEL.

ULOAD, the transit passenger loading program, loads trips (described in trip tables output by MBUILD, UMATRIX or UMODEL) on the transit network using minimum paths. ULOAD summarizes, reports and plots the results. Outputs include a description of the origin destination demand for selected segments of the transit network.

USTOS, the station to station transit volume analyzer, reports passenger flows between selected stations in the system. Based on transit paths and trip tables, outputs include station-to-station volumes as well as summaries of access and egress volumes by mode for each station.

UFARE, the transit fare analyzer, computes inter zonal transit fares and associated out-of-pocket automobile access costs. By using previously created transit line descriptions (from INET) and path descriptions (from UPATH), UFARE can build transit cost matrices without rebuilding networks or paths. UFARE is also for revenue analyses and for developing inputs to mode choice models and trip distribution choice models which consider out-of-pocket costs to the trip maker.

2.3 Computer Requirements

UTPS runs under the following IBM operating systems : MFT, MVT, VS1, VS2, MVS, SVS, VM/SP AND VM/CMS. These operating systems are available only on IBM mainframes or IBM-compatible computers. UTPS is made available in two computer tapes. The Release tape contains program, JCL, data libraries and other datasets needed to run the modules. The Source tape contains the source code of these modules. The UTPS user must be familiar with the Job Control Language (JCL) and the text editor of the IBM machine in which the software is installed, to successfully run the various modules.

2.4 Network representation in UTPS

Information describing the urban area and the transportation system requires identifying that information with a numerical code to facilitate automated retrieval. To do this the area being studied is divided into small geographical areas called zones, and the boundaries of each zone are drawn on a base map to a convenient scale. A unique number, usually consecutive, starting with number one is assigned to each zone. The boundaries of zones are usually defined by geographical features or transportation facilities. It is desirable that the kind of activity within each zone be reasonably homogenous. The transportation system is represented by a network of links. The intersections of links are called nodes. Each node is assigned a unique number, starting with a number greater than the highest zone number. Node numbers need not be sequential. The resulting transportation network is a series of links connected to one another at nodes. The two node numbers at the ends of any link identify that link. A roadway is defined by the links along its path. Transit routes are identified by a series of node numbers along the route. For transit routes operating on roadways, the string of node numbers identifies the roadway nodes traversed by the transit route. The characteristics of the roadway represented by each link are coded as attributes of that link. The attributes usually include the length of the link, the vehicle capacity of the roadway, and the speed or time of movement along the link. Other attributes of the link or activity along the link may also be coded, such as adjacent land use, type of area in which the link is located, and the classification of the facility that the link represents. Attributes coded for transit routes usually include a route identifying number, the mode of transit service offered on that route (e.g., bus,rail) and the headway of the transit route.

The transportation network provides the path for movement from one zone to another in the study area. In order to accomplish this movement, each zone must be linked to the transportation facilities near it by a zone connector. The centroid of activity in the zone is located and given the same number as the zone and is treated as a node. The centroid can be at any location in a zone, not necessarily in the geographic center. The zone is connected to the network by a link from the zone centroid to a node in the network. This link is called the zone connector. All centroids must be connected to the roadway and/or transit network if there are to be trips to and from the zone.

HNET, is the UTPS highway network data building program, that creates or updates a highway network from link and node data cards. The link cards contain information about link distances, travel times, facility type, number of lanes and other characteristics. The node cards contain information on the X and Y coordinates of the nodes in the network. Outputs include a data file describing the highway network for other programs and printer plots of network and its associated attributes.

2.5 Structure of UTPS data files

As discussed in the previous article the UTPS software consists of many modules which perform various planning functions. Each module requires input data specific to that module. Each module outputs information specific depending on the function of that module. While many kinds of planning information are input to the various UTPS program modules, only some information is used for the purpose of this research. Table 2-1 lists the data files that are made use of for the purpose of this research and also indicates whether the file is an input or an output data file. The information contained in these files are explained in detail in this article. This planning information contained in these files are later converted to information that the traffic engineer would need for traffic simulation.

Table 2-1 UTPS data files

Data files	UTPS Input/Output
HNET Node data card	Input
HNET Link data card	Input
HNET SYSIN card	Input
O-D Trip table file	Output
INET &ROUTE card	Input

The various features of these files and their file structure are explained below.

HNET Node data card

The node card is an input file to the HNET module. This card specifies the node numbers and their X and Y coordinates, the geographical location of the node, the type of area where the node is located, the zone number which covers this node and other node attributes. It is specified in eighty column records. This card is used by HNET along with the link data card to generate the highway network. For the purpose of this research, it is sufficient to specify the node numbers and the X and Y coordinates of the node.

The format of the file is shown in table 2-2.

Table 2-2 HNET Node data card

Column #	Format	Name	Contents	Range
1	A1		Action code	blank or D
2-6	I5		Node	1 to Nodes
7			Unused	
8-15	F8.0	X	X Coordinate	$0 < X < 10000000.0$
16			Unused	
17-24	F8.0	Y	Y Coordinate	$0 < Y < 10000000.0$
25			Unused	
26-29	I4	Z	Zone	1 to 2500
30			Unused	
31-34	I4	Dist	User node data	1 to 16383
35			Unused	
36-39	I4	Super	User node data	1 to 16383
40			Unused	
41-42	I2	GL	Geographic Location	1 to 49
43			Unused	
44	I1	AT	Area type	1 to 5
45-72			Unused	
73-80	A80		Sequence number	

HNET Node Card Coding

HNET Node card coding rules are given below, only for those entries which are relevant to the research. The program writeup should be consulted for detailed explanation of other entries.

1. Nodes are numbered as explained in article 2.4. They must be entered in the appropriate columns as right-justified integers.

2. X and Y are the coordinates of the node. If X is coded, Y must be coded and vice versa.

3. The data formats follow FORTRAN coding conventions. For example, I4 would represent an integer with four digits, A3 would represent a character string with three characters, F8.2 would represent a real number with two digits after the decimal point.

HNET Link data card

Link information is input to HNET through the link data card which describes the basic link data for all links in the network. The link data card effects the addition and deletion of links and changes to the attributes of existing links. The format of the link data card file is shown in table 2-3.

Table 2-3 HNET Link card

Column	Format	Name	Contents	Range
1	A1		Action code	A/C/D/blank
2	A1		Focus code	1/2/blank
3-7	I5		ANODE	1 to Nodes
8-12	I5		BNODE	1 to Nodes
13-16	F4.0	D	Link distance	0 to 99
17-18	I2	TC	Toll class	1 to 20
19	I1	FT	Facility type	1 to 6
20	I1	AT	Area type	1 to 5
21-22	I2	CC	Construction code	
23	I1	LU	Land use code	0 to 9
24-27	I4	Z	Zone	1 to Zones
28-29	I2	GL	Geographic location	1 to 49
30	I1	UC	Use code	1 to 9
31	A1		Time/ speed	T/S/U/blank
32-34	F3.0	FFS/FFT	Free flow speed or time	>0 to 999
35-38	F4.0	OS/OT/UT	Observed speed or time or uniform time	>0 to 999
39-43	I5	C	Hourly lane capacity	1 to 32767
44-48	I5	OV	Vehicle count	0 to 99999
49	I1	NL	Number of lanes	1 to 9

Column	Format	Name	Contents	Range
50-51	I2	LG	Link group	1 to 99
52-72			B-to-A link values in same format as columns 31-51	
73-80	A8		Sequence number	

HNET Link card coding

HNET link card coding rules are given below only for those entries which are relevant to the research problem. The reader should consult the HNET program writeup for detailed explanation of other entries in the link card.

1. Action code A,D and C respectively is interpreted by HNET to add, delete and change the description of the link that is described by this particular card.

2. Focus code is interpreted as follows :

1	Indicated action is to be performed for the A-B link only
2/blank	Indicated action is to be performed for both A-B and B-A links.

3. ANODE is the " FROM " node of the link whose attributes are given in columns 32-51 of the link card.

4. BNODE is the "TO" node of the link whose attributes are given in columns 32-51 of the link card.

5. D is the link distance in miles.

HNET SYSIN Card

This card is the HNET program control card. It specifies parameter keywords, option keywords and select keywords that control the HNET program execution.

There are many kinds of keyword statements. The &PARAM statement of HNET is the one that is used for this study. The "&" in &PARAM starts in column number 2. The keywords are specified as "keyword=value", and "&END" signifies the end of the keyword list. If more than one card is required for all the keyword equalities coded on a keyword statement, then the "&END" appears only on the last card of that statement. The parameter keyword ZONES specifies the number of zones in the network. For example ZONES=10 specifies 10 as the highest zone in the network. This parameter is used to specify the number of zone centroids and to differentiate between the zone centroids and the highway nodes. All highway nodes are numbered with a value greater than 10 in this case. The parameter keyword NODES specifies the highest permissible node in the network. For example NODES=300 specifies

300 as the highest node number.

The UTPS reference manual and the HNET program writeup should be consulted for detailed explanation of other parameters and options.

O-D Trip table file

Trip generation models estimate the productions from and attractions to each zone, whereas trip distribution models estimate where the trips originating from each zone will be destined. In UTPS, the module used to apply gravity type distributions is the AGM module, while other user defined trip distribution models can be applied using the UMODEL module. Given the productions, attractions, friction factors, K-factors and impedance matrix, the AGM model can output forecasted trip tables for up to eight different purposes. These trips can be daily trips, morning peak hour trips, evening peak hour trips etc. They can also include trucks and carpools. This trip table file is created as a binary file in UTPS.

The origin-destination trip table values must be converted into units of vehicles/hour. The binary files containing the trip interchange matrix must be converted to a file whose format is shown in table 2-4. This can be done using the UMCON module, which can convert binary files to records eighty columns in length.

The O-D file is in the form of a square matrix, whose dimension is dependent upon the number of zones in the network, as specified by the ZONES keyword parameter of the HNET SYSIN card. For example if the value of the ZONES parameter is 5 then the dimension of the O-D matrix file is 5x5. The value of the (i,j) cell in the 5x5 matrix would represent the trips in vehicles/hour distributed from the i^{th} zone to the j^{th} zone.

TABLE 2-4 O-D trip table file

Column #	Format	Description
1-4	I4	Trips from zone i to zone 1
5-6	2X	Blank
7-10	I4	Trips from zone i to zone 2
11-12	2X	Blank
13-16	I4	Trips from zone i to zone 3
17-18	2X	Blank
19-22	I4	Trips from zone i to zone 4
23-24	2X	Blank
25-28	I4	Trips from zone i to zone 5
29-30	2X	Blank

Column #	Format	Description
31-34	I4	Trips from zone i to zone 6
35-36	2X	Blank
37-38	I4	Trips from zone i to zone 7
39-40	2X	Blank
41-44	I4	Trips from zone i to zone 8
45	2X	Blank
46-49	I4	Trips from zone i to zone 9

Zone numbering should be consecutive, starting from one. Only a maximum of nine zones can be handled by the methodology. Hence the maximum dimension of the O-D matrix that can be handled by the methodology is 9x9. The reason for this limitation is explained in the fourth chapter.

INET ROUTE card

The transit lines are depicted by routes through sequences of nodes contained in the highway network. Transit lines in INET are mainly characterized by three components : Identification, headway, and route. These characteristics are all coded on &ROUTE cards using appropriate keywords. Each of the above characteristics are described below in detail.

Identification : A transit line is uniquely identified by its mode number (M) and its line number (L). A value of 4 for M, would indicate that the mode is a bus mode. Thus M=4,L=1 identifies the first line of the bus mode, whereas M=4, L=3 would identify the third line of the bus mode.

Headway : The actual headway (H) specifies the actual fixed time (in minutes) between consecutive vehicles servicing a line.

Route : The transit line's route is described with a sequence of node numbers (N) and a direction indicator (ONEWAY). For example, N=111,23,134,56 gives a transit line route which touches four nodes in the highway network. The highway network must contain all the links a transit line references. Another characteristic of a route is that it may be oneway or twoway. ONEWAY is a logical variable which denotes whether the transit service on a particular route segment is oneway or twoway in nature. Coding ONEWAY=T, indicates that the transit service on that particular route segment is oneway directional along the node sequence read from left to right. Also, for a transit line, a minus sign preceding a node number in the node number sequence, indicates that the node is passenger transfer point, i.e., a node where two or more lines intersect. These nodes are the only locations in the network where passenger demand activity can occur. For example coding M=4,L=9, N=-121,123,-216 denotes a bus transit line with a route segment that runs on links 121 to 123 to 216 and has possible transfer activity at nodes 121 and 216.

The "&" in &ROUTE starts in column number 2. The keywords are specified as "keyword=value", and "&END" signifies the end of the keyword list. The INET program writeup should be consulted for a detailed explanation of all the keyword options.

2.6 Summary

UTPS is a powerful transportation planning software tool. It provides a broad range of planning capabilities and is well suited to the evaluation of multiple alternatives. It permits consideration of many transportation system related factors including levels of service, capacity, environmental and economic impacts and system costs. In this chapter the functions of various program modules were discussed. The data file structure of five files was explained. The information contained in these five files will be used to develop the interfacing methodology. The next chapter is dedicated to explain the various features of the TRAF family of simulation models.

Chapter 3. Traffic simulation models (TRAF)

3.1 Introduction

Computer simulation is one of the most important tools of traffic engineering. If a traffic system is simulated on a computer by means of a simulation model, it is possible to predict the effect of traffic engineering and Transportation System Management (TSM) strategies on the system's operational performance, as expressed in terms of various measures of effectiveness (MOE). These MOE include average vehicle speed, vehicle stops, delays, vehicle-hours of travel, vehicle-miles of travel, fuel consumption and emissions. In addition the MOE provide insight into the effects on the traffic stream of the applied strategy. The availability of traffic simulation models greatly expands the opportunity for development of new TSM concepts and designs. Planners and engineers are no longer restricted by the lack of a mechanism for testing ideas prior to field demonstration.

Many TSM strategies effect the mode and route choice of trip makers. In order to test the effect of TSM strategies on trip patterns, it is necessary to analyze an area which contains a substantial portion of the routes that the trip makers may follow. Hence there is a need for a simulation model capable of representing traffic flow in large urban areas containing surface street networks and freeways, with reasonable computer usage requirements. This concept of a single integrated simulation systems which can provide the user with flexibility and ease of use, as well as optimize the efficiency of all computations, was conceived by the Federal Highway Administration (FHWA) in the mid 1970's. Subsequently FHWA supported a series of projects to implement this design and develop the software for TRAF.

This chapter is organized as follows : Article 3.2 discusses the component models of TRAF. In article 3.3, the salient features of NETSIM simulation model is discussed and in article 3.4, the salient features of the NETFLO 1 simulation model is discussed. The network representation procedure followed in TRAF is explained in article 3.5. The structure of the input dataset for NETFLO is explained in article 3.6 and the article 3.7 explains the structure of the input dataset for NETSIM. The computer requirements for using the TRAF system are listed in article 3.8.

3.2 Components of TRAF

TRAF consists of an integrated set of simulation models which, in aggregate, represent the traffic environment. The user can partition the analysis network into sub-networks, each of which can be analyzed at a different level of detail. Each component model of TRAF is designed to represent traffic on a particular physical environment (arterials, rural roads, freeways) at a specific level of simulation detail (microscopic or macroscopic). Microscopic simulation models represent movements of individual vehicles, including influences of driver behavior. The effects of very detailed strategies, such as relocating bus stations or changing parking restrictions may be studied with such models. Less detailed strategies, involving changes in circulation patterns, for example may be studied with macroscopic simulation models.

The ability to combine these models in a single analysis run is a major feature of TRAF. TRAF is and integrated software system which currently consists of five major component models and a variety of supporting programs. The simulation models of TRAF are :

- ROADSIM, a microscopic simulation model of traffic on a two lane, two way rural road.
- NETSIM, a microscopic simulation model of urban traffic.
- FREFLO, a macroscopic freeway simulation model.
- NETFLO 1, a detailed macroscopic simulation model of urban traffic.
- NETFLO 2, a less detailed macroscopic simulation model of urban traffic.

• FRESIM, a microscopic freeway simulation model (currently being developed)

The naming convention for these models is based on a combination of prefix and suffix. The prefix indicates what kind of a network is being simulated. The prefixes NET, FRE and ROAD are for surface street network, freeway network and two lane road network, respectively. The suffixes SIM and FLO are for microscopic simulation and macroscopic simulation respectively. The FREFLO, NETFLO 1 and NETFLO 2 are distributed as a group for use in analyzing transportation corridors and together go by the name of CORFLO.

3.3 NETSIM

NETSIM applies interval-based simulation to describe the traffic operations. The model treats every vehicle as a distinct object, which is moved every second, and every variable control device (traffic signals) and events are updated every second. Each vehicle is also identified by category (auto, carpool, truck, bus) and by type. Up to sixteen different types of vehicles, with different operating and performance characteristics can be specified, defining the four categories of vehicle fleet. In addition the behavioral characteristic of drivers (passive, aggressive) can be assigned to each vehicle. The kinematic properties of the vehicle (speed, acceleration) are also specified. Turn movements are assigned stochastically, as are its queue discharge headways, freeflow speed and other behavioral attributes. Consequently each vehicle's behavior may be simulated in a manner reflecting real world processes.

Each time a vehicle is moved its position, both lateral and longitudinal on the link and its relationship to other vehicles nearby are recalculated. Its speed, acceleration and status (free flowing, queued) are recalculated. Actuated signal control and interaction between cars and buses are explicitly modelled).

Vehicles are moved according to car following logic, response to traffic control devices and response to other demands. For example, buses must service passengers at bus stops ; hence their movements differ from those of private vehicles. Congestion can result in queues extending throughout the length of the link and blocking the upstream intersection, thus impeding the traffic flow. Pedestrian traffic can delay turning vehicles at intersections. Table 3-1 summarizes the various features of the NETSIM model. Table A-1 lists the various MOE that can be obtained from NETSIM.

TABLE 3-1 Major features of NETSIM and NETFLO 1

Characteristics	NETSIM	NETFLO 1
Fleet components	Buses, Carpools, Cars, Trucks	Buses, Carpools, Cars, Trucks
Load Factors (passengers/veh)	YES	YES
Turn Movement	YES	YES
Bus Operations Paths Flow volumes Stations, dwell times, routes	 YES YES YES	 YES YES YES
Trucks Carpools	YES YES	YES YES
H.O.V Lanes	YES	YES
Queue discharge distribution	YES	YES
Detailed approach geometry	YES	YES
Number of lanes per approach	7	6
Incidents/ temporary events	YES	Blockage Factor
Traffic Assignment	NO	YES

3.4 NETFLO

NETFLO is an event based simulation model of traffic operations. The traffic stream is modelled explicitly; each vehicle on the network is treated as an identifiable entity. Each vehicle is identified by type (auto, carpool, truck, bus) and a driver behavioral characteristic (aggressive, passive) is assigned. In addition its kinematic properties (speed, acceleration) are specified as well as its status (queued, free flowing). Turn movements are assigned stochastically, as are it free flow speed, queue discharge headways and other behavioral attributes.

Each time a vehicle is moved by the program logic, its position (both lateral and longitudinal) on a network link and its relationship to other vehicles nearby is determined. Actuated signal control and bus-auto interaction can be modelled in NETFLO. Most conditions experienced in an urban traffic environment can be realistically described. NETFLO model consists of NETFLO 1 and NETFLO 2. Both these models produce similar MOE, but the NETFLO 2 model produces simulation results at a lower lever of detail than NETFLO 1.

This treatment of traffic environment by NETFLO appears to be comparable to that of the NETSIM microscopic traffic simulation model. The NETFLO model differs in detail from NETSIM in many respects. The most important difference is the level of detail of the individual vehicle movements. NETSIM moves each vehicle, each second according to a car following logic. NETFLO on the other hand moves each vehicle intermittently (i.e., whenever an event occurs) and moves that vehicle as far downstream as possible in single jump. No car-following logic is employed. Hence NETFLO does not generate detailed vehicle trajectories. Apart from having the capability to simulate traffic conditions NETFLO also can perform traffic assignment. This feature has been incorporated in NETFLO so as to extend the potential user group of this model to include planners as well as traffic engineers. Table 3-1 summarizes the salient features of the NETFLO 1 model. Table A-2 lists the various MOE that can be obtained from NETFLO models.

3.5 Network representation in TRAF

The traffic environment must be specified by the user to exercise the TRAF models. The traffic environment consists of the following :

- Topology of the roadway system (in the form of link-node diagram)
- Geometrics of each roadway component
- Channelization of traffic (left, through, right, buses, carpools, etc.)
- Motorist behavior which determines the operational performance of vehicles in the system (acceleration, deceleration, yellow light response, etc.)
- Traffic control devices (stop, yield, signal timing, detectorization)

- Traffic volumes entering the roadway system
- Turning movements or origin-destination data
- Transportation modes (cars, carpools, buses, trucks)
- Specification of bus system (routes, stations, frequency of service)

The physical environment is represented as a network comprised of nodes and unidirectional links. The nodes of the network generally represent urban intersections. The nodes are given unique numbers, not exceeding 750. Entry and exit nodes are given 8### numbers, where ### is any combination of three numbers from 0 to 9. Traffic enters and exits the network through these nodes. The nodes between the entry nodes and the intersection nodes are called buffer nodes. The traffic flow on a link is from it's upstream node to it's downstream node. The characteristics of the link such as it's length, the number of lanes, the nodes of the links receiving the turning movements are also specified. Turning movement percentages are also specified. Traffic control at a node as either signs or signals can be specified. Traffic volumes in vehicles/hour entering the network through the entry nodes are also specified.

Bus paths are specified as starting from an 8### node, traversing a sequence of intersection nodes and termination in another 8### node. Bus stops are identified by the upstream and downstream node numbers of the links in which they are located. Each bus stop is given a unique number. Bus routes are identified by the bus stop numbers. The headway information is also specified.

The entire network can be divided into one or more sub-networks, and each sub-network can be analyzed at a different level of detail. TRAF simulates the traffic and traffic control conditions of a network over a period of time. Consequently, the input section accommodates specifications which not only differ from one point on the network to another, but which may also change with time. The time varying portion of the simulation analysis is expressed as a sequence of time periods specified by the user. The input data specified by a user for a certain time period remains in force unless changed in a subsequent time period. The user may specify up to nineteen time periods. For each such time period, the user must specify those exogenous conditions which apply during the time period. Hence the input stream consists of a sequence of blocks of data records, each block defining the conditions which apply for one time period. Each block of data records for a time period is subdivided into sections of data records. Some sections define conditions on particular sub-networks; additional sections provide inputs for those specifications which must be specified for the global network (e.g., bus routes). Within each such section, the input stream consists of a sequence of record types. Each record type contains a specific set of data items; the record type identifying number is always entered on each record. Records are also referred to as record types, cards and card types.

In addition to defining the time periods, the user must also identify the duration of time known as a time interval. A sub-network is brought into central computer memory and simulated once over each time interval. At the end of the time interval, all information pertaining to the sub-network is stored and the sub-network is removed from memory. The next sub-network is then brought in and simulated over the same interval. The process is repeated for the next time interval until the requested duration of the run is reached.

The card types required for the NETFLO 1 and the NETSIM models are discussed next, as these models are the ones used in the research.

3.6 NETFLO 1 CARD TYPES

Table 3-2 shows the card types required to specify a network that is to be simulated using the NETFLO 1 model. The requirements listed in this table are for the first time period only.

TABLE 3.2 NETFLO 1 Card types

Card type	Description	NETFLO 1
Blank	Comment	Optional
00	Title	Required
01	Identification	Required
02	Run Control	Required
03	Time period	Required
04	Time step control	Required
05	Output options	Required
10	Link names	Optional
11	Urban link characteristics	Required
15	Freeway link characteristics	N/A
21	Urban Street Turning Movements	Required
26	Freeway Turn Movements	N/A
27	Freeway Incident specifications	N/A
34	Freeway Parameters	N/A
35	Sign or pre-timed control nodes	Optional
36	Sign or pre-timed control codes	Optional
39	Actuated controller specifications	Optional
40	Actuated Phases	Optional
41	Phase Operations	Optional
50	Entry link volumes	Optional
51	Source/Sink volumes	Optional
52	Load factors	Optional

Card type	Description	NETFLO 1
54	Short term events	N/A
150	Bus dwell time distribution	Optional
170	Model data delimiter	Required
175	Traffic assignment parameters	Optional
176	Origin-destination trip table	Optional
177	Internal centroids	Optional
185	Bus station parameters	Optional
186	Bus station dwell times	Optional
187	Bus route paths	Optional
188	Bus routes	Optional
189	Bus flows	Optional
195	Node coordinates	Optional
196	Link geometrics	Optional
210	Time period delimiter	Required

Each of these records are used to describe a particular characteristic of the traffic environment that is to be simulated using NETFLO 1. A detailed explanation of the information specified in these records is explained in the TRAF user reference guide.

3.7 NETSIM CARD TYPES

Table 3-3 shows the card types that are used to represent the traffic network using the NETSIM simulation model. The requirements listed in this model are for the first time period only.

TABLE 3-3 NETSIM Card types

Card type	Description	NETSIM
Blank	Comment	Optional
00	Title	Required
01	Identification	Required
02	Run control	Required
03	Time period	Required
04	Time step control	Required
05	Output options	Required
10	Link names	Optional
11	Urban link characteristics	Required
21	Urban street turning movements	Required
22	Conditional turning movements	Optional
35	Sign or pre-timed control nodes	Optional
36	Sign or pre-timed control codes	Optional
43	Actuated approach configuration	Optional
44	Signal coordination	Optional

Card type	Description	NETSIM
45	Traffic movements	Optional
46	Detectors	Optional
47	Phase operations	Optional
48	Pedestrian actuations	Optional
50	Entry link volumes	Required
51	Source/Sink volumes	Optional
52	Load factors	Optional
54	Short term events	Optional
55	Long term events	Optional
56	Parking activity	Optional
58	Vehicle specifications	Optional
60	Environmental tables	Optional
90	Link aggregations	Optional
140	Turn calibration data	Optional
141	Spillback, lagger, vehicle length	Optional
142	Acceptable near side gap	Optional
143	Acceptable far side gap	Optional
144	Amber phase response data	Optional
145	Left turn gap	Optional
146	Pedestrian delay	Optional
147	Freeflow speed percentages	Optional
148	Short term event duration	Optional
149	Queue discharge headways	Optional
150	Bus dwell time distribution	Optional

Card type	Description	NETSIM
170	Model data delimiter	Required
185	Bus station parameters	Optional
186	Bus station dwell times	Optional
187	Bus route paths	Optional
188	Bus routes	Optional
189	Bus flows	Optional
210	Time period delimiter	Required

Each of these records are used to describe a particular characteristic of the traffic environment that is to be simulated using NETSIM. The information that is coded in these records are explained in detail in the TRAF user reference guide.

3.8 Computer requirements

Simulation using the TRAF family of simulation models is performed at the microcomputer level. The minimum requirements for running the simulation models are a 80386/80387 class machine with at least 4MB of free extended memory. EGA graphics display capability is required to utilize the static and animated graphics capability of the TRAF software system.

3.9 Summary

This chapter provides an overview of the component models in TRAF. The major features of NETSIM and NETFLO were discussed. The network representation procedures in TRAF was explained. The card types needed for the NETFLO and the NETSIM simulation models were listed. The information contained in these card types are utilized in the development of the methodology. The next chapter explains the methodology developed to interface UTPS planning data and TRAF simulation data.

Chapter 4. Methodology development

4.1 Introduction

This chapter explains the methodology developed in developing the interface between planning and simulation using UTPS and TRAF. The research objectives are explained in article 4.2. Article 4.3 provides a detailed explanation of the methodology. The steps to be followed in implementing the procedure is explained in article 4.4. Article 4.5 explains the capabilities and limitations of the interface methodology.

4.2 Objectives

As mentioned in chapter one, transportation planners and traffic engineers use various mathematical and simulation tools to perform planning and simulation respectively. While the goals of planners and engineers are different, information used by them are interrelated, though in different form and format. This difference in the representation of the transportation system by planners and engineers prohibits them form sharing information for the same area being studied. Currently the planner and engineer collect data independently for planning and simulation purposes respectively. This leads to duplication of effort to collect information in different form and format. The main objective of the research is to develop a methodology to convert the planning information into a form that can be used by the traffic engineer for simulation purposes, with no or little modification. Though the methodology is developed based on the requirements of the UTPS planning software and the TRAF simulation software, it can easily be adapted to other planning and simulation tools as well. The overall research objectives can be classified into two, namely :

1) Interfacing UTPS planning data with TRAF-CORFLO macroscopic model.
2) Interfacing UTPS planning data with TRAF-NETSIM microscopic model.

Though the two objectives are different, the various features of the TRAF simulation models make it possible to develop one single methodology to achieve them. Article 4.4 explains the procedures to be followed while implementing the methodology to achieve the two above stated objectives.

The next article explains in detail how the information needed for simulation using TRAF can be obtained from the UTPS planning information.

4.3 Methodology Development

As mentioned in the second and third chapters, the transportation network is represented in UTPS and TRAF in different forms. Article 2.5 described the UTPS planning files that are essential to develop the methodology. Articles 3.5 and 3.6 described the various record types needed to represent the traffic network for simulation using NETFLO 1 and NETSIM models respectively. The following paragraphs explain how the information needed by the TRAF records can be obtained from the UTPS planning information.

TRAF-Run title

Record type 00 is used to provide a title for the simulation run. Default information informing the user that the data set is created by an interface program is provided. Subroutine REC00 is used to create records of type 00.

TRAF- Run Identification

Record type 01 is used to describe the name, the date of the simulation run, the name of the agency and an optional run identification number. Default values for name and date are provided. Subroutine REC01 creates TRAF records of type 01.

TRAF- Run control

Record type 02 is used to control the flow of TRAF model execution. Information such as which model to execute, units of measurement, beginning time of simulation, fill time are provided. Subroutine REC02 creates TRAF records of type 02.

TRAF-Time period specification

Record type 03 is used to specify the time period for simulation. The TRAF system describes the changing conditions that prevail over a roadway network.

The system allows the partition of the simulation time into series of time periods of varying durations. The default values provided by the methodology are explained in article 4.4. Only one time period can be handled by the methodology. Subroutine REC03 creates TRAF records of type 03.

TRAF-Time intervals

Record type 04 is used to specify the time interval duration. The time period is subdivided into series of time intervals. The time interval duration is typically the same as the duration of one signal cycle length. The time period must be an integral multiple of the time period duration. The methodology provides default values for time interval. Subroutine REC04 creates TRAF records of type 04.

TRAF- Reports and graphics

Record type 05 is used to specify output options for generating graphic files, and simulation statistic reports. Subroutine REC05 provides default values for these options and creates TRAF records of type 05.

TRAF-Urban link characteristics

Record type 11 is used to specify the urban link characteristics of the traffic network. The similarities in the representation of the link characteristics of the UTPS network and the TRAF network, provides the first opportunity to interface these two systems. Network representation procedures in UTPS was discussed in article 2.4 and network representation procedures in TRAF was discussed in article 3.5.

In TRAF a link is represented by it's upstream and a downstream node number, it's link length, the nodes receiving the link's left turn, through, right and diagonal turn movements. The methodology developed to obtain this information from the network representation information of UTPS is mainly based upon the information contained in the HNET link card file, HNET Node card file and HNET SYSIN file. The format and content of these UTPS files have been discussed already in article 2.5.

In UTPS, while coding the transportation network, all the zone centroids are numbered first and then the internal nodes are numbered. The "ZONES" keyword parameter in HNET SYSIN file specifies the maximum zone number in the network. A node with a node number greater than the value specified in the "ZONES" parameter is a highway node. In UTPS the zone centroids are nodes where the trips from that zone can be thought of as originating.
Trips disperse from the zone centroids through centroid connectors to the highway nodes, thus loading the network.

On the other hand, in TRAF, the traffic volume enters the network by means of entry links and exit the network by means of exit links. Entry and exit nodes in

TRAF are differentiated from internal nodes by means of node numbers greater than 8000. Traffic enters the network on (8###,###) links and exits the network on (###,8###) links. The nodes in between the entry nodes and the intersection nodes are the buffer nodes. The "###" after the "8" represents any arbitrary combination of digits from 0 to 9. The "###" symbol represents any valid node number for internal nodes.

Since the centroid nodes in UTPS can be considered as nodes from where the zone traffic originates and the buffer nodes in TRAF can be considered as nodes through which the traffic enters the network, the methodology treats the centroid nodes in the UTPS network as equivalent to the buffer nodes of the TRAF network. But the UTPS network does not have a nodes whose characteristics can be considered as equivalent to the 8### nodes of the TRAF network. To solve this problem new nodes with a node number of (8000+zone number) are created and a new links with upstream node (8000+zone number) and a downstream node of (zone number) are established for each zone centroid. By creating the 8### numbered nodes, which are absent in the UTPS network, compatibility between UTPS and TRAF network is established, which would enable creation of other TRAF record types.

The information about the first link contained in the HNET link card file such as it's upstream node number, the downstream node number, the distance of the link in miles, and the number of lanes is first considered. The units of the link distance is converted to feet as required by TRAF. The number of lanes in the link is stored. The HNET link card file contains information on the upstream and downstream nodes of the individual links, the focus code for each link indicating whether the link is a one-way or a two-way link, and the link distance in miles. From the HNET link card file, one can identify for each link, the outgoing links and their node numbers. Then, as explained in the previous paragraph, if the ANODE of the link is less than the "ZONES" parameter specified in the HNET SYSIN card, it is a zone centroid. Therefore a new link with an upstream node number of (8000+ANODE) and a downstream node number of ANODE is created, to represent the TRAF entry links. Depending on the focus code, one way or two way links are created. This is done for all the links in the HNET link card file and is stored in the LINK.TMP file. But since the link card may contain more than one link with the same ANODE, duplicate links with the same ANODEs of the 8### type may be created. Therefore this information is sorted to create a file with unique ANODE and BNODE pairs. This file is named as LINK1.TMP. Another file, LINK2.TMP which is identical to LINK1.TMP is also simultaneously created for future use. In summary LINK1.TMP contains all the links which would be needed to represent the TRAF network.

In TRAF, for each link, the nodes which receive the turning movement traffic also needs to be represented. The X and Y coordinates of all the nodes in UTPS network including the zone centroids are contained in the HNET Node card. But since there is no equivalent node in UTPS to represent the TRAF 8### nodes coordinate values for these nodes need to be created. The location of the 8### nodes in the TRAF network is important since these 8### nodes can be receiving nodes for some links. So a new node card is created (NEWNODE.CRD) which contains the node numbers and X and Y coordinates of all the nodes in the TRAF network including the 8### nodes. Since the program has to understand the location of these 8### nodes, all 8### nodes have been placed to the left of the corresponding zone centroids.

Now the process of finding the nodes that receive the turning movements begins. The LINK1.TMP file contains all the links that need to be represented int the TRAF network. The first link in LINK1.TMP file is considered. The NEWNODE.CRD is searched to determine the X and Y coordinates of the ANODE of the link. Similarly, the X and Y coordinates of the BNODE of the link are determined. Then for this link (ANODE,BNODE), the node numbers of outgoing links are found by searching all the links of the LINK2.TMP file for links with BNODE as their upstream node. All the outgoing nodes for this link are stored in an array. Now, the X and Y coordinates of each of the outgoing nodes are found from the NEWNODE.CRD and stored in arrays. With the X and Y coordinates of ANODE, BNODE and all the outgoing nodes available, the process of finding the nature of the turn movement of the (ANODE-BNODE- Outgoing node) set of nodes begins. For this purpose a comparison is made between the coordinates of the three nodes and using a look up table the nature of movement is decided as right, through, left, diagonal and opposing. The movement type for each outgoing node is stored in an array. Now, for a link (ANODE,BNODE), a set of outgoing nodes and their movement type is available. The array containing the movement type is sorted in the order of left turn, through turn, right turn, right diagonal and left diagonal. The opposing node for the left turn movement is assumed to be the through node. Finally a record type 11 is created for this link and written to "FILE11". After all the links in LINK1.TMP are processed by the above methodology, the "FILE11" will contain a set of records of type 11 that will be required to represent the traffic network. Subroutine REC11 is used to create TRAF records of type 11.

TRAF-Sign of pretimed control nodes

Record type 35 is used to specify the traffic controls used at an intersection. The stop sign, yield sign and pretimed signal controls are described in record type 35. Links are controlled by the nodes at the downstream end. For entry and exit links, a buffer node between the entry or exit node and the internal node should be controlled by perpetual green. No control is specified for the entry and exit node. Apart from specifying each of the internal nodes, the upstream node of all the approaches to the node that is controlled is also specified.

The methodology developed to obtain some of the information contained in this record type makes use of HNET link card file. The ANODE and BNODE of all the links are put together in one array. This array is then sorted in ascending order of node numbers, retaining duplicate node numbers. This array is processed again to pick unique node numbers, eliminating duplicate node numbers. A NODE.TMP file containing all the unique node numbers which needs to be represented in record type 35 is created. As previously mentioned the LINK1.TMP file contains the ANODEs and BNODEs of all the links of the TRAF network. This information in LINK1.TMP file is used to find approaches to intersections. For each node in the NODE.TMP file, a search is conducted in the LINK1.TMP file to find if there are any links with BNODE equal to the node in question. If any such link exists then the ANODE of the link is the approach link to the node in question. All such approach nodes to the intersection is held in an array. Finally a TRAF record of type 35 containing the node and the approaches is created. It should be understood that only certain information that are similar to UTPS and TRAF can be interfaced. Subroutine REC35 creates TRAF records of type 35.

TRAF- Control codes for signs/signals

Record type 36 is used to represent the traffic control codes such as yield sign codes, stop sign codes, pretimed signal control codes for each intersection.

Since at planning level the traffic control at intersections is not of much importance, the user is given the option to indicate his choice of control codes at intersections. But, the signal control at buffer nodes must always be specified as green. This permits the uncontrolled entry of traffic volume into the network through the buffer node.

The methodology obtains information on intersection nodes and their approaches from subroutine REC35. The HNET SYSIN card contains information on the highest zone number in the UTPS network. As explained earlier, these zone centroids are considered as buffer nodes in TRAF. In record type 36, the signal control for these buffer nodes is to be specified as green. The methodology scans only those intersection nodes with a node number less than or equal to the "ZONES" keyword parameter value. These are the buffer nodes of the TRAF network. Then for each buffer node, all the approach node numbers are obtained. If for a buffer node, the approach node number is a 8### node, then the sign control for that approach node number is specified as green. This is repeated for all the buffer nodes. Subroutine REC36 creates TRAF records of type 36.

TRAF-Model delimiter

This information is used to separate model and time period data. Within a time period the sets of data are separated by the type 170 record. Subroutine REC170 creates a suitable TRAF record of type 170.

TRAF- Traffic assignment parameters

Although traffic assignment models are not categorized as simulation models, they represent an interface between travel demand and actual traffic flows. The main purpose of the traffic assignment models is to convert origin-destination (O-D) trip tables into actual network loadings for processing by simulation models. In the TRAF system, two optimization techniques are used in equilibrium traffic assignment model (1) user's optimal assignment and (2) system's optimal assignment. The criterion for determining when user equilibrium has been reached is that no driver can reduce his journey time by choosing a new route. The criterion for the system's optimization is the minimum total costs of the entire network. Results of the traffic assignment model will interface with other TRAF simulation models such as CORFLO. A new version of NETSIM with traffic assignment feature is being developed currently. A given O-D demand matrix is assigned over the specified network. The results of the traffic assignment are then transformed into link-specific turn percentages as required by the simulation models, which commence operation following the assignment process.

Record type 175 is optional in the input stream for the first time period if traffic assignment was requested on the type 02 record. It must me omitted if traffic assignment was not requested and appears in the input stream of the first time period only. Two impedance functions are available to evaluate the travel time on a link. These are the FHWA impedance function and the modified Davidson's queuing functions.

Entry #14 of record type 175 provides an option to create simulation result data sets from the results of the traffic assignment. This option creates records of type 21 which contain turning movements in percentages and it also creates records of type 50 based on the O-D values specified in record type 176. The methodology supplies default values for various traffic assignment parameters. Subroutine REC175 creates the TRAF record of type 175.

TRAF Origin-Destination trip table

Record type 176, is used to represent the O-D trip table matrix. The origin 8### node number is specified first, followed by pairs of destination node numbers (also 8###) and the traffic volumes in vehicle/hour travelling from the origin node to the destination nodes are specified.

This O-D data needed by TRAF is obtained from the UTPS O-D file. The O-D trip table obtained from UTPS is utilized to create record type 176. For example if the ZONES parameter has a value of 5, thereby indicating that there are five zones in the UTPS network, then the O-D table will be a matrix of 5x5 dimension. While representing the UTPS network, the zones must be numbered consecutively, starting from one. This ensures that the entry in the ith row and jth column represents the trips in vph travelling from the ith zone to the jth destination. The methodology first reads the ZONES parameter from the HNET.SYSIN file to determine the size of the O-D matrix. Then all the entries of the O-D matrix are read into an array, Then each row of the O-D matrix is considered, converting the row number into a origin node with node number (8000+row number) and writing it into a file REC176.TMP. Then for each column number which would represent a destination other than the origin node itself, the methodology creates a destination node number (8000+column number) and writes it into the REC176.TMP file. Then the element (i,j) of the UTPS O-D matrix is written to the REC176.TMP file. This process is repeated for all the rows and all the columns of the UTPS O-D trip table. Finally all the entries in REC176.TMP are read into an array. The elements of the array are then written to FILE176, which contains all records of type 176 that were created by the above mentioned method. It should be insured that the units of the entries in the origin-destination trip table are in vehicles/hour. Subroutine REC176 creates TRAF records of type 176.

BUS OPERATIONS

Bus operations in a TRAF network are described in terms of bus routes, paths, stations and flow rates. Each route is assigned a route number. This route is then used to identify a bus path, bus route and a bus flow rate. The bus path is the geometric path of nodes which the bus traverses as it travels through the network. The bus flow rate is the mean headway for buses which service a particular route number. The bus stations are defined in terms of the link they are on, the distance from the downstream node and their capacity (in number of buses). the average dwell time buses spend at stations is also specified.

In TRAF record types 185 through 189 are used to define bus operations. TRAF computes measures of effectiveness for buses on route specific basis. The delay and stops for buses are also included in the overall measures of effectiveness computed by TRAF.

In UTPS, INET is the transit network processing module. INET's principle task is to calculate transit running times. These times are necessary to calculate vehicle requirements and costs. Since transit speeds are usually related to the highway speed of the links that the transit vehicle traverses, INET computes transit speeds as a linear function of the highway speed.

The transit lines are depicted by routes through sequences of nodes contained in the highway network. Transit lines in INET are mainly characterized by three components :

- Identification
- Headway
- Route

These characteristics are all coded on &ROUTE cards using appropriate keywords. Each of the above characteristics are described below in detail :

Identification : A transit line is uniquely identified by its mode number (M) and its line number (L). A value of 4 for M, would indicate that the mode is a bus mode. Thus M=4,L=1 identifies the first line of the bus mode, whereas M=4, L=3 would identify the third line of the bus mode.

Headway : The actual headway (H) specifies the actual fixed time (in minutes) between consecutive vehicles servicing a line.

Route : The transit line's route is described with a sequence of node numbers (N) and a direction indicator (ONEWAY). For example, N=111,23,134,56 gives a transit line route which touches four nodes in the highway network. The highway network must contain all the links a transit line references. Another characteristic of a route is that it may be oneway or twoway. ONEWAY is a logical variable which denotes whether the transit service on a particular route segment is ONEWAY or TWOWAY in nature. Coding ONEWAY=T, indicates that the transit service on that particular route segment is oneway directional along the node sequence read from left to right. Also, for a transit line, a minus sign preceding a node number in the node number sequence, indicates that the node is a passenger transfer point, i.e., a node where two or more lines intersect. These nodes are the only locations in the network where passenger demand activity can occur. For example coding M=4,L=9,N=-121,123,-216 denotes a bus transit line with a route segment that runs on links 121 to 123 to 216 and has possible transfer activity at nodes 121 and 216.

The methodology to create TRAF bus operation records mainly uses the INET &ROUTE card to extract the required information. The methodology recognizes the description of bus paths in TRAF by means of 8### nodes, which are not present in the representation of transit lines in UTPS. In TRAF, each of the paths, of a twoway path are represented separately in two TRAF records, whereas in the &ROUTE card used to represent transit lines in UTPS, the ONEWAY parameter keyword specifies whether the path indicated by the sequence of nodes read from left to right is oneway or twoway. The methodology recognizes this difference in coding conventions and creates two different TRAF records for two way links.

One major assumption the methodology makes is in interpreting passenger transfer points in the INET &ROUTE card for suitable representation in TRAF records. As discussed above, in the &ROUTE card, a negative node number represents a passenger transfer point. Thus passenger transfer points are represented by nodes in UTPS. On the other hand in TRAF, bus stations are identified by the upstream and downstream nodes of the links in which they are situated and not on the nodes itself. Thus for example if the &ROUTE card in INET is coded as M=4,L=1,N=-1,2,-3,4,-5 then the methodology assumes that there are TRAF bus stations in links 1-2, 2-3, and 4-5 if the line is oneway and on 1-2,2-3,4-5,5-4,3-2 and 2-1 if the line is two way.

The following paragraphs will describe in detail the methodology developed to represent TRAF bus records from UTPS transit records.

TRAF-Bus station parameters

Record type 185 is used to represent information about bus stations. Bus stations are also called as bus stops. The bus stations are identified by station numbers. The location of the bus station is defined by what link it is on, by how far it's downstream end is from the downstream stopline and by its capacity for holding buses. Most of the information needed to represent bus stations in TRAF can be obtained from UTPS transit information.

The data in the first &ROUTE is read, and all the information is entered into arrays. Then each node in the node sequence is checked to determine if it is passenger transfer point. If the node is a passenger transfer point, then the upstream node number and downstream node number are found and written to the STOPS.ALL file. Depending on whether the ONEWAY logical parameter is true or false, the upstream and downstream node numbers are generated and written to the STOPS.ALL file. This process is repeated for the data contained after all &ROUTE cards. Since different transit lines may have intersecting routes, the STOPS.ALL file may contain duplicate node data. So the upstream and downstream node data of bus stations are read into arrays and processed to find unique pairs of upstream and downstream node numbers. This information is written into a file called STOPS.UNQ which contains all unique node pairs. This file is then read again to give numbers to the unique pairs, starting from one. These numbers represent the bus stop numbers and the unique node pairs represent the link in which these stops are located. Finally, a record of type 185 is created for each bus stop. Subroutine REC185 creates the records of type 185.

TRAF-Bus station dwell times

Record type 186 specifies the average time the bus spends in each bus station. Buses may also frequently bypass bus stations for lack of passengers to pick up or unload. This bypass percentage can also be specified. This record type may be input for each time period to reflect changes in mean dwell time over time.

The methodology supplies a default value e of 120 seconds for dwell times at each bus station. A default value of 20% is given to represent the percentage of buses which do not stop at an intersection for lack of demand. These values may be changed by the user. Subroutine REC186 is creates the records of type 186.

TRAF-Bus route paths

Record type 187 specifies the bus paths. Bus paths must enter the network from an entry node (type 8###) and travel internal nodes before exiting at an exit node (type 8###). The methodology developed to obtain bus path information from UTPS data is explained below.

The ZONES parameter is read from the HNET SYSIN card. The INET &ROUTE card is then read and the information is stored in arrays. Then depending upon the first and last node numbers describing the transit line in the INET &ROUTE card, the entry and exit nodes are created. This is done because in TRAF the bus paths must enter and exit through entry and exit nodes which are 8### nodes. Two files are created at this stage. REC187.NST contains node numbers of bus paths starting with an 8### node and continuing with a sequence of internal nodes and ending with and 8### node. All the entries in this file are positive. If the ONEWAY parameter is not true then another sequence of node numbers in reverse order is created and written to this file. The other file REC187.NEG contains the same node sequence information as the previously described file except that negative node numbers of INET &ROUTE card are retained for future use. Since the REC187.NST file contains information about all the bus paths, it is read again to give each path a route number. Information about the bus route number along with the sequence of nodes that describe the bus path is used to create records of type 187. Subroutine REC187 is creates the TRAF records of type 187.

TRAF Bus routes

Record type 188 describes each bus route by means of the bus stations at which it stops. The bus route is the unique series of bus stations which a bus stops at, as it traverses its route. Two bus routes may have the same bus path, but stop at different bus stations. This record must appear only in the first time period. It must appear in conjunction with record type 185, since it uses bus station numbers to identify the bus routes.

Information on all the bus stop numbers and the node numbers of the link in which they are located are contained in file FILE185. This information is read arrays. REC187.NEG which was created by the REC187 subroutine contains a sequence of node numbers which describe the bus path. Some of the node numbers in the node sequence that are negative represent the passenger transfer points in UTPS and therefore represent the existence of a TRAF bus station.

The upstream and downstream node numbers that would represent a bus station are matched with the information contained in FILE185 to find the exact bus station number that has the same upstream and downstream node numbers. This bus station number is stored in an array. This is the first bus station at which the bus stops in the route. The process continues to identify all other bus stations in the route. After all bus stations have been identified for one bus route, a record of type 188 containing the bus route number and the bus station numbers that describe the route is created. The process continues for all the bus paths described in REC187.NEG creating as many records of type 188 as there are bus routes. Subroutine REC188 is used to create this record type.

TRAF Bus flows

Record type 189 represents the bus headways (flow rates). This must be specified for all the routes. If record types 185 through 187 are missing, then this record type must not be specified. Bus flow rates for a route are defined in terms of mean headway between buses on that route. They are not defined in terms of a schedule which emits buses at particular clock times. This record type may appear in successive time periods to modify the flow rates. This may be used to generate higher flow rates in the rush hour period and lower flow rates in the post-rush hour periods.

The INET &ROUTE card is read and the headway information is stored. The headway specified in the &ROUTE card is in minutes. It is converted to seconds as required by TRAF. Depending upon whether the route is oneway or twoway, the route number and the headway in seconds are written into FILE189. Only nine routes can be specified in one record of type 189. The methodology is not capable of handling more than nine routes. Subroutine REC189 creates records of type 189.

TRAF Time period delimiter

Record type 210 is required to mark the end of input specification for a time period. It identifies the first section of the input stream for the next time period. The final record in the input stream must be of the type 210.

The methodology specifies that the time period is the last time period and that this record is the last record in the input stream. Subroutine REC210 creates a suitable record of type 210.

4.4 Methodology implementation

The methodology is implemented by means of a computer program written in Lahey Fortran 77 version 5.01. A listing of the program is shown in Appendix B. The procedures to be followed to implement the methodology is explained below. Instructions on installation and running of the software are given in the fifth chapter.

INPUT PREPARATION

The inputs to the interface program are the five UTPS files explained in the second chapter. These files, listed below should be prepared in the same format as explained in the second chapter. The input files needed are :

- HNET Node card file
- HNET Link card file
- HNET SYSIN file
- O-D trip table file
- INET &ROUTE card file

INTERFACE PROGRAM

Once the inputs are ready, the interface program can be run to implement the methodology. The sequence of procedures to be followed to interface UTPS data with TRAF-CORFLO and TRAF-NETSIM are explained below.

Interfacing UTPS and TRAF-CORFLO

As explained in article 4.2, interfacing UTPS data with TRAF-CORFLO is the first objective of the research. This is achieved as follows. The interface program is executed on the UTPS files. The program produces an output file. This output file has the following TRAF records 00, 01, 02, 03, 04, 05, 11, 35, 36, 170, 175, 176, 185, 186, 187, 188, 189 and 210. This program output file is used as an input file to execute the CORFLO simulation model. Specifically, the NETFLO 1 model is the model requested for simulation. As explained in table 3.2, the record type 21, which describes the turning movement percentages is required to be specified. But the interface program does not create this record from the UTPS planning data. The record type 50 is also not created by the program. Instead record types 175 and 176 are created. The traffic assignment feature of CORFLO model is utilized to create the turning percentage information of record type 21. The record type 176 specifies the origin-destination traffic volume information. The CORFLO model uses this information and the traffic assignment parameters provided in record type 175 to assign traffic to the network. This information is utilized by the NETFLO 1 model for simulation purposes.

The default values provided in record type 02 request the TRAF system to simulate the traffic environment described in the program output file using NETFLO 1 simulation model with traffic assignment option. As explained above, the traffic assignment feature is requested so as to create the turning percentages information. In record type 175 of the program output file, entry number fourteen requests that simulation records be written out into a file that is specified in record type 5. This file contains all the records that would typically be needed to simulate a traffic network, without requesting traffic assignment to be performed by the TRAF system. In otherwords, this file would contain record type 21 containing turning movement information and record type 50 containing traffic volume information. This file created at this stage will be later used in establishing an interface between UTPS and TRAF-NETSIM.

Figure 4-1 illustrates the procedure for implementing the UTPS-CORFLO interface.

In summary, the five UTPS files explained above are supplied as inputs to the interface program. An output file for program output is supplied. The program works on the UTPS files and creates an output file which would serve as the TRAF input file. This file is created with default values necessary to run the NETFLO 1 model and requests TRAF to perform traffic assignment. First traffic assignment is conducted to calculate the turning percentages and then the traffic network is simulated for a default duration of thirty minutes. The result of the simulation is contained in a TRAF output file. As mentioned earlier, a file containing record types 21 and 50 as well as other records needed for simulation is also created by the CORFLO model. This file will be used for establishing the UTPS-NETSIM interface. Thus starting from UTPS planning data, simulation was able to be performed using TRAF-CORFLO. This establishes an interface between UTPS planning data and TRAF-CORFLO, a macroscopic model. Various measures of effectiveness can be obtained for analysis.

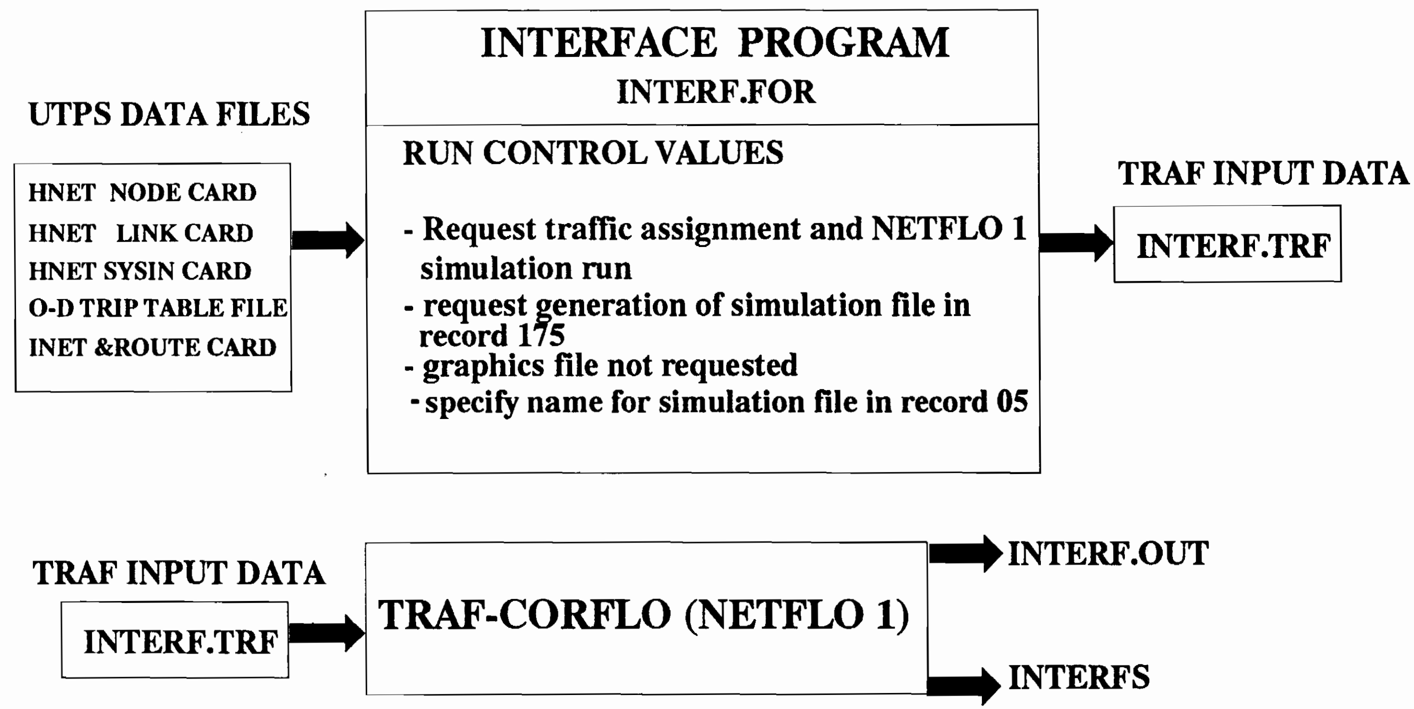

Fig. 4-1 UTPS-CORFLO INTERFACE

Interfacing UTPS and TRAF-NETSIM

The second objective is to interface UTPS planning data with the microscopic simulation model of TRAF, namely TRAF-NETSIM. To accomplish this, the file with simulation records output by the CORFLO model is utilized. This file contains all the records needed for simulation. It contains record types 00, 01, 02, 03 ,04, 05, 11, 21, 35, 36, 50, 170, 185, 186, 187, 188 and 189. The record type 21 in this file is created by the traffic assignment feature of TRAF-CORFLO. Record type 50 is created from the information contained in record type 176. Before establishing an interface between this file and NETSIM, certain additional information are to be supplied. The record type 02 in this file is to be changed to request NETSIM simulation instead of NETFLO 1 simulation. Also, before performing the UTPS-CORFLO interface, the interface program created the record type 11 describing the urban link characteristics. Since CORFLO is a macroscopic model, the lane channelizations were not required to be specified. But to run the NETSIM microscopic simulation model, the lane channelizations is required to be input. So the simulation file obtained from the TRAF-CORFLO interface is edited to provide information about lane channelizations in record type 11. After this is done, the file is ready to be supplied as an input to the NETSIM simulation model. The NETSIM model is executed to perform simulation for a default duration of thirty minutes and the simulation output is obtained. The simulation performed by NETSIM is at a more detailed level than the simulation performed by CORFLO. Thus an interface is established between the UTPS planning data and TRAF-NETSIM simulation model. Thus the second objective of the research is achieved.

Figure 4-2 illustrates the methodology sequence to be followed to establish the interface between the UTPS-CORFLO and the UTPS-NETSIM models. The program structure is illustrated in figure 4-3.

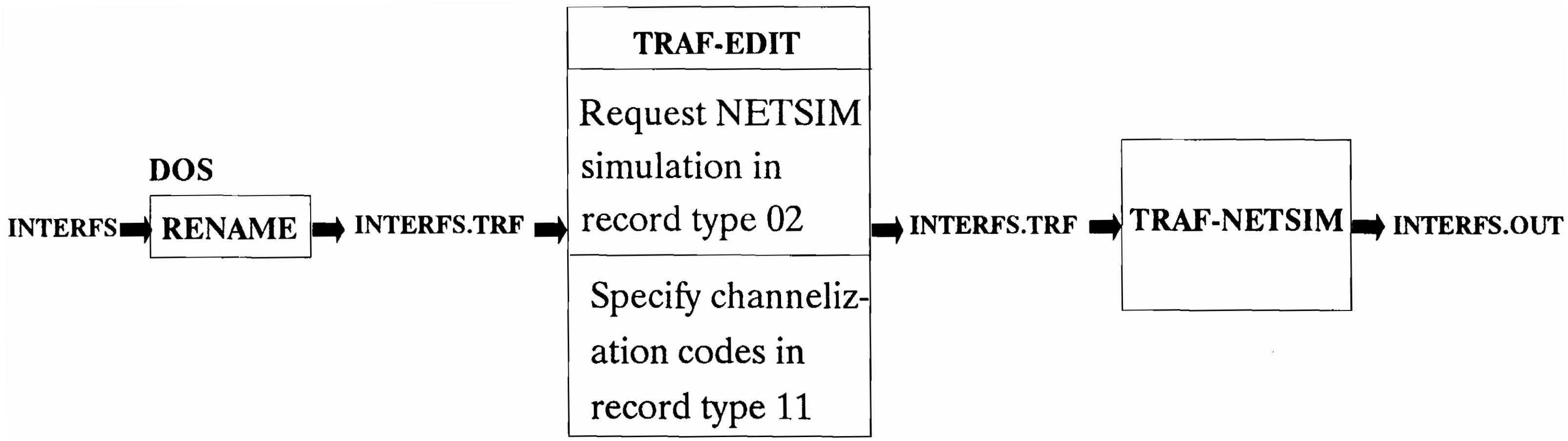

Fig. 4-2 UTPS-NETSIM INTERFACE

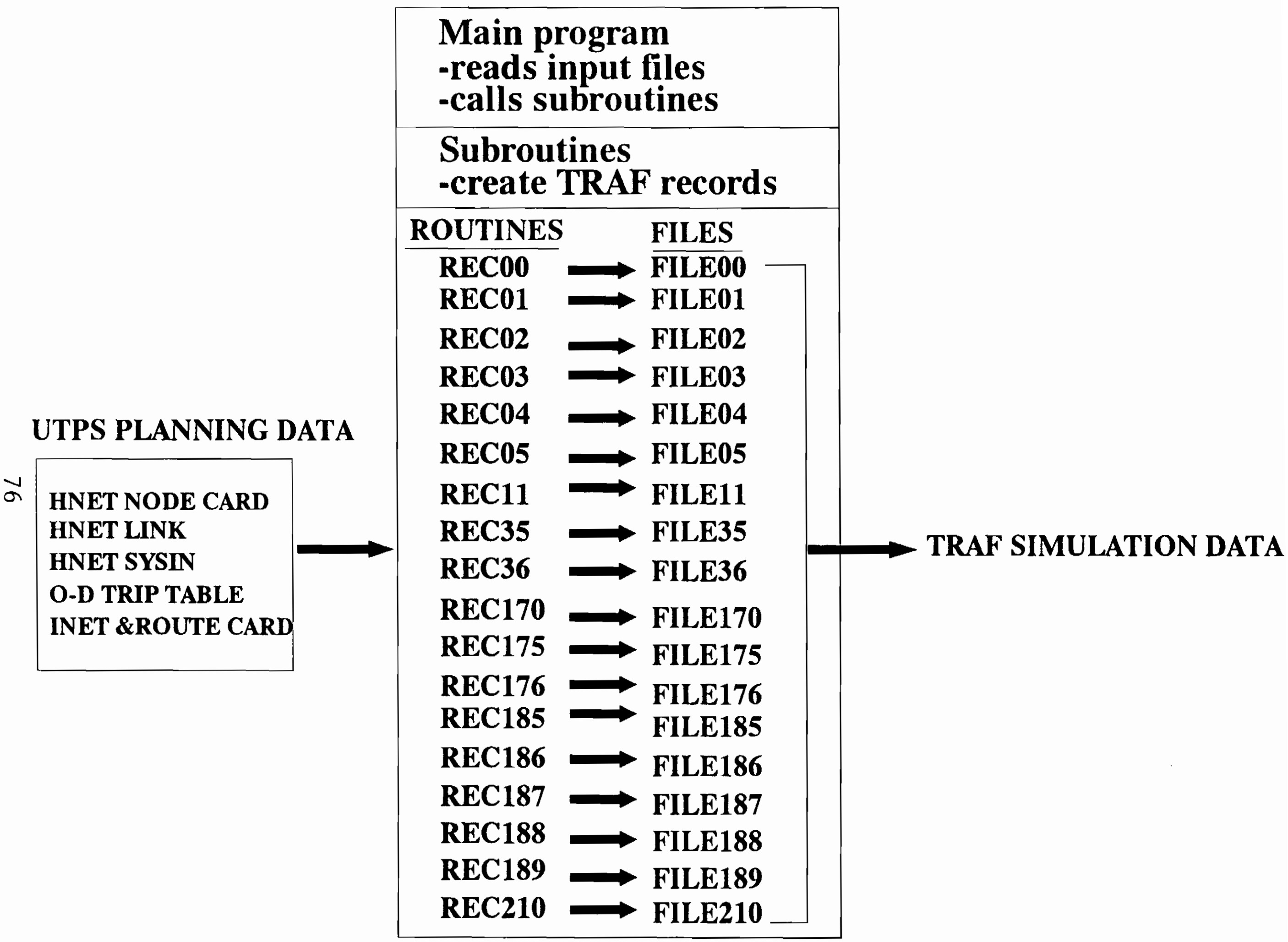

Fig. 4-3 INTERFACE PROGRAM

4.5 Assumptions and limitations

Certain assumptions have been made while developing the methodology. The interface program also has certain limitations. These assumptions and limitations are listed in this article.

1) For any TRAF link, whenever there is a left turn movement, then the opposing node is assumed to be the same as the through node. This may also be considered as a limitation.

2) In the UTPS HNET link card file, distances are coded in miles. The interface program converts them into feet. But in NETSIM the maximum link length can be only 4000 feet. This imposes a restriction that the UTPS links must not be more than 4000 feet.

3) Normally, up to nineteen time periods can be specified for simulation. Traffic characteristics can be varied in each of these time periods. If the methodology is implemented exactly as described, then the program is capable of simulating a network for only one time period. But if the program output is considered only as a file containing basic TRAF information, then it can be modified to simulate the traffic network for many time periods.

4) The output file from the program assumes a default time period of thirty minutes. This can be modified to simulate the traffic network for any duration.

5) While representing the UTPS network, the zones should be numbered consecutively beginning from one. If the zone numbering is not consecutive,

then the program would create incorrect records of type 176.

6) The program is not capable of handling sub-networks.

7) The output of the program does not contain X and Y coordinate information. This may be input by the user, if needed.

8) The assumption made in creating record type 35 is that all the intersections controlled by signs. After this file is created, the intersections can be signalized by specifying appropriate control codes.

9) Only nine zones can be handled by the program.

10) While specifying transit routes in the &ROUTE cards, the beginning node and the ending node must be zone centroids. The program is not capable of processing other internal nodes as starting and ending nodes for a route. This imposes a restriction that all transit services are restricted to start and terminate at zone centroids.

11) In TRAF bus stops are located on links, while in UTPS bus stops are specified by nodes with negative signs. The assumption made here is that if an UTPS node is negative then the TRAF bus stop is located at the preceding link.

13) The dwell times for buses at bus stations is assumed to be 120 seconds.

14) The program is not designed to handle source/sink nodes of TRAF.

15) In record type 50, the traffic volume entering the network is specified. The percentage of trucks and carpools has been given a default value of 0%. This can be changed by the user to specify the appropriate percentages.

4.7 Summary

This chapter explains the research objectives and discusses the development of the methodology in detail. The procedures for implementing the UTPS-CORFLO interface and the UTPS-NETSIM interface were explained. The assumptions and limitations of the interface program were discussed.

In the next chapter, a typical urban town network is used as an example to demonstrate the interface methodology.

Chapter 5. Methodology demonstration

5.1 Introduction

This chapter is intended to provide an example to demonstrate the methodology on a typical network of an urban town (UTOWN). The UTPS planning datasets that are required as inputs to the interface program are explained in article 5.2. Instructions for installing the interface software are given in article 5.3.

The software operating procedures are outlined in article 5.4. The results of the operation and outputs obtained are discussed in article 5.5.

5.2 Demonstration network

The Urban town network (UTOWN) that is used to demonstrate the methodology is shown in Figure 5-1. As shown in this figure, the network consists of five zones, forty two nodes and one hundred and twenty six links.

The HNET Node card file is used to input information regarding the node numbers and their X and Y coordinates. This file is presented in appendix C.

The HNET link card provides information on the links present in the network, whether they are one way or two way, the link distance and other link specific information. This file is presented in appendix C.

The HNET SYSIN file specifies parameters which control the HNET program. This file specifies that the highest zone number used is five, and other keyword parameters. This file is presented in appendix C.

The O-D trip table file contains forecasted trip table values in vehicles/hour. In UTPS, there are many modules which are used to perform various planning operations such as trip generation, trip distribution, modal split and traffic assignment. Based on the data available for the base year, UTPS can be used to forecast the traffic volume on a network for a future horizon year. The program module AGM is used to distribute the production and attraction between zones and create the trip table. Most of the output files created by UTPS modules are binary files. Parameters specific to each module, which control the operation of that module are the means by which the required output information is obtained. The parameters specific to each module are explained in detail in the program writeups. All program modules contain provisions for printing reports of information contained in the binary output files. The UTPS user must obtain the forecasted origin-destination information for the zones in a matrix format by running the trip distribution module. Since this matrix file is in binary form, it is to be converted using UMCON to conform to the format of the O-D trip table specified in the second chapter. This methodology can handle a maximum matrix size of 9x9. Since the zones are numbered consecutively, the matrix obtained will represent the trips distributed from one origin zone to other destination zones. The O-D trip table file is presented in appendix C.

The INET &ROUTE card file describes the transit routes in UTPS. This file is presented in appendix C.

These files are all created in the format explained in the second chapter. These files are names according to the DOS format of filename.ext, where filename can be a maximum of eight characters.

Figure 5-2 illustrates the same UTOWN network as represented by TRAF coding conventions

5.2 Software installation

Before installing the interface software, the TSIS software containing both CORFLO and NETFLO models must be installed. Instructions for installing the TSIS software can be found in the TSIS installation manual.

TSIS is a Traffic Software Integrated System, which contains TRAF-EDIT, the editor for preparing TRAF input datasets, the TRAF family of simulation models, GTRAF, the graphics processors for TRAF-NETSIM and GCOR, the graphics processor for CORFLO. All activities such as editing datasets to running the TRAF models can be performed from within this environment.

The "INTERF.EXE" is the executable interface program file. This is copied into the [drive]:\TSIS\TRAF\IO directory. This is the directory that contains the TRAF input and output files. All the UTPS files that are the inputs to the program must be present in this directory.

5.3 Software Operation

This article is intended to provide information on the sequence of tasks to be performed to utilize the maximum capabilities of the program.

As mentioned in the previous article the following files must be present at the same directory as the executable program file.

- HNET Node card file (NODE.CRD)
- HNET Link card file (LINK.CRD)
- HNET SYSIN card file (HNET.SYS)

- O-D FILE (OD.FIL)
- INET &ROUTE card file (INET.CRD)

The next step is to run the program. The program is executed by typing "INTERF" at the [drive]:\TSIS\TRAF\IO> prompt. When the program executes, it will prompt for the file names of the above mentioned five files as well as the file name of the output file. This output file, created by the program must have the filename extension as "TRF". This file is created by the interface program and is the input to the TRAF model. For example,if in response to the prompt for the output file name, the user enters "INTERF.TRF", then the file "INTERF.TRF" is created by the program. This program output file is presented in appendix D.

Now the TRAF-CORFLO interface is to be established. The CORFLO simulation model is executed, specifying the 'INTERF.TRF' file as the input file and 'INTERF.OUT' as the output file. The INTERF.TRF file contains all TRAF record types necessary to execute the NETFLO1 simulation model and to obtain the simulation output. Record type 02 in this file also contains information requesting both traffic assignment and NETFLO simulation to be performed and record type 05 contains information specifying the name of the simulation file to be generated. INTERF.TRF contains the following record types 00, 01, 02, 03, 04, 05, 11, 35, 36, 170, 175, 176, 185, 186, 187, 188, 189 and 210. But record type 21 which describes the turning movement percentages which is required for NETFLO 1 simulation during the first time period is not generated by the program. Instead the traffic assignment feature of the CORFLO model is used to generate the turning percentages. The UTPS origin-destination table is used to create TRAF O-D record type 176. The traffic assignment parameters are specified in record type 175. The O-D information contained in record type 176 is used in the assignment of traffic to the various links. Thus, traffic assignment is first performed and then using the turning movement percentages, the traffic simulation is performed to obtain various measures of effectiveness.

After running the TRAF-CORFLO model two output files are created : one is the INTERF.OUT file which contains the traffic assignment and simulation results generated by the NETFLO program. Since NETFLO 1 is a macroscopic simulation model, the simulation results obtained will not be at the same level of detail as that of microscopic models. Nevertheless, by performing TRAF-CORFLO simulation using the INTERF.TRF file, one objective of the methodology has been demonstrated, namely to interface UTPS and

TRAF-CORFLO. The output of the CORFLO simulation can be seen in the "INTERF.OUT" file. The INTERF.OUT file and the INTERFS file are presented in appendix D.

The second file generated by running the TRAF-CORFLO model is the "INTERFS" file. This file contains all the records that are required to perform traffic simulation. The results of the traffic assignment is present in this file as record type 21. Also the O-D information contained in record type 176 is converted into information for record type 50. Specifically, the "INTERFS" file contains the following record types : 00, 01, 02, 03, 04, 05, 11, 21, 35, 36, 50, 170, 185, 186, 187, 188, 189 and 210. Thus record types 21 and 50 have been added to and record types 175 and 176 are absent from this file. This file can be used to perform simulation using NETSIM. But before doing this, the user has to perform the following tasks :

1) Rename the "INTERFS" file to "INTERFS.TRF", as required by TRAF.

2) Change the eighth entry in record type 2, to 3 to specify that simulation is to be done using NETSIM.

3) Specify lane channelization codes in record type 11. In TRAF, the links can be channelized for left turn only, buses only, right turn only , carpool only, carpools and buses only or the links can be closed. To execute the

TRAF-CORFLO model, the channelizations are not input in record type 11. But to execute the TRAF-NETSIM model the channelizations have to be input in record type 11. This can be done using TRAF-EDIT, which is an editor to prepare the TRAF input datasets, or by using other editors. If for a particular link, the receiving links are only left or only right, each lane of the link must be channelized using appropriate channelization codes. After entering the channelization information, the "INTERFS.TRF" file is saved. File INTERFS.TRF is the input file for NETSIM. This file is presented in appendix E.

4) Now the TRAF-NETSIM model is ready to be run. The INTERFS.TRF file is specified as the input file and the TRAF-NETSIM model is executed.
The output file of the simulation is contained in INTERFS.OUT. This file is presented in appendix E.

This establishes an interface between UTPS and TRAF-NETSIM.

5.5 Discussion of results

As explained in the previous article, all the activities necessary for establishing the interface between UTPS and CORFLO and UTPS and NETSIM are easily performed in the TSIS environment. The TRAFEDIT editor can be used to modify the information contained in the input datasets to test many different traffic management strategies. Intersection nodes can be signalized by providing phasing information. The program output file should be considered as a generic TRAF input file containing basic information necessary to simulate the traffic network.

5.6 Summary

The foregoing discussion establishes the research objectives. Starting from UTPS planning datasets, the interface program generates TRAF-CORFLO input data set. Then, by executing the TRAF-CORFLO model with traffic assignment and simulation option, an interface is established between UTPS and TRAF-CORFLO. A simulation file with record types 21 and 50 is output by the CORFLO model. The run control record of this simulation file is modified to specify NETSIM model, channelizations are input in record type 11 and the TRAF-NETSIM model is executed. Thus by executing both the TRAF-CORFLO model and the TRAF-NETSIM model, simulation is performed at macroscopic as well as microscopic levels. Various measures of effectiveness can be obtained at these levels to analyze the impact of forecasted distributions on the existing transportation network.

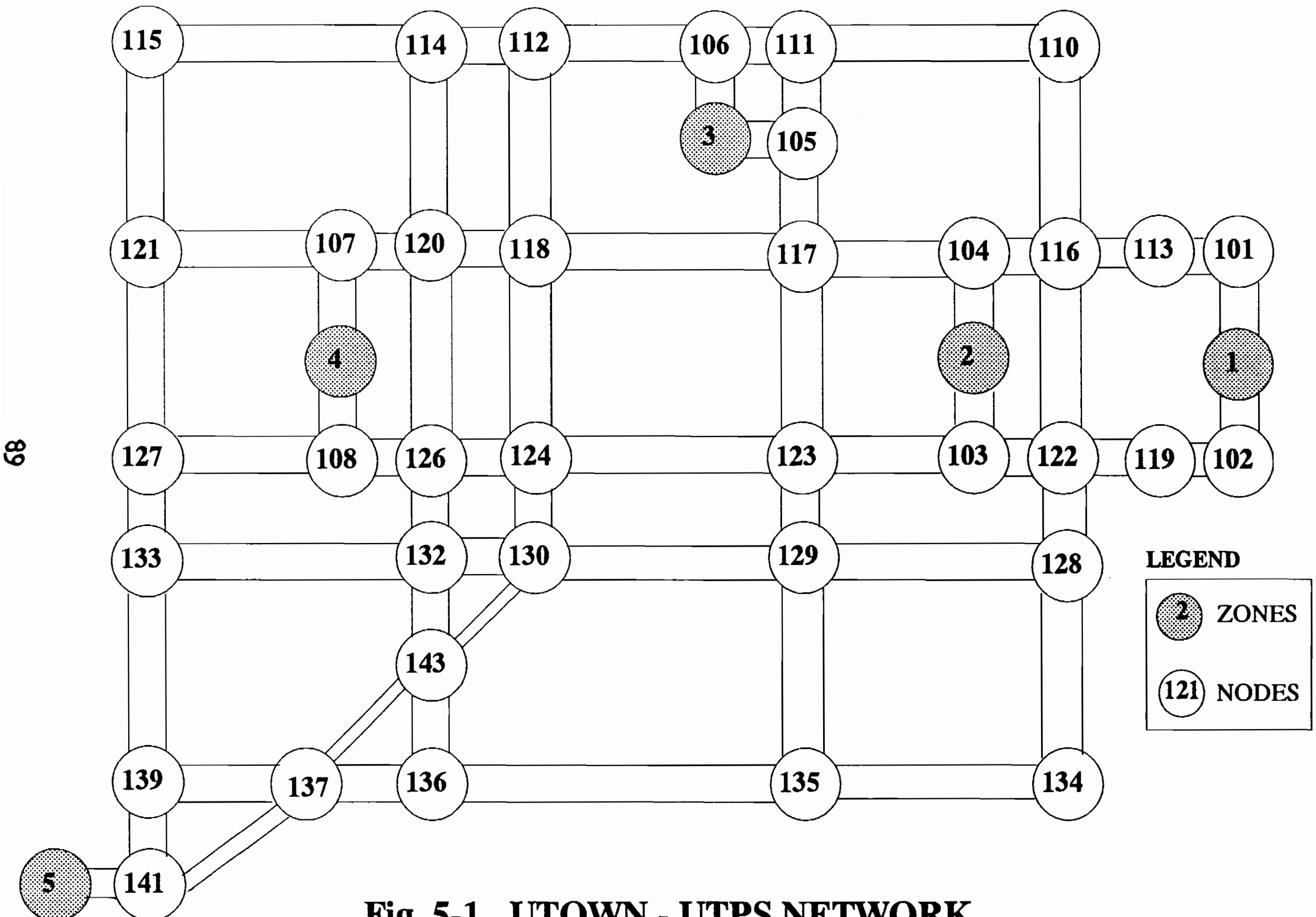

Fig. 5-1 UTOWN - UTPS NETWORK

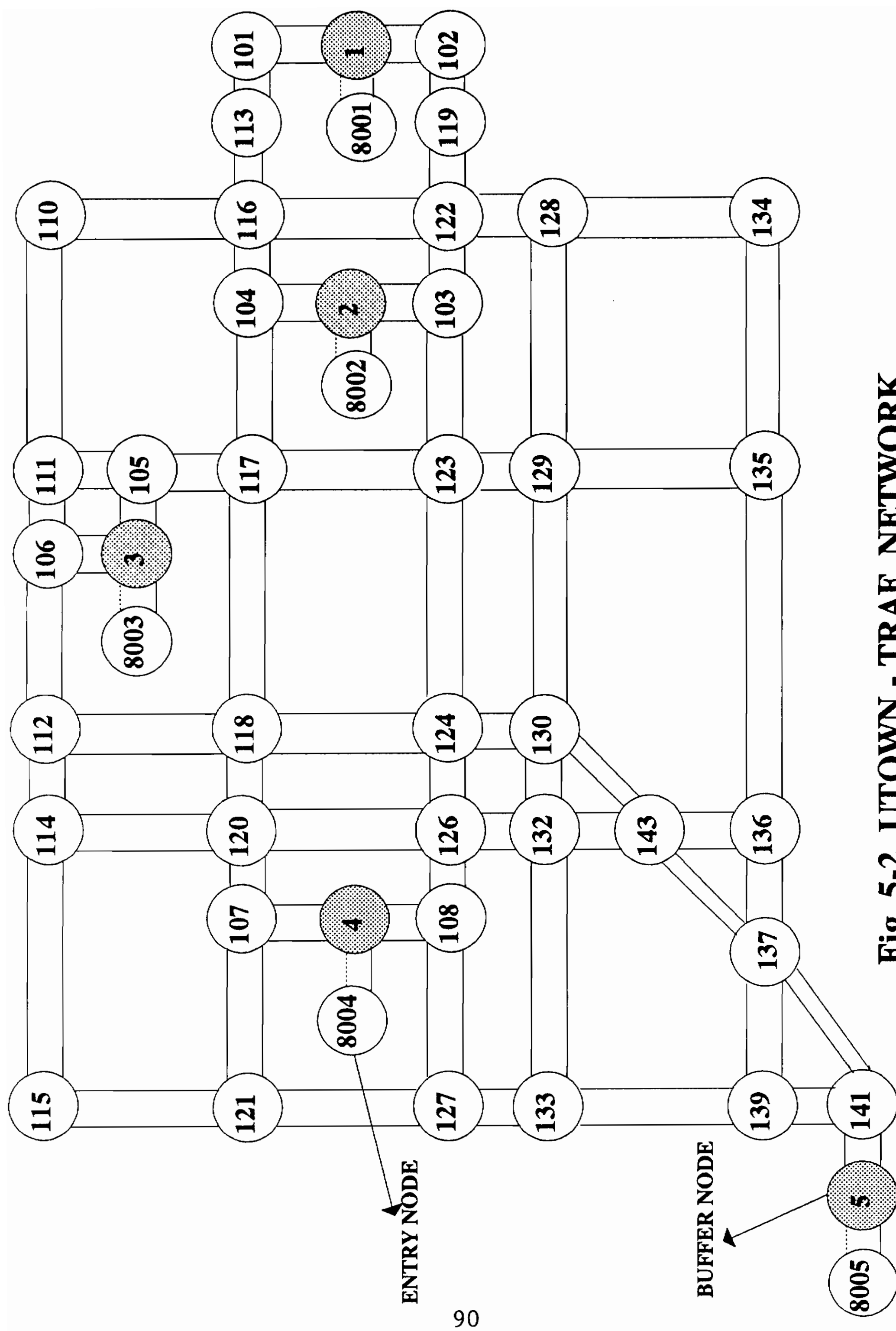

Fig. 5-2 UTOWN - TRAF NETWORK

Chapter 6. Conclusions and recommendations

6.1 Introduction

As mentioned in the previous chapters, the methodology can be utilized to interface UTPS datasets with CORFLO and NETSIM models. The methodology was demonstrated in the fifth chapter by testing it on a typical urban town network. This chapter discusses the benefits of the research methodology and provides recommendations for future enhancements to it.

6.2 Benefits

The main objective of this research is research is to establish an interface between planning and traffic engineering. Transportation networks are represented by planners and engineers in different ways. This prohibits them from sharing information for the same area being studied. This leads to duplication of effort to collect information for planning and simulation purposes respectively. The methodology developed, seeks to bridge the gap between planning information and traffic information, thus eliminating the need to prepare same data in two different forms.

This research methodology also provides an opportunity to approach planning and simulation of transportation networks as an integrated exercise rather than two separate exercises. The methodology provides many opportunities to the engineer to test various traffic management strategies without expending much effort. The user can modify the TRAF input files before running the simulation models. For example, the interface program creates record type record type 03 with default simulation time of 1800 seconds. This value can be changed to specify any required simulation time. The starting time for simulation in record type 02 has been given a default value of 07.15 AM. This can be changed to specify a different starting time for simulation. The program creates record types 35 and 36 with the default assumption that they are unsignalized nodes. The interface program assumes that all the nodes are sign-controlled. The user can change these information to provide signal controls to the intersection nodes and provide phasing information in record type 36. The purpose of the interface program is to create a generic TRAF file that can be used as input the TRAF model. Most of the information in this TRAF file can be changed to perform various analyses of traffic strategies.

Representation of the transportation network using nodes to represent the highway intersections and links to represent the existence of roadway between two nodes is fundamental to transportation planning and traffic engineering. The UTPS and TRAF have certain similarities and differences in the way the network is represented. The planner uses demographic data to predict the future trip distributions and link volumes in the network. The traffic engineer on the other hand is interested in evaluating the efficiency of the transportation system by means of various measures of effectiveness. By using the methodology developed, the performance of the network for future traffic volumes indicated in the origin-destination trip table, as measured by various measures of effectiveness can be estimated. This will aid the traffic engineer in understanding the performance of the network under future conditions and in adopting appropriate traffic strategies.

The methodology takes into account the similarities and differences in the representation of data in these two systems. It also uses the traffic assignment features of the TRAF models to generate turning movement information. Transportation planning and traffic simulation can be performed on an integrated basis using this software. The UTPS user can utilize the program to perform traffic simulation for various conditions as well.

This methodology, though developed using the UTPS and TRAF software, can be easily adapted to fit other software tools as well.

6.3 Recommendations

Some recommendations are given below to enhance the capabilities of the methodology.

1) The methodology can be adapted to make use of the traffic assignment feature of the upcoming version of NETSIM.

2) The methodology can be enhanced to create graphics file to make use of SNETG and ACORG.

3) The methodology also highlights the need for a integrated menu driven software for preparing input datasets for both planning and simulation. Such a software should be able to establish a correspondence between zone centroids of planning and dummy nodes of TRAF, and also be able to handle TRAF entry and exit nodes.

4) The interface program provides many default values. The program can be made interactive to request the user of information such as time period duration, time interval duration, starting simulation time etc., thereby reducing the editing effort by the user.

5) The methodology should be adapted for more popular planning software such as MINUTP, EMME/2 etc., which run on microcomputers. The interactive graphical preprocessors used in creating the data files that contain node and link specific information can reduce the time spent in creating the network.

APPENDICES

APPENDIX A

TABLE A-1 NETSIM measure of effectiveness

Link specific measures

Measure	Units
Travel	Vehicle miles Person miles Vehicle trips Person trips
Bus travel	Bus trips
Bus passenger travel	Person trips
Total travel time	Vehicle minutes Person minutes
Bus travel time Bus delay Bus moving time	Minutes
Mean speed Bus speed	Miles/hour, km/hr
Bus stops	Number of stops
Fuel consumed	Gallons, liters
CO emissions HC emissions NOx emissions	Kilograms/mile-hour

Bus station specific measures

Buses serviced	Number
Time bus station is empty	Minutes
Total dwell time	Minutes

TABLE A-1 (Continued)

Measures	Units
Bus route specific meaures	
Bus travel on route	Bus trips
Bus travel time on route	Bus-minutes
Mean travel time on route	Seconds/bus
Turn movement specific measures by link	
Travel	Vehicle miles, vehicle trips
Total travel time Moving time Delay time	Vehicle minutes
Efficiency	Ratio of moving time to total time
Vehicle stops	Percent
Mean speed	Miles/hour

TABLE A-2 NETFLO 1 measures of effectiveness

Link specific measures

Measure	Units
Travel	Vehicle-miles Person-miles Vehicle-trips Person-trips
Total travel time Delay time	Vehicle minutes, person minutes
Moving time	Vehicle minutes
Mean travel time	seconds/vehicle
Mean speed	miles/hour
Vehicle stops	percent
Bus travel	Bus trips
Bus passenger travel	Person trips
Bus stops	Number of stops
Mean content	Vehicles
Fuel economy	Vehicle-miles/gallon
Fuel consumed	Gallons
CO emissions HC emissions	Kilogram

APPENDIX B

```
C     **********************************************************************
C                        GRADUATE RESEARCH PROJECT #23
C     A methodology to interface UTPS and TRAF-NETSIM
C     Programmer : Ranga Raghunathan
C     Purpose : This program uses various UTPS planning data sets to create
C     the TRAF input data set.
C     **********************************************************************
C     This main program call the following subroutines :
C     REC00,REC01,REC02,REC03,REC04,REC05,REC11,REC35,REC36,REC170,REC175
C     REC176,REC185,REC186,REC187,REC188,REC189,REC210
C     **********************************************************************
C     Glossary of variable names
C     OUTPUT = The output file generated by the program
C     LNKCRD = HNET link card file name
C     NODECRD= HNET node card file name
C     HNESYS = HNET SYSIN file name
C     ODFILE = MBUILD O-D file name
C     INETCRD= INET &ROUTE card file name
C     **********************************************************************
      WRITE(*,*) 'THIS PROGRAM USES UTPS PLANNING DATA TO CREATE TRAF IN
     &PUT DATA SET'
      WRITE(*,*)


C     All the input files are supplied

      CHARACTER*12 OUTPUT,LNKCRD,HNESYS,INETCRD,NODECRD,ODFILE
C     Enter the interface output file name
      WRITE(*,1)
 1    FORMAT(3X,'Enter the INTERFACE OUTPUT file name *.TRF' /)
      READ(*,*) OUTPUT

C     Enter the HNET Node card file name
      WRITE(*,2)
 2    FORMAT(3X,' Enter the HNET Node card file name' /)
      READ(*,*) NODECRD

C     Enter the HNET Link card file name
      WRITE(*,3)
 3    FORMAT(3X,' Enter the HNET Link card file name' /)
      READ(*,*) LNKCRD

C     Enter the HNET SYSIN file name
      WRITE(*,4)
 4    FORMAT(3X,'Enter the HNET SYSIN file name' /)
      READ(*,*) HNESYS

C     Enter the O-D file name
      WRITE(*,5)
 5    FORMAT(3X,'Enter the O-D file name' /)
      READ(*,*) ODFILE


C     Enter the INET ROUTE CARD  file name
      WRITE(*,6)
 6    FORMAT(3X,'Enter the INET ROUTE CARD file name' /)
      READ(*,*) INETCRD

      WRITE(*,*) OUTPUT,'FILE IS BEING CREATED ... PLEASE WAIT'

C     ****************************************************************************
      CALL REC00(OUTPUT)
      CALL REC01(OUTPUT)
      CALL REC02(OUTPUT)
      CALL REC03(OUTPUT)
```

```
      CALL REC04(OUTPUT)
      CALL REC05(OUTPUT)
      CALL REC11(LNKCRD,HNESYS,NODECRD,OUTPUT)
C     CALL REC21(OUTPUT)
      CALL REC35(LNKCRD,OUTPUT)
      CALL REC36(NODECRD,HNESYS,OUTPUT)
C     CALL REC50(HNESYS,ODFILE,OUTPUT)
      CALL REC170(OUTPUT)
      CALL REC175(OUTPUT)
      CALL REC176(HNESYS,ODFILE,OUTPUT)
      CALL REC185(INETCRD,OUTPUT)
      CALL REC186(OUTPUT)
      CALL REC187(INETCRD,HNESYS,OUTPUT)
      CALL REC188(OUTPUT)
      CALL REC189(INETCRD,OUTPUT)
      CALL REC210(OUTPUT)

      WRITE(*,*) OUTPUT, 'FILE HAS BEEN CREATED'
      WRITE(*,*) 'THIS FILE CAN BE EDITED,IF NEEDED BEFORE RUNNING TRAF'
      WRITE(*,*)'THE USER SHOULD CHECK THE VALIDITY OF DATA BEFORE RUNNI
     &NG TRAF'

      END

C     ******************************************************************
C     Name of subroutine : REC00
C     Purpose : To create TRAF record type 00 with default values and append
C     FILE00 to output file.

C     Unit #       File name     Created/Supplied
C     -------------------------------------------
C     1            FILE00        Created
C     1000         OUTPUT        Created

C     This subroutine calls : None
C     This subroutine is called by : main program


      SUBROUTINE REC00(OUTPUT)
      CHARACTER*12 OUTPUT
      CHARACTER*80 CARD
      OPEN(1,'FILE00')
      OPEN(1000,OUTPUT)
      WRITE(1,1)
  1   FORMAT(T1,'GRAF PROJECT #23, UTPS-TRAF INTERFACE',T79,'00')

C     ADD FILE00 TO THE OUTPUT FILE
      REWIND 01
      I=1
 8    READ(01,50,END=7) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 8
 7    ENDFILE 01
      RETURN
      END
C       ******************************************************************

C     Name of subroutine : REC01
C     Purpose : To create TRAF record type 01 with default values and
C     append FILE01 to output file.

C     This subroutine calls : None
C     This subroutine is called by : main program

C     Unit #       File name     Created/Supplied/Appended
```

```
C     ----------------------------------------------------
C     2             FILE01       Created
C     1000          OUTPUT       Appended

      SUBROUTINE REC01(OUTPUT)
      CHARACTER OUTPUT*12, CARD*80

      OPEN(2,'FILE01')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      WRITE(2,1)
    1 FORMAT(T1,'RANGA RAGHUNATHAN',T39,'08',T43,'14',T47,'93',T49,
     &'FEDERAL HIGHWAY ',T73,'1',T79,'01')
C     ADD FILE01 TO OUTPUT FILE
      REWIND 02
      I=1
   10 READ(02,50,END=9) CARD
      WRITE(1000,50) CARD
   50 FORMAT(T1,A80)
      I=I+1
      GOTO 10
    9 ENDFILE 02
      RETURN
      END
C     ************************************************************************

C     Name of subroutine : REC02
C     Purpose : To create TRAF record type 02 with default values and
C     append FILE02 to output file

C     This subroutine calls : None
C     This subroutine is called by : main program


C     Unit #        File name    Created/Supplied
C     ----------------------------------------------
C     3             FILE02       Created
C     1000          OUTPUT       Appended

      SUBROUTINE REC02(OUTPUT)
      CHARACTER OUTPUT*12, CARD*80
      OPEN(3,'FILE02')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      WRITE(3,1)
    1 FORMAT(T4,'0',T8,'3',T18,'180',T46,'0',T48,'0',T52,'5',T53,'0715'
     &,T65,'7681',T73,'7581',T79,'02')

C     ADD FILE02 TO OUTPUT FILE
      REWIND 03
      I=1
   12 READ(03,50,END=11) CARD
      WRITE(1000,50) CARD
   50 FORMAT(T1,A80)
      I=I+1
      GOTO 12
   11 ENDFILE 03
      RETURN
      END
C     ************************************************************************

C     Name of subroutine : REC03
C     Purpose : To create Record type 03 with default values and append
C     FILE03 to output file.

C     Unit #        File name    Created/Supplied
C     ----------------------------------------------
C     4             FILE03       Created
```

```
C     1000          OUTPUT        Appended

C     This subroutine calls : None
C     This subroutine is called by : main program

      SUBROUTINE REC03(OUTPUT)
      CHARACTER OUTPUT*12, CARD*80
      OPEN(4,'FILE03')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      WRITE(4,1)
  1   FORMAT(T1,'1800',T79,'03')
      REWIND 04
      I=1
 14   READ(4,50,END=13) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 14
 13   ENDFILE 04
      RETURN
      END
C     ************************************************************************
C     Name of subroutine : REC04
C     Purpose : To create TRAF record type 04 with default values and append
C     FILE04 to the output file

C     This subroutine calls : None
C     This subroutine is called by : main program

C     Unit #        File name     Created/Supplied
C     ------------------------------------------
C     5             FILE04        Created
C     1000          OUTPUT        Appended

      SUBROUTINE REC04(OUTPUT)
      CHARACTER OUTPUT*12, CARD*80
      OPEN(5,'FILE04')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      WRITE(5,1)
  1   FORMAT(T19,'60',T79,'04')

C     ADD FILE04 TO OUTPUT FILE

      OPEN(05,'FILE04')
      REWIND 05
      I=1
 16   READ(05,50,END=15) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 16
 15   ENDFILE 05
      RETURN
      END
C     ************************************************************************

C     Name of subroutine : REC05
C     Purpose : To create TRAF record type 05 with default values and
C     append FILE05 to the output file.


C     This subroutine calls : None
C     This subroutine is called by : main program
C     Unit #        File name     Created/Supplied
C     ------------------------------------------
C     6             FILE05        Created
C     1000          OUTPUT        Appended
```

```
      SUBROUTINE REC05(OUTPUT)
      CHARACTER OUTPUT*12, CARD*80
      OPEN(6,'FILE05')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      WRITE(6,1)
  1   FORMAT(T52,'0',T53,'INTERF',T79,'05')

C     ADD FILE05 TO OUTPUT FILE
      REWIND 06
      I=1
 10   READ(06,50,END=11) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 10
 11   ENDFILE 06

      RETURN
      END
C     ************************************************************************

C     Name of subroutine : REC11
C     Purpose : To create TRAF record type 11 and append FILE11 to the
C     output file.
C     This subroutine calls : none
C     This subroutine is called by : main program

C     Unit #        File name     Created/Supplied
C     -------------------------------------------
C     100           NODCRD        Supplied
C     101           LKCRD11       Supplied
C     102           HNSY11        Supplied
C     99            NEWNODE.CRD   Created
C     11            FILE11        Created
C     199           LINK.TMP      Created
C     200           LINK1.TMP     Created
C     201           LINK2.TMP     Created
C     1000          OUTPUT        Appended

      SUBROUTINE REC11(LKCD11,HNSY11,NODCRD,OUTPUT)
      NAMELIST/PARAM/ZONES,NODES,DFAC
      DIMENSION DIST(500),X(500),Y(500)
      INTEGER ANODE(500),BNODE(500),NDIST(500),N(500),FC(500),ZONES,A,B,
     &ND,XA,YA,XB,YB,OB(5),XOB(5),YOB(5),NLA,NL(500)

      CHARACTER*2 MVMT(3)
      CHARACTER*12 LKCD11,HNSY11,NODCRD,OUTPUT
      CHARACTER*80 CARD
      OPEN(101,LKCD11)
      OPEN(102,HNSY11)
      OPEN(1000,OUTPUT,STATUS='APPEND')
      OPEN(199,'LINK.TMP')
      OPEN(200,'LINK1.TMP')
      OPEN(201,'LINK2.TMP')
      OPEN(11,'FILE11')

C    Read zones parameter from HNET SYSIN CARD
      READ (102,PARAM)
C     WRITE(*,*) 'ZONES=',ZONES

C     ************************************************************************
C          READ LINK.CRD TO CREATE LINK.TMP
C     ************************************************************************

        I=1
 97     READ(101,2,END=101) FC(I),ANODE(I),BNODE(I),DIST(I),NL(I)
  2      FORMAT(T2,I1,T3,I5,T8,I5,T13,F4.2,T49,I1)
```

```
           NDIST(I)=INT(DIST(I)*5280)
           IF(FC(I).EQ.1) THEN
                 WRITE(199,4)ANODE(I),BNODE(I),NDIST(I),NL(I)
 4               FORMAT(T1,I4,T5,I4,T9,I4,T22,I1)
                   IF(ANODE(I).LE.ZONES) THEN
                       WRITE(199,3) 8000+ANODE(I),ANODE(I),NL(I)
 3                   FORMAT(T1,I4,T5,I4,T22,I1)
                   ENDIF
           ELSE
                   WRITE(199,4)ANODE(I),BNODE(I),NDIST(I),NL(I)
                   WRITE(199,4) BNODE(I),ANODE(I),NDIST(I),NL(I)
                       IF(ANODE(I).LE.ZONES) THEN
                           WRITE(199,3) 8000+ANODE(I),ANODE(I),NL(I)
                           WRITE(199,3) ANODE(I),8000+ANODE(I),NL(I)
                       ENDIF
            ENDIF
        I=I+1
        GOTO 97
 101    ENDFILE 101

C     SORT THE LINK.TMP FILE TO CREATE UNIQUE A-B PAIRS
C     CREATE LINK2.TMP FILE AND LINK1.TMP FILE
      REWIND 199

      I=1
 16   READ(199,4,END=19) ANODE(I),BNODE(I),NDIST(I),NL(I)
      I=I+1
      GOTO 16
 19   NR=I-1

      DO 14 U=1,NR
         DO 17 V=1,NR
           IF(U.EQ.V) GOTO 17
           IF(ANODE(V).EQ.ANODE(U).AND.BNODE(V).EQ.BNODE(U)) THEN
             ANODE(V)=ANODE(V)+10000
           ENDIF
 17     CONTINUE
 14   CONTINUE
      DO 18 P=1,NR
         IF(ANODE(P).LT.10000) THEN
         WRITE(200,4) ANODE(P),BNODE(P),NDIST(P),NL(P)
         WRITE(201,4) ANODE(P),BNODE(P),NDIST(P),NL(P)
         ENDIF
 18   CONTINUE
        REWIND 200
        REWIND 201

C     *********************************************************************
C     CREATE NEWNODE.CRD FROM NODE.CRD. NEWNODE.CRD COVERS 8000 NODES
C
      OPEN(100,NODCRD)
      OPEN(99,'NEWNODE.CRD')
      I=1
 6    READ(100,7,END=100) N(I),X(I),Y(I)
 7    FORMAT(T2,I5,T8,F8.0,T17,F8.0)
      WRITE(99,7) N(I),X(I),Y(I)
      IF(N(I).LE.ZONES) THEN
           WRITE(99,7) 8000+N(I),X(I)-5,Y(I)
      ENDIF
      I=I+1
      GOTO 6
 100  ENDFILE 100
C     NN=I-1
C     WRITE(*,*) 'NUMBER OF NODES IN NODE.CRD=',NN

C     READ IN THE NEWNODE.CRD INTO THE ARRAYS N,X,Y
      REWIND 99
```

```
      I=1
 5     READ(99,7,END=8)N(I),X(I),Y(I)
      I=I+1
      GOTO 5
 8    ENDFILE 99
      NNEW=I-1
C     WRITE(*,*) 'NUMBER OF NEWNODE.CRD RECORDS=',NNEW
C     ****************************************************************
C       READ IN THE LINK2.TMP FILE INTO ARRAYS ANODE,BNODE,NDIST,NL
        K=1
   15   READ(201,4,END=201) ANODE(K),BNODE(K),NDIST(K),NL(K)
        K=K+1
        GOTO  15
  201   ENDFILE 201
        NRL2=K-1
C       WRITE(*,*) 'NO OF LINK2.TMP RECORDS=',NRL2
C       **********************************************************
C     PROCESSSING FOR FIRST LINK BEGINS
      I=1
 9    READ(200,10,END=200) A,B,ND,NLA
 10   FORMAT(T1,I4,T5,I4,T9,I4,T22,I1)
C     PROCESS 8###-B LINKS ALSO BUT DONT PROCESS A-8### LINKS

      IF (B.GT.8000)  GOTO 11

C       FIND XA AND YA
        DO 12 J=1,NNEW
             IF (A.EQ.N(J)) THEN
                  XA=X(J)
                  YA=Y(J)
             ENDIF
 12     CONTINUE
C       FIND XB AND YB
        DO 13 K=1,NNEW
             IF(B.EQ.N(K)) THEN
                   XB=X(K)
                   YB=Y(K)
              ENDIF
 13      CONTINUE

C     **********************************************************************
C             FOR FIRST LINK A-B PAIR FIND NODES OUTGOING FROM B
C     **********************************************************************
 30   L=0
     DO 31 M=1,NRL2

            IF (B.EQ.ANODE(M)) THEN
                  IF(BNODE(M).EQ.A) THEN
                  GOTO 31
                  ELSE
                  L=L+1
                  OB(L)=BNODE(M)
                  ENDIF
            ENDIF
 31    CONTINUE
C      WRITE(*,*) A,B,(OB(J),J=1,L)
C      *****************************************************
C           FOR EACH OB(L), FIND XOB(L),YOB(L)
C      *****************************************************
       DO 33 M=1,L
           DO 34 K=1,NNEW
                IF(OB(M).EQ.N(K)) THEN
                XOB(M)=X(K)
                YOB(M)=Y(K)
                ENDIF
  34       CONTINUE
  33   CONTINUE
```

```
C     ************************************************************************
C           COMPARE THE COORDS OF A,B AND OB(L) TO FIND IF TURN IS
C           LEFT/RIGHT/THRU MOVEMENT. THESE TURNS DEPEND ON WHETHER
C           B IS RIGHT/LEFT/TOP/BELOW A. FOUR CASES NEED DEFINITION HERE

C          NOW DEFINE TABLE AND FIND SPECIFIC MOVEMENT
      DO 65 M=1,L

C      B IS NORTH OF A

       IF ((YB.GT.YA).AND.(XOB(M).LT.XB)) MVMT(M)='L'
       IF ((YB.GT.YA).AND.(YOB(M).GT.YB)) MVMT(M)='T'
       IF ((YB.GT.YA).AND.(XOB(M).GT.XB)) MVMT(M)='R'

C     B IS EAST OF A

       IF ((XB.GT.XA).AND.(XOB(M).EQ.XB).AND.(YOB(M).GT.YB)) MVMT(M)='L'
       IF ((XB.GT.XA).AND.(XOB(M).GT.XB).AND.(YOB(M).EQ.YB))MVMT(M)='T'
       IF ((XB.GT.XA).AND.(YOB(M).LT.YB)) MVMT(M)='R'
       IF ((XB.GT.XA).AND.(XOB(M).GT.XB).AND.(YOB(M).GT.YB))MVMT(M)='LD'

C      B IS SOUTH OF A

       IF ((YB.LT.YA).AND.(XOB(M).GT.XB)) MVMT(M)='L'
       IF ((YB.LT.YA).AND.(YOB(M).LT.YB).AND.(XOB(M).EQ.XB))MVMT(M)='T'
       IF ((YB.LT.YA).AND.(XOB(M).LT.XB).AND.(YOB(M).EQ.YB))MVMT(M)='R'
       IF ((YB.LT.YA).AND.(XOB(M).LT.XB).AND.(YOB(M).LT.YB))MVMT(M)='RD'

C      B IS WEST OF A
       IF ((XB.LT.XA).AND.(XOB(M).LE.XB).AND.(YOB(M).LT.YB))MVMT(M)='L'
       IF ((XB.LT.XA).AND.(XOB(M).LT.XB).AND.(YOB(M).EQ.YB))MVMT(M)='T'
       IF ((XB.LT.XA).AND.(YOB(M).GT.YB)) MVMT(M)='R'

C      B IS NORTH EAST OF A
       IF ((XB.GT.XA).AND.(YB.GT.YA).AND.(XOB(M).LT.XB).AND.(YOB(M).EQ.
     & YB)) MVMT(M)='L'
       IF ((XB.GT.XA).AND.(YB.GT.YA).AND.(XOB(M).GT.XB).AND.(YOB(M).GT.
     & YB)) MVMT(M)='T'
       IF ((XB.GT.XA).AND.(YB.GT.YA).AND.(XOB(M).GE.XB).AND.(YOB(M).LE.
     & YB)) MVMT(M)='R'
       IF ((XB.GT.XA).AND.(YB.GT.YA).AND.(XOB(M).EQ.XB).AND.(YOB(M).GT.
     &  YB)) MVMT(M)='RD'

C      B IS SOUTH WEST OF A
       IF ((XB.LT.XA).AND.(YB.LT.YA).AND.(XOB(M).GE.XB).AND.(YOB(M).LE.
     & YB)) MVMT(M)='L'
       IF ((XB.LT.XA).AND.(YB.LT.YA).AND.(XOB(M).LT.XB).AND.(YOB(M).
     & LT.YB)) MVMT(M)='T'
       IF ((XB.LT.XA).AND.(YB.LT.YA).AND.(XOB(M).LE.XB).AND.(YOB(M).
     & EQ.YB)) MVMT(M)='R'
       IF ((XB.LT.XA).AND.(YB.LT.YA).AND.(YOB(M).GT.YB))  MVMT(M)='RD'

 65    CONTINUE
C      WRITE(*,*) A,B,(MVMT(K),OB(K),K=1,L)
C     ************************************************
C       SORT MOVEMENTS IN ORDER L,T,R
       DO 36 K=1,L

           IF (MVMT(K).EQ.'L') NLEFT=OB(K)
           IF (MVMT(K).EQ.'T') NTHRU=OB(K)
           IF (MVMT(K).EQ.'R') NRITE=OB(K)
           IF (MVMT(K).EQ.'RD') NDIAG=OB(K)
           IF (MVMT(K).EQ.'LD') NDIAG=-OB(K)

 36     CONTINUE

        NOPP=NTHRU
```

```
        IF((NLEFT.EQ.0).AND.(NTHRU.EQ.0).AND.(NDIAG.NE.0)) THEN
        NTHRU=NRITE
        NRITE=NDIAG
        NDIAG=0
        GOTO 50
        ENDIF

        IF ((NLEFT.EQ.0).AND. (NDIAG.NE.0)) THEN
        NLEFT=NDIAG
        IF (NLEFT.LT.0) NLEFT=-NLEFT
        NDIAG=0
        GOTO 50
        ENDIF


        IF ((NTHRU.EQ.0).AND.(NDIAG.NE.0)) THEN
        NTHRU=NDIAG
        IF (NTHRU.LT.0) NTHRU=-NTHRU
        NDIAG=0
        GOTO 50
        ENDIF

        IF((NRITE.EQ.0).AND.(NDIAG.NE.0)) THEN
        NRITE=NDIAG
        NDIAG=0
        GOTO 50
        ENDIF

C        WRITE(*,*) A,B,NLA,NLEFT,NTHRU,NRITE,NLEFTD,NRITED,NOPP


 50       IF(A.GT.8000) THEN
            IF(NLEFT.EQ.0) THEN
              WRITE(11,57) A,B,NLA,NLEFT,NTHRU,NRITE,NDIAG
 57           FORMAT(T1,I4,T5,I4,T22,I1,T37,I4,T41,I4,T45,I4,T49,I4,
     &        T79,'11')
            ELSE
              WRITE(11,58) A,B,NLA,NLEFT,NTHRU,NRITE,NDIAG,NOPP
 58           FORMAT(T1,I4,T5,I4,T22,I1,T37,I4,T41,I4,T45,I4,T49,I4,
     &        T53,I4,T79,'11')
            ENDIF
        ELSE
C       IF (A.NOT GT 8000)

        IF (NLEFT.EQ.0) THEN
        WRITE(11,56) A,B,ND,NLA,NLEFT,NTHRU,NRITE,NDIAG
 56     FORMAT(T1,I4,T5,I4,T9,I4,T22,I1,T37,I4,T41,I4,T45,I4,T49,I4,
     &  T79,'11')

        ELSE

        WRITE(11,55) A,B,ND,NLA,NLEFT,NTHRU,NRITE,NDIAG,NOPP
 55     FORMAT(T1,I4,T5,I4,T9,I4,T22,I1,T37,I4,T41,I4,T45,I4,T49,I4,
     &  T53,I4,T79,'11')

      ENDIF
      ENDIF

 95    NLEFT=0
       NTHRU=0
       NRITE=0
       NDIAG=0
C       NRITED=0
C       NLEFTD=0
C     ****************** FIRST LINK PROCESSED, GOTO NEXT LINK ************
 11   I=I+1
      GOTO 9
```

```
 200   ENDFILE 200

C     ADD FILE11 TO OUTPUT FILE
      REWIND 11
      I=1
 71   READ(11,72,END=70) CARD
      WRITE(1000,72) CARD
 72   FORMAT(T1,A80)
      I=I+1
      GOTO 71
 70   ENDFILE 11

  99    RETURN
        END

C     *********************************************************************
C      Name of subroutine : REC21
C      Purpose : To create TRAF record type 21
C      Comments : This subroutine has been made disfunctional and is not
C      called by the main program. The routine has been listed here for
C      possible future enhancements

C     This subroutine calls : None
C     This subroutine is called by : main program

C     Unit #        File name     Created/Supplied
C     ------------------------------------------
C     21            FILE21        Created
C     1000          OUTPUT        Appended

      SUBROUTINE REC21(OUTPUT)
      CHARACTER OUTPUT*12,CARD*80
      INTEGER A(500),B(500),TN(4)
      OPEN(21,'FILE21')
      OPEN(11,'FILE11')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      REWIND 11

         I=1
  11      READ(11,1,END=12) A(I),B(I),(TN(K),K=1,4)
   1      FORMAT(T1,I4,T5,I4,T37,I4,T41,I4,T45,I4,T49,I4)
          C=0
          DO 13 M=1,4
             IF(TN(M).NE.0) THEN
                C=C+1
                NPTR=M
             ENDIF
  13      CONTINUE
          IF (C.EQ.1) THEN
              IF(NPTR.EQ.1) THEN
              WRITE(21,14) A(I),B(I)
  14          FORMAT(T1,I4,T5,I4,T10,'100',T79,'21')
              ELSE IF (NPTR.EQ.2) THEN
              WRITE(21,15) A(I),B(I)
  15          FORMAT(T1,I4,T5,I4,T14,'100',T79,'21')
              ELSE IF (NPTR.EQ.3) THEN
              WRITE(21,16) A(I),B(I)
  16          FORMAT(T1,I4,T5,I4,T18,'100',T79,'21')
              ELSE IF (NPTR.EQ.4) THEN
              WRITE(21,17) A(I),B(I)
  17          FORMAT(T1,I4,T5,I4,T22,'100',T79,'21')
              ENDIF
         ELSE
              WRITE(21,18) A(I),B(I)
  18          FORMAT(T1,I4,T5,I4,T79,'21')
         ENDIF
        I=I+1
```

```
        GOTO 11
  12    ENDFILE 11


C  ADD FILE21 TO OUTPUT FILE
      REWIND 21
      I=1
 20   READ(21,50,END=19) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 20
 19   ENDFILE 21

      RETURN
      END
C     ***********************************************************************************

C     Name of subroutine : REC35
C     Purpose : To create TRAF record type 35 and append FILE35 to the
C     output file. It reads the link.crd file to identify unique nodes which
C     need to be represented in REC 35 in output file.

C     This subroutine calls : None
C     This subroutine is called by : main program

C     Unit #        File name     Created/Supplied
C     -------------------------------------------
C     101           LINKCAR       Supplied
C     202           NODE.TMP      Created
C     35            FILE35        Created
C     1000          OUTPUT        Appended


      SUBROUTINE REC35(LINKCAR,OUTPUT)
      CHARACTER LINKCAR*12, OUTPUT*12, CARD*80
      INTEGER A(500),B(500),C(500),P,HOLD(5),APP
      OPEN(202,'NODE.TMP')
      OPEN(35,'FILE35')
      OPEN(101,LINKCAR)
      OPEN(200,'LINK1.TMP')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      REWIND 101
        I=1
  18        READ(101,1,END=101) A(I),B(I)
  1         FORMAT(T3,I5,T8,I5)
        I=I+1
        GOTO 18
 101  ENDFILE 101
        P=I-1
C       WRITE(*,*) 'NO OF RECORDS IN LINK.CRD IS=',P

C       TRANSFER ALL THE A AND B NODES INTO ONE MATRIX - C
        DO 19 K=1,P
                  C(K)=A(K)
                  C(P+K)=B(K)
  19   CONTINUE

C      SORT THE C MATRIX IN ASCENDING ORDER OF ZONE NOS
C      DUPLICATE NODES ARE RETAINED IN ASCENDING ORDER
        DO 20 J=1,2*P-1
            DO 21 I=1,2*P-J
                 IF (C(I).LT.C(I+1))  GOTO 21
                 T=C(I)
                 C(I)=C(I+1)
                 C(I+1)=T
 21     CONTINUE
```

```
 20     CONTINUE
C        RESORT TO PICK UNIQUE NODES IN ASCENDING ORDER
C         CREATE NODE.TMP
            WRITE(202,3) C(1)
            DO 23 I=1,2*P
                  IF (C(I+1).GT.C(I))  THEN
                         WRITE(202,3) C(I+1)
 3                      FORMAT(T1,I4)
                  ELSE
                         GOTO 23
                  ENDIF
 23     CONTINUE

C        ENTER THE A-B NODES OF LINK1.TMP INTO THE ARRAYS A AND B
         REWIND 200
         I=1
  4      READ(200,5,END=6) A(I),B(I)
  5      FORMAT(T1,I4,T5,I4)
         I=I+1
         GOTO 4
  6      ENDFILE 200
         LT1R=I-1

C        FOR EACH NODE IN NODE.TMP BEGIN PROCESS OF FINDING APPROACHES
         REWIND 202
         I=1
 7       READ(202,3,END=9) NODE
C        WRITE(*,*) 'NODE=',NODE
         IA=1
         DO 8 V=1,LT1R
               IF (B(V).EQ.NODE) THEN
                  APP=A(V)
                  HOLD(IA)=APP
                  IA=IA+1
               ENDIF
 8       CONTINUE
C        BECAUSE IA IS INCREMENTED ONCE AFTER THE FINAL ENTRY INTO IT
C        PRINTING IS DONE ONLY UNTIL IA-1
C        WRITE INTO FILE35
         WRITE(35,10) NODE,(HOLD(X),X=1,IA-1)
 10      FORMAT(T79,'35',T1,I4,T9,5I4)
         I=I+1
         GOTO 7
 9       ENDFILE 202

C     ADD FILE35 TO OUTPUT FILE
      REWIND 35
      I=1
 70   READ(35,50,END=71) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 70
 71   ENDFILE 35

      RETURN
      END
C     ********************************************************************************

C     Name of subroutine : REC36
C     Purpose : to create TRAF record type 36 and append FILE36 to
C     the output file. It reads FILE35 and writes record 36 for sign/pretimed
C     control codes
C     UNIT=36, FILE='FILE36' UNIT=202, NODE.TMP

C     This subroutine calls : None
C     This subroutine is called by : main program
```

```
C      Unit #         File name      Created/Supplied
C      -------------------------------------------
C      100            NODCRD         Supplied
C      11             FILE11         Supplied
C      102            HNESYS         Supplied
C      36             FILE36         Created
C      1000           OUTPUT         Appended

        SUBROUTINE REC36(NODCRD,HNESYS,OUTPUT)
        INTEGER D(500),APP(5)
        CHARACTER OUTPUT*12,NODCRD*12,HNESYS*12,CARD*80
        NAMELIST/PARAM/ZONES,NODES,DFAC
        OPEN(36,'FILE36')
        OPEN(35,'FILE35')
        OPEN(100,NODCRD)
        OPEN(102,HNESYS)
        OPEN(1000,OUTPUT,STATUS='APPEND')
        REWIND 35
        REWIND 102

        READ(102,PARAM)

        I=1

 27           READ(35,1,END=103) D(I),(APP(V),V=1,5)
 1            FORMAT(T1,I4,T9,5I4)

              IF (D(I).LE.ZONES) THEN
                 DO 3 K=1,5
                   IF (APP(K).EQ.0) GOTO 4
                   IF (APP(K).GT.8000) IN=K
 3               CONTINUE
 4             IF (IN.EQ.1) THEN
                 WRITE(36,2) D(I)
 2               FORMAT(T1,I4,T6,'1',T79,'36')

               ELSE IF (IN.EQ.2) THEN
                WRITE(36,5) D(I)
 5              FORMAT(T1,I4,T7,'1',T79,'36')

               ELSE IF (IN.EQ.3) THEN
                WRITE(36,6) D(I)
 6              FORMAT(T1,I4,T8,'1',T79,'36')

               ELSE IF (IN.EQ.4) THEN
                WRITE(36,7) D(I)
 7              FORMAT(T1,I4,T9,'1',T79,'36')

               ELSE IF (IN.EQ.5) THEN
                 WRITE(36,8) D(I)
 8               FORMAT(T1,I4,T10,'1',T79,'36')
               ENDIF
             ELSE
              WRITE(36,9) D(I)
 9            FORMAT(T1,I4,T79,'36')
            ENDIF
        I=I+1
        GOTO 27
 103    ENDFILE 35

C      ADD FILE36 TO OUTPUT FILE
       REWIND 36
       I=1
 24    READ(36,50,END=23) CARD
       WRITE(1000,50) CARD
 50    FORMAT(T1,A80)
```

```
      I=I+1
      GOTO 24
 23   ENDFILE 36

        RETURN
        END
C     ********************************************************************************

C     Name of subroutine : REC50
C     Purpose : to create TRAF record type 50 and append FILE50 to the output
C     file.
C     Comments : This subroutine is made disfunctional, but has been listed
C     here for possible future enhancements. Since traffic assignment feature
C     of TRAF models is used, this subroutine is not needed.

C     This subroutine calls : None
C     This subroutine is called by : main program


C     Unit #        File name     Created/Supplied
C     --------------------------------------------
C     102           HNETSY        Supplied
C     301           ODFIL         Supplied
C     50            FILE50        Created
C     1000          OUTPUT        Appended


      SUBROUTINE REC50(HNETSY,ODFIL,OUTPUT)
      CHARACTER*12 HNETSY,ODFIL,OUTPUT
      CHARACTER*80 CARD
      INTEGER OD(9,9),ZONES,FR
      NAMELIST/PARAM/ZONES,NODES,DFAC

      OPEN(102,HNETSY)
      OPEN(301,ODFIL)
      OPEN(50,'FILE50')
      OPEN(1000,OUTPUT,STATUS='APPEND')
C     READ IN VALUE OF ZONES FROM HNET.SYS FILE TO ASCERTAIN
C     SIZE OF OD MATRIX

      REWIND 102
      READ(102,PARAM)
C     WRITE(*,*) 'ZONES=',ZONES

      REWIND 301
C     READ IN THE O-D TABLE INTO THE OD(8,8) ARRAY

      IF (ZONES.EQ.2) THEN
      READ(301,2,END=14) ((OD(I,J),J=1,2),I=1,2)
 2    FORMAT(T1,2(I4,2X))

      ELSE IF (ZONES.EQ.3) THEN
      READ(301,3,END=14) ((OD(I,J),J=1,3),I=1,3)
 3    FORMAT(T1,3(I4,2X))

      ELSE IF (ZONES.EQ.4) THEN
      READ(301,4,END=14) ((OD(I,J),J=1,4),I=1,4)
 4    FORMAT(T1,4(I4,2X))

      ELSE IF (ZONES.EQ.5) THEN
      READ(301,5,END=14) ((OD(I,J),J=1,5),I=1,5)
 5    FORMAT(T1,5(I4,2X))

      ELSE IF (ZONES.EQ.6) THEN
      READ(301,6,END=14) ((OD(I,J),J=1,6),I=1,6)
 6    FORMAT(T1,6(I4,2X))
```

```
      ELSE IF (ZONES.EQ.7) THEN
      READ(301,7,END=14) ((OD(I,J),J=1,7),I=1,7)
 7    FORMAT(T1,7(I4,2X))

      ELSE IF (ZONES.EQ.8) THEN
      READ(301,8,END=14) ((OD(I,J),J=1,8),I=1,8)
 8    FORMAT(T1,8(I4,2X))

      ENDIF
 14   ENDFILE 301

C     WRITE(*,*)  ((OD(I,J),J=1,ZONES),I=1,ZONES)
C     ADD ROWS OF OD TABLE TO USE IN REC50

      DO 9 I=1,ZONES
        FR=0
        DO 10 J=1,ZONES
            FR=FR+OD(I,J)
 10     CONTINUE
       WRITE(50,15) 8000+I,I,FR
 15    FORMAT(T1,I4,T5,I4,T9,I4,T79,'50')
 9     CONTINUE

C     ADD FILE50 TO OUTPUT FILE
      OPEN(50,'FILE50')
      REWIND 50
      I=1
 26   READ(50,50,END=25) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 26
 25   ENDFILE 50


       RETURN
       END

C     ***********************************************************************************
C     Name of subroutine : REC170
C     Purpose : to create the model delimiter record.

C     This subroutine calls : None
C     This subroutine is called by : main program

C     Unit #        File name     Created/Supplied
C     --------------------------------------------
C     170           FILE170       Created
C     1000          OUTPUT        Appended

      SUBROUTINE REC170(OUTPUT)
      CHARACTER CARD*80, OUTPUT*12
      OPEN(170,'FILE170')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      WRITE(170,1)
 1    FORMAT(T78,'170')

C     ADD FILE170 TO OUTPUT FILE
      REWIND 170
      I=1
 28   READ(170,50,END=27) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 28
 27   ENDFILE 170
```

```
      RETURN
      END
C     ******************************************************************************

C     Name of subroutine : REC175
C     Purpose : to create the TRAF record type 175 and append FILE170 to
C     the output file

C     This subroutine calls : None
C     This subroutine is called by : main program

C     Unit #        File name     Created/Supplied
C     ------------------------------------------
C     175           FILE175       Created
C     1000          OUTPUT        Appended


      SUBROUTINE  REC175(OUTPUT)
      CHARACTER CARD*80, OUTPUT*12
      OPEN(175,'FILE175')
      OPEN(1000,OUTPUT,STATUS='APPEND')
      WRITE(175,1)
 1    FORMAT(T24,'3',T40,'0',T44,'1',T56,'2',T78,'175')
C     ADD FILE175 TO OUTPUT FILE
      REWIND 175
      I=1
 44   READ(175,50,END=43) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 44
 43   ENDFILE 175

      RETURN
      END
C     ******************************************************************************

C     Name of subroutine : REC176
C     Purpose : to create record type 176 and append FILE176 to the
C     output file

C     This subroutine calls : None
C     This subroutine is called by : main program

C     Unit #        File name     Created/Supplied/Appended
C     ---------------------------------------------------
C     102           HNETSY        Supplied
C     301           ODFIL         Supplied
C     210           REC176.TMP    Created
C     176           FILE176       Created
C     1000          OUTPUT        Appended


      SUBROUTINE REC176(HNETSY,ODFIL,OUTPUT)
      CHARACTER*12 HNETSY,ODFIL, OUTPUT
      CHARACTER*80 CARD
      INTEGER OD(9,9),ZONES ,ODZ(18)
      NAMELIST/PARAM/ZONES,NODES,DFAC

      OPEN(102,HNETSY)
      OPEN(301,ODFIL)
      OPEN(210,'REC176.TMP')
      OPEN(176,'FILE176')
      OPEN(1000,OUTPUT,STATUS='APPEND')
C     READ IN VALUE OF ZONES FROM HNET.SYS FILE TO ASCERTAIN
C     SIZE OF OD MATRIX
```

```
      REWIND 102
      READ(102,PARAM)
C     WRITE(*,*) 'ZONES=',ZONES

      REWIND 301
C     READ IN THE O-D TABLE INTO THE OD(8,8) ARRAY

      IF (ZONES.EQ.2) THEN
      READ(301,2,END=14) ((OD(I,J),J=1,2),I=1,2)
 2    FORMAT(T1,2(I4,2X))

      ELSE IF (ZONES.EQ.3) THEN
      READ(301,3,END=14) ((OD(I,J),J=1,3),I=1,3)
 3    FORMAT(T1,3(I4,2X))

      ELSE IF (ZONES.EQ.4) THEN
      READ(301,4,END=14) ((OD(I,J),J=1,4),I=1,4)
 4    FORMAT(T1,4(I4,2X))

      ELSE IF (ZONES.EQ.5) THEN
      READ(301,5,END=14) ((OD(I,J),J=1,5),I=1,5)
 5    FORMAT(T1,5(I4,2X))

      ELSE IF (ZONES.EQ.6) THEN
      READ(301,6,END=14) ((OD(I,J),J=1,6),I=1,6)
 6    FORMAT(T1,6(I4,2X))

      ELSE IF (ZONES.EQ.7) THEN
      READ(301,7,END=14) ((OD(I,J),J=1,7),I=1,7)
 7    FORMAT(T1,7(I4,2X))

      ELSE IF (ZONES.EQ.8) THEN
      READ(301,8,END=14) ((OD(I,J),J=1,8),I=1,8)
 8    FORMAT(T1,8(I4,2X))

      ENDIF
 14   ENDFILE 301

C     WRITE(*,*)  ((OD(I,J),J=1,ZONES),I=1,ZONES)

      DO 9 I=1,ZONES
         WRITE(210,11) 8000+I
        DO 10 J=1,ZONES
            IF(J.EQ.I) GOTO 10
            WRITE(210,11) 8000+J
            WRITE(210,11) OD(I,J)
  11        FORMAT(T1,I4)
  10    CONTINUE
        REWIND 210
C        READ IN REC176.TMP INTO ARRAY ODZ
         READ(210,11,END=15) (ODZ(K),K=1,2*ZONES-1)
 15      ENDFILE 210
         WRITE(176,16) (ODZ(K),K=1,2*ZONES-1)
 16      FORMAT(T78,'176',T1,I4,T13,I4,T17,I4,T21,I4,T25,I4,T29,I4,T33,
     &   I4,T37,I4,T41,I4,T45,I4,T49,I4,T53,I4,T57,I4,T61,I4,T65,I4,T69,
     &   I4,T73,I4)
         REWIND 210
   9    CONTINUE

C     ADD FILE176 TO OUTPUT FILE
      REWIND 176
      I=1
 46   READ(176,50,END=45) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 46
```

```
 45   ENDFILE 176
      RETURN
      END
C     ********************************************************************************
C     Name of subroutine: REC185
C     Purpose : to create TRAF record type 185 and append FILE185
C     to output file
C     Unit #       File name     Created/Supplied/Appended
C     ---------------------------------------------------
C     103          INETCAR       Supplied
C     204          STOPS.ALL     Created
C     205          STOPS.UNQ     Created
C     185          FILE185       Created
C     1000         OUTPUT        Appended
C     This subroutine calls : None
C     This subroutine is called by : main program
      SUBROUTINE REC185(INETCAR,OUTPUT)
      INTEGER N(150),A(25),B(25),S(20),C
      CHARACTER ONEWAY*1, CARD*80
      CHARACTER*12 INETCAR,OUTPUT
      NAMELIST/ROUTE/M,L,H,N,ONEWAY,LAY
      OPEN(185,'FILE185')
      OPEN(103,INETCAR)
      OPEN(204,'STOPS.ALL')
      OPEN(205,'STOPS.UNQ')
      OPEN(1000,OUTPUT,STATUS='APPEND')
C     STOPS.ALL -- ALL U/S AND D/S PAIRS ARE WRITTEN
C     STOPS.UNQ -- READS STOP.UNQ AND SORTS IT--PRODUCES UNIQUE PAIRS
        I=1
 1      DO 22 K=0,150
               N(K)=0
 22   CONTINUE
          READ(103,ROUTE,END=103)
         DO 2 J=1,150
           IF (N(J).EQ.0) GOTO 1
           IF (N(J).LT.0) THEN
            IF (ONEWAY.EQ.'T') THEN
                 NUPS=ABS(N(J-1))
                 NDWNS=ABS(N(J))
                   IF(NUPS.EQ.0) THEN
                        NUPS=ABS(N(J))
                        NDWNS=ABS(N(J+1))
                   ENDIF
                 WRITE(204,4) NUPS,NDWNS
C               WRITE(*,*) NUPS,NDWNS
  4         FORMAT(T1,I4,T5,I4)
           ELSE
                NUPS=ABS(N(J-1))
                NDWNS=ABS(N(J))
C              WRITE(*,*) 'I=',I,'J=',J,'NUPS=',NUPS,'NDWNS=',NDWNS
                IF(NUPS.EQ.0) THEN
                        NUPS=ABS(N(J))
                        NDWNS=ABS(N(J+1))
                   ENDIF
                   WRITE(204,6)NUPS,NDWNS
C                 WRITE(*,*) NUPS,NDWNS
  6          FORMAT(T1,2I4)
                   WRITE(204,6)NDWNS,NUPS
C             WRITE(*,*) NDWNS,NUPS
```

```
             ENDIF
            ELSE
                    GOTO 2
             ENDIF
  2        CONTINUE
          I=I+1
          GOTO 1
 103  ENDFILE 103
  3   REWIND 204

          I=1
 11          A(I)=0
                  B(I)=0
                  READ(204,12,END=15) A(I),B(I)
 12          FORMAT(T1,2I4)
          I=I+1
          GOTO 11
 15    ENDFILE 204
           C=I-1
C      WRITE(*,*) 'C=',C

          DO 7 I=1,C
               DO 8 J=1,C
                     IF(J.NE.I) THEN
                        IF(A(J).EQ.A(I) .AND. B(J).EQ.B(I)) THEN
                              A(J)=0
                              B(J)=0
                        ENDIF
                     ENDIF
  8         CONTINUE
                    IF(A(I).NE.0) THEN
                       WRITE(205,12) A(I),B(I)
                    ELSE
                       GOTO 7
                    ENDIF
  7    CONTINUE
         REWIND 205
           I=1
 20        READ(205,16,END=205) A(I),B(I)
 16        FORMAT(T1,2I4)
              S(I)=I
              WRITE(185,17) S(I),A(I),B(I)
 17        FORMAT(T1,I2,T5,2I4,T15,'20',T18,'1',T20,'1',T78,'185')
           I=I+1
           GOTO 20
 205 ENDFILE 205
C       WRITE(*,*) 'STOPS=',I-1

C      ADD FILE185 TO OUTPUT FILE
       REWIND 185
       I=1
 30    READ(185,50,END=29) CARD
       WRITE(1000,50) CARD
 50    FORMAT(T1,A80)
       I=I+1
       GOTO 30
 29    ENDFILE 185
        RETURN
          END
C      *************************************************************************
C      Name of subroutine : REC186
C      Purpose : to create TRAF record type 186

C      This subroutine calls : None
C      This subroutine is called by : main program

C      Unit #       File name     Created/Supplied
```

```
C      ------------------------------------------
C      185           FILE185         Supplied
C      186           FILE186         Created
C      1000          OUTPUT          Appended

         SUBROUTINE REC186(OUTPUT)
         CHARACTER OUTPUT*12, CARD*80
         OPEN(186,'FILE186')
         OPEN(185,'FILE185')
         OPEN(1000,OUTPUT,STATUS='APPEND')

         REWIND 185
         I=1
  1        READ(185,2,END=3) NSTOP
  2        FORMAT(T1,I2)
             WRITE(186,4)NSTOP
  4        FORMAT(T3,I2,T6,'120',T11,'20',T78,'186')
         I=I+1
         GOTO 1
  3    ENDFILE 185

C      ADD FILE186 TO OUTPUT FILE
       REWIND 186
       I=1
 32    READ(186,50,END=31) CARD
       WRITE(1000,50) CARD
 50    FORMAT(T1,A80)
       I=I+1
       GOTO 32
 31    ENDFILE 186

         RETURN
         END
C      ********************************************************************************

C      Name of subroutine : REC187
C      Purpose : to create TRAF record type 187 and append FILE187 to the
C      output file. It reads INET route card and creates REC187.NST,REC187.NEG

C      This subroutine calls : None
C      This subroutine is called by : main program

C      Unit #        File name     Created/Supplied
C      ------------------------------------------
C      103           INETCD         Supplied
C      102           HNESY          Supplied
C      206           REC187.TMP     Created
C      208           REC187.NST     Created
C      209           REC187.NEG     Created
C      187           FILE187        Created
C      1000          OUTPUT        Appended

         SUBROUTINE REC187(INETCD,HNESY,OUTPUT)
         INTEGER N(20),ENTN,EXTN,C,A(100)
         CHARACTER*12 INETCD,HNESY,OUTPUT
         CHARACTER ONEWAY*1, CARD*80
         REAL LAY
         NAMELIST/ROUTE/M,L,H,N,LAY,ONEWAY
         NAMELIST/PARAM/ZONES,NODES,DFAC

         OPEN(102,HNESY)
         OPEN(103,INETCD)
         OPEN(187,'FILE187')
         OPEN(208,'REC187.NST')
         OPEN(209,'REC187.NEG')
         OPEN(1000,OUTPUT,STATUS='APPEND')
          REWIND 102
```

```
        REWIND 103
        READ(102,PARAM)
        I=1
  1     DO 7 K=1,20
               N(K)=0
  7     CONTINUE
          READ(103,ROUTE,END=103)
          DO 2 J=1,20
            IF (N(J).EQ.0) GOTO 3
  2     CONTINUE
  3     C=J-1
C        WRITE(*,*) 'I=',I,'C=',C
          IF (ABS(N(1)).LE.ZONES .AND. ABS(N(C)).LE.ZONES) THEN
                ENTN=8000+ABS(N(1))
                EXTN=8000+ABS(N(C))
                WRITE(208,5)ENTN,(ABS(N(L)),L=1,C),EXTN
                WRITE(209,5)ENTN,(N(L),L=1,C),EXTN
  5            FORMAT(T78,'187',T5,18I4)
                 IF(ONEWAY.NE.'T') THEN
                   WRITE(208,5) EXTN,(ABS(N(L)),L=C,1,-1),ENTN
                   DO 8 V=C,1,-2
                   IF(N(V).LT.0) THEN
                     N(V)=ABS(N(V))
                     N(V-1)=-N(V-1)
                     ENDIF
  8                CONTINUE
                    WRITE(209,5) EXTN,(N(L),L=C,1,-1),ENTN
                 ENDIF

          ELSE IF (ABS(N(1)).LE.ZONES .AND. ABS(N(C)).GT.ZONES) THEN
                ENTN=8000+ABS(N(1))
                EXTN=8000+ABS(N(C))
                WRITE(208,5)ENTN,(ABS(N(L)),L=1,C),EXTN
                WRITE(209,5)ENTN,(N(L),L=1,C),EXTN
C               WRITE(206,6)EXTN,ABS(N(C))
C 6             FORMAT(2I4)
                  IF(ONEWAY.NE.'T') THEN
                    WRITE(208,5) EXTN,(ABS(N(L)),L=C,1,-1),ENTN
                    WRITE(209,5) EXTN, (N(L),L=C,1,-1),ENTN
                  ENDIF

          ELSE IF (ABS(N(1)).GT.ZONES .AND. ABS(N(C)).LT.ZONES) THEN
                ENTN=8000+ABS(N(1))
                EXTN=8000+ABS(N(C))
                WRITE(208,5)ENTN,(ABS(N(L)),L=1,C),EXTN
                WRITE(209,5)ENTN,(N(L),L=1,C),EXTN
C               WRITE(206,6)ENTN,ABS(N(1))
                  IF(ONEWAY.NE.'T') THEN
                    WRITE(208,5) EXTN,(ABS(N(L)),L=C,1,-1),ENTN
                    WRITE(209,5) EXTN,(N(L),L=C,1,-1),ENTN
                  ENDIF

          ELSE IF (ABS(N(1)).GT.ZONES .AND. ABS(N(C)).GT.ZONES) THEN
                ENTN=8000+ABS(N(1))
                EXTN=8000+ABS(N(C))
                WRITE(208,5)ENTN,(ABS(N(L)),L=1,C),EXTN
                WRITE(209,5)ENTN,(N(L),L=1,C),EXTN
C               WRITE(206,6)ENTN,ABS(N(1))
C               WRITE(206,6)EXTN,ABS(N(C))
                  IF(ONEWAY.NE.'T') THEN
                    WRITE(208,5) EXTN,(ABS(N(L)),L=C,1,-1),ENTN
                    WRITE(209,5) EXTN, (N(L),L=C,1,-1),ENTN
                  ENDIF
         ENDIF
       I=I+1
       GOTO 1
 103  ENDFILE 103
```

```
        REWIND 208
C      WRITE INTO REC187

        I=1
  21      READ(208,22,END=187) (A(K),K=1,18),NI
  22     FORMAT(T5,18I4,T78,I3)
          DO 25 L=1,18
                IF (A(L).EQ.0) GOTO 26
  25     CONTINUE
  26     C=L-1
          WRITE(187,23) I,NI,(A(K),K=1,C)
  23     FORMAT(T3,I2,T78,I3,T5,18I4)
        I=I+1
        GOTO 21
187     ENDFILE 208

C      ADD FILE187 TO OUTPUT FILE
       REWIND 187
       I=1
 34    READ(187,50,END=33) CARD
       WRITE(1000,50) CARD
 50    FORMAT(T1,A80)
       I=I+1
       GOTO 34
 33    ENDFILE 187

        RETURN
        END
C      ********************************************************************
C      Name of subroutine : REC188
C      Purpose : to create TRAF record type 188 and append FILE188 to
C      the output file.

C      This subroutine calls : None
C      This subroutine is called by : main program

C      Unit #        File name     Created/Supplied/Appended
C      ----------------------------------------------------
C      185            FILE185        Supplied
C      209            REC187.NEG     Supplied
C      188            FILE188        Created
C      1000           OUTPUT         Appended

C      TO FIND STOP NUMBERS FOR EACH ROUTE
         SUBROUTINE REC188(OUTPUT)
         CHARACTER CARD*80, OUTPUT*12
         INTEGER N(150),A(99),B(99),S(99),ST(99),O
         OPEN(209,'REC187.NEG')
         OPEN(185,'FILE185')
         OPEN(188,'FILE188')
         OPEN(1000,OUTPUT,STATUS='APPEND')


C      FILE185 CONTAINS STOP NOS AND A-B NODES
C      UNIT188 IS OUTPUT FILE188
C      UNIT209 IS REC187.NEG
          REWIND 185

C         READ IN THE STOPNOS,ANODE AND BNODE FROM FILE185
          O=1
 30       READ(185,31,END=185) S(O),A(O),B(O)
 31       FORMAT(T1,I2,T5,2I4)
          O=O+1
          GOTO 30
185       ENDFILE 185
          NC=O-1
C         WRITE(*,*) 'NO OF RECORDS IN FILE185 IS=',NC
```

```
C        CONSIDER REC187.NEG
         REWIND 209
         I=1
C          READ IN ONLY INTERNAL NODES, NOT 8### NODES
  1        READ(209,21,END=209) (N(K),K=1,16)
 21        FORMAT(T9,16I4)

             DO 22 L=1,16
                   IF(N(L).EQ.0) GOTO 11
 22          CONTINUE
 11         C=L-1
C           WRITE(*,*) 'C=',C

             IC=0
             DO 2 J=1,C
                    IF(N(J).LT.0) THEN
                          IF (J.EQ.1) THEN
                              NUPS=ABS(N(J))
                              NDWNS=ABS(N(J+1))
                              IC=IC+1
                              GOTO 10
                           ELSE
                              NUPS=ABS(N(J-1))
                              NDWNS=ABS(N(J))
                              IC=IC+1
  10                         DO 23 M=1,NC
                               IF(NUPS.EQ.A(M) .AND. NDWNS.EQ.B(M)) THEN
                                     ST(IC)=S(M)
                               ENDIF
 23                          CONTINUE
                           ENDIF
                    ENDIF
 2            CONTINUE
         WRITE(188,33) I,(ST(L),L=1,IC)
 33      FORMAT(T78,'188',T3,I2,T9,34I2)
        I=I+1
        GOTO 1
 209    ENDFILE 209

C      ADD FILE188 TO OUTPUT FILE
       REWIND 188
       I=1
 36    READ(188,50,END=35) CARD
       WRITE(1000,50) CARD
 50    FORMAT(T1,A80)
       I=I+1
       GOTO 36
 35    ENDFILE 188

         RETURN
         END
C      ******************************************************************
C      Name of subroutine : REC189
C      Purpose : to create TRAF record type 189 and append FILE189 to the
C      output file

C      This subroutine calls : None
C      This subroutine is called by : main program

C      Unit #        File name      Created/Supplied
C      -------------------------------------------
C      103           INETCAR        Supplied
C      189           FILE189        Created
C      1000          OUTPUT         Appended

         SUBROUTINE REC189(INETCAR,OUTPUT)
```

```
        CHARACTER ONEWAY*1, OUTPUT*12, CARD*80
        CHARACTER*12 INETCAR
        OPEN(103,INETCAR)
        OPEN(189,'FILE189')
        OPEN(1000,OUTPUT,STATUS='APPEND')
        INTEGER N(150)
        NAMELIST/ROUTE/M,L,H,N,LAY,ONEWAY
        REWIND 103
        IR=0
        I=1
 1          READ(103,ROUTE,END=103)
                IR=IR+1
                IH=H*60
                WRITE(189,2) IR,IH
                IF (ONEWAY.NE.'T') THEN
                  IR=IR+1
                  WRITE(189,2) IR,IH
 2                FORMAT(T3,I2,T6,I3,T78,'189')
               ENDIF
        I=I+1
        GOTO 1
 103  ENDFILE 103

C     ADD FILE189 TO OUTPUT FILE
      REWIND 189
      I=1
 38   READ(189,50,END=37) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 38
 37   ENDFILE 187

        RETURN
        END
C     ****************************************************************************
C     Name of subroutine : REC210
C     Purpose : to create TRAF record type 210 and append FILE210 to output file

C     This subroutine calls : None
C     This subroutine is called by : main program

C     Unit #        File name     Created/Supplied
C     ------------------------------------------
C     210           FILE210       Created
C     1000          OUTPUT        Appended

        SUBROUTINE REC210(OUTPUT)
        CHARACTER OUTPUT*12, CARD*80

        OPEN(210,'FILE210')
        OPEN(1000,OUTPUT,STATUS='APPEND')

        WRITE(210,1)
        FORMAT(T4,'1',T78,'210')

C     ADD FILE210 OUTPUT FILE
      REWIND 210
      I=1
 39   READ(210,50,END=40) CARD
      WRITE(1000,50) CARD
 50   FORMAT(T1,A80)
      I=I+1
      GOTO 39
 40   ENDFILE 210

      RETURN
```

```
      END
C     ************************************************************************
```

APPENDIX C

HNET NODE CARD FILE (NODE.CRD)

1	121.00	104.00
2	89.00	104.00
3	65.00	144.00
4	29.00	104.00
5	5.00	10.00
101	121.00	114.00
102	121.00	94.00
103	89.00	94.00
104	89.00	114.00
105	75.00	144.00
106	65.00	154.00
107	29.00	114.00
108	29.00	94.00
110	105.00	154.00
111	75.00	154.00
112	55.00	154.00
113	114.00	114.00
114	45.00	154.00
115	15.00	154.00
116	105.00	114.00
117	75.00	114.00
118	55.00	114.00
119	114.00	94.00
120	45.00	114.00
121	15.00	114.00
122	105.00	94.00
123	75.00	94.00
124	55.00	94.00
126	45.00	94.00
127	15.00	94.00
128	105.00	54.00
129	75.00	54.00
130	55.00	54.00
132	45.00	54.00
133	15.00	54.00
134	105.00	14.00
135	75.00	14.00
136	45.00	14.00
137	25.00	14.00
139	15.00	14.00
141	15.00	10.00
143	45.00	31.00

HNET LINK CARD FILE (LINK.CRD)

A2	1	101	.50	51	1	1	3.00	2
A2	1	102	.50	51	1	1	3.00	2
A2	2	103	.30	52	2	1	1.20	2
A2	2	104	.30	52	2	1	1.20	2
A2	3	105	.50	54	3	2	2.00	2
A2	3	106	.50	54	3	2	2.00	2
A2	4	107	.30	54	4	1	1.20	2
A2	4	108	.30	54	4	1	1.20	2
A2	5	141	.50	54	5	3	2.00	2
A2	101	113	.50	61	1	1		2
A2	102	119	.50	61	1	1		2
A2	103	123	.65	32	2	1		2
A1	103	122	.60	62	2	1		211
A1	122	103	.60	62	2	1		2
A2	104	117	.65	32	3	1		2
A1	104	116	.60	62	3	1		211
A1	116	104	.60	62	3	1		2
A2	105	111	.55	33	3	2		2
A2	105	117	.60	34	3	2		2
A2	106	112	.60	34	3	1		1
A2	106	111	.50	34	3	2		1
A2	107	121	.65	35	4	2		1
A2	107	120	.70	34	4	2		2
A2	108	127	.65	35	4	2		1
A2	108	126	.70	34	4	2		2
A2	110	111	.70	34	3	2		1
A1	110	116	.65	32	3	1		211
A1	116	110	.65	32	3	1		2
A2	112	114	.65	34	4	2		1
A2	112	118	.65	23	3	2		2
A2	113	116	.40	162	1	1		2
A2	114	115	.70	35	4	2		1
A2	114	120	.65	34	4	2		2
A2	115	121	.65	35	4	2		1
A2	117	118	.70	33	3	2		2
A2	117	123	.65	43	2	1		2
A2	118	120	.65	33	4	2		2
A2	118	124	.65	23	2	2		2
A2	119	122	.60	162	1	1		2
A2	120	126	.65	33	4	2		2
A2	121	127	.65	35	4	2		1
A2	122	116	.65	41	1	1		2
A2	122	128	.60	32	1	1		2
A2	123	124	.60	33	2	2		2
A2	123	129	.60	34	2	2		2
A2	124	126	.65	33	4	2		2
A2	124	130	.60	23	2	2		2
A2	126	132	.60	33	4	2		2
A2	127	133	.60	35	4	2		1
A2	128	129	.65	34	2	2		2
A2	128	134	.60	35	1	3		1
A2	129	130	.60	33	2	2		2
A2	129	135	.40	34	2	3		2
A2	130	132	.45	33	5	2		2
A2	130	143	.45	13	2	3		2
A2	132	133	.55	34	5	2		2
A2	132	143	.40	33	5	3		2
A2	133	139	.60	34	5	3		1
A2	134	135	.65	35	2	3		1
A2	135	136	.65	34	2	3		1
A2	136	137	.60	34	5	3		2
A1	136	143	.60	34	2	3		222
A1	143	136	.60	34	2	3		2
A2	137	139	.65	34	5	3		2
A2	137	141	.65	14	5	3		2

O-D TRIP TABLE FILE (OD.FIL)

100	200	300	400	500
100	200	300	400	500
100	200	300	400	500
100	200	300	400	500
100	200	300	400	500

HNET SYSIN FILE

```
&PARAM ZONES=5, NODES=143, &END
&SELECT
Z1LAVS='C','D','FFT','FFS','NL','UC','GL','FT','AT','TC','LG',
REPORT=1,2,7,14,16
&END
&PLOT
 PLOTXY=8,5,11.5,PLOTN=T,
 WINDOW=4.80,9.99,121.01,154.01,
 POST='NL',
 TITLE1=' UTOWN HIGHWAY NETWORK'
&END
```

INET &ROUTE CARD FILE (INET.CRD)

```
&ROUTE M=4, L=1, H=5.0, N=-3,106,111,-105,117,-104,116,113,101,-1, ONEWAY=F,   &END
&ROUTE M=4, L=2, H=6.0, N=-4,107,120,118,117,-104,116,113,101,-1, ONEWAY=F,    &END
&ROUTE M=4, L=3, H=7.0, N=-5,141,139,133,-127,121,115,114,112,106,-3,ONEWAY=F, &END
```

APPENDIX D

INTERF.TRF

```
GRAF PROJECT #23, UTPS-TRAF INTERFACE                                                         00
RANGA RAGHUNATHAN                          08  14  93FEDERAL HIGHWAY          1       01
   0    3           180                            0 0    50715         7681       7581  02
1800                                                                                   03
                     60                                                                04
                                                       0INTERF                         05
   1 1012640          2                    113   0    0    0    0                      11
 101   12640          2                      0 1028001    0                            11
8001    1             2                    101   0  102    0    0                      11
   1 1022640          2                      0   0  119    0                            11
 102   12640          2                   8001 101    0    0  101                      11
   2 1031584          2                    122   0  123    0    0                      11
 103   21584          2                   8002 104    0    0  104                      11
8002    2             2                    104   0  103    0    0                      11
   2 1041584          2                    117   0  116    0    0                      11
 104   21584          2                      0 1038002    0                            11
   3 1052640          2                    111   0  117    0    0                      11
 105   32640          2                      08003  106    0                            11
8003    3             2                    106 105    0    0  105                      11
   3 1062640          2                    112   0  111    0    0                      11
 106   32640          2                    105    08003    0    0                      11
   4 1071584          2                    121   0  120    0    0                      11
 107   41584          2                      0 1088004    0                            11
8004    4             2                    107   0  108    0    0                      11
   4 1081584          2                    126   0  127    0    0                      11
 108   41584          2                   8004 107    0    0  107                      11
   5 1412640          2                    139 137    0    0    0                      11
 141   52640          2                      08005    0    0                            11
8005    5             2                      0 141    0    0                            11
 101 1132640          2                      0 116    0    0                            11
 113 1012640          2                      0   0    1    0                            11
 102 1192640          2                      0 122    0    0                            11
 119 1022640          2                      1   0    0    0    0                      11
 103 1233431          2                    129 124  117    0  124                      11
 123 1033431          2                      2 122    0    0  122                      11
 103 1223168          2                    116 119  128    0  119                      11
 122 1033168          2                      0 123    2    0                            11
 104 1173431          2                    123 118  105    0  118                      11
 117 1043431          2                      0 116    2    0                            11
 104 1163168          2                    110 113  122    0  113                      11
 116 1043168          2                      2 117    0    0  117                      11
 105 1112904          2                    106   0  110    0    0                      11
 111 1052904          2                      0 117    3    0                            11
 105 1173168          2                    104 123  118    0  123                      11
 117 1053168          2                      3 111    0    0  111                      11
 106 1123168          1                    118 114    0    0  114                      11
 112 1063168          1                      0 111    3    0                            11
 106 1112640          1                      0 110  105    0                            11
 111 1062640          1                      3 112    0    0  112                      11
 107 1213431          1                    127   0  115    0    0                      11
 121 1073431          1                      0 120    4    0                            11
 107 1203695          2                    114 118  126    0  118                      11
 120 1073695          2                      4 121    0    0  121                      11
 108 1273431          1                    133   0  121    0    0                      11
 127 1083431          1                      4 126    0    0  126                      11
 108 1263695          2                    120 124  132    0  124                      11
 126 1083695          2                      0 127    4    0                            11
 110 1113695          1                    105 106    0    0  106                      11
 111 1103695          1                      0   0  116    0                            11
 110 1163431          2                    113 122  104    0  122                      11
 116 1103431          2                    111   0    0    0    0                      11
 112 1143431          1                    120 115    0    0  115                      11
 114 1123431          1                      0 106  118    0                            11
 112 1183431          2                    117 124  120    0  124                      11
 118 1123431          2                    114   0  106    0    0                      11
 113 1162112          2                    122 104  110    0  104                      11
 116 1132112          2                      0 101    0    0                            11
 114 1153695          1                    121   0    0    0    0                      11
 115 1143695          1                      0 112  120    0                            11
```

114	1203431	2	118	126	107	0	126	11
120	1143431	2	115	0	112	0	0	11
115	1213431	1	107	127	0	0	127	11
121	1153431	1	0	0	114	0		11
117	1183695	2	124	120	112	0	120	11
118	1173695	2	105	104	123	0	104	11
117	1233431	2	103	129	124	0	129	11
123	1173431	2	118	105	104	0	105	11
118	1203431	2	126	107	114	0	107	11
120	1183431	2	112	117	124	0	117	11
118	1243431	2	123	130	126	0	130	11
124	1183431	2	120	112	117	0	112	11
119	1223168	2	128	103	116	0	103	11
122	1193168	2	0	102	0	0		11
120	1263431	2	124	132	108	0	132	11
126	1203431	2	107	114	118	0	114	11
121	1273431	1	108	133	0	0	133	11
127	1213431	1	0	115	107	0		11
122	1163431	2	104	110	113	0	110	11
116	1223431	2	119	128	103	0	128	11
122	1283168	2	0	134	129	0		11
128	1223168	2	103	116	119	0	116	11
123	1243168	2	130	126	118	0	126	11
124	1233168	2	117	103	129	0	103	11
123	1293168	2	128	135	130	0	135	11
129	1233168	2	124	117	103	0	117	11
124	1263431	2	132	108	120	0	108	11
126	1243431	2	118	123	130	0	123	11
124	1303168	2	129	143	132	0	0	11
130	1243168	2	126	118	123	0	118	11
126	1323168	2	130	143	133	0	143	11
132	1263168	2	108	120	124	0	120	11
127	1333168	1	132	139	0	0	139	11
133	1273168	1	0	121	108	0		11
128	1293431	2	135	130	123	0	130	11
129	1283431	2	122	0	134	0	0	11
128	1343168	1	0	0	135	0		11
134	1283168	1	129	122	0	0	122	11
129	1303168	2	143	132	124	0	132	11
130	1293168	2	123	128	135	0	128	11
129	1352112	2	134	0	136	0	0	11
135	1292112	2	130	123	128	0	123	11
130	1322375	2	143	133	126	0	133	11
132	1302375	2	124	129	143	0	129	11
130	1432375	2	136	137	132	0	137	11
143	1302375	2	132	124	129	0	0	11
132	1332904	2	139	0	127	0	0	11
133	1322904	2	126	130	143	0	130	11
132	1432112	2	130	136	137	0	136	11
143	1322112	2	133	126	130	0	126	11
133	1393168	1	137	141	0	0	141	11
139	1333168	1	0	127	132	0		11
134	1353431	1	0	136	129	0		11
135	1343431	1	128	0	0	0	0	11
135	1363431	1	0	137	143	0		11
136	1353431	1	129	134	0	0	134	11
136	1373168	2	141	139	143	0	139	11
137	1363168	2	143	135	0	0	135	11
136	1433168	2	137	132	130	0	132	11
143	1363168	2	135	0	137	0	0	11
137	1393431	2	141	0	133	0	0	11
139	1373431	2	143	136	141	0	136	11
137	1413431	2	0	5	139	0		11
141	1373431	2	139	143	136	0	143	11
137	1433168	2	132	130	136	0	130	11
143	1373168	2	136	141	139	0	141	11
139	1413168	2	137	0	5	0	0	11

```
141 1393168          2                    0 133 137   0                        11
  1     1018001 102                                                            35
  2     1038002 104                                                            35
  3     1058003 106                                                            35
  4     1078004 108                                                            35
  5     1418005                                                                35
101       1 113                                                                35
102       1 119                                                                35
103       2 123 122                                                            35
104       2 117 116                                                            35
105       3 111 117                                                            35
106       3 112 111                                                            35
107       4 121 120                                                            35
108       4 127 126                                                            35
110     111 116                                                                35
111     105 106 110                                                            35
112     106 114 118                                                            35
113     101 116                                                                35
114     112 115 120                                                            35
115     114 121                                                                35
116     104 110 113 122                                                        35
117     104 105 118 123                                                        35
118     112 117 120 124                                                        35
119     102 122                                                                35
120     107 114 118 126                                                        35
121     107 115 127                                                            35
122     103 119 116 128                                                        35
123     103 117 124 129                                                        35
124     118 123 126 130                                                        35
126     108 120 124 132                                                        35
127     108 121 133                                                            35
128     122 129 134                                                            35
129     123 128 130 135                                                        35
130     124 129 132 143                                                        35
132     126 130 133 143                                                        35
133     127 132 139                                                            35
134     128 135                                                                35
135     129 134 136                                                            35
136     135 137 143                                                            35
137     136 139 141 143                                                        35
139     133 137 141                                                            35
141       5 137 139                                                            35
143     130 132 136 137                                                        35
  1  1                                                                         36
  2  1                                                                         36
  3  1                                                                         36
  4  1                                                                         36
  5  1                                                                         36
101                                                                            36
102                                                                            36
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 136                                                                            36
 137                                                                            36
 139                                                                            36
 141                                                                            36
 143                                                                            36
                                                                               170
                        3               0   1          2                       175
8001        8002 2008003 3008004 4008005 500                                   176
8002        8001 1008003 3008004 4008005 500                                   176
8003        8001 1008002 2008004 4008005 500                                   176
8004        8001 1008002 2008003 3008005 500                                   176
8005        8001 1008002 2008003 3008004 400                                   176
 1      3 106   20 1  1                                                        185
 2    106   3   20 1  1                                                        185
 3    111 105   20 1  1                                                        185
 4    105 111   20 1  1                                                        185
 5    117 104   20 1  1                                                        185
 6    104 117   20 1  1                                                        185
 7    101   1   20 1  1                                                        185
 8      1 101   20 1  1                                                        185
 9      4 107   20 1  1                                                        185
10    107   4   20 1  1                                                        185
11      5 141   20 1  1                                                        185
12    141   5   20 1  1                                                        185
13    133 127   20 1  1                                                        185
14    127 133   20 1  1                                                        185
   1 120  20                                                                   186
   2 120  20                                                                   186
   3 120  20                                                                   186
   4 120  20                                                                   186
   5 120  20                                                                   186
   6 120  20                                                                   186
   7 120  20                                                                   186
   8 120  20                                                                   186
   9 120  20                                                                   186
  10 120  20                                                                   186
  11 120  20                                                                   186
  12 120  20                                                                   186
  13 120  20                                                                   186
  14 120  20                                                                   186
   18003   3 106 111 105 117 104 116 113 101     18001                         187
   28001   1 101 113 116 104 117 105 111 106     38003                         187
   38004   4 107 120 118 117 104 116 113 101     18001                         187
   48001   1 101 113 116 104 117 118 120 107     48004                         187
   58005   5 141 139 133 127 121 115 114 112 106     38003                     187
   68003   3 106 112 114 115 121 127 133 139 141     58005                     187
   1        1 3 5 7                                                            188
   2        8 6 4 2                                                            188
   3        9 5 7                                                              188
   4        8 610                                                              188
   5       1113 2                                                              188
   6        114                                                                188
   1 300                                                                       189
   2 300                                                                       189
```

3 360	189
4 360	189
5 420	189
6 420	189
1	210

INTERFS

```
GRAF PROJECT #23, UTPS-TRAF INTERFACE                                                0
RANGA RAGHUNATHAN                        08  14  93FEDERAL HIGHWAY          1        1
   0    1         180                          0 0   30715        7681     7581      2
1800                                                                                 3
                   60                                                                4
                                                     0INTERF                         5
   1 1012640          2          113    0    0    0    0                            11
 101   12640          2            0 1028001      0                                 11
8001    1             2          101    0  102    0    0                            11
   1 1022640          2            0    0  119    0                                 11
 102   12640          2         8001  101    0    0  101                            11
   2 1031584          2          122    0  123    0    0                            11
 103   21584          2         8002  104    0    0  104                            11
8002    2             2          104    0  103    0    0                            11
   2 1041584          2          117    0  116    0    0                            11
 104   21584          2            0 1038002      0                                 11
   3 1052640          2          111    0  117    0    0                            11
 105   32640          2            08003  106     0                                 11
8003    3             2          106  105    0    0  105                            11
   3 1062640          2          112    0  111    0    0                            11
 106   32640          2          105    08003     0    0                            11
   4 1071584          2          121    0  120    0    0                            11
 107   41584          2            0 1088004      0                                 11
8004    4             2          107    0  108    0    0                            11
   4 1081584          2          126    0  127    0    0                            11
 108   41584          2         8004  107    0    0  107                            11
   5 1412640          2          139  137    0    0    0                            11
 141   52640          2            08005     0    0                                 11
8005    5             2            0  141    0    0                                 11
 101 1132640          2            0  116    0    0                                 11
 113 1012640          2            0    0    1    0                                 11
 102 1192640          2            0  122    0    0                                 11
 119 1022640          2            1    0    0    0    0                            11
 103 1233431          2          129  124  117    0  124                            11
 123 1033431          2            2  122    0    0  122                            11
 103 1223168          2          116  119  128    0  119                            11
 122 1033168          2            0  123    2    0                                 11
 104 1173431          2          123  118  105    0  118                            11
 117 1043431          2            0  116    2    0                                 11
 104 1163168          2          110  113  122    0  113                            11
 116 1043168          2            2  117    0    0  117                            11
 105 1112904          2          106    0  110    0    0                            11
 111 1052904          2            0  117    3    0                                 11
 105 1173168          2          104  123  118    0  123                            11
 117 1053168          2            3  111    0    0  111                            11
 106 1123168          1          118  114    0    0  114                            11
 112 1063168          1            0  111    3    0                                 11
 106 1112640          1            0  110  105    0                                 11
 111 1062640          1            3  112    0    0  112                            11
 107 1213431          1          127    0  115    0    0                            11
 121 1073431          1            0  120    4    0                                 11
 107 1203695          2          114  118  126    0  118                            11
 120 1073695          2            4  121    0    0  121                            11
 108 1273431          1          133    0  121    0    0                            11
 127 1083431          1            4  126    0    0  126                            11
 108 1263695          2          120  124  132    0  124                            11
 126 1083695          2            0  127    4    0                                 11
 110 1113695          1          105  106    0    0  106                            11
 111 1103695          1            0    0  116    0                                 11
 110 1163431          2          113  122  104    0  122                            11
 116 1103431          2          111    0    0    0    0                            11
 112 1143431          1          120  115    0    0  115                            11
 114 1123431          1            0  106  118    0                                 11
 112 1183431          2          117  124  120    0  124                            11
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118	1123431	2	114	0	106	0	0	11
113	1162112	2	122	104	110	0	104	11
116	1132112	2	0	101	0	0		11
114	1153695	1	121	0	0	0	0	11
115	1143695	1	0	112	120	0		11
114	1203431	2	118	126	107	0	126	11
120	1143431	2	115	0	112	0	0	11
115	1213431	1	107	127	0	0	127	11
121	1153431	1	0	0	114	0		11
117	1183695	2	124	120	112	0	120	11
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117	1233431	2	103	129	124	0	129	11
123	1173431	2	118	105	104	0	105	11
118	1203431	2	126	107	114	0	107	11
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122	1193168	2	0	102	0	0		11
120	1263431	2	124	132	108	0	132	11
126	1203431	2	107	114	118	0	114	11
121	1273431	1	108	133	0	0	133	11
127	1213431	1	0	115	107	0		11
122	1163431	2	104	110	113	0	110	11
116	1223431	2	119	128	103	0	128	11
122	1283168	2	0	134	129	0		11
128	1223168	2	103	116	119	0	116	11
123	1243168	2	130	126	118	0	126	11
124	1233168	2	117	103	129	0	103	11
123	1293168	2	128	135	130	0	135	11
129	1233168	2	124	117	103	0	117	11
124	1263431	2	132	108	120	0	108	11
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130	1243168	2	126	118	123	0	118	11
126	1323168	2	130	143	133	0	143	11
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133	1273168	1	0	121	108	0		11
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129	1283431	2	122	0	134	0	0	11
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134	1283168	1	129	122	0	0	122	11
129	1303168	2	143	132	124	0	132	11
130	1293168	2	123	128	135	0	128	11
129	1352112	2	134	0	136	0	0	11
135	1292112	2	130	123	128	0	123	11
130	1322375	2	143	133	126	0	133	11
132	1302375	2	124	129	143	0	129	11
130	1432375	2	136	137	132	0	137	11
143	1302375	2	132	124	129	0	0	11
132	1332904	2	139	0	127	0	0	11
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139	1373431	2	143	136	141	0	136	11

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141	1373431			2		139	143	136	0	143	11
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143	1373168			2		136	141	139	0	141	11
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141	1393168			2		0	133	137	0		11
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101	1	0	0	100	0						21
141	137	0	76	24	0						21
1	102	0	0	100	0						21
102	1	100	0	0	0						21
2	103	0	0	100	0						21
103	2	100	0	0	0						21
137	143	0	100	0	0						21
2	104	83	0	17	0						21
104	2	0	0	100	0						21
3	105	0	0	100	0						21
105	3	0	100	0	0						21
143	137	0	0	100	0						21
3	106	90	0	10	0						21
106	3	0	0	100	0						21
4	107	0	0	100	0						21
107	4	0	0	100	0						21
139	141	0	0	100	0						21
4	108	17	0	83	0						21
108	4	100	0	0	0						21
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104	117	0	56	44	0						21
117	104	0	34	66	0						21
104	116	0	100	0	0						21
116	104	26	74	0	0						21
105	111	50	0	50	0						21
111	105	0	80	20	0						21
105	117	35	36	29	0						21
117	105	100	0	0	0						21
106	112	56	44	0	0						21
112	106	0	0	100	0						21
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108	127	100	0	0	0						21
127	108	100	0	0	0						21
108	126	0	100	0	0						21
126	108	0	0	100	0						21
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112	118	0	100	0	0						21
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116	113	0	100	0	0						21

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115	121	20	80	0	0	21
121	115	0	0	100	0	21
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116	122	20	60	20	0	21
122	128	0	0	100	0	21
128	122	0	0	100	0	21
123	124	54	46	0	0	21
124	123	43	57	0	0	21
123	129	0	100	0	0	21
129	123	0	0	100	0	21
124	126	0	100	0	0	21
126	124	0	100	0	0	21
124	130	0	100	0	0	21
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132	126	20	60	20	0	21
127	133	0	100	0	0	21
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128	129	52	48	0	0	21
129	128	100	0	0	0	21
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137	136	0	100	0	0	21
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143	136	50	0	50	0	21
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139	137	20	60	20	0	21
137	141	0	100	0	0	21
8001	1	64	0	36	0	21
8002	2	46	0	54	0	21

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8004   4  45   0  55   0                                             21
8005   5   0 100   0   0                                             21
   1     1018001 102                                                 35
   2     1038002 104                                                 35
   3     1058003 106                                                 35
   4     1078004 108                                                 35
   5     1418005                                                     35
 101       1 113                                                     35
 102       1 119                                                     35
 103       2 123 122                                                 35
 104       2 117 116                                                 35
 105       3 111 117                                                 35
 106       3 112 111                                                 35
 107       4 121 120                                                 35
 108       4 127 126                                                 35
 110     111 116                                                     35
 111     105 106 110                                                 35
 112     106 114 118                                                 35
 113     101 116                                                     35
 114     112 115 120                                                 35
 115     114 121                                                     35
 116     104 110 113 122                                             35
 117     104 105 118 123                                             35
 118     112 117 120 124                                             35
 119     102 122                                                     35
 120     107 114 118 126                                             35
 121     107 115 127                                                 35
 122     103 119 116 128                                             35
 123     103 117 124 129                                             35
 124     118 123 126 130                                             35
 126     108 120 124 132                                             35
 127     108 121 133                                                 35
 128     122 129 134                                                 35
 129     123 128 130 135                                             35
 130     124 129 132 143                                             35
 132     126 130 133 143                                             35
 133     127 132 139                                                 35
 134     128 135                                                     35
 135     129 134 136                                                 35
 136     135 137 143                                                 35
 137     136 139 141 143                                             35
 139     133 137 141                                                 35
 141       5 137 139                                                 35
 143     130 132 136 137                                             35
   1  1                                                              36
   2  1                                                              36
   3  1                                                              36
   4  1                                                              36
   5  1                                                              36
 101                                                                 36
 102                                                                 36
 103                                                                 36
 104                                                                 36
 105                                                                 36
 106                                                                 36
 107                                                                 36
 108                                                                 36
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 111                                                                 36
 112                                                                 36
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 115                                                                 36
 116                                                                 36
 117                                                                 36
 118                                                                 36
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 119                                                                                  36
 120                                                                                  36
 121                                                                                  36
 122                                                                                  36
 123                                                                                  36
 124                                                                                  36
 126                                                                                  36
 127                                                                                  36
 128                                                                                  36
 129                                                                                  36
 130                                                                                  36
 132                                                                                  36
 133                                                                                  36
 134                                                                                  36
 135                                                                                  36
 136                                                                                  36
 137                                                                                  36
 139                                                                                  36
 141                                                                                  36
 143                                                                                  36
8001    11400   0   0                                                                 50
8002    21300   0   0                                                                 50
8003    31200   0   0                                                                 50
8004    41100   0   0                                                                 50
8005    51000   0   0                                                                 50
                                                                                     170
 1      3 106  20 1 1                                                                185
 2    106   3  20 1 1                                                                185
 3    111 105  20 1 1                                                                185
 4    105 111  20 1 1                                                                185
 5    117 104  20 1 1                                                                185
 6    104 117  20 1 1                                                                185
 7    101   1  20 1 1                                                                185
 8      1 101  20 1 1                                                                185
 9      4 107  20 1 1                                                                185
10    107   4  20 1 1                                                                185
11      5 141  20 1 1                                                                185
12    141   5  20 1 1                                                                185
13    133 127  20 1 1                                                                185
14    127 133  20 1 1                                                                185
   1 120  20                                                                         186
   2 120  20                                                                         186
   3 120  20                                                                         186
   4 120  20                                                                         186
   5 120  20                                                                         186
   6 120  20                                                                         186
   7 120  20                                                                         186
   8 120  20                                                                         186
   9 120  20                                                                         186
  10 120  20                                                                         186
  11 120  20                                                                         186
  12 120  20                                                                         186
  13 120  20                                                                         186
  14 120  20                                                                         186
  18003   3 106 111 105 117 104 116 113 101     18001                                187
  28001   1 101 113 116 104 117 105 111 106     38003                                187
  38004   4 107 120 118 117 104 116 113 101     18001                                187
  48001   1 101 113 116 104 117 118 120 107     48004                                187
  58005   5 141 139 133 127 121 115 114 112 106     38003                            187
  68003   3 106 112 114 115 121 127 133 139 141     58005                            187
  1        1 3 5 7                                                                   188
  2        8 6 4 2                                                                   188
  3        9 5 7                                                                     188
  4        8 610                                                                     188
  5       1113 2                                                                     188
  6        114                                                                       188
  1 300                                                                              189
```

2 300	189
3 360	189
4 360	189
5 420	189
6 420	189
1	210

INTERF.OUT

```
TTTTTTTTTTT  RRRRRRRRR        AAAAAAA     FFFFFFFFFFF
TTTTTTTTTTT  RRRRRRRRRR     AAAAAAAAA     FFFFFFFFFFF
TTTTTTTTTTT  RRRRRRRRRRR  AAAAAAAAAAA    FFFFFFFFFFF
    TTT      RRR     RRR  AAA     AAA    FFF
    TTT      RRR     RRR  AAA     AAA    FFF
    TTT      RRRRRRRRRRR  AAAAAAAAAAA    FFFFFFF
    TTT      RRRRRRRRRR   AAAAAAAAAAA    FFFFFFF
    TTT      RRR RRR      AAA     AAA    FFF
    TTT      RRR  RRR     AAA     AAA    FFF
    TTT      RRR   RRR    AAA     AAA    FFF
    TTT      RRR    RRR   AAA     AAA    FFF
    TTT      RRR     RRR  AAA     AAA    FFF

     MICRO-COMPUTER PROTECTED-MODE VERSION
      (REQUIRES 80386 AND 80387 OR ABOVE)
```

```
                                   VERSION 4.00
                                RELEASE DATE APR 1993
                                TRAF SIMULATION MODEL

                                   DEVELOPED FOR

                          U. S. DEPARTMENT OF TRANSPORTATION
                            FEDERAL HIGHWAY ADMINISTRATION
                   INTELLIGENT VEHICLE HIGHWAY SYSTEM RESEARCH DIVISION
**************************************************************************************************************************

                                   START OF CASE   1

**************************************************************************************************
              TRAF SIMULATION MODEL

                                   DEVELOPED FOR

                          U. S. DEPARTMENT OF TRANSPORTATION
                            FEDERAL HIGHWAY ADMINISTRATION
                   INTELLIGENT VEHICLE HIGHWAY SYSTEM RESEARCH DIVISION
0*************************************************************************************************************************

                                   START OF CASE   1

**************************************************************************************************************************
                      GRAF PROJECT #23, UTPS-TRAF INTERFACE


                              DATE  -  08/  14/  93
                              USER  -  RANGA RAGHUNATHAN
                            AGENCY  -  FEDERAL HIGHWAY
                                    RUN CONTROL DATA

              VALUE                        RUN PARAMETERS AND OPTIONS

               1000     RUN IDENTIFICATION NUMBER
                  0     NEXT CASE CODE - (0,1) IF ANOTHER CASE (DOES NOT, DOES) FOLLOW
                  3     RUN TYPE CODE - ( 1, 2, 3) TO RUN (SIMULATION, ASSIGNMENT, BOTH)
                                        (-1,-2,-3) TO CHECK (SIMULATION, ASSIGNMENT, BOTH) ONLY

                  0     NETFLO FUEL RUN CODE - (0,1) IF FUEL (WILL, WILL NOT) BE CALCULATED
                  0     INPUT  UNITS CODE - (0,1) IF INPUT IS IN (ENGLISH, METRIC) UNITS
                  0     OUTPUT UNITS CODE - (0,1,2,3) IF OUTPUT IS IN (SAME AS INPUT, ENGLISH, METRIC, BOTH) UNITS
                715     CLOCK TIME AT START OF SIMULATION (HHMM)
               7581     RANDOM NUMBER SEED
               7681     RANDOM NUMBER SEED TO GENERATE TRAFFIC STREAM FOR NETSIM OR LEVEL I SIMULATION

               1800     DURATION (SEC) OF TIME PERIOD NO.  1
                 60     LENGTH OF A TIME INTERVAL, SECONDS
                180     MAXIMUM INITIALIZATION TIME, NUMBER OF TIME INTERVALS
                  0     NUMBER OF TIME INTERVALS BETWEEN SUCCESSIVE STANDARD OUTPUTS
                  0     NUMBER OF TIME INTERVALS BETWEEN SUCCESSIVE INTERMEDIATE OUTPUTS FOR MACROSCOPIC MODELS
                                     TRAFFIC ASSIGNMENT PARAMETERS

                           EPSILON (OBJ.FUNC.THRESHOLD VALUE)  -  1.0 %  +

                           LINE SEARCH ACCURACY OF OBJ.FUNCION -  1.0 %  +

                           MAX.NUMBER OF ASSIGNMENT ITERATIONS -  5      +

                           MAX.NUMBER OF CAPACITY CALIBRATIONS -  3

                               CARRY-OVER CAPACITY FACTOR ( %) -  0

                           TYPE OF OBJECTIVE FUNCTION
                             (0:USER OPTIMAL, 1:SYSTEM OPTIMAL)-  0      +

                           IMPEDANCE FUNCTION PARAMETERS:
                                                    ALPHA - 60/100  +
                                                    BETA  - 40/ 10  +

                             TYPE (0:FHWA, 1:MODIFIED DAVIDSON)-  0      +

                                  (+) :INDICATES DEFAULT VALUE
```

REQUESTED INTERMEDIATE OUTPUT CODE = 0
0: NO INTERMEDIATE OUTPUT
1: PATH ASSIGNMENTS
2: TREE CONSTRUCTS
3: DETAILED O-D TREES
4: ALL OUTPUTS 1,2 AND 3

EQUIVALENT SIMULATION DATA SET WILL BE WRITTEN AS REQUESTED TO FILE: INTERFS

TRIP TABLE

FOR EACH ORIGIN NODE, TABLE PROVIDES LISTING OF PAIRS OF DATA : DESTINATION NODE/VOLUME

ORIGIN NODE (8001)	8002/ 200	8003/ 300	8004/ 400	8005/ 500
ORIGIN NODE (8002)	8001/ 100	8003/ 300	8004/ 400	8005/ 500
ORIGIN NODE (8003)	8001/ 100	8002/ 200	8004/ 400	8005/ 500
ORIGIN NODE (8004)	8001/ 100	8002/ 200	8003/ 300	8005/ 500

PROPERTIES OF BUS STATIONS

STATION NO.	LANE SERVICED	LINK	DISTANCE FROM UPSTREAM NODE FEET	/ METERS	CAPACITY (BUSES)	MEAN DWELL (SEC)	TYPE	PERCENT OF BUSES STOPPING
1	0	(3, 106)	2620	799	1	120	1	80
2	0	(106, 3)	2620	799	1	120	1	80
3	0	(111, 105)	2884	879	1	120	1	80
4	0	(105, 111)	2884	879	1	120	1	80
5	0	(117, 104)	3411	1040	1	120	1	80
6	0	(104, 117)	3411	1040	1	120	1	80
7	0	(101, 1)	2620	799	1	120	1	80
8	0	(1, 101)	2620	799	1	120	1	80
9	0	(4, 107)	1564	477	1	120	1	80
10	0	(107, 4)	1564	477	1	120	1	80
11	0	(5, 141)	2620	799	1	120	1	80
12	0	(141, 5)	2620	799	1	120	1	80
13	0	(133, 127)	3148	960	1	120	1	80
14	0	(127, 133)	3148	960	1	120	1	80

THE TYPE CODE IDENTIFIES THE APPLICABLE STATISTICAL DISTRIBUTION OF DWELL TIME

BUS ROUTE PATHS

ROUTE	SEQUENCE OF NODES DEFINING PATH											
1	8003	3	106	111	105	117	104	116	113	101	1	8001
2	8001	1	101	113	116	104	117	105	111	106	3	8003
3	8004	4	107	120	118	117	104	116	113	101	1	8001
4	8001	1	101	113	116	104	117	118	120	107	4	8004
5	8005	5	141	139	133	127	121	115	114	112	106	3 8003
6	8003	3	106	112	114	115	121	127	133	139	141	5 8005

BUS STATIONS BY ROUTE

ROUTE	SEQUENCE OF STATIONS SERVICED BY ROUTE			
1	1	3	5	7
2	8	6	4	2
3	9	5	7	
4	8	6	10	
5	11	13	2	
6	1	14		

MAXIMUM NUMBER OF BUS ROUTES ALLOWED 100
MAXIMUM NUMBER OF BUS MANUVERS ALLOWED 2500
MAXIMUM NUMBER OF BUS STATIONS ALLOWED 99

BUS VOLUMES

ROUTE	VOLUME (VEH/HR)	MEAN HEADWAY (SEC)
1	12	300
2	12	300
3	10	360
4	10	360
5	9	420
6	9	420

TRAFFIC ASSIGNMENT :SOURCE VOLUMES

ORIGIN NODE	VOLUME (VPH)
8001	1400
8002	1300
8003	1200
8004	1100
8005	1000

TRAFFIC ASSIGNMENT :SINK VOLUMES

DESTINATION NODE	VOLUME (VPH)
8001	400
8002	800
8003	1200
8004	1600
8005	2000

DESTINATION TRIP TABLE

FOR EACH DESTINATION NODE, TABLE PROVIDES LISTING OF DATA PAIRS: ORIGIN NODE/VOLUME

DESTINATION (8001)	8002/ 100	8003/ 100	8004/ 100	8005/ 100
DESTINATION (8002)	8001/ 200	8003/ 200	8004/ 200	8005/ 200
DESTINATION (8003)	8001/ 300	8002/ 300	8004/ 300	8005/ 300
DESTINATION (8004)	8001/ 400	8002/ 400	8003/ 400	8005/ 400
DESTINATION (8005)	8001/ 500	8002/ 500	8003/ 500	8004/ 500

TRAFFIC ASSIGNMENT EVALUATION

ITERATION	OBJECTIVE FUNCTION VALUE (VEH-SEC)	BOUND GAP(%)	LAMBDA	CONTRIBUTION(%)
1	0.1255981820E+10	100.000000	1.000000	51.973316
2	0.1247731580E+10	0.945492	0.480267	48.026684

TRAFFIC ASSIGNMENT RESULTS

LEVEL I SUBNETWORK

LINK	INTERNAL CENTROID	RIGHT TURN VOL. VPH	RIGHT TURN PCT.	THRU VOL. VPH	THRU PCT.	LEFT TURN VOL. VPH	LEFT TURN PCT.	DIAGONAL VOL. VPH	DIAGONAL PCT.	SOURCE FLOW VPH	SINK FLOW VPH	DISCHARGE VOLUME VPH	SPEED ESTIMATE MPH
(1, 101)	0	0	0	0	0	900	100	0	0	0	0	900	24.8
(101, 1)	0	300	100	0	0	0	0	0	0	0	0	300	25.0
(8001, 1)	0	500	36	0	0	900	64	0	0	0	0	1400	
(1, 102)	0	500	100	0	0	0	0	0	0	0	0	500	26.9
(102, 1)	0	0	0	0	0	100	100	0	0	0	0	100	26.1
(2, 103)	0	708	100	0	0	0	0	0	0	0	0	708	21.9
(103, 2)	0	0	0	0	0	304	100	0	0	0	0	304	23.6
(8002, 2)	0	708	54	0	0	592	46	0	0	0	0	1300	
(2, 104)	0	100	17	0	0	492	83	0	0	0	0	592	23.7
(104, 2)	0	496	100	0	0	0	0	0	0	0	0	496	24.2
(3, 105)	0	720	100	0	0	0	0	0	0	0	0	720	24.1
(105, 3)	0	0	0	612	100	0	0	0	0	0	0	612	25.3
(8003, 3)	0	0	0	720	60	480	40	0	0	0	0	1200	
(3, 106)	0	48	10	0	0	432	90	0	0	0	0	480	24.9
(106, 3)	0	588	100	0	0	0	0	0	0	0	0	588	25.9
(4, 107)	0	496	100	0	0	0	0	0	0	0	0	496	25.0
(107, 4)	0	1184	100	0	0	0	0	0	0	0	0	1184	8.7
(8004, 4)	0	604	55	0	0	496	45	0	0	0	0	1100	
(4, 108)	0	500	83	0	0	104	17	0	0	0	0	604	24.7
(108, 4)	0	0	0	0	0	416	100	0	0	0	0	416	20.1
(5, 141)	0	0	0	600	60	400	40	0	0	0	0	1000	23.1
(141, 5)	0	0	0	2000	100	0	0	0	0	0	0	2000	17.2
(8005, 5)	0	0	0	1000	100	0	0	0	0	0	0	1000	
(101, 113)	0	0	0	900	100	0	0	0	0	0	0	900	26.2
(113, 101)	0	300	100	0	0	0	0	0	0	0	0	300	27.2
(102, 119)	0	0	0	500	100	0	0	0	0	0	0	500	26.8
(119, 102)	0	0	0	0	0	100	100	0	0	0	0	100	26.4
(103, 123)	0	0	0	448	63	260	37	0	0	0	0	708	27.1
(123, 103)	0	0	0	0	0	304	100	0	0	0	0	304	26.7
(103, 122)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(122, 103)	0	0	20	0	80	0	0	0	0	0	0	0	0.0
(104, 117)	0	456	44	592	56	0	0	0	0	0	0	1048	20.8
(117, 104)	0	296	66	152	34	0	0	0	0	0	0	448	27.5
(104, 116)	0	0	0	252	100	0	0	0	0	0	0	252	27.3
(116, 104)	0	0	0	556	74	200	26	0	0	0	0	756	26.5
(105, 111)	0	0	50	0	0	0	50	0	0	0	0	0	0.0
(111, 105)	0	0	20	0	80	0	0	0	0	0	0	0	0.0
(105, 117)	0	208	29	260	36	252	35	0	0	0	0	720	26.4
(117, 105)	0	0	0	0	0	612	100	0	0	0	0	612	21.7
(106, 112)	0	0	0	192	44	240	56	0	0	0	0	432	26.6
(112, 106)	0	444	100	0	0	0	0	0	0	0	0	444	21.5
(106, 111)	0	0	0	48	100	0	0	0	0	0	0	48	26.8
(111, 106)	0	0	0	0	0	144	100	0	0	0	0	144	26.3
(107, 121)	0	0	50	0	0	0	50	0	0	0	0	0	0.0
(121, 107)	0	192	100	0	0	0	0	0	0	0	0	192	27.5

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TRAFFIC ASSIGNMENT RESULTS (CONT.)

LEVEL I SUBNETWORK

LINK	INTERNAL CENTROID	RIGHT TURN VOL. VPH	RIGHT TURN PCT.	THRU VOL. VPH	THRU PCT.	LEFT TURN VOL. VPH	LEFT TURN PCT.	DIAGONAL VOL. VPH	DIAGONAL PCT.	SOURCE FLOW VPH	SINK FLOW VPH	DISCHARGE VOLUME VPH	SPEED ESTIMATE MPH
(107, 120)	0	0	0	340	69	156	31	0	0	0	0	496	27.5
(120, 107)	0	0	0	0	0	992	100	0	0	0	0	992	12.9
(108, 127)	0	0	0	0	0	500	100	0	0	0	0	500	21.5
(127, 108)	0	0	0	0	0	208	100	0	0	0	0	208	26.4
(108, 126)	0	0	0	104	100	0	0	0	0	0	0	104	27.6
(126, 108)	0	208	100	0	0	0	0	0	0	0	0	208	27.9
(110, 111)	0	0	0	144	100	0	0	0	0	0	0	144	27.6
(111, 110)	0	48	100	0	0	0	0	0	0	0	0	48	27.9
(110, 116)	0	0	0	0	0	48	100	0	0	0	0	48	27.1
(116, 110)	0	0	0	0	0	144	100	0	0	0	0	144	27.2
(112, 114)	0	0	0	0	0	192	100	0	0	0	0	192	26.8
(114, 112)	0	0	0	156	100	0	0	0	0	0	0	156	27.4
(112, 118)	0	0	0	240	100	0	0	0	0	0	0	240	27.3
(118, 112)	0	288	100	0	0	0	0	0	0	0	0	288	27.5
(113, 116)	0	144	16	756	84	0	0	0	0	0	0	900	25.1
(116, 113)	0	0	0	300	100	0	0	0	0	0	0	300	26.1
(114, 115)	0	0	0	0	0	0	100	0	0	0	0	0	0.0
(115, 114)	0	0	20	0	80	0	0	0	0	0	0	0	0.0
(114, 120)	0	192	100	0	0	0	0	0	0	0	0	192	27.0
(120, 114)	0	156	100	0	0	0	0	0	0	0	0	156	27.8
(115, 121)	0	0	0	0	80	0	20	0	0	0	0	0	0.0
(121, 115)	0	0	100	0	0	0	0	0	0	0	0	0	0.0
(117, 118)	0	0	0	800	100	0	0	0	0	0	0	800	24.2
(118, 117)	0	0	0	196	100	0	0	0	0	0	0	196	27.6
(117, 123)	0	0	0	260	100	0	0	0	0	0	0	260	27.1
(123, 117)	0	0	0	156	100	0	0	0	0	0	0	156	27.4
(118, 120)	0	0	0	800	100	0	0	0	0	0	0	800	26.4
(120, 118)	0	0	0	196	58	144	42	0	0	0	0	340	27.3
(118, 124)	0	0	0	240	100	0	0	0	0	0	0	240	27.4
(124, 118)	0	0	0	144	100	0	0	0	0	0	0	144	27.4
(119, 122)	0	0	0	0	0	500	100	0	0	0	0	500	25.1
(122, 119)	0	0	0	100	100	0	0	0	0	0	0	100	27.3
(120, 126)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(126, 120)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(121, 127)	0	0	0	0	80	0	20	0	0	0	0	0	0.0
(127, 121)	0	192	100	0	0	0	0	0	0	0	0	192	27.5
(122, 116)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(116, 122)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(122, 128)	0	500	100	0	0	0	0	0	0	0	0	500	26.0
(128, 122)	0	100	100	0	0	0	0	0	0	0	0	100	27.6
(123, 124)	0	0	0	208	46	240	54	0	0	0	0	448	27.0
(124, 123)	0	0	0	208	57	156	43	0	0	0	0	364	27.1
(123, 129)	0	0	0	520	100	0	0	0	0	0	0	520	25.9
(129, 123)	0	96	100	0	0	0	0	0	0	0	0	96	27.6
(124, 126)	0	0	0	208	100	0	0	0	0	0	0	208	27.5

TRAFFIC ASSIGNMENT RESULTS (CONT.)

LEVEL I SUBNETWORK

LINK	INTERNAL CENTROID	RIGHT TURN VOL. VPH	RIGHT TURN PCT.	THRU VOL. VPH	THRU PCT.	LEFT TURN VOL. VPH	LEFT TURN PCT.	DIAGONAL VOL. VPH	DIAGONAL PCT.	SOURCE FLOW VPH	SINK FLOW VPH	DISCHARGE VOLUME VPH	SPEED ESTIMATE MPH
(126, 124)	0	0	0	104	100	0	0	0	0	0	0	104	27.5
(124, 130)	0	0	0	480	100	0	0	0	0	0	0	480	27.0
(130, 124)	0	260	64	144	36	0	0	0	0	0	0	404	27.4
(126, 132)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(132, 126)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(127, 133)	0	0	0	500	100	0	0	0	0	0	0	500	25.8
(133, 127)	0	208	52	192	48	0	0	0	0	0	0	400	26.8
(128, 129)	0	0	0	240	48	260	52	0	0	0	0	500	27.1
(129, 128)	0	0	0	0	0	100	100	0	0	0	0	100	27.2

(128, 134)	0	0	100	0	0	0	0	0	0	0	0	0	0.0
(134, 128)	0	0	0	0	80	0	20	0	0	0	0	0	0.0
(129, 130)	0	0	0	0	0	240	100	0	0	0	0	240	26.6
(130, 129)	0	0	0	52	100	0	0	0	0	0	0	52	27.3
(129, 135)	0	780	100	0	0	0	0	0	0	0	0	780	23.0
(135, 129)	0	48	33	96	67	0	0	0	0	0	0	144	26.3
(130, 132)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(132, 130)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(130, 143)	0	0	0	720	100	0	0	0	0	0	0	720	26.0
(143, 130)	0	52	11	404	89	0	0	0	0	0	0	456	26.4
(132, 133)	0	0	50	0	0	0	50	0	0	0	0	0	0.0
(133, 132)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(132, 143)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(143, 132)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(133, 139)	0	0	0	500	100	0	0	0	0	0	0	500	19.3
(139, 133)	0	0	0	400	100	0	0	0	0	0	0	400	26.7
(134, 135)	0	0	20	0	80	0	0	0	0	0	0	0	0.0
(135, 134)	0	0	0	0	0	0	100	0	0	0	0	0	0.0
(135, 136)	0	0	0	780	100	0	0	0	0	0	0	780	22.0
(136, 135)	0	0	0	0	0	144	100	0	0	0	0	144	26.9
(136, 137)	0	0	0	0	0	780	100	0	0	0	0	780	2.0
(137, 136)	0	0	0	144	100	0	0	0	0	0	0	144	27.3
(136, 143)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(143, 136)	0	0	50	0	0	0	50	0	0	0	0	0	0.0
(137, 139)	0	0	0	0	0	720	100	0	0	0	0	720	20.2
(139, 137)	0	0	20	0	60	0	20	0	0	0	0	0	0.0
(137, 141)	0	0	0	780	100	0	0	0	0	0	0	780	18.5
(141, 137)	0	144	24	456	76	0	0	0	0	0	0	600	26.3
(137, 143)	0	0	0	456	100	0	0	0	0	0	0	456	27.2
(143, 137)	0	720	100	0	0	0	0	0	0	0	0	720	21.3
(139, 141)	0	1220	100	0	0	0	0	0	0	0	0	1220	2.4
(141, 139)	0	0	0	400	100	0	0	0	0	0	0	400	27.0

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TRAFFIC ASSIGNMENT

LEVEL I ENTRY LINK VOLUMES

LINK	FLOW RATE (VEH/HOUR)	TRUCKS (PERCENT)	CAR POOLS (PERCENT)
(8001, 1)	1400	0	0
(8002, 2)	1300	0	0
(8003, 3)	1200	0	0
(8004, 4)	1100	0	0
(8005, 5)	1000	0	0

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INITIALIZATION STATISTICS

TIME INTERVAL NUMBER	SUBNETWORK TYPE	PRIOR CONTENT (VEHICLES)	CURRENT CONTENT (VEHICLES)	PERCENT DIFFERENCE	
1	LEVEL I	0	108	10000	
2	LEVEL I	108	208	92	
3	LEVEL I	208	308	48	
4	LEVEL I	308	409	32	
5	LEVEL I	409	511	24	
6	LEVEL I	511	605	18	
7	LEVEL I	605	698	15	
8	LEVEL I	698	779	11	
9	LEVEL I	779	844	8	EQUILIBRIUM ATTAINED

ALL EXISTING SUBNETWORKS REACHED EQUILIBRIUM

CUMULATIVE LEVEL I STATISTICS AT TIME 7:45: 0

ELAPSED TIME IS 0:30: 0 (1800 SECONDS), TIME PERIOD 1 ELAPSED TIME IS 1800 SECONDS

LINK STATISTICS

LINK	VEHICLE MILES	VEHICLE TRIPS	VEHICLE MINUTES MOVE TIME	VEHICLE MINUTES DELAY TIME	VEHICLE MINUTES TOTAL TIME	RATIO MOVE/ TOTAL	MINUTES/MILE TOTAL TIME	MINUTES/MILE DELAY TIME	SECONDS/VEHICLE TOTAL TIME	SECONDS/VEHICLE DELAY TIME	AVERAGE VALUES STOPS (PCT)	AVERAGE VALUES VOLUME VPH	AVERAGE VALUES SPEED MPH	AVERAGE VALUES OCCUP VEH.	STORAGE (PCT)
(1, 101)	231.50	463	463.00	182.02	645.02	0.72	2.79	0.79	83.6	23.6	100	926	21.5	16.7	6.3
(101, 1)	73.00	146	146.00	69.55	215.55	0.68	2.95	0.95	88.6	28.6	100	292	20.3	7.4	2.8
(8001, 1)		711										1422			
(1, 102)	125.00	250	250.00	63.98	313.98	0.80	2.51	0.51	75.4	15.4	100	500	23.9	10.5	4.0
(102, 1)	24.00	48	48.00	27.98	75.98	0.63	3.17	1.17	95.0	35.0	100	96	19.0	2.6	1.0
(2, 103)	106.80	356	213.60	86.65	300.25	0.71	2.81	0.81	50.6	14.6	100	712	21.3	10.0	6.3
(103, 2)	36.00	120	72.00	50.90	122.90	0.59	3.41	1.41	61.5	25.5	100	240	17.6	4.2	2.6
(8002, 2)		650										1300			
(2, 104)	88.50	295	177.00	107.23	284.23	0.62	3.21	1.21	57.8	21.8	100	590	18.7	9.5	6.0
(104, 2)	75.76	254	151.52	69.30	220.82	0.69	2.91	0.91	52.2	16.4	100	508	20.6	7.3	4.6
(3, 105)	179.00	358	358.00	121.22	479.22	0.75	2.68	0.68	80.3	20.3	100	716	22.4	16.1	6.1
(105, 3)	147.00	294	293.99	143.06	437.05	0.67	2.97	0.97	89.2	29.2	100	588	20.2	14.6	5.5
(8003, 3)		610										1220			
(3, 106)	125.00	250	250.00	113.15	363.15	0.69	2.91	0.91	87.2	27.2	100	500	20.7	12.1	4.6
(106, 3)	138.00	276	276.00	135.25	411.25	0.67	2.98	0.98	89.4	29.4	100	552	20.1	13.9	5.3
(4, 107)	76.20	254	152.40	53.47	205.87	0.74	2.70	0.70	48.6	12.6	100	508	22.2	6.8	4.3
(107, 4)	115.42	385	230.84	100.25	331.08	0.70	2.87	0.87	51.6	15.6	100	770	20.9	11.2	7.1
(8004, 4)		555										1110			
(4, 108)	91.20	304	182.40	64.33	246.73	0.74	2.71	0.71	48.7	12.7	100	608	22.2	8.2	5.2
(108, 4)	64.39	215	128.79	91.29	220.08	0.59	3.42	1.42	61.4	25.5	100	430	17.6	7.3	4.6
(5, 141)	253.00	506	506.00	259.83	765.83	0.66	3.03	1.03	90.8	30.8	100	1012	19.8	16.7	6.3
(141, 5)	415.00	830	830.00	769.17	1599.17	0.52	3.85	1.85	115.6	55.6	100	1660	15.6	16.7	6.3
(8005, 5)		504										1008			
(101, 113)	230.50	461	461.00	148.08	609.08	0.76	2.64	0.64	79.3	19.3	100	922	22.7	16.7	6.3
(113, 101)	75.00	150	150.00	48.65	198.65	0.76	2.65	0.65	79.5	19.5	100	300	22.7	6.7	2.5
(102, 119)	125.50	251	251.00	66.45	317.45	0.79	2.53	0.53	75.9	15.9	100	502	23.7	10.6	4.0
(119, 102)	26.00	52	52.00	14.20	66.20	0.79	2.55	0.55	76.4	16.4	100	104	23.6	2.2	0.8
(103, 123)	226.78	349	453.57	156.35	609.92	0.74	2.69	0.69	104.9	26.9	100	698	22.3	16.7	4.9
(123, 103)	81.74	126	163.47	75.09	238.57	0.69	2.92	0.92	113.6	35.8	100	252	20.6	8.3	2.4
(103, 122)	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0	0	0.0	0.0	0.0
(122, 103)	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0	0	0.0	0.0	0.0
(104, 117)	348.95	537	697.90	350.09	1047.98	0.67	3.00	1.00	117.1	39.1	100	1074	20.0	16.7	4.9
(117, 104)	152.71	235	305.41	109.37	414.78	0.74	2.72	0.72	105.9	27.9	100	470	22.1	14.1	4.1
(104, 116)	83.40	139	166.80	37.38	204.18	0.82	2.45	0.45	88.1	16.1	100	278	24.5	7.0	2.2
(116, 104)	237.60	396	475.20	205.87	681.07	0.70	2.87	0.87	103.2	31.2	100	792	20.9	16.7	5.3
(105, 111)	3.30	6	6.60	14.27	20.87	0.32	6.32	4.32	208.7	142.7	100	12	9.5	0.7	0.2
(111, 105)	3.30	6	6.60	11.73	18.33	0.36	5.56	3.56	183.3	117.3	100	12	10.8	0.6	0.2
(105, 117)	218.40	364	436.80	203.07	639.87	0.68	2.93	0.93	105.5	33.5	100	728	20.5	16.7	5.3
(117, 105)	179.33	300	358.66	206.14	564.80	0.64	3.15	1.15	113.0	41.2	100	600	19.1	16.7	5.3
(106, 112)	135.60	226	271.20	96.13	367.33	0.74	2.71	0.71	97.5	25.5	100	452	22.1	12.4	7.8
(112, 106)	132.00	220	264.00	97.45	361.45	0.73	2.74	0.74	98.6	26.6	100	440	21.9	12.1	7.7
(106, 111)	9.50	19	19.00	3.03	22.03	0.86	2.32	0.32	69.6	9.6	100	38	25.9	0.8	0.6
(111, 106)	32.50	65	65.00	25.80	90.80	0.72	2.79	0.79	83.8	23.8	100	130	21.5	3.1	2.3
(107, 121)	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0	0	0.0	0.0	0.0
(121, 107)	56.53	87	113.07	30.37	143.43	0.79	2.54	0.54	98.9	20.9	100	174	23.6	5.1	2.9

1

CUMULATIVE LEVEL I STATISTICS AT TIME 7:45: 0

ELAPSED TIME IS 0:30: 0 (1800 SECONDS), TIME PERIOD 1 ELAPSED TIME IS 1800 SECONDS

LEVEL I BUS STATISTICS

LINK	BUS TRIPS	PERSON TRIPS	TRAVEL TIME (MINUTES)	MOVING TIME (MINUTES)	DELAY TIME (MINUTES)	M / T	NO.OF STOPS
(1, 101)	11.0	275.0	27.1	11.0	16.1	0.41	11
(101, 1)	9.0	225.0	24.9	9.0	15.9	0.36	9
(3, 106)	10.0	250.0	30.9	10.0	20.9	0.32	10
(106, 3)	7.0	175.0	16.9	7.0	9.9	0.41	7
(4, 107)	5.0	125.0	8.6	3.0	5.6	0.35	5
(107, 4)	3.0	75.0	3.1	1.8	1.3	0.58	3
(5, 141)	4.0	100.0	10.4	4.0	6.4	0.38	4
(141, 5)	3.0	75.0	6.6	3.0	3.6	0.45	3
(101, 113)	11.0	275.0	14.7	11.0	3.7	0.75	11
(113, 101)	11.0	275.0	14.2	11.0	3.2	0.78	11
(104, 117)	10.0	250.0	36.3	13.0	23.3	0.36	10
(117, 104)	11.0	275.0	37.7	14.3	23.4	0.38	11
(104, 116)	11.0	275.0	16.2	13.2	3.0	0.81	11
(116, 104)	11.0	275.0	18.7	13.2	5.5	0.71	11
(105, 111)	6.0	150.0	20.9	6.6	14.3	0.32	6
(111, 105)	6.0	150.0	18.3	6.6	11.7	0.36	6
(105, 117)	6.0	150.0	10.4	7.2	3.2	0.69	6
(117, 105)	6.0	150.0	8.5	7.2	1.3	0.85	6
(106, 112)	5.0	125.0	8.1	6.0	2.1	0.74	5
(112, 106)	3.0	75.0	5.1	3.6	1.5	0.71	3
(106, 111)	5.0	125.0	5.9	5.0	0.9	0.85	5
(111, 106)	5.0	125.0	6.4	5.0	1.4	0.78	5
(107, 120)	4.0	100.0	6.6	5.6	1.0	0.84	4
(120, 107)	3.0	75.0	16.9	4.2	12.7	0.25	3
(112, 114)	4.0	100.0	6.6	5.2	1.4	0.79	4
(114, 112)	4.0	100.0	7.6	5.2	2.4	0.69	4
(113, 116)	11.0	275.0	12.1	8.8	3.3	0.73	11
(116, 113)	11.0	275.0	11.6	8.8	2.8	0.76	11
(114, 115)	4.0	100.0	6.6	5.6	1.0	0.85	4
(115, 114)	4.0	100.0	7.9	5.6	2.4	0.70	4
(115, 121)	4.0	100.0	6.3	5.2	1.1	0.83	4
(121, 115)	5.0	125.0	8.9	6.5	2.4	0.73	5
(117, 118)	4.0	100.0	7.5	5.6	1.9	0.75	4
(118, 117)	6.0	150.0	11.2	8.4	2.8	0.75	6
(118, 120)	4.0	100.0	6.7	5.2	1.5	0.78	4
(120, 118)	5.0	125.0	8.0	6.5	1.5	0.82	5
(121, 127)	4.0	100.0	6.3	5.2	1.2	0.82	4
(127, 121)	5.0	125.0	9.1	6.5	2.6	0.71	5
(127, 133)	4.0	100.0	14.4	4.8	9.6	0.33	4
(133, 127)	5.0	125.0	13.2	6.0	7.2	0.45	5
(133, 139)	4.0	100.0	7.7	4.8	2.9	0.63	4
(139, 133)	4.0	100.0	7.0	4.8	2.2	0.69	4
(139, 141)	3.0	75.0	8.1	3.6	4.5	0.45	3
(141, 139)	5.0	125.0	8.9	6.0	2.9	0.68	5

1

LEVEL I ENVIRONMENTAL MEASURES OF EFFECTIVENESS

LINK	AVG MPH	VEH-MI PER GALLON	PERSON-MI PER GALLON	GALLONS OF FUEL	GRAMS PER MILE CO	GRAMS PER MILE HC	KILOGRAMS CO	KILOGRAMS HC
(1, 101)	21.5	9.6	17.9	24.1	66.3	4.0	15.344	0.935
(101, 1)	20.3	9.0	24.9	8.1	69.9	4.3	5.104	0.311
(8001, 1)								
(1, 102)	23.9	10.1	13.1	12.4	64.0	3.9	8.000	0.488
(102, 1)	19.0	9.6	12.5	2.5	66.2	4.0	1.589	0.096
(2, 103)	21.3	9.9	12.9	10.7	64.0	3.9	6.835	0.417
(103, 2)	17.6	9.4	12.2	3.8	69.4	4.2	2.498	0.150
(8002, 2)								
(2, 104)	18.7	9.6	12.5	9.2	66.8	4.0	5.912	0.357
(104, 2)	20.6	9.9	12.8	7.7	64.0	3.9	4.849	0.295
(3, 105)	22.4	10.0	13.0	17.9	64.0	3.9	11.456	0.698
(105, 3)	20.2	9.8	12.8	15.0	64.0	3.9	9.408	0.573
(8003, 3)								
(3, 106)	20.7	9.3	20.9	13.4	67.8	4.1	8.480	0.517
(106, 3)	20.1	9.5	18.0	14.6	66.4	4.0	9.168	0.559
(4, 107)	22.2	9.7	17.2	7.8	65.9	4.0	5.021	0.306
(107, 4)	20.9	9.8	14.5	11.8	64.7	3.9	7.473	0.455
(8004, 4)								
(4, 108)	22.2	10.0	13.0	9.1	64.0	3.9	5.837	0.356
(108, 4)	17.6	9.4	12.2	6.9	69.4	4.2	4.471	0.268
(5, 141)	19.8	9.7	14.4	26.2	65.2	4.0	16.497	1.006
(141, 5)	15.6	8.9	12.3	46.6	75.4	4.4	31.291	1.839
(8005, 5)								
(101, 113)	22.7	9.7	18.1	23.8	66.3	4.0	15.280	0.931
(113, 101)	22.7	9.0	27.5	8.3	71.0	4.3	5.328	0.325
(102, 119)	23.7	10.1	13.1	12.5	64.0	3.9	8.032	0.489
(119, 102)	23.6	10.1	13.1	2.6	64.0	3.9	1.664	0.101
(103, 123)	22.3	10.0	13.0	22.6	64.0	3.9	14.514	0.884
(123, 103)	20.6	9.9	12.8	8.3	64.0	3.9	5.231	0.319
(103, 122)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000
(122, 103)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000
(104, 117)	20.0	9.5	16.6	36.6	65.9	4.0	23.007	1.405
(117, 104)	22.1	9.3	22.5	16.3	68.5	4.2	10.459	0.637
(104, 116)	24.5	9.0	28.6	9.2	71.6	4.4	5.971	0.364
(116, 104)	20.9	9.5	18.6	25.0	66.7	4.1	15.840	0.965
(105, 111)	9.5	2.8	69.0	1.2	266.3	14.6	0.879	0.048
(111, 105)	10.8	3.0	74.3	1.1	241.8	13.5	0.798	0.044
(105, 117)	20.5	9.6	16.3	22.7	65.6	4.0	14.323	0.873
(117, 105)	19.1	9.4	16.6	19.1	68.0	4.1	12.192	0.739
(106, 112)	22.1	9.7	17.7	14.0	66.1	4.0	8.966	0.546
(112, 106)	21.9	9.8	15.9	13.5	65.3	4.0	8.621	0.525
(106, 111)	25.9	7.2	54.0	1.3	89.3	5.4	0.848	0.052
(111, 106)	21.5	8.9	27.9	3.6	71.4	4.3	2.320	0.141
(107, 121)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000
(121, 107)	23.6	10.1	13.1	5.6	64.0	3.9	3.618	0.220

DATA FOR LINKS WITH SPEED EXCEEDING 20 MPH ARE APPROXIMATIONS

0

BUSES ARE ASSUMED EQUIVALENT TO 2.5 AUTOS FOR THESE ESTIMATES.

1

LEVEL I ENVIRONMENTAL MEASURES OF EFFECTIVENESS

LINK	AVG MPH	VEH-MI PER GALLON	PERSON-MI PER GALLON	GALLONS OF FUEL	GRAMS PER MILE CO	GRAMS PER MILE HC	KILOGRAMS CO	KILOGRAMS HC
(107, 120)	24.3	9.8	16.5	17.8	65.5	4.0	11.466	0.699
(120, 107)	7.3	5.8	8.9	37.0	132.2	7.0	28.544	1.511
(108, 127)	20.2	9.8	12.8	16.4	64.0	3.9	10.314	0.628
(127, 108)	22.3	10.0	13.0	6.5	64.0	3.9	4.159	0.253
(108, 126)	26.0	10.0	13.0	3.7	64.0	3.9	2.374	0.145
(126, 108)	23.0	10.1	13.1	7.7	64.0	3.9	4.971	0.303
(110, 111)	24.0	10.1	13.1	4.4	64.0	3.9	2.866	0.175
(111, 110)	26.2	10.0	13.0	1.1	64.0	3.9	0.717	0.044
(110, 116)	22.6	10.0	13.0	1.1	64.0	3.9	0.707	0.043
(116, 110)	24.6	10.1	13.1	4.3	64.0	3.9	2.773	0.169
(112, 114)	24.6	9.6	20.7	7.5	67.5	4.1	4.824	0.294

(114, 112)	22.4	9.3	23.2	5.6	68.8	4.2	3.577	0.218
(112, 118)	22.9	10.0	13.1	7.5	64.0	3.9	4.824	0.294
(118, 112)	22.4	10.0	13.0	8.9	64.0	3.9	5.698	0.347
(113, 116)	22.0	9.7	18.0	19.0	66.3	4.0	12.173	0.742
(116, 113)	23.6	9.1	27.4	6.7	70.9	4.3	4.314	0.263
(114, 115)	25.6	4.0	100.0	0.7	160.0	9.8	0.448	0.027
(115, 114)	21.1	4.0	99.2	0.7	160.0	9.8	0.448	0.027
(114, 120)	18.9	9.6	12.5	6.2	66.3	4.0	3.963	0.240
(120, 114)	24.4	10.1	13.1	4.8	64.0	3.9	3.119	0.190
(115, 121)	24.8	4.0	100.9	0.6	160.0	9.8	0.416	0.025
(121, 115)	22.0	4.0	99.9	0.8	160.0	9.8	0.520	0.032
(117, 118)	21.8	9.8	15.2	26.9	65.0	4.0	17.179	1.047
(118, 117)	22.7	9.2	24.5	7.9	69.5	4.2	5.106	0.311
(117, 123)	22.1	10.0	13.0	8.9	64.0	3.9	5.698	0.347
(123, 117)	22.3	10.0	13.0	4.7	64.0	3.9	3.036	0.185
(118, 120)	20.9	9.7	15.4	22.4	65.1	4.0	14.181	0.864
(120, 118)	23.7	9.7	19.2	11.6	66.8	4.1	7.507	0.457
(118, 124)	23.5	10.1	13.1	7.4	64.0	3.9	4.783	0.291
(124, 118)	22.7	10.0	13.1	4.3	64.0	3.9	2.786	0.170
(119, 122)	21.5	10.0	12.9	15.3	64.0	3.9	9.715	0.592
(122, 119)	24.7	10.1	13.1	3.1	64.0	3.9	2.025	0.123
(120, 126)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000
(126, 120)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000
(121, 127)	24.6	4.0	100.9	0.6	160.0	9.8	0.416	0.025
(127, 121)	24.2	9.4	23.7	6.7	69.0	4.2	4.304	0.262
(122, 116)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000
(116, 122)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000
(122, 128)	21.4	9.9	12.9	15.3	64.0	3.9	9.754	0.594
(128, 122)	24.3	10.1	13.1	3.3	64.0	3.9	2.112	0.129
(123, 124)	22.3	10.0	13.0	14.0	64.0	3.9	8.986	0.548
(124, 123)	23.2	10.1	13.1	9.6	64.0	3.9	6.198	0.378
(123, 129)	22.0	10.0	13.0	15.5	64.0	3.9	9.907	0.604
(129, 123)	23.9	10.1	13.1	2.9	64.0	3.9	1.882	0.115
(124, 126)	24.4	10.1	13.1	7.0	64.0	3.9	4.533	0.276

0 DATA FOR LINKS WITH SPEED EXCEEDING 20 MPH ARE APPROXIMATIONS

BUSES ARE ASSUMED EQUIVALENT TO 2.5 AUTOS FOR THESE ESTIMATES.

SUBNETWORK RESULTS ASSUME 100 PERCENT AUTO TRAFFIC

0 DATA FOR LINKS WITH SPEED EXCEEDING 20 MPH ARE APPROXIMATIONS

BUSES ARE ASSUMED EQUIVALENT TO 2.5 AUTOS FOR THESE ESTIMATES.

LEVEL I PERSON MEASURES OF EFFECTIVENESS

LINK	PERSON MILES	PERSON TRIPS	DELAY PERSON-MIN	TRAVEL TIME PERSON-MIN
(1, 101)	431.3	862.6	618.6	1481.2
(101, 1)	201.6	403.1	466.1	869.2
(1, 102)	162.5	325.0	83.2	408.2
(102, 1)	31.2	62.4	36.4	98.8
(2, 103)	138.8	462.8	112.6	390.3
(103, 2)	46.8	156.0	66.2	159.8
(2, 104)	115.0	383.5	139.4	369.5
(104, 2)	99.1	330.2	88.9	287.1
(3, 105)	232.7	465.4	157.6	623.0
(105, 3)	191.1	382.2	186.0	568.2
(3, 106)	281.0	562.0	642.0	1204.0
(106, 3)	262.4	524.7	410.5	935.2
(4, 107)	134.6	448.7	201.0	470.3
(107, 4)	171.5	571.6	160.5	503.5
(4, 108)	118.6	395.2	83.6	320.8
(108, 4)	83.8	279.5	118.4	286.1
(5, 141)	376.3	752.6	490.3	1242.9
(141, 5)	575.0	1150.1	1085.6	2235.7
(101, 113)	430.0	860.0	279.4	1139.4
(113, 101)	227.8	455.7	138.7	594.4
(102, 119)	163.1	326.3	86.4	412.7
(119, 102)	33.8	67.6	18.5	86.1
(103, 123)	294.8	453.7	203.3	792.9
(123, 103)	106.4	163.8	97.3	310.1
(103, 122)	0.0	0.0	0.0	0.0
(122, 103)	0.0	0.0	0.0	0.0
(104, 117)	607.6	935.1	1008.2	2223.5
(117, 104)	367.9	566.2	696.5	1432.3
(104, 116)	264.8	441.4	120.1	649.8
(116, 104)	465.3	775.5	397.6	1328.2
(105, 111)	82.5	150.0	356.7	521.7
(111, 105)	82.5	150.0	293.3	458.3
(105, 117)	369.2	615.4	340.6	1079.1
(117, 105)	319.3	532.2	296.7	935.3
(106, 112)	247.4	412.3	174.7	669.5
(112, 106)	214.3	357.1	162.2	590.8
(106, 111)	71.6	143.2	25.7	168.9
(111, 106)	101.5	203.0	66.7	269.7
(107, 121)	0.0	0.0	0.0	0.0
(121, 107)	73.5	113.1	39.5	186.5

CUMULATIVE NETWORK-WIDE BUS STATISTICS AT TIME 7:45: 0

ELAPSED TIME IS 0:30: 0 (1800 SECONDS), TIME PERIOD 1 ELAPSED TIME IS 1800 SECONDS

ROUTE STATISTICS

ROUTE	BUS TRIPS	TOTAL TRAVEL TIME (BUS-MIN.)	MEAN TRAVEL TIME (SEC/BUS)	PERSON TRIPS	PERSON TRAVEL TIME (MINUTES)
1	5	108.6	0.0	125	2714.2
2	4	110.4	0.0	100	2760.0
3	4	86.0	0.0	100	2150.0
4	3	78.5	0.0	75	1962.1
5	3	84.9	0.0	75	2123.3
6	3	80.5	0.0	75	2013.3

THESE ESTIMATES ASSUME AN AVERAGE BUS OCCUPANCY OF 25.0 PASSENGERS PER BUS THROUGHOUT THE NETWORK

TOTAL CPU TIME FOR THIS RUN = 172.58 SECONDS

LAST CASE PROCESSED

APPENDIX E

INTERFS.TRF

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GRAF PROJECT #23, UTPS-TRAF INTERFACE                                                          0
RANGA RAGHUNATHAN                           08  14  93FEDERAL HIGHWAY           1              1
   0    1           180                              0 0   30715         7681       7581       2
1800                                                                                           3
                    60                                                                         4
                                                           0INTERF                             5
   1 1012640          2       11        113   0    0    0   0                                 11
 101   12640          2                   0 1028001    0                                      11
8001    1             2       41        101   0  102    0   0                                 11
   1 1022640          2       44          0   0  119    0                                     11
 102   12640          2                8001 101    0    0 101                                 11
   2 1031584          2       41        122   0  123    0   0                                 11
 103   21584          2                8002 104    0    0 104                                 11
8002    2             2       41        104   0  103    0   0                                 11
   2 1041584          2       41        117   0  116    0   0                                 11
 104   21584          2                   0 1038002    0                                     11
   3 1052640          2       41        111   0  117    0   0                                 11
 105   32640          2                  08003 106    0                                       11
8003    3             2                 106 105    0    0 105                                 11
   3 1062640          2       41        112   0  111    0   0                                 11
 106   32640          2       11        105    08003    0   0                                 11
   4 1071584          2       41        121   0  120    0   0                                 11
 107   41584          2                   0 1088004    0                                     11
8004    4             2       41        107   0  108    0   0                                 11
   4 1081584          2       41        126   0  127    0   0                                 11
 108   41584          2                8004 107    0    0 107                                 11
   5 1412640          2                 139 137    0    0   0                                 11
 141   52640          2                  08005      0    0                                     11
8005    5             2                   0 141    0    0                                     11
 101 1132640          2                   0 116    0    0                                     11
 113 1012640          2       44          0   0    1    0                                     11
 102 1192640          2                   0 122    0    0                                     11
 119 1022640          2       11          1   0    0    0   0                                 11
 103 1233431          2                 129 124  117    0 124                                 11
 123 1033431          2                   2 122    0    0 122                                 11
 103 1223168          2                 116 119  128    0 119                                 11
 122 1033168          2                   0 123    2    0                                     11
 104 1173431          2                 123 118  105    0 118                                 11
 117 1043431          2                   0 116    2    0                                     11
 104 1163168          2                 110 113  122    0 113                                 11
 116 1043168          2                   2 117    0    0 117                                 11
 105 1112904          2       41        106   0  110    0   0                                 11
 111 1052904          2                   0 117    3    0                                     11
 105 1173168          2                 104 123  118    0 123                                 11
 117 1053168          2                   3 111    0    0 111                                 11
 106 1123168          1                 118 114    0    0 114                                 11
 112 1063168          1                   0 111    3    0                                     11
 106 1112640          1                   0 110  105    0                                     11
 111 1062640          1                   3 112    0    0 112                                 11
 107 1213431          1                 127   0  115    0   0                                 11
 121 1073431          1                   0 120    4    0                                     11
 107 1203695          2                 114 118  126    0 118                                 11
 120 1073695          2                   4 121    0    0 121                                 11
 108 1273431          1                 133   0  121    0   0                                 11
 127 1083431          1                   4 126    0    0 126                                 11
 108 1263695          2                 120 124  132    0 124                                 11
 126 1083695          2                   0 127    4    0                                     11
 110 1113695          1                 105 106    0    0 106                                 11
 111 1103695          1                   0   0  116    0                                     11
 110 1163431          2                 113 122  104    0 122                                 11
 116 1103431          2       11        111   0    0    0   0                                 11
 112 1143431          1                 120 115    0    0 115                                 11
 114 1123431          1                   0 106  118    0                                     11
 112 1183431          2                 117 124  120    0 124                                 11
 118 1123431          2       41        114   0  106    0   0                                 11
```

113	1162112	2		122	104	110	0	104	11
116	1132112	2		0	101	0	0		11
114	1153695	1		121	0	0	0	0	11
115	1143695	1		0	112	120	0		11
114	1203431	2		118	126	107	0	126	11
120	1143431	2	41	115	0	112	0	0	11
115	1213431	1		107	127	0	0	127	11
121	1153431	1		0	0	114	0		11
117	1183695	2		124	120	112	0	120	11
118	1173695	2		105	104	123	0	104	11
117	1233431	2		103	129	124	0	129	11
123	1173431	2		118	105	104	0	105	11
118	1203431	2		126	107	114	0	107	11
120	1183431	2		112	117	124	0	117	11
118	1243431	2		123	130	126	0	130	11
124	1183431	2		120	112	117	0	112	11
119	1223168	2		128	103	116	0	103	11
122	1193168	2		0	102	0	0		11
120	1263431	2		124	132	108	0	132	11
126	1203431	2		107	114	118	0	114	11
121	1273431	1		108	133	0	0	133	11
127	1213431	1		0	115	107	0		11
122	1163431	2		104	110	113	0	110	11
116	1223431	2		119	128	103	0	128	11
122	1283168	2		0	134	129	0		11
128	1223168	2		103	116	119	0	116	11
123	1243168	2		130	126	118	0	126	11
124	1233168	2		117	103	129	0	103	11
123	1293168	2		128	135	130	0	135	11
129	1233168	2		124	117	103	0	117	11
124	1263431	2		132	108	120	0	108	11
126	1243431	2		118	123	130	0	123	11
124	1303168	2		129	143	132	0	0	11
130	1243168	2		126	118	123	0	118	11
126	1323168	2		130	143	133	0	143	11
132	1263168	2		108	120	124	0	120	11
127	1333168	1		132	139	0	0	139	11
133	1273168	1		0	121	108	0		11
128	1293431	2		135	130	123	0	130	11
129	1283431	2	41	122	0	134	0	0	11
128	1343168	1		0	0	135	0		11
134	1283168	1		129	122	0	0	122	11
129	1303168	2		143	132	124	0	132	11
130	1293168	2		123	128	135	0	128	11
129	1352112	2	41	134	0	136	0	0	11
135	1292112	2		130	123	128	0	123	11
130	1322375	2		143	133	126	0	133	11
132	1302375	2		124	129	143	0	129	11
130	1432375	2		136	137	132	0	137	11
143	1302375	2		132	124	129	0	0	11
132	1332904	2	41	139	0	127	0	0	11
133	1322904	2		126	130	143	0	130	11
132	1432112	2		130	136	137	0	136	11
143	1322112	2		133	126	130	0	126	11
133	1393168	1		137	141	0	0	141	11
139	1333168	1		0	127	132	0		11
134	1353431	1		0	136	129	0		11
135	1343431	1		128	0	0	0	0	11
135	1363431	1		0	137	143	0		11
136	1353431	1		129	134	0	0	134	11
136	1373168	2		141	139	143	0	139	11
137	1363168	2		143	135	0	0	135	11
136	1433168	2		137	132	130	0	132	11
143	1363168	2	41	135	0	137	0	0	11
137	1393431	2	41	141	0	133	0	0	11
139	1373431	2		143	136	141	0	136	11
137	1413431	2		0	5	139	0		11

141	1373431			2			139	143	136	0	143	11
137	1433168			2			132	130	136	0	130	11
143	1373168			2			136	141	139	0	141	11
139	1413168			2		41	137	0	5	0	0	11
141	1393168			2			0	133	137	0		11
1	101	100	0	0	0							21
101	1	0	0	100	0							21
141	137	0	76	24	0							21
1	102	0	0	100	0							21
102	1	100	0	0	0							21
2	103	0	0	100	0							21
103	2	100	0	0	0							21
137	143	0	100	0	0							21
2	104	83	0	17	0							21
104	2	0	0	100	0							21
3	105	0	0	100	0							21
105	3	0	100	0	0							21
143	137	0	0	100	0							21
3	106	90	0	10	0							21
106	3	0	0	100	0							21
4	107	0	0	100	0							21
107	4	0	0	100	0							21
139	141	0	0	100	0							21
4	108	17	0	83	0							21
108	4	100	0	0	0							21
5	141	40	60	0	0							21
141	5	0	100	0	0							21
141	139	0	100	0	0							21
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113	101	0	0	100	0							21
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119	102	100	0	0	0							21
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123	103	100	0	0	0							21
103	122	20	60	20	0							21
122	103	0	80	20	0							21
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117	104	0	34	66	0							21
104	116	0	100	0	0							21
116	104	26	74	0	0							21
105	111	50	0	50	0							21
111	105	0	80	20	0							21
105	117	35	36	29	0							21
117	105	100	0	0	0							21
106	112	56	44	0	0							21
112	106	0	0	100	0							21
106	111	0	100	0	0							21
111	106	100	0	0	0							21
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121	107	0	0	100	0							21
107	120	31	69	0	0							21
120	107	100	0	0	0							21
108	127	100	0	0	0							21
127	108	100	0	0	0							21
108	126	0	100	0	0							21
126	108	0	0	100	0							21
110	111	0	100	0	0							21
111	110	0	0	100	0							21
110	116	100	0	0	0							21
116	110	100	0	0	0							21
112	114	100	0	0	0							21
114	112	0	100	0	0							21
112	118	0	100	0	0							21
118	112	0	0	100	0							21
113	116	0	84	16	0							21
116	113	0	100	0	0							21
114	115	100	0	0	0							21

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114	120	0	0	100	0	21
120	114	0	0	100	0	21
115	121	20	80	0	0	21
121	115	0	0	100	0	21
117	118	0	100	0	0	21
118	117	0	100	0	0	21
117	123	0	100	0	0	21
123	117	0	100	0	0	21
118	120	0	100	0	0	21
120	118	42	58	0	0	21
118	124	0	100	0	0	21
124	118	0	100	0	0	21
119	122	100	0	0	0	21
122	119	0	100	0	0	21
120	126	20	60	20	0	21
126	120	20	60	20	0	21
121	127	20	80	0	0	21
127	121	0	0	100	0	21
122	116	20	60	20	0	21
116	122	20	60	20	0	21
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124	123	43	57	0	0	21
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126	124	0	100	0	0	21
124	130	0	100	0	0	21
130	124	0	36	64	0	21
126	132	20	60	20	0	21
132	126	20	60	20	0	21
127	133	0	100	0	0	21
133	127	0	48	52	0	21
128	129	52	48	0	0	21
129	128	100	0	0	0	21
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134	135	0	80	20	0	21
135	134	100	0	0	0	21
135	136	0	100	0	0	21
136	135	100	0	0	0	21
136	137	100	0	0	0	21
137	136	0	100	0	0	21
136	143	20	60	20	0	21
143	136	50	0	50	0	21
137	139	100	0	0	0	21
139	137	20	60	20	0	21
137	141	0	100	0	0	21
8001	1	64	0	36	0	21
8002	2	46	0	54	0	21
8003	3	40	60	0	0	21

```
8004    4  45    0  55    0                                                          21
8005    5   0  100   0    0                                                          21
   1      1018001  102                                                               35
   2      1038002  104                                                               35
   3      1058003  106                                                               35
   4      1078004  108                                                               35
   5      1418005                                                                    35
 101         1  113                                                                  35
 102         1  119                                                                  35
 103         2  123  122                                                             35
 104         2  117  116                                                             35
 105         3  111  117                                                             35
 106         3  112  111                                                             35
 107         4  121  120                                                             35
 108         4  127  126                                                             35
 110      111  116                                                                   35
 111      105  106  110                                                              35
 112      106  114  118                                                              35
 113      101  116                                                                   35
 114      112  115  120                                                              35
 115      114  121                                                                   35
 116      104  110  113  122                                                         35
 117      104  105  118  123                                                         35
 118      112  117  120  124                                                         35
 119      102  122                                                                   35
 120      107  114  118  126                                                         35
 121      107  115  127                                                              35
 122      103  119  116  128                                                         35
 123      103  117  124  129                                                         35
 124      118  123  126  130                                                         35
 126      108  120  124  132                                                         35
 127      108  121  133                                                              35
 128      122  129  134                                                              35
 129      123  128  130  135                                                         35
 130      124  129  132  143                                                         35
 132      126  130  133  143                                                         35
 133      127  132  139                                                              35
 134      128  135                                                                   35
 135      129  134  136                                                              35
 136      135  137  143                                                              35
 137      136  139  141  143                                                         35
 139      133  137  141                                                              35
 141        5  137  139                                                              35
 143      130  132  136  137                                                         35
   1  1                                                                              36
   2  1                                                                              36
   3  1                                                                              36
   4  1                                                                              36
   5  1                                                                              36
 101                                                                                 36
 102                                                                                 36
 103                                                                                 36
 104                                                                                 36
 105                                                                                 36
 106                                                                                 36
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 119                                                                                 36
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 120                                                                                   36
 121                                                                                   36
 122                                                                                   36
 123                                                                                   36
 124                                                                                   36
 126                                                                                   36
 127                                                                                   36
 128                                                                                   36
 129                                                                                   36
 130                                                                                   36
 132                                                                                   36
 133                                                                                   36
 134                                                                                   36
 135                                                                                   36
 136                                                                                   36
 137                                                                                   36
 139                                                                                   36
 141                                                                                   36
 143                                                                                   36
8001    11400   0   0                                                                  50
8002    21300   0   0                                                                  50
8003    31200   0   0                                                                  50
8004    41100   0   0                                                                  50
8005    51000   0   0                                                                  50
                                                                                      170
 1       3 106  20 1 1                                                                185
 2     106   3  20 1 1                                                                185
 3     111 105  20 1 1                                                                185
 4     105 111  20 1 1                                                                185
 5     117 104  20 1 1                                                                185
 6     104 117  20 1 1                                                                185
 7     101   1  20 1 1                                                                185
 8       1 101  20 1 1                                                                185
 9       4 107  20 1 1                                                                185
10     107   4  20 1 1                                                                185
11       5 141  20 1 1                                                                185
12     141   5  20 1 1                                                                185
13     133 127  20 1 1                                                                185
14     127 133  20 1 1                                                                185
   1 120  20                                                                          186
   2 120  20                                                                          186
   3 120  20                                                                          186
   4 120  20                                                                          186
   5 120  20                                                                          186
   6 120  20                                                                          186
   7 120  20                                                                          186
   8 120  20                                                                          186
   9 120  20                                                                          186
  10 120  20                                                                          186
  11 120  20                                                                          186
  12 120  20                                                                          186
  13 120  20                                                                          186
  14 120  20                                                                          186
   18003    3 106 111 105 117 104 116 113 101      18001                              187
   28001    1 101 113 116 104 117 105 111 106      38003                              187
   38004    4 107 120 118 117 104 116 113 101      18001                              187
   48001    1 101 113 116 104 117 118 120 107      48004                              187
   58005    5 141 139 133 127 121 115 114 112 106      38003                          187
   68003    3 106 112 114 115 121 127 133 139 141      58005                          187
   1        1 3 5 7                                                                   188
   2        8 6 4 2                                                                   188
   3        9 5 7                                                                     188
   4        8 610                                                                     188
   5      1113 2                                                                      188
   6        114                                                                       188
   1 300                                                                              189
   2 300                                                                              189
```

3 360	189
4 360	189
5 420	189
6 420	189
1	210

INTERFS.OUT

```
TTTTTTTTTTT  RRRRRRRRR       AAAAAAA     FFFFFFFFFFF
TTTTTTTTTTT  RRRRRRRRRR     AAAAAAAAA    FFFFFFFFFFF
TTTTTTTTTTT  RRRRRRRRRRR  AAAAAAAAAAA   FFFFFFFFFFF
    TTT      RRR     RRR  AAA     AAA  FFF
    TTT      RRR     RRR  AAA     AAA  FFF
    TTT      RRRRRRRRRRR  AAAAAAAAAAA  FFFFFFF
    TTT      RRRRRRRRRR   AAAAAAAAAAA  FFFFFFF
    TTT      RRR RRR      AAA     AAA  FFF
    TTT      RRR  RRR     AAA     AAA  FFF
    TTT      RRR   RRR    AAA     AAA  FFF
    TTT      RRR    RRR   AAA     AAA  FFF
    TTT      RRR     RRR  AAA     AAA  FFF

       MICRO-COMPUTER PROTECTED-MODE VERSION
        (REQUIRES 80386 AND 80387 OR ABOVE)
```

```
                                     VERSION 4.00
                                  RELEASE DATE APR 1993
1                                 TRAF SIMULATION MODEL

                                     DEVELOPED FOR

                            U. S. DEPARTMENT OF TRANSPORTATION
                              FEDERAL HIGHWAY ADMINISTRATION
                    INTELLIGENT VEHICLE HIGHWAY SYSTEM RESEARCH DIVISION

                                    START OF CASE   1

*****************************************************************************************************************
0                         GRAF PROJECT #23, UTPS-TRAF INTERFACE
0

                                 DATE - 08/ 14/  93
                                 USER - RANGA RAGHUNATHAN
                               AGENCY - FEDERAL HIGHWAY
                                        RUN CONTROL DATA

                 VALUE                        RUN PARAMETERS AND OPTIONS

                  1000    RUN IDENTIFICATION NUMBER
                     0    NEXT CASE CODE - (0,1) IF ANOTHER CASE (DOES NOT, DOES) FOLLOW
                     1    RUN TYPE CODE - ( 1, 2, 3) TO RUN (SIMULATION, ASSIGNMENT, BOTH)
                                          (-1,-2,-3) TO CHECK (SIMULATION, ASSIGNMENT, BOTH) ONLY

                          NETSIM ENVIRONMENTAL OPTIONS
                          ----------------------------
                     0    FUEL/EMISSION RATE TABLES ARE NOT PRINTED
                     0    SIMULATION: PERFORMED                                 ENVIRONMENTAL MEASURES:  CALCULATED
                          RATE TABLES: EMBEDDED                                 TRAJECTORY FILE:         NOT WRITTEN
                     0    INPUT  UNITS CODE - (0,1) IF INPUT IS IN (ENGLISH, METRIC) UNITS
                     0    OUTPUT UNITS CODE - (0,1,2,3) IF OUTPUT IS IN (SAME AS INPUT, ENGLISH, METRIC, BOTH) UNITS
                   715    CLOCK TIME AT START OF SIMULATION (HHMM)
                     0    SIGNAL TRANSITION CODE - (0,1,2,3) IF (NO, IMMEDIATE, 2-CYCLE, 3-CYCLE) TRANSITION WAS REQUESTED
                  7581    RANDOM NUMBER SEED
                  7681    RANDOM NUMBER SEED TO GENERATE TRAFFIC STREAM FOR NETSIM OR LEVEL I SIMULATION

                  1800    DURATION (SEC) OF TIME PERIOD NO.  1
                    60    LENGTH OF A TIME INTERVAL, SECONDS
                   180    MAXIMUM INITIALIZATION TIME, NUMBER OF TIME INTERVALS
                     0    NUMBER OF TIME INTERVALS BETWEEN SUCCESSIVE STANDARD OUTPUTS
                     0    TIME INTERMEDIATE OUTPUT WILL BEGIN AT INTERVALS OF    0 SECS. FOR    0 SECS. FOR MICROSCOPIC MODELS
                     0    NETSIM MOVEMENT-SPECIFIC OUTPUT CODE - (0,1) (IF NOT, IF) REQUESTED FOR NETSIM SUBNETWORK
                     0    NETSIM GRAPHICS OUTPUT CODE - (0,1) IF GRAPHICS OUTPUT (IS NOT, IS) REQUESTED
*****************************************************************************************************************

                                   TIME PERIOD   1 - NETSIM DATA

*****************************************************************************************************************
1                                        ENTRY LINK VOLUMES

                            LINK              FLOW RATE    TRUCKS      CAR POOLS
                                              (VEH/HOUR)  (PERCENT)   (PERCENT)

                         (8001,   1)            1400          0           0
                         (8002,   2)            1300          0           0
                         (8003,   3)            1200          0           0
                         (8004,   4)            1100          0           0
                         (8005,   5)            1000          0           0

                                     INITIALIZATION STATISTICS

        TIME INTERVAL        SUBNETWORK       PRIOR CONTENT      CURRENT CONTENT       PERCENT
           NUMBER               TYPE            (VEHICLES)          (VEHICLES)         DIFFERENCE

              1               NETSIM               0                 108               10000
              2               NETSIM             108                 209                  93
              3               NETSIM             209                 308                  47
              4               NETSIM             308                 408                  32
              5               NETSIM             408                 508                  24
              6               NETSIM             508                 604                  18
              7               NETSIM             604                 695                  15
              8               NETSIM             695                 778                  11
              9               NETSIM             778                 842                   8      EQUILIBRIUM ATTAINED
```

ALL EXISTING SUBNETWORKS REACHED EQUILIBRIUM
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1500 SECONDS INTO SIMULATION
SPILLBACK ON NETSIM LINK (104, 117) ENDS 1567 SECONDS INTO SIMULATION AFTER A DURATION OF 67 SECONDS
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1604 SECONDS INTO SIMULATION
SPILLBACK ON NETSIM LINK (104, 117) ENDS 1606 SECONDS INTO SIMULATION AFTER A DURATION OF 2 SECONDS
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1607 SECONDS INTO SIMULATION
SPILLBACK ON NETSIM LINK (104, 117) ENDS 1668 SECONDS INTO SIMULATION AFTER A DURATION OF 61 SECONDS
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1669 SECONDS INTO SIMULATION
SPILLBACK ON NETSIM LINK (104, 117) ENDS 1670 SECONDS INTO SIMULATION AFTER A DURATION OF 1 SECONDS
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1671 SECONDS INTO SIMULATION
SPILLBACK ON NETSIM LINK (104, 117) ENDS 1672 SECONDS INTO SIMULATION AFTER A DURATION OF 1 SECONDS
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1720 SECONDS INTO SIMULATION
SPILLBACK ON NETSIM LINK (104, 117) ENDS 1721 SECONDS INTO SIMULATION AFTER A DURATION OF 1 SECONDS
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1722 SECONDS INTO SIMULATION
SPILLBACK ON NETSIM LINK (104, 117) ENDS 1772 SECONDS INTO SIMULATION AFTER A DURATION OF 50 SECONDS
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1777 SECONDS INTO SIMULATION
SPILLBACK ON NETSIM LINK (104, 117) ENDS 1783 SECONDS INTO SIMULATION AFTER A DURATION OF 6 SECONDS
SPILLBACK ON NETSIM LINK (104, 117) STARTS 1789 SECONDS INTO SIMULATION

CUMULATIVE NETSIM STATISTICS AT TIME 7:45: 0

ELAPSED TIME IS 0:30: 0 (1800 SECONDS), TIME PERIOD 1 ELAPSED TIME IS 1800 SECONDS

LINK	VEHICLE MILES	VEHICLE TRIPS	VEHICLE MINUTES MOVE TIME	VEHICLE MINUTES DELAY TIME	VEHICLE MINUTES TOTAL TIME	RATIO MOVE/ TOTAL	MINUTES/MILE TOTAL TIME	MINUTES/MILE DELAY TIME	SECONDS / VEHICLE TOTAL TIME	SECONDS / VEHICLE DELAY TIME	SECONDS / VEHICLE QUEUE* TIME	SECONDS / VEHICLE STOP* TIME	AVERAGE VALUES STOPS (%)	AVERAGE VALUES VOLUME VPH	AVERAGE VALUES SPEED MPH
(1, 101)	229.00	458	458.0	126.3	584.3	0.78	2.55	0.55	76.5	16.5	0.6	3.1	3	916	23.5
(101, 1)	49.50	99	99.0	24.7	123.7	0.80	2.50	0.50	75.0	15.0	0.8	4.2	2	198	24.0
(8001, 1)		708												1416	
(1, 102)	126.00	252	252.0	43.3	295.3	0.85	2.34	0.34	70.3	10.3	0.4	0.4	0	504	25.6
(102, 1)	0.50	1	1.0	0.0	1.0	0.97	2.07	0.07	62.0	2.0	0.0	0.0	0	2	29.0
(2, 103)	105.60	352	211.2	52.5	263.7	0.80	2.50	0.50	44.9	8.9	0.4	0.4	0	704	24.0
(103, 2)	0.60	2	1.2	0.1	1.3	0.90	2.22	0.22	40.0	4.0	0.5	0.5	0	4	27.0
(8002, 2)		519												1038	
(2, 104)	33.90	113	67.8	600.6	668.4	0.10	19.72	17.72	354.9	318.9	561.4	524.7	78	226	3.0
(104, 2)	37.96	127	75.9	17.3	93.2	0.81	2.46	0.46	44.0	8.2	0.7	0.3	0	254	24.4
(3, 105)	180.00	360	360.0	83.3	443.4	0.81	2.46	0.46	73.9	13.9	0.7	0.5	2	720	24.4
(105, 3)	27.50	55	55.0	14.1	69.1	0.80	2.51	0.51	75.3	15.3	1.2	0.7	27	110	23.9
(8003, 3)		610												1220	
(3, 106)	126.00	252	252.0	66.9	318.9	0.79	2.53	0.53	75.9	15.9	2.3	6.8	11	504	23.7
(106, 3)	86.00	172	172.0	54.2	226.2	0.76	2.63	0.63	78.9	18.9	0.9	2.8	2	344	22.8
(4, 107)	75.60	252	151.2	35.6	186.8	0.81	2.47	0.47	44.5	8.5	0.4	2.4	1	504	24.3
(107, 4)	59.31	198	118.6	42.8	161.4	0.73	2.72	0.72	48.9	13.0	0.7	0.3	0	396	22.0
(8004, 4)		554												1108	
(4, 108)	91.50	305	183.0	39.9	222.9	0.82	2.44	0.44	43.8	7.8	0.5	0.5	3	610	24.6
(108, 4)	30.30	101	60.6	16.9	77.5	0.78	2.56	0.56	46.0	10.0	0.6	0.3	0	202	23.5
(5, 141)	251.00	502	502.0	118.2	620.2	0.81	2.47	0.47	74.1	14.1	0.5	1.3	7	1004	24.3
(141, 5)	138.76	279	277.5	88.8	366.3	0.76	2.64	0.64	78.8	19.1	0.7	0.4	0	558	22.7
(8005, 5)		504												1008	
(101, 113)	225.50	451	451.0	105.0	556.0	0.81	2.47	0.47	74.0	14.0	1.1	0.6	13	902	24.3
(113, 101)	49.50	99	99.0	16.3	115.3	0.86	2.33	0.33	69.9	9.9	0.6	0.4	4	198	25.8
(102, 119)	127.00	254	254.0	77.9	331.9	0.77	2.61	0.61	78.4	18.4	2.5	1.5	57	508	23.0
(119, 102)	0.50	1	1.0	0.1	1.1	0.94	2.13	0.13	64.0	4.0	1.0	0.0	0	2	28.1
(103, 123)	241.38	373	482.8	1254.8	1737.6	0.28	7.20	5.20	279.5	201.9	140.3	113.0	80	746	8.3
(123, 103)	0.65	1	1.3	0.1	1.4	0.92	2.18	0.18	85.0	7.0	0.0	0.0	0	2	27.5
(103, 122)	0.00	0	0.0	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0	0	0.0
(122, 103)	0.00	0	0.0	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0	0	0.0
(104, 117)	53.28	82	106.6	1426.5	1533.1	0.07	28.77	26.77	1121.8	1043.8	983.6	930.3	100	164	2.1
(117, 104)	53.28	82	106.6	23.7	130.2	0.82	2.44	0.44	95.3	17.3	0.7	5.9	13	164	24.5
(104, 116)	37.73	63	75.5	11.2	86.7	0.87	2.30	0.30	82.6	10.7	0.8	0.4	3	126	26.1
(116, 104)	187.20	312	374.4	304.3	678.7	0.55	3.63	1.63	130.5	58.5	62.8	56.6	33	624	16.6
(105, 111)	0.55	1	1.1	2.5	3.5	0.31	6.45	4.45	213.0	147.0	2.0	146.0	100	2	9.3
(111, 105)	3.30	6	6.6	14.6	21.3	0.31	6.44	4.44	212.5	146.5	2.7	138.3	100	12	9.3
(105, 117)	76.38	129	152.8	1152.1	1304.8	0.12	17.08	15.08	606.9	535.9	609.6	581.4	100	258	3.5
(117, 105)	32.84	55	65.7	18.3	84.0	0.78	2.56	0.56	91.7	20.0	0.4	0.4	0	110	23.5
(106, 112)	127.80	213	255.6	62.0	317.6	0.80	2.49	0.49	89.5	17.5	0.7	0.4	5	426	24.1
(112, 106)	59.36	99	118.7	25.1	143.8	0.83	2.42	0.42	87.2	15.2	0.9	0.5	9	198	24.8
(106, 111)	14.91	30	29.8	4.0	33.8	0.88	2.27	0.27	67.6	7.9	0.9	0.4	6	60	26.5
(111, 106)	36.00	72	72.0	18.5	90.5	0.80	2.51	0.51	75.4	15.4	1.9	1.4	44	144	23.9
(107, 121)	0.00	0	0.0	0.0	0.0	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0	0	0.0
(121, 107)	60.43	93	120.9	32.4	153.2	0.79	2.54	0.54	98.9	20.9	1.6	0.9	11	186	23.7

* AVERAGE QUEUE AND STOP TIME ARE COMPUTED AS TOTAL QUEUE TIME OR TOTAL STOP TIME DIVIDED BY TOTAL NUMBER OF VEHICLES DISCHARGED FROM LINK PLUS NUMBER OF VEHICLES CURRENTLY ON THE LINK.

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CUMULATIVE NETSIM STATISTICS AT TIME 7:45: 0

ELAPSED TIME IS 0:30: 0 (1800 SECONDS), TIME PERIOD 1 ELAPSED TIME IS 1800 SECONDS

LINK	VEH-MINS * QUEUE TIME	VEH-MINS * STOP TIME	AVERAGE OCCUPANCY (VEHICLE)	CONGESTION STORAGE (%)	CONGESTION PHASE FAILURE	AVERAGE QUEUE BY LANE ** 1	2	3	4	5	6	7	MAXIMUM QUEUE BY LANE 1	2	3	4	5	6	7
(1, 101)	4.5	24.8	19.6	8.4	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0
(101, 1)	1.3	7.1	4.7	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1, 102)	1.9	1.9	10.3	4.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(102, 1)	0.0	0.0	0.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(2, 103)	2.6	2.6	9.1	6.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(103, 2)	0.0	0.0	0.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(2, 104)	1796.6	1678.9	65.8	45.7	0	0	63	0	0	0	0	0	1	79	0	0	0	0	0
(104, 2)	1.5	0.7	3.6	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3, 105)	4.2	3.4	14.8	6.2	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0
(105, 3)	1.1	0.7	2.5	1.1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
(3, 106)	10.2	29.7	11.0	4.8	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0
(106, 3)	2.7	8.2	8.0	3.4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
(4, 107)	1.5	10.5	6.6	4.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(107, 4)	2.2	1.1	5.8	4.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(4, 108)	2.5	2.5	7.8	5.4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
(108, 4)	1.1	0.5	3.0	2.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5, 141)	4.0	11.0	21.2	8.9	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
(141, 5)	3.3	1.8	12.8	5.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(101, 113)	8.8	5.1	19.2	8.2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
(113, 101)	1.0	0.7	4.4	1.9	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
(102, 119)	10.9	6.5	11.4	4.8	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
(119, 102)	0.0	0.0	0.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(103, 123)	940.3	757.0	55.9	17.9	0	18	17	0	0	0	0	0	55	54	0	0	0	0	0
(123, 103)	0.0	0.0	0.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(103, 122)	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(122, 103)	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(104, 117)	6737.5	6372.4	241.5	79.8	0	109	121	0	0	0	0	0	160	171	0	0	0	0	0
(117, 104)	0.9	8.1	4.7	1.6	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
(104, 116)	0.8	0.4	3.3	1.2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
(116, 104)	422.0	380.0	33.5	12.0	0	7	8	0	0	0	0	0	39	45	0	0	0	0	0
(105, 111)	0.0	2.4	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(111, 105)	0.3	13.8	1.4	1.2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
(105, 117)	4317.8	4118.0	158.7	56.1	0	76	72	0	0	0	0	0	150	144	0	0	0	0	0
(117, 105)	0.4	0.3	3.1	1.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(106, 112)	2.7	1.5	11.4	8.1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
(112, 106)	1.5	0.9	5.2	3.8	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
(106, 111)	0.5	0.2	1.6	1.7	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
(111, 106)	2.5	1.8	3.7	3.2	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
(107, 121)	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(121, 107)	2.5	1.5	5.8	3.7	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0

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CUMULATIVE NETSIM STATISTICS AT TIME 7:45: 0

ELAPSED TIME IS 0:30: 0 (1800 SECONDS), TIME PERIOD 1 ELAPSED TIME IS 1800 SECONDS

* THESE VALUES INCLUDE THE TIME FOR VEHICLES CURRENTLY ON THE LINK.
** AVERAGE QUEUE CALCULATED BASED ON TIME SINCE BEGINNING OF SIMULATION

1

NETSIM PERSON MEASURES OF EFFECTIVENESS

LINK	PERSON MILE	PERSON TRIPS	DELAY PERSON-MIN	TRAVEL TIME PERSON-MIN
(1, 101)	428.0	856.1	236.0	1092.1
(101, 1)	88.0	176.1	43.9	220.0
(8001, 1)				
(1, 102)	163.8	327.6	56.3	383.9
(102, 1)	0.6	1.3	0.0	1.3
(2, 103)	137.3	457.6	68.2	342.8
(103, 2)	0.8	2.6	0.2	1.7
(8002, 2)				
(2, 104)	44.1	146.9	780.8	868.9
(104, 2)	49.4	165.1	22.5	121.2
(3, 105)	234.0	468.0	108.4	576.4
(105, 3)	35.8	71.5	18.3	89.8
(8003, 3)				
(3, 106)	282.3	564.6	150.0	714.6
(106, 3)	159.2	318.4	100.3	418.7
(4, 107)	133.8	446.1	63.0	330.7
(107, 4)	77.1	257.4	55.6	209.8
(8004, 4)				
(4, 108)	118.9	396.5	51.8	289.7
(108, 4)	39.4	131.3	22.0	100.8
(5, 141)	373.7	747.4	176.0	923.4
(141, 5)	215.7	433.8	138.1	569.5
(8005, 5)				
(101, 113)	411.7	823.3	191.6	1014.9
(113, 101)	99.9	199.8	32.9	232.7
(102, 119)	165.1	330.2	101.2	431.4
(119, 102)	0.6	1.3	0.1	1.4
(103, 123)	313.8	484.9	1631.3	2258.9
(123, 103)	0.8	1.3	0.2	1.8
(103, 122)	0.0	0.0	0.0	0.0
(122, 103)	0.0	0.0	0.0	0.0
(104, 117)	100.1	154.0	2679.1	2879.2
(117, 104)	115.5	177.7	51.3	282.2
(104, 116)	91.6	153.0	27.3	210.6
(116, 104)	371.3	618.9	603.5	1346.2
(105, 111)	13.8	25.0	61.3	88.8
(111, 105)	82.5	150.0	366.3	531.3
(105, 117)	127.4	215.1	1921.1	2175.8
(117, 105)	56.8	95.2	31.7	145.4
(106, 112)	223.0	371.7	108.3	554.3
(112, 106)	119.8	199.8	50.7	290.3
(106, 111)	90.1	181.2	23.9	204.1
(111, 106)	58.7	117.3	30.1	147.4
(107, 121)	0.0	0.0	0.0	0.0

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NETSIM PERSON MEASURES OF EFFECTIVENESS

LINK	PERSON MILE	PERSON TRIPS	DELAY PERSON-MIN	TRAVEL TIME PERSON-MIN
(121, 107)	78.6	120.9	42.1	199.2
(107, 120)	306.4	439.6	93.4	706.1
(120, 107)	94.2	135.2	53.1	241.5
(108, 127)	211.1	326.3	142.0	564.2
(127, 108)	85.3	131.3	39.1	209.8
(108, 126)	49.1	70.2	15.0	113.3
(126, 108)	0.0	0.0	0.0	0.0
(110, 111)	68.2	97.5	29.4	165.8
(111, 110)	23.7	33.8	5.8	53.1
(110, 116)	22.8	35.1	16.3	61.9
(116, 110)	60.6	93.6	17.5	138.6
(112, 114)	159.6	245.6	69.1	388.3
(114, 112)	131.2	202.7	62.4	324.8
(112, 118)	0.0	0.0	0.0	0.0
(118, 112)	11.0	16.9	1.8	23.7
(113, 116)	331.4	828.5	167.0	829.8
(116, 113)	77.8	194.6	28.2	183.8
(114, 115)	87.5	125.0	25.5	200.4
(115, 114)	70.0	100.0	47.5	187.5
(114, 120)	92.9	143.0	44.5	230.4
(120, 114)	64.2	98.8	22.3	150.7
(115, 121)	81.2	125.0	21.7	184.2
(121, 115)	65.0	100.0	42.1	172.1
(117, 118)	0.0	0.0	0.0	0.0
(118, 117)	53.2	76.0	91.3	197.7
(117, 123)	34.6	53.3	64.5	133.8

1 *** NOTE *** TIME PERIOD 1 SPECIFIC NETSIM STATISTICS ARE THE SAME AS CUMULATIVE OUTPUT AT THE END OF TIME PERIOD 1.

NETSIM BUS STATISTICS

LINK	BUS TRIPS	PERSON TRIPS	TRAVEL TIME (MINUTES)	MOVING TIME (MINUTES)	DELAY TIME (MINUTES)	M/T	SPEED (MPH)	NUMBER OF STOPS
(1, 101)	11	275	36.6	11.0	25.6	0.30	9.0	11
(101, 1)	2	50	6.7	2.0	4.7	0.30	9.0	3
(8001, 1)	10	250						
(8003, 3)	10	250						
(3, 106)	10	250	35.8	10.0	25.8	0.28	8.4	10
(106, 3)	4	100	12.4	4.0	8.4	0.32	9.7	4
(4, 107)	5	125	12.9	3.0	9.9	0.23	7.0	5
(8004, 4)	5	125						
(5, 141)	4	100	10.2	4.0	6.2	0.39	11.8	4
(141, 5)	3	75	3.8	3.0	0.8	0.79	23.8	0

(8005, 5)	4	100						
(101, 113)	10	250	12.3	10.0	2.3	0.81	24.3	0
(113, 101)	3	75	3.7	3.0	0.7	0.80	24.1	0
(104, 117)	2	50	41.7	2.6	39.1	0.06	1.9	2
(117, 104)	3	75	10.2	3.9	6.3	0.38	11.4	4
(104, 116)	3	75	4.5	3.6	0.9	0.80	23.9	0
(116, 104)	9	225	19.0	10.8	8.2	0.57	17.1	0
(105, 111)	1	25	3.5	1.1	2.5	0.31	9.3	1
(111, 105)	6	150	21.3	6.6	14.6	0.31	9.3	6
(105, 117)	2	50	26.6	2.4	24.2	0.09	2.7	0
(117, 105)	1	25	1.2	1.2	0.0	1.00	30.4	0
(106, 112)	4	100	5.8	4.8	1.0	0.83	24.8	0
(112, 106)	3	75	4.7	3.6	1.1	0.76	22.9	0
(106, 111)	6	150	7.1	6.0	1.1	0.85	25.5	0
(111, 106)	1	25	1.1	1.0	0.1	0.92	27.7	0
(107, 120)	5	125	8.1	7.0	1.1	0.87	26.1	0
(112, 114)	4	100	6.6	5.2	1.4	0.79	23.8	0
(114, 112)	4	100	7.0	5.2	1.8	0.74	22.2	0
(113, 116)	10	250	10.2	8.0	2.2	0.78	23.5	0
(116, 113)	3	75	3.0	2.4	0.6	0.79	23.6	0
(114, 115)	5	125	8.0	7.0	1.0	0.87	26.2	0
(115, 114)	4	100	7.5	5.6	1.9	0.74	22.3	0
(115, 121)	5	125	7.4	6.5	0.9	0.88	26.5	0
(121, 115)	4	100	6.9	5.2	1.7	0.76	22.7	0
(118, 117)	2	50	5.8	2.8	3.0	0.48	14.5	0
(120, 118)	2	50	20.7	2.6	18.1	0.13	3.8	0
(121, 127)	4	100	5.8	5.2	0.6	0.90	27.0	0
(127, 121)	4	100	7.1	5.2	1.9	0.74	22.1	0
(127, 133)	4	100	16.4	4.8	11.6	0.29	8.8	4
(133, 127)	5	125	18.1	6.0	12.1	0.33	10.0	4
(133, 139)	4	100	6.3	4.8	1.5	0.76	22.9	0
(139, 133)	4	100	6.5	4.8	1.7	0.74	22.3	0
(139, 141)	3	75	4.7	3.6	1.1	0.77	23.2	0
(141, 139)	4	100	6.4	4.8	1.6	0.75	22.6	0

1 NETSIM BUS STATION STATISTICS

STATION NUMBER	TIME CAPACITY EXCEEDED (MINUTES)	TIME EMPTY (MINUTES)	TOTAL DWELL TIME (BUS-MIN.)	BUSES SERVICED
1	4.9	9.7	20.5	10
2	0.5	23.8	6.4	4
3	0.0	16.5	13.6	6
4	0.0	27.7	2.4	1
5	0.0	23.3	6.8	3
6	0.0	24.6	5.4	2
7	0.0	24.1	5.9	2
8	1.5	10.9	19.5	10
9	0.0	20.9	9.3	5
11	0.0	23.3	6.8	4
13	0.0	21.4	8.6	5
14	0.0	20.3	9.8	4

1 CUMULATIVE VALUES OF FUEL CONSUMPTION AND OF EMISSIONS

0 LINK	FUEL CONSUMPTION GALLONS			M.P.G.			VEHICLE EMISSION RATES (KG/MILE.HOUR)		
0 VEHICLE TYPE-	AUTO	TRUCK	BUS	AUTO	TRUCK	BUS	HC	CO	NO X
(1, 101)	15.3	0.0	0.9	14.4	0.0	6.1	0.132	1.985	0.540
(101, 1)	3.2	0.0	0.3	15.1	0.0	5.9	0.027	0.407	0.108
(8001, 1)									
(1, 102)	8.6	0.0	0.0	14.5	0.0	0.0	0.078	1.208	0.347
(102, 1)	0.0	0.0	0.0	18.6	0.0	0.0	0.000	0.003	0.001
(2, 103)	7.9	0.0	0.0	13.2	0.0	0.0	0.116	1.823	0.527
(103, 2)	0.0	0.0	0.0	15.4	0.0	0.0	0.000	0.006	0.002
(8002, 2)									
(2, 104)	18.1	0.0	0.0	2.2	0.0	0.0	0.269	3.249	0.402
(104, 2)	2.7	0.0	0.0	13.8	0.0	0.0	0.040	0.624	0.177
(3, 105)	11.7	0.0	0.0	15.4	0.0	0.0	0.102	1.544	0.412
(105, 3)	1.7	0.0	0.0	15.9	0.0	0.0	0.015	0.220	0.057
(8003, 3)									
(3, 106)	7.9	0.0	1.0	15.1	0.0	5.3	0.070	1.080	0.302
(106, 3)	5.7	0.0	0.4	14.7	0.0	5.6	0.049	0.742	0.193
(4, 107)	5.2	0.0	0.3	14.0	0.0	5.3	0.076	1.244	0.360
(107, 4)	4.4	0.0	0.0	13.5	0.0	0.0	0.063	0.963	0.257
(8004, 4)									
(4, 108)	6.6	0.0	0.0	13.5	0.0	0.0	0.099	1.581	0.458
(108, 4)	2.2	0.0	0.0	13.5	0.0	0.0	0.033	0.522	0.144
(5, 141)	18.0	0.0	0.4	13.9	0.0	5.7	0.157	2.345	0.659
(141, 5)	10.1	0.0	0.3	13.6	0.0	5.6	0.086	1.271	0.335
(8005, 5)									
(101, 113)	15.2	0.0	0.9	14.6	0.0	6.1	0.133	2.030	0.549
(113, 101)	3.1	0.0	0.2	15.2	0.0	6.3	0.027	0.415	0.115
(102, 119)	8.8	0.0	0.0	14.1	0.0	0.0	0.077	1.155	0.306
(119, 102)	0.0	0.0	0.0	18.1	0.0	0.0	0.000	0.003	0.001
(103, 123)	24.9	0.0	0.0	9.1	0.0	0.0	0.166	2.467	0.456
(123, 103)	0.0	0.0	0.0	15.7	0.0	0.0	0.000	0.003	0.001
(103, 122)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000
(122, 103)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000
(104, 117)	62.0	0.0	1.7	1.9	0.0	2.3	0.429	4.777	0.577
(117, 104)	2.9	0.0	0.5	16.5	0.0	5.8	0.019	0.293	0.076
(104, 116)	2.2	0.0	0.3	15.7	0.0	5.9	0.016	0.240	0.065
(116, 104)	18.4	0.0	1.0	11.9	0.0	5.9	0.135	2.010	0.470
(105, 111)	0.0	0.0	0.1	0.0	0.0	7.2	0.000	0.000	0.000
(111, 105)	0.0	0.0	0.6	0.0	0.0	6.0	0.000	0.000	0.000
(105, 117)	44.5	0.0	0.9	3.1	0.0	2.5	0.332	3.954	0.535
(117, 105)	2.0	0.0	0.1	16.2	0.0	6.5	0.014	0.201	0.048
(106, 112)	8.1	0.0	0.4	15.8	0.0	5.8	0.057	0.834	0.206
(112, 106)	4.0	0.0	0.3	14.3	0.0	5.5	0.030	0.451	0.127
(106, 111)	0.7	0.0	0.6	17.4	0.0	6.0	0.006	0.083	0.021
(111, 106)	2.5	0.0	0.1	14.7	0.0	6.8	0.022	0.336	0.089
(107, 121)	0.0	0.0	0.0	0.0	0.0	0.0	0.000	0.000	0.000
(121, 107)	4.1	0.0	0.0	15.1	0.0	0.0	0.027	0.395	0.099

THE MAXIMUM NUMBER OF VEHICLES ON THE NETWORK WAS 2710 VEHICLES.
THIS MAXIMUM OCCURED AT 1799 SECONDS.

1 CUMULATIVE NETWORK-WIDE BUS STATISTICS AT TIME 7:45: 0

ELAPSED TIME IS 0:30: 0 (1800 SECONDS), TIME PERIOD 1 ELAPSED TIME IS 1800 SECONDS

ROUTE STATISTICS

ROUTE	BUS TRIPS	TOTAL TRAVEL TIME (BUS-MIN.)	MEAN TRAVEL TIME (SEC/BUS)	PERSON TRIPS	PERSON TRAVEL TIME (MINUTES)
1	1	84.1	1925.1	25	2101.3
2	1	66.0	2244.8	25	1649.2

3	1	65.8	1675.8	25	1645.0
4	0	62.3	1711.1	0	1558.8
5	3	84.1	1268.5	75	2102.1
6	3	81.1	1178.9	75	2027.9

THESE ESTIMATES ASSUME AN AVERAGE BUS OCCUPANCY OF 25.0 PASSENGERS PER BUS THROUGHOUT THE NETWORK
TOTAL CPU TIME FOR THIS RUN = 919.51 SECONDS
LAST CASE PROCESSED

REFERENCES

1. Urban Transportation Planning System Reference Manual, Urban Mass Transportation Administration and the Federal Highway Administration, December 1982.
2. Urban Transportation Planning Software writeups, 1984.
3. TRAF User Reference Guide, Office of Safety and Traffic Operations, IVHS research division.
4. Urban Transportation Planning Software, MVS version.
5. TRAF simulation software, version 4.00, April 1993.

Mr. Ranga Raghunathan was born in 1967 in Tamil Nadu, India. He obtained his Bachelor's degree in Civil Engineering from Birla Institute of Technology and Science, Pilani, India. After gaining some experience in civil engineering he joined the Virginia Polytechnic Institute and State University, Blacksburg, VA to pursue his Master's degree in Civil Engineering with specialization in Transportation engineering. During the spring semester 1992, he worked as a Teaching Assistant to Dr. A.A Trani for a course in Airport Planning. During the summer of 1992, he worked as a graduate co-op student with Delta Associates p.e Inc, in Richmond Virginia, where he gained experience in planning and design of airports.

Mr. Raghunathan was awarded the Dwight David Eisenhower Grants for Research Fellowship by the Federal Highway Administration in April 1992. To fulfill the requirements of this fellowship, he conducted research in the Turner Fairbank Highway Research Center in McLean, VA for a period of one year. During this period he developed a methodology to interface transportation planning and traffic simulation, which also was the subject of his thesis.

R. Raghunathan

Ranga Raghunathan
September 10, 1993