A COMBINED METHODOLOGY FOR TRANSPORTATION PLANNING ASSESSMENT. APPLICATION TO A CASE STUDY

L. MONTERO[1], E.CODINA[1], J. BARCELÓ[1], P. BARCELÓ[2]

[1] Dept. Estadística i Investigació Operativa. Universitat Politècnica de Catalunya,

C/ Pau Gargallo 5, 08028 Barcelona (SPAIN). Tel. 34.93.401.10.38. Fax. 34.93.401.58.55. E-mail: lidia.montero@upc.es

[2] TSS (Transport Simulation Systems). C/Tarragona 110-114, 08015 Barcelona (Spain).

INTRODUCTION

Traffic assignment models based on the user equilibrium approach are one of the most widely used tools in transportation planning analysis. All the modeling hypotheses lead to a nice mathematical model for which there are efficient algorithms that provide solutions in terms of the expected flows on network links. Modeled flows offer a static average view of the expected use of the road infrastructure under the modeling hypothesis. This information has usually been sufficient for planning decisions.

However, the evolution of advanced technologies and their application to modern traffic management systems require in most cases a dynamic view complementing the static estimates provided by the assignment tools. The planned infrastructure is probably sufficient for average demand, but time-varying traffic flows, i.e. at peak periods, combined with the influence of road geometry, can produce undesired congestion that can not be forecasted or analysed with the static tools. There is a clear case for changing in the analysis methodology. This paper proposes of the combination of a well-known traffic assignment tool, the EMME/2 model, with a microscopic traffic simulator, the AIMSUN2 (**A**dvanced **I**nteractive **M**icroscopic **S**imulator For **U**rban And **N**on-Urban **N**etworks).

There is another type of situation in a dialogue between a microscopic and a macroscopic approach may be desirable. Microscopic simulation can admit two types of input; the more classical one models traffic flows at model-input sections and turning proportions at the intersections. Current trends in microscopic modeling allow the input to be defined in terms of a time-sliced origin-destination matrix (Barceló *et al.*, 1995). Time-sliced origin-destination matrices are usually very difficult to obtain and quite often analysts must resort to heuristic procedures to adjust matrices and use measured flows for different time intervals. Most of these adjustment procedures are based on bi-level optimization approaches that solve a traffic assignment problem at an intermediate stage. The outcome of the adjustment procedure becomes the input to the microscopic model. A direct communication between the two systems makes the input task easier and error-free.

The methodology proposed in this paper can be summarized as follows: starting from the graphic user interface GETRAM (**G**eneric **E**nvironment for **T**raffic **A**nalysis and **M**odeling) and utilizing a set of graphic editors working on the network representation provided by a GIS, a microsimulation model is built of the road network under study. This network representation is then transferred into the network representation used by the assignment model, the EMME/2 in our case. The transfer ensures the consistency of both representations, and a one-to-one correspondence between the centroids used in the assignment to model the demand matrix and the centroids used in the microscopic model for the same purpose. This consistency enables the exchange of information between the two models. The logic of the proposed methodology is illustrated in Figure 1.

This methodology is illustrated in the paper with a real life project: a study done for the Spanish company APIA XXI to compare two alternative geometric designs of a motorway in Barcelona, with complex exchange nodes with other motorways.

First, GETRAM environment and AIMSUN2 simulator are briefly described and the case study is exposed. In a Technical Appendix, the macroscopic-microscopic integration through GETRAM is discussed in detail, including what has been put into practice.

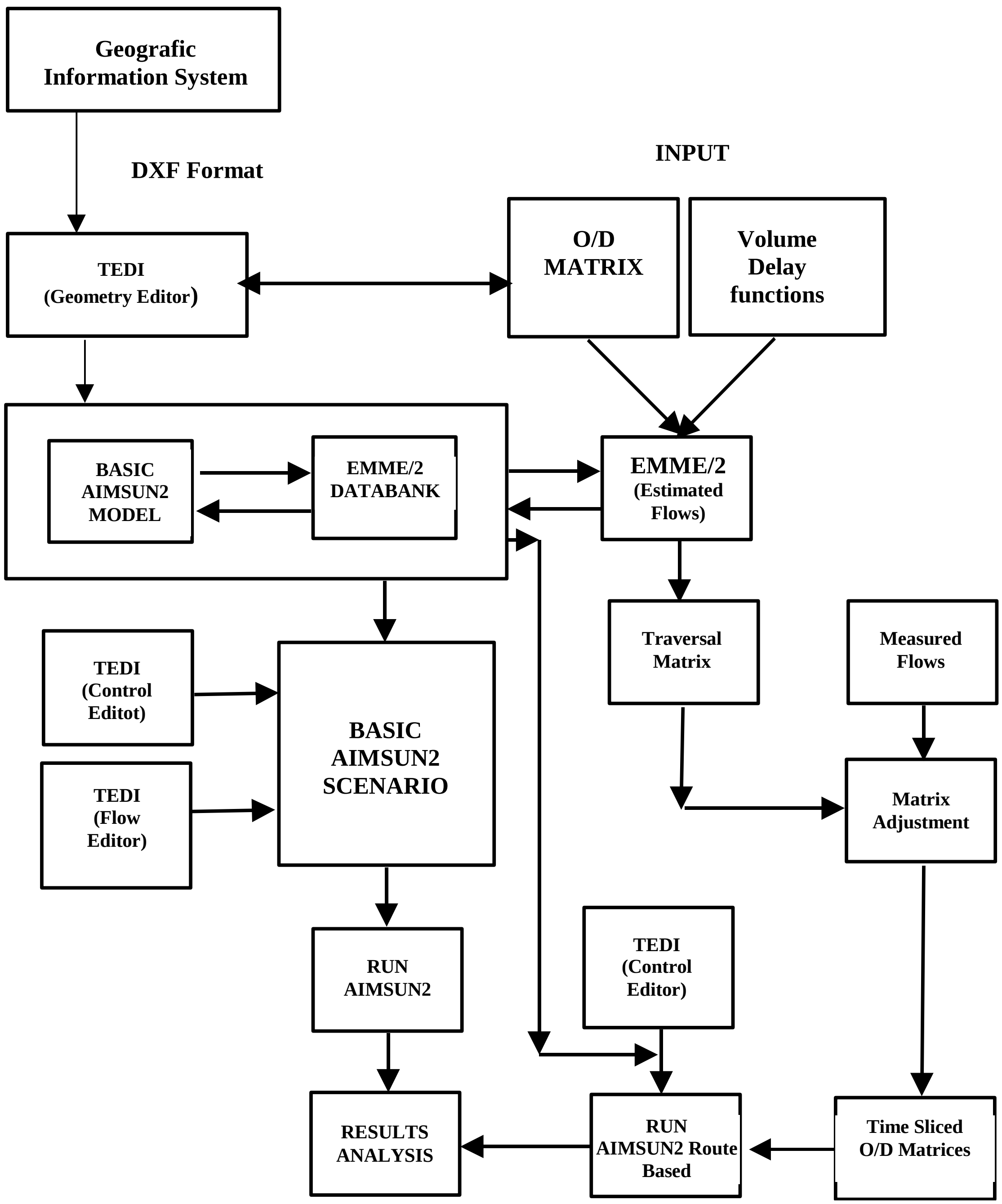

Figure 1. Flow Diagram of the Methodology

GETRAM ENVIRONMENT

GETRAM (**G**eneric **E**nvironment for **T**raffic **A**nalysis and **M**odeling) (Barceló & Casas, 1999) consists of a user-friendly graphical interface, a traffic network graphical editor (called TEDI) supporting any kind of road network geometry, urban or interurban, a network database and a module for storing and presenting results, including the possibility of an animated simulation output. A set of high-level, object-based application programming functions (API) provides the support for integrating a new model into the environment, accessing any kinds of data and manipulating objects in the network representation. Recently, GETRAM has incorporated the models AIMSUN2 and EMME/2 (see Figure 2).

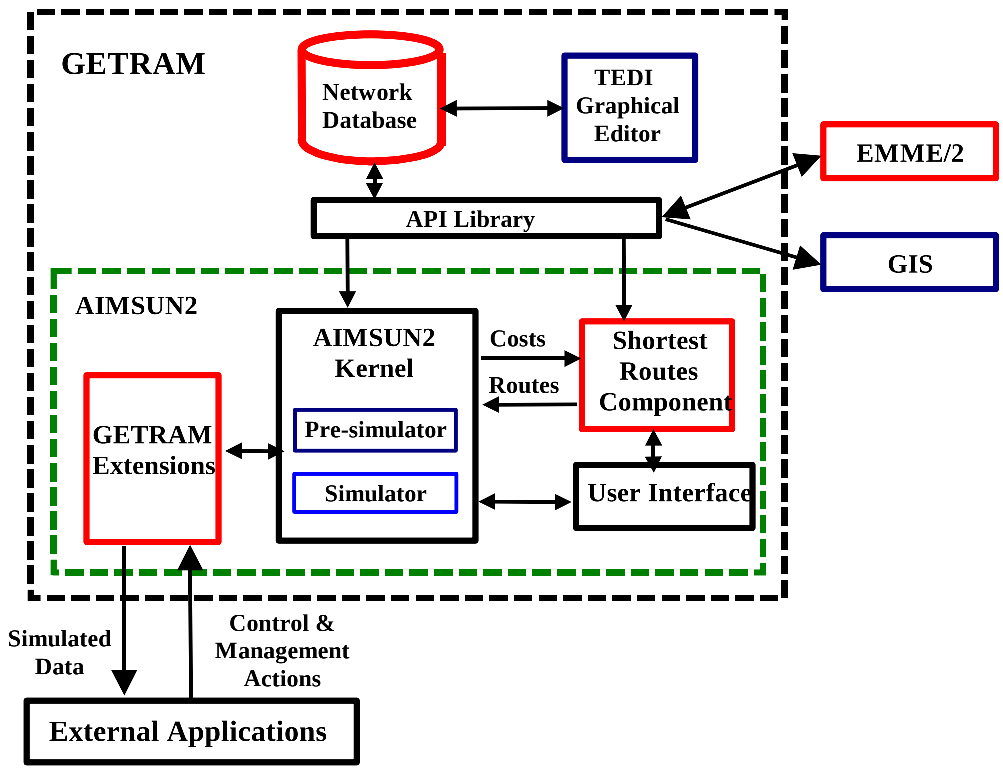

Figure 2. GETRAM Conceptual Diagram: Integration of Macroscopic and Microscopic Analysis Tools

The system has fully open software architecture, in the sense that traffic control models, vehicle behavior models, route calculation and route choice models, among others, are independent of the simulation logic and therefore can easily be exchanged for alternative models.

AIMSUN2 (Barceló & Ferrer, 1998; Hughes, 1998) is a microscopic simulator integrated into GETRAM and capable of reproducing the real traffic conditions on an urban network which contains both expressways and arterial routes. It provides a very detailed modeling of the traffic network since it distinguishes between different types of vehicles and drivers, and deals with a wide range of network geometries, incidents, etc..

The output provided by AIMSUN2 includes a continuous animated graphical representation of the traffic network performance, a printout of statistical data (flows, speeds, journey times, delays, stops) and data gathered by the simulated detectors (counts, occupancy, speeds, queue lengths). Figures 3a and 3b are included for comparison purposes, between a typical EMME/2 assignment output and an AIMSUN2 simulation.

The input required by AIMSUN2 is composed of three types of data: network description, traffic control plans and traffic conditions. The network description contains information about the geometry of the network, turning movements, layout of links (or sections) and junctions, and location of detectors along the network. The traffic control plans are composed of the description of stages and their durations for signal controlled junctions, the priority definition for unsignalized junctions, and any required ramp-metering information. AIMSUN2 accepts two classes of input for the simulation, depending on how traffic conditions are going to be simulated.

AIMSUN2 models a traffic network as a set of sections (links) connected to each other through nodes. The basic modeling structure is the Entity: sections are composed of section entities which correspond to lanes, and nodes are made up of node entities which connect input and output entities and define the turning movement. Vehicles move along the network through entities according to behavior models, which are a function of their state, defined by the current and adjacent entities.

An entity link, or section, is defined by a set of attributes whose values are specified through a dialogue window with five fields: Basics, Detectors, Metering, VMS and Reserved. The Basics group of attributes concerns the section type (several possibilities), maximum speed (speed limit in the section), capacity, altitude (slope of the section) and a user attribute.

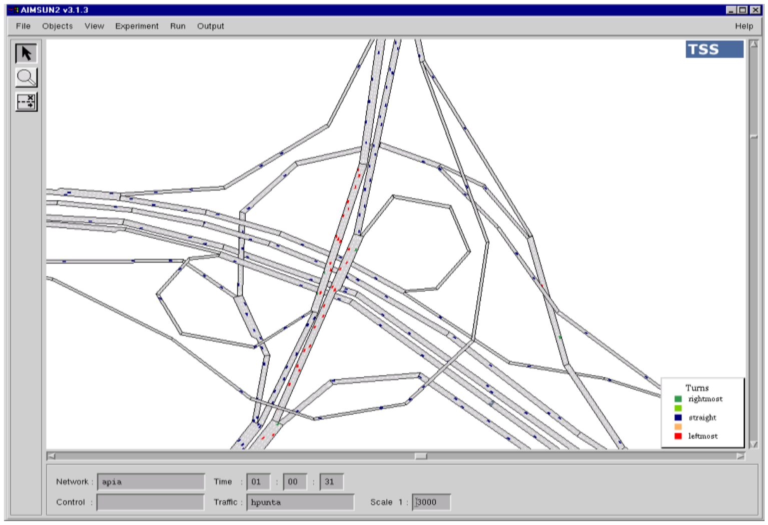

Figure 3a. AIMSUN2 vs EMME/2: AIMSUN2 model for Llobregat Ring-road in one of the scenarios **.**

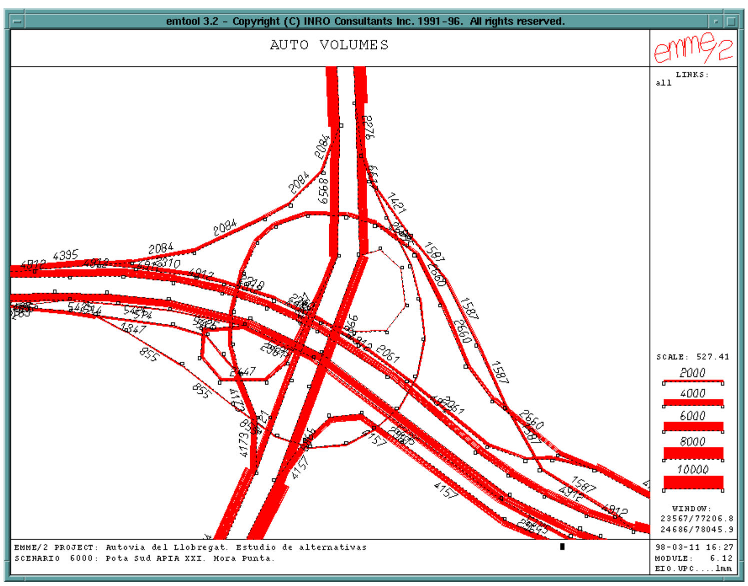

Figure 3b. AIMSUN2 vs EMME/2: EMME/2 model for Llobregat Ring-road in one of the scenarios

The traffic conditions may be input in two ways: as time-sliced O/D matrices in EMME/2 3.11 Module Input Batch Entry format, or as the turning proportions at junctions plus the input distribution of vehicles. It depends on the selected input mode how vehicles are generated and input into the network during the simulation process: either at the input section following a random generation model based on the mean input flows for that section (a negative exponential or shifted negative exponential or a platoon distribution), or at their specific origins. In the first case, they are distributed randomly on the network according to the turning proportions defined for each junction of the network, which means that vehicles do not know their complete path along the network, but only their next turning movement. In the second case (Barceló *et al*., 1995), vehicles are allocated to specific routes from their origins to their destinations. In this case explicit routes are computed, according to various model alternatives, such as time-dependent shortest paths, according to vehicle origins and destinations, and vehicles are allocated to the routes following specific route choice models. Drivers tend to travel at the speed they want in each section, but within certain objective conditions by their state (preceding and adjacent vehicles, traffic lights, etc.).

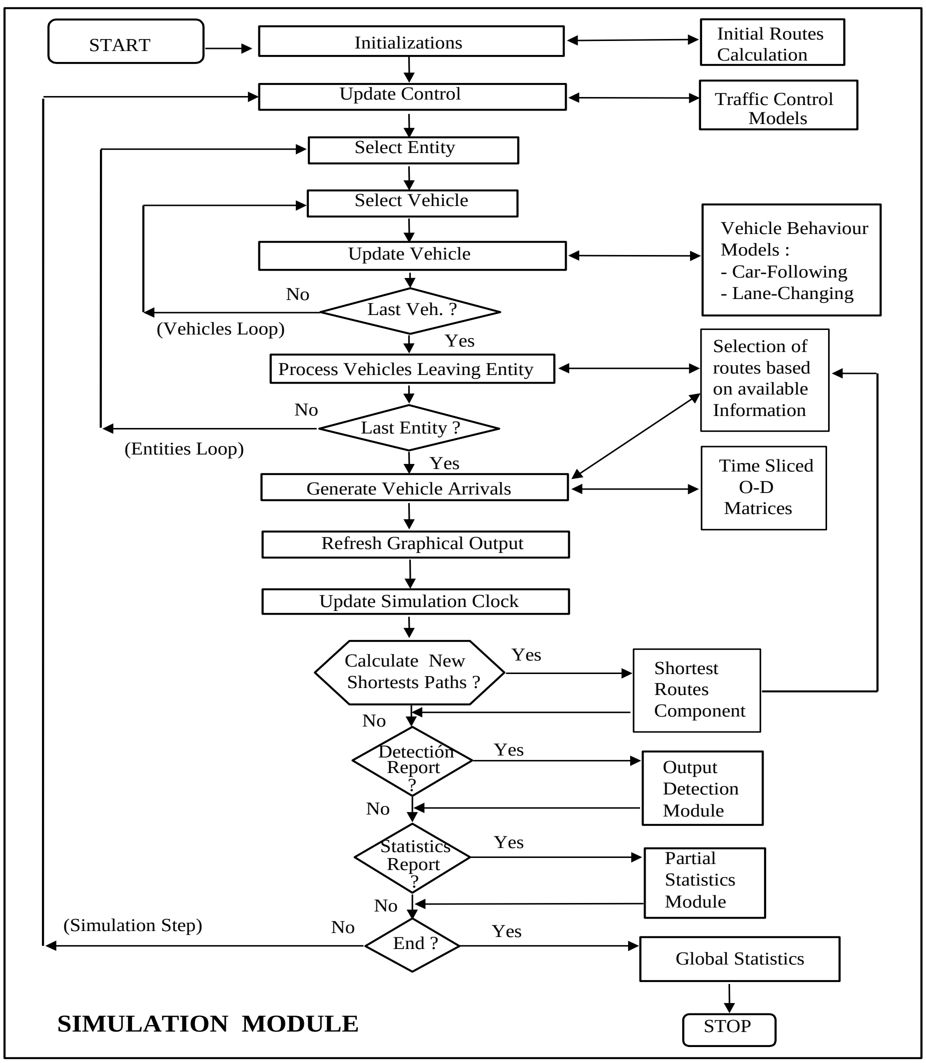

Figure 4. AIMSUN2 Simulation Process

The simulation process in AIMSUN2 is detailed in Figure 4. One can see three loops in the process: per simulation step, per entities and per vehicles in entities reflecting the object-oriented design. In the right hand side of the figure, models are referenced in the stages of the process, in a fully modular design that allows the interchange of such modules to fullfil the customization to user-implemented modules.

MACROSCOPIC-MICROSCOPIC MODEL INTEGRATION IN GETRAM

From digitalized cartography representing the area of study, in *.dxf* format, the graphical editor TEDI allows the user, by clicking on the screen, to define network links, nodes, centroids, turning movements and traffic control, through dialogue windows. Once the network, traffic control and traffic conditions are defined in TEDI, there are several interfaces that can be activated in the GETRAM environment (details are given in the Technical Appendix):

- GETRAM to EMME/2.
- GETRAM to AIMSUN2.
- EMME/2 to AIMSUN2 via GETRAM (partially developed).

CASE STUDY

In the River Llobregat valley to the South of the Metropolitan Area of Barcelona (Spain) a new motorway is being built. This area is one of the most active industrialised in Spain. Some existent infrastructure, such as the Llobregat and Bellvitge ring-roads, will be adapted for this new Llobregat Motorway (*Autovia del Llobregat*). In addition, a new by-pass between the urban area and the south coast access road (called the *South Leg*) will be incorporated to the road network.

Five infrastructural elements, either alone or together, are included in this case study: Llobregat Motorway, South Leg Proposal 1, South Leg Proposal 2, Sant Boi Ring-road Modification and Bellvitge Ring-road Modification.

The authors are responsible for assessing several options (`scenarios`). The study follows the classical four-step methodology, but breaks new ground with respect to the computer tools used for model building and assessment, which combine macroscopic models, through the static traffic assignment facilities of EMME/2, with the microscopic simulation facilities of AIMSUN2. Both were integrated into the GETRAM environment.

The semi-authomatic building of the required transportation graphs by the macroscopic tool EMME/2 and the microscopic tool AIMSUN2 was performed with the graphical editor of GETRAM (called TEDI), which enables the attributes of network sections involved, i.e. number of lanes, width, speed, length, capacity, to be defined by using a digitalized map of the study area. From GETRAM internal binary format, an automatic process generates either the macroscopic network and turning movements description in EMME/2 batch entry format or the microscopic network description in AIMSUN2 entry format, for the whole area or a part of the area requiring detailed analysis by microscopic simulation. The characteristics of some of the scenarios developed, the Base scenario and the South Leg proposals (the ones for which a microscopic simulation analysis was requested) are depicted in Table 1.

Table 1. Scenario characteristics: Base and South Leg Proposals

Scenario description **(*Peak Period*)**	***Zones***	***Nodes***	***Links***
BASE (Llobregat Motorway)	106	2962	3759
South Leg Proposal 1	106	3022	3845
South Leg Proposal 2	106	3063	3899

The most recent mobility information available for the whole study area dated from 1991, in the so-called EMO’91. It contained the full set of compulsory home-based trips for the population of Catalonia. This information came from the 1991 Census. During the present study (1997), a large scale mobility survey was conducted in the area, but results did not become available soon enough for inclusion. The EMO’91 modal matrices were easily adapted to the zonification of the current study, since EMO’91 zonification is detailed and only requires a simple aggregation phase for conversion.

An exhaustive plan of traffic counts was designed, so that there would be sufficient traffic data to update the obsolete O/D matrices mandatory trips, covering cars and trucks, for the daily and the peak morning period (from 6 to 9 a.m.). This updating would reflect full private mobility and use EMME/2 auxiliary macro `demadj.mac` for matrix adjustment (Spiess, 1990). EMME/2 software enables current O/D mobility matrices to be calculated and several scenarios to be evaluated. Table 2 shows the total number of trips, after adjustment because of traffic counts, for a day and a peak period, for the whole area and for the sub-area selected for microscopic simulation analysis. The microscopic simulation sub-area contains 977 links in the Base scenario; around 100 traffic counts are available for each time period (daily and peak periods). For the whole area, around 250 traffic counts were available: the linear regression model between observed and EMME/2 predicted volumes has a determination coefficient greater than 0.9.

Table 2. EMME/2: O/D totals after adjustment because of traffic counts

OD TOTALS	***DAILY PERIOD***	***PEAK PERIOD***
WHOLE AREA	868 000	161 000
MICROSCOPIC SIMULATION AREA	407 000	71 000

The dialog to include a EMME/2 batchout file for O/D matrix description in GETRAM (to be used in AIMSUN2) is partially shown in Figure 5: the name of the batchout file (one per matrix), the relevant time interval and vehicle modality have to be specified.

The total number of scenarios developed with GETRAM for EMME/2 model is 10. The most conflictive sub-areas are the Llobregat and Bellvitge ring-roads and the South Leg connection to the airport. In order to correct the designs of these critical ring-roads to prevent congestion black spots in peak morning scenarios and improve the level of service, microscopic simulation with AIMSUN2 was run. Two peak morning scenarios modeling Proposal 1 and Proposal 2 for the Llobregat ring-road were studied in detail and evaluated in terms of average speed, average occupancy and queue lengths.

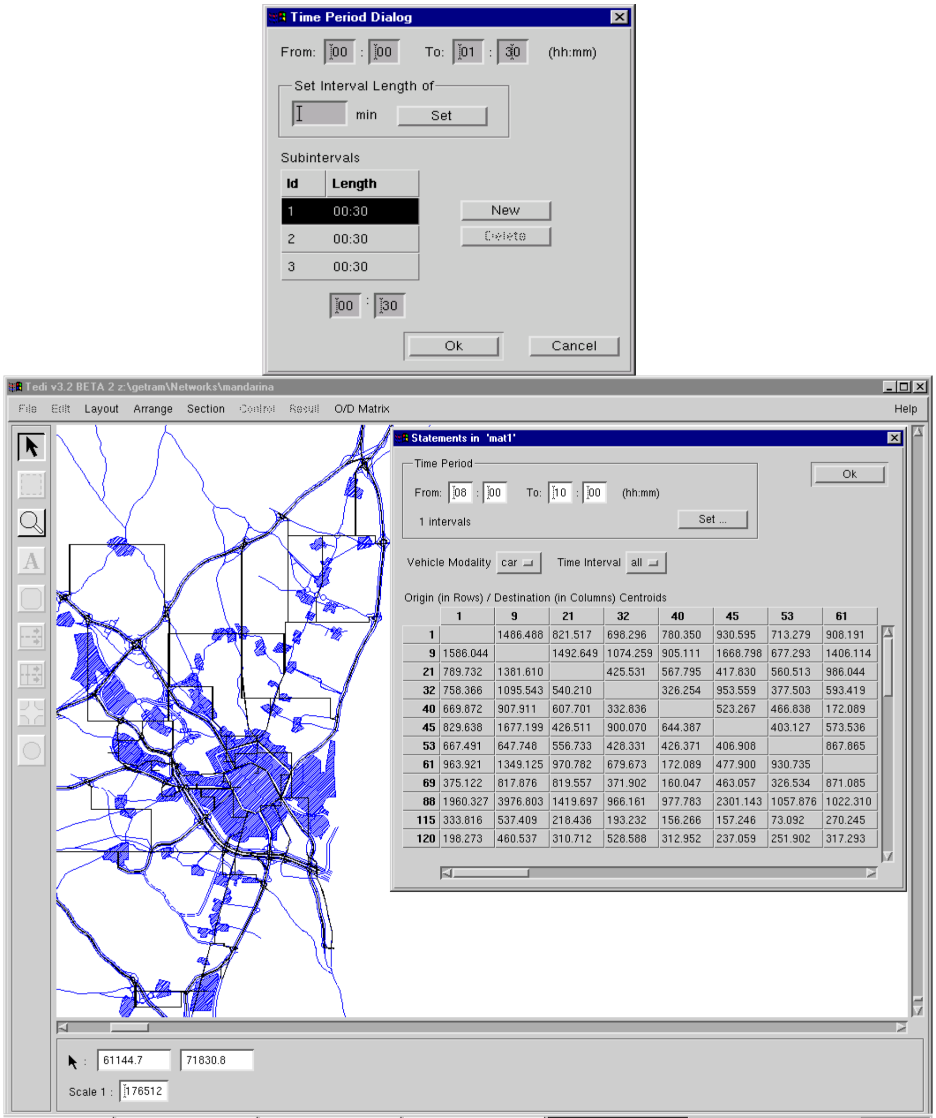

Figure 5. GETRAM interface from EMME/2 to AIMSUN2: A time-sliced OD matrix definition

Macroscopic assignment results provided by EMME/2 on the Base and South Leg proposal scenarios in the microscopic simulation sub-area are shown in Table 3. The global congestion rate in Table 3 is a global index of quality computes as the average volume-capacity ratio.

Table 3. EMME/2 results. Base and South Leg proposal scenarios: microscopic simulation area

EMME/2	***MICRO AREA***	***DAILY PERIOD***		***PEAK PERIOD***	
SCENARIOS (PEAK PERIOD)	**Links**	**Speed (km/h)**	**Global Congestion Rate**	**Speed (km/h)**	**Global Congestion Rate**
BASE (Base Scenario)	*977*	*54.65*	*0.316*	*42.29*	*0.484*
South Leg Proposal 1	*1 061*	*62.30*	*0.233*	*49.00*	*0.393*
South Leg Proposal 2	*1 115*	*60.06*	*0.231*	*48.78*	*0.396*

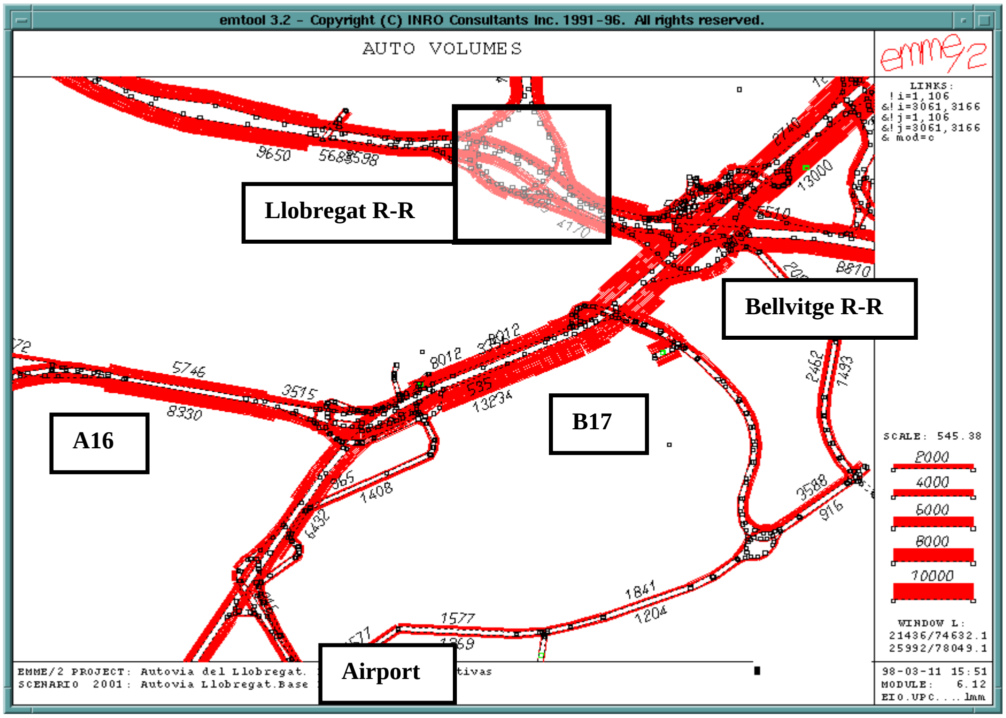

Figure 6a. EMME/2: Base Scenario. Microsimulation area

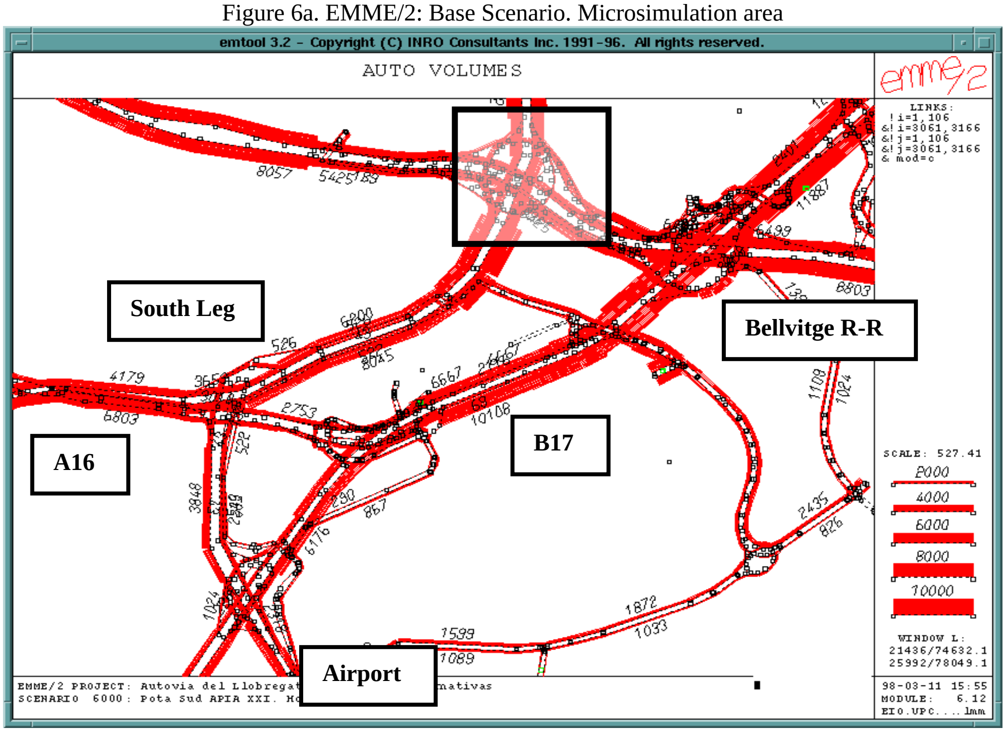

Figure 6b. EMME/2: South Leg Proposal 2. Microsimulation area

Some proposals for improving the designs were formulated at the conclusion of the study. For microscopic simulation, the detailed network description was submitted by GETRAM to the AIMSUN2 simulator, the pattern of demand was provided by the results of EMME/2 assignment to the selected scenarios, in terms of turning probabilities and volumes to input sections of the microscopic simulation sub-area. The microscopic simulation areas, for the Base and South Leg proposal 2 scenarios are shown in Figures 6a and 6b. The Llobregat ring-road is highlighted.

The main differences between the two South Leg proposals depend on the design of the Llobregat ring-road complex and the connection between the A-16 motorway and the B-17 arterial for the South access to Barcelona. A detail of the ring-roadrepresented by AIMSUN2, in both proposals, is shown Figures 7a and 7b.

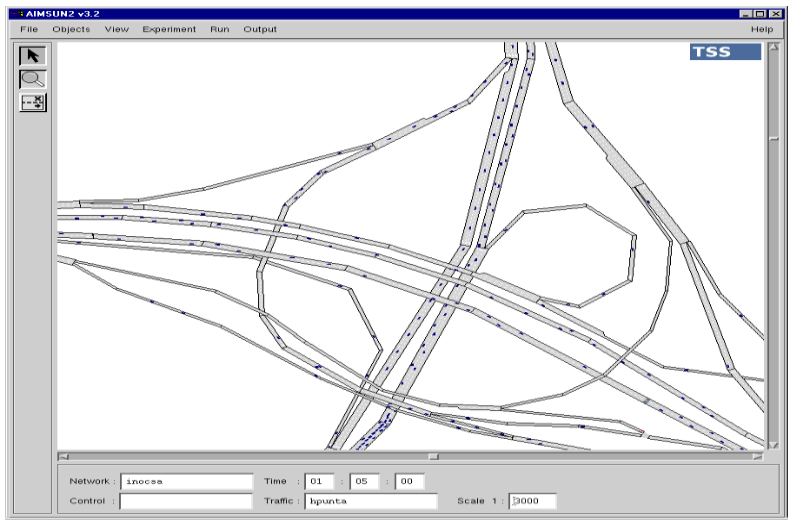

Figure 7a. AIMSUN2 Llobregat ring-road. South Leg proposal 1

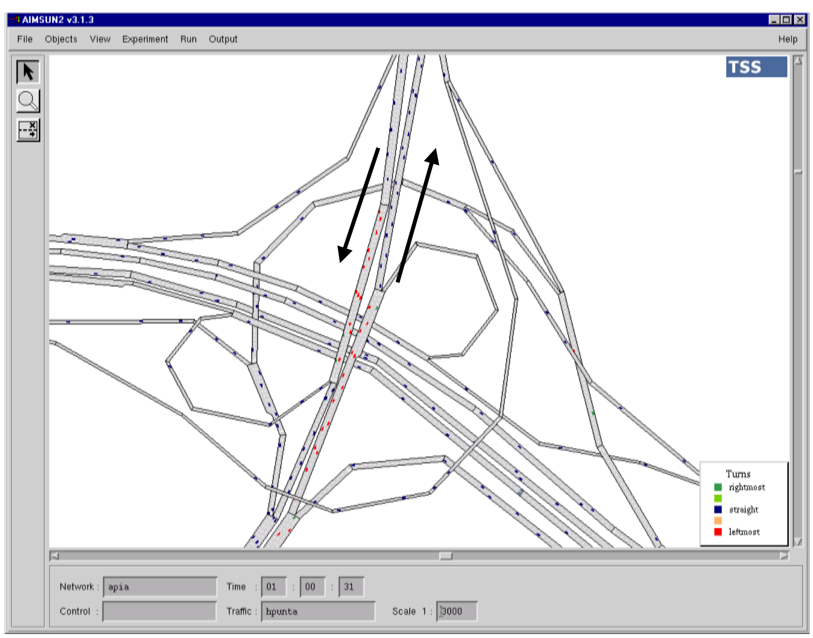

Figure 7b. AIMSUN2 Llobregat ring-road. South Leg proposal 2

At any moment in the simulation time, the traffic state and the movement of the vehicles can be visualized (see Figures 7, for example).

The dynamic evolution of the traffic conditions in selected sections can easily be visualized by using the *Statistics Menu*. Every five minutes (or less, according to user definition), traffic conditions are computed at section and general levels. For the two sections indicated with an arrow in Figure 7b for the SL-Proposal 2, a graphical representation of the evolution of the traffic conditions every five minutes is shown (Figure 8).

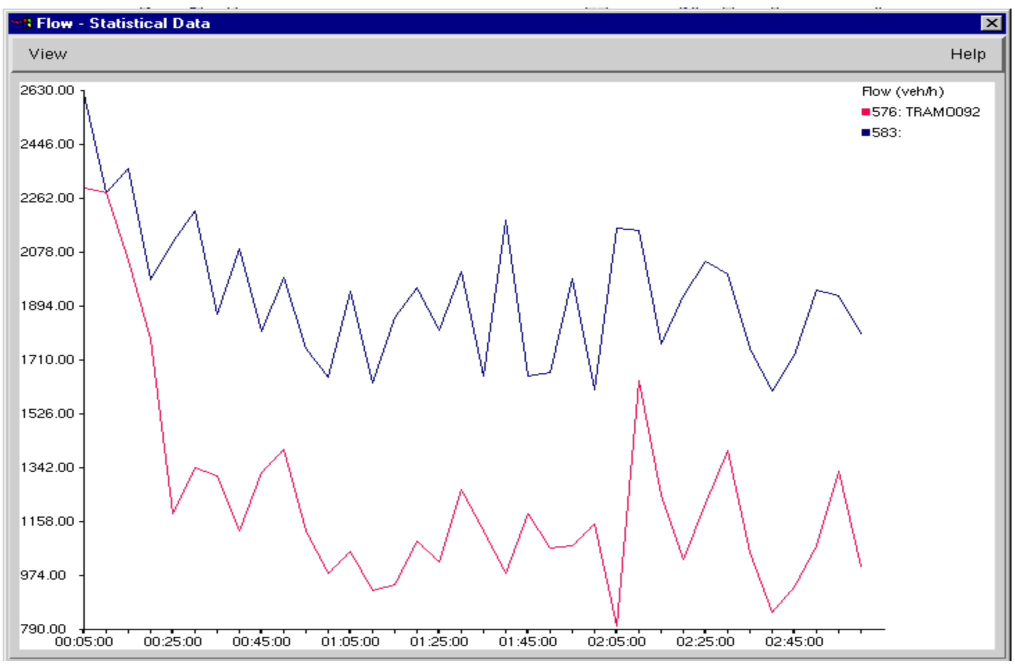

Figure 8. AIMSUN2 results: dynamic evolution of traffic conditions. South Leg-Proposal 2: arrow marked sections

In the analysis of the results, the concept of level of service has been employed, ranging from A (very good) to F (very poor). Categories A to F are defined according to density intervals defined in the *Highway Capacity Manual* (TRB, 1985).

In the Base scenario and for the first hour of the peak period, the west access to the Llobregat ring-road has a level of service C, and the A-16 motorway and the B-17 road (south access to Barcelona) both have a level of service B. There are some service lanes with long queues from the Llobregat ring-road (Barcelona-bound) and level of service D. The connection to the airport shows a level of service B-C. During the second hour of the peak period, we find a level of service D-E in the southern area (B17 south access) and a worsening of the situation in the service lanes around the Llobregat ring-road, with a level of service C-D. The connection to the airport is C-D. In the third hour, the Llobregat ring-road area presents long queues and level of service D, and the B17 access maintains a level of service D; however, on average, traffic conditions tend to improve. The critical points in the network are: the connection between the A-16 motorway and the B-17 south access to Barcelona, the connection from the B-17 to the airport, and the service lanes close to the Llobregat ring-road.

In the South Leg Proposal 1, during the first hour of the peak period there are no problems either in the access to the airport or in the B-17, due to the South Leg's additional infrastructure. In the second hour, the level of service at the black spots remains at level B. A level of service C appears in the Bellvitge ring-road, and the level of service of the B-17 is B-C. During the third hour the level of service of the B-17 reaches C and the problem on the Bellvitge ring-road remains.

In the South Leg-Proposal 2, during the first peak hour there are no problems. In the second hour, the level of service at the black spots remains at level B. The level of service of the B-17 is B. During the third hour the level of service of the B-17 is B-C. No problems are detected in the service lanes.

The Base scenario presents serious problems that are solved by both of the SL proposals. The main difference between the proposals lies in the volumes in the South Leg and B-17 accesses: SL-Proposal 1 benefits the load on the B-17 access, but SL Proposal 2 benefits the load on the South Leg access. Local problems in service lanes appear more frequently in SL-Proposal 1, and could constitute a source of future congested points.

CONCLUSIONS

This article describes a procedure for evaluating private transportation planning alternatives, which depends on how well macroscopic and microscopic traffic models can be integrated through a common user-friendly environment (GETRAM). The GETRAM editor reduces drastically one of the most time-consuming aspects in transportation modeling: the network building stage. The authors applied the procedure described in several local studies, such as traffic studies in Barcelona's Historical District (La Ribera), in Castellón (a small city 200 km south of Barcelona) and Vigo (a medium-sized city on the Northwest coast of Spain). In the Vigo study, the bus network was also modeled. This feature is not yet incorporated into the GETRAM network editor. However, the base private network was built with the GETRAM editor and the transit lines over the GETRAM nodes were defined through an external procedure based on Microsoft Access DB.

GETRAM3.1 and AIMSUN2 have been developed by the Department of Statistics and Operational Research of the Technical University of Catalonia and are currently distributed by TSS (Transport Simulation Systems).

REFERENCES

Barceló, J., Ferrer, J.L., Martín, R. (1999) "Simulation Assisted Design and Assessment of Vehicle Guidance Systems". *International Transactions on Operations Research, Vol. 6, No. 1 pp. 123-143*.

Barceló, J., Casas, J., Ferrer, J.L., García, D. (1999) "Modeling Advanced Transport Telematic Applications with Microscopic Simulators: The Case of AIMSUN2" in *Traffic and Mobility: Simulation, Economics, Environment. W. Brilon, F. Huber, M. Schreckenberg and H. Wallentowitz Editors, Springer Verlag*.

Barceló, J., Ferrer, J.L., García, D., Florian, M., Le Saux, E. (1998) "Parallelization of Microscopic Traffic Simulation for ATT Systems Analysis", in *Equilibrium and Advanced Transportation Modeling, P. Marcotte and S. Nguyen Editors, Kluwer Academic Publishers pp. 1-26.*

Barceló, J., Ferrer, J.L., Grau, R., Florian, M., Chabini, I., Le Saux, E. (1995) " A Route Based variant of the AIMSUN2 Microsimulation Model". *Proceedings of the 2nd World Congress on Intelligent Transport Systems, Yokohama*.

Barceló, J. (1991) "Software Environments for Integrated RTI Simulation Systems". *Advanced Telematics in Road Transport pp. 1095-1115, Proceedings of the DRIVE Conference, Brussels, Elsevier*.

Hughes, J. (1998) "AIMSUN2 Simulation of a Congested Auckland Freeway". *Proceedings of the EURO Working Group on Transportation Meeting, Göteborg*.

INRO Consultants, EMME/2 User´s Manual. Software Release 8.0 (1996).

Spiess, H. "A Gradient Approach for the O-D Matrix Adjustment Problem". *Centre de Recherche sur les Transports de Montréal. Publication* **693**, (1990).

UPC. Departament of Statistics and Operational Research. LIOS. "GETRAM Environment. Tedi: The GETRAM Editor User's Guide. AIMSUN2 User's Manual" (1997).

Transportation Research Board (1985) " Highway Capacity Manual". *Washington, D.C.*

TECHNICAL APPENDIX

GETRAM to EMME/2 INTERFACE

Figure 9 shows the dialog box that generates a compatible EMME/2 network and turning movement description, in Batch Entry formats for 2.11 and 2.31 Modules. Once in GETRAM, select the File menu and the Export option.

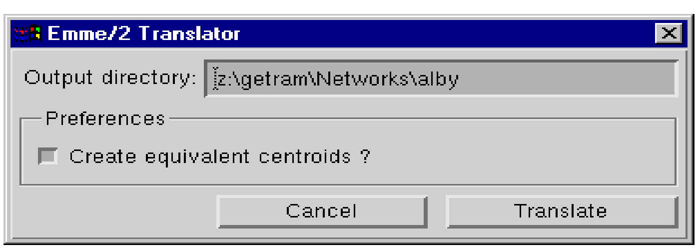

Figure 9. GETRAM to EMME/2 Interface process

An EMME/2 network consists of modes, nodes and links (which constitute the base network), turns, transit vehicles, transit lines and transit segments. These components of the network have three types of attributes: standard attributes, extra attributes (user-defined and not considered in the current version of the interface) and assignment results. A proper EMME/2 Databank for performing the loading operation of the former two files must satisfy the following:

- To avoid further problems when analyzing equilibrium assignment results, the unit of length and the length of units of coordinates units have to be defined in the EMME/2 environment (module 1.23). GETRAM usually in UTM coordinates and by default the EMME/2 Databank is set to be compatible.
- Modes must be loaded (Module 2.01). The mode table compatible with the GETRAM interface is shown in Table 4.
- Transit vehicles must be loaded (Module 2.02). The description of transit lines is not included in the current version of the interface or in the GETRAM Network Database. Since some studies might require transit modeling, a basic set of transit modes is assumed and a default vehicle table containing the definition of the transit vehicle types is proposed (see Table 5).
- Volume delay and penalty functions must be loaded (Module 4.11). EMME/2 allows six classes of functions: auto volume-delay (fd*n*), turn penalty (fp*n*), transit time (ft*n*), auto demand (fa*n*), transit demand (fb*n*) and user function (fu*n*). Only auto volume-delay functions for auto times on links on the auto network (in minutes) and turn penalty functions for auto times on turns at intersection nodes (in minutes) are included in current version of the GETRAM to EMME/2. The default set of functions is partially shown in Table 6.

Table 4. GETRAM to EMME/2 interface: table of compatible modes

	MODE CODE	MODE NAME	MODE TYPE	PLOT CODE	COST COEFF. 1	COEFF. 2	ENERGY COEFF. 1	COEFF. 2	MODE SPEED
a	c	car	1	1	0.00	0.00	0.00	0.00	
a	b	bus	2	25					
a	r	renfe	2	25					
a	g	fgc	2	25					
a	m	metro	2	25					
a	n	tram	2	26					
a	p	pedestrian	3	54	0.00	0.00	0.00	0.00	4.00
a	t	transfer	3	33	0.00	0.00	0.00	0.00	4.00
a	h	HOV	4	33	0.00	0.00	0.00	0.00	

Table 5. GETRAM to EMME/2 interface: table of compatible transit vehicles

```
   VEHICLE              AVAIL. CAPACITY    COST COEFF.    ENERGY COEFF.   AUTO
   ID.    NAME     CODE FLEET SEATED TOTAL    1      2       1       2    EQUIVALENCE

 a    1 renshor     r     999   300    500    0.00    0.00    0.00    0.00 999.00
 a    2 renlong     r     999   600    900    0.00    0.00    0.00    0.00 999.00
 a    3 bushort     b     999    51    100    0.00    0.00    0.00    0.00   2.50
 a    4 buslong     b     999    71    200    0.00    0.00    0.00    0.00   4.50
 a    5 fgcshor     g     999   300    300    0.00    0.00    0.00    0.00 999.00
 a    6 fgclong     g     999   400    400    0.00    0.00    0.00    0.00 999.00
 a    7 metro       m     999   120    500    0.00    0.00    0.00    0.00 999.00
 a    8 tram        n     999   120    300    0.00    0.00    0.00    0.00   4.50
```

Table 6. GETRAM to EMME/2 interface: partial table of default compatible functions

```
  VDF   Functional form (according to EMME/2 keywords)

a fd1  =0
a fd2  =length
a fd5  =length*( (ms(2) * 31.35 * ms(1) ^ 4.7 *
        (put(volau/(lanes*ul2)) - ms(1)) + 1+ 5.5* ms(1) ^ 5.7)
        .max. (1 + 5.5 * (get(1)) ^ 5.7))
a fd17  =length*( (ms(2) *17.2*(put(volau/(lanes*ul2))-ms(1))
        + 4.5 ).max.(1+2.5*get(1)-8*get(1)^2+12*get(1)^3 ) )
a fd18  =length*( (ms(2) *17.2*(put(volau/(lanes*ul2))-ms(1))
        + 4.5 ).max.(1+2.5*get(1)-8*get(1)^2+12*get(1)^3 ) )
a fd21  =length*( (ms(2) * 22 * ms(1) ^ 3.6 *
        (put(volau/(lanes*ul2)) - ms(1)) + 1 +4.8* ms(1) ^ 4.6)
        .max. (1 +4.8 * (get(1)) ^ 4.6))
…
```

The Base Network Batch Entry file generated by GETRAM comprises:

- Node description: node identifiers, coordinates and labels.

- Link description: each record defines a directional link whose origin and destination node are previously defined in the node description section. Each record contains: origin node, destination node, list of modes allowed on the link, link type (`type`), number of lanes, volume-delay function (`vdf`) set to 1, user link fields 1 to 2 set to 0 and user link field 3 containing the `section id.` in GETRAM Network Database.

In the current version of this interface, EMME/2 attribute `vdf` is set to 1, and a self-developed EMME/2 macro assigns `link` capacities and `vdf` codes according to link `type` and number of `lanes`. Link capacities are held by user link field 1 (`ul1`) after EMME/2 setting macro execution.

Penalty codes for turning movements are assigned according to maximum turning speed value defined by TEDI. Turn penalty functions are assigned by the interface according to the maximum speed. The main link types included in the interface are: connector, motorway, road, urban road, arterial, signalized street and unsignalized street. In most cases, several vdf functions are allowed for each of these main types, depending on the maximum speed, number of lanes and lane capacity (see Table 7 for a partial list of the vdf-link type correspondence). Currently, there are thirty link types and 18 different vdf functions. The file containing link types available for a given application is a user file that can be customized as necessary: for each type, an identifier, the maximum speed allowed and the lane capacity must be defined. The EMME/2 setting macro should be adapted to be compatible with the GETRAM/TEDI link type definition.

Table 7. GETRAM to EMME/2 interface: partial table of compatible link types and functions

TYPE	**MAX.**	**LANE**	**VDF**	**LINK TYPE DESCRIPTION**
	SPEED	**CAPACITY**		
10	0	9999	1	**Connector**
10	120	2100	5	**Motorway**
40	90	1200	21	**Interurban Road**
44	50	800	22	**Mountain Road**
50	50	800	23	**Urban Road without Lights**
60	50	900	25	**Arterial**
61	50	650	26	Arterial (not coordinated)
70	50	800	28	**Street without Lights** (>=2 lanes)

One of the most complicated aspects of the conversion process at the interface is the transfer of the centroid-connector structure. There are two ways of transferring GETRAM connector structure to EMME/2:

- Identical one by one. This is the default option.

- Using the so-called *total equivalent centroid option*, that performs the transfer depicted in Figure 10 for a centroid *n*. Equivalent centroids can be used subsequently in the EMME/2 traffic model, in which total generations and/or attractions for a zone or centroid can be used as a traffic count. In the figure, centroid n is connected to the network using an auxiliary regular node m. The interface automatically bans turning *movements* $i \rightarrow m \rightarrow j, \quad i \rightarrow m \rightarrow k, \ ...$ and so on and only movements $i \rightarrow m \rightarrow n, \ n \rightarrow m \rightarrow j, \ n \rightarrow m \rightarrow k \ \ and \ \ n \rightarrow m \rightarrow l$ are allowed.

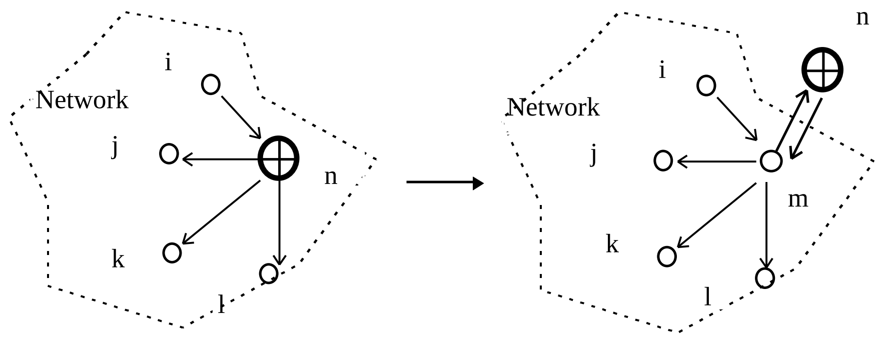

Figure 10. GETRAM to EMME/2 interface: total equivalent centroid-connectors transfer

GETRAM TO AIMSUN2 INTERFACE

From its network database, GETRAM generates a compatible AIMSUN2 model with traffic control and traffic conditions defined as available or requested by the user. The AIMSUN2 simulator is fully integrated into the GETRAM environment, and so the user does not have to worry about with the input simulation data files: the natural way of preparing and starting a simulation is from the GETRAM environment.

EMME/2 TO AIMSUN2 VIA GETRAM INTERFACE

It offers several possibilities that will be fully integrated into *GETRAM Menu options*:

- To define turning proportions and average input vehicle rates to be included as traffic conditions in a microscopic simulation in AIMSUN2. A C program takes as input: a report of assigned auto volumes from EMME/2 (`volau`) and a *batchout EMME/2 ASCII file* generated by a user macro containing the corresponding turning flows. These two files are processed to obtain a traffic conditions file in AIMSUN2 simulator format.

- If the only O/D matrix available is obsolete, but some traffic counts can be gathered from at least 10% of EMME/2 links, well-distributed, spatially and in link types, the matrix-updating macro (`demadj.mac`) in EMME/2 can be used to get a current matrix for microscopic simulation in AIMSUN2 as an O/D matrix or set of time-slices O/D matrices (defined by the user). To include a EMME/2 batchout file for O/D matrix description in GETRAM (to be used in AIMSUN2), the name of the batchout file (one per matrix), the relevant time interval and vehicle modality have to be specified by a dialogue which is partially shown Figure 5 in the body text.

- Using EMME/2 transversal matrix computation and equilibrium assignment procedures to define traffic conditions for a given sub-area that requires a detailed study by simulation. This option is not yet fully automatic.

A COMBINED METHODOLOGY FOR TRANSPORTATION PLANNING ASSESSMENT. APPLICATION TO A CASE STUDY.

L. MONTERO[1], E.CODINA[1], J. BARCELÓ[1], P. BARCELÓ[2]

[1] Dept. Estadística i Investigació Operativa. Universitat Politècnica de Catalunya,

C/ Pau Gargallo 5, 08028 Barcelona (SPAIN). Tel. 34.93.401.10.38. Fax. 34.93.401.58.55. E-mail: lidia.montero@upc.es

[2] TSS (Transport Simulation Systems). C/Tarragona 110-114, 08015 Barcelona (Spain).

Abstract - Traffic assignment models based on the user equilibrium approach are one of the most widely used tools in transportation planning analysis. Resulting flows offer a static average view of the expected use of the road infrastructure under the modeling hypothesis. This information has usually been enough for the planning decisions. The planned infrastructure is probably sufficient for average demand, but time-varying traffic flows, i.e. at peak periods, combined with the influence of road geometry, can produce undesired congestion that can not be forecasted or analysed with the static tools. There is a clear case for a change in the analysis methodology such as combination of a traffic assignment tool, with a microscopic traffic simulator.

This paper illustrates, by means of a case study, the combination of a well-known traffic assignment tool, the EMME/2 model, with a microscopic traffic simulator AIMSUN2 with emphasis on the description of the specific interfaces that make consistent the combination of both tools in the GETRAM environment. Models for complex transportation systems should be the combination of mathematical models and computer models, to overcome, for example, the difficulties of the integration of modeling tools. GETRAM environment has an open and flexible computer architecture suitable for such purposes.

Keywords - Transportation planning, microscopic simulation, graphical interfaces, motorway assessment.

List of Figures:

List of Tables: