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VALIDATION OF A NEW MULTICLASS MESOSCOPIC SIMULATOR BASED ON INDIVIDUAL VEHICLES FOR DYNAMIC NETWORK LOADING

M.Paz Linares
Inlab FIB
Universitat Politècnica de Catalunya - BarcelonaTech
Barcelona, SPAIN

Carlos Carmona
Inlab FIB
Universitat Politècnica de Catalunya - BarcelonaTech
Barcelona, SPAIN

Jaume Barceló
Universitat Politècnica de Catalunya - BarcelonaTech
Barcelona, SPAIN

Cristina Montañola-Sales
Universitat Politècnica de Catalunya - BarcelonaTech
Barcelona Supercomputing Center
Barcelona, SPAIN

ABSTRACT

The dynamic network loading problem is crucial for performing dynamic traffic assignment. It must reproduce the network flow propagation, while taking into account the time and a variable traffic demand on each path of the network. In this paper, we consider a simulation-based approach for dynamic network loading as the best-suited option. We present a multiclass multilane dynamic network loading model based on a mesoscopic scheme that uses a continuous-time link-based approach with a complete demand discretization. In order to demonstrate the correctness of the model, we computationally validate the proposed simulation model using a variety of laboratory tests. The obtained results look promising, showing the model's ability to reproduce multilane multiclass traffic behaviors for medium-size urban networks.

1 INTRODUCTION

For years, models that reproduce the dynamic behavior of traffic have been studied from the perspective of traffic flow theory. They are applied to freeway systems but not to other extensions commonly seen in more complex networks. Simplified assumptions may be necessary to extend the models to other networks. Practical needs and natural curiosity have prompted research on dynamic models for traffic networks, especially urban networks. This has put dynamic traffic assignment (DTA) models in the forefront. These models can be used to evaluate traffic flow both to simulate traffic management strategies and their impacts on user behavior.

The extension of static models to take into account dynamics is by no means straightforward, since dynamic supply modeling requires an entirely new definition and formulation of the problem. To properly perform a DTA, it is necessary to be able to describe traffic flow dynamics on the entire network. This is the problem addressed by the dynamic network loading (DNL): to develop a model that can reproduce network flow propagation while taking into account time and variable traffic demand on each path of the network.

DTA models for predicting dynamic user equilibrium flows on urban traffic networks are often solved by an algorithm that iterates between two main components (the DNL and flow reassignment) until a convergence criterion is satisfied. Linares et al. (2014) proposed a DTA model based on this combined approach. The flow reassignment component is solved by an extension of the Method of Successive Averages (Linares et al. 2012), while the DNL component is performed through a mesoscopic traffic simulation model proposed in Linares et al. (2013). This proposed DNL is a multiclass multilane model based on a mesoscopic scheme that considers a continuous-time link-based approach with microscopic demand discretization.

In the present paper, we present the validation of the proposed DNL model using laboratory tests in order to demonstrate the proposed multilane multiclass model. As far as we know, a standard DNL validation methodology has not appeared in the literature; thus, here, we address the validation problem taking into account experiments that have appeared in earlier work, as well as new computational tests.

First, the model is applied on a small network and the corresponding fundamental diagrams are examined for basic correctness. Then, we study the propagation of the shockwaves arising from a traffic incident. To achieve that, the model is run over a small freeway corridor where we simulate an incident during certain time intervals.

Finally, the model is tested on two real networks. In both cases, the obtained results are compared with those obtained from a microsimulator. In this case, we want to make sure that we have the same high correspondence between the results obtained with the benchmark microscopic simulator and our simulator. This is very interesting considering the great difference of the number of parameters required to calibrate the models in both cases: hundreds of parameters on the microsimulator versus only two parameters to calibrate in the proposed model.

The paper is structured as follows. The first section summarizes the proposed multiclass multilane DNL model, including the classification of the DNL model among the others in the literature. The next section explicitly describes the validation procedure with the corresponding experiments and their computational results obtained after the calibration and validation of the model for certain specific test scenarios. Finally, the analysis of the results is discussed in the conclusions.

2 LITERATURE REVIEW

Figure 1 shows our DNL classification inspired by the representation proposed by Astarita (2002), who developed a classification of the DNL mechanisms based on whether or not each of the procedures discretizes time, space and demand. Figure 1 represents the models in three-dimensional space, where the axes x, y and z are time, space and demand, respectively. The value zero represents continuous models that do not make any discretization; while advancing on one of the axes towards infinity represents a discretization of the variable of that axis.

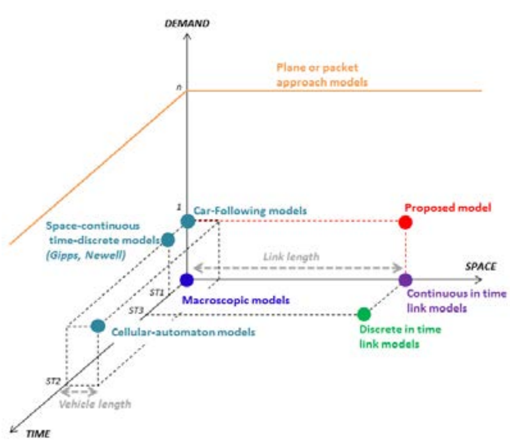

Figure 1: Proposed classification inspired by Astarita’s representation.

This classification identifies the following models for the DNL procedure. These are intended particularly for link flow propagation: microsimulation models divided into the car-following models (CFM) and the cellular-automaton models (CA), space-continuous time-discrete models, continuous or discrete in time link models, models following a packet approach, and macroscopic simulation models.

Some of the most relevant CFM works are Pipes(1953), Gipps (1981) and Mahut (1999) who develop different approaches for collision avoidance model; Newell (2002) who introduced a car-following rule based on the trajectories of the vehicles, extended by Yeo (2008); and Hidas (2005) who extended the desired spacing model with the vehicle interactions in microscopic simulations of merging and weaving.

In the scope of CA models for traffic, we can find the pioneering work by Gerlough (1956), later improved by Biham (1992). Nagel and Schreckenberg (1992) proposed the Stochastic Traffic Cellular Automaton for one dimensional vehicular traffic.

From the macroscopic perspective, Daganzo (1994) provided one of the most popular first-order macroscopic dynamic models of traffic flow: the Cell Transmission Model, based on a three-linear-segment flow density relationship. Payne (1971) suggested a second-order model which takes into account the reaction time of the drivers. Finally, Helbing (1996) extended the Payne models by introducing an additional partial differential equation for velocity variance.

3 A NEW DYNAMIC NETWORK LOADING MODEL

Because the objective is to develop a new DNL model as one of the main components of the proposed iterative DTA procedure, it is necessary to have an efficient DNL process with the shortest possible computational times even in the case of medium or large-sized traffic networks. It is also very important to try to reach a balance in the number of parameters without losing a proper description of the traffic flow dynamics. On the one hand, one handicap to calibration could be: the more parameter values that depend on the network, the more difficult it will be to find the most suitable values for reproducing reality. On the other hand, failure to use any input parameter will probably make it more difficult to reproduce traffic behaviors that should not be overlooked and that are related to network characteristics.

Taking into account the above requirements for selecting DNL approaches in a DTA model, we can rule out models based on macroscopic simulation. These models, which are very suitable in terms of execution times, do not reproduce traffic behaviors that are required for a DNL model embedded into a DTA scheme. Furthermore, microscopic simulation models are also routinely discarded because they usually require very high computational time and a large number of input parameters, which in practice are difficult to calibrate.

Thus, the most suitable option is a model that combines the best properties of both microscopic and macroscopic models, i.e., a mesoscopic model. Our goal is to develop models that can reproduce reality like microscopic models, but without so many details. In this way, we can achieve better execution times and remove excessive input parameters that are difficult to calibrate, but without sacrificing the essentials of flow dynamics.

The proposed DNL considers time in a continuous form instead of the microscopic traffic simulation method of discretizing time in previously defined steps. The proposed model is different from microsimulation models in that space is considered as discrete rather than continuous, except for the case of cellular automaton models, which work with cells. Thus, in our case, there is no explicit control of what happens with vehicles inside the links. The model focuses only to particular points of the link that are essential for correctly defining network loading. However, the proposed model keeps the key feature of microscopic models: demand discretization considered for each vehicle. Thus, we locate the model at the point $(0, arcLength, 1)$ int the previously presented scheme classification, as shown in Figure 1.

Like some microscopic models based on car-following theory or cellular-automaton, vehicles in the proposed model move by trying to maximize their speeds in the presence of certain constraints that ensure that vehicle trajectories satisfy the position, speed and acceleration bounds while trying to avoid collisions.

This model is based on a mesoscopic scheme that considers continuous-time link-based approach with complete demand discretization. Considering a disaggregated treatment of each individual vehicle allows the use of different vehicles classes in the problem. In addition, because one of the goals is to reproduce the traversal movements of vehicles when changing lanes, which considerably increases link congestion, this model allows longitudinal discretization of the links in lanes. Therefore, the proposed DNL is a multilane multiclass traffic simulation model.

The DNL problem is considered from a discrete demand point of view, so, it is formulated by defining a function for each vehicle which returns the time when that vehicle reaches specific position (t_{veh}^{a}(x)) or leaves it (t_{veh}^{d}(x)).

The objective of the DNL is to calculate time-dependent traffic variables for each link, using the time-dependent flow assignment in each of the network paths. Calculating this link variables requires knowledge of the input and output times of the vehicle for each of the network links. Thus, the proposed model considers only two positions at each lane of a link (the initial and the final) where it should evaluate the functions t_{veh}^{a}(x) and t_{veh}^{d}(x).

The model is solved using an algorithm based on discrete events. During its development, different events have been designed and implemented. Some of these events are related with the different times when the vehicle arrives at or departs from the abovementioned specific link positions (initial and end). Also, some other events are directly related with the traffic simulation (start or end), and with the entry and exit of a vehicle in the network. Finally, some complementary events have been needed to facilitate the implementation of the process and to improve the computational time results.

One of the motivations for adopting an event-based simulator in our DNL component is that it can potentially be much more computationally efficient than a time-step model. The computation time is particularly important in the context of a DTA, which usually needs some iterations of the simulation model in order to achieve the DUE. However, the main motivation is that we must consider that the other option, the time-step paradigm, considers time as an independent variable. As we explained before, our mesoscopic simulation model considers the flow propagation process vehicle to vehicle, and it is formulated from the relationship: space-dependent time. So, in this case, it is more suitable to use the event-based paradigm, which coincides with the idea of considering time as a dependent variable.

For a more detailed description of this mesoscopic model, we refer the reader to Linares et al. (2013).

4 COMPUTATIONAL EXPERIENCE

In this section the proposed DNL model is evaluated using laboratory tests. In order to demonstrate the proposed multilane multiclass model, the following computational experiments are conducted.

4.1 Fundamental Diagram Accomplishment

In the proposed experiment the performance of the proposed model is validated over the sample network shown in Figure 2 and the input data of each link.

This exercise tries to empirically investigate the accomplishment of the fundamental diagram by the presented mesoscopic simulation model (see for instance Mahut, 2000). The traffic fundamental diagram describes the relations among the main macroscopic traffic variables: flow, speed and density.

In order to obtain a wide range of simulated values, the demand among the feasible OD pairs is varied over different runs of the simulation. A 2-hour long simulation determines the average link measurements for each 3-min interval. Two classes of vehicles have been considered: light vehicles with an effective length of 5 meters (90% of the total demand) and reaction time of 0.5 seconds, and heavy vehicles with an effective length of 9 meters (10% of the total demand) and reaction time of 0.75 seconds.

Figure 3 shows flow-density relationship of the proposed model for certain links of the sample network. These results were obtained by different runs of the model over the network. Superimposed on

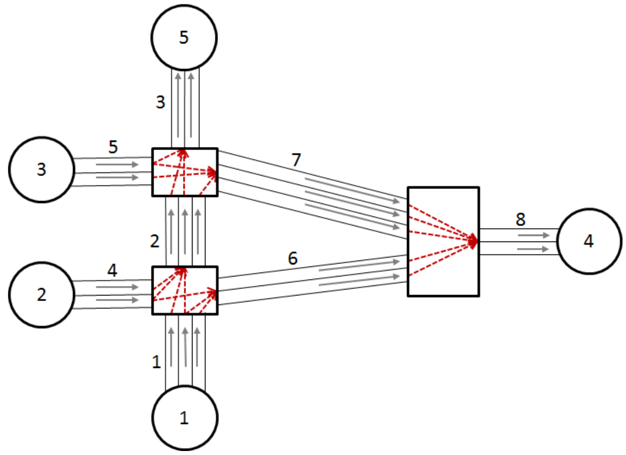

Figure 2: Sample network.

this plot is the relationship between density and flow derived on the Fundamental Traffic Equation and the speed-density relationship suggested by Underwood (1961) showed in the following equation:

$$q = k \cdot v$$
$$= v_f \cdot \exp(-k/k_m)$$

where:

q Flow (veh/h/lane).
k Density (veh/km/lane).
v Average speed (km/h).
v_f Free-flow speed (km/h).
k_m Average density (veh/km/lane).

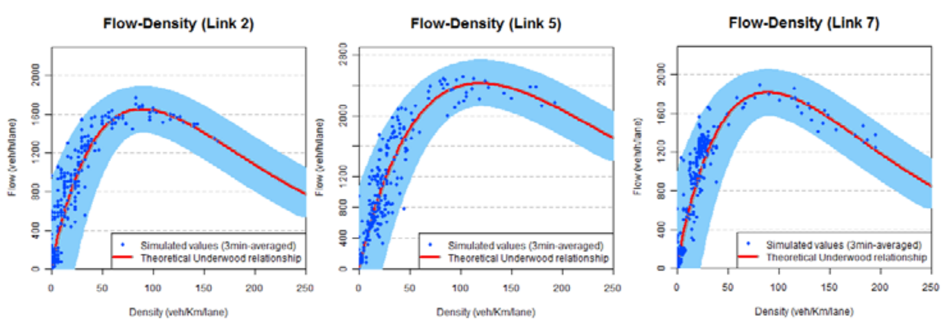

Figure 3: Graphics of flow vs. density.

In conclusion, the obtained results experimentally show that the presented model is able to reproduce the fundamental diagram that describes the relationships among the main macroscopic traffic variables.

4.2 Study of the Shockwaves Propagation

Burghout (2004) proposed the following experiment in order to study if a model reproduces the propagation of the congestion properly. In order to replicate it, we create an incident in a proposed small freeway network and we run our model over this scenario. The objective is to complement the fundamental diagram in demonstrating the basic traffic performance on links in the proposed mesoscopic model.

The proposed test network is a simple network consisting of 10 consecutive links. It simulates a small freeway corridor. The link segments are each 400 meters long, have two lanes, and free flow speed of 80 Km/h. Demand is represented by four 15-min matrices used to perform a one-hour simulation. The total number of vehicles is 3,000. Two vehicle classes are considered with 4 and 6 meters effective length.

A blocking incident is created in the node downstream from Link 4. The incident starts 20 minutes after the beginning of the simulation and its duration is 10 minutes. Both lanes of the network links are affected by the incident, and no vehicle can pass as long as it exists.

In order to obtain the cumulative flow of all the links in the network, we execute a one-hour long simulation. The proposed mesoscopic simulation determines the number of vehicles that have entered/exited the link (cumulative inflow/outflow) for each 1-min interval.

Figure 4 shows, both cumulative flows over time are plotted for all the links in the test network. The slopes of the lines are the flow rates and the distance between the lines represents the density of the links.

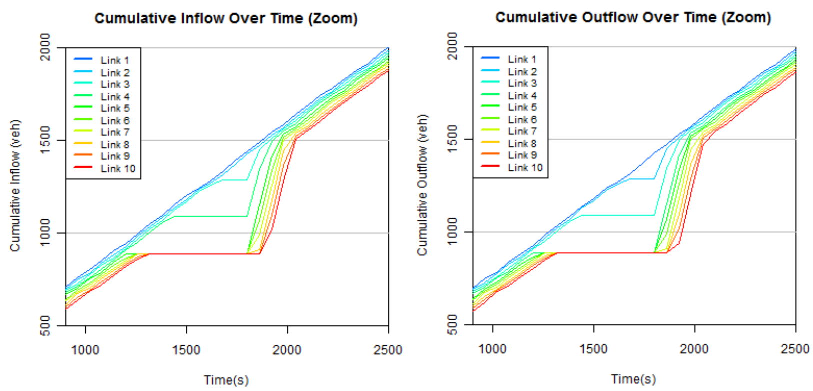

Figure 4: Cumulative inflow/outflow of all the links in the test network with an incident.

Analyzing the cumulative outflow plot, Figure 4 shows how the incident starts on the downstream node of Link 4, 20 minutes after the simulation begins. At time=1200 seconds, the slope of the line corresponding to Link 4 presents a slope equal to zero, so no vehicles are exiting from this link because the node is blocked by the incident. Also, we can observe how the incident backs up to Link 3 and Link 2. And also, how Links 5, 6, 7, 8, 9 and 10 progressively tend to this zero-slope (during the next two minutes of the simulation). At time=1800 seconds, the blocked situation is removed from the scenario. At this time, we can observe that the slope of the line corresponding to Link 4 becomes different to zero, so vehicles exit from this link. This behavior is propagated via Links 3 and 2. Some seconds later, vehicles arrive at the downstream links and their slopes become different to zero. Around t=2100 seconds traffic situation is completely restored. Link 1 is unaffected by the incident.

This simple experiment graphically shows that the proposed model performs correctly when changes in traffic conditions occur. We see that the model respects the propagation of the congestion, ensuring correct temporal and spatial location of the congestion at the link level.

4.3 Proposed model vs Microsimulation

Finally, in this section the model is applied to two real networks. The purpose of this exercise is to validate the correctness of the proposed DNL model. Our model is less detailed than microscopic models that are considered the most realistic simulation tools for emulating the flow of individual vehicles. So, in order to experimentally investigate the performance of the proposed multilane multiclass model, we compare the results obtained through a microsimulator with the results obtained through the proposed model. Astarita et al. (2001) proposed a similar experiment in order to compare three different DNL proposals. Aimsun v7.0. (2011) is chosen as the benchmark microsimulator.

Aimsun is a fully integrated suite of traffic and transportation analysis tools, developed by a research group at the Universitat Politècnica de Catalunya - BarcelonaTECH and led by Professor Jaume Barceló (1986). It can be used for transport planning, microscopic simulation and dynamic traffic assignment, among others. In this work, Aimsun microscopic component is used.

4.3.1 Used Goodness-of-fit Measures

We use the Root Mean Squared Error (RMSE) to measure the difference between values obtained the microscopic simulator Aimsun and the proposed mesoscopic simulation. And the Normalized Root Mean Squared Error (NRMSE) that normalizes the RMSE to the range of obtained values through Aimsun.

In addition, Geoffrey E.Harvers' statistic GEH (Highways Agency, 1996) is a measurement widely accepted by practitioners because it provides an overall view which is considered more useful than the individual measurements. GEH calculates the index for each link (GEH_i).

$$GEH_i = \sqrt{\frac{2\left(X_{Aimsun,i} - X_{newDNL,i}\right)^2}{X_{Aimsun,i} + X_{newDNL,i}}}$$

If the deviation of the proposed model values with respect to the Aimsum values is smaller than 5% in at least 85% of the cases, then the proposed model is accepted. In addition, the GEH average for all links can also be calculated. In this case, the proposed model is accepted if this value is smaller than 4%.

The use of aggregated values to validate a simulation seems contradictory if one takes into account that it is dynamic in nature, and thus time dependent. Consequently, other analysts propose statistical methods which account specifically for the comparison of the disaggregated time series of the values. Theil (1961) defined a set of indices aims at this goal. The first index is Theil's indicator (U) which provides a normalized measure of the relative error that smoothes out the impact of large errors.

$$U = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(X_{Aimsun,i} - X_{newDNL,i}\right)^2}}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(X_{Aimsun,i}\right)^2} + \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(X_{newDNL,i}\right)^2}}$$

The index U is bounded, $0 \leq U \leq 1$, with $U = 0$ for a perfect fit between the two values. For $U \leq 0.2$, the obtained values with the proposed model can be accepted as replicating the microscopic simulated values acceptably well. For values greater than 0.2, the proposed model is rejected.

4.3.2 Case Study 1: Real Freeway Network

The first case study used to test the proposed DNL model against the selected microscopic simulator is the SH1 freeway in Auckland (New Zealand). This proposed test network consists of 119 nodes, 223 links and 276 turns. The lengths are distributed among the minimum length of 7.91m and the maximum length of 1,801.77m. The maximum allowed speed goes from 50 Km/h to 100Km/h, depending on the link type. Each link has its corresponding longitudinal division by lanes among 1 and 6 lanes.

In this experiment we use a real demand corresponding to the interval from 6:45 a.m. to 9:00 a.m. So, for each vehicle class we use nine 15-min matrices. A total of 27 matrices provides the origin-destination demand data for 34 zones resulting in 221 OD pairs. The total number of trips in the matrices is 69,272 corresponding with a congested scenario. A multiclass demand is considered with differently effective lengths (4.4m, 6.5m or 7.5m) and reaction time of 0.75s.

In the proposed experiment we run each simulation model over the previously presented freeway network. The objective is to perform a comparison between both results, so we decided to use the same set of paths for each OD pair. If we use the same paths, we are avoiding the differences in the traffic flow variables on links which arise from different flow distribution. In this case, we suggest an experiment that uses 1-3 paths for each OD pair. These paths and their corresponding assignments are the result of previously performed DUE in the network. This set of paths is imported to both models respectively.

In addition, the calibration procedure was conducted for the proposed DNL model, which consisted of adjusting only the following parameters: lane change penalty (t_{LCH}) and cross node time penalty ($t_{crossNode}$). The final adjusted values for these parameters were: $t_{LCH} = 0.1s$ and $t_{crossNode} = 0.7s$. After this calibration, we execute a 135 minutes long simulation through both models. In this case, ten replications are made for each of the simulation models. In the following, the average results over these runs are compared.

We quantitatively examine the results obtained through the proposed mesoscopic simulation. Figure 5 shows the residual analysis for the obtained densities (veh/h/lane) and travel times (sec) on each network link at the end of each 15-min simulation interval running both models (proposed vs benchmark). The RMSE has the same unit as the original measurements and the NRMSE shows percentage. In the case of the density results, the NRMSE obtained value is 3.61% and the RMSE value is 7.86 veh/h/lane. In the travel time results, the obtained NRMSE value is 0.38% and the RMSE value is 15.48 seconds. In addition, we show a residual analysis with the 95% confidence interval using RMSE.

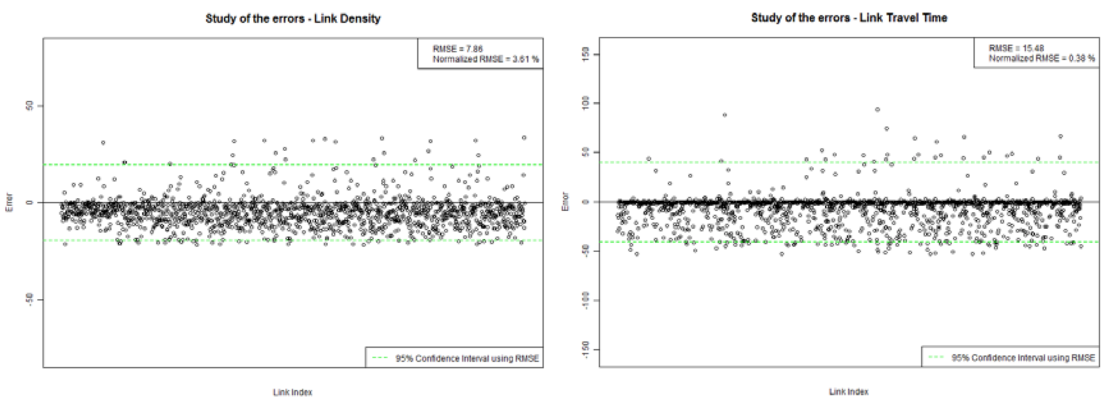

Figure 5: Residual Analysis for Link Densities (benchmark vs. proposed model).

In summary, the results obtained for the presented computational experiences demonstrate the ability of the developed model to reproduce multilane multiclass traffic behavior for freeway networks.

4.3.3 Case Study 2: Real Urban Network

In the previous experiment, we showed the proper performing of our mesoscopic model when is deployed in a freeway scenario. This network type is relatively simple in terms of traffic propagation. Since the good results obtained, we now consider appropriate to increase the level of difficulty of the test network. So, we repeat the experiments of comparison with a microscopic traffic simulator but using an urban network instead. Specifically, we use a European network with roundabouts and short length links that complicate the propagation process. The used real urban test network corresponds to Amara Berri district in the city of San Sebastian (Spain). The proposed test network consists of 76 nodes, 192 links and 301 turns. Four 15-min matrices provide the origin-destination demand data for 13 zones, resulting in 80 OD pairs. The total number of trips in the matrices is on the order of 8,428 vehicles. Two vehicle classes are considered: 90% of the demand corresponds to light vehicles while the remaining 10% corresponds to a heavy vehicle class.

With respect to the characteristics of different vehicle classes, our model distinguishes classes taking into account only two vehicle attributes: the effective length and the reaction time. We consider two vehicle classes: light and heavy, with effective lengths of 5 and 9 meters respectively. With respect to the reaction times, we consider the times defined in the calibrated Aimsun model: light vehicle class = 0.75 seconds and heavy vehicle class = 1.5 seconds. Moreover, we decided to use the same set of paths for each OD pair. In this case, we propose an experiment that uses three different paths for each OD pair. These paths are calculated with an external shortest path (standard Dijskstra algorithm), and they are imported to both models respectively.

A calibration procedure was conducted for the proposed DNL model, which consisted of adjusting the following parameters: lane change penalty and cross node time penalty. The final adjusted values for these penalty parameters were $0.1s$ and $0.6s$.

In order to obtain the computational results of the proposed experiment, we execute a one-hour long simulation. In this case, as in the previous case study, ten replications are performed for each of the simulation models to achieve reasonable results from the simulated values.

First of all, Figure 6 shows the link density at the end of the simulation of the Amara network for the proposed model and for the benchmark. For an easy visual comparison, we show the results obtained through the proposed model next to those through Aimsun for the same simulation interval.

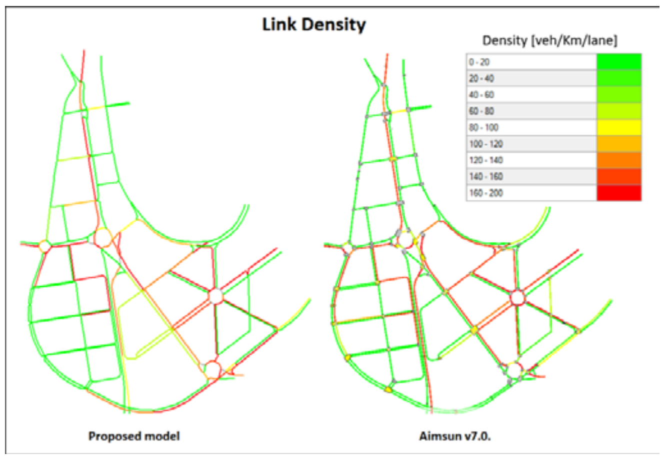

Figure 6: Average link densities in the network at the end of run simulation.

The results obtained for both models (proposed and benchmark) are similar, except for the congestion caused by roundabouts. The proposed model overestimates congestion at the roundabouts, causing significant differences in some adjacent links compared with the results obtained through Aimsun. Secondly, we show quantitatively the results obtained through the proposed mesoscopic simulation. We analyze density, travel time and vehicles per link for each link in the network for each interval.
First, in Table 1 we show the obtained results for the GEH measurements and the Theil's indicator for each of the measured variables. We can observe that the deviations of the proposed model values with respect to the Aimsum values are smaller than 5% in more than 85% of the cases (98.87%, 89.47% and 91.41%). Moreover, the GEH statistics for the sum of all the links are smaller than 4% in all cases. In addition, the obtained values for the Theil's Indicator are smaller (or equal) than 0.2 for the three studied variables. So, taking into account these measurements, the proposed model can be accepted as replicating the microscopic simulated values acceptably well.

After this, Figure 7 shows the corresponding for both models (proposed vs. benchmark) at the end of each 15-min simulation interval for all the links in the network. Each point plotted in the graphics corresponds to the coordinates: (measured variable obtained through Aimsun, measured variable obtained through the proposed model). Superimposed on these plots is the 45-degree line that would represent an identical simulation results for both models. Dots over the line represent that the proposed model overestimates the variable values, while dots under the line represent an underestimation. Moreover, we study the obtained errors in order to evaluate the correctness of the proposed model. We calculate RMSE and NRMSE. We also show a residual analysis with the 95% Confidence Interval using RMSE.

Table 1: Results of GEH measurements and Theil's Indicator.

CRITERIA AND MEASURES	ACCEPTANCE TARGETS

GEH Statistic < 5 for Individual Link	**> 85% of cases**
Vehicles Per Link	98,87
Travel Time	89,47
Density	91,41
GEH Statistic for Sum of All Link	**GEH < 4 for sum of all link counts**
Vehicles Per Link	0,82
Travel Time	1,44
Density	2,07
Theil Indicator(U)	**U<=0,2**
Vehicles Per Link	0,14
Travel Time	0,20
Density	0,14

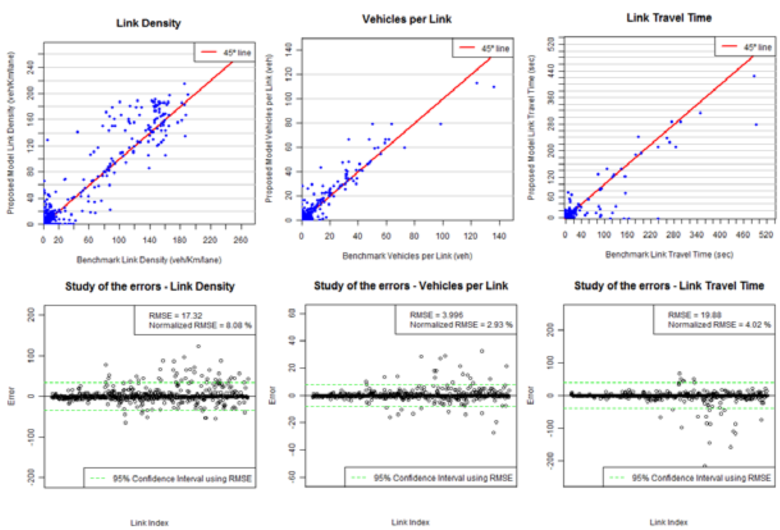

Figure 7: Link Densities: benchmark vs. proposed model.

In the case of density, the NRMSE obtained value is 8.08% and the RMSE values is 17.32 vehicles per hour per lane. Although the proposed DNL model considers considerably fewer parameters than the benchmark microsimulator, the reproduced densities are similar in both cases. However, the topology of the network is impacting in the results. The used test network is a typical European urban network with many short links. This causes small variations in the number of vehicles in the links results in substantial changes in density values. The variable "vehicles per link", which does not consider the length of the link explicitly, removes this effect. In this case the NRMSE value is 2.93% and the RMSE is 4 vehicles.

And, finally, in the case of the travel time variable, the NRMSE value is 4.02% and the RMSE value is 19.88 seconds. It is important to say that both models assume that any vehicle may exit a certain link during a certain time interval. In this case, the Aimsun model returns the value "-1" for this link for this interval. To facilitate the comparison, we adopt the same convention.

5 CONCLUSIONS

In this paper, intensive computational experiments were conducted in order to test the developed mesoscopic simulation model.

The first experiment tried to demonstrate that the proposed model was able to reproduce the fundamental diagram that relates the main macroscopic variables: flow, density and speed. With this objective, we graphically compared the obtained simulation results with the macroscopic theoretical relationship. We conclude that the obtained test results experimentally show that the developed DNL model is able to reproduce the fundamental diagram.

The second proposed experiment investigated whether the developed model can reproduce the propagation of congestion properly. In this case, the results show that our model respects the propagation of congestion, ensuring correct temporal and spatial location of the congestion on links.

In the third set of experiments, we tested our model against a microscopic simulator. The proposed model is less detailed than microscopic models, which are considered the most realistic simulation tools for emulating the flow of individual vehicles. So, to experimentally investigate the performance of our model, we compared the results obtained through a selected microsimulator with the obtained through our model. In this case we used two real networks for the experiments: a freeway network in Auckland and the urban Amara network. The obtained results show that, although the proposed model considers fewer parameters than benchmark (only two), the reproduced traffic behavior results similar in both cases.

The results obtained for the performed computational experiments demonstrate the ability of the developed model to reproduce multilane multiclass traffic behavior for medium-sized networks.

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AUTHOR BIOGRAPHIES

M.PAZ LINARES is a researcher at the inlab FIB (Barcelona School of Informatics laboratory). She obtained her Ph.D. in Operations Research on 2014 from UPC. Her research interests include DTA, traffic simulation and optimization. Her email is: mari.paz.linares@upc.edu.

CARLOS CARMONA is a researcher at the inLab FIB. He received his computer engineering from FIB. He works developing simulation and optimization projects since 2002. His research interests include the application of simulation to traffic and transport problems. His email is: carlos.carmona@fib.upc.edu.

JAUME BARCELÓ is a full professor at the department of Statistics and Operations Research at UPC and the head of ICT and Transport Projects at inLab FIB. He has taken part as main researcher in more than 20 projects of the R&D Programs of the European Union. His email is: jaume.barcelo@upc.edu.

CRISTINA MONTAÑOLA-SALES is a PhD student at Statistics and Operations Research Deparment at UPC. She is currently doing her research at Barcelona Supercomputing Center. She holds an MSc in Computer Science from UPC. Her research interests include agent-based simulation, high-performance computing and computational social science. Her email address is cristina.montanola@upc.edu.