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ANALYSIS OF SIMULATION INPUT AND OUTPUT TO COMPARE SIMULATION TOOLS

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LATVIA

Abstract**:** *The paper presents the results of input characteristics and output measures comparison between two different simulation tools (AIMSUN and Synchro/Simtraffic). The purpose is to operate a comparative evaluation of potentialities and limits for each simulation tool. For this purpose two intersections were built on existing data basis, collected in the city of Riga.*

Key words**:** *simulation tools, comparison*

INTRODUCTION

Simulation modelling is an effective approach for quantifying the benefits and limitations of different alternatives for traffic flow management and scenario evaluation. Traffic models are computer-based models, which are used to describe and analyse different aspects of transportation *in the different* level of detail and size of model area. Detail level can be divided into three types: macro, meso and micro level. Micro-simulation models incorporate specific car following, vehicle performance and lane changing algorithms to model individual vehicle behaviour. Macro-simulation models focus not on individual vehicles in the traffic stream, but instead consider traffic as an aggregate flow using continuum equations. And meso-models are between macro and micro models - analyse traffic in an intermediate model size at an intermediate level of detail. The aim of the paper is to summarize the findings of potentialities and limits for traffic flow management and scenario evaluation using two commercially available simulation tools (Aimsun and Syncro/Simtraffic) at the micro level. The both simulation tools are frequently used for traffic flow analysing under different conditions. The micro level was chosen in order to examine the impacts of system alternatives in greater detail.

Each simulation tool was evaluated based on the following parameters:

Input characteristics: link geometry, demand and traffic signal setting.

Output parameters: simulated volumes (vehicles per hour), delay (sec) and queue length (maximum and average; m).

For the operate a comparative evaluation of potentialities and limits for scenario evaluation two intersections were built on existing data basis, collected in the city of Riga.

2. OVERVIEW OF SIMULATION TOOLS

The paper consists of a review and comparison of two traffic simulation tools: SimTraffic (version 6.0) – developed by Trafficware Corporation [4] and AIMSUN (version 6.0.5) – developed by Traffic Simulation Systems [2]. Descriptions of each simulation tool are given below.

2.1 SYNCHRO/SIMTRAFFIC

Simtraffic simulation tool was designed as modelling and optimisation software for traffic

flow and signal timing. It is a microscopic simulation tool that uses the outputs of the Synchro (macroscopic level) to modelling street networks (modelling travel through signalised and unsignalised intersections and arterial networks, as well as freeway sections, with cars, trucks, pedestrians and buses). Most of the input is entered through the Synchro program, but some parameters, such as the driver and vehicle characteristics are modified through SimTraffic specifically.

2.2 AIMSUN

Aimsun simulation tool is fully integrated software, which provides macro, meso and micro level detail. At the micro level Aimsun has an ability to obtain detailed state variable information on each vehicle on time scales with better than second-by-second accuracy. The same as Simtraffic Amsun allows simulate surface street networks, freeways, and interchanges; weaving sections, pre-timed and actuated signals, stop controlled intersections, and roundabouts.

During last five years both simulation tools are made a big step forward in developing more flexible and sophisticated software for traffic flows management. Below are presented Simtraffic and Aimsun capabilities comparison (Table 1) and relationship to others simulation tools (Table 2). Data was adopted from 2004-year A.J.Sullivan, N.Cheekoti, M.D.Anderson and D.Malave "Traffic simulation software comparison study" research and were added new capabilities and tools.

Table 1. Simtraffic and Aimsun capabilities

	Simtraffic	Aimsun
Network:		
Surface Streets	+	+
Freeways	+	+
HOV Lanes		+
Control:		
Unsignalized Intersections	+	+
Actuated Signals	+	+
All-Way Stop	+	+
Coordination	+	+
Roundabouts	+	+
Ramp Metering		+
Signal Priority		+
Operations:		
Weaving Sections	+	+
Transit Operations		+
Pedestrians	+	+
Parking		+
Other:		
Incidents		+
Spillback	+	+
Time Varying Demand		+
O/D Assignment		+
Dynamic Traffic Assignment		+
Variable Message Signs		+
2-D Animation	+	+
3-D Animation		+
Signal Optimisation	+	

Table 2. Relationship to others simulation tools

	Simtraffic		Aimsun	
	Import	Export	Import	Export
Emme/2			*	*
HCS +		+		
Transyt		+	+*	
Synchro		+	*	*
CORSIM		+	*	
SimTraffic		+	*	
AIMSUN	*	*	+*	
Visum/Vissim			*	
SATURN			*	*
Paramics			*	

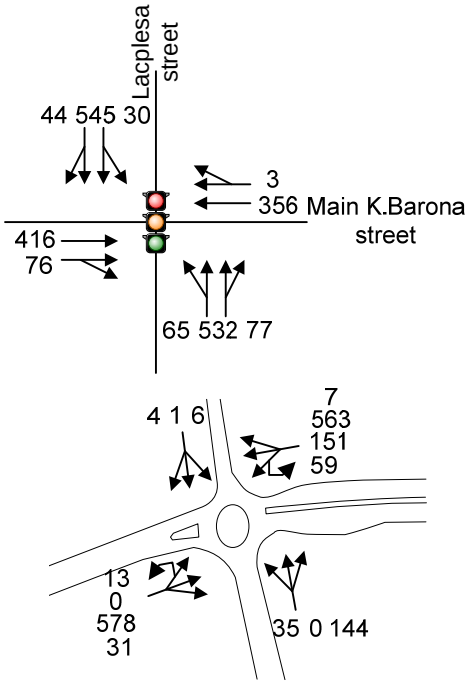
[1)] * - new features from 2004 till 2009

As it can be seen from Table 1, Aimsun simulation tool has greater numbers of capabilities compared with Simtraffic. The most important of them is dynamic traffic assignment that based on the concept of user equilibrium (travelers try to minimize their individual travel times, that is, traveler chose the routes that they perceive as the shortest under the prevailing traffic conditions). The modeling hypothesis is formulated in terms of Wardrop's first principle "*The journey times on all the routes actually used are equal, and less than those, which would be experienced by a single vehicle on any unused route"*. Also Aimsun simulation tool gives the ability to modeling transit operations, parking and possibility applying some traffic management actions (incidents, variable message signs) to facilitate the access to the accident position. On the other hand Simtraffic simulation tool has a signal optimization option that are argued on the practice that it is one of the best tool for signal timing optimization.

3. NETWORK AND INPUT PARAMETERS

Micro simulation models require fairly extensive data collection prior to network coding. To evaluate and compare simulation tools two intersections were selected – signalized and roundabout. Data about vehicles

which entering and exiting the intersections, lanes geometry, speeds, signal setting were collected on November 2008 at the working day in peak evening hour from 17:00 till 18:00 in the city of Riga. All three intersections are working under congested conditions (volume to capacity < 1) and there are located in the center of the city. PM peak hour traffic volumes in passenger car equivalent and intersections geometries are shown in Figure 1.



35 – traffic counts in PCU (passenger car units)

Fig 1. Intersections with intensity for pm period

To satisfy the accuracy of results the following assumptions were taken into account:

1) The warm-up period was set 15min for both models. Simulation period was taken one hour from 5pm till 6pm (evening peak hour period).
2) Number of lanes, grades, free-flow speed data, turning speed data, traffic signal timing data, traffic (without public transport and trucks) and pedestrians counts were selected the same for Aimsun and Synhro models.
3) Public transport data. For Aimsun model transit schedules (separately for buses, trolleybuses and trams) were added with public transport lanes and stops. For Synchro model only the number of buses that stop and actually block traffic are possible to add. To avoid the accuracy of data it was taken a decision to use passenger car equivalents for public and trucks data. Synchro allows choosing only heavy vehicles percentage.
4) Traffic states were used in both models because of Synchro tool does not support origin-destination (O/D) trip table's option.

After the data was inserted into models and all parameters were set, validation and calibration of outputs of the models were accomplished.

4. COMPARISON PARAMETERS AND RESULTS

One of the most effective ways of identifying advantages ands limitations in system operations is to use a set of measures that show areas of deficiency or possibilities for improvements.

After input parameters and main characteristics were defined, ten replications are repeated for both simulation tools (calculation based on normal distribution with 95 percent level of confidence). The next two sections are shown the results of Aimsun and Synchro models simulation.

4.1 INPUT CHARACTERISTICS COMPARISON

To compare input measures three characteristics were chosen:

Link geometry. Simtraffic use the link – node format with friendless interface to represent network geometry. The nodes are joined by links that can significantly reduce time. The advantage of this format is easy network drawing, but on the other hand that intersections are more complex (for example interchange, TUDI) the harder to represent them. The level of effort required to drawing a network in Aimsun is much greater that that required in Simtraffic, but also it require longer time to represent the network. For network representation Aimsun use nodes, segments, sections and connectors. The advantage of Aimsun is that network all the time is visible and it is possible to see geometry inaccuracy during drawing process. Another differences from Simtraffic are option define intersections in term of permitted turning movements that allow to modelling complex interchanges more accurate.

Traffic signal settings. The advantages of Simtraffic are possibilities automatically assign phase numbers to each movement and optimise

the split, cycle length and offsets of intersections or whole network with one touch of button. The result of optimisation should be delay and stops time reduction. Traffic signal modelling in Aimsun is implemented using fluctuations stopped vehicles, which are created and located at the stop line when the light turns red and eliminated when it turns green. In this way, the car-following model can be used to model braking to stop in front of a red light that give more flexible options for traffic and pedestrian flows control. For new users it can be time consuming for understanding how to work with signal timing in Aimsun, the pre-training is necessary.

Demand. Demand flows can characterize by the set of o/d pairs or traffic states. Aimsun uses as input o/d flows or turning percentages and turning volumes. Synchro simulation tool enable to use only turning volumes for represent demand flow. The approach based on turning percentage or turning volumes has been neglected for the two reasons: to maintain the same demand representation in the static and in the dynamic simulation and to evaluate the new traffic flow configuration after the opening, for example, of the new infrastructure. With an approach based on turning percentages or volumes it would have been not possible to establish traffic flows and turning for the new network configuration before the infrastructure opening.

In the end of description of input characteristics it should be noted that no the best tool for the representation of a real situation on the road with simulation. Each simulation tool has it own weakness and strong sides. And choice of one or another simulation tool depends on specific tasks that are assigned to the user.

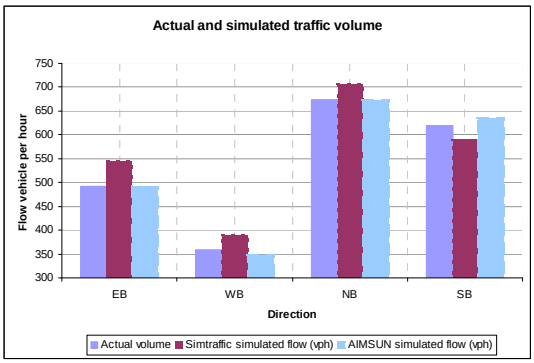
4.2 OUTPUT PARAMETERS AND COMPARISON RESULTS

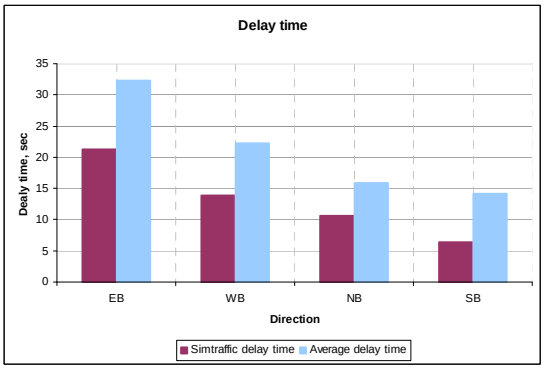
Output results were analyzed with respect to key performance measures:

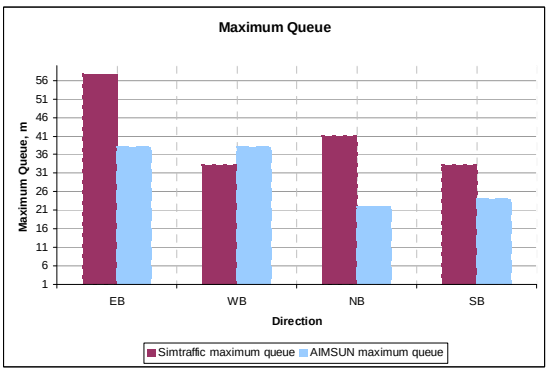
- ✓ Simulated volumes (vehicles per hour) – number of vehicles per hour that have passed through the network during the simulation period,
- ✓ Control delay per vehicle (sec) - the difference between the expected travel time (the time it would take to traverse the system under ideal conditions) and the travel time,
- ✓ Maximum queue length (m) - maximum length of the queue in fixed section and
- ✓ Average queue length (m) - average length of the queue in fixed section.

In the background of delay time and queue length calculations Simtraffic and Aimsun tools following the Highway Capacity Manual methodology. Despite the fact that the simulation tools use similar methodology, the delay time and queue length are expressed in different units. For example delay time in Simtraffic is expressed as average time per vehicle, but in Aimsun time are shown as delay time per vehicle per kilometre. To avoid these problems delay time are transformed in term of delay time per vehicle and queue length in meters per section.

In figures 2 and 3 are represented simulation results (has shown how outputs replicates real-world conditions) for both models.







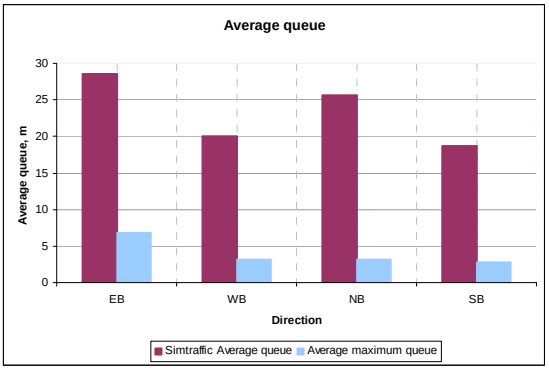
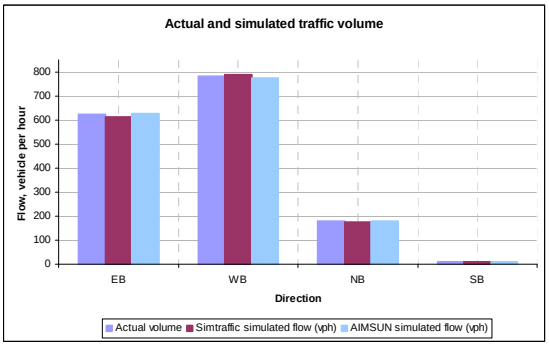
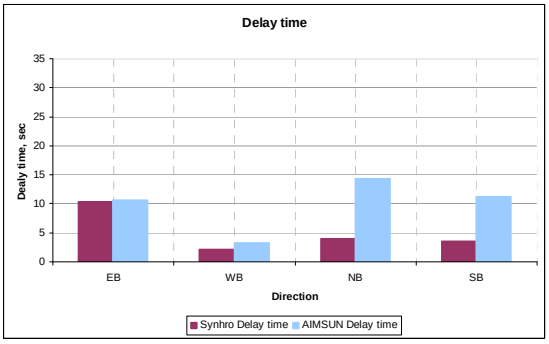
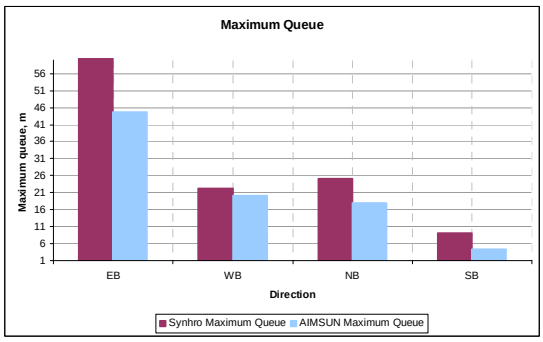


Fig 2. Output parameters for signalized intersection







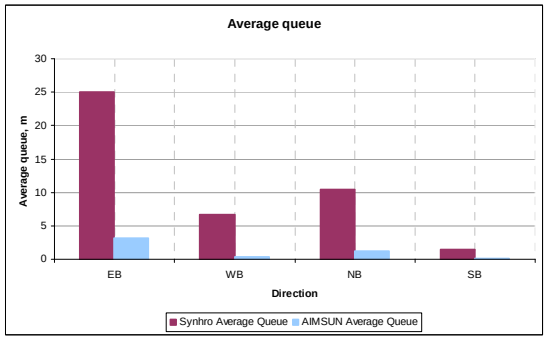


Fig 3. Output parameters for roundabout

As the data of figures show, the accuracy of simulated traffic flows generated by both models are similar to real conditions (varies within the range 5-10% due to daily fluctuations) for signalized intersection and roundabout. Maximum and average queue significantly varies between Simtraffic and Aimsun models because of different approach calculating the queue length. Simtraffic provides the closest estimates for queuing since it calculating the length taking into account spillbacks (situation when queue from a downstream intersection uses up all the space on a link and prevents vehicles from entering the upstream intersection on green). Aimsun calculates queue only for closest sections without taking into account spillbacks. On the other hand delay time per movement in Aimsun model are meaningfully differ from Simtraffic due to possibility to support more flexible and complex options for model control and evaluation.

5. CONCLUSION

Both simulation tools (Aimsun and Simtraffic) perform reasonably well with some limitations that should be understood prior to selecting one or another tool for network evaluation. It was found that Aimsun have the greatest variation from observed delay time because car following algorithms in tool generate higher saturation flow rates than SimTraffic. On the other hand if it is necessary to make a quick analysis for non-complex network (without interchanges) or signal-timing optimisation Synchro simulation tool should be chosen.

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АНАЛИЗ НА ВХОДЕН И ИЗХОДЕН СИГНАЛ ПРИ СИМУЛАЦИЯ ЗА СРАВНЯВАНЕ НА СИМУЛАЦИОННИТЕ ПРИСПОСОБЛЕНИЯ

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ЛАТВИЯ

Ключови думи: *симулационни приспособления, сравнение*
Анотация*: Статията представя резултатите от входните характеристики и сравнението на изходните измервания между две различни симулационни приспособления (AIMSUN и Synchro/Simtraffic). Целта е осъществяването на сравнителна оценка на възможностите и ограниченията за всяко симулационно приспособление. За целта са построени две кръстовища въз основа на наличната база данни, събрани в Рига.*