Smartest

Simulation Modelling Applied to Road Transport European Scheme Tests
http://www.its.leeds.ac.uk/smartest

Update Specifications

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APPENDIX - A: DETAILED MODEL UPDATE SPECIFICATIONS

INTRODUCTION

This document is the fourth deliverable of the SMARTEST project.

The SMARTEST project directly addresses task 7.3/17 in the second call for proposals in the Transport RTD, Road Transport Traffic, Transport and Information Management area. The project is directed towards modelling and simulation of dynamic traffic management problems caused by incidents, heavy traffic, accidents, road works and events. It covers incident management, intersection control, motorway flow control, dynamic route guidance and regional traffic information.

The objectives of the project are to:

1. review existing micro-simulation models, so that gaps can be identified
2. investigate how the SMARTEST models can best be enhanced to fill the identified gaps, thus advancing the State-of-the-Art
3. incorporate the findings of the study into a best practice manual for the use of micro-simulation in modelling road transport and to disseminate these findings throughout Europe.

This document responds to the second objective of the project. It is the output of Workpackage 3 - Model Update Specification - for which five different work areas have been identified, each being addressed by one specific chapter.

Chapter 1 - *Operational Aspects* - concerning practical and technological aspects related to the use and development of micro-simulation models.
Chapter 2 - *Prioritisation of Gaps* - focusing on the main gaps identified in the SMARTEST models and on the consequent enhancements being implemented during the course of the project.
Chapter 3 - *Scenario Building* - providing a schematic description of the scenarios made available by the SMARTEST sites for testing, evaluating and validating the updated models.
Chapter 4 - *Inputs and Outputs* - defining data requirements for model calibration and evaluation and data availability from the SMARTEST test sites.
Chapter 5 - *Specification for Modifications to the Existing Micro-simulation Packages* - providing general specifications for modelling the features highlighted as gaps in Chapter 2.

Appendix A includes details that extend the descriptions reported in Chapter 5.

1. OPERATIONAL ASPECTS

Chapter 2 from the SMARTEST deliverable entitled "Review of Micro-Simulation Models" identifies the users' requirements for micro-simulation of traffic. The requirements can be summarised as follows:

Users would like to analyse the performance of a variety of specific applications, including on-line applications, control strategies, large scale schemes and product performance tests. The scale of applications ranges from regional applications to single road cases, and the time horizon ranges from on-line to several years. The requested time span for simulation runs extends from as little as 5 minutes up to 12 hours with an emphasis on peak time periods.

There is then demand for:

- **Functionality**: which includes the ability to model incidents, public transport stops, roundabouts, commercial vehicles, traffic calming and parked vehicles.
- **Relevance**: which gives the user the opportunity to obtain results in terms of:
  - *Efficiency*: travel time, congestion, travel time variability, queue lengths, speed, public transport regularity.
  - *Safety*: headway, interaction with pedestrians, overtaking.
  - *Environment:* exhaust emissions, noise level, roadside pollution levels.
  - *Technical performance*: fuel consumption.
- **Telematics modelling ability:** adaptive traffic signals, co-ordinated traffic signals, priority to public transport vehicles, vehicles detectors, ramp metering, variable message signs, incident management and dynamic route guidance.

Figure 1 shows the elements of a simulation evaluation scheme process. Furthermore, for each element shown it identifies the different issues that need to be addressed in order to discover likely gaps in users' requirements.

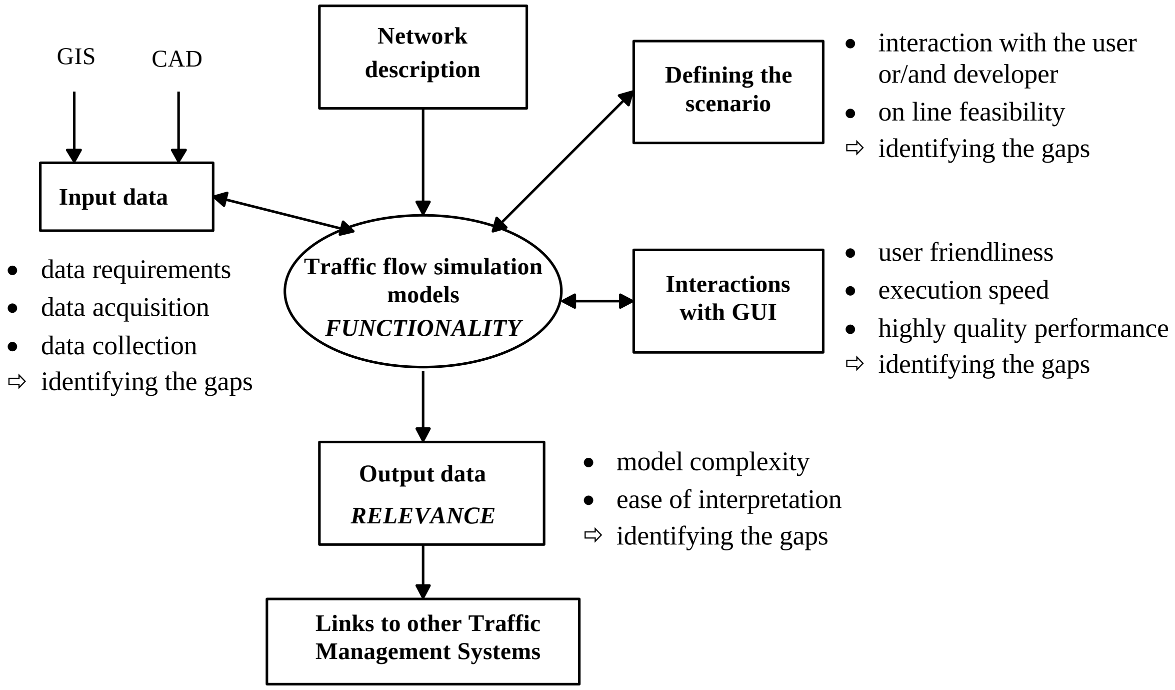

Figure 1: User requirements of the micro-simulation process.

1.1 FUNCTIONALITY

From the users' requirements point of view, a micro-simulation model should be able to model incidents, public transport stops, roundabouts, commercial vehicles, traffic calming and parked vehicles. Therefore, the following aspects have been addressed:

- **Information required for the modelling**. A list of all relevant information regarding the phenomenon to model is proposed. In order to prioritise the gaps, the relevance of each piece of information ranges from **h** (highly relevant) to **m** (relevant) to **l** (fairly relevant). Moreover, the way to collect this information (**A**: automatic or **M**: manually) and the cost (**h**: high cost, **m**: medium, **l**: low) are discussed.
- **Interactions in defining the scenario**: is the scenario defined by the user, by the developer or both by the user and the developer?
- **Feasibility of on-line modelling**.

1.1.1 Input information required for the modelling

Incident

An incident can be defined as any unexpected event that can influence the capacity of a road. It results in delay and a reduction in average speed.

At the onset of an incident, the traffic flow is reduced from a *normal demand flow* to a *reduced incident flow* that is maintained for the duration of the incident. Once the incident has been cleared, traffic flow increases from the *incident flow* back up to the *normal demand flow*. Both the lane where the incident is located and the adjacent lanes are affected by a reduction in capacity.

In order to simulate an incident, the following information is needed (See Table 1): its location and placement in the lane, the length of blockage, the effective number of lanes blocked, its duration (start and end times). The modelling should also take into account the nature/severity of the incident. This qualitative information can be difficult to collect and process.

All this information can be collected automatically way. It is important to emphasise that the duration can only be known afterwards, i.e., only when the incident has been cleared, hence its high collection cost.

The model should output the new capacity, flow and speed on the lane where the incident is located and the impacts on the adjacent lanes. The new capacity can be derived from information related to the length of blockage and number of lanes blocked. The model must also output the delay resulting from the incident, which implies knowing the average speed under both incident free and incident conditions.

Calibrating the simulation model means adjusting the parameters used in the simulation so that the description provided by the model fits the real one. Validating the simulation model ensures that the simulation model provides a reasonable and accurate representation of the traffic conditions, within acceptable levels of confidence. Outputs provided by the model are compared with those obtained from field data. Both calibration and validation imply the availability of adequate and correct measurements.

The new capacity, as a result of the length of blockage and number of lanes blocked, can only be determined manually. Speed and flow are available directly and automatically, hence their low collection cost.

Incident	**Modelling**			**Calibration &Validation**		
	Relevance	**Data Collection**	**Collecting Cost**	**Relevance**	**Data Collection**	**Collecting Cost**
Inputs to the model						
location	h	A/M	l	h	A/M	l
nature/severity	l	M	h	l	M	h
duration	h	A	h	h	A	h
length of blockage	h	A	l	h	A	l
nb of lanes blocked	h	A	l	h	A	l
Outputs from the model	**Complexity**					
current capacity	l				M	m
flow	l				A	l
speed	l				A	l
effects on surrounding links	h				M/A	h

Table 1: Input information for simulating an incident

Public Transport Services

In order to simulate public transport stops, the following information is needed (See Table 2):

- *the location of the stop*. It can be collected either automatically or manually. Automatic collection implies a sophisticated location system is available (such as GPS); hence the high cost. Manual collection can cost less if reliable maps giving bus stop locations to sufficient accuracy are available.
- *the placement of the stop*. The location of the stop can be at the roadside or in a specific lane or layby dedicated to public transport. A roadside stop will cause a temporary reduction in the capacity of the lane when a public transport vehicle is at the stop.
- *the duration of the stop*. The duration of the stop is related to the number of passengers boarding the public transport vehicle and the number of passengers wanting to get off.

In order to provide the users (passengers) with estimated arrival times of public transport services, timetables for different routes have to be made available. It would clearly be useful if micro-simulation models could use data on public transport timetables and scheduled routes in the same format as could be provided by public transport operators. Estimated arrival times could also be obtained from any Urban Traffic Control system that incorporates a Public Transport Priority System, as such systems need vehicle location systems in order to work.

	Relevance	**Data Collection**	**Collecting Cost**
location of the stop	h	M/A	h/m
roadside or special lane	m	M	m
duration	h	M/A	h
route scheduled or timetables	h	M/A	l

Table 2: Input information to model Public Transport stops

Commercial vehicles

Commercial vehicles are vehicles used for goods deliveries. Their movements can be easily modelled by adapting the usual car models. The major differences between goods vehicles and cars are as follows:

- they can follow fixed routes taking in destinations for collection and delivery of goods,
- they are usually longer and wider than cars, so they occupy more space on the lane,
- they cannot accelerate or decelerate as quickly as cars,
- they usually require a larger headway for travelling behind other vehicles,
- they may contribute more to exhaust emissions than cars,
- their fuel consumption is also different.

The information on vehicle characteristics (length, width, mass, maximum speed, acceleration and deceleration, exhaust emissions and fuel consumption rates can be provided by vehicle manufacturers. Scheduled routes would usually be collected manually, but with the advent of fleet tracking systems there might be opportunities for automatic collection. See Table 3.

	Relevance	**Data Collection**	**Collecting Cost**
Vehicle characteristics			
length	m	M	l
width	m	M	l
mass	l	M	l
Fixed route	h	M/A	m
Flow features	h	M	l
max speed	h	M	l
max acceleration	h	M	l
max deceleration	h	M	l
Fuel consumption	l	M	l
Exhaust emissions	l	M	l

Table 3: Input information to model commercial vehicles

Traffic Calming

Traffic calming is a combination of policies and physical measures to reduce the negative effects of the use of motorised vehicles in a community. The key to successful traffic calming lies in changing the design and role of the streets in such a fashion that drivers will have to slow down.

Traffic calming devices include speed humps, forced turn islands, street closures, chicanes, mini-roundabouts, small radii corners at junctions, build outs, one-way streets, stop signs, and narrowed streets.

Traffic calming focuses on speed and capacity management.

Traffic calming can be modelled for two purposes (See Table 4):

- *To model already implemented traffic calming strategies*. Therefore, it is rather straightforward since all the necessary information (kind of traffic calming devices, its location, the impacts on traffic flow) are already available.
- *To develop new traffic calming schemes*. Herein, one has to choose one particular traffic calming device, its location on the street. More complex is the estimation of its impacts on traffic flow (speed reduction or capacity reduction). This task becomes even more complex when considering a combination of different calming techniques. Traffic claming is community-based planning and public participation is essential to its success. The selection of these measures is best done by public consensus. The elaboration of a traffic calming scheme usually requires very skilled operators, hence the high cost in collecting the required information. A Virtual Reality or 3D representation world can make the evaluation easier.

	Modelling an already implemented strategy			**Developing a traffic calming scheme**		
	Relevance	**Data Collection**	**Collecting Cost**	**Relevance**	**Data Collection**	**Collecting Cost**
location	h	M	m	h	M	h
kind of traffic calming	h	M	m	h	M	h
kind of impacts on the traffic flow (speed or capacity)	h	A	m	h	M	h

Table 4 Input information to model traffic calming

Roundabouts

Before modelling traffic flow on roundabouts, one has to question the ability of GIS/CAD tools to provide sufficiently detailed representations of roundabouts. Table 5 summarises the information needed to model the traffic flow on a roundabout. This includes the geometric characteristics of the roundabout and the traffic flow features.

	Relevance	Data Collection	Cost
Geometrical characteristics			
radius	l	M	l
number of lanes	m	M	l
number of internal lanes	l	M	l
location of the internal lanes	l	M	l
number of incoming links	m	M	l
number of outgoing links	m	M	l
Traffic flow information			
priorities	m	M	l
speed per lane	h	M	l
capacity per lane	h	M	l
saturation flow per lane	h	M	l

Table 5: Information to represent roundabouts

Parked vehicles

If parked vehicles are just considered as stationary vehicles then their modelling is fairly simple. An excessive number of vehicles parked at the roadside can considerably reduce the capacity of the road. Vehicles queuing to enter or exit a car park can also lead to a reduction of capacity. Searching for a free roadside parking space is something that needs to be considered as usually traffic models direct vehicles to an exit node rather than to a link where parking spaces are available.

To model vehicles parked on the roadside, the following information is required (See Table 6):

- the location of the parking spaces in the road network,
- parking duration times,
- the resulting capacity reduction.

All this information has to be collected manually and the collection cost is low.

- In the case of a car park, data should be collected on vehicle queuing times to access the car park and the capacity of the car park.

	Relevance	Data Collection	Cost
location	m	M	l
start and end time	m	M	l
capacity reduction	h	M	h

Table 6: Information to model parked vehicles

1.1.2 Ease of scenario definition and the feasibility of using on-line data collection

This section investigates the amount of data required, and the ease of collecting it, to model scenarios that incorporate the new features to be added by the SMARTEST project. It finds out how much data needs to be provided by the users and how much can be provided by the model developers. It also investigates the feasibility of using on-line data collection methods to automatically provide the required input data for a given scenario.

The data required to define a scenario featuring each of the following elements is (See Table 7):

- *Incident*, needs the location of the incident, its duration, the length of the blockage, the number of lanes blocked, the impacts on traffic flow. All this information has to be provided by the user. A sophisticated automatic incident detection system could help provide real values of some of these items for a given scenario.
- *Public transport stops*, providing information describing the location and placement of the stop and the duration of vehicle stops. The users have to provide the location of the stops and the routes servicing them in the scenario. The developers can provide default values on boarding and leaving rates and give typical stop dimensions. A public transport vehicle tracking system might be helpful in providing some of this data.
- *Roundabouts* the users will have to provide most of the information related to the geometry of the roundabout.
- *Commercial vehicles* a strong interaction with the user since at the present time most of the information is collected manually.
- *Traffic calming* a strong interaction with the developers since the different traffic calming techniques are made available to the users by the developers.
- *Parked vehicles* the users need to supply details of the location of parking facilities, the developers can provide default values for typical parking duration times and times to enter car parks via automatic barriers. Data from car park management schemes that monitor car park capacities could be used to provide some of this data on-line.

	Scenario Inputs *u:* user, *d*: developer, *b*: user + developer	**On-line feasibility** *h:* highly feasible, *m*: feasible, *l*: fairly feasible
Incident	u	m
Public transport stop	b	m-l
Roundabouts	u	
Commercial vehicles	u	m-l
Traffic Calming	d	
Parked vehicles	b	m-l

Table 7: Data provision in defining the scenario and the feasibility of on-line data collection

1.2 RELEVANCE

The users would like to express the results of their applications in terms of:

- *Efficiency*: travel time, congestion, travel time variability, queue lengths, speed, public transport regularity.
- *Safety*: headway, interaction with pedestrians, overtaking.
- *Environment:* exhaust emissions, noise level, roadside pollution levels.
- *Technical performance*: fuel consumption.

Each of these indicators has been analysed from two points of view: the complexity of computation and their ease of interpretation. From Table 8, the following conclusions can be drawn:

- *Efficiency*. Among the standard traffic variables provided by almost all traffic flow models, travel times and speeds are both easy to calculate and interpret, while queue lengths are easier to interpret than to compute. A key issue lies in the modelling and interpreting of the efficiency indicators that are both complex to compute and difficult to interpret. These are: travel time variability, congestion, and public transport regularity. A consistent definition of these indicators is of prime importance.
- *Safety*. From a safety point of view, the most difficult aspect to take into account is pedestrians. Pedestrian flow is difficult to model for several reasons:
  - pedestrian movements are not as restricted as vehicle movements,
  - walking speed depends on the following factors: age, sex, physical ability, social position (in groups or individual), trip purpose, weather, amount of baggage, density of pedestrians,
  - pedestrians interact with road vehicles when they cross the road, but they can cross the road at many different places. These include signalised crossings, zebra crossings, unsignalised junctions and mid-link if there is a suitable gap in the traffic flows.

  Safety is also related to vehicle flows on different road types, headways between vehicles and the amount of overtaking and lane changing, but these are much easier to calculate and interpret.
- *Environment and technical performance*. Exhaust emissions are usually computed from very basic analytic equations, depending on the state of activity of the vehicle. Their computation is made easy thanks to look up tables. Roadside pollutants levels are far more complex to estimate since they involve atmospheric phenomena such as wind speeds and air temperature. Fuel consumption is easily determined on the basis of driving cycles.

	Model complexity *h:* high, *l*: low, *m*: medium	**Ease of interpretation** *h:* high, *l*: low, *m*: medium
Efficiency		
travel time	l	l
travel time variability	h	h
congestion	h	h
queue length	m	l
speed	l	l
public transport regularity	h	m
Safety		
pedestrian interactions	h	h
headway	m	l
overtaking	m	m

Environment		
exhaust emissions	l	l
noise levels	m	l
roadside pollutants levels	h	l
Technical performance and comfort		
fuel consumption	l	l

Table 8: Computational complexity and ease of interpretation of the performance indicators

1.3 TELEMATICS MODELLING ABILITY

For many transport telematics applications the use of micro-simulation models is essential for their development. This is because many such transport telematics systems interact with individual vehicles at frequent time intervals. Therefore the capability of modelling individual vehicle movements using short time steps is essential. Responsive urban traffic control and motorway ramp metering systems respond to changes in vehicle flows, measured by counting vehicles passing over detectors, typically on a second-by-second basis. Automatic incident detection systems also use vehicle detection systems to measure changes in flow characteristics following an incident. Dynamic Route Guidance Systems and Incident Management Systems divert selected traffic around congested areas and incidents.

Although it is possible to model new telematics systems without connecting real systems with micro-simulation tools, such an approach is wasteful of resources, as a model of the telematics system has to be developed as well as the telematics system itself. The capability of allowing direct interaction between micro-simulation models and real transport telematics systems is therefore becoming essential. The micro-simulation model needs to supply the information required by the telematics system. It should also be able to implement any control actions suggested by the telematics system. Once these two requirements are in place it is possible to link the telematics system to the micro-simulation model and let the telematics system operate in precisely the same way as it would do in the real world. Such a set-up can then model the performance and interactions of the telematics system in a realistic fashion. As a real telematics system is used there is no need to develop a model of its operation. This also has a side benefit that the details of the operation of the telematics system, which may be commercially confidential, do not have to be revealed to the transport modeller. As a micro-simulation model replaces the real world, new strategies can be developed in complete safety and the modeller can have complete control over the test conditions. Examples of the requirements for linking micro-simulation models to various transport telematics systems are shown in Table 9.

Telematics System	Information needed by the telematics system	Control actions to be implemented by the micro-simulation tool
Adaptive Traffic Signals	Vehicle flows	Signal timings
Public Transport Priority	PT vehicle locations & schedules	Signal timings
Variable Message Signs	Traffic data for selecting strategies.	Diversionary information
Dynamic Route Guidance	Traffic data for selecting strategies.	Routes for equipped vehicles
Incident Management	Vehicle flows, speeds & occupancy	VMS and/or signal activation
Ramp Metering	Vehicle flows, speeds & occupancy	Ramp metering timings

Table 9: Operational requirements for linking micro-simulation models and telematics systems

2. PRIORITISATION OF GAPS

2.1 INTRODUCTION

In the context of Workpackage 2 the main missing features of the state-of-the-art micro-simulation models were identified (32 tools were analysed) based primarily on the results of a specific User Requirements survey (ref. Deliverable 3, Chapter 4).

This section addresses the gaps identified in the SMARTEST models, with the objective of focusing on enhancements planned for these models. It proposes prioritising the gaps based firstly on the user requirements; then actual model features, developers' interests and the feasibility of the implementation. It leads to the final definition of the improvements in the models that are planned within the lifetime of the project.

2.2 MAIN GAPS IDENTIFIED IN THE SMARTEST MODELS

User requirements resulting from the survey concern several categories of features and capabilities of the micro-simulation models, but only those considered crucial or important by at least 50% of users are considered for gaps prioritisation.

According to the users' requirements, particular attention has to be paid to the "Transport Telematics Functions".

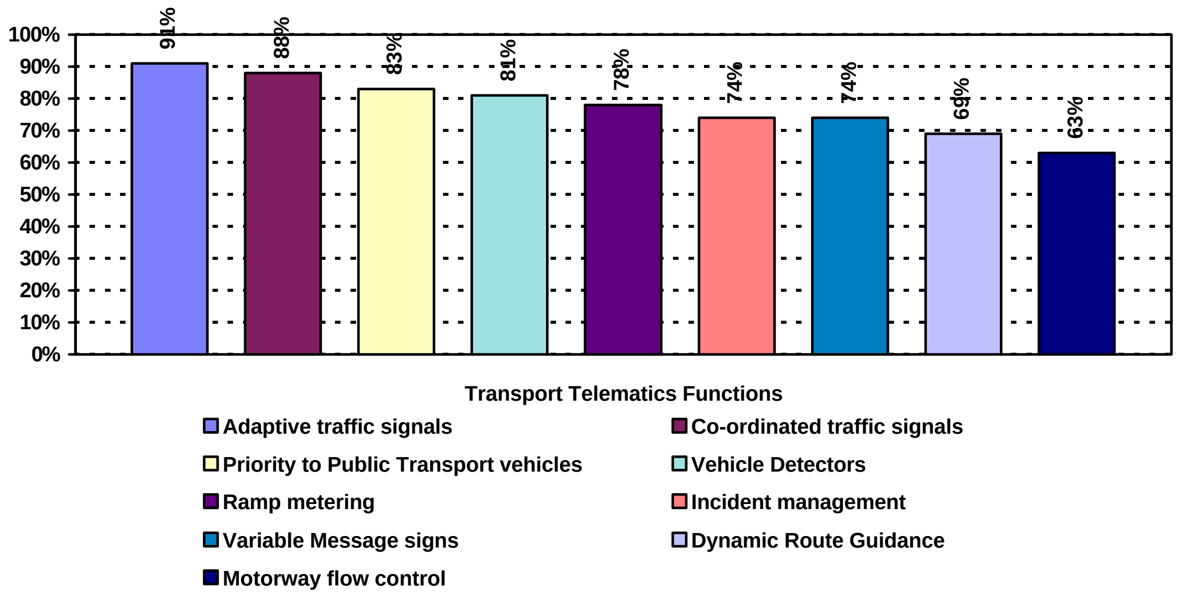

Figure 2: Users' interest in Transport Telematic Application modelling

Regarding "traffic objects and phenomena" it clearly appears that *incidents*, *public transport* and *roundabouts* are the most important traffic phenomena to be modelled.

Commercial vehicles and *pedestrians* are considered important by users but less important by developers (although three of the SMARTEST micro-simulation tools support a model for commercial vehicles).

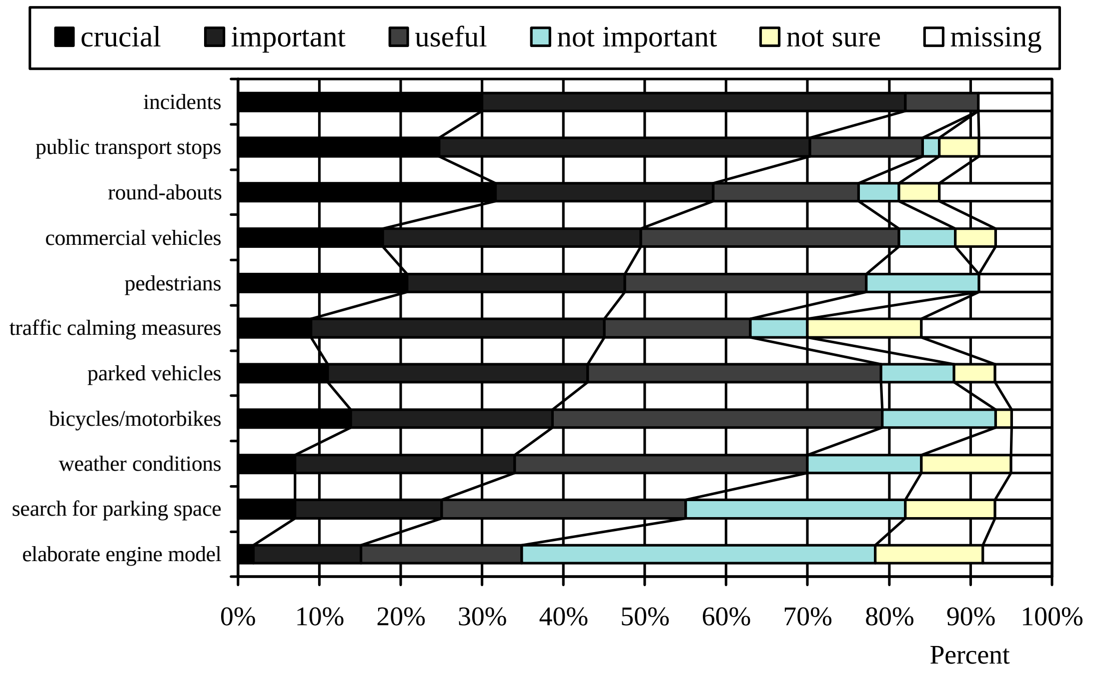

Figure 3: Users' interest in traffic objects/phenomena modelling

Table 10 summarises the modelling capabilities of the four SMARTEST simulation tools.

Indicators of efficiency and technical performance are widely diffused into the SMARTEST micro-simulation tools. Safety indicators, such as the environmental ones, are not supported by SMARTEST models even if they are considered useful by a large amount of users.

Users clearly appreciate the benefit of a user friendly interface for input and editing, and an animated presentation of the results. Three of the four SMARTEST simulation tools already include an animated Graphical User Interface for presentation of results, however only one of them includes a Graphical User Interface to input the network topology and geometry data (AIMSUN2). So a great effort could be spent in this direction.

As a final comment one can state that the SMARTEST models are in a good position even though improvements are required for all of them.

Based on this analysis and taking into account the resources and of the time available in the project, the SMARTEST partners agreed to direct their effort to the items shown in Table 11.

Traffic objects - phenomena

Features vs Micro Sim Models	**AIMSUN2**	**DRACULA**	**NEMIS**	**SITRA-B+**
Incidents	Yes	Yes	Yes	Yes
Public Transport	Yes	Yes	Yes	Yes
Roundabouts	Yes	Yes	Yes	No
Commercial Vehicles	No	Yes	Yes	Yes
Pedestrians	No	No	No	No

Efficiency indicators

Features vs Micro Sim Models	AIMSUN2	DRACULA	NEMIS	SITRA-B+
Travel Time	Yes	Yes	Yes	Yes
Congestion	Yes	No	Yes	Yes
Travel time variability	No	Yes	Yes	Yes
Queue length	Yes	No	Yes	Yes
Speed	Yes	No	Yes	Yes
Public Transport regularity	No	No	Yes	Yes

Safety indicators

Features vs Micro Sim Models	AIMSUN2	DRACULA	NEMIS	SITRA-B+
Headway	No	No	Yes	No
Interaction with pedestrians	No	No	No	No
Overtaking	No	No	Yes	No
Number of accidents	No	No	No	No
Accident speed severity	No	No	No	No
Time to collision	No	No	No	No

Environment Indicators

Features vs Micro Sim Models	AIMSUN2	DRACULA	NEMIS	SITRA-B+
Exhaust emissions	Yes	Yes	Yes	No
Noise level	No	No	No	No
Roadside pollution level	No	No	No	No

Technical Performance and Comfort

Features vs Micro Sim Models	AIMSUN2	DRACULA	NEMIS	SITRA-B+
Fuel consumption	Yes	Yes	Yes	No

Transport telematic functions

Features vs Micro Sim Models	AIMSUN2	DRACULA	NEMIS	SITRA-B+
Adaptive Traffic signals	Yes	Yes	Yes	Yes
Co-ordinated Traffic signals	Yes	Yes	Yes	Yes
Priority to Public Transport vehicles	No	Yes	Yes	Yes
Vehicle Detectors	Yes	Yes	Yes	Yes
Ramp Metering	Yes	No	No	No
Variable Message signs	Yes	No	Yes	No
Incident Management	Yes	No	Yes	Yes
Dynamic Route Guidance	Yes	No	Yes	Yes
Motorway Flow Control	No	No	No	No
Congestion Pricing	No	Yes	No	No

Table 10: Modelling capabilities of the SMARTEST simulation tools.

traffic phenomena modelling	Public Transport
	Roundabout
	Traffic Calming
	Parking Management
Transport Telematic Functions	Adaptive Traffic Signals
	Public Transport Priority
	Vehicle Detectors
	Variable Message Signs
	Dynamic Route Guidance
	Incident Management
	Ramp Metering
user friendly (graphical) interface	Results Analysis
	Network Builder
Better Validation	

Table 11: Prioritisation of gaps to fill into the SMARTEST models.

2.3 SMARTEST MICROSIMULATION TOOLS IMPROVEMENT

Table 12 summarises improvements and new implementation planned for the SMARTEST tools in the lifetime of the project.

	AIMSUN2		**DRACULA**		**NEMIS**		**SITRA-B+**	
Public Transport Services			✓	☺	✓	☺	✓	☺
Roundabout			✓	☺	✓			☺
Traffic Calming				☺	✓			
Parking Management							✓	☺
Adaptive Traffic Signals	✓	☺	✓	☺	✓	☺	✓	☺
Public Transport Priority			✓	☺	✓	☺	✓	☺
Vehicle Detectors	✓		✓	☺	✓	☺	✓	
Variable Message Signs	✓	☺			✓	☺		☺
Dynamic Route Guidance		☺			✓	☺	✓	
Incident Management	✓	☺					✓	☺
Ramp Metering	✓	☺						
Network Builder				☺				
Results Analysis		☺			✓	☺		
Better Validation		☺	✓	☺		☺		☺

✓	already exists
☺	to be implemented or to be improved

Table 12: Improvements and new implementations in the SMARTEST models.

In the following paragraphs the enhancements planned for each micro-simulation tool are described in more detail.

2.3.1 AIMSUN2

In order to comply with the Model Update Specifications proposed in Chapter 5, the following functions are to be developed or enhanced in AIMSUN2:

- *Incident Management*
- *Adaptive Traffic Signals*
- *Ramp Metering*
- *Variable Message Signs*
- *Dynamic Route Guidance*
- *Results Analysis Tool*

Improvements to the incident generation model will include deterministic and random incident generation. Deterministic incidents will be defined either through the user’s interface or by means of an incidents log file. Random incidents will be generated according to certain random distributions that can be variable according to certain section characteristics.

The adaptive traffic signals improvements will consist of a new and more flexible definition of the traffic control plans and the development of a new interfacing protocol between AIMSUN2 and any external traffic control or management application. This link will be implemented by the use of Dynamic Link Libraries (DLL) through which any user will be able to either implement or communicate any control or management strategy.

Through this interfacing protocol it will be possible not only to control any traffic signal but also any ramp metering or Variable Message Sign.

Regarding VMS and Dynamic Route Guidance Systems, a better behavioural model that emulates the influence that routing information may have on the drivers will be implemented. To achieve a better characterisation of the drivers, several former global parameters will be transformed into local or individual parameters (i.e. compliance level and speed acceptance parameters).

A new Result Analysis Tool will be developed. Its main functionalities will be to define and conduct simulation experiments, to perform results analysis and make data representation and to provide statistical tools for model calibration and validation.

2.3.2 DRACULA

In order to comply with the Model Update Specifications proposed in Chapter 5, five models will be improved in DRACULA:

- *Roundabouts*
- *PT Services*
- *Adaptive Traffic Signals*
- *PT Priority*
- *Detectors*

one new model will be added:

- *Traffic Calming*

Improved validation of car-following, lane changing and gap acceptance models will also take place. To aid *user friendliness*, the possibility of adding an improved Windows based interface and of using the GETRAM network builder will also be investigated.

Improvements in the *PT services* model will include a new bus stop model and the development of guided bus and tram operations. New *roundabout* and *traffic calming* models will also be developed, which will be calibrated and validated using data collected in Leeds.

The *adaptive traffic signals* improvements will concentrate on linking DRACULA to a BALANCE UTC system that is due to be installed in Leeds and Sheffield. The installed BALANCE system is planned to use the new NTCIP communications protocol to link up its various components. With this in mind a DRACULA interface that also uses NTCIP will be developed. The improvements in the *detector* model in DRACULA will concentrate on providing the BALANCE system with the on-street information it requires. As well as the usual loop detector data this will also include both public transport and emergency vehicle location information. *PT Priority* will look at the priority measures to both buses and trams that are provided by the BALANCE system. A test network in Sheffield will be used to calibrate and validate the new models.

2.3.3 NEMIS

In order to comply with the Model Update Specifications proposed in Chapter 5, two models will be improved in NEMIS:

- *Public Transport Services*
- *Vehicle Detectors*

Results Analysis will be improved from the point view of both indicators and graphics representation.

Main efforts will be spent to improve and standardise the interface between the micro-simulation model and the external Transport Telematic Applications. This activity involves:

- *Adaptive Traffic Signals*
- *Public Transport Priority*
- *Variable Message Signs*
- *Dynamic Route Guidance*

The standard interface will be based on a TCP/IP communication protocol that will be adopted to connect the computer where the model runs to the network where the external strategies will operate.

The models that are going to be enhanced will be tested according to the verification tests described in the Model Update Specifications chapter.

- Public Transport Services model will be tested onto a common scenario involving the UTC controlled area. Data are available from the SIS AVM system.
- Vehicle detector validation concerns performance, error rate and breakdown occurrence. Data are available from the UTOPIA maintenance statistics.
- The validation of the standard interface concerns mainly operational aspects. Stress conditions will be generated connecting the model to a real network of SPOT traffic control units.

Further validation activities are envisaged that concern the calibration of the car following rule according to data collected from the field.

Further parameters such as driver compliance to VMS and DRG indications will be calibrated against the information made available by surveys conducted in the test-site by other specific projects.

2.3.4 SITRA-B+

In order to comply with the Model Update Specifications proposed in Chapter 5, the following functions are to be developed or enhanced in SITRA-B+:

- *Roundabout*
- *Public Transport Services*
- *Incident Management*
- *Adaptive Traffic Signals*
- *Public Transport Priority*
- *Variable Message Signs*
- *Parking Management*

Two of these functions are to be submitted to a detailed validation plan. They are:

- Roundabout: validation concerns lane changing in the roundabout, lane choice at roundabout entrance and driver behaviour entering the roundabout (gap acceptance)
- Public Transport Services: validation concerns bus behaviour along the route and at bus stops (waiting time, travel time)

Other functions to be developed or enhanced in SITRA-B+ will be tested according to the verification tests described in the model update specifications. Note that:

- for Incident Management, the incident time, place and duration will be tested to perform as specified. Driver reaction to the management actions has been already tested in SITRA-B+ as long as these actions are stop signs, traffic lights, speed limits and reserved lanes for incident response units. For validation concerning VMS, see the next point.
- validation of Variable Message Signs concerns the determination of user compliance rates. Driver interviews downstream the VMS are planned to be performed in 1998 on a radial axis of the Toulouse Test Site. They could be used for model calibration if data are available.
- validation does not really apply for Adaptive Traffic Signals. It would rather concern the adaptive strategy itself. The verification tests described in the model update specifications will be performed.
- concerning Public Transport Priority, tests related to the external strategy or to the communication process are not considered. Verification tests will be performed.
- Parking Management validation requires data like car park occupancy rates, average travel time of vehicles in search of a parking space and average of other vehicle travel time down links containing car park entries. Such data are not available for the Toulouse Test Site.

3. SCENARIO BUILDING

In the following paragraphs the main characteristics of the SMARTEST test-site scenarios are provided.

3.1 TORINO

3.1.1 Torino Test Site overview

The model being updated will be tested into the IRTE architecture scenario implemented by the 5T applications and depicted in the following picture.

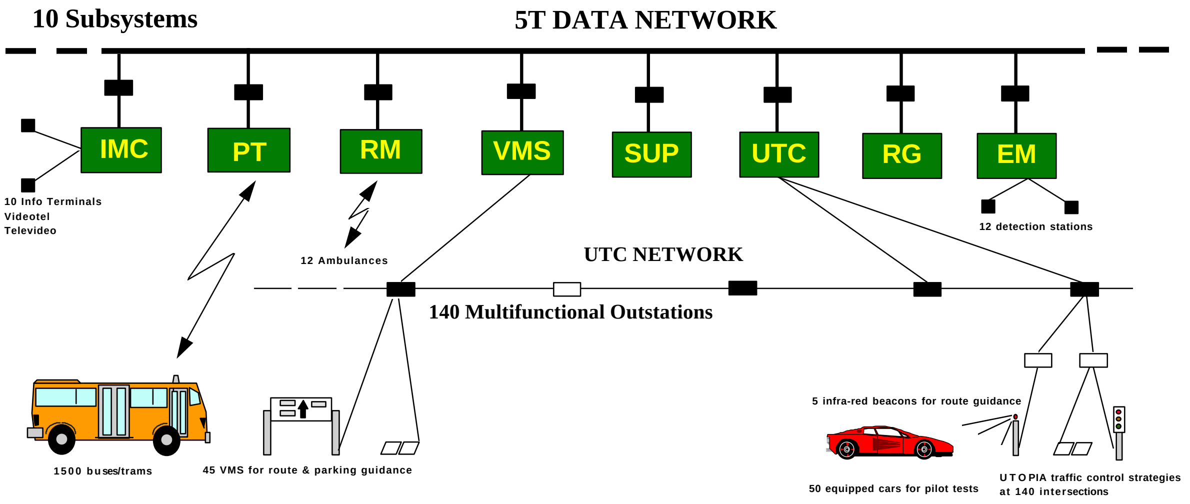

Figure 4: The 5T IRTE architecture

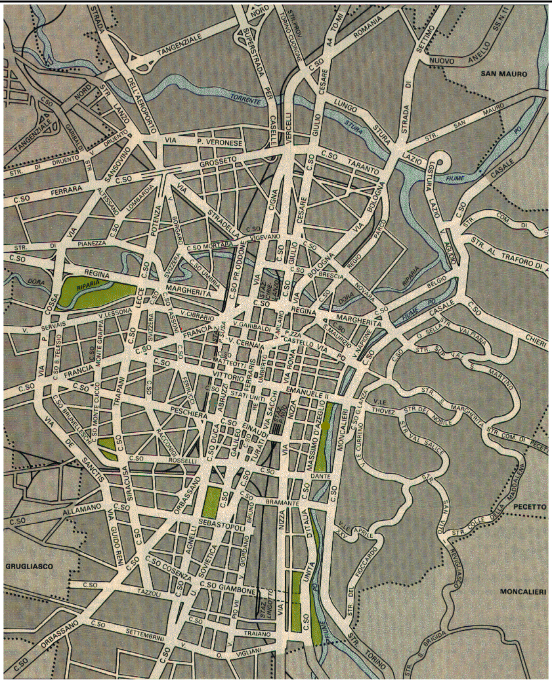

Figure 5: Torino Test Site map

The city of Turin covers an area of about 10 km radius where Public Transport and Private Traffic are managed and controlled by the 5T System. During the last years, population decreased significantly, passing from 1.18 million in 1979 to 0.99 million in 1991.

Citizens moved towards the conurbation increasing the commuter traffic. The number of trips increased from 1.95 million in 1979 to 3.43 million in 1991.

In the same time, the trips by bus decreased from 37% to 26% in favour of trips by car, and the cars per inhabitants increased from 0.46 to 0.6. The effects on traffic volumes and congestion were significant.

The 5T System represents the attempt of the City to face the traffic problems via Transport Telematics Applications and a way to bring people back to public transport.

Currently, one quarter of the total number of traffic light intersections (600) is controlled by the UTOPIA UTC System. At these intersections the 1350 vehicles of the urban fleet receive selective priority. About 200 bus stops are equipped with signs for users' information.

Twenty-seven VMS/VDS panels guide drivers towards their main destinations and 22 VMS panels provide for parking guidance. See figure 3.

PT users and drivers are provided with dynamic information for trips planning at home and road-side interactive kiosks, Televideo and panels.

A prototype of the EUROSCOUT individual route guidance is operational in a significant area in the south of the city (five infrared beacons, fifty equipped cars).

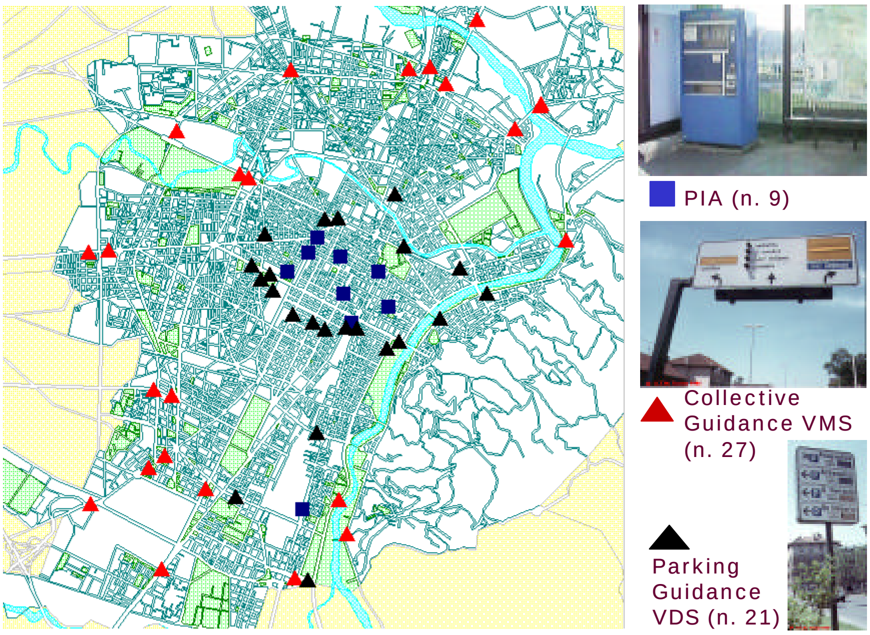

Figure 6: Information peripheral units location in the Torino scenario

Figure 7: UTC Controlled area in Torino test-site scenario

3.1.2 Torino Test Site description

Road Network

Kind of roads	Single and double carriageway
Number of lanes	Min 1, Max 4
Roundabouts	a few
Intersections	Max 6 entries/exits, with/without traffic light

Public Transport

Service	tram, bus
Route	double directions, circular
Lane	mixed, reserved, protected

Urban Traffic Control

Control	fixed plan, co-ordinated, adaptive (150)
Public Transport priority	selective, absolute, weighted

Automated Vehicle Monitoring

vehicle location	+/- 2m absolute error
arrival time prediction	at stops/intersections

Dynamic Route Guidance

technology	Euroscout
equipment	5 intersections, 50 vehicles

Variable Message Signs

Traffic diversion/information	26 panels
Parking guidance	22 panels

Incident Management Systems

Incident Management System	Town Supervisor Control

Ramp Metering

No.

Motorway flow control

No.

3.1.3 Torino Common Scenario

One area has been selected in Torino (see Figure 9) to provide a common scenario for the validation of models and improvements introduced in NEMIS. The urban area has been modelled in NEMIS (a scheme is depicted in Figure 8, where route guidance beacons locations are shown too). The model consists of 117 nodes, 65 of which are traffic light intersections, and 315 arcs. The area has a surface of 7.5 km^2 and involves 71 km of roads.

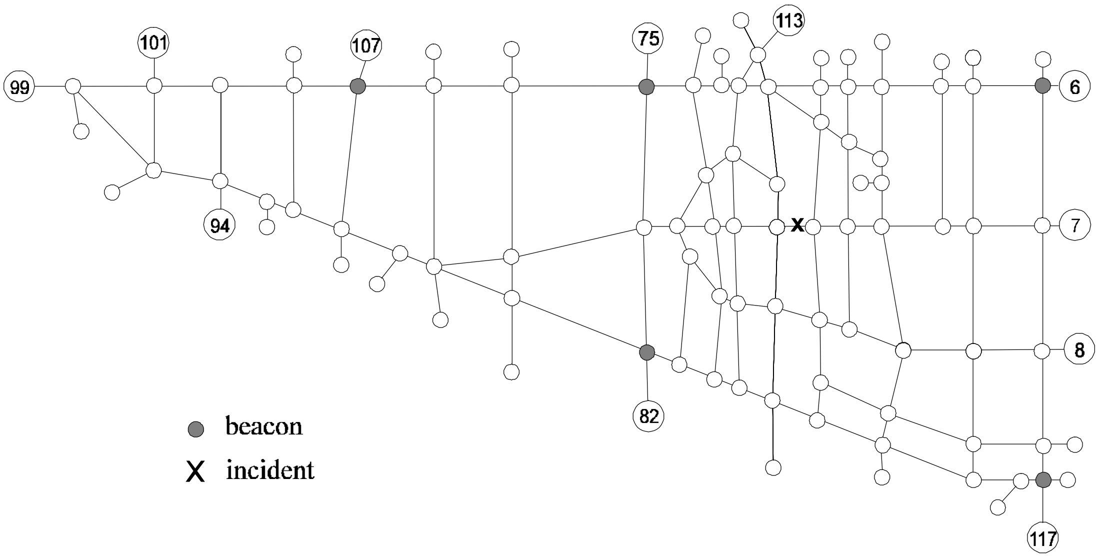

Figure 8 - Scheme of the road network included in the test scenario

In this area several Transport Telematics Applications operate: UTOPIA UTC, P.T. Priority, Collective Route Guidance via VMS/VDS (10), Individual Route Guidance (5 beacons).

Interaction of private traffic and public transport with these applications is already modelled in NEMIS.

Public Transport is operated by bus and tram services (12), and in several kinds of conditions: mixed to private traffic, in reserved and protected lanes.

Traffic volumes and variations make the area really interesting for traffic control strategies analysis.

The T.T. Applications operated in the area ensure the availability of a quantity of data useful for model validation.

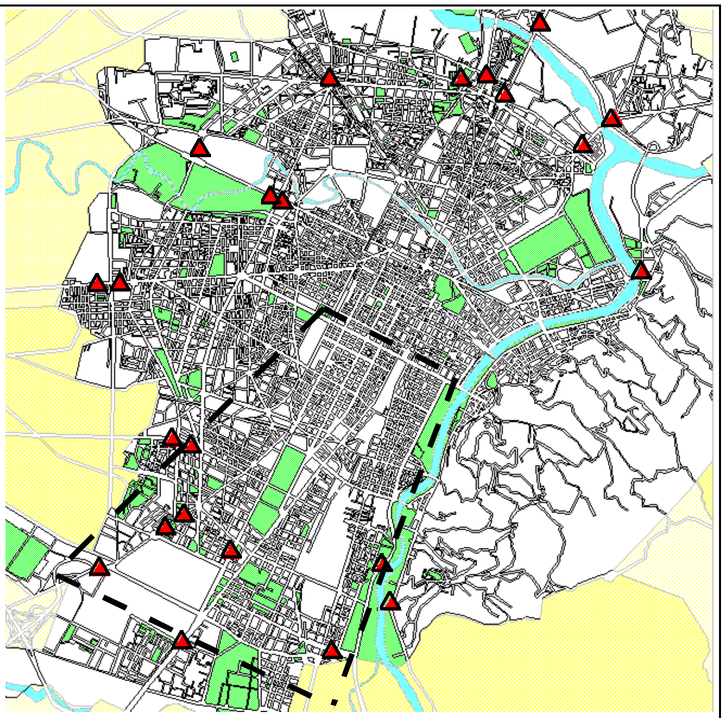

Figure 9: Torino test-site common scenario

3.2 TOULOUSE

3.2.1 Toulouse Test Site overview

The Toulouse Urban Area contains 662,000 inhabitants owning 400,000 vehicles with an increase of 50,000 between 1990 and 1996. Each inhabitant of the urban area makes 3.7 daily trips using different transport modes which represents an increase of 20% since 1990 (the number of trips by car is 1,260,000 daily). Each day, a non sedentary inhabitant of the Toulouse urban area spends approximately 1 hour for his/her trip. There are 51 bus routes that serve the urban area with 1,169 bus stops.

The SMARTEST Toulouse Test Site is described in Figure 10. It includes the south part of the urban area and the centre of the town. The centre is surrounded by a two way circular boulevard. Eleven Variable Message Signs are located on the radial roads entering this boulevard. The extreme south of the test site is delimited by a freeway section with three radial axes connecting the freeway to the boulevard.

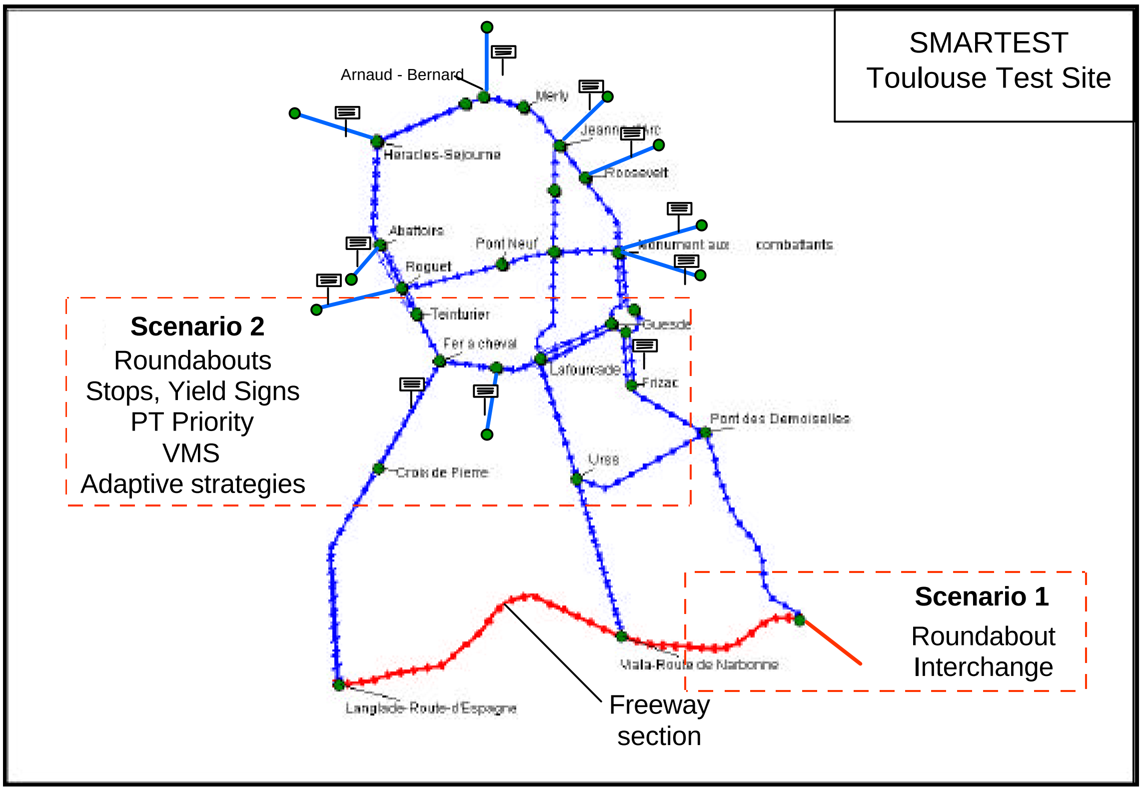

Figure 10: Toulouse Test Site map

3.2.2 Toulouse Test Site description

Road Network

Road type	Single and double carriageway
Number of lanes	Min 1, Max 4
Roundabouts	2 signal-controlled roundabouts 2 roundabouts in 1 grade-separated Interchange
Intersections	Max 5 input/output, with/without traffic light

Public Transport

Service	Bus
Route	Double directions
Lane	Mixed or reserved

Urban Traffic Control

Control	Fixed plan, co-ordinated, adaptive
Public Transport priority	Prodyn Bus

Automated Vehicle Monitoring

Yes, but no available data.

Dynamic Route Guidance

No intersection or link equipped.

Variable Message Signs

Traffic information	11 panels in urban area
Parking guidance	No

Incident Management Systems

No.

Ramp Metering

No.

Motorway flow control

No.

3.2.3 Scenario description

In order to validate the new roundabout and public transport stop models two scenarios are proposed inside the Toulouse Test Site area (see Figure 10).

Scenario 1: Interchange Roundabout

Roundabout validation in SITRA-B+ will require data on lane changing in the roundabout, lane choice at the roundabout entrance and driver behaviour entering the roundabout. The evolution of gap acceptances with the time spent waiting at the entrance is particularly interesting.

The chosen area is a grade-separated interchange with one bridge and two Roundabouts (see the terminology adopted in model update specifications for roundabout). One of these roundabouts, where priority is given to the inside traffic, has 3 entries (each with two lanes) and 3 exits (2 with two lanes and 1 with one lane). Furthermore it has 1 segregated lane that allows a part of traffic to go from an entry to the first exit.

Data collection will be performed by video from a point where all entries/exits are visible and with:

- a 30 minute video recording during the peak period
- a 30 minute video recording during the off-peak period.

Video data analysis will allow the determination of the:

- traffic flow for each entry/exit
- for each Origin/Destination pair
    - traffic flow
    - average travel time
    - lane choice at roundabout entrance
    - lane changing inside the roundabout
- average travel time inside the roundabout
- average gap acceptance time for each entry
- driver behaviour near each entry

Some of this data will be used to tune the roundabout model to real traffic conditions. They are lane choice, lane changing and gap acceptance. All the data will then be used in two 30 minute simulations to check that the roundabout model developed in SITRA-B+ performs close to reality.

Scenario 1: video recording and data analysis have to be performed.

Scenario 2: Urban Test Site

Scenario 2 will be used to validate the Public Transport Services model. The chosen Test Site (see Figure 10) is a rectangular area of 3.2 by 2.4 km. It is composed of a section of the circular boulevard (3 km long) and of 4 radial axes (each is about 1.5 km long) that connect the circular boulevard to the freeway section. Furthermore it contains one large signal-controlled roundabout (3 lanes inside the roundabout). Among the bus routes that cross the test site, 4 two-way routes have been chosen:

- route number 1 which serves the circular boulevard
- routes number 2 and 62 which have in common the same radial axis
- route number 92 that serves a part of the circular boulevard and a radial axis (different to the one served by bus route number 2 and 62)

A section of these bus routes has reserved lanes forbidden to other types of vehicles.

Validation will concentrate on bus behaviour along the route and at bus stops. This will be performed with a simulation run of one hour long. Bus behaviour will be validated with travel time data for buses and other vehicles (detailed data could be obtained for bus route number 2). Average waiting time at bus stops will also be used if data is available.

Scenario 2:

- *General available data: cruise speeds, flow data, occupancy rates*
- *Public Transport available data: PT stop locations, PT timetables*
- *Public Transport data to be gathered: PT travel times from stop to stop, PT waiting time at stops*

3.3 STOCKHOLM

3.3.1 Stockholm Test Site overview

The Stockholm County contains 1,725 million inhabitants, of which 711,000 lives in the City of Stockholm. The number of private cars in use is 587,000 cars. The car ownership level is 340 cars per 1,000 inhabitants.

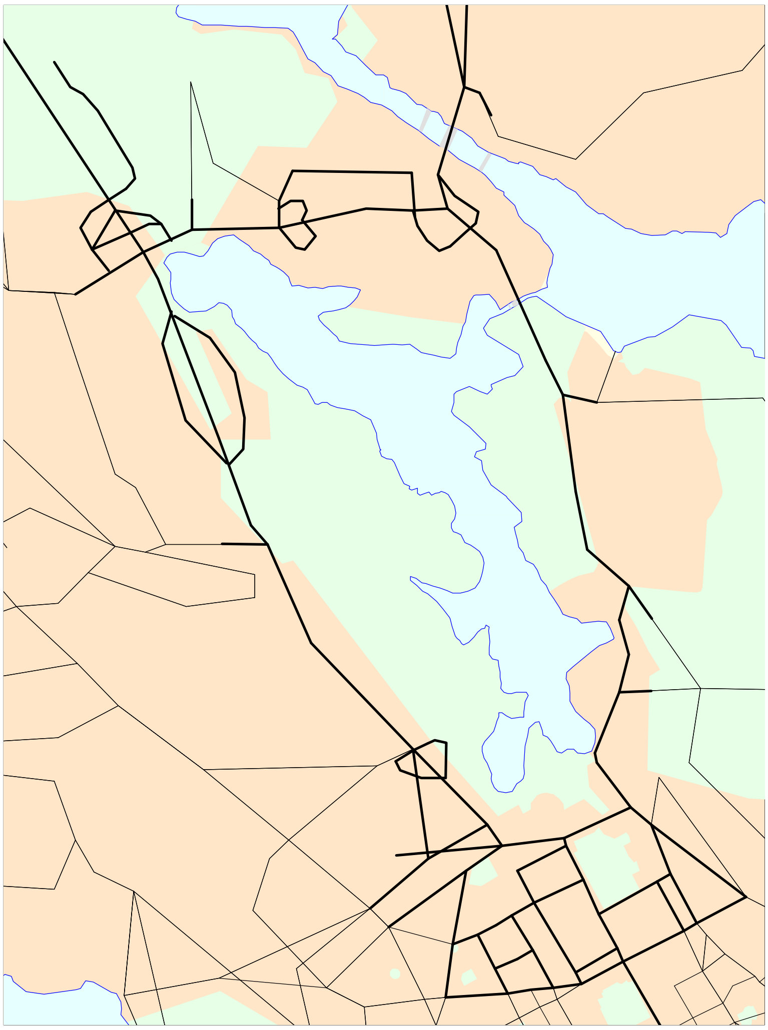

Figure 11: Stockholm Test Site map

The SMARTEST Stockholm Test Site is described in Figure 11. It shows the current emme/2 network with the proposed test network highlighted. The size of the network is approx. 4x2 km.

The are several reasons for choosing this part of the Stockholm network as a test network:

- The network contains the main inbound arterials from the northern suburbs, and they are congested during peak conditions. For instance, queue spill-back on the E4 freeway frequently occurs
- The area contains intersections that are bottlenecks in case of incidents.
- There is an interesting route choice situation (west route (E4) or east route for traffic coming from the north and heading to CBD).
- The Swedish National Road Administration (SNRA) is currently evaluating various traffic models to use in the Traffic Management Centre of Stockholm, and the chosen network is in focus of this evaluation. The 5T system of Torino is one of the models that are being tested.

- The network contains the Motorway Control System along the E4 freeway inaugurated in 1996 as one of the very first ITS applications in Stockholm.
- There are some traffic calming measures in the urban (southern) part of the network, i e speed humps and 30 km/h speed limit.

3.3.2 Stockholm Test Site description

Road Network

Road type	single and double carriageway freeway, arterials with signalised intersections, urban roads
Number of lanes	min 1, max 4
Roundabouts	two, both signalised
Intersections	max 4 exits/entries, with/without traffic lights

Public Transport

Service	bus
Route	double directions
Lane	mixed, reserved

Urban Traffic Control

Control	fixed plan, co-ordinated
PT priority	no
Adaptive traffic signals	no

Traffic calming

Speed limit	30 km/h near schools and nurseries
Speed interruption	speed humps

Automated Vehicle Monitoring

No.

Dynamic Route Guidance

No (traffic reports on radio every 15 min)

Variable Message Signs

Traffic information	11 panels in urban area
Parking guidance	No

Incident Management Systems

Yes, included in the MCS system.

Ramp Metering

No.

Motorway flow control

Motorway flow control	Dutch MCS system
Location	Approx. 6 km along the E4

3.3.3 Scenario description

None of the SMARTEST micro-simulation models have previously been used in Sweden (except for a small test of NEMIS). The main objective of the Stockholm scenario will therefore be to check model usability and transferability to Swedish conditions. Basic model characteristics such as network representation and driver behaviour (speed and lane changing) will be evaluated. Simulated values of speed, flow and travel time will be compared to available data from the Motorway Control System.

Since the test network is chosen because of its sensibility to incidents, modelling of queues, delay and route choice under disturbed conditions will be of specific interest. Modelling of driver behaviour in connection to traffic calming measures will also be studied.

The development of ITS technology is not as advanced in Stockholm as in the other test sites. The potential of introducing new traffic control and traveller information systems is therefore of high interest to the Stockholm traffic authorities. Three application areas have been pointed out by SNRA to be of specific interest in the future:

- Adaptive signal control in four critical intersections in the test network
- Use of VMS to inform drivers of incidents and the shortest route to CBD
- Alternative strategies of the MCS system

Given that the basic model evaluations turn out to be successful, one of the above ITS applications will be tested in the Stockholm scenario.

3.4 BARCELONA

3.4.1 Barcelona Test Site overview

The Barcelona Urban Area has 1,640,000 inhabitants, although the population in the whole Metropolitan Area is around 3,000,000, that represents about 1,500,000 vehicles. The SMARTEST Barcelona Test Site is described in Figure 12. It is mainly composed of the Barcelona Ring Roads (Ronda de Dalt and Ronda Litoral are 40 km of urban freeway), the main approaches to the city (Freeways A-2, A-16, A-17, A-18, A-19 and Roads C-246 and N-II) and some urban streets either connected to the ring roads or to the city accesses.

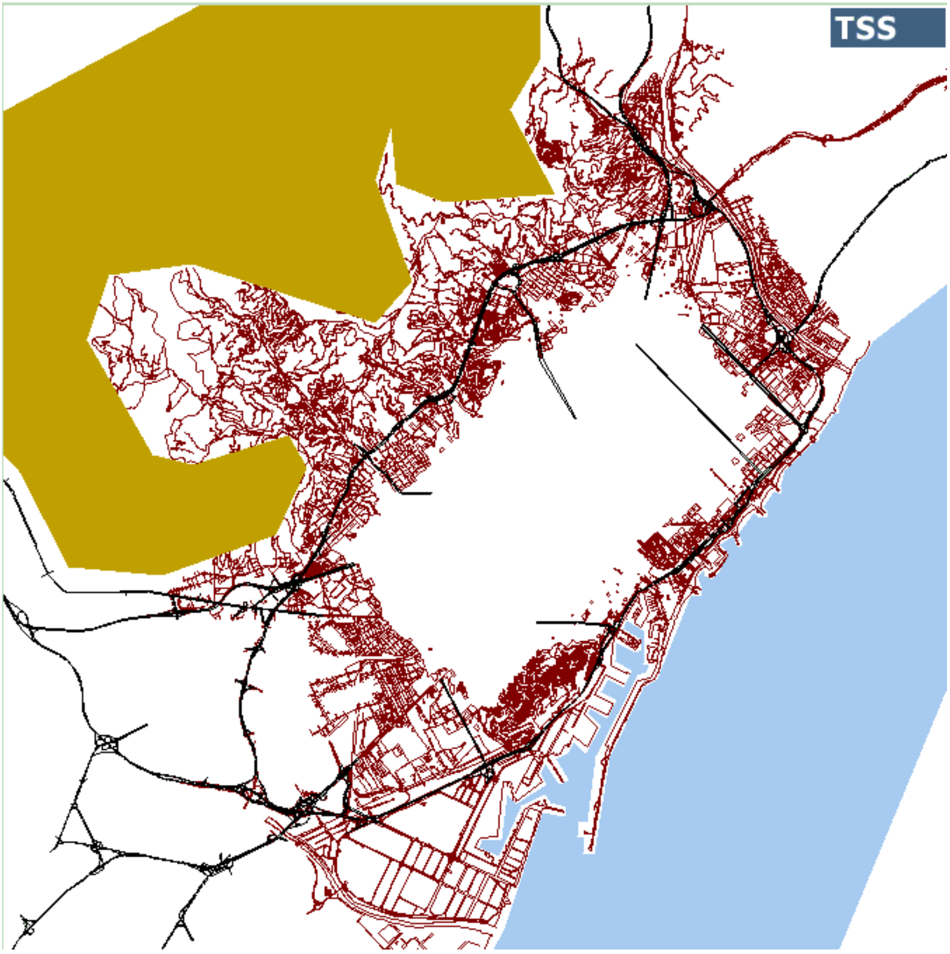

Figure 12: Barcelona Test Site map

3.4.2 Barcelona Test Site description

Road Network

Road type	Single and double carriageway freeway, arterials with signalised intersections and roads
Number of lanes	Min 1, Max 4
Roundabouts	2 signal-controlled roundabouts 2 uncontrolled roundabouts
Intersections	Max 6 input/output, with/without traffic light

Public Transport

No.

Urban Traffic Control

Control	Fixed plan, co-ordinated

Automated Vehicle Monitoring

No.

Dynamic Route Guidance

No intersection or link equipped

Variable Message Signs

Traffic diversion/information	20 panels in Ring Roads and accessing freeways
Parking guidance	No.

Incident Management Systems

Incident Management System	Barcelona Traffic Control Centre (Collserola)

Ramp Metering

Yes. A few ramp meters in the ring roads, controlled from the Collserola Traffic Control Centre

Motorway flow control

No.

3.4.3 Scenario description

The objective of the Barcelona Test Site is to test some Incident Management Policies that can make use of ramp metering control and VMS to avoid congestion related to the incidents. Figure 13 shows the Barcelona Test Site AIMSUN2 model.

A scenario containing a real incident will be chosen. Detector data corresponding to a certain day in which an incident had occurred will be provided by the Barcelona Municipality. The purpose will be to reproduce the incident and test different Incident Management Policies using VMS to divert or inform the drivers as well as controlling the input flow to the ring roads through the ramp metering signs.

As most of the VMS and ramp meters are located in the north part of the ring road (Ronda de Dalt) and on the freeways accessing the city through the main north roundabout (Nus de Trinitat), an incident occurring in this area will be selected. The data available from the existing traffic detection system in this part of Barcelona comes from the detection system. The data supplied by each detector are as follows:

- Traffic flow (vehicles/hour)
- Occupancy (percentage)
- Speed (km/h)
- Density (vehicles/km)
- Relative error (percentage)
- Number of time slice.

All these data items are supplied for each time interval, which can be defined by the operator (e.g. every 5 minutes).

On the other hand, the influence of the different messages presented to the drivers through VMS will need to be calibrated, therefore different hypotheses will be taken into account. Driver's reaction to traffic information will be modelled through the use of Actions in AIMSUN2.

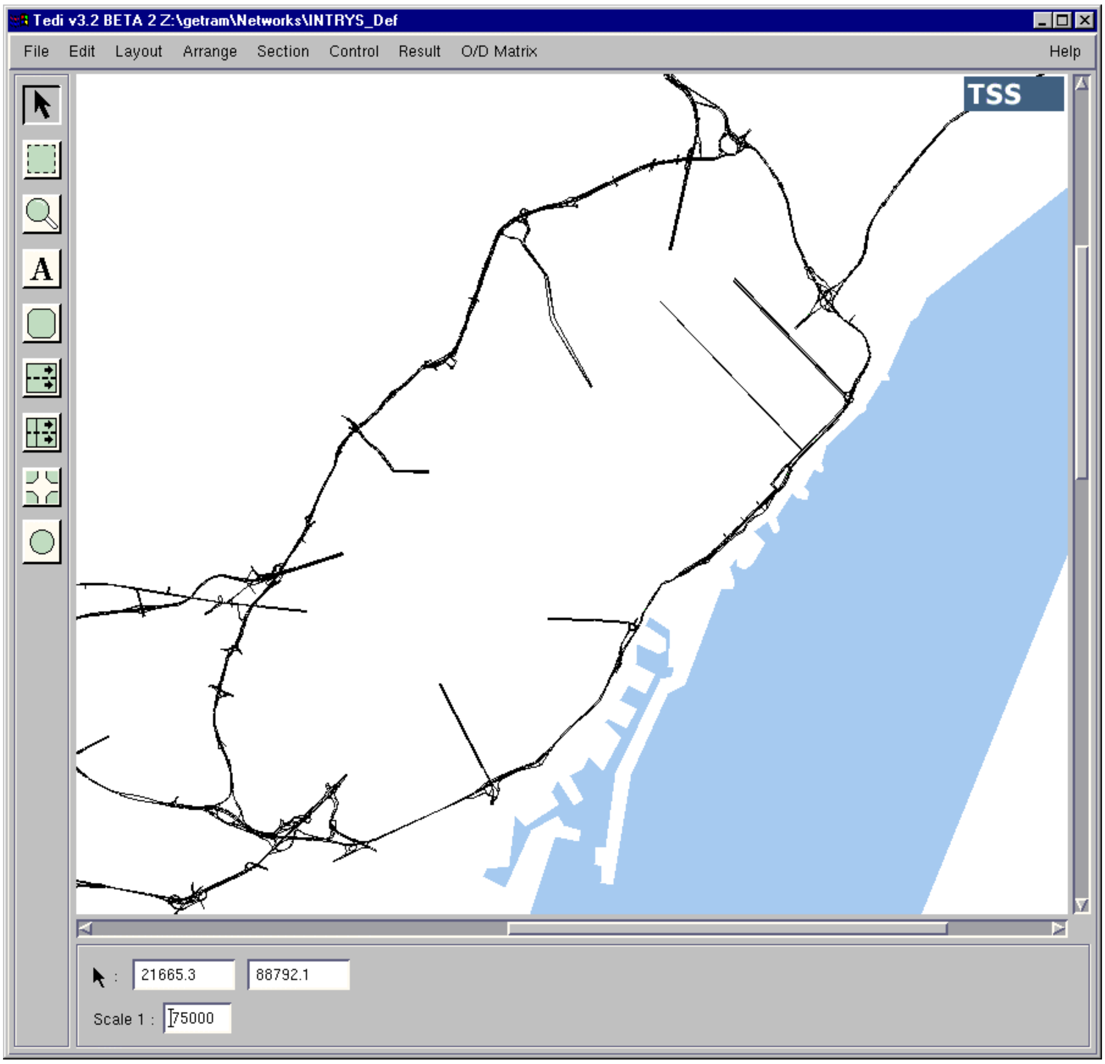

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Figure 13: Barcelona Test Site Model

3.5 GENOVA

3.5.1 Genova Test Site overview

The city of Genova, in the Regione Liguria, will provide an additional Italian test site for the evaluation of enhanced SMARTEST models. It is located in a narrow, coastal land strip, delimited southward by the Mediterranean sea and northward by the Appenine Mountains. Overall, the layout of the metropolitan territory can be thought of as a kind of “Greek letter Π” extending for about 60 km^2 in total, with the head facing south and extending for some 30 kilometres along the East-West direction, and the legs consisting of two main valleys penetrating the mountain area for about 12 Km and 10 Km respectively.

Genova is an important industrial and service urban centre of about 700,000 inhabitants, traditionally based on its passenger and goods harbour acting as a fundamental link between the Mediterranean sea and Northern Europe countries. The role of mobility is crucial for the economical development of the city and it is primarily relying on an urban road network with a total length of about 1,400 km. The compactness of built-up areas, the chronic lack of space (especially in the hilly parts of the urban territory) and the increase of average vehicle length (about 10% during the last ten years) make vehicle circulation particularly difficult in many areas as well as resulting in problems for public transport mobility. For these reasons, the level of motorization in Genova is about 15% less than in other metropolitan areas of comparable socio-economic conditions, with some 300,000 vehicle trips per day.

At present, centralised traffic signal control is applied in the test site, organised on a three layer structure (intersection control, area control, UTC). Area and network-level control is achieved by conventional traffic-actuated signal plan selection strategies (threshold-based approach) including co-ordination and green waves calculated during the signal planning phase. Traffic data (vehicle counts, occupancies) is acquired every three minutes by inductive loops placed at about 200 points in the whole network and about 50 of these are included in the test area.

In addition, 15 CCTV cameras located at the principal nodes of the road network make traffic state pictures continuously available to the technical staff in the UTC and allow monitoring and surveillance operations.

Generic traffic and travellers information is disseminated to road users by 13 VMS panels located on the main arterial roads entering into the inner city centre.

Part of the inner city centre (a small portion, so far) is restricted to private traffic (ZTL, Zona a Traffico Limitato) however, there are plans to extend this area in the near future.

Public transport services are operated by the Transit Company across the whole urban area, including 121 PT lines over a transportation network of about 780 km. Passenger services cater for some 169,000 passenger trips per year (1996) and are operated by normal buses and also, during the last two years, by low emission vehicles and trolley buses in the inner part of the centre (along two major routes).

Figure 14 below, shows the inner centre area where the SMARTEST test site will be located, including the main intersections and traffic routes, the VMS panels and traffic restricted areas.

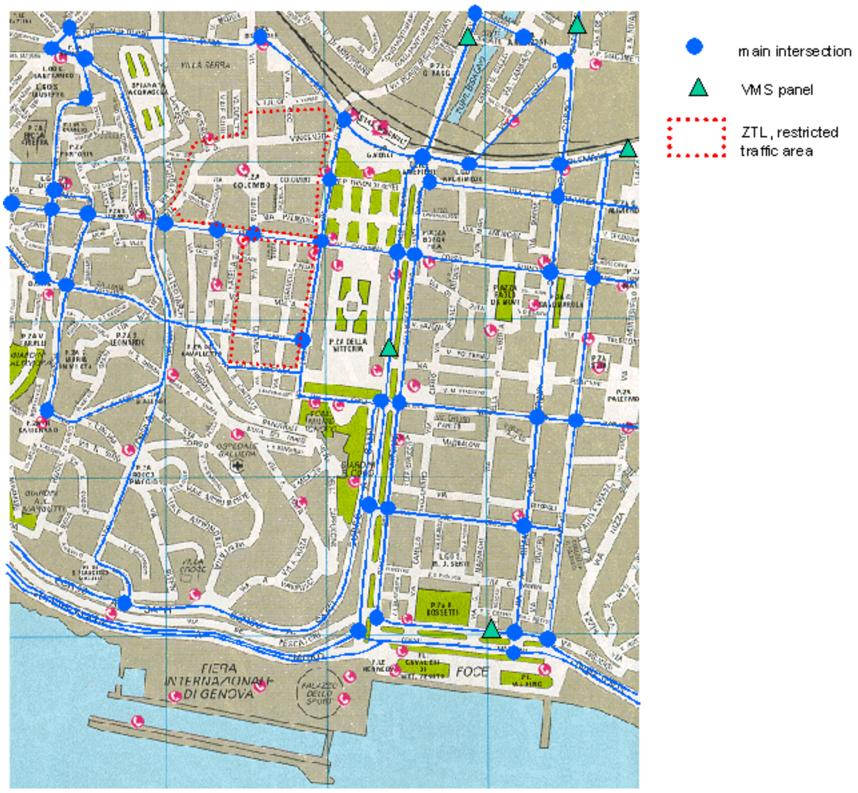

Figure 14: Genova Test Site map

3.5.2 Genova Test Site description

Road Network

Road type	Single and double carriageway
Number of lanes	Min 1, Max 4
Roundabouts	No
Intersections	Max 5 input/output, with/without traffic light

Public Transport

Service	Bus (Mini, single deck, articulated), low emission buses, trolley buses
Route	Double directions
Lane	Mixed, reserved, segregated (high capacity corridor)

Urban Traffic Control

Control	Pre-calculated fixed plan, co-ordinated (area control), time-based selection, traffic-actuated selection, dynamic micro-regulation over a single, complex intersection
Public Transport priority	Absolute priority in a single arterial (few

	intersections)

Automated Vehicle Monitoring

Few vehicles, no available data.

Dynamic Route Guidance

No intersection or link equipped.

Variable Message Signs

Traffic information	13 panels in urban area
Parking guidance	No

Incident Management Systems

No.

Ramp Metering

No.

Motorway flow control

No.

3.5.3 Scenario description

The SMARTEST Genova Test Site will be selected in the inner part of the urban road network, consisting of a rather dense grid and including some 30 main intersections. For validation of the selected enhanced SMARTEST models in Genova, a suitable test scenario will be identified. The reference network will contain characteristics, and be of a size, that will allow a transferability analysis across at least two sites (e.g. between Torino and Genova).

A detailed description of the scenario for testing will be produced together with the local traffic authorities concerned (DMT, Directorate for Mobility and Traffic). The goals of authorities in Genova and the elements for definition of a scenario for SMARTEST include:

- Evaluation of alternative circulation schemes, including road closures, road reversions, creation or extension of vehicle restricted areas (ZTL) in the historical part of the city centre
- Evaluation of new traffic signal strategies, including adaptive traffic signal control
- Evaluation of traffic information and re-routing strategies via VMS panels
- Evaluation of measures for improved public transport services, including segregated lanes for main lines and bus priority at key intersections
- Evaluation of alternative parking services location and parking management strategies (parking guidance)

4. INPUTS AND OUTPUTS

Both dynamic data (e.g. from roadside instrumentation) and static data (network definition) are needed to build and calibrate simulation models. Data availability is then a fundamental criterion to select suitable scenarios.

Specific outputs are required to determine measures of success and accuracy, both quantitative and qualitative.

In the following paragraphs a general overview of the data availability from the SMARTEST test-sites is summarised.

4.1 TORINO

Calibration Data

Acceleration rates	to be gathered by campaign
Deceleration rates	to be gathered by campaign
Cruise speeds	to be gathered by campaign
Headways	to be gathered by campaign
Vehicle size	available by statistics
Vehicle mix	available by statistics
Flow data	available by 5T
Number of Occupants per vehicle	available by statistics
Pollution emission parameters	(ITS data)
Fuel consumption parameters	estimate available

Validation Data

Travel times	available by 5T
Travel time variability	available by 5T
Saturation flows	available by 5T
Speed - flow curves	estimate available by 5T
Queue length	available by 5T on 3 sec and 5 min intervals (UTC area)
Number of stops	available by 5T on 3 sec and 5 min intervals (UTC area)
Amount of lane changing	Motorway ?
Lane usage vs. Flows	to be gathered by campaign
Spot speeds	?
Roadside pollution data	estimate available by 5T
Fuel consumed	to be gathered by campaign
Headways	to be gathered by campaign
Conflict data	?
Accident rates	available by statistics
PT waiting time at stops	estimate available by 5T

Network Data

O/D Data	Available by 5T
Layout	AutoCAD
PT stop locations	Available by 5T
PT Timetables	Available by 5T
Traffic calming measures	Not available

4.2 TOULOUSE

Calibration Data

Acceleration rates	Not available
Deceleration rates	Not available
Cruise speeds	Available
Headways	Time headways to be gathered by campaign
Vehicle size	Not available
Vehicle mix	Vehicle type statistics available for the freeway sub-network
Flow data	Available
Number of Occupants per vehicle	Statistical data (1996)
Pollution emission parameters	Not available
Fuel consumption parameters	Not available

Validation Data

Travel times	To be gathered by campaign
Travel time variability	To be gathered by campaign
Saturation flows	Available by data analysis
Speed - flow curves	Available by data analysis
Queue length	Not available
Number of stops	Not available
Amount of lane changing	To be gathered by campaign
Lane usage vs. Flows	?
Spot speeds	Available on the freeway part of the test site
Roadside pollution data	Not available
Fuel consumed	Not available
Headways	To be gathered by campaign
Conflict data	Not available
Accident rates	Not available
PT waiting time at stops	Not sure

Network Data

O/D Data	Partially available (1996)
Layout	Available in MapInfo format
PT stop locations	Available
PT Timetables	Available
Traffic calming measures	Not available

4.3 STOCKHOLM

Calibration and Validation Data

Flow and speed	Continuous measurements in the MCS system (loop detectors), 70s sampling, 15 points within 4 km (*2 directions), no separation between lanes
Speed-flow curves	Reported in the TPMA* project (1996-97)
Travel times + variability	Floating car studies along the E4 (1996) (before and after the introduction of the MCS system) Measurements used to calibrate HUTSIM (1997)
Traffic generator for micro simulation (vehicle mix, speed distribution, headway distribution)	Software from the TPMA project (1996-97).
Vehicle trajectories, mostly for qualitative validation	Video taken from helicopter, data partially processed (1996-97)
PT travel time and speed Waiting time at stops Number of passengers	Available through ATR (Automatic Traffic Counter), 6% of the bus fleet equipped
Queue lengths (mean during 5-15 min, max)	Measurements used to calibrate HUTSIM (1997)
Fuel consumption	Fuel consumption (l/vehicle km), NOX, HC, particles for eleven road types and four vehicle types. Simulation for year 2000.

Network Data

EMME/2 network	whole test area available
CONTRAM network	whole test area available, not completed
HUTSIM network	4 intersections, not completed
OD-data	available as EMME/2 traversal matrices
Drawings of intersection layout	available
Signal timing plans	available
Public transport stops and timetables	available
dxf files of city map	available for approx. half of the test area

4.4 BARCELONA

Calibration and Validation Data

Flow data	Available from continuos measurements of detectors, both in the main stream of the ring roads and in the city accesses
Speed data	Available from continuos measurements of detectors, both in the main stream of the ring roads and in the city accesses
Occupancy	Available from continuos measurements of detectors, both in the main stream of the ring roads and in the city accesses
Lane usage vs. Flows	Detection in the ring roads can be per lane basis

Network Data

O/D Data	O/D matrix available for the entire city. An adjusted traversal O/D matrix has been derived for the model
Network Layout	Available in DXF format
Detailed intersections layout	Detailed maps available
Ramp Metering location	Detailed maps available
VMS location	Detailed maps available
VMS Messages	Available from the Barcelona Traffic Control Centre
Signal Timing Plans	Available from the Barcelona Traffic Control Centre

4.5 GENOVA

Calibration Data

Acceleration rates	Not available
Deceleration rates	Not available
Cruise speeds	Not available
Headways	Not available
Vehicle size	Available by statistics
Vehicle mix	Available by statistics
Flow data	Available
Number of Occupants per vehicle	Available by statistics
Pollution emission parameters	Available by studies
Fuel consumption parameters	Available by studies

Validation Data

Travel times	To be gathered by campaign
Travel time variability	To be gathered by campaign
Saturation flows	To be estimated by data analysis
Speed - flow curves	To be estimated by data analysis
Queue length	Not available

Number of stops	Not available
Amount of lane changing	To be gathered by campaign
Lane usage vs. Flows	?
Spot speeds	Available on urban expressway (Sopraelevata) sections
Roadside pollution data	Available
Fuel consumed	Not available
Headways	Not available
Conflict data	Not available
Accident rates	Not available
PT waiting time at stops	Not available

Network Data

O/D Data	Partially available (census zones)
Layout	Available in Autocad format
PT stop locations	Available
PT Timetables	Available
Traffic calming measures	Not applicable