ICT-Emissions

Deliverable 5.1: Case studies definition

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Deliverable (D 5.1) Case Studies Definition

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0 Executive summary

Aim of this deliverable (D5.2. Case studies definition) is to describe the case studies which are going to be used in WP5. With these case studies, the general project architecture will be tested in order to prove that all the interfaces between the different modules and submodules are working properly and to prove the overall functionality.

Taking into account this objective, two cases in the cities of Turin and Madrid have been selected according to specific criteria. After contacts with traffic authorities of the cities, the criteria are based mainly on data availability and the possibility of activation and deactivation of certain ICT measures in some areas or sections.

The consortium decided to select the following case studies to test the functionality of the platform:

- Turin: a section of Corso Lecce between the intersection with Corso Regina Margherita and the intersection with Via Lera (total length about 1700 m.)

- Madrid: a section of the urban motorway M30 between Arroyofresno and A5, with a total length of 7.1 km.

In addition to the detailed description of the two sections in terms of lanes, traffic intensities and other characteristics, the available data are also specified. Both cities have carried out surveys using floating cars in order to acquire time speed profiles under different circumstances of traffic and measure activation. Together with this data, traffic intensities and average speeds collected from induction loops and other devices will be used in order to calibrate the models and in further steps validate the methodology.

This deliverable also contains a brief description of the expected process and the software which is being used to build the models. In order to test the functionality of the platform under diverse environments, different modeling software is being used in each city:

- Turin: MT Model and AIMSUM for traffic macro and micro simulation and COPERT and CRUISE for emissions.

- Madrid: VISUM and VISSIM for traffic macro and micro simulation and COPERT and CRUISE for emissions.

1 INTRODUCTION: Aim of case studies in ICT emissions methodology

The main concept of ICT-Emissions is to develop an integrated methodology that can be used to quantify the impact of ITS solutions on road transport CO_2 emissions. This methodology is based on an integrated architecture which links the different models and tools within a common platform.

At this point of methodology development, there is the need to define some case studies in order to test the functionality of the common platform based on real data of the ICT-Emissions participant cities. In this procedure it is expected that some communication and definition issues are identified and solved, providing a very interesting input for the manual of procedures which constitutes the core of Deliverable 5.2 of the project. Therefore, the aim of this deliverable is to describe the criteria and the finally selected case studies which will be used to test the functionality of the architecture developed in WP5.

In parallel, an important outcome of the case studies is also a partial validation of the methodology. These real cases will make possible to compare the simulation outputs with the data acquired directly in the field by monitoring traffic and vehicle parameters under different traffic situations with and without interventions (ITS measures activated or deactivated). The basecase data (ITS OFF) will be used to calibrate the models and test the functionality, while the data obtained with ITS activated will be used in a following step (WP6) for validating the impacts of these measures.

2 SELECTION CRITERIA

Ideally, the best way to test the proper operation of the different tools and interfaces would be case studies which go through all (or most) models: driving behaviour, traffic and emissions.

In this case, it is necessary to take into account that the models which affect driver behaviour (ADAS) are mostly experimental and therefore there is not real data to calibrate the model.

It is precisely the need for actual data that makes the selection of case studies. Along with participating cities, case studies were selected with real applicability and availability of data to calibrate the models and then to enable also the validation of the methodology and results.

Another determinant selection criterion has been the use of two different families of traffic simulation software, in order to understand the differences and solve possible communication problems, testing this way the general applicability of the platform.

Under all these premises, the consortium has finally decided to test the platform by simulating an urban section in Turin and urban motorway section in Madrid which will be described in detail in the following chapters.

2.1. PROCESS FOR SELECTING THE CASE STUDIES

The starting point of this selection is the range of measures analysed in work package 2. In this workpackage the modelling level for each measure was established, as shown in the following table:

ICT-E Measure	Reason for not being case study
Driver behaviour change and eco driving	
Eco driving	
Gear Shift Indicator	
Start&Stop	
Tyre pressure Monitoring	

ICT-E Measure	Reason for not being case study
Navigation and Travel Information	
On-Board navigation Systems based on Historical data	Simulated at macro level: NO feedback to micro models
Navigation systems based on traffic information -real time data	
Green Routing (based on hystory)	
Green Routing (based on traffic information)	
Intelligent Parking	
Pre-Trip Information	
Traffic Management and Control	
Intersection control	
Area Control - Green Wave	
Area Control - Green Wave + V2I	
Traffic Adaptive Urban Traffic Control	
Ramp Metering	
Speed Control (point-to-point)	
Dynamic Speed Limits	
Cooperative Cruise Control - Lane merging Assistance	
Demand&Access Management	
Infrastructure-use pricing	Simulated at macro level: NO feedback to micro models
Carbon-credit scheme	
Restricted traffic zones	
Pay-as-you-drive strategy	
Mobility credits	
ADAS	
Adaptive cruise Control	Mostly experimental: NO real data to calibrate the model
STOP&GO	
Adaptive cruise Control (Cooperative)	

As previously said, the case studies should go through all, or at least most, of the different models considered within the project. Therefore, ADAS measures simulated at a macro traffic level have been rejected as case studies, though some of them will be simulated in WP6.

From the measures included in the previous table, case studies have been selected after discussions with the city traffic authorities, in order to find the measure with a higher interest for both the project and the city.

In the case of Turin, the city transport authority is already part of the Consortium, but in the case of Madrid, though Calle-30 is also a member of the ICT-E Consortium, they are not the only traffic authority of the city. Therefore, meetings for selecting the case studies have been held with both traffic authorities, the city council and Calle-30.

This process has led to select the case studies defined in chapter 3. Both case studies are included in the Traffic Management and Control Category, as has more interest for city transport authorities rather than Driver behaviour and Eco-driving.

3 CASE STUDIES SELECTION

3.1. TURIN CASE STUDY. URBAN SECTION

3.1.1. DESCRIPTION

Regarding the city of Turin, in the selected area both the micro and macro approaches and their interactions will be adopted in order to test the functionality of the architecture.

With reference to the macro model, it simulates the whole area included in the TOC (Traffic Operation Centre) of the city, which is managed by 5T inside its traffic management facilities.

The TOC area was set in 2006 for managing in real time the traffic during the Winter Olympic Games of Turin. It includes the whole metropolitan zone (Turin cities and surrounding towns) and the west rural and mountain areas of the Piedmont region.

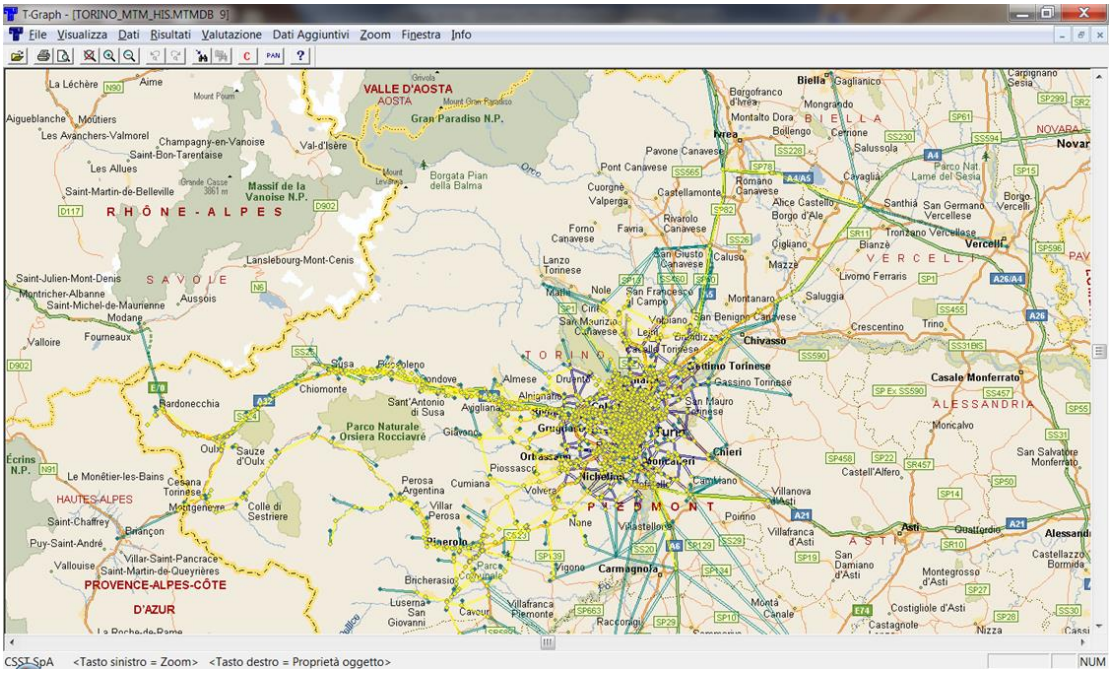

Figure 1: Torino Network with real and fictitious links as used in the simulation tool

The micro approach focuses on a subset of the main network in the urban part of the TOC. In this regard, a section of Corso Lecce between the intersection with Corso Regina Margherita and the intersection with Via Lera (total length about 1700 m) was selected.

Corso Lecce is part of one of the main corridors crossing the city north to south; in the selected section, there are two lanes in each direction and six intersections which are controlled by an Urban Traffic Control (UTC) system. The mean flow in weekday peak hours is about 1800 vehicles per hour and direction.

Figure 2: Portion of Corso Lecce micro simulated

The selection has been done taking into account the availability of measured data together with the detailed data needed for calibrating the transport model.

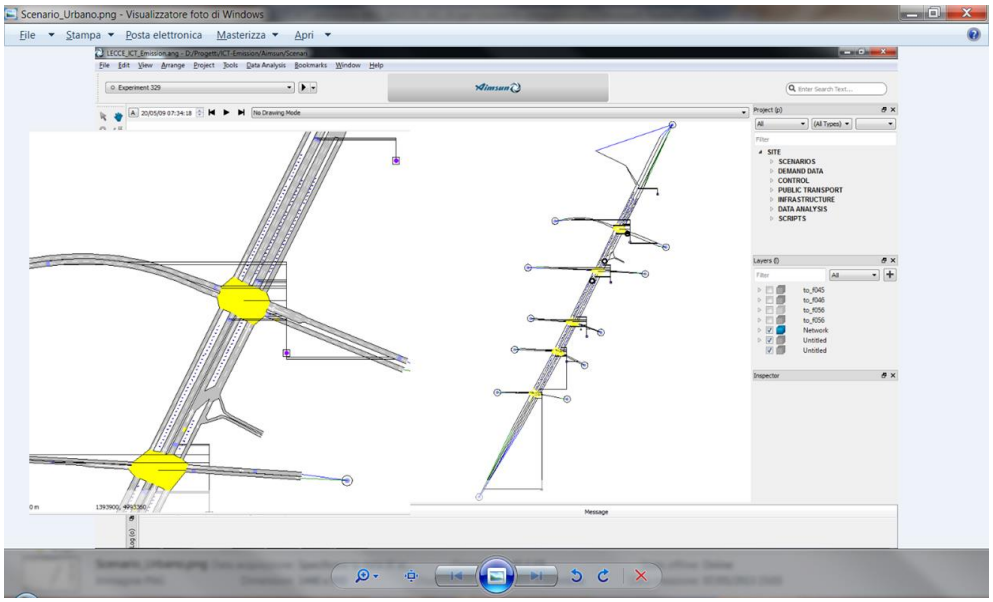

Figure 3: Network corridor in traffic micro-simulation

For both approaches, three different scenarios of traffic congestion will be considered: free flow, normal (medium) traffic and congested traffic.

For the aim of WP5 the following ITS applications will be simulated and calibrated, although only at a first stage, the base scenario (OFF-case):

- UTC: This scenario can be compared with measured data. In fact ICT-Emissions project has already performed measurements (traffic and vehicle parameters) in Turin in selected corridors with activated and deactivated UTC system (ON and OFF case).

  The Turin simulation mainly concentrates on the **urban** network.

3.1.2. SIMULATION METHODOLOGY

The UTC measure will be evaluated using the whole methodology: it will include the simulation at micro level and the scaling up at macro level, calibrating the macro cost function.

The interface between Micro and Macro in both directions will be tested, as well as the interface with the emission models (also at micro and macro levels)

Figure 4: Macro and Micro network

3.1.3. DATA AVAILABILITY

For this case study, there are different types of available data. The traffic control centre measures the flows crossing many sections of Turin road network. Therefore, the intensities (vehicle/hours) in many sections are available. Furthermore dedicated surveys measuring travel time and speed profile of some vehicles with UTC ON and OFF have been carried out.

These surveys were carried out on a segment lying on Corso Lecce between intersections Corso Regina Margherita and Via Lera, with a sequence of six centralized intersections:

- Corso Lecce/Corso Appio Claudio;
- Corso Lecce/Via Michele Lessona;
- Corso Lecce/Via Nicola Fabrizi;
- Corso Lecce/Via Giacomo Medici;
- Corso Lecce/Via Rosolino Pilo;
- Corso Lecce/Via Lera.

Four cars (two FIAT Panda, a FIAT Punto Evo and a car sharing vehicle) equipped with GPS devices detecting and tracking vehicle position every second were used to cover the chosen segment in both directions.

Two measurement campaigns, the first in January and the second in November 2012, were conducted in weekdays (Tuesday, Wednesday and Thursday), in three different time slots (traffic free, normal and saturated) and in the two conditions UTC ON and UTC OFF.

Only significant samples were kept, trips influenced by particular road events such as accident or road works or with a travel time diverging from average more than one standard deviation have been neglected; the remaining samples were:

- 32 samples for UTC ON in saturated condition (time slot 8:00-9:00, survey of 6-8-13-15 November 2012), in both directions;
- 45 samples for UTC ON in normal condition (time slot 12:00-13:00, survey of 6-8-13-15 November 2012), in both directions;
- 14 samples for UTC OFF in saturated condition (time slot 8:00-9:00, survey of 7-14 November 2012), in both directions;
- 19 samples for UTC ON in normal condition (time slot 12:00-13:00, survey of 7-14 November 2012), in both directions;
- 23 samples for free condition (time slot 5:00-6:00, 25-26 January 2012), in both directions; in this condition, the difference between UTC ON and OFF was not considered because the low level of traffic flows.

The data provided by the test cars consisted of GPS tracks: position (coordinates in latitude and longitude) and timestamp; the speed was calculated as the ratio between the distance of two consecutive positions and their time difference. The calculation of acceleration was similar.

Some statistical parameters had been calculated starting from all measured data of all valid runs (grouped by direction, time slot and conditions UTC). These parameters are being compared with results coming out from simulations in order to calibrate the micro traffic model.

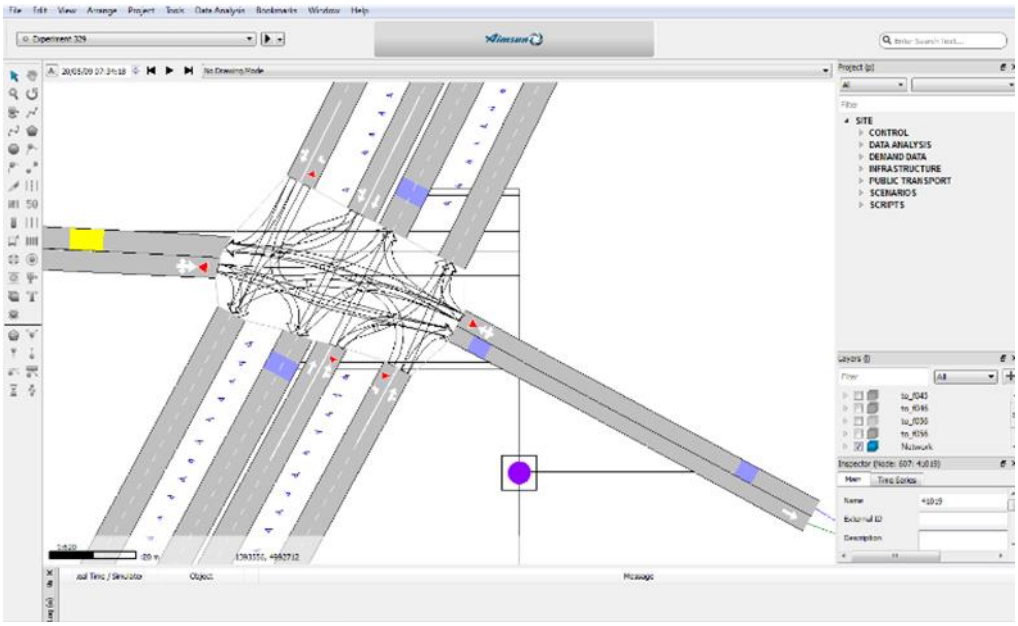

Figure 5: Detailed data on UTC intersections

3.1.4. SOFTWARE

For traffic simulation tool at macro level MT.MODEL tool will be used. At micro level AIMSUM will be used.

For the emission models at macro level COPERT tool will be used. At micro level CRUISE will be used.

3.2. MADRID CASE STUDY. URBAN MOTORWAY SECTION

3.2.1. DESCRIPTION

Madrid is a city of about 3.5 Million inhabitants and its metropolitan area reaches 6 Million. The city is surrounded by 3 ring motorways, the M30 being the closest to downtown.

In a normal workday, the M30 presents in the afternoon peak hours high traffic levels southbound on East and West sections. Trying to avoid this usual congestion and its externalities, the Madrid Traffic Department is testing Variable Speed Limits (VSL) system based on recommended speed limits.

The section is a 3 lane motorway (southbound) with traffic intensity in the afternoon peak hours of about 3,300 veh/h (before M500 junction) and with a length of 6.7 km. Most of the section has a speed limit of 90 km/h, except the last 100 m, which are limited to 70 km/h (tunnel entrance). The congestion is usually caused by the bottleneck situated in the M500 junction, as around 2,800 vehicles merge into the M30.

Figure 6 shows the tested section (southbound from A to B) with the Variable Message Signs (VMS) as well as the bottleneck junction where the congestion usually starts (M-500).

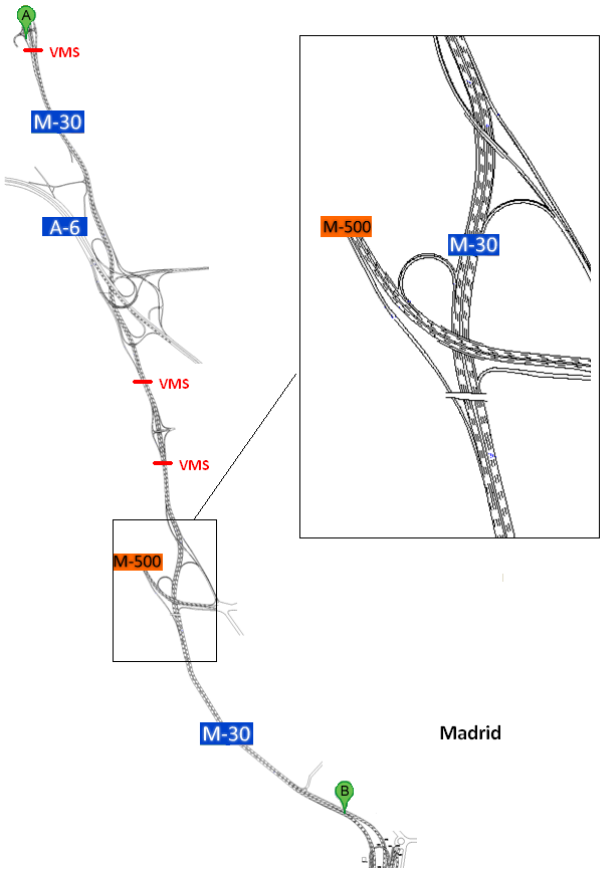

Figure 6: West section of the Madrid ring motorway

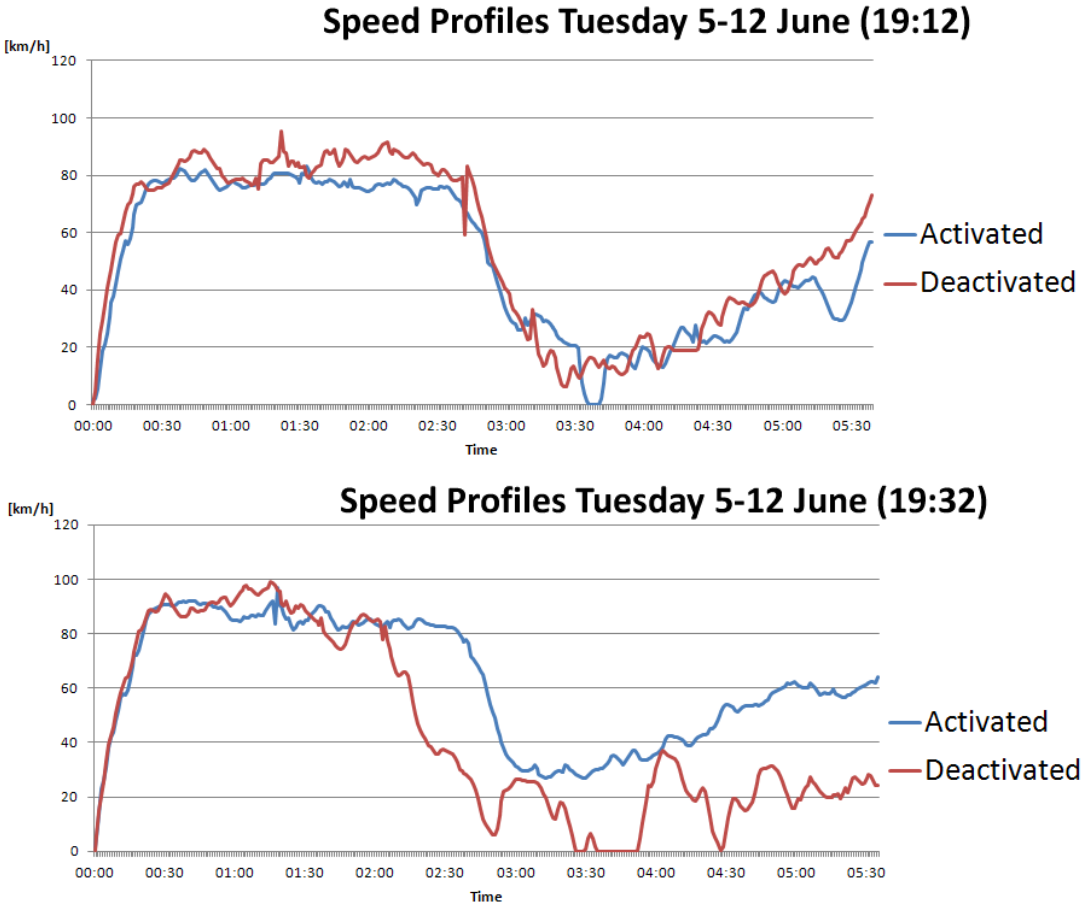

Figure 7: Examples of comparison of speed profiles for trips with VSL activated and deactivated for Tuesdays of consecutive weeks.

3.2.2. SIMULATION METHODOLOGY

The section will be simulated at a micro level using the data available as input (volumes) and the average speed as well as the speed profiles to calibrate some of the parameters. The results of the micro simulation tools will be then used as input for the interface between the micro and macro models. This interface will calibrate the cost functions which are key in the macro model algorithm.

The results of the micro traffic models also will constitute the basic input for the emission model at the micro level.

3.2.3. DATA AVAILABILITY

A first microscopic car study was undertaken in the afternoon peak traffic period 18:00-20:00. A total of 9 trips were conducted during the 6th and 7th of June 2012 (Tuesday and Wednesday) with the VSL system activated. One week later (12th and 13th of June) another

9 trips were performed at exactly the same hours, this time with the VSL system deactivated. The intensity levels upstream for the test days were very similar and there were no special incidents, weather conditions or accidents during the test trips, except an unusual congestion on 6th of June.

The mobile study was carried out using an instrumented vehicle (Skoda Fabia 1.9 TDI) equipped with a GPS data recorder (747+ GPS Trip Recorder), which was subsequently downloaded as Excel Sheet (.csv) and georeferenced (.kml) files.

The collected data included travel distance (m), position and speed (m/s), recorded every second, which makes possible to obtain the speed and acceleration profiles. For this first experiment no fuel consumption data were recorded.

In March and April 2013, a more detailed measurement campaign was conducted. This new campaign includes data measurements in the same west section of the M-30 ring road previously presented, as well as a new section in the east section of this same ring road M-30, where speed control by section is going to be tested.

These new measurements were carried out using a device provided by CRF, which allows to measure car speed, engine speed (rpm) and fuel consumption (l/h) each second. The campaign took place during two weeks in March (measure deactivated) and two weeks in April (measure activated).

Data is acquired from 3 cars: 1 passenger car gasoline<1.4l and 2 passenger cars Diesel<2.0l, driven by 9 different drivers following the floating car procedure.

The total number of trips performed for this section is 389 (201 with the measure off and 188 with the measure on).

Apart from the data obtained on these measurement campaigns, detailed geometric data is also available.

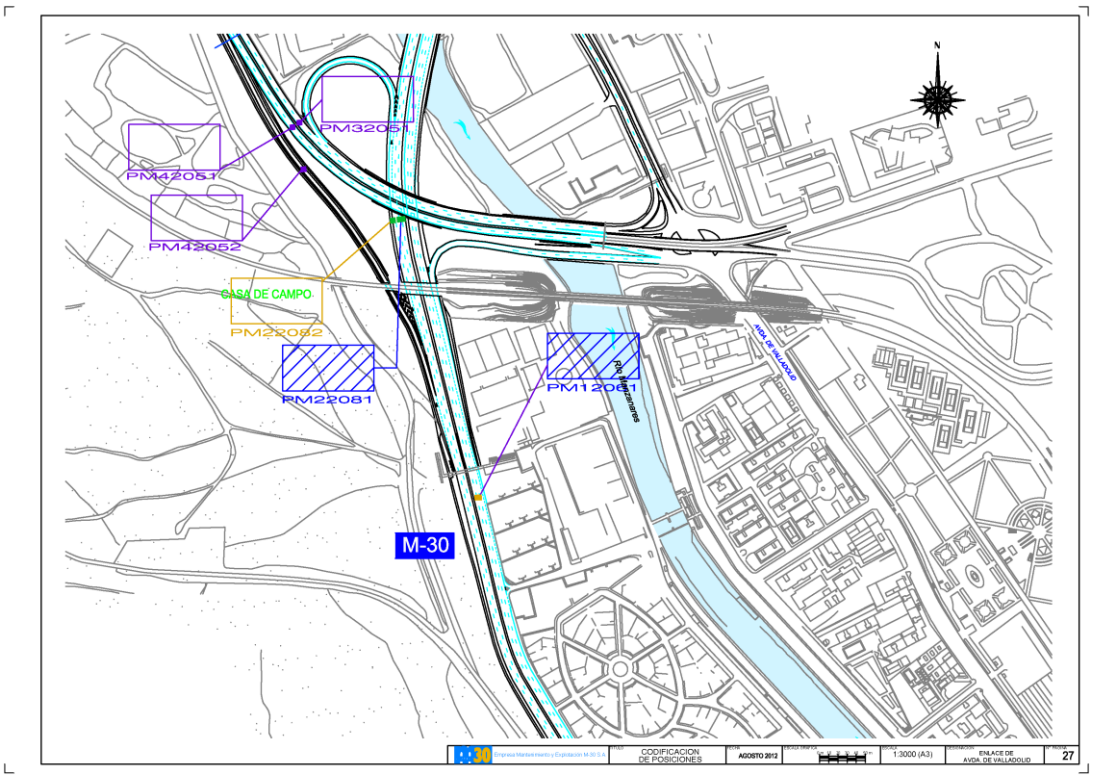

Figure 8: Detailed geometrical data

As we can see in figure 9, measuring points have been also provided. For each of these measuring points (induction loop detectors) speed, intensity and occupation are provided every 5 minutes.

Puntos medida_ICT DATOS IMD OCUP VEL [Vista protegida] - Microsoft Excel

	FECHA	PM	INTENSID	OCUPACIC	VELOCIDA
2	06/03/2013 0:01	PM20261	660	2	97
3	06/03/2013 0:06	PM20261	540	1	94
4	06/03/2013 0:11	PM20261	480	0	97
5	06/03/2013 0:16	PM20261	900	2	90
6	06/03/2013 0:21	PM20261	600	1	88
7	06/03/2013 0:26	PM20261	300	0	88
8	06/03/2013 0:31	PM20261	420	0	95
9	06/03/2013 0:36	PM20261	240	0	88
10	06/03/2013 0:41	PM20261	300	0	95
11	06/03/2013 0:46	PM20261	300	1	96
12	06/03/2013 0:51	PM20261	300	0	89
13	06/03/2013 0:56	PM20261	180	0	92
14	06/03/2013 1:01	PM20261	480	1	93
15	06/03/2013 1:06	PM20261	180	0	90
16	06/03/2013 1:11	PM20261	420	0	95
17	06/03/2013 1:16	PM20261	60	0	101
18	06/03/2013 1:21	PM20261	360	1	86
19	06/03/2013 1:26	PM20261	180	1	90
20	06/03/2013 1:31	PM20261	240	0	97
21	06/03/2013 1:36	PM20261	360	1	88
22	06/03/2013 1:41	PM20261	120	0	105
23	06/03/2013 1:46	PM20261	60	0	92

Figure 9: Detailed traffic data (intensity, occupation and speed)

3.2.4. SOFTWARE

For traffic simulation the software package developed by PTV (Planung Transport Verkehr) will be used. It includes VISSIM at micro level and VISUM for the macro.

For the emission models at macro level COPERT tool will be used, while CRUISE (AVL) will produce the emissions results at micro level.

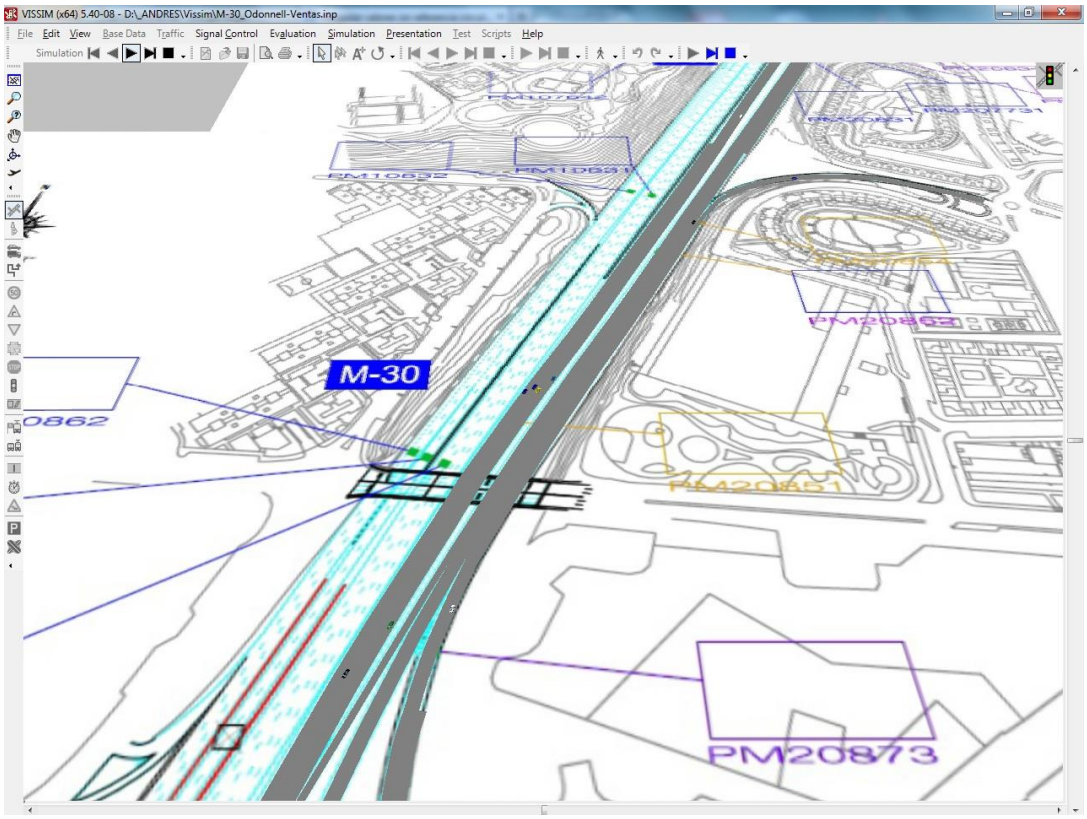

Figure 10: Micro simulation in VISSIM of the M30 motorway. Madrid

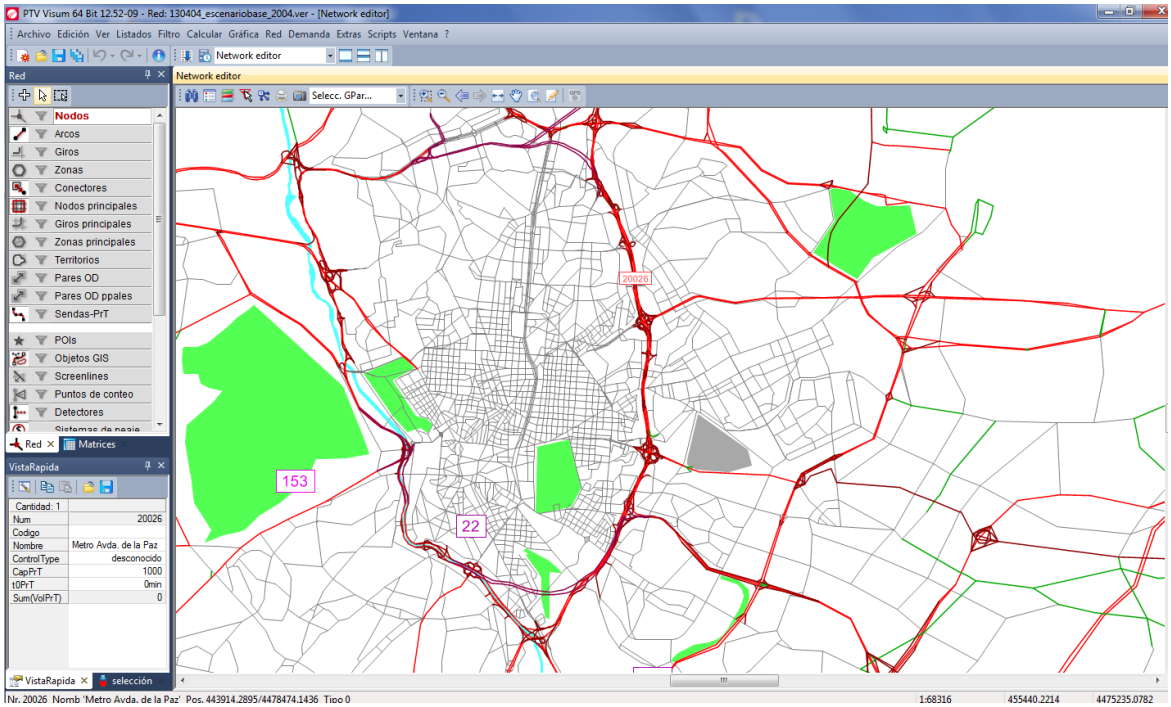

Figure 11: Macro model of Madrid metropolitan area in VISUM

4 SUMMARY

This deliverable describes the process and the selection criteria taken into account by selecting the two case studies for testing the functionality of the platform.

Although it might be seen as a straightforward task, selecting the case studies required many discussions inside the ICT-Emissions Consortium as well as with local transport authorities.

First of all, within the ICT-Emissions Consortium, discussions focused on two aspects: whether to test the same measure in different cities or not, and the expected quality of results from the modelling point of view of the different categories of measures established in D2.1.

Secondly, the city transport authorities had to provide data and allow the development of the test cases.

This has meant a rapprochement of positions between the city transport authorities' interest and the preferences of the ICT-Emission Consortium and has led to a large number of meetings with the local transport authorities, before and after the different meetings held by the ICT-Emission Consortium, in order to translate the different needs of ones and others and finally select the case studies which better fit for the project objectives.

The consortium strongly believes that the two test cases finally selected assure that the platform will be tested in following project steps under different traffic and software environments. Furthermore, and anticipating further steps, these case studies can also be used for validation activities in WP6.

ABBREVIATIONS

Abbreviation	Explanation
ADAS	Advanced Driver Assistance Systems
ITS	Intelligent Transportation Systems
TOC	Traffic Operation Centre of Turin
UTC	Urban Traffic Control system
VSL	Variable Speed Limits
WP	Work Package