Final Report for Publication

# *DIRECT*

***Data Integration Requirements of European Cities for Transport***

*contract N°: UR-97-SC.2131*

**Project Coordinator :** **STRATEC (Belgium)**

**Partners :** **CERTU (France)**
**University of Southampton (TRG) (United Kingdom)**
**Barcelona Tecnologia SA (Spain)**
**TNO Inro (The Netherlands)**
**Azienda Torinese Mobilità (Italy)**
**Lille Métropole Communauté Urbaine (France)**
**CETE Nord-Picardie (France)**
**CETE de Lyon (France)**
**SIMULOG SA (France)**

**Project Duration : 01/01/98 to 15/02/00**

**Date : January 2001**

**PROJECT FUNDED BY THE EUROPEAN COMMISSION UNDER THE TRANSPORT RTD PROGRAMME OF THE 4TH FRAMEWORK PROGRAMME**

# SUMMARY

The collection, use and dissemination of transport data and, in particular, the use of Intelligent Transport Systems (ITS) is widespread. Increased travel demand in European cities has necessitated improvements in traffic control and management, and the provision of real-time travel information. The need for more sustainable transport systems in urban areas is apparent, requiring the redefinition of travel demand policies and infrastructure operations. To this end, strategic modelling and simulation tools alongside traffic regulation techniques are required for short, medium and long-term decision making. The Transport Intermodality Task Force promoted the necessity to look beyond existing modelling techniques, to connect all transport systems and generate transport policies which will improve urban areas. The integration of transport planning and traffic control applications, within a single system architecture, forms an essential element of this.

The development of a Transport Data Sharing Structure (TDSS) is a central aim of the DIRECT project. The TDSS would include software tools and institutional agreements to permit the sharing and exchange of information between organisations. Additional aims of DIRECT are to generate recommendations and guidelines to orient future research. The definition of a conceptual framework for data sharing at the European level represents a first step towards the definition of possible European standards.

Inclusive within such a system should be the integration of long-term strategic transport planning and short-term dynamic traffic control applications. Transport planning, traditionally dominated by the four stage model (Demand – distribution – mode split – assignment) commonly utilises data which is unstructured and often dated. Little dynamic modelling, or more importantly data, is utilised within long term decision-making. Conversely, dynamic models are widespread within short-term traffic management situations, generating significant databases of transport volumes, structures and incidents. However, little integration exists between the two fields, resulting in the under-utilisation of data resources and inflated data collection costs. Data is required on an area-wide basis, systematically collected, stored and managed.

The collection, storage and dissemination of traffic and travel information are dependent upon the institutional organisation of individual nations. The structure of local, regional and national planning authorities and urban control centres determines which data types are collected, the use to which they are put and the level and quality of data exchanges. Transport planning issues are covered at a range of organisational levels. Long-term strategic planning requires highly aggregated information, including travel demand statistics, population growth and overall network operational characteristics. Conversely, urban traffic control centres require more detailed and dis-aggregated information. The characteristics of urban areas, including mode availability and land use structures, also influence data collection and dissemination processes. Cities supporting comprehensive and well-established public transport networks will have different transport information requirements than car based areas. Furthermore, data types and storage processes are dependent upon the data standards operating in individual nations.

A TDSS should integrate all transport related organisations and data requirements, with its design dependent on the local characteristics. However, no comprehensive data exchange structure exists that can handle and disseminate the large amount of transport and travel data presently collected. The ever diversifying information needs of travellers can therefore not be met. Individual European Member States have contributed considerable resources to the

development of integrated transport data systems, mostly focusing on selected urban or regional areas.

The DIRECT project has been mainly considering the sites of Turin (Italy), Southampton (UK) and Rotterdam (the Netherlands) as a basis to analyse the various aspect of development, implementation and operation of TDSS : not only the technological aspects have been envisaged, but also the institutional, legal, organisational and financial aspect.

Moreover to validate the recommendations of this "theoretical" approach, two prototypes have been developed, implemented and evaluated.

✓ ***The DIRECT Barcelona prototype***

The Barcelona TDSS was developed with a view :

- to be used as an information/booking system for potential users of a park 'n ride scheme : the demonstrated prototypes have enabled these potential users to question a web-server on Internet and request information on possible alternative routes to their destination in the City centre, either by car only or through the proposed P & R scheme or by public transport. The possibility to book a parking space on one of the two parking facilities involved in the scheme has been demonstrated as a prototype to the municipal parking operator.
- to provide local operators with disaggregated information concerning users travel needs and behaviour obtainable by on-line trip planner operation
- to enable the parking operator to improve its forecast for parking spaces availability and display appropriate messages on the existing VMS panels which have been installed along the roads that access the facilities
- to enable off-line evaluation of the P & R scheme, as well as its contribution to the reduction of car traffic in Barcelona city centre, and possible adjustments of the public transport services.

✓ ***The DIRECT Lille prototype***

It has taken the form of a Mobility Observatory for the LILLE METROPOLE Communauté Urbaine : under the recently approved Clean Air Act, this local authority which is responsible for the transport sector in the Lille conurbation has developed and implemented an Urban Transport Master Plan. The achievement of the Plan's objectives is to be monitored, and the tool being developed and implemented in this respect is a Mobility Observatory. This shall make use of the various transport planning, traffic, pollution, safety, etc data which are available in existing databases, through the development of interfaces enabling easy access to the existing databases, data loading from these databases and flexible computation of appropriate indicators.

The prototypes and their demonstration have been evaluated on the basis of evaluation plans defined in the course of the project.

The synthesis of the above mentioned analysis of the Barcelona and Lille prototypes activity has led to recommendations and guidelines that aims to orient future research work as well as development and implementation work in the future.

The interest of achieving the definition of a conceptual framework at the European level lies in the fact that this framework represents a first step towards the definition of possible European standards.

**TABLE OF CONTENTS**

# I. PROJECT OBJECTIVES AND PARTNERSHIP

## I.1. INTRODUCTION

In many European cities, urban travel patterns have significantly developed during the last two decades. Urban road networks have been extended and their operation has been improved with a view to satisfy the internal travel demand as well as the entering/outgoing and through traffics. In the meantime however the private car mobility, notably due to the development of peripheral housing and the increase of the proportion of households with two and more cars. This led to major disruptions in those cities, notably under the following forms:

- **disruption of the urban structure, due to the barrier effect of heavy transport infrastructures, either temporarily during the building period or permanently, due to their very nature;**
- development of the traffic congestion on the road network, and, as an immediate consequence, development of the related negative impacts;
- increasing road safety problems, notably due to the development of (long distance) traffic in the service streets of residential neighbourhoods at detriment of the vulnerable users safety.

In the meantime, despite important investments (creation/extension of metro and/or tramway lines, development of railway services, renewing of road vehicles rolling stock, etc), the public transport operation usually faced financial difficulties and the best which operators could achieve was to stabilize their market share of the urban travel demand. Finally, the use of the other modes developed diversely, but if one excepts those cities where it was vigorously and/or traditionally promoted, the use of the bicycle diminished less or more rapidly in favour of the private car; pedestrians proportion remained less or more stable when considering the trip distance.

**The need to ensure a sustainable development in the urban areas and to provide better solutions to come up with the citizens' expectations make it necessary to consequently redefine the policies addressing urban travel demand management and infrastructure operation**, in order to remedy the problems of the urban environment deterioration (chemical pollution, acoustic nuisances, deterioration of the urban landscapes, etc), the road traffic congestion, the public transport underuse and deficit, etc.

To achieve an effective multi-modal policy that would safeguard/improve the urban environment and take advantage of the modes of transport complementing each other, **the transport systems' planners and operators must rely on new strategic modelling/simulation tools and new traffic regulation techniques that could more efficiently help them in their long, medium and short term decision making**.

With the setting up of the 'Transport Intermodality' Task Force, emphasis was also put on the need to go beyond the limitations of the existing modelling tools and sector related policies, with a view to achieve future interconnection of the various transport systems (Intermodality concept), and to implement transport policies which will efficiently contribute to protect the urban environment, improve the road safety and release the traffic congestion. This means that, under generally unfavourable budget constraints, physical capacities and human resources would be used more efficiently, as is expected all over Europe by citizens as well as by economic operators.

The DG VII's **Research, Technological Development and Demonstration Programme in the Field of Transport** has addressed this concern within the context of the "Techniques and Tools" : this included the following tasks :

- Task 5.1.2/4 : **Identification of Information Requirements (Acquisition, Processing, Distribution) of Transport Management Operators Considering Organizational Structures and Financial Implications**;
- Task 5.1.2/5 : **Predictive Modelling**, and
- Task 5.1.2/6 : **Development and Integration of Strategies to Optimize Multi-faceted Systems Considering the Application of Developments in the Field of Advanced Technologies.**

The **DIRECT** (**D**ata **I**ntegration **R**equirements of **E**uropean **C**ities for **T**ransport) Project has been aimed at addressing the 5.1.2/4 task in the Urban Transport part of the DG VII's Transport RTD Work Programme.

## I.2. PROJECT OBJECTIVES

The objectives of the DIRECT Project are to study and to produce guidelines concerning the various aspects of the development, implementation and operation of a **Transport-Data Sharing Structure (TDSS)** that should acquire, process, store and disseminate relevant data as required and namely be an interface between Transport Planning and Traffic Management procedures to achieve the full benefits that can be expected from integration.

The aspects to be considered are not only functional and technological, but also institutional, legal, organizational and financial.

The effective achievement of the objectives shall be measured through the carrying out of the development of functional specification of a generic Transport-Data Sharing Structure, and the validation of this specification through the implementation and demonstration of related prototypes in Lille and Barcelona.

The project has therefore comprised the following steps:

- The first step of the approach has consisted of a **review of the State-of-the-Art** and is the subject of Deliverable 1;

- As it is of outmost importance to start the work on the basis of the existing and future users requirements, the next step had as an aim to **identify these users requirements** and to draw up **specifications that transport-data sharing structures should consequently satisfy**: these are the subject of Deliverables 2 and 3 respectively;

- On the basis of the resulting specifications, the various aspects of the development, implementation and operation of such transport-data sharing structures shall then be reviewed in order to identify the various problems to address and possible feasible solutions. The following groups of aspects have been examined :
    - **the technological aspects**, and
    - **the institutional, legal, organizational and financial aspects.**

THESE ARE THE SUBJECTS OF DELIVERABLES 4 AND 5 RESPECTIVELY.

The project has included a certain number of case studies. These shall concern either all the aspects that are to be envisaged for a transport-data sharing structure or a specific aspect which is of particular interest.

The case studies which are presently envisaged are the following :

- in France: Lille for the various aspects of the development and implementation of an Observatory of the Mobility;
- in Italy, the Turin case, in the general framework of the 5T Project;
- in Belgium, the case of the Brussels-Capital Region, whose authorities have taken steps towards the development and the implementation of an Urban Transport Management Centre/System;
- in the Netherlands, Rotterdam;
- in the United Kingdom, Southampton, in the general framework of the ROMANSE Project.

These case studies have been carried out mainly during the study of the various groups of aspects referred to here above so as to provide input to the work of the above mentioned tasks and to enable production of synthesis based on both the general theoretical reflection and a representative sample of the various actual situations that have to be faced in the development, implementation and operation of TDSS.

To complete the theoretical work and the case studies, two applications have been developed, implemented and demonstrated, in Barcelona and in Lille.

The policy background of the **Barcelona demonstration** is the objective to reduce car traffic in the central area. There is already evidence that the Park & Ride strategy developed by SMASSA (parking operator) and TMB (public transport operator) has contributed to reduce car trips to the congested central area (ANTARES Project, Final Report). By promoting modal switch from a wider catchment area, the aim is to further reduce car traffic in central Barcelona. The Barcelona demonstration will therefore consist of an information/trip planning/booking system associated to a P & R scheme.

Technologically speaking, the Barcelona demonstration has been supported by the Internet and the web-server of the public transport operator (TMB). The message interchange and the integration of the Internet platform with other systems was the focus of the work.

This **Barcelona prototype implementation/demonstration** has been presented in Deliverable 6.

The policy background of the **Lille demonstration** derives from the enforcement of the recently approved Clean Air Act, which imposes on each urban area with more than 100.000 inhabitants to develop, implement and monitor the achievement of an Urban Transport Master Plan (*Plan de Déplacements Urbains* or *PDU*).

The *LILLE METROPOLE Communauté Urbaine (LMCU),* the local authority with competences in transport for the Lille metropolitan area, has revised its previous Urban Transport Master Plan. The following step was the development and implementation of an **Urban Mobility Observatory**, i.e. a tool that enables to monitor the achievement of the Plan objectives on a yearly base with a set of relevant indicators and to possibly envisage appropriate actions to correct the observed evolution.

The demonstration has consisted of developing, implementing and validating the interfaces required to set up the Urban Mobility Observatory data sharing platform. These interfaces shall enable to easily access the existing databases to carry out the data loading of the prototype so that the relevant indicators could actually be computed in a flexible way. Technologically speaking, the Lille demonstration has been supported by the existing facilities of the *LMCU*.

This **Lille prototype implementation/demonstration** is presented in Deliverable 7.

The Project has been completed with **the integration of the results and the derivation of guidelines** (WP8), including the evaluation of the two demonstrations on the basis of the criteria defined within the identification of user requirements and the design of the specifications that TDSS should satisfy. For this evaluation, reference has been made to the CONVERGE guidelines.

## I.3. PARTNERSHIP

The organisations involved in the performance of the DIRECT project were as follows :

- Contractors :
  - STRATEC S.A. (Belgium), Project Coordinator;
  - Transportation Research Group of the University of Southampton (United Kingdom);
  - Department of Urban Technical Systems of CERTU (France);
  - SIMULOG S.A. (France) ;
  - Azienda Torinese Mobilità (Italy) ;
  - TNO Inro (the Netherlands) ;
  - Barcelona Tecnologia S.A. (Spain);

- Associated Contractors
  - CETE de Lyon (France);
  - CETE Nord-Picardie (France);
  - LILLE METROPOLE Communauté Urbaine (France)
  - SMASSA S.A. (Spain).

Contact information is provided in the hereafter table

Table I.1 : **Partnership and contact information**

| **Contractors** | |
|---|---|
| **Organisation** : STRATEC S.A., Project Coordinator<br>**Contact name**: Claude Rochez, Pascale Lobé<br>**Address :** Avenue A. Lacomblé 69-71,<br>B - 1030 , Brussels, Belgium<br>**Tel. Nr** : +32-2-7350995<br>**Fax Nr** : +32-2-7354917<br>**E-mail** : stratec@stratec.be<br>**Website** : www.stratec.be | **Organisation** : Transportation Research Group (TRG)<br>**Contact name** : Professor Mike McDonald<br>**Address :** University of Southampton, Highfield<br>Southampton SO17 1BJ, United Kingdom<br>**Tel Nr** : +44-2380-592192<br>**Fax Nr** : +44-2380-593152<br>**E-mail** : m.mcdonald@soton.ac.uk<br>**Website** : www.trg.soton.ac.uk |
| **Organisation** : CERTU<br>**Contact name** : Patrick Gendre<br>**Address :** Rue Juliette Récamier 9<br>F - 69456, Lyon Cedex 06, france<br>**Tel. Nr** : +33-4-72745926<br>**Fax Nr** : +33-4-72745960<br>**E-mail** : pgendre@certu.fr<br>**Website** : | **Organisation** : SIMULOG S.A.<br>**Contact name** : Marc Loriot<br>**Address :** Rue James Joule 1<br>F – 78286, Guyancourt Cedex, France<br>**Tel Nr** : +33-1-30122700<br>**Fax Nr** : +33-1-30122727<br>**E-mail** : loriot@simulog.fr<br>**Website** : |
| **Organisation** : Azienda Torinese Mobilità<br>**Contact name** *: PIERO LA SCALA*<br>**Address :** Via Chisone 6<br>I – 10128, Torino, Italy<br>**Tel. Nr** : +39-011-5764537<br>**Fax Nr** : +39-011-5764592<br>**E-mail** : lascala@atm.torino.it<br>**Website** : | **Organisation** : TNO Inro<br>**Contact name** : Erik J. Verroen<br>**Address :** Schoemakerstraat 97, PO Box 6041<br>NL – 2600 JA, Delft, the Netherlands<br>**Tel Nr** : +31-15-2696864<br>**Fax Nr** : +31-15-2696050<br>**E-mail** : eve@inro.tno.nl<br>**Website** : |
| **Organisation** : Barcelona Tecnologia S.A.<br>**Contact name** : Simon Hayes<br>**Address** : Carreer 60, num 25-27, Sector A Poligon<br>Industrial Zona Fra nca<br>SP – 08040, Baaarcelona, Spain<br>**Tel. Nr** : +34-93-4314650<br>**Fax Nr** : +34-93-4314163<br>**E-mail** : btsa2@telelines.net<br>**Website** : | |
| **Associated Contractors** | |
| **Organisation** : CETE Nord-Picardie<br>**Contact name** : Bernard Quetelard<br>**Address :** Rue de Bruxelles 2, BP 275<br>F – 59019, Lille Cedex, France<br>**Tel. Nr** : +33-3-20496112<br>**Fax Nr** : +33-3-20496094<br>**E-mail** : bernard.quetelard@equipement.gouv.fr<br>**Website** : | **Organisation** : CETE de Lyon<br>**Contact name** : Christophe Damas<br>**Address :** Avenue François Mitterand 25, Case n°1<br>F – 69674 Bron Cedex, France<br>**Tel Nr** : 33-4-72143183<br>**Fax Nr** : 33-4-72143180<br>**E-mail**:christophe.damas@cetelyon.equipement.gouv.fr<br>**Website** : |
| **Organisation** : LILLE METROPOLE Communauté Urbaine<br>**Contact name** : Jean-Louis Séhier<br>**Address :** Rue du Ballon 1, BP 749<br>F – 59034, Lille Cedex, France<br>**Tel. Nr** : +33-3-20213115<br>**Fax Nr** : +33-3-20213014<br>**E-mail** :<br>**Website** : | **Organisation** : SMASSA S.A.<br>**Contact name** : Alfred Morales<br>**Address :**<br>**Tel Nr** :<br>**Fax Nr** :<br>**E-mail** :<br>**Website** : |

# II FIVE PRELIMINARY QUESTIONS

## II.1 WHAT IS A TDSS?

The DIRECT project has identified a TDSS as a system exchanging data between distributed data bases, whose users include urban transport applications (Figure II.1).

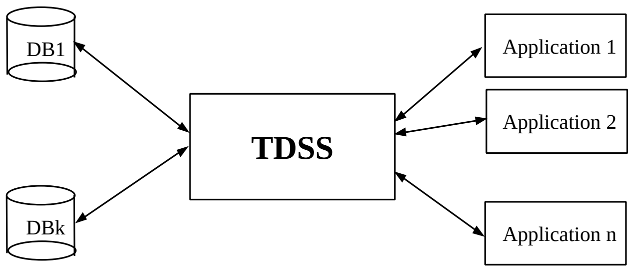



Figure II.1: Outline of the role of a Transport Data Sharing Structure (TDSS).

The DIRECT project has defined a TDSS as composed of three key layers (Figure II.2):

- a data layer
- The role of this layer is to provide the data, to store them and to guarantee their quality (generally through specific data processing and manual checking)
- 
- an application layer
- This layer concerns the user needing to consult or update the data
- 
- a TDSS layer
- This is the strategic layer which allows communication between applications and data sources. The TDSS knows where to find and retrieve the data required by the applications within the confines of the user's data rights.
- 
- 

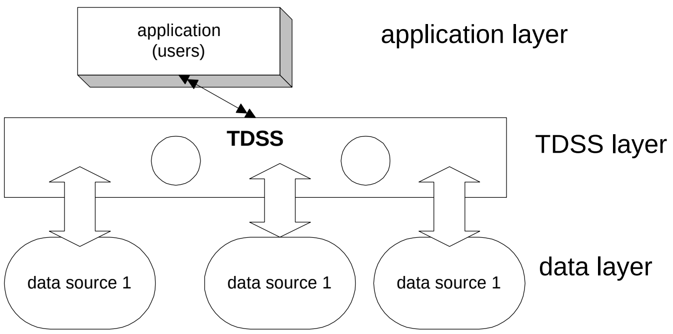



Figure II.2: levels in the TDSS specifications[1]

[1] note that depending on the actual application and site :
- there may be one TDSS for each application, or one TDSS for all applications (if there are several), or something in between
- the application may reside in the same machine as the TDSS
- the application may reside in a machine which is also a data source
- the application may be limited to a manual access to the TDSS by a human operator
- the TDSS may have its own database (e.g. for storing a reference repository or archives), in which case the connection with external data sources may well be done manually or off-line, rather that in real-time.

- The DIRECT project has also analysed the TDSS process. Figure II.3 shows the steps decomposition of a request:

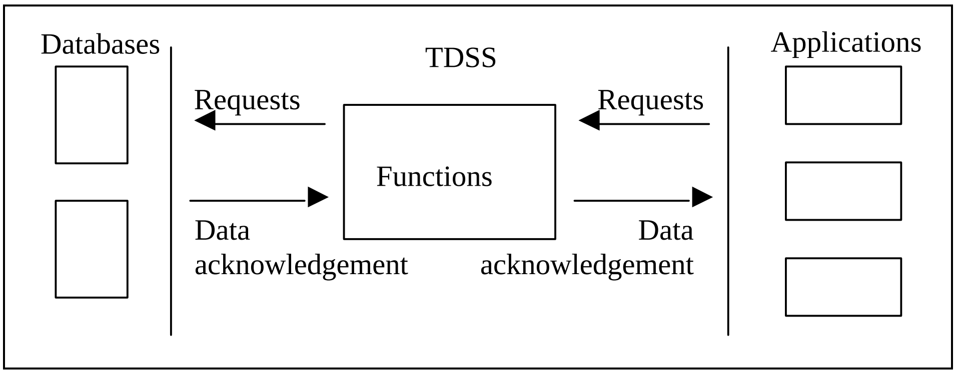



Figure II.3: Decomposition of a request

- First, an application sends a request to the TDSS. It could be a consulting or an updating request.
- Then the TDSS receives the request and controls the rights associated to the application user. If the user does not have the correct rights, the request is rejected. In the other case, the TDSS transmits the request to the databases being concerned.
- Finally, the databases operate an authentication check and then execute the requests (consulting or updating data) and reply to the TDSS (with an error code or the data depending on the request).

Chapter III of the present document provides with the description of the sites of Turin (Italy), Southampton (UK) and Rotterdam (the Netherlands) which have been considered as a basis to analyse the various aspects of development, implementation and operation of TDSS in the DIRECT project. The state of the art of German, Austrian and US experiences have also been evoked.

Chapter V of the present document reviews and discusses the general characteristics to be envisaged in the development of a TDSS.

## II.2 WHAT IS THE USE OF A TDSS?

In the transport sector, a TDSS can be used by two main types of functions : ***transport planning functions*** and ***integrated traffic management functions***.

✓ ***Transport planning***

Transport planning is aimed at improving mobility in the medium to long-term. The use of computing tools to assist in the decision making could be through :

- performing the diagnosis of present or future insufficiencies of the transport system
- testing and comparing potential strategies which could be implemented
- carrying out export analysis of policies and measures
- monitoring the achievement of policy goals
- etc.

✓ ***Traffic management***

Traffic management deals with the on-line monitoring and control of transport systems. It aims to improve mobility on-line by keeping operators and users informed as to the state of the transport system and enabling operators to take appropriate control measures. For example, it aims to provide:

- road network operators with on-line information concerning traffic conditions and access to traffic control equipments (traffic signals, VMS, etc.);
- car users with on-line information relating to route guidance (linked to existing road traffic conditions), parking availability and public transport availability;
- public transport operators with on-line information to enable them to modify service routes if an accident happens, and deal with possible technical problems of a vehicle.
- public transport users with bus stop on-line information about service characteristics such as the departure time of the next vehicle and on board information such as the name of the next stop and the expected time of arrival at next stops.

✓ ***Interaction between transport planning and traffic management***

Both systems are or should be linked : data exchanges take place or should take place between them at various levels and in both directions:

- from the planning system to the traffic management system : vehicle origin-destination data which can be used as a starting point for on-line matrix estimation and calibration
- from the traffic management system to the planning system, comprehensive traffic flow data, network response characteristics[2], parking data, etc.

Both operational and planning model systems should have common databases, which are to be updated according to the changing conditions in a network.

Chapter IX of the present document describes the Lille DIRECT prototype as an example of TDSS uniquely built for the purpose of transport planning. It is dealing with the evaluation and monitoring of the achievement of the Urban Transport Masterplan and consequently uses data from the traffic management systems.

The description of the Barcelona DIRECT prototype considering on-line data such as traveller origin and destination requests, optimal multi-route displays, parking space booking as well as off-line data such as planning data concerning travel demand, data concerning demographic and socio-economic features is the subject of chapter X.

## II.3 WHO MAKES USE OF A TDSS?

A number of actors are concerned with urban transport data to the extent they bear responsibilities for the road network, the public transport, the railways, the parking, the car park facilities, the emergency services, the police, the environment protection. Data sharing between actors is needed in application domains such as ticketing, prioritisation of vehicles at intersections, mobility observatory, management of park and ride schemes, traveller information, co-ordination of operations, planning, and modelling.

The review of the requirements has shown that these are very diverse from one city to another, that the users have a clearer idea of their own information requirements than needs of their information exchange system, and that present concerns are oriented towards improving existing applications and systems rather than developing integrated multi-purpose

[2] Journey times as a function of network loading

data exchange structures.

The first step in the development of a TDSS consists of analysing the users needs. By adding together site specific user needs, the DIRECT project has shown a quite adequate picture of the diversity of situations which a generic TDSS should cover, and will hopefully be useful in terms of recommendations relevant for any given European city.

The users' needs analysis, as described in chapter IV of the present document, consists of identifying the users, discussing the relevant domains where information is either exchanged or intended to be shared, and listing and summarising the constraints and wishes for future TDSS. It considers the requirements at three levels : strategic, operational and technical, in order to match the user roles of policy decision-maker, operator and technical staff respectively.

## II.4 HOW TO DEVELOP, IMPLEMENT AND OPERATE A TDSS?

The DIRECT project has tried to fill in the knowledge gap existing on the condition, requirement and guidelines for the realisation of TDSS system, particularly dynamic TDSS system.

Guidelines regarding TDSS development, implementation and operation by European cities have been derived from the integration of :

- the analysis of the sites of Turin (Italy), Southampton (UK), Rotterdam (the Netherlands) and Brussels (Belgium)
- the practical experience of the development, implementation and validation of the Barcelona and Lille prototypes whereby the DIRECT recommendations and guidelines have been tested with a view to orient research as well as TDSS'development and implementation in the future.

From the technical point of view the following conclusions have been drawn :

- The best value for money solution for TDSS supporting *Transport Planning* applications consists of a data management including an access layer, that allows all applications to access requested data stored in a single data base or in a set of data bases linked through a local network.
- *Traffic Management* applications often require connections to distant data bases and publication on Internet. The TDSS manages the dialogue between several applications servers, each of them hosting more than one database and more than one application. In this case, the TDSS can make use of the application server, which manages, formats and publishes information on the Internet

Not only the technological aspects have been investigated, but also the institutional, legal, organisational and financial aspects.

- The *institutional issues* are related to the organisations that perform tasks or have responsibilities regarding the establishment, operation and maintenance of a TDSS. This includes any particular issue that might affect the willingness or possibilities to exchange data.
- The *legal issues* are related to all legal provisions that can affect the establishment, maintenance and operation of a TDSS.
- The *financial issues* describe the cost of the process of data purchasing, collection and sharing. The market opportunities for a TDSS are considered alongside the "added value"

of reduced data collection costs within a sharing structure. Such issues are intrinsically linked with the development of partnerships between transport actors.

- The *organisational issues* address all actors/stakeholders responsibilities and tasks that are needed to establish, maintain and operate a TDSS.

Chapter VI of the present document provides with TDSS technical recommendations while chapter VII recommendations address non-technical issues.

## II.5 HOW TO VALIDATE A TDSS?

A TDSS appears as a transport telematics application aiming to optimise the management of data collection and provision for all transport related applications. The objective of TDSS assessment is to demonstrate the benefit of the integration of a TDSS in the user application, or between the user application and the databases. Validation is a key step in the development and implementation process of Transport Telematics applications. From the initial creation of a system, consideration must be given to defining a well ordered testing process, to be undertaken during the system development.

Chapter VIII defines criteria and measurements aiming to identify TDSS benefits. Moreover, it provides DIRECT evaluation guidelines, in seven key stages, as identified by the CONVERGE[3] method.

Appendix 5 provides with the practical experience of the Barcelona and Lille prototype assessment. Results of the assessment of 5T, Romanse and TIC-Rotterdam are available in appendix 6.

[3] *Guidebook for assessment of Transport Telematics Applications : updated version* - Deliverable D2.3.1., CONVERGE Project TR 1101 - Telematics Applications Programme - Transport Sector, ERTICO, prepared September 1998

# III HOW DO TDSS ALREADY EXIST?

Urban Traffic Management/Information Centres are able to integrate a diversity of systems within individual areas. However, a variety of collection techniques, computer databases and storage facilities are used throughout Europe, such that integration *between* member states is at present limited. Indeed communications *within* member states is also inefficient. The requirement for a top-down and bottom-up approach is therefore apparent. The aim of DIRECT is to develop a TDSS to fill the gap between the raw data bottom-up and architectural top-down areas of information exchange systems.

This section provides an overview of the present diversification in processes of transport data collection and exchange in European Cities, and key barriers to universal inter-operability are discussed. Evidence of architectural developments in the United States are used to highlight current limitations of physical, institutional and data structure designs within European urban areas.

## III.1 ITALY - 5T (TURIN)

Transport planning and operations in Turin are the responsibility of Azienda Torinese Mobilità (ATM) and the Municipality of Turin. ATM and the Municipality established the 5T (Telematic Technologies for Traffic and Transport in Turin) consortium, which is responsible for improving telematic information services in the urban area. The consortium consists of the following organisations: Municipality of Turin, ATM Esercizio (public transport operator), ATM Parcheggi (parking operator) and Atm Pianficazione (inter-urban transport operator).

5T was developed within the 1992 DRIVE II research and development programme QUARTET project. The aim was to foster the interaction of several sub-systems, to generate and manage urban mobility strategies. Methodologies have been developed within the 5T project to facilitate the exchange of information between sub-systems and transport operators, using a modular type architecture. A supervisor sub-system evaluates data relating to traffic measurement, public transport journey times and pollution trends, to generate strategies that, through collective and individual routing and user information, can redistribute drivers to alternative routes. The main user of data generated by 5T is the Municipality of Turin. The data serves as a basis for the mobility observatory and is used to re-calibrate the road network as well as acting as an aid to design simulation activities.

The city of Torino is building a telematic network at a city level, the so-called Metropolitan Area Network, which will link the City Council with four municipal-owned utility companies (sanitary and refuse, electricity, transport and water), the Regional government, The Ministry of Finance and other authorities. The network will provide access to the SAMPO Project carried out by ATAF in Florence. The project, which is still in progress, examines the development of a Demand Responsive Transport Service (DRTS) based, in architectural terms, on elements taken from the TRANSMODEL data model. The database used by the service has been developed using Oracle 7.3.

✓ ***Data Requirements and System Limitations***

Improvements are required in the data exchanges that occur between the various automatic systems existing in the Turin urban area. Developments in data sharing processes are required for Turin's Urban Traffic Plan and Town-Planning Scheme, as well as for the provision of pre-trip, on-trip, and incident related information. Although dynamic and automated data collection systems exist for individual applications inefficiencies remain and the three ATM organisations continue to focus on tightly defined areas of transport operations with little integration occurring between operators or with the 5T consortium. Specific and confined data exchanges occur between the 5T sub-systems including all data required generating management strategies. However, this does not include all information collected. Data is therefore often under-utilised and potential benefits lost. A more comprehensive and integrated TDSS would facilitate the collection, collation and dissemination of all data types required by all existing and planned systems. This will enable Turin's overall urban transport plan to be monitored more accurately and in more detail. The proposed developments for each transport operator are outlined below:

✓ ***ATM Pianificazione*:**

Table III.1 summarises the developments and future data requirements envisaged within a TDSS controlled environment. A more in-depth and widespread data collection process will integrate and widen the decision making of all organisations working in the same domain. The more rational use of available resources and available information will be pursued to promote the use of public transport services. The TDSS would facilitate the handling of such data at the Mobility Turin Office. The higher quality of information and service knowledge generated from the proposed developments will allow passengers to be more assured of public transport service availability and reliability. This, it is hoped, will engender the global acceptance of services as an alternative to car based modes, meeting the needs of end users.

| **Data/Application** | **Uses** |
|---|---|
| Mobility in Turin area | Estimate potential demand for public transport. |
| Perceived Public Transport quality | Evaluate company objectives, calibrate service strategies. |
| Line load monitoring | Estimate potential demand - long term service provision. |
| Observatory | Graphical and map displays - dissemination to end-user. |
| All public transport data | Analyse demand and link all public transport operators. |
| Internet access | Supply end users allowing informed decisions - real-time trip planners using accurate and reliable information. |
| Network performance, occupancy | Define, monitor and evaluate parameters associated with public transport citizens' charter - improve service quality. |
| Fares, network supply, timetables | Provide user information services. |
| Fleet monitoring | Fleet control, real times arrival estimates. |
| Accident data | Generate accident management strategies. |
| Parking ticket sales | |

Table III.1: Potential data and information development for ATM Pianificanzione.

✓ ***ATM Esercizio***

ATM Esercizio require more accurate information relating to vehicle locations and bus services adherence to timetables. Improvements in information provision to the public is also envisaged, using geographical Information System displays and interfaces.

✓ ***ATM Parcheggi***

ATM Parcheggi requires a more complete data set, to permit a dynamic study of mobility and to assess existing commercial parking policies. Extended occupation figures, disaggregated by geographical location and time period are required for the whole of the Turin area. A significant aim of ATM Parcheggi is the provision of improved real-time information to motorists, indicating parking space availability and directions to reach designated locations. This could also stimulate an increase in demand for park and ride services. Such a

rationalisation of parking in Turin will reduce the cost of operating and maintaining sites, while increasing the revenue generated by ATM Parcheggi. However, a lack of integration exists between the various systems, and interfaces with relevant databases remains difficult. Data stores are commonly established for set and varied purposes and are thus organised differently. Furthermore, the updating processes required to provide increased parking information to drivers do not exists to-date.
Improvements within 5T are required in the collection and dissemination of information, including:

- Pre-trip information: on suitable modes and routes, parking availability and incident occurrence. Information on public and private journey times and parking availability is also required.
- On-trip information: pertaining to route guidance using VMS, estimated travel times and public transport availability provided at bus stops. Accurate measurements of travel times, flows and network restrictions are required, which are not available within the existing system.
- Information of incidents using VMS and Teletext services.

The collection of more detailed network information could be utilised to provide accurate and real-time route guidance to drivers, thus improving network efficiency and reducing vehicle hours driven. The exploitation and integration of data collected within 5T would increase the efficiency of systems connected to it, and reduce the operating costs involved. The integration of all transport operators within a TDSS would provide the opportunity meet the requirements outlined above. A TDSS will necessitate improvements in management and maintenance activities, associated with greater data reliability and system functionality. Improvements in data storage activities are required, as information is currently stored for a fixed period and subsequently erased. This removes the opportunity for additional value to be generated by the data. Information is also not made available to all potential users as access is presently considered unnecessary, producing an inefficient exchange system.

## III.2 UNITED KINGDOM – ROMANSE (SOUTHAMPTON)

Research in the UK to promote the integration of data collection and network management tools, has led to the development of Urban Traffic Management and Control Systems (UTMC's). Such systems are epitomised by the ROMANSE (ROad MANagement System for Europe) Traffic Information Control Centre (TICC) operating in Southampton within the DRIVE II project EUROSCOPE. The vision of the ROMANSE project is to generate "an information rich society based on Advanced Transport Telematics (ATT), in which travellers and operators have access to up-to-date information on traffic conditions and travel opportunities" [4]. It is envisaged that this will lead to more informed and responsible travel choices and improved living and travelling conditions for the South Hampshire area. In turn this will influence travel demand, encouraging a shift in modal preference, journey times and route. A large amount of data is collected and exchanged by these actors. Table III.2 summarises the main data flows between selected interfaces (users).

---

[4] Wren, A. C., & Laughlin, K. G. (1997) "ROMANSE - Monitoring and Evaluating. ITS" 4th World Congress on Intelligent Transport Systems. Berlin 1997

| Interfaces | Data | Function |
|---|---|---|
| Public Transport Operator | Schedules, updates, information | 5, 6 |
| Public Transport Passenger | Bus location, priority, | 5, 6 |
| ROMANSE System Operator | Equipment status, incident data, information exchange, map displays | 1, 8, 9, 10 |
| ROMANSE Transport Planner | Incident data, modelling data, policy inputs and strategy analysis, travel demand figures, | 1, 2, 3, 8, 10 |
| Southampton Port Information Network (SPIN) | VMS data on entering ports | 3, 7 |
| TrafficMaster Central System | | 6, 7 |
| Travel Terminal Network | | 6, 11 |
| Vehicle Image | | 3 |
| Vehicle Presence | Vehicle counts leading to traffic flow computation | 1, 2, 3, 7, 8 |
| Pre-trip Traveller | Itineraries of trips | 2, 4, 6, 10, 11 |
| Drivers and Pedestrians | Current and predicted occupancies, leading to VMS parking guidance | 2, 3, 4, 6, 7 |
| Emergency Services | Vehicle location leading to prioritisation | 3, 7 |
| Environmental Conditions | Pollution levels | 1 |
| GIS Data Supply | Digitised map data | 6, 8, 9, 10, 11 |
| GPS Data Source | GPS data | |
| Internet | Data and trip plan requests | 3, 4, 6, 9, 10, 11 |
| Maintenance Organisation | Equipment status | 1, 5 |
| Media Presenter | Incident reports | 6, 7 |
| Other TTIC’s | Input information from external systems | 6, 7 |

Table III.2: ROMANSE terminator descriptions.

The data collection and dissemination processes are undertaken by a number of sub-systems, which in turn are related to general policy and management functions of the ROMANSE approach. These functions are referred to in Table III.2 and are identified in Table III.3. The ROMANSE system architecture was designed to define and integrate the interfaces, functions, sub-systems and communications involved in meeting user needs. To facilitate the collection, processing and transference of all required data, the ROMANSE system was constructed around a Traffic and Travel Information Centre (TTIC). There are several data stores within the ROMANSE system, including those for digitised map data, GIS data, network data, public transport operations data, public transport schedule data, strategy store and traffic data. Such information is made available to other functions and interfaces on a request basis.

| Function | Physical Sub-systems |
|---|---|
| 1. Road management and logistics | PREFECT, Planning |
| 2. Demand management | Planning |
| 3. Traffic management | UTC, INGRID, ARTEMIS |
| 4. Parking management | UTC |
| 5. Public transport management | STOPWATCH |
| 6. Traveller Information | TRIPlanner |
| 7. Traffic Information | ITMC, Travel Terminal |
| 8. Internal services | UTC, SIS, STOPWATCH, VMS |
| 9. Provide map based display | SIS |
| 10. Manage network data and incidents | ITMC |
| 11. Provide WWW interface | WWW Server |

Table III.3: ROMANSE functional areas and sub-systems.

### Data Requirements and System Limitations

Despite the high performance of the ROMANSE system inefficiencies remain and substantial amounts of data are under-utilised or lost. The following areas of ROMANSE are presently under development and represent areas that could lead to, and be promoted by the establishment of a more complete TDSS:

- In-trip traveller information using roadside Variable Message signs.
- On-trip traveller information on board public transport vehicles.
- Pre-trip travel information using public access terminals and in-home/office terminals.
- The application of a "pre-gate" facility to improve access for freight vehicles to the port of Southampton using SMARTCARD technology.
- Comprehensive monitoring of the transport network which will include environmental studies.
- Integrated Incident Management Strategies.
- Links between control and information centres.
- Strategic Information Systems links with travel information.

Further to these, a greater coverage of South Hampshire is required to include areas where data is not currently available. As in Turin, increases in data coverage and quality will necessitate the development of more advanced storage and exchange systems. At present, network and parking information is erased after a fixed period, making it unavailable for long-term strategic planning purposes. Another potential area of development is crisis management relating to traffic incidents. At present, CONTRAM is used off-line to model incident management strategies. Increased data collection and more detailed network monitoring could facilitate the implementation of on-line modelling, generating real-time solutions. However, improvements in the on-line modelling tools are required, such that they more efficiently fit the systems presently used by ROMANSE operators. The collection and storage of data required for this process is considerable and could only be accommodated within a more integrated and efficient exchange structure. Improvements in the prioritisation of public transport modes are also planned, incorporating accurate vehicle location systems and additional roadside beacons. However, the network of beacons and dissemination software required is again considerable and must be compatible with existing ROMANSE systems.

Automatic traffic counts are required, utilising technologies such as numberplate recognition, to reduce data collection costs. Improvements in data quality and accuracy would be produced, introducing the ability to link many sites within a single network. Developments of this nature would need to be effectively co-ordinated and automated, so as to increase data quality and coverage, not simply the amount of data collected. Existing systems are not suitable for this process. Following the deregulation of public transport services in the UK, operators are permitted six weeks to notify local authorities of changes to service timetables. Although authorities are informed of changes, they are not permanently at liberty to act upon them, because of financial and personnel constraints, with schedules therefore becoming out of date. Public transport operators are encouraged to provide information in a standard and electronic format, allowing accurate information to be provided to the public.

An example of the present incompatibility of transport systems is the use of Geographical Information Systems (GIS). Mapinfo is presently used to display public transport accessibility in the short-term while ArcInfo is used for the long-term research and database design. These two GIS systems, and a further process considering development control, are not at present compatible. The long-term aim is to unify the three systems, thus making more efficient use of available data sources. More detailed monitoring of car park occupancy is also required, thus increasing the accuracy of parking guidance information given to drivers. However, institutional barriers and issues of data ownership exist that prevent the development and operation of a single data sharing system.

## III.3 THE NETHERLANDS (ROTTERDAM)

A central consideration and potential barrier to data integration on a European-wide basis, is the issue of data standardisation. Telematic applications are at an early stage of development, so *de facto* standards are not widespread and commonly do not spread beyond national boundaries. The US has acknowledged the importance of standards within and between system architectures, pursuing research within the ISO TC204 programme[5]. The EU established the CEN TC278 standardisation project to similarly consider all aspects of urban transport data. However, significant variations between, and even within, individual nation states remain. The collection and exchange of traffic data in Rotterdam, the Netherlands, considers this issue further. Information used by Traffic Information Centres – Netherlands (TIC-NL) consists of both automatically and manually collected information. The sources of the former are the MoniCa (collection of data) and MoniBas (calculation of basic information, for example travel time) systems that at present operate at a regional level. Currently, no traffic data is obtained from neighbouring countries, although TIC-NL is in discussion with Belgium and the border provinces of Germany. For the distribution of information to the customers of TIC-NL the DATEX-TRAVIN format is preferred, using RDS-TMC coding[6]. The experience of TIC-NL with the DATEX-standard[7] is that it is at points ambiguous. Problems are therefore foreseen regarding the interoperability of systems that have their own interpretation of the DATEX-standard.

The vast majority of the Netherlands primary road network is equipped with vehicle detection loops, consisting of monitoring configurations and signalling configurations. The former has loops located at every intersection, while the latter has loops every 500 meters. However, at the regional level, the location of vehicle detection loops and the description of the road network are coded into different databases. Thus, to identify the exact location of any loop, the position of the road and associated traffic lanes must first be established. This process makes analysis difficult and time consuming. Furthermore, several independent signal operators are responsible for collecting traffic data for urban areas, and they employ a range of protocols and storage mechanisms. Developments are underway, using the MoniCa system, to establish a single collection process and database at the regional level, a process that will also permit some technical data validation. The introduction of the IVERA-protocol to standardise traffic signal data is envisaged on a nation-wide level. However, the present inability of individual member states to develop urban data sharing systems that are compatible represents a significant barrier to the development and implementation of a TDSS.

---

[5] ISO TC204: http://www.sae.org/TECHCMTE/204.htm

[6] POTGRAVEN, P. J. G., 1997, Information for clients of TIC-Nederland. Report produced by TIC-Nederland

[7] SALA, A. AND TRENTA, G. 1997, DATEX: Data exchange in Europe. *Traffic Technology International*, Dec 1996, 50-52

## III.4 GERMANY AND AUSTRIA

Resulting from research and funding since the 1980s The "ÖPNV[8] Data Model", also known as the "VDV[9] Data Model" outside German territory, has provided a basis for data modelling in public transport in Austria and Germany. A decade since the introduction of a universally applicable data model for all standard applications in the transport business was first considered, many service providers have been guided by the ÖPNV Data Model and developed their own product data model using it as a basis. The VDV awarded a large number of these service providers the "compatible with the ÖPNV Data Model" rating. In many transport operator advertisements, "compatibility with the ÖPNV Data Model" has become a much-used claim.

Due largely to the success of the ÖPNV model, the VDV faced increasing demands to also develop practically orientated solutions, extending beyond the capabilities of the ÖPNV Data Model. The model is seen as a basis since it is written in a language which can be understood by a wide number of users. It incorporates ideas which include standard interfaces which, due to their plug-compatibility, are instantly usable, and permit standard software modules to communicate with each other at a reasonable cost.

The demand in public transport for readily usable interfaces has not only been generated by the transport operators themselves but also by third parties. In dynamic areas such as passenger information, a steadily increasing demand for information from non transport-related businesses is evident. However, the need for communication beyond the boundaries of the transport business is also rising due to co-operatives and the formation of public transport bodies. This has let to the VDV's establishment of an initiative entitled "The ÖPNV Interface Initiative" in order to promote the creation of standardised data interfaces based on the ÖPNV Data Model.

These interfaces basically represent a part of the ÖPNV model. This, therefore, is not a new concept, but features a logical application of the ÖPNV Data Model which was the result of many years of investigation. Provision of a more exact description and an expansion on technical specifications concerning data transfer, as well as functional aspects, means, however, that it is more practice oriented than was the case with the simple ÖPNV Data Model.

## III.5 INTERNATIONAL RESEARCH – UNITED STATES OF AMERICA

The US National ITS Architecture documentation provides an excellent source of reference on ITS systems. A fundamental element of ITS America is the integration within the overall transport planning processes, taking into consideration the broader set of goals, policies and programmes. Features of the US architecture that increase the benefits from ITS include sensitivity to larger transportation planning and policy objectives; system flexibility and openness; system modularity; support for multiple levels of functionality and technical sophistication; leverage of existing infrastructure and communications systems; opportunities for interface specification and standards; deployment within existing institutional arrangements; and effective allocation of costs and benefits. The National Architecture includes an ITS Planning market package to facilitate co-ordinated ITS planning and

[8] *Öffentlicher Personennahverkehr* – Public Transport

[9] *Verband Deutscher Verkehrsunternehmen* - Association of German Transport Operators

deployment. At its broadest level, this market package allows local ITS implementers and transportation decision-makers to consult a common set of information about ITS and associated technology implementations. For planning purposes, this information can lead to more effective ITS research, development, planning and implementation.

The US architecture depends upon several collection packages, including network surveillance and vehicle tracking, which provide a significant amount of information relating to transport operations. The collection of large amounts of data enhances the practise of ITS and also more traditional transport planning and evaluation. Importantly, the US has identified the need to integrate long-term considerations, alongside the more prominent urban traffic control and management. The need to support transportation planning issues though links with key organisations represents a central element of architectural designs. The eventual integration of transport planning and surveillance/monitoring functions is envisaged.

# IV. TDSS PROJECT USER REQUIREMENTS

The users' needs analysis consists of identifying the users, discussing the relevant domains where information is exchanged or intended to be shared and listing and summarising the constraints and wishes for future TDSS.

The DIRECT case studies[10] have been used for building the core requirements and completed where needed by other sources so as to give a more significant picture of a TDSS. Users' needs analysis has been used as an input towards more precise specifications, so as to propose in the end architectural as well as non-technical (organisational, institutional, legal and financial) recommendations.

It appears that the requirements are very diverse from one city to another, that the users have a clearer idea of their information requirements than of their information exchange system needs, and that actual needs are - unsurprisingly - oriented towards improving current applications and systems rather than developing fully integrated all-purpose data exchange structures. Nonetheless, when adding together all the site specifics, we get a quite adequate picture of what would be a generic TDSS, which covers the diversity of situations, and will be hopefully useful for tools and recommendations relevant for any given European city.

Urban transport data concern actors responsible for main roads, toll roads, public transport, railways, parking, facilities, emergency, police, administrations, environment. Data sharing between actors is needed in applications domains such as ticketing, vehicle priority at intersections, observatory, park and ride, traveller information, co-ordination of operations, planning, and modelling. The requirements have been considered at three levels : strategic, operational and technical, which match the users role of decision-maker, operator and technical staff.

At the institutional level, a TDSS is seen as a tool helping at sustainable co-operation between urban transport stakeholders, and at defining and implementing integrated transport strategies. Such a structure could only be incrementally developed in the long run from the existing systems, and therefore needs to be adaptable to any foreseeable kind of exchange and data types.

At the operational level, the improvement of the data quality and information chain processes is a major issue, which is related to issues such as defining a reference network, aggregation or sampling levels, and metadata. Actual users of a TDSS are either software applications or human operators, that access to data on occasions or on a regular basis.

At the technical level, operations, administration, maintenance and provision for the TDSS will require resources, in particular if a transport data archive is implemented ; this is seldom considered in initial opportunity studies whereas it should not be underestimated.

Data to be exchanged can be either structured (e.g. geo-referenced, traffic, events, supervision, mobility, financial data) or unstructured (e.g. documents, notes, forum, images) ; data types used and volume, timeliness, and availability constraints depend on the application domain. Relevant metadata is seen as a key to ensuring success of a TDSS. Some standard

[10] Lille, Lyon, Turin, southampton, barcelona, brussels and Rotterdam

protocols and formats do exist, however a TDSS will have to handle heterogeneous representations and communications, which incidentally demand that these are unambiguously documented.

Functions of a TDSS comprise the exchange itself (collect, store, send, broadcast, share, and workflow) and the associated processes (search, check, convert, log, copy, export, and automate).

Non-functional requirements are key criteria for architectural design. At this level of generality, we can only say that a TDSS should be seen as an open toolbox which includes modules such as secure intranet, archive, data quality control, pre-defined report edition, interface to transport application such as traffic control, fare collection, or traveller information, as well as interfaces to general-purpose software package such as GIS, spreadsheet, word-processor, simulators.

## IV.1 USERS IDENTIFICATION

In general for software applications[11] four categories of actors are considered: stakeholders, primary users, secondary users and end-users. However, the TDSS is more of a « back-office » concept, meaning that the end-users are not connected to it directly, but rather to some traveller or traffic information service (which itself is connected to the TDSS). Another category of actor often considered is that of system designers and providers.

| Role | User category | Mission | Level |
|---|---|---|---|
| Decision makers | Stakeholders | Responsible for strategy, budget<br>And change management | Strategic |
| Process owners | Operator : primary user | Responsible for quality of service<br>(including information chain) | Operational |
| Technical staff | System administrator : secondary user | Maintain the systems | Technical |

Table IV.1 Users identification

## IV.2 DOMAINS / APPLICATIONS

The following table summarises typical correspondence between organisations and ITS applications which have been identified as potentially connected to a TDSS.

| | ticketing | PT oper. | Observatory | Park + ride | planning | information | traffic | co-operation |
|---|---|---|---|---|---|---|---|---|
| Main roads | | | X | | X | X | X | X |
| Toll roads | X | 0 | X | | X | X | X | X |
| PT | X | X | X | X | X | X | X | X |
| Railways | X | | X | | X | X | X | X |
| Facilities | | | X | | X | X | 0 | X |
| Urban roads | | X | X | X | X | X | X | X |
| Planning | | | X | | X | X | | X |
| ISP | | | X | | X | X | | 0 |
| Emergency | 0 | X | | | | X | X | X |
| Police | | X | X | | | X | X | X |
| Parking | X | | X | X | X | X | 0 | X |
| Other adm. | | | X | | X | | | 0 |
| Environment | | | X | 0 | X | X | 0 | X |

(X : major need ; 0 : occasional need)

Table IV.2 Organisations versus ITS functions

11 see Converge system architecture guidelines [5]

## IV.3 FUNCTIONS

After a discussion on strategic requirements, including identifying major barriers and benefits expected from a TDSS, the needs' analysis has focused on the link between the basic TDSS functions and the applications to be connected to a TDSS, as shown in the table IV.3 below.

| | collection | Broadcast | messaging | repository | sharing | workflow |
|---|---|---|---|---|---|---|
| Ticketing | | | | X | | X |
| PT operations | | | X | 0 | X | |
| Observatory | X | X | | X | | |
| Park + ride | | | X | 0 | | |
| Planning | | | | X | | |
| Information | X | X | | X | | X |
| Traffic management | | | X | X | X | |
| Co-operation | | | X | | X | |

(X : major need ; 0 : occasional need)

Table IV.3 Application domains vs. Exchange functions

## IV.4 USE CASES

The functional requirements are represented as interactions between the users and the TDSS in the following use cases diagram (figure IV.1). A document can be an actual readable document, a data file or any other piece of information. The TDSS user is either a human operator or a software app

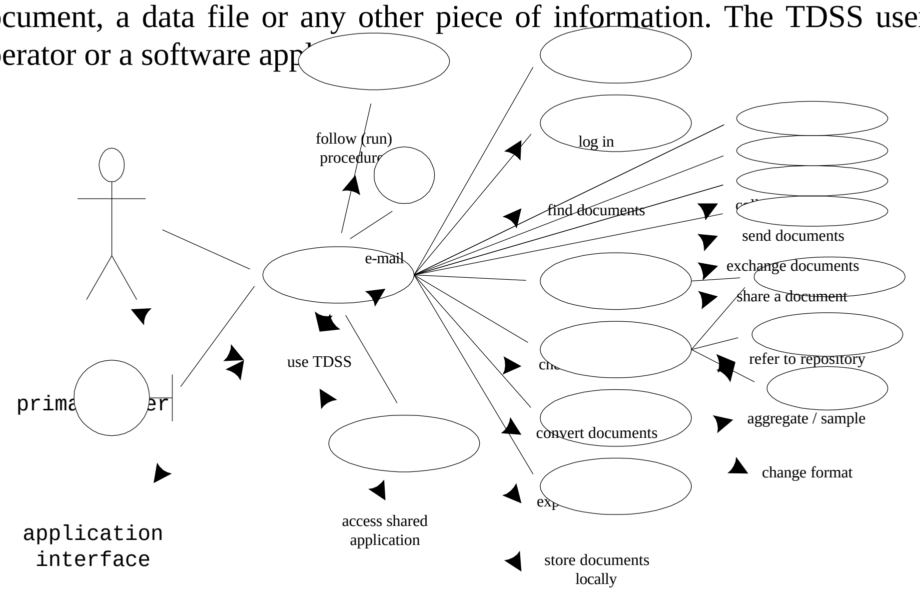



Figure IV.1 Functional requirements

## IV.5 SECONDARY USE CASES

The TDSS users' needs (access to a network, possibly to databases, access security, etc.) induce Operations, Administrations, Maintenance and Provision (OAMP) needs. The TDSS will thus, in one way or another, require resources and staff for its OAMP. At this level, no clear requirements have been stated so far, except that of minimising costs, partly because the induced OAMP costs will depend on technical design and solutions. This need is often overlooked by the stakeholders but concerns them as they agree on a common organisation for the TDSS and define a resource allocation mechanism. Another important requirement is related to archiving. As for OAMP, the need for managing archived data exists, whether the archives are centralised or not. However, although the need for accessing historical data over longer time periods (i.e. the need for archives) has been widely recognised, the secondary need for managing the archives is seldom stated explicitly.

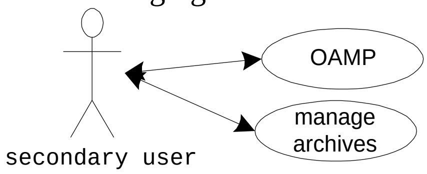



Figure IV.2 T*echnical use cases*

## IV.6 DATA

The typology of information for a TDSS is quite broad : diversity, complementarity and the potential overlaps between data sources are of concern. A major difficulty relating to data is that heterogeneity is inevitable and must be taken into account. Even for data of the same type (e.g. traffic measurements or network description) differences can occur at the three levels that characterise data in general: Conceptual view - models, Representation - formats and Content - scope (time-scale, geographic coverage). Moreover, the TDSS should be able to incorporate new data flows as they are made available by organisations. Therefore, metadata will have a crucial importance in a TDSS. The information types we identified are:

| | Structured | | | | | | | unstructured | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | geo-ref. | traffic | events | supervision | mobility | finance | others | reports | notes | forums | image, voice |
| Ticketing | 0 | 0 | | 0 | 0 | X | | | | | |
| PT operation | 0 | X | X | 0 | | | | | | | |
| Observatory | X | X | 0 | | X | X | X | X | | | 0 |
| Park + ride | 0 | X | X | 0 | | | | | | | |
| Planning | X | X | X | | X | X | X | X | 0 | 0 | |
| Information | X | X | X | | | 0 | 0 | 0 | | 0 | X |
| Traffic mgt.. | X | X | X | 0 | | | 0 | | X | | X |
| Co-operation | | | | | | | | X | X | X | 0 |

(X : major need ; 0 : occasional need)

Table IV.4 Information types

## IV.7 NON-FUNCTIONAL REQUIREMENTS

Non-functional needs include traceability, multi-vendor procurement, compliance to standards, quality and methods, smooth integration with legacy systems, progressive deployment, modularity, extensibility, scalability, multi-service, open to international users, adaptable to new needs, availability, robustness, coherence, security, safety, user-friendliness, performance, testability. Of course, it must be remembered that so-called non-functional issues do have a functional impact on the system. They play a key role in the architecture solutions.

## IV.8 TECHNICAL CONSTRAINTS

It is difficult to give generic constraints for a TDSS, as the constraints reflect the existing systems and resources. Listed below are general requirements identified:

| | Volume | real-time | availability |
|---|---|---|---|
| Ticketing | Medium | high | very high |
| PT operation | Low | very high | very high |
| Observatory | High | low | - |
| park + ride | Low | medium | high |
| Planning | High | low | - |
| Information | High | medium | high |
| traffic mgt.. | Medium | high | high |
| co-operation | High | low | - |

Table IV.5 General requirements by information types

The data exchanges between two systems rely on successive layers: human user, semantic level, format, and network. As the systems communicate via layers, interfaces are to be properly defined. A very crude classification is as follows:

| | Structured | | | | | | | Unstructured | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Geo-ref. | Traffic | events | Supervision | mobility | others : finance, env., socio-eco... | | reports | notes | forums | image, voice |
| Comm. | Digital : usually TCP-IP over any network link | | | | | | | word-processors | e-mail | e-mail | analog and digital |
| Storage | GDF | Specific | DATEX | Vendor-specific- | ? | ISO smart cards | ? | | | | |

Table IV.6 Classification of data exchange

## IV.9 CORRESPONDENCE BETWEEN DIRECT AND CASE STUDIES

Table IV.7 gives a very simplified view of the TDSS applications in each of the DIRECT sites, so as to show how this general summary is linked to the case studies.

| | Lille | Lyon | Turin | Southampton | Barcelona | Rotterdam | Brussels |
|---|---|---|---|---|---|---|---|
| Ticketing | not studied here | not studied here | experimental | operational | operational | not studied here | not studied here |
| PT operation | not studied here | not studied here | operational | operational | operational | not studied here | not studied here |
| Observatory | under dev’t | under dev’t | considered | to be improved | considered | considered | under dev’t |
| Park + ride | not studied here | not studied here | operational | operational | to be improved | not studied here | not studied here |
| Planning | considered | considered | to be improved | operational | to be improved | considered | considered |
| Information | not studied here | not studied here | operational | operational | to be improved | operational | not studied here |
| Traffic mgt.. | not studied here | not studied here | operational | operational | not studied here | not studied here | under dev’t |
| Co-operation | considered | considered | considered | considered | considered | considered | considered |

Table IV.7 Overview of the TDSS application in each of the DIRECT site

## IV.10 DIFFICULTIES WITH THE REQUIREMENTS ANALYSIS

The reader might have noticed a discrepancy between the requirements as described in this general summary and those mentioned in the site studies. Two observations can be made:

- Users have a clearer idea of the data and information they need than the kind of information exchange system they want.

- An explicit project encompassing an all-purpose TDSS does not exist in any project site. However, partial improvements of existing information exchanges between organisations or systems, reflecting the diversity of local situations, do exist.

The TDSS concept has been forged from top-down considerations (that lead to the transport research task identified in the European call for proposals) and two major trends:

- A more integrated urban transport.
- An ever increasing usage of information technology.

A closer integration between all transport information systems and applications is therefore anticipated, in particular in the major urban areas; however this long-term vision (or concept) of a TDSS is not commonly shared by the urban transport actors, who have more mundane goals of improving their existing information systems. This explains the gap between the case studies and the inferred requirements of what would be a generic TDSS. Even if the general TDSS doesn't exist in reality, we feel that the conceptual framework is valid for a wide diversity of actual situations encountered in European cities. Transport data is ever more shared and the TDSS will continue to improve this thanks to:

- Co-operation between organisations.
- Efforts on data quality.
- Information exchange tools.

# V. TDSS FUNCTIONAL SPECIFICATIONS

A TDSS is a system exchanging data between distributed data bases, whose users include urban transport applications (Figure V.1).

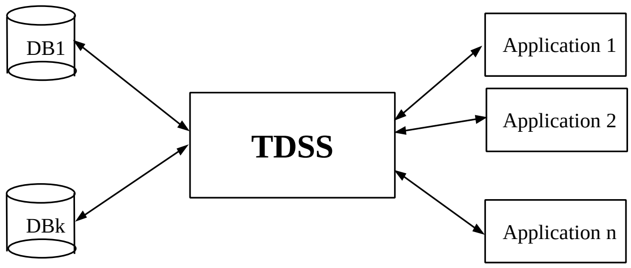



Figure V.1: Outline of the role of a Transport Data Sharing Structure (TDSS).

Starting from this information, this section considers the specifications of functions of a generic TDSS.

## V.1 TDSS CONCEPTUAL MODEL SPECIFICATION

TDSS functions can be classified in two main types, ***transport planning*** and ***traffic management.***

### V.1.1 TRANSPORT PLANNING

Transport planning is aimed at improving mobility in the medium to long-term. The use of computing tools to assist in the decision making could be through :

- performing the diagnosis of present or future insufficiencies of the transport system
- testing and comparing potential strategies which could be implemented
- carrying out export analysis of policies and measures
- monitoring the achievement of policy goals
- etc.

### V.1.2 TRAFFIC MANAGEMENT

Traffic management deals with the on-line monitoring and control of transport systems. It aims to improve mobility on-line by keeping operators and users informed as to the state of the transport system and enabling operators to take appropriate control measures. For example, it aims to provide:

- road network operators with on-line information concerning traffic conditions and access to traffic control equipments (traffic signals, VMS, etc.);
- car users with on-line information relating to route guidance (linked to existing road traffic conditions), parking availability and public transport availability;
- public transport operators with on-line information to enable them to modify service routes if an accident happens, and deal with possible technical problems of a vehicle.
- public transport users with bus stop on-line information about service characteristics such as the departure time of the next vehicle and on board information such as the name of the next stop and the expected time of arrival at next stops.

### V.1.3 INTERACTION BETWEEN TRANSPORT PLANNING AND TRAFFIC MANAGEMENT

Both approaches are linked: data exchanges take place between both systems at various levels and in both directions (Figure V.2):

- from the planning system to the integrated traffic management system : vehicle origin-destination data which can be used as a starting point for on-line matrix estimation and calibration; and
- from the integrated traffic management system to the planning system, comprehensive traffic flow data collected by control system detector[12] can be used, network response characteristics[13] provide with parking data and general journey time data.

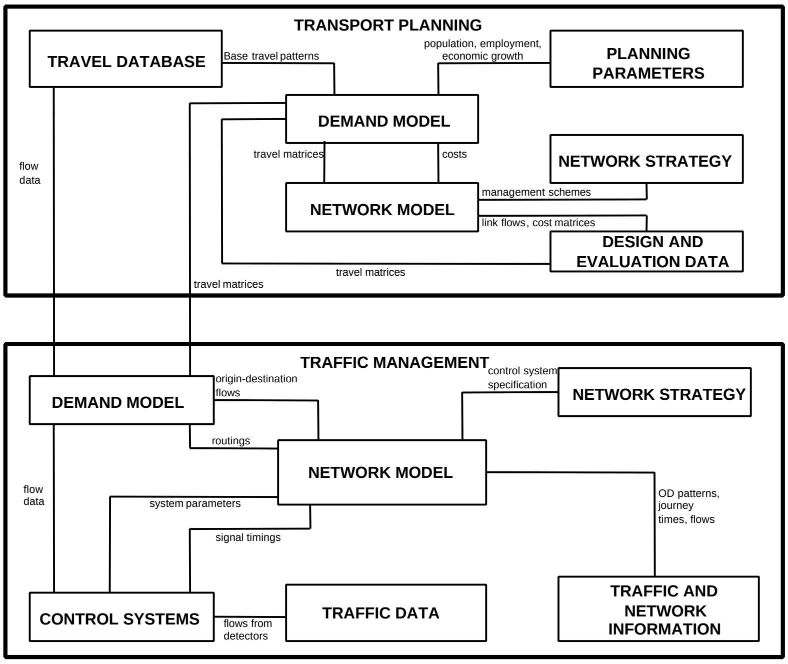


**Figure V.2 : LINKS BETWEEN TRANSPORT PLANNING AND INTEGRATED TRAFFIC MANAGEMENT**

The Barcelona DIRECT prototype considers on line data such as car traveller origin and destination requests, optimal multi-route displays, parking space booking as well as off-line data, such as planning data concerning travel demand, data concerning demographic and socio-economic features.

Both operational and planning model systems have common databases, which are updated according to the changing conditions in a network.

Figure V.3 provides a general conceptual model of the integration of both static and dynamic data within a TDSS. The identification of data sharing functions and specifications required to develop a TDSS is addressed in section V.3 of this document.

Off-line traffic management functions are fed by a « static » database, which is updated using infrastructure data (supply side) as well as on-line management data. On-line traffic management functions are also partly fed up by static data bases.

[12] To update the base travel pattern, notably in case of marginal forecasting when a good representation of the base situation is necessary

[13] change in journey times in response to change of network loading

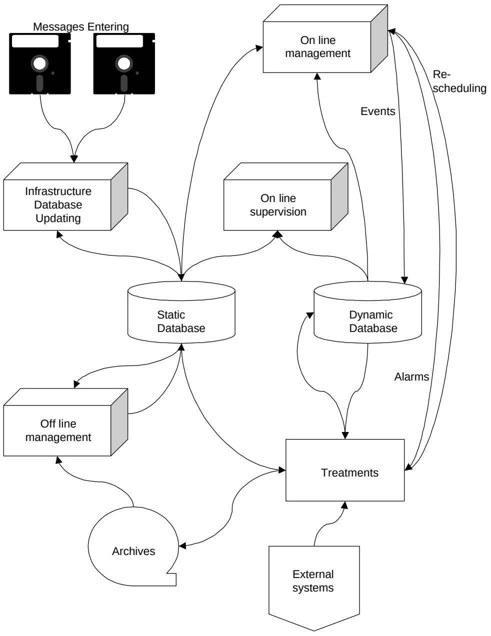



Figure V.3: General conceptual model according to the integration of both static and dynamic data

## V.2 TDSS DATA SPECIFICATION

### V.2.1 DATA CHARACTERISTICS

The examination of Barcelona and Lille DIRECT prototypes as well as the Brussels case study have led to a general overview of the required input data for a TDSS and the possible links between transport planning and traffic management (Figure V.4).

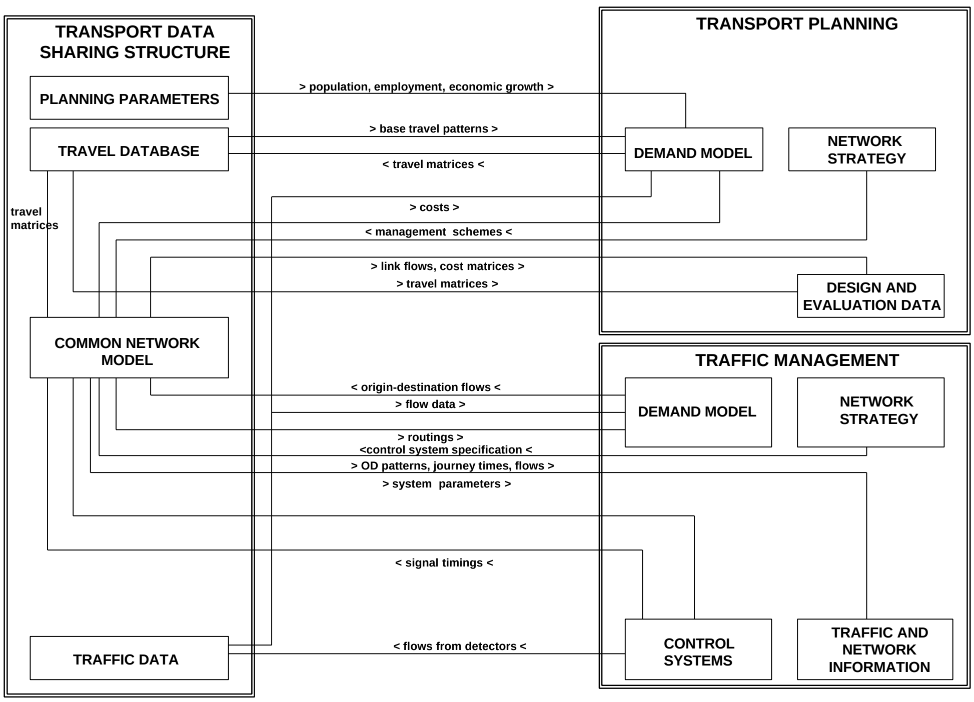



Figure V.4 : POSSIBLE LINKS BETWEEN TRANSPORT PLANNING AND INTEGRATED TRAFFIC MANAGEMENT THROUGH A TRANSPORT-DATA SHARING STRUCTURE

TDSS data can be characterised according to items describing ***transport supply*** or ***travel demand*** by origin-destination zone.

Transport supply data consists of three main sub-groups : road, public transport and parking. Although different approaches are used for road and public transport supply information both can be linked.

✓ ***Transport supply***

| |
|---|
| <u>*Road supply*</u><br>The information characterising road systems can be itemised in a structure set up on two types of entities:<br>➢ **node** : a single point on a road network normally defined as a junction or single point within a complex of junctions (entry or exit of the junction).<br>➢ **link** : a road section delimited by two successive nodes, or possible movement between an entry node and an exit node within a junction<br>Traffic model software[14] generally used for off-line traffic monitoring and forecasting are computed on this structure. |
| <u>*Public transport supply*</u><br>Information about public transport services can be itemised according to the following structure:<br>➢ **nodes**: which represent public transport stops/stations or single points of the infrastructure;<br>➢ **links**: which represent the route sections between successive nodes; and<br>➢ **service characteristics**: including operator, mode, route in terms of succession of nodes, headway according to type and time of day and stop equipment/furniture. |
| <u>*Parking supply*</u><br>Parking supply information can be split into two central groups:<br>• On-street parking spaces itemised according to road section units defined by their respective identificators.<br>• Off-street parking categorised by their connecting nodes with the road network. |

*Although different approaches are used for road and public transport supply information both can be linked.*

✓ **Travel demand**

| |
|---|
| <u>*Origin-Destination matrices*</u><br>➢ **Origin and destination zones** are defined according to Statistical sector limits[15]<br>➢ **Cells size of Origin-destination matrices** is related to the number of trips it generates and attracts |

*The zones are connected to the road and public transport networks by fictive links between nodes of the network and the gravity centre of the zone.*

### V.2.2 DATA CLASSIFICATION AND UPDATING

According to the classification of TDSS functions in two types, as presented at section V.1, data can also be classified into three groups according to their appropriate updating frequency related to the need of the application.

[14] Like SATURN, TRIPS, MEPLAN, TRANUS,…

[15] One zone is composed of one or several entire "statistical sectors". A "statistical sector" is the smallest geographical entity for which statistics characterising travel demand are available

✓ **Static data**
For static data, changes are small or few over time. For example, they concern road infrastructure or population and employment. These are useful for off-line transport system monitoring and particularly in a posteriori analysis of policies and measures, in off-line design of new strategies and short/medium term forecast of the traffic conditions. These data do not fluctuate significantly over short periods and their collection is difficult and expensive. Hence, a five to ten years updating frequency is appropriate[16].

✓ **Semi-dynamic data**
Semi-dynamic data are linked to predefined or periodic events. For example, demonstrations, road works, weather conditions can be forecast as well as their consequences in term of road capacity restriction or road level of service. These data fluctuate over time but non continuously. They have to be regularly updated[17].

✓ **Dynamic data**
Dynamic data are describing real time traffic evolution. For example, real time road traffic counts and public transport services compliance with their time schedule, which enable to provide an on line overview of the transport system status at any time of the day. Of course, dynamic data have to be updated in real time[18].

APPENDIX 1 provides a list of 'raw' data referenced by themes and data type[19], which has been built in accordance with various European sites within the DIRECT Consortium and represents a comprehensive list.

### V.2.3 DATA OWNERSHIP

The actors involved in data ownership are :

✓ ***All actors concerned by the transport system*** :
- local, regional and national authorities
- public transport operators
- road operators
- public car parks operators

✓ ***Producers of other related statistics***, such as :
- emissions and noise measurement institutes
- meteorological organisations

### V.2.4 DATA AVAILABILITY

The DIRECT prototypes and case studies have demonstrated that :
- Data are presently available from individual data owners or from "information island" applications.
- It is common use to address the needs of a given operator for a given purpose.

The purpose of TDSS is to provide data to the whole set of transport actors.

---

[16] In Belgium the General Population Census which provides population and employment data is carried out every 10 years

[17] Events have to be characterised in terms of nature, location, time and duration, and stored in a log book. The period between two updates of semi-dynamic data has to be defined in accordance with the period within their impacts can be forecast.

[18] On the Brussels server, road traffic count averages are presently available every minute for the last six minutes.

[19] S = Static data; SD = Semi-dynanic data; D = Dynamic data

## V.3 TDSS SPECIFICATIONS

### V.3.1 OVERVIEW OF A TDSS

The DIRECT project has identified a TDSS as composed of three key layers (Figure V.5):

- A data layer
- The role of this layer is to provide the data, to store them and to guarantee their quality (by manual and/or computerized control)
- An Application layer:
- This part concerns the user needing to consult or update the data
- a TDSS layer:
- This layer is the strategic layer which allows communication between applications and data sources. The TDSS knows where to find and retrieve the data required by the applications within the confines of the user's data rights.

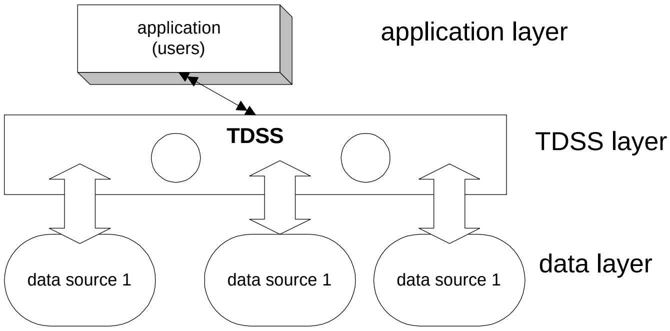
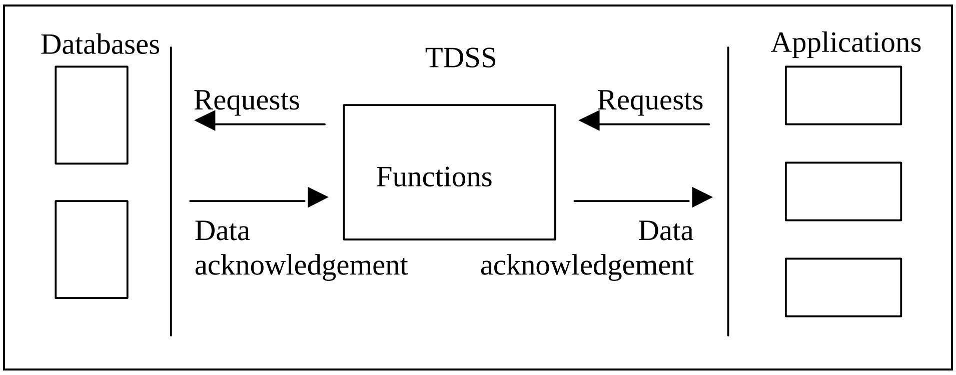



Figure V.5: levels in the TDSS specifications[20]

The DIRECT project has also distinguished two types of TDSS functions :

- requests for data consultation
- requests for data updating

Figure V.6 shows the steps decomposition of a request:




[20] note that depending on the actual application and site :
- there may be one TDSS for each application, or one TDSS for all applications (if there are several), or something in between
- the application may reside in the same machine as the TDSS
- the application may reside in a machine which is also a data source
- the application may be limited to a manual access to the TDSS by a human operator

Figure V.6: Decomposition of a request

- First, an application sends a request to the TDSS. It could be a consulting or an updating request.
- Then the TDSS receives the request and controls the rights associated to the application's user. If the user does not have the correct rights, the request is rejected. In the other case, the TDSS transmits the request to the databases concerned.
- Finally, the databases operate an authentication check and then execute the requests (update or consulting data) and reply to the TDSS (with an error code or the data depending on the request).

### V.3.2. GENERAL CHARACTERISTICS TO BE ENVISAGED IN THE DEVELOPMENT OF A TDSS.

- Data requirements

| |
|---|
| *Voluminous data*<br>➢ Transport of this data is often responsible for network overloading |
| *Constraints time data*<br>➢ Some data have a short validity period and need to be brought as fast as possible |
| *Other data*<br>➢ Which are not subject to particular constraints |

✓ ***TDSS Functional requirements***

| |
|---|
| *Security*<br>➢ *Authentication Service*: provides an assurance of the identity of a user.<br>➢ *Authorisation Service*: assigns privilege to a user. This applies to different multi-level users in an application.<br>➢ *Confidentiality Service*: make sure that only the authorised user receives information.<br>➢ *Integrity Service*: prevents data from modification without authorisation.<br>➢ *Non repudiation Service*: prevents a receiver or sender from falsely denying the receipt or transmission of data |
| *Archive/Storage*<br>➢ This functionality occurs in the optimisation of the TDSS consultation[21]. It allows the results of previous requests to be stored locally in order to save time. The limit of this function is the time validity of the data. |
| *Traceability*<br>➢ This function stores information about requests which are either satisfied or unsatisfied by the TDSS. This information will help to maintain the TDSS and assist in its evolution[22]. |

- Non-functional requirements

| |
|---|
| *Modularity*<br>➢ The needs to realise a complete and generical TDSS are consequential. So, for the significant and representative applications we choose, it would be interesting to implement the TDSS taking into account the main functionalities needed while retaining the possibility to make it evolve step by step. |
| *Availability*<br>➢ This point is important because it defines the behaviour of the TDSS in case of an |

- the TDSS may have its own database (e.g. for storing a reference repository or archives), in which case the connection with external data sources may well be done manually or off-line, rather that in real-time.

[21] it must be differentiated from the traceability functionality described below

[22] The TDSS should respect data confidentiality by, for example, only keeping a trace of the exchange or the number of connections per hour.

| |
|---|
| unexpected event. The first case would be, for example, how much time the TDSS can be stopped for maintenance purposes. An other case would be the recovery period after a database or an application failure. |

### V.3.3 TDSS FUNCTIONALITIES

✓ ***Data process***

| |
|---|
| *Internal computation rules and means* such as:<br>➢ *Average values*<br>➢ *Standard definitions*<br>➢ *Compound variables* |
| *Internal data aggregation / sampling* such as:<br>➢ data sampling<br>➢ data aggregation from same data types (tendencies computation)<br>➢ data aggregation from different data types (services levels constitution) |
| *Internal format conversion*[23] such as:<br>➢ conversion of the occupation rates to coloured services levels<br>➢ conversion to standard formats as Excel spreadsheets or G.I.S., tools for example |

Two types of local transformation are required to completed such treatments:
- arithmetic calculation (sum, mean, average, ...)
- transformation conversion

Figure V.7 provides the more complex case of data processing, requiring two steps before being considered as the final result:
- Step1: conversion of all the data in an equivalent format
- Step2: compute all the data with a specific method (average, number of accidents , ...) in order to get one result

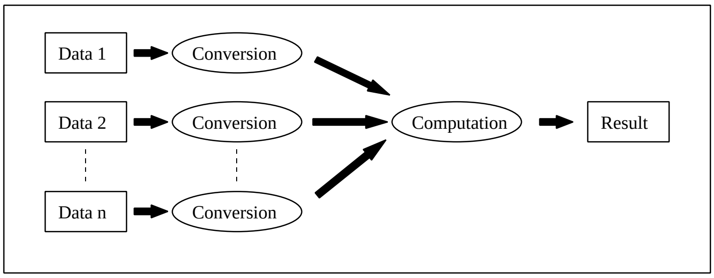



Figure V.7: Data processing

✓ ***Data validation***

| |
|---|
| ➢ Process regarding existence<br>➢ Process regarding likelywood<br>➢ Process regarding consistency<br>➢ Process regarding replacements to be envisaged for data that should be detected missing or not valid |

[23] if enough metadata is available it should be possible to convert from one format to another, between the TDSS and the user's system.

| |
|---|
| <u>*Transport Planning : Example of the DIRECT Lille prototype*</u>.<br>➢ Data providers are responsible about the quality of information.<br>➢ Data providers collect, store and treat data thanks to a standard definition.<br>➢ A data checking program has been developed to ensure data quality.<br>➢ Missing data handling, percentage figures control[24], minimum and maximum value check[25] procedure are investigated in-depth<br>➢ Whether there is only one way flows of data, from the TDSS to the application, data updating is not allowed through the application |
| <u>*Traffic Management : Example of the Brussels Information management centre*</u>[26]<br>➢ There are algorithms to check the information validity, and a hierarchical definition of the information to be disseminated in case the information is not valid.<br>➢ If an event[27] has been detected somewhere on the road network, the information dissemination about the road level of service will have been predefined according to this type of event.<br>➢ If no event is detected and the on-line information is available and acceptable, according to the bench predicted, the on-line information is disseminated.<br>➢ If the information is not available or incorrect, a predicted level is disseminated.<br>➢ In case of not acceptable values resulting from counts, the quality of information provided from loops has to be checked (loop calibration) and/or predicted levels of service have to be reviewed. |

✓ ***Error management***[28]

| |
|---|
| <u>*Potential error between the TDSS layer and the database*</u><br>➢ Data not available[29]: in that case, according to the data type, the TDSS will react by stopping the request or by responding partially to the application.<br>➢ Expired data time stamp and no recent data available: if the time stamp is given by a frequency, the TDSS can suspend the response to wait for the next expiration date otherwise it could stop the request by an error.<br>➢ TDSS not responding : in that case the privileged solution for the database is to stop the request. |
| <u>*Potential error between application layer and TDSS layer*</u><br>➢ *TDSS not responding*: the recommended solution is to stop the application and contact the application administrator; an alternative solution would be to retry to contact the TDSS until a fixed time-out.<br>➢ *Application not more responding*: the TDSS store locally the results of the request and continue waiting for other requests[30]. |

[24] To be sure that the sum of the percentages equals 100%

[25] To be sure that the value are in a predefined interval.

[26] Centralisation and treatment of on-line and off-line information

[27] Such has a lane to be closed or an accident somewhere of the network

[28] The comportment of the application has to be defined for each detected critical error. Within the TDSS application, this implies consideration of the potential problems which can appear in the communication between the TDSS layer and the Databases layer on one hand and between the Application layer and the TDSS layer on the other hand. DIRECT is only concerned in the error management relating directly to the TDSS : error treatment could not be changed if another application is plugged to the TDSS.

[29] broken network, databases not responding or non-existing file, ...

[30] this solution is linked to the storage functionality

✓ ***Storage operation***[31]

| |
|---|
| *Database level*<br>➢ The storage operation functionality allows the database to be searched for an available result request |
| *TDSS level*<br>➢ The TDSS skips the databases request for a single or a complex result |

✓ ***Dissemination of the resulting data***

| |
|---|
| *Traceability*<br>➢ *Statistics aspect* : evaluation of data flows exchanged through the TDSS and/or the frequency of requests for each data with a view to optimise the request response time or reduce the volume of data exchanged<br>➢ *Security aspect* : restriction of the data access to permitted users only : the stored information includes the identification of the applications that contact the databases, the nature of the requested or updated data[32] |
| *Dissemination*<br>➢ Security mechanism enabling to verify that the resulting data dissemination respect the wishes given by the data providers, which can include the different levels of security |

Figure V.8 hereafter provides a particularity which can happen about traceability when data concerned is potentially confidential information. The TDSS will therefore need to keep the results of this function locally for the operation. The different administrators (if they are distinct) of the databases, the TDSS and the applications will be the only entities permitted to see the traced information.

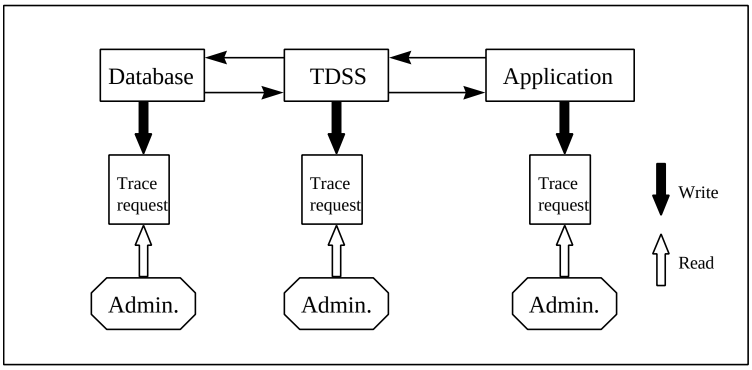



Figure V.8: Traceability functionality

## V.4 LINK BETWEEN GIS AND TDSS

The objective of the concept of Geographic Information Systems (GIS) is to manipulate information to be analysed, treated and visualised on maps by the way of computer tool, for decision making purposes.

TDSS and GIS therefore appear to be complementary. Firstly, the TDSS concept consists of the exchange and sharing of data on the transport system between the different actors

---

31 The storage operation process has to be developed in order to enable to provide the results to an application more quickly

32 See section V.3.1

involved in the system. According to this, very big volumes of data must be available in compatible formats in numerical representation. Because the objective of TDSS is to facilitate Transport Planning and Traffic management, GIS represents the analysis and treatment tool to be used to efficiently manage the collected data. In the direct DIRECT case studies, GIS appears as applications of the TDSS.

The DIRECT Barcelona prototype which is described at chapter X makes use of the same set of maps, to ensure the consistency of all the application available on the server.

In the DIRECT Lille prototype whose description is available in chapter IX, a GIS software has been developed for the relevant subzone of the *Lille Métropole Communauté Urbaine* perimeter to provide:

- thematic maps of the existing transport system situation : location of the transport supply[33], synthetic view of the travel demand[34] and of its environmental impacts[35],
- location maps of the Urban Transport Master plan projects, with their main characteristics : high quality PT services, Park 'n Ride facilities, bike network,…
- statistics about the local urban transport situation : number of inhabitants, number of jobs, number of trips with origin or destination in the zone[36]

33 Public Transport lines, Public Transport stops, road network, bike lines, parking places

34 traffic flows, number of people frequenting each PT stop,…

35 accidents, noise, air pollution

36 with breakdown by mode of transport

# VI. TDSS TECHNICAL RECOMMENDATION

The best value for money solution for TDSS supporting **Transport Planning** applications consists of a data management including an access layer, that allows all applications to access requested data stored in a single data base or in a set of linked data bases, and local applications through a local network.

**Traffic Management** applications can require connections to distant data bases and publication on Internet. The TDSS manages the dialogue between several applications servers, each of them hosting more than one database and more than one application. In this case, the TDSS can make use of the application server, which manages, formats and publishes information on the Internet

This section provides with the DIRECT technical recommendations and guidelines for development, implementation and operation of TDSS.

## VI.1 MAIN CONCEPTS

➢ **TR1 :** ***Choose the architecture according to the objectives of the project***.

| **Application field** | | **Chosen architecture** | | |
|---|---|---|---|---|
| | | ***Local database*** | ***Distributed objects architecture*** | ***Intranet / Internet architecture*** |
| Transport Planning | | **Best choice** | *Bad choice* | Good choice if a light product is selected (ex Oracle WebDB) |
| Traffic Management | Traffic information[37] (aggregated demand) | *Bad choice* | **Best choice** | Good choice, but implies a very powerful configuration |
| | Traveller information[38], Trip planning[39] (individual demand) | Difficult to publish the data, low scalability | Good choice, but implies high development costs, and a web interface | **Best choice** |

Table VI.1 – Architecture choice

➢ ***TR2 : Choose the architecture according to cost limitation***

The choice of the tools should also be based on cost reason. Depending on the budget allocation, some tools and/or architectural choices may be rejected.

➢ ***TR3 : Choose the architecture according to future potential integration of the***

[37] VMS, radio based,… collective information

[38] Combination of traffic information and trip planning : travellers with mobile phone will serve to generate large amounts of real time floating data that are used to generate congestion message – two ways communication

[39] Pre-trip and on board trip information

***project*** : The diffusion of tools for future integration of other tools has to be considered. If the chosen tool is widely distributed, it ensures that it will be maintained and that other software applications will easily be integrated.

- ***TR4: Consider future potential evolutions of the project :*** Depending on the technical choices, the project could be easily upgraded or not. Following parameters have to be considered.

3 ***Hardware platform***
Even if the hardware platform can be changed if the OS supports several processors, this would imply a complex manipulation and would probably cost a lot.

3 ***Operating system***
An open system, which is available on several hardware platforms would be a benefit for the future of the project.

3 ***Programming tools / languages***:
The level of standardisation of the chosen language is an important point for the scalability of the project. A proprietary language, available on only one operating system could become a great drawback.

3 ***Architecture***
The architecture of the system also impacts the scalability: a monolithic system will be less scalable than a distributed one.

- ***TR5 : Choose the architecture choices according to the objective in term of system time response performance***

3 ***Local area systems***
This case matches with the single database and local access architecture. In this case, the performance depends mainly on the hardware of the server, and the software code.

3 ***Intranet systems***
Time response performance has to be considered in term of:
- Database server : Check that it performs the queries in a good response time
- Application server : Check that it generates the HTML pages, and publishes them on the network in good conditions.
- Network : Main potential problem: note that it is always possible to define a specific TCP/IP network from the application server to the client workstations, in order to improve the global performance.

3 ***Internet systems***
The global response time greatly depends on the network access of the client workstation, and, as it is on Internet, there is no possible action to improve the performance. Nevertheless, check that data server and the application server are correctly sized[40].

Acceptable response times are provided at table VI.2

[40] see TR 7 hereafter

| Operation | Kind of system | Part of the system | Response time |
|---|---|---|---|
| Access to a typical data screen | Local system with a single database | Client workstation | < 3 seconds |
| Access to a typical HTML page | Intranet system | Client workstation (browser) | < 5 seconds |
| Access to a typical HTML page | Internet system | Client workstation (browser) | < 15 seconds |
| Generation of a typical HTML page | Intranet / Internet system | Application server | < 3 seconds |
| Perform a typical query of the application | All kinds of systems | Data server | < 2 seconds |
| Perform a typical insert/update | All kinds of systems | Data server | < 2 seconds |
| Application-specific processing[41] | All kinds of systems | Application server | < 20 seconds |

Table VI.2 : Response times table

## VI.2 SOFTWARE TOOLS AND TECHNOLOGIES

- ***TR6 : Select data management systems according to the required speed (off-line or on-line data), the volume of data and the frequency of transactions***

TRANSPORT PLANNING APPLICATIONS
TRAFFIC MANAGEMENT APPLICATIONS

LOW-END DATA MANAGEMENT SYSTEM
LOCAL USAGE
FAST DATA MANAGEMENT SYSTEM
INTERNET DEVELOPMENT

LOW DATA VOLUME / LOW FREQUENCY OF TRANSACTIONS
**MICROSOFT ACCESS**

HIGH DATA VOLUME / HIGH FREQUENCY OF TRANSACTIONS
**ORACLE RDBMS and WebDB**[42]
**ORACLE RDBMS**
**Oracle 8i**[43]
**Oracle Portal-to GO**[44]

Table VI.3 Data management systems

[41] For example, the application can be about trip planning and specific processing can concern the computation of the shortest way for a journey or the fastest one, how can the user avoid a traffic jam located on his usual way.

[42] WebDB tool enabling access of the data through a web navigator

[43] Deployment of EJB (Enterprise Java Beans)

[44] Providing hardware independent access to the application

➢ ***TR7: HTML page size recommendation for Internet applications***

3 ***HTML pages size***[45]
Loaded HTML page must not exceed 50 kbytes. If the size is larger, provide a simplified page without heavy images in order to improve access time and let the complete HTML page remains available for users accepting to spend time for loading.

3 ***Image loading***
Perform the image loading at the end of the HTML page loading.

3 ***Use of applets***[46]
Limit the use of applets since their execution is time consuming.

3 ***Time of page generation***
Limit time of page generation to 3 seconds because this time is to be added to the HTML page loading time which can itself reach almost 10 seconds.

➢ ***TR8 : Software aspects related to system availability***[47]

3 ***Degraded functional mode***
Define an acceptable degraded functional mode by sorting clients by priority to restrict system access in case of problems

➢ ***TR9 : Software aspects related to system quality assurance***

3 ***Data model***
Use Domain Key Normal Form (DKNF) normalisation form[48]. Nevertheless, for an optimisation purpose, a limited "denormalisation" can be accepted.

3 ***Source code comments***
Comment the source code. Depending on the language used, the requirements in terms of comments are different.

➢ *Procedural languages* : The source code developed using procedural languages, object oriented or not, like C, C++, Java, PL/SQL, should include at least a comment in the header of each file, and in the header of each function/procedure/method.

➢ *4th generation language* (4GL) :The usage of a 4GL, as Powerbuilder, Delphi, Access, sometimes does not allow to write comments in the same place as other languages. In

[45] images sizes impact drastically the load time for end-users

[46] Applets : short routines enabling to embellish HTML pages.

[47] What does happen when some components or resources are not available? In case of failure of the server, if the system is supported by only one server, the whole system becomes unreachable for any user.

[48] standard normalisation level for relational database projects

addition, these languages use an event-based model. Depending on the tool, comments should be written at least for each method/callback linked to an event.

- *HTML page* : An HTML page does not allow for a lot of comments[49]. However, it is possible to define some "metas", to allow search tools to easily find the page.

- ***TR9 : Recommendation for possible standardisation***

3 ***Make use of XML Standard (eXtensible Markup Language)***

New technologies and associated standards are pursuing the objective of a large broadcast to end-users. The future is Internet oriented and individual terminal diffusion is dramatically increasing. The information diffusion cannot be envisaged without the use of new technologies like web sites, mobile phones[50], in-board navigation terminals. XML standard is the new emerging standard that will be the native language for the next generation of WWW browsers[51]

Appendix 4 provides with an overview of Data format and major existing standard approaches.

- ***TR10: Recommendation of standards for traffic management applications***

INTERACTION LEVEL

AGREGATED DEMAND
INDIVIDUALS

LEVEL OF INFORMATION PROVIDED
NETWORK
**TRAFFIC INFORMATION**

**RDS-TMC related standards developed in CEN/TC278/WG4 (road traffic)**
**ENV13106-2 DATEX related standard**
**(road traffic)**
**Standards such as ENV 12896**
**(multimodal traffic)**
**Location referencing standard developed in ISO/TC204/SWG3.3**
**TRAVELLER INFORMATION**

Combination of Traffic Information and Trip Planning applications

TRIP

**TRIP PLANNING**

**Location referencing standards such as**
**GDF, UTM,WGS84**

Table VI.4 : Standards for traffic management application

## VI.3 HARDWARE TOOLS AND TECHNOLOGIES

---

[49] In order to reduce to the maximum the loading time of this page, avoid unnecessary characters increasing the code weight. Anyway, HTML pages of an application are usually not static, but dynamically generated by the application server using another language (C, C++, Java, …), of which the code is recommended to be commented.

[50] Web browsers and e-mail over mobile phones users should reach 450 millions users in the next four years, according to Kurt Hellstrom (CEO of Ericsson).

[51] XML supplies possibility to reuse DATEX dictionary and to improve it by defining DTDs

➢ ***TR11: : Hardware aspects related to system availability***[52]

3 ***Implement high availability systems as clusters***

It allows the failure of one of the machines without stopping the service, even if the response time is not as good as in normal mode[53]. The main drawback of such a system is a heavy implementation and maintenance cost.

➢ ***TR12: : Select the network technology according to the required speed (of-line or on-line data) and the type of connection (permanent or not permanent)***

TRANSPORT PLANNING APPLICATIONS
TRAFFIC MANAGEMENT APPLICATIONS

LOW-END DATA MANAGEMENT SYSTEM
LOCAL USAGE
FAST DATA MANAGEMENT SYSTEM
INTERNET DEVELOPMENT

PERMANENT CONNECTION

**LAN[54] Technologies**
**Ethernet/Fast Ethernet (10 to 100Mb/s)**
**Token Ring (4 to 16 Mb/s)**
**WAN[55] technologies**
**Frame relay /ATM[56]**

SHORT TIME CONNECTIONS

**WAN technologies (switched communications)**
**X25 network protocol**
**XDSL (512 kb/s to 6Mb/s)**
**ISDN(56 to 128 kb/s)**

Table VI.5 : Network technology

➢ ***TR13: Traffic management : Select platform development and technological tools according to the type of application***

INTERACTION LEVEL

AGREGATED DEMAND
INDIVIDUALS

LEVEL OF INFORMATION PROVIDED

[52] What does happen when some components or resources are not available? In case of failure of the server, if the system is supported by only one server, the whole system becomes unreachable for any user.

[53] For example, sorting functions according to their importance allows low importance functions to be temporary disabled

[54] Local Area Network

[55] Wide Area Network

[56] Asynchronous Transfer Mode

NETWORK

**TRAFFIC INFORMATION**[57]

**VMS and radio based platform and DATEX and RDS/TMC**

**TRAVELLER INFORMATION**[58]

**Server linkage using Javascript,CGI,CORBA**

TRIP

**TRIP PLANNING**[59]

**Fixed and mobile Internet**
**GPS/GSM localisation and GSM/WAP**[60] **messaging technologies**

Table VI.6 : Platforms and tools for traffic management applications

## VI.4 ACTORS COMMITMENT

➢ ***TR14 : Check that the transport service operators data suppliers and communication services providers are committed to developing this platform***.

## VI.5 RECOMMENDED PROTOTYPE TECHNICAL DOCUMENTATION

➢ ***TR15: Produce prototype documentation***

For ensuring the good quality insurance of a project, the documentation is a key aspect. The documentation of the prototype should at least include the following documents:

3 ***Summary of user specifications***
Clear definition of the objectives of the project

3 ***Installation and configuration guide***
Guide allowing somebody to install the application in another place

The following documents or reports would be a benefit for the future project:

3 ***Technical specifications document***

57 VMS, radio-based,…collective information

58 Combination of traffic information and trip planning : travellers with mobile phone will serve to generate large amounts of real time floating car data that are used to generate congestion message - two way communication

59 Pre-trip and on board trip information

60 Wireless Application Protocol

3 ***Design document***
Description of the architecture and the detailed design of the application

3 ***Test plan***
Description of all the necessary tests to be applied to the project

3 ***Test report***
Description of the test results

3 ***User manual***

# VII. TDSS NON-TECHNICAL RECOMMENDATIONS

The first experiences and findings with TDSS indicate that the conditions and requirements are different from the conditions and requirements for traditional transport information systems. The DIRECT project has tried to fill in the knowledge gap existing on the condition, requirement and guidelines for the realisation of TDSS, particularly dynamic TDSS.

This section provides with the DIRECT non-technical recommendations and guidelines for development, implementation and operation of TDSS. It addresses the following aspects:

- ✓ ***Institutional issues*** are related to the institutions/companies that perform tasks or have responsibilities regarding the establishment, operating and maintenance of a TDSS. This includes any particular issue that might affect the willingness or possibilities to exchange data.
- ✓ ***Legal issues*** describe all legal arrangements that affect the establishment, maintenance and operation of a TDSS.
- ✓ ***Financial issues*** describe the cost of the processes of data purchasing, collection and sharing. The market opportunities of a TDSS are considered alongside the “added value” of reduced data collection costs within a sharing structure. Such issues are intrinsically linked with the development of partnerships between transport actors.
- ✓ ***Organisational issues*** describe all necessary tasks and responsibilities of actors/stakeholders that are needed to establish, maintain and operate a TDSS.

An inventory of existing national legislation relevant for TDSS implementation and operation is available at APPENDIX 7

## VII.1 INSTITUTIONAL ISSUES

| | | |
|---|---|---|
| ➢ | **NTR 16 :** | **Strategy : Create a framework or strategy establishing a common goal between the actors.** |
| ➢ | **NTR 17 :** | **Co-operation : Co-operation between actors is required in the collection, use and spread of data. It is prescribed to have only one leader.** |
| ➢ | **NTR 18 :** | **Responsibilities : Define clear responsibilities for each actor.** |
| ➢ | **NTR 19 :** | **Public-Private Partnership (PPP) : Explore opportunities for public and private actors to work together.[61]** |
| ➢ | **NTR 20 :** | **Agreement : The need for an agreement has to be stressed. The agreement should define the responsibilities and roles of each actor within the structure but should be flexible enough so that actors are able to intensify or reduce their responsibilities and liabilites . The conditions, under which new parties can join in, have to be clearly defined too.** |

## VII.2 LEGAL ISSUES

| | | |
|---|---|---|
| ➢ | **NTR 21 :** | **National context : Explore legal issues: the national context has to be taken into account. The legal systems of European countries are not the same.** |
| ➢ | **NTR 22 :** | **Binding contracts : Establish contracts ensuring that all actors keep their promises** |
| ➢ | **NTR 23 :** | **Data files : The origin and structure (of data sources) have to be clearly defined.** |

[61] EU directives and national legislation transposing the directives on public procurement should be amended in order to introduce the concept of “complex market” where companies can be involved in the definition phase and can submit a bid to the procurement.

| | |
|---|---|
| ➢ **NTR 24 :** | **Data Liability : The data producers have to be liable: The users of data and information have to be sure that they can trust the data/information.** |
| ➢ **NTR 25 :** | **Data Ownership : Check the national rules regulating access and ownership of data in public databases, such as real time traffic information data. In some countries the data collected by public companies is considered public (accessible for everybody). If not public, it might be necessary to buy data.** |
| ➢ **NTR 26 :** | **Data Privacy : Check data privacy guarantees. Not all data can be collected, stored and disseminated and it is not allowed for everybody to collect data.** |
| ➢ **NTR 27** | **Copyrights : Knowledge and data may only be reproduced considering the copyrights.** |

## VII.3 FINANCIAL ISSUES

| | |
|---|---|
| ➢ **NTR 28 :** | **Investment funding : Raise an investment funding plan programming investment over a medium term and budgeted annually considering establishment as well as maintenance of TDSS and public and private constraints[62].** |
| ➢ **NTR 29 :** | **Private finance : Explore opportunities of funding by Private Public Partnership including balance of risk between the parties.** |
| ➢ **NTR 30 :** | **Income from data sales : Explore opportunities for data and information sales to private providers, users on internet** |

## VII.4 ORGANISATIONAL ISSUES

| | |
|---|---|
| ➢ **NTR 31 :** | **Realisation and Maintenance plans : Establish a realisation and maintenance plan defining clear structures in association with institutional agreements** |
| ➢ **NTR 32 :** | **Users needs : Make use of the users needs as a central consideration to be sure that the TDSS will realise the expected results** |
| ➢ **NTR 33 :** | **Leadership : Elect one leader functioning as a catalyst.** |
| ➢ **NTR 34 :** | **Administration hierarchy : Establish a clear administration hierarchy for procedures, logbooks** |
| ➢ **NTR 35 :** | **Project management : Select one party who should be responsible for project management[63].** |
| ➢ **NTR 36 :** | **Process management : Choose one actor who has to make sure that the processes between the different parties run smoothly[64].** |
| ➢ **NTR 37 :** | **Blocking power : Estimate risk of blocking powers by individual actors** |
| ➢ **NTR 38 :** | **Other uncertainties : Estimate other organisational uncertainties influencing the progress of the development or maintenance of the TDSS.** |

62 Note that such spending is vulnerable to public spending cuts. If private financing is considered, take account about the effects in tax for example.

63 Including monitoring of the progress, make sure that milestones are met, informing actors about the progress, procedures

64 As a TDSS takes place in a dynamic environment, process management has to be carried out continuously

# VIII. TDSS EVALUATION PROCESS

TDSS assessment aims to demonstrate the benefit of the integration of a TDSS in the user application, or between the user applications and the databases.

Validation represents a part of assessment as far as it consists to check the conformity of the technical specifications of the project.

Assessment and validation is a key step in the development and implementation process of Transport Telematics applications. From the initial creation of a system, consideration must be given to defining a well ordered testing process, to be undertaken during the system development.

The objective of this chapter is to define criteria and measurements aiming to identify TDSS benefits, using the CONVERGE[65] guidelines. DIRECT evaluation guidelines are provided hereafter, in seven key stages, as identified by the CONVERGE method.

## VIII.1 STEP 1 : IDENTIFICATION OF THE USERS NEEDS

**The first relevant question of the TDSS evaluation process is**: ***"Does the system as applied/tested perform as intended and meet the users' needs in practice?***

TDSS projects need to target and combine the needs of many different users, decision-makers and other stakeholders:

- Users usually include traffic managers, system or services operators, passengers, individual and commercial drivers, fleet operators, police and emergency services, freight operators etc.
- Decision-makers are in general those responsible for the production, introduction and/or implementation of applications, e.g. relevant governmental agencies, competent authorities, road infrastructure owners and system providers. Their requirements and preferences must reflect the needs of users for successful implementation.
- Other stakeholders might include residents alongside a highway or citizens of a town affected by poor air quality. In addition, the requirements and preferences of relevant European, national, regional and local authorities must be taken into account. For instance, the assessment of a transport telematics application might simultaneously address the European objective of improving system interoperability or of promoting the European transport telematics industrial sector, and the national or regional objective of improving transport efficiency in a specific area.

Section IV addresses users' requirements of a TDSS and its connected applications[66]. A check list for user interview framework which is available in appendix 2.

[65] *Guidebook for assessment of Transport Telematics Applications : updated version* - Deliverable D2.3.1., CONVERGE Project TR 1101 - Telematics Applications Programme - Transport Sector, ERTICO, prepared September 1998

[66] The requirements of users of a TDSS and its connected applications have been identified in DIRECT Deliverable 2 for Lille, Lyon, Turin, Southampton, Barcelona, Brussels and Rotterdam.

## VIII.2 STEP 2 : DESCRIPTION OF THE APPLICATION TO BE ASSESSED

***The second precondition for an effective assessment or validation plan must be a clear and concise description of the key characteristics of the transport telematics applications to be validated.***

CONVERGE recommends that the key characteristics of these applications are summarised in a table, including the following information:

- application name or type;
- major technologies (e.g. VMS, cellular radio, short-range beacons etc.) whose application is going to be validated;
- functionality or service offered; and
- verification and demonstration site.

As an example, table VIII.1 presents the key characteristics allowing to make an effective evaluation plan for the DIRECT Barcelona prototype.

| **Application** | **Technologies** | **Function or service** | **Verification and demonstration sites *** |
|---|---|---|---|
| P. T. Application | • Internet<br>• Databases | Programme calculating optimal routes in Public Transport given an origin and a destination (Intranet response time; Internet response time) | Barcelona and 10 adjacent municipalities of the metropolitan area |
| Parking application | • Internet<br>• Databases | Programme calculating optimal routes to the car park nearer to destination introduced by the user. This application will work more on-line than the former (on-line network classification and parking booking simulation). | Barcelona |
| Monitor | • Access<br>• Excel<br>• GIS tools<br>• Databases | To generate indicators of consultations realised by the users. (daily, weekly, monthly indicators). | Barcelona (Parking)<br>Barcelona and 10 adjacent municipalities of the metropolitan area (Public Transport) |
| Parking booking | • Internet | Simulation | Selected car parks, Barcelona |

* use key to technology application : Blank box = Not used / Regular type = existing / Bold type = New or revised application of existing technology

Table VIII.1 Summary of applications built and demonstrated, Barcelona

## VIII.3 STEP 3 : DEFINING ASSESSMENT OBJECTIVES

The assessment objectives relate closely to the implementation and use of the application. They are not necessarily the same as the application design objectives, those set by designers and manufacturers for developing the system. Generally speaking, assessment objectives incorporate all application design objectives, as well as those related to needs and requirements of public authorities, operators and end-users.

Different types of assessment can be identified according to the needs of users, to the assessment purpose and request precision. The DIRECT project has identified the following category of assessment as relevant in TDSS context:

- Technical assessment - functional aspect

- Technical assessment - non functional aspects
- Institutional, legal and organisational aspect assessment
- Financial assessment
- Users' requirement satisfaction

The CONVERGE guidebook recommended three steps in developing assessment objectives

✓ ***Association of assessment objectives with the analysis of user needs***

✓ ***Grouping assessment objectives under different categories of assessment***

✓ ***Translation of the assessment objectives in quantitative terms***[67]

Tables VIII.2 and VIII.3 provide the example of the synthesis of the assessment objectives, respectively in the case of the Barcelona and the Lille DIRECT prototypes.

| **Application** | **Decision maker** | **Assessment objectives** |
|---|---|---|
| P. T. Internet application | TMB | • to create a database with information on main Public Transport operators of the Barcelona metropolitan area.<br>• to develop cartography (up to now, there were only maps of the Barcelona city owned by the IMI) for the cities belonging the Barcelona metropolitan area.<br>• to inform Public Transport users on the best routes to realise their trips (with modal shifts) as well as on tariffs, passage frequencies, etc. |
| Parking Internet application | SMASSA, IMI | • to create a database with information on car parks of SMASSA and of the rest of operators of the parking sector of Barcelona.<br>• to define the private transport network of Barcelona, weighting links according to the network type they belong (primary, secondary or local).<br>• to use the file generated by the road network situation file for classifying the network in real time.<br>• to inform the citizens on the car parks nearest to their destinations showing them the best routes, and advising them when it is convenient to use Public Transport or P&R (data exchange with Public Transport application).<br>• to introduce the possibility of selling products and booking car park spaces by Internet (this will be a simulation) |
| Monitor application | TMB, SMASSA, BTSA | • to supply Internet applications owners with a tool enable them to know the level of use and weak points of their applications.<br>• to produce monthly reports for parking and public transport operators.<br>• to have a tool which in the future (when Internet usage will increase) will allow to compute monthly or yearly mobility indicators. |
| Parking booking | SMASSA | • precise used needs in detail. |

Table VIII.3 Lille DIRECT prototype : Synthesis of the assessment objectives by application

[67] translate the assessment objectives into more precise and specific objectives for the trial or demonstration. For example, the assessment objective 'increasing regularity of service' might be translated into measuring the discrepancy between time-tabled and actual arrival times. Furthermore, specifying the expected improvement for the assessment objective may be a statistically significant reduction defined in the percentage of buses/trains arriving more than 5 minutes late.

| Application | Decision maker | Assessment objectives |
|---|---|---|
| Urban mobility observatory | *Lille Métropole Communauté Urbaine* | • improving data exchange between the different partners involved in the Lille urban transport master plan,<br>• observing the evolution of the urban transport system in regard to the strategic directions defined in the urban transport master plan,<br>• enabling comparisons with other French urban areas<br>• producing a yearly report presenting some statistics and analysis about the urban transport evolution |
| Urban transport diagnostic maps | *Lille Métropole Communauté Urbaine* | • providing the institutional actors involved in the Lille urban transport master plan with the necessary urban transport data to carry out studies for limited geographic zones of the Lille urban area :<br>• providing location maps of the urban transport master plan projects, with their main characteristics,<br>• providing thematic maps of the existing urban transport system situation, |

Table VIII.3 Lille DIRECT prototype : synthesis of the assessment objectives

## VIII.4 STEP 4 : PRE-ASSESSMENT OF THE EXPECTED IMPACTS

It is essential to establish a test plan when identified the requirements of each prototype. As the objective of the project is to demonstrate the reliability of a TDSS, the tests and measures have to be based on the TDSS functions and performances. A process to validate a prototype step by step is provided below:

- ✓ During the requirement phase of the development cycle, define input data sets and the corresponding results or behaviour of the application and quality measures.
- ✓ During the design of the application, establish the list of the integration tests to realise.
- ✓ During the code implementation, test units.
- ✓ During the integration phase of the development cycle, test the integration of each module as defined in the design.
- ✓ During the validation phase, test the application with the data sets provided by the requirements and compare the results and behaviour of the application with estimated figures. Measuring the quality of the TDSS part. For the traceability of the project, writing a validation report containing a reference cross table between the requirements and the resulted application functions.

CONVERGE guidebook recommends to identify system impacts expected in principle and assess their approximate magnitude and target groups, before deciding which impacts should be assessed in the project. This pre-assessment process is also valuable for clarifying assessment objectives.

Table VIII.4 and VIII.5 here after provide examples of table for the pre-assessment of expected impacts concerning Barcelona and Lille DIRECT prototypes.

| Impacts expected | Target groups | System | Impact |
|---|---|---|---|
| Improvement of Public Transport and Parking information given to citizens. | Citizens | P. T. Application<br>Parking Application<br>Monitor application | ++<br>++ |
| Improvement of the city mobility. | Citizens | P. T. Application<br>Parking Application<br>Monitor application | +<br>+ |
| Benefits for the different operators and for the end users. | Operators supplying data and end users. | P. T. Application<br>Parking Application<br>Monitor application | ++<br>++ |
| Car park spaces booking by Internet | Parking operators and end users | P. T. Application<br>Parking Application<br>Monitor application | <br>+ |
| Improvement of data exchange | Operators supplying data and end users. | P. T. Application<br>Parking Application<br>Monitor application | +<br>++ |
| More dynamic mobility statistics. | Parking and Public Transport operators. | P. T. Application<br>Parking Application<br>Monitor application | +<br>+<br>+ |
| ++: very positive ; +: positive ; 0 neutral/uncertain ; - negative ; - - very negative | | | |

Table VIII.4 : pre-assessment of expected impacts of the Barcelona DIRECT prototype

| Impacts expected | Target groups | System | Impact |
|---|---|---|---|
| A city and its transport network which more synergistically evolve | Public authorities and urban planners | Urban mobility observatory<br>Urban transport diagnostic maps | +<br>+ |
| A more global and coherent public action | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | ++<br>+ |
| A better knowledge of the global transport system, including all modes of transport | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | +<br>++ |
| A better co-operation between the local public institutions | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | +<br>+ |
| Dissemination of the results of the assessment of the impacts of the urban transport master plan actions | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | ++ |
| Dissemination of the results of the assessment of the impacts of the urban transport master plan actions | End users | Urban mobility observatory<br>Urban transport diagnostic maps | ++ |
| Improved data exchanges | Urban transport data providers and users | Urban mobility observatory<br>Urban transport diagnostic maps | ++<br>+ |
| Improved transport modelling tools | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | +<br>+ |
| ++: very positive ; +: positive ; 0 neutral/uncertain ; - negative ; - - very negative | | | |

Table VIII.5 : pre-assessment of expected impacts of the Lille DIRECT prototype

## VIII.5 STEP 5 : DEFINE THE ASSESSMENT METHODOLOGY

### VIII.5.1GENERAL ASSESSMENT METHODOLOGY

The CONVERGE guidebook recommends to process the following steps in the assessment methodology.

***For each assessment category and assessment objective, define :***

- ✓ ***Indicators*** measuring how far the objectives will be achieved by the application[68].
- ✓ ***The Reference Case***
- ✓ ***The Methods of Measurement or Simulation***
- ✓ ***The Measurement or simulation Conditions***
- ✓ ***Statistical Considerations***[69]
  - ✓ Sampling
  - ✓ Statistical Confidence Level
  - ✓ Overall Definition of Success
- ✓ ***The Measurement Plan***
- ✓ and assess the ***Integrity of Measurement or Simulation***

### VIII.5.2CHECK LIST OF INDICATOR PRESCRIBED FOR TDSS EVALUATION

The table VIII.6 hereafter provides with a checklist of the criteria, which are prescribed to be considered in the evaluation of a TDSS[70]. More detailed information about each criteria is available in Appendix 5.

---

[68]Two basic requirements have to be taken into account when defining indicators: they must be **able to reflect clearly the related performance or impact**; and they must be **capable of reliable assessment** using the experimental tools and measurement methods chosen.

[69] The main considerations are:

- ✓ in general terms, a larger sample is needed:
  - the smaller the expected improvement in performance
  - the greater the variation between individual measurements of the indicator
  - the greater the required statistical accuracy
- ✓ if the results are to be compared with those at other sites.
- ✓ a larger sample is needed for questionnaire surveys as the level of required analysis becomes more disaggregate (simply because fewer responses become available at higher levels of disaggregation).
- ✓ it is reasonable to attach a higher level of credibility (as distinct from statistical confidence) to results based on objective or 'hard' measurement than to results based on subjective or 'soft' measurement such as by interview/ questionnaire methods.

[70] The technical evaluation of the Lille and Barcelona DIRECT prototypes as well as the 5T, ROMANSE and TIC DIRECT cases study are provided in Appendix 3 and Appendix 4 as an practical implementation of the non-technical evaluation criteria here above defined.

| **Category of assessment** | **List of indicators** |
|---|---|
| Technical assessment (functional aspects) | • Number of applications of the TDSS<br>• Number of domains for which data are integrated in the TDSS<br>• Number of types of information made available through the TDSS<br>• Number of functions of a generic TDSS implemented in the Lille site<br>• Quality of the functions made available: security, data quality checks, archive / storage facilities, format conversion, traceability, export,…<br>• OAMP[71] activities |
| Technical assessment (non functional aspects) | • Architecture and technical choices<br>• Scalability :Hardware, Operating System, Programming tools / languages, Architecture<br>• Performances : - data server, - application server, - client<br>• Availability<br>• Quality assurance(- data model, - documentation, - source code)<br>• Implementation cost<br>• Maintenance costs |
| Institutional aspects assessment | • Existence of a clear strategy<br>• Level Co-operation<br>• Existence of clear definition of each actor's responsibilities<br>• Existence of Public-private-partnership<br>• Existence of agreements for database maintenance<br>• Existence of agreements for data exchange : data sharing / providing / exploitation agreements for the TDSS and its applications |
| Legal aspects assessment | • Existence of binding contracts between the actors according to the different national context<br>• Existence of clear definition of the data source<br>• Level of data liability<br>• Existence of data ownership checking according to the national rules<br>• Existence of data privacy checking according to the national rules<br>• Existence of data copyright checking according to the national rules |
| Organisational assessment | • Existence of investment funding plan<br>• Are users needs a central consideration?<br>• Leadership<br>• Administration hierarchy<br>• Project management<br>• Process management<br>• Blocking power risk<br>• Other uncertainties risk |
| Financial assessment | • Existence of investment funding plan including initial investment costs (in Euros) and yearly OAMP costs (in Euros)<br>• Participation of the private sector in the project<br>• Level of income from data sales<br>• Value for money of data users and end-users |
| Users' requirements satisfaction | • Operator acceptance<br>• clear and understandable data representation (maps, graphs, indicators)<br>• Applications response time (traffic management application)<br>• Quality of human – machine interface : measurement based on a questionnaire to be filled by the sample of users who will test the prototype |

Table VIII.6 : DIRECT indicators check list for TDSS assessment

[71] Operations, Administrations, Maintenance and Provision

## VIII.6 STEP 6 : DATA ANALYSIS

Basic principles and methods for the statistical analysis of different types of data, which leads to the final presentation of assessment results are the following : Data on an interval scale can usually be transformed to a normal distribution and ‘t’ tests (for comparing two sample means), ‘F’ tests (for comparing more than two sample means), or regression analyses (looking for linear relationships), can be carried out. However, data on nominal or ordinal scales should usually be analysed using chi-squared techniques (for testing the hypothesis of independence between rows and column in a table of counts), or related approaches. They are available in the CONVERGE guidelines.

The technical assessment of Lille and Barcelona prototypes have been carried out by SIMULOG. The non-technical assessment (users' requirements satisfaction, organisational and legal issues) has to be carried out using interviews of a sample of the technical users of the application.

## VIII.7 STEP 7 : REPORTING OF RESULTS

As it is recognised that there will be different audiences for the assessment results[72], results should be expressed in clear and simple language, all conditions or provisos important for their interpretation should be made transparent, and statistical analysis should be used to assess the significance of the results.

Hence, it is recommended that the following structure is used for project validation results deliverable(s)[73]:

✓ ***Part I : Key validation results at project level***

Part I should be a summary of Parts II and III. It should be aimed at policy makers and key decision makers and should therefore be a concise overview of the project and its main achievements

✓ ***Part II Detailed validation results***

Part II should present detailed validation results at the level of individual assessment objectives for each application.

✓ ***Part III Comparison of validation results across sites***

Part III should simply take results from Part II without changing their format and compare them between sites.

The results of the Barcelona and Lille DIRECT prototypes assessment are available in APPENDIX 5.

[72] Whilst traffic managers and engineers require a detailed and technical presentation of all project results, the "end clients" who are usually not specialists in the field, require more of an overview of the key results

[73] see CONVERGE

# IX. THE LILLE URBAN TRANSPORT OBSERVATORY : EXAMPLE OF A TDSS BUILT FOR PLANNING PURPOSE

## IX.1 CONTEXT

The Lille Transport Master Plan (UTMP) was approved by the LILLE urban community (*Lille Métropole Communauté Urbaine* : *LMCU*), on 8th October 1999. Six main strategic directions have been defined :

1. A sharing of the streets in favour of environmentally sound transport modes : public transport, walking and cycling,
2. A high quality public transport system,
3. Adapted actions in order to protect the people's health and safety,
4. A global and consistent public action,
5. The involvement of the citizens,
6. The involvement of firms and administrations.

In order to monitor the UTMP goals achievement, it is planned to set up an urban mobility observatory and provide evaluation tools.

### IX.1.1 THE URBAN MOBILITY OBSERVATORY'S OBJECTIVES

The «Lille Urban Mobility Observatory» (LUMO) in the Lille metropolis enables to meet the following objectives :

- To collect, from the various data mobility managers, specific indicators to be used by the observatory (the centralised input of pre-processed data by data providers, on an annual basis, the quality of which is checked),
- To store this information in a relational data base,
- To disseminate information to the technical committee partners involved in the Lille Urban Transport Master Plan (UTMP, security, user-interface) : the indicators chosen by the Observatory will monitor the achievement of the UTMP in the Lille metropolis (used as an evaluation tool), and providing an annual report which will be sent to the UTMP's institutional partners,
- To use the resultant data for statistical purposes, compound indicators and to produce maps.

The locally set-up framework for data exchange on mobility figures is aimed at enabling :

- each partner of the urban mobility master plan to evaluate the impact of his policy and to build his action program accordingly, while remaining consistent as far as the general directions of the urban mobility master plan are concerned,
- to develop the exchanges between the technical departments of the public bodies (State, Region, *Département*, *LMCU*,…) : definition, treatment, validation and storage of the selected data.
- to be relevant and efficient in the monitoring of the evolution of the trip behaviours. As there is much interference within the urban system, we have to find monitoring tools adapted to what must be observed. The choice of the tools must take into account the importance of the events in regard to the urban mobility master plan objectives, the observation cost, and the meaning of the potential evolutions,
- to develop communication and evaluation tools that are simple, clear and understandable.

### IX.1.2 THE EVALUATION TOOL'S OBJECTIVES CONCERNING THE MOBILITY SITUATION WITHIN A SPECIFIC GEOGRAPHICAL AREA (UTMP MICROSTUDIES)

This is an additional application provided by the LUMO, when it adopts a general aspect due to the size of the Lille metropolis territory.

By using this second application it is possible to detail actions in the Lille urban transport master plan according to the different territories, the diversity of places and the multiplicity of implications. Indeed, there is a highly concentrated population in the urban centres of the Lille metropolis and it also comprises a suburban and rural fabric, whose problems, developments and evolution prospects cannot be compared.

The objective is to have a tool which is representative of existing local data in the Lille metropolis, so that it is easier to take into account urban mobility issues in town planning projects and vice versa. Indeed, all urban planning projects must also comprehensively include urban mobility aspects : the mobility flow, parking, transport networks, noise,…

## IX.2 DESCRIPTION OF THE OBSERVATORY PROTOTYPE

### IX.2.1 TECHNICAL ASPECTS

The data base has been designed with *Microsoft ACCESS 97*. This prototype version does not use any external *ActiveX* checking procedure.

The data is stored in the « PDU_DATA.MDB » *ACCESS* base, and programmes in the « PDU.MDB » *ACCESS* base.

With regard to the link with the *MAPINFO* cartographic tool used by the services of *Lille Métropole Communauté Urbaine de Lille* (*LMCU*, the public transport network authority), it was decided, at the prototype stage, that the user wishing to produce maps has a menu available in the data base. It is then possible :

- to check the joining of geographical areas defined in the *ACCESS* data base to store the data (*communes* – the smallest administrative subdivisions, groups of *communes*, according the areas used for interviewing the public, the Lille urban community, the Lille *arrondissement* - administrative area) and geographical items which are already part of the G.I.S. tool used,
- to create a table in the *ACCESS* data base, according to choices made by the user on an indicator, the division of an area and a specific year (e.g. : the number of accidents in a specific area of the Lille urban community, for each *commune*, for 1998). This table is then used to prepare a thematic analysis using *MAPINFO*,

This table is then used with *MAPINFO* to produce a thematic analysis.

### IX.2.2 ANALYSIS

✓ ***The "indicators" table***

Different indicators are used in the Lille Urban Mobility Observatory (LUMO). It should be noted that the data chosen by the observatory only corresponds to a very limited selection of the data stored in the various existing data bases which are managed in the Lille metropolis. The indicators chosen to the Observatory's use are based on strategic questions relative to mobility practices, public transport, impacts on the environment (and above all, road accidents), to parking management, urban planning and mobility costs. Their choice meets the following criteria :

- They must be comparable with other French built-up areas : this means that a common definition of the indicators is required,
- Their design and presentation must be simple and comprehensible, so that they can be widely transmitted to people who have no specialised knowledge of the domain,
- They must be pertinent for the evaluation of changes to the urban transport system : the choice of indicators takes into account the importance of phenomena to be observed within the framework of the UTMP's objectives, observation costs and the significance of potential evolutions.

Each indicator is identified by a code and a heading and is attached either to a theme (for example : urban mobility data, parking data, land use data, environmental data), or by a monitoring action decided in the UTMP (e.g. monitoring the number of facilities at bus stops which comply with the UTMP's bus charter).

Some indicators are numerical and others alphanumerical :

- In the first case, this may concern numbers for anything (e.g. the number of inhabitants, annual investment costs for public transport network,…), for percentages (e.g. % of journeys made on foot, by car, by public transport), of numbers controlled by thresholds (e.g. the average number of journeys per person per day for the different areas of the travel demand survey), which must be included in a predefined interval [0 - 10]),
- In the second case = the indicator can either be linked to a lexicon which will provide a relationship between the numerical value and the alphanumerical value (e.g. when there are multiple replies to the question asked, a list will provide the correspondence between a numerical code and various possible replies (no exclusion = 0, all pedestrian journeys = 1,…), or linked to any alphanumerical field (e.g., with regard to words which appear more suitable to qualify cars in the town, people interviewed can reply: "pollution", "practical", "quick",…).

Other details make it possible to characterise indicators more clearly, namely :

- The indicator's owner number (organisation or person managing the data used to calculate the indicator), which is linked to a more detailed table containing information such as : the name of the organisation, the name of the contact person, the address, the telephone number, the facsimile number, the e-mail address,
- The indicator's measuring unit, (km², %, the number of paying parking spaces...),
- The UTMP's theme or trend which the indicator is linked to,
- Minimum and maximum values used by the indicator (it this should be pertinent),
- Information about the kind of indicator : whether it is a basic indicator (raw data) provided by the managers of existing data bases, or on the contrary, whether it is an indicator calculated by the Observatory using basic indicators (e.g. the ratio of the number of public transport stops in a commune per km²)
- The indicator's format : number, %, text,….

Compound indicators, calculated using basic numerical indicators, can be defined using basic arithmetical calculations (+, -, x, /).

✓ ***Geographical division :***

Each piece of information stored in the LUMO concerns a specific geographical area (point, district, small administrative area, specific survey area, the Lille urban community, the Lille *arrondissement,…*). This area can be defined using known administrative boundaries (*communes, arrondissements*), or it can be created by defining a group of more «elementary» areas.

Areas can be grouped together in different ways. Each one is called a division. For example, the Lille *arrondissement,* comprising 125 *communes,* 86 of which are located within the Lille urban community's perimeter, can be divided into :

- 2 areas : the Lille urban community, and the rest of the *arrondissement*,
- 125 areas, which correspond to 125 *communes*,
- 5 areas, 12 areas, 23 areas or 68 areas, corresponding to various divisions used for the 1998 mobility survey, 8 areas, corresponding to areas in the 1997 opinion survey,…

Different tables are used to manage the geographical coding of the LUMO's indicators :

- an « areas» table, which describes the areas (sizes or points) to which the indicators are attached : area number, code, name *INSEE* (the national institute for statistics and economic studies) with regard to *communes*, type of area, co-ordinates (W,Y in *Lambert I Carto*) with regard to an area limited to a point (e.g. the location of a road traffic counting station or a station measuring air pollution),
- a "standard" table, which defines the kind of area : point, district, *commune,* mobility survey zone,…
- a division» table, which defines the various division used to store data in the Observatory,
- an "area group" table, which defines the links between areas describing a division : e.g. to divide the Lille *arrondissement* into 5 areas for the 1998 mobility survey, this table provides the relationship between *communes*, the 5 survey areas and the division number itself,
- a "consolidation" table, which defines the links between the Observatory's indicators and the various possible divisions.

✓ ***The "values" table:***

This table can be used to store the value concerning an indicator for a given area and a year, every time the relevant information exists and the Observatory considers it useful.

If necessary the stored value can be calculated using information contained in other «basic» indicators for the same area and for the same year, a formula is provided to link the various indicators together (e.g. calculating the population density, to find out the size and number of inhabitants in a specific area).

The value can also be calculated for an area which groups several areas together when each area has the information. In this case, the sum of values will represent the resultant value (e.g. by knowing the annual number of accidents for each *commune*, it will be possible to deduce how many accidents there are in the mobility survey area (when dividing into 5 areas), without having to input data, but by simply knowing how to use the table which provides the link between the division into *communes* and the 5 mobility survey areas.

✓ ***The conceptual model of data in the ACCESS database where information is stored which is used by the Urban Mobility Observatory:***

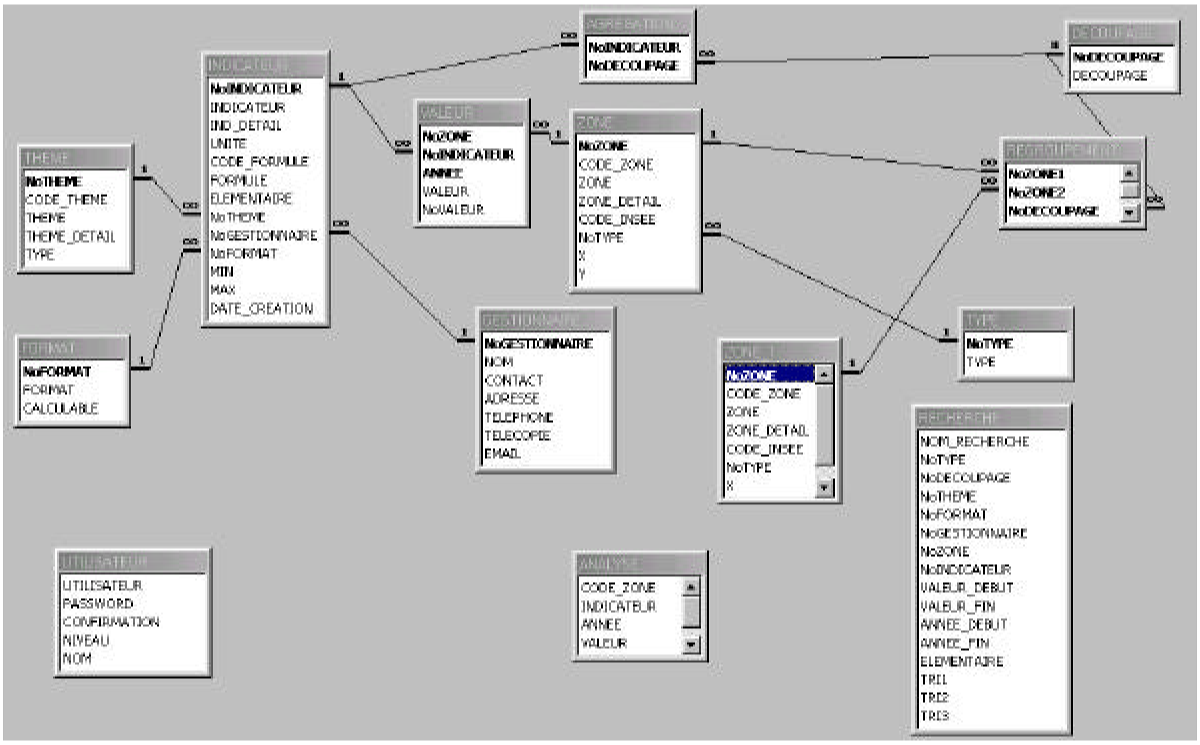
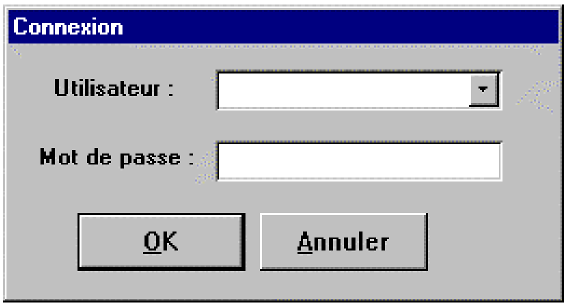



Figure IX.1: Structure of the conceptual data model

## IX.2.3 COMPILING THE TABLES

✓ ***Security:***

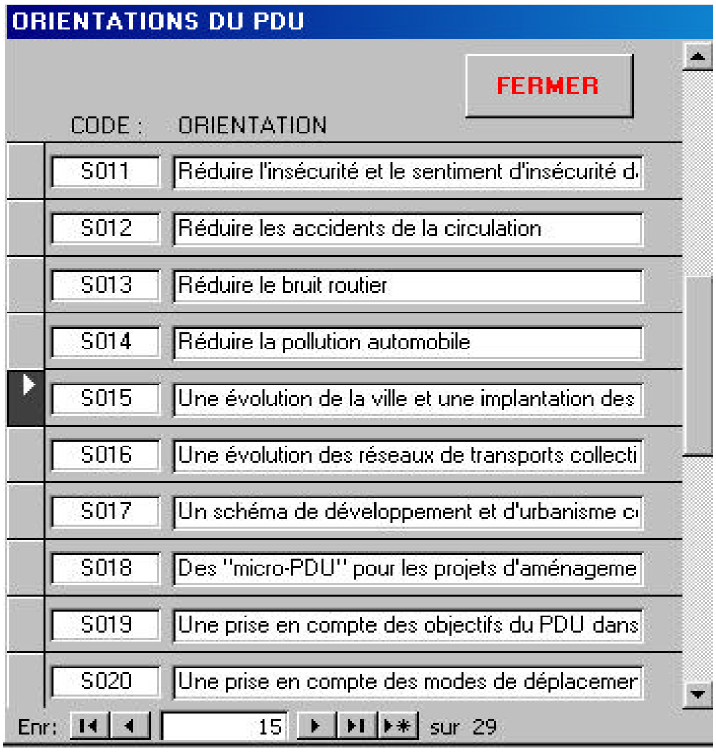
Three levels of users have been defined :




- The Urban Mobility Observatory manager: who will be the only person authorised to modify the structure of the data base (namely, to add, modify or delete certain parameters in the basic tables),
- Users authorised to input data (updating) : this concerns a limited number of clearly identified people, who are authorised to update data if, while doing so, they inform the director of any changes made. They can also obtain authority to have access to the data for their own statistical work,
- Users who are only permitted to consult data in a standardised form : they have no access to use this data for their work.

✓ ***Inputting data for "simple tables " :***

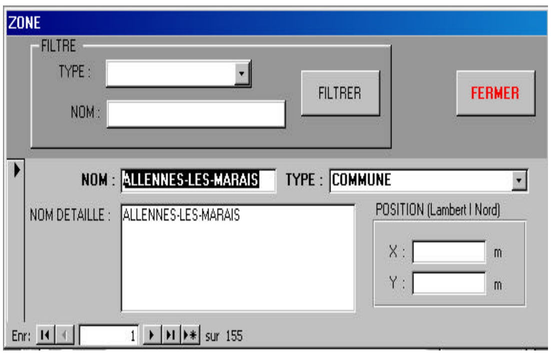
For " simple tables", namely tables which do not have many fields and/or items recorded (THEME / TREND, FORMAT, TYPE OF AREA, OWNER tables), one screen will be used for data input, modification or deletion, which will scroll all items recorded.




✓ ***Inputting data for "complex tables " :***

On the other hand, there are complex tables, which have more fields and are likely to be used to store a high and increasing number of data records, (for example, INDICATOR, DIVISION or AREA tables).

A single screen is also used for data input, modification and deletion, but a filter is provided to restrict the number of visible recordings on the screen. Furthermore, each recording is shown on a separate screen.

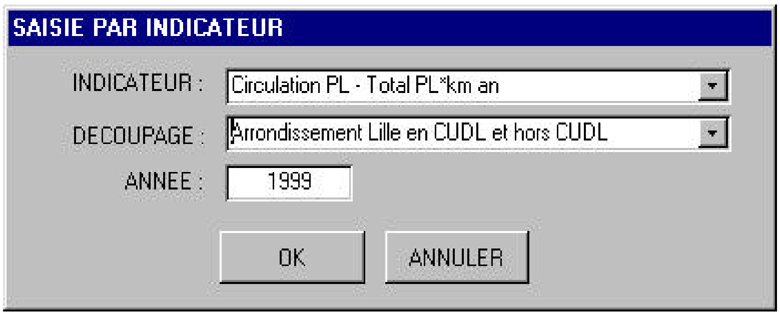


✓ ***Inputting data in the «Values» Table :***

To input values, the user has several possibilities :


- **Direct inputting** when the user is only authorised to input new values (modifications cannot be made), the user inputs the name of the indicator, area, year and the value,

- **Inputting data for different areas** when the user can input or modify all the indicators' values which concern a given theme for an area and a specific year,




- **Inputting data for different indicators** when the user can input or modify all an indicator's values for a specific year and for all the areas in a given division,

- the **Modification** function is used to modify values already provided.

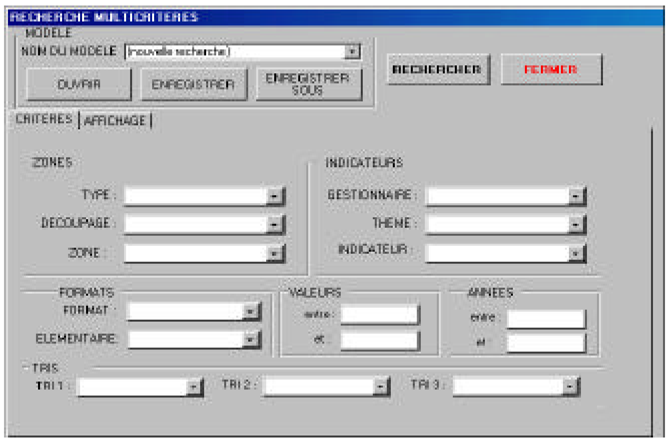
### IX.2.4 PROCESSING DATA STORED IN THE *ACCESS* DATABASE

✓ ***Checking :***

It is possible to check in three different ways :

- Using the «***Contrôle composition***» function to check that data have been input for the elementary indicators in all areas in the divisions and for the years concerned : for example, if the user has chosen to divide the Lille *arrondissement* into 125 *communes* for the year 1990, the checking programme will have to verify that a value has effectively been input for each of the 125 *communes* for this specific year.
- Using the « ***Contrôle format*** » function to verify that values for one of the indicators conform to the format effectively defined for this indicator.
- Using the « ***Contrôle table MAPINFO*** » to verify coherence between the areas defined in *ACCESS* format and those defined in *MAPINFO* format.

✓ **The *Recherche multicritère* function**

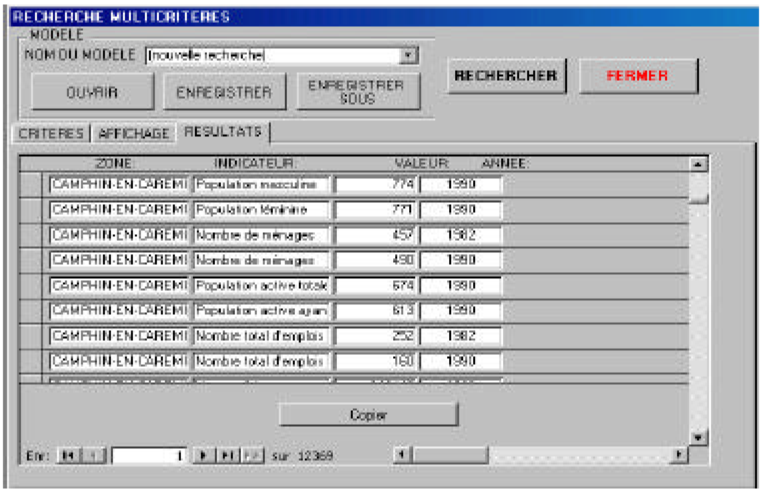



This data search function can be used to extract indicators' values from the base, according to some of their characteristics which have been input using the form opposite.

It is possible to store search requests.

The ***AFFICHAGE*** label is used to define the characteristics of values one wishes to retrieve from the database. One always retrieves, at least, the indicator name, the area concerned, the year and the value.

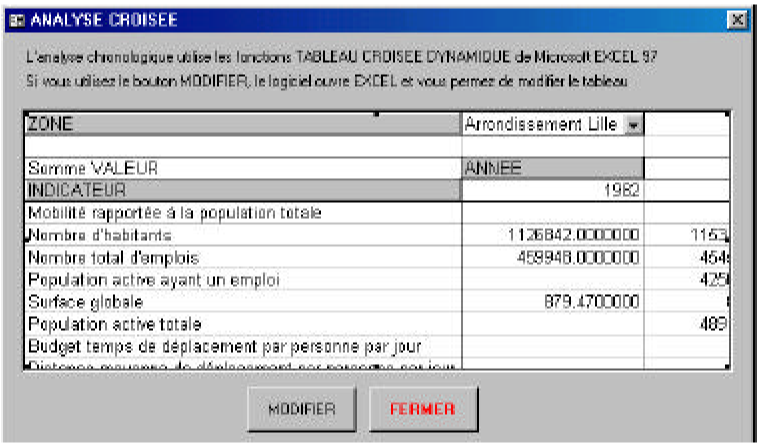
The form opposite shows retrieved data. The user can copy it in the *WINDOWS* «clipboard» and then paste it in software such as *EXCEL*.




✓ **The *analyse croisée* function :**

Cross-reference analysis is used to create a link with an *EXCEL* «dynamic cross-reference table.

After changing over to EXCEL, one can modify the table which shows all data in the base using «page» as a variable for areas, «line» as a variable for indicators, and «column» as a variable for years. By using the **dynamic cross-reference «help» table** it is simple to make such modifications.




| INDICATEUR | Arrondissement Lille | EM 12 zones banlieue est Lille | EM 12 zones banlieue nord ouest Lille | EM 12 zones banlieue Roubaix | EM 12 zones banlieue sud Lille | EM 12 zones Banlieue Tourcoing | EM 12 zones hors CUDL |
|---|---|---|---|---|---|---|---|
| Mobilité rapportée à la population totale | 3.99 | 3.85 | 4.54 | 3.96 | 4.06 | 4.20 | 3.77 |
| Marche (tous motifs) | 1340814 | 132767 | 170198 | 127188 | 137657 | 53640 | 74356 |
| Vélo (tous motifs) | 90920 | 10587 | 9721 | 8236 | 8653 | 6289 | 8576 |
| 2 roues motorisées (tous motifs) | 35682 | 1576 | 7612 | 4077 | 2996 | 3823 | 3597 |
| VP conductur (tous motifs) | 2090039 | 232314 | 281082 | 260790 | 261941 | 224645 | 183599 |
| VP passager (tous motifs) | 780654 | 79166 | 97917 | 98071 | 92527 | 87192 | 63359 |
| TC (tous motifs) | 315024 | 49413 | 40467 | 25694 | 34515 | 13646 | 23124 |
| Autres modes (tous motifs) | 41377 | 2395 | 8056 | 3195 | 8079 | 3164 | 4504 |

Table IX.1: Mobility and modal split of the travel demand by geographic sector in the LMCU area

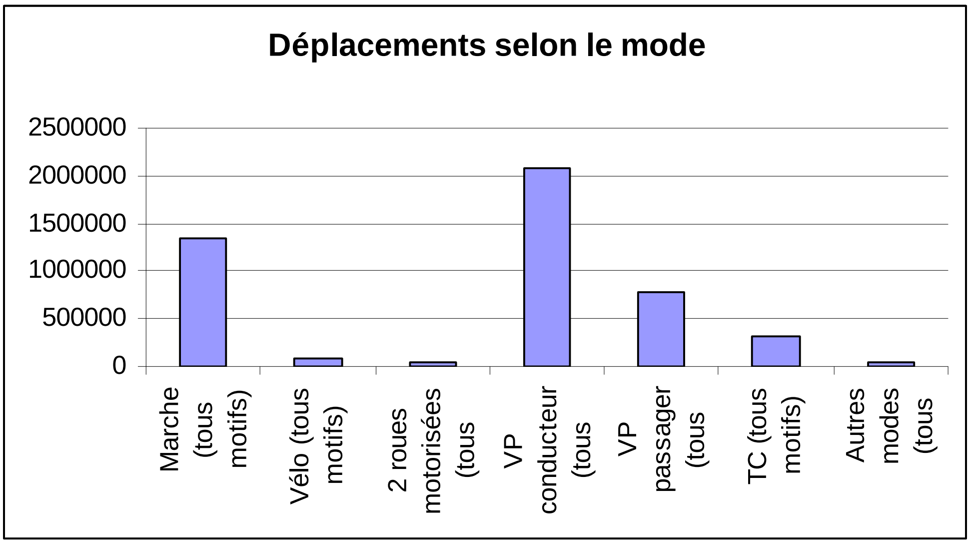


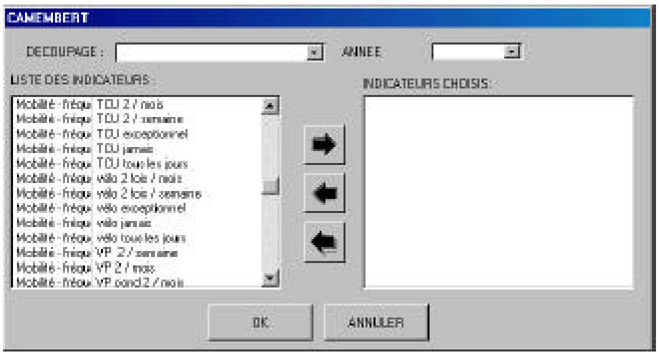

Figure IX.2: Modal split of the travel demand in the LMCU area

✓ **The *analyse thématique* function :**


This is used to produce thematic analysis maps with colour variations according to the values of the indicator chosen. With *ACCESS*, the user selects the indicator, division and year, using the form opposite.

The user then changes to *MAPINFO* where the analysis results can be displayed (see below).

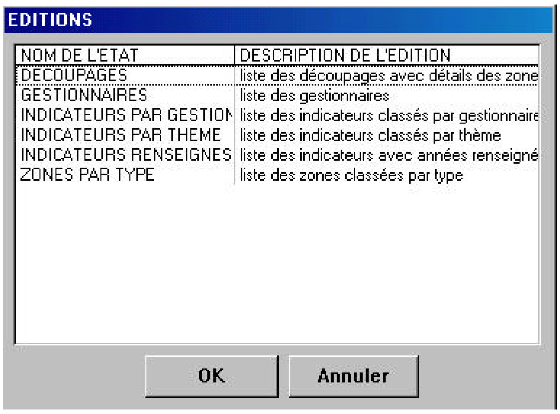
✓ ***Camembert* analyses :**




This function can be used to produce thematic analysis maps in pie chart format according to the indicator values chosen. With ACCESS, the user chooses the indicators, division and the year, as shown in the form opposite.

The user then changes over to *MAPINFO* where the analysis results can be displayed (see below).

✓ ***Editions* :**




The editing form opposite is used to display the list of database contents :

- divisions list,
- data owners list,
- indicators list by themes,
- list of indicators containing data,
- areas list by type

Other lists will be added in the future such as:

- a calculation formula for compound indicators,
- modifications to the indicators list[74].

### IX.2.5 *ACCESS* APPLICATION MENUS

According to the user's rights, 4 to 6 menu titles are indicated in the menu bar :

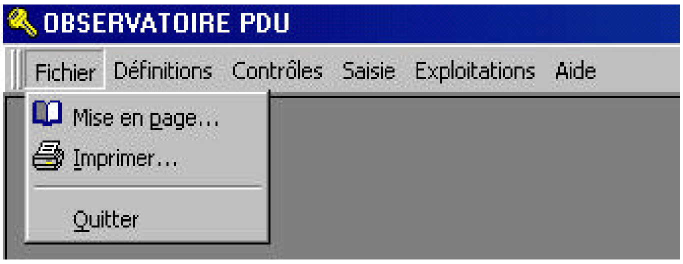
- the database manager has access to all the menus,
- the user authorised to input data has access to all menus except the «*Définitions*» menu,
- the user authorised to consult data only has access to «*Fichier*», *Contrôles*», «*Exploitations*», «*Aide*» menus, (File, Checking, Exploitation and Help).


✓ **The *Fichier* menu**

The file menu has three functions:

– « *Mise en page*» for layout and «*Imprimer*» to print, are only activated when one of the lists accessed by «*Edition*» in the *Exploitation* menu is displayed on the screen (see below). They are respectively used to prepare the layout and print the list displayed.

– «*Quitter*» is used to leave the application.




✓ **The *Définitions* menu**

The *Définitions* menu comprises two sub-menus and a function.

- <u>*The Indicateur sub-menu*</u>

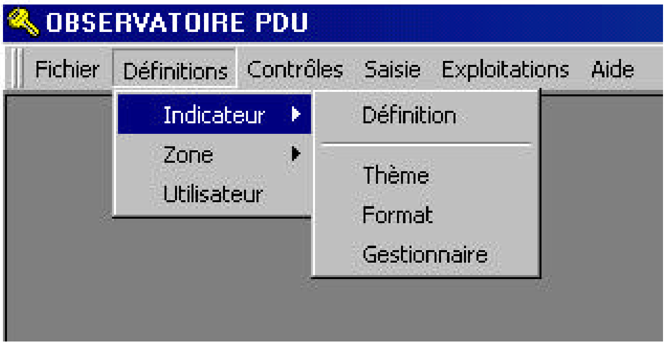
The ***Indicateur*** sub-menu comprises 4 functions :

– the ***Définition*** function to create indicators with their definitions,

– the ***Thème*** function to define themes or trends linked to the indicators,

– the ***Format*** function to define possible formats for the indicators,

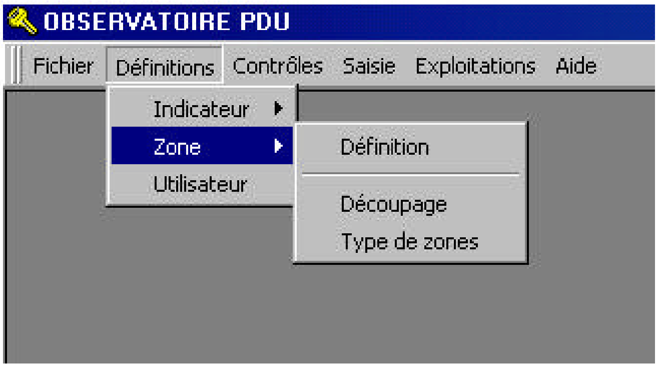
– the ***Gestionnaire*** function to define organisations that manage the data required to calculate an indicator.




[74] Indeed, a certain number of users will have the possibility adding indicators to the basic list and to store new data in the Observatory, to be shared with the other members. In this case, the «new» field in the indicators table will be validated, so that when each year the data base manager wants to edit a list of new indicators added to the data base, he will be able to know what the different partners have added to their personal version of the observatory data base.

- <u>The *Zone* sub-menu</u>

  The *Zone* (area) sub-menu has 3 functions :
  - the ***Définition*** function to create and define the areas,
  - the ***Découpage*** function to define divisions and the grouping together of elementary areas,
  - the ***Type de zones*** function to define types of areas (*commune*, district…).

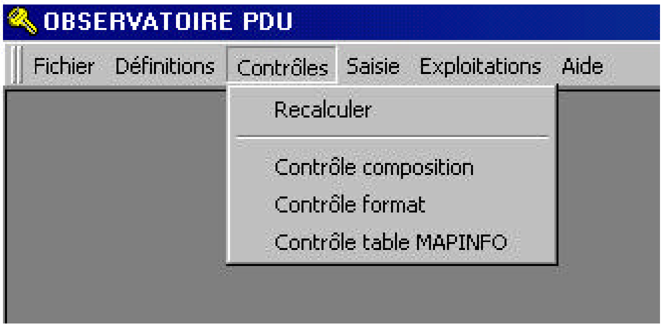



- <u>The *Utilisateur* function</u>

  This function is used to create new users with their name, access rights and password.

– **The *Contrôles* menu**

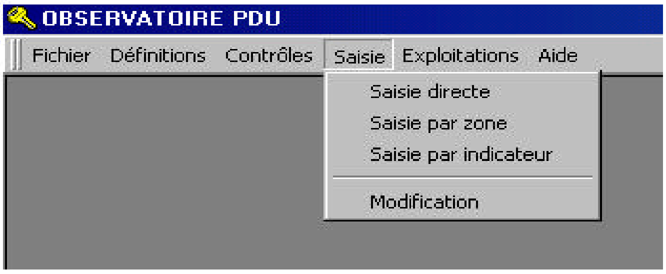
This menu has 4 functions :




- the ***Recalculer*** function, to calculate all the indicators defined by a formula, as well as the addition of indicators in consolidated divisions.
- The ***Contrôle Composition*** function verifies that the elementary indicators contain data for all areas in the divisions and the relevant years.
- The ***Contrôle format*** function verifies that an indicator's values conform to the format defined for this indicator.
- The ***Contrôle table MAPINFO*** function verifies that there is coherence between the areas defined using *ACCESS* and those defined using *MAPINFO* software.

– **The *Saisie* menu**

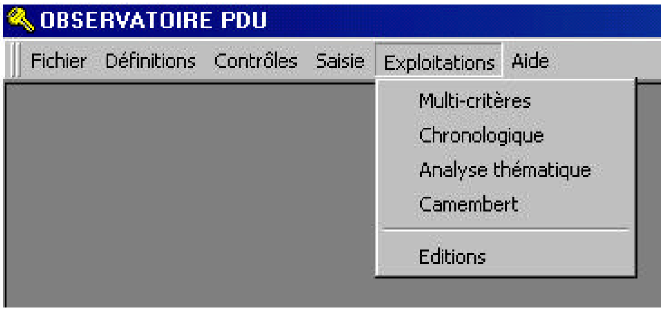
This menu has 4 functions :




- the ***Saisie directe*** function, to directly input indicators, value by value,
- the ***Saisie par zone*** function, to input all the indicators for a theme into a divisionand for a given year,
- the ***Saisie par indicateur*** function, to input an indicator value for a division and a given year,
- the ***Modification*** function, to modify the indicators, value by value,

– **The *Exploitation* menu**

This menu has 5 functions :

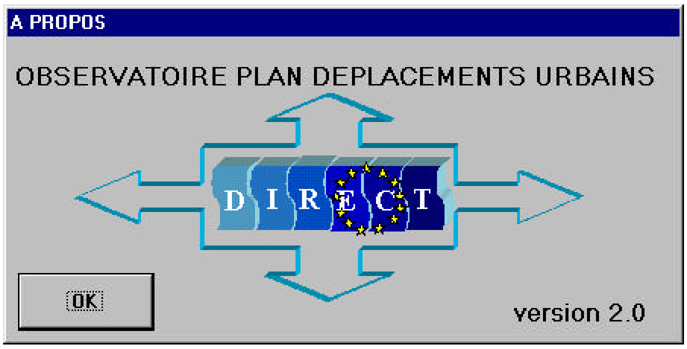



- the ***Multi-critères*** function, to search for data corresponding to a set of criterions,
- the ***Chronologique*** function, to consult indicator values year by year (dynamic *EXCEL* table),
- the ***Analyse thématique*** function, to define (indicator, division, year) and carry out preparatory work for a thematic analysis by groups using *MAPINFO*,
- the ***Camembert*** function, to define (list of indicators, division, year) and carry out preparatory work for a pie chart thematic analysis using *MAPINFO*,
- the ***Editions*** function, to edit lists of the main items in the database

– **The *Aide* menu**

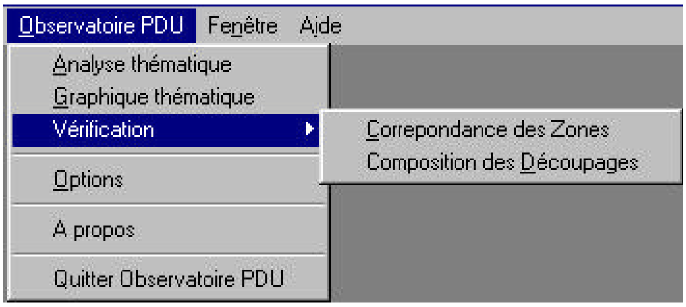
The ***Aide*** menu has 2 help functions :

- The *Aide en ligne* function for on-line assistance is not operational,
- The *A Propos* function displays a window containing the softwares name and version number.



## IX.2.6 CHECKING AND DISPLAYING RESULTS USING *MAPINFO*

After installing *MAPINFO* software, an additional menu « *Observatoire PDU* » (LUMO) can be used for different actions.




✓ ***Checking***

To function correctly, the *ZONE* (area) table in *ACCESS* has to correspond the *ZONE* table in *MAPINFO*.

The ***Vérification*** sub-menu is used to check the compliance of two tables:

- The *Correspondance* ***des zones*** function checks that the two tables have correctly joined areas together.
- The *Composition* ***des Découpages*** function is used to check the defined divisions using *ACCESS*.

✓ ***Thematic analysis***

The ***Analyse thématique*** function is used to display results of a thematic analysis produced with *ACCESS* software.

By clicking on this function a « thematic analysis map by group » is automatically opened. The thematic analysis can be modified using the usual *MAPINFO* procedures (see examples next page).

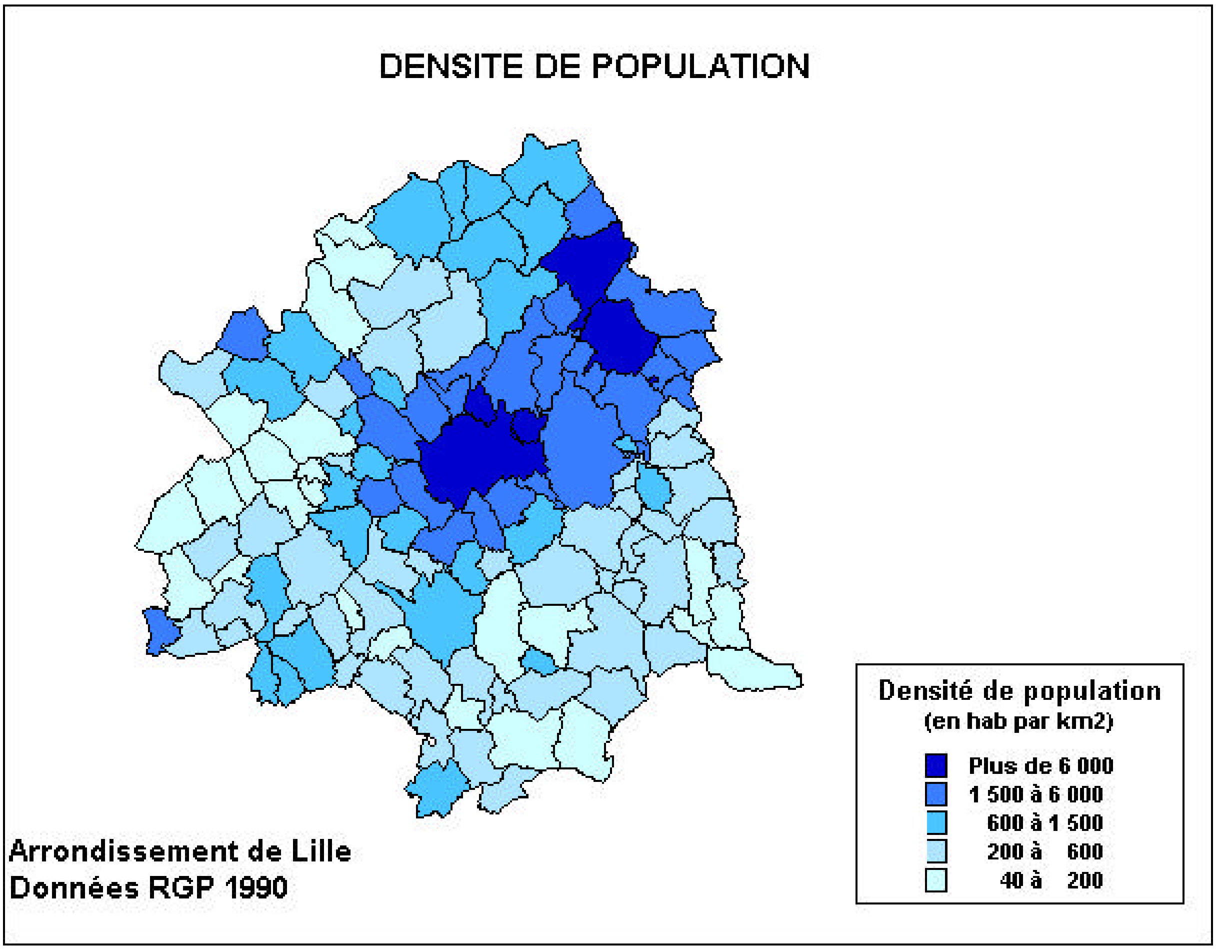



Figure IX.3: Map of the population density in the Lille Arrondissement

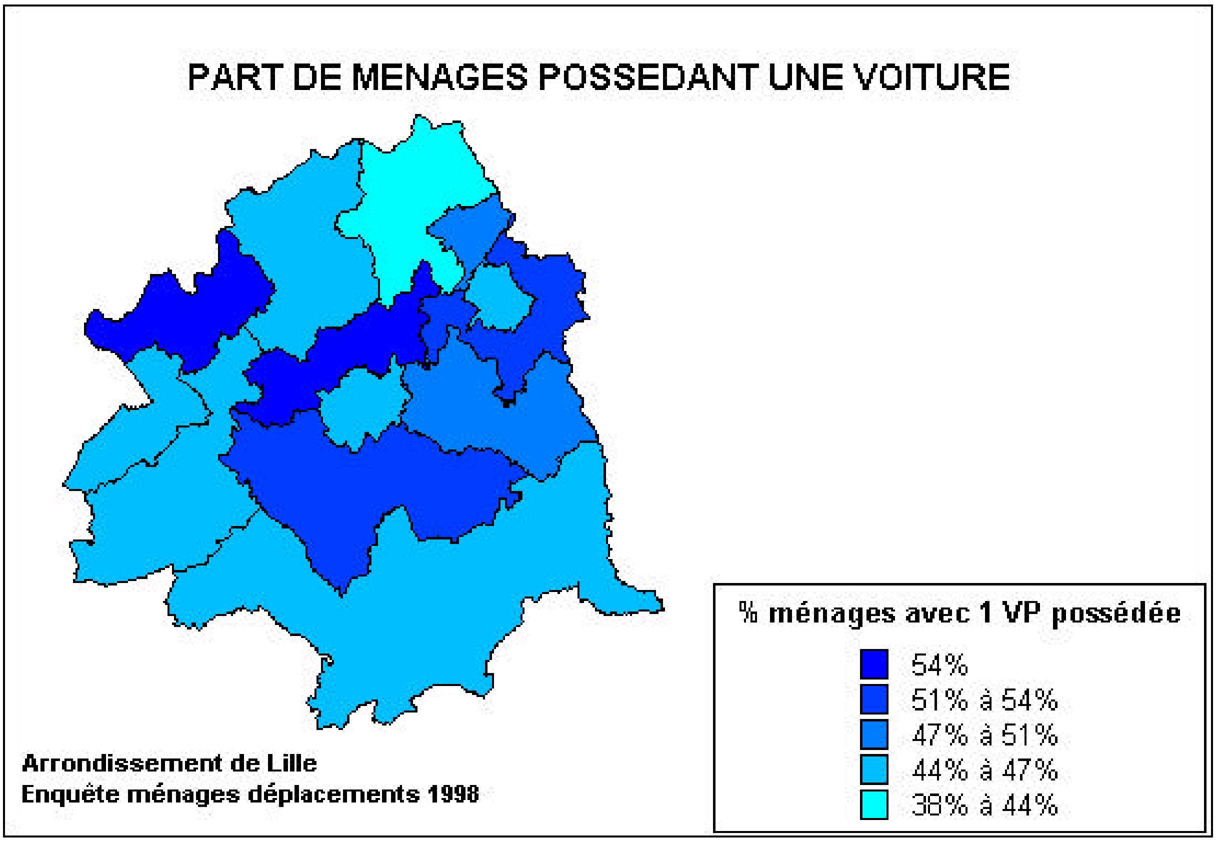



Figure IX.4: Map of the car ownerships : percentage of households owing 1 car in the Lille Arrondissement

### ✓ *Thematic graphic*

The *Graphique thématique* function is used to display the results achieved by the « *Camembert* » pie chart function, using *ACCESS* software. By clicking on this function a « thematic analysis map by areas » is automatically opened. The thematic analysis can be modified using the usual *MAPINFO* procedures. Other thematic analyses can be produced (bar charts) using the table automatically generated by the «*Camembert_Temp*» function. (See examples below).

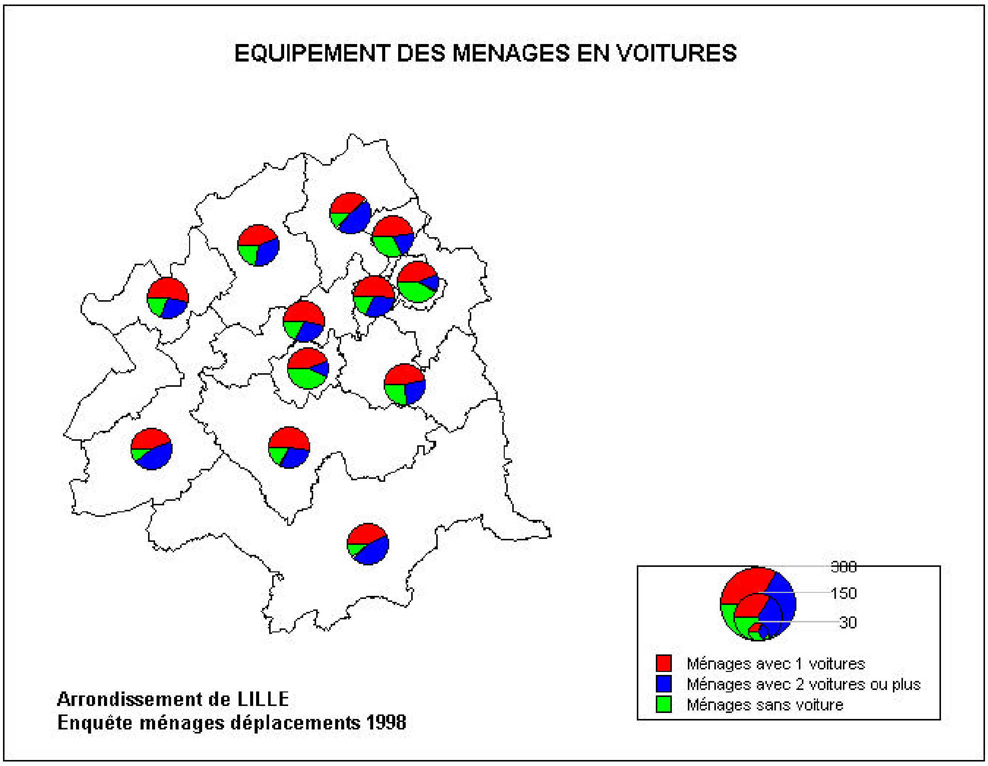



Figure IX.5: Map of the car ownership in the Lille Arrondissement

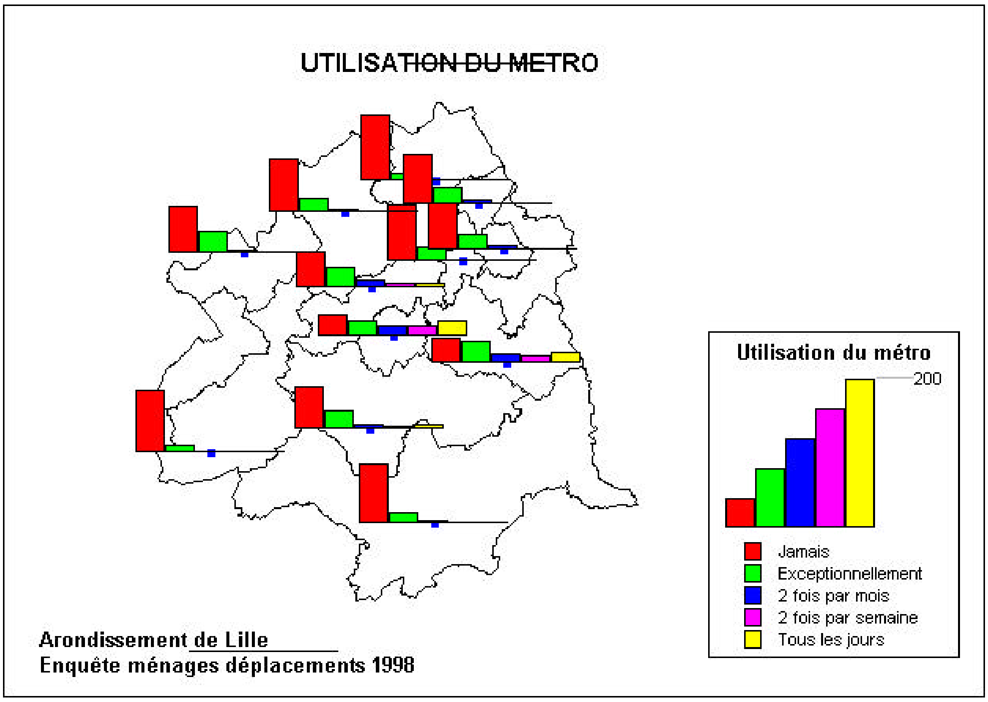



Figure IX.6: Map of the frequency of the use of the underground services

## IX.3 DESCRIPTION OF THE PROTOTYPE DIAGNOSIS TOOL FOR THE MOBILITY SITUATION IN A SPECIFIC GEOGRAPHICAL AREA (URBAN MOBILITY MICROSTUDIES)

### IX.3.1 THE METHOD USED TO CARRY OUT AN UTMP STUDY IN A SPECIFIC AREA

The charter for UTMP study in a specific area aims to develop better co-operations between the *LMCU*'s services who are directly involved in town planning and transport projects (public transport management, highways, infrastructures and traffic management, town planning and development, renovated districts, UTMP services), as well as encouraging co-operation with other players responsible for urban development : other institutions (the State, Regional Council and County Council,….), private investors, engineering consultants,…

*A priori*, the objective is not to develop a precise method to produce a highways or town development study in the Lille metropolis territory, but to progressively build a transversal study method by consulting each other and co-operating with the various services involved in such studies.

One of the most important parts of this procedure concerns using cartography as a tool to assist in the diagnosis and presentation of projects which have been selected for the Lille Urban transport Master Plan. The use of such a tool was studied with regard to transport data sharing systems (TDSS), and complements the Lille Urban Mobility Observatory tool.

### IX.3.2 THE MAPPING TOOL FOR URBAN MOBILITY (UTMP SPECIFIC AREA STUDIES)

The charter for UTMP specific area studies, for which the objectives are outlined above, acts as a diagnosis tool and is based on factors concerning mobility and town planning in a specific geographical sector (district, *commune*,…).

The objective is to facilitate the consultation of existing urban planning and mobility data in the *LMCU*'s various services, by standardising them in a cartographic format, to obtain an overview of pertinent factors in the urban mobility field.

It is also planned that all design or planning offices working in the Lille metropolis territory, as well as local authorities (*communes* and County and Regional Councils,…), the State, private investors and in the long term, the population, will be able to synthetically have access to a minimum amount of available data, using a computer server. Therefore, diagnosis work in specific areas should be easier.

However, it must be stressed that if cartography is a significant aid for diagnosis work, it also has its limits when a more precise analysis is required to fully comprehend how the whole of the sector studied really functions. Additional means are required through on-site observations or qualitative studies.

✓ ***Technical aspects:***

The global perimeter of the Lille urban community is to be studied, and *LMCU*'s various services already have geographical data which is defined for the same reference framework.

It will be possible to obtain all the thematic maps (see the list below for a study area, or to choose those which will be more useful for an UTMP study in a specific area. The maps' scales are $1/5000^e$, $1/2000^e$ and $1/1000^e$. $1/10\ 000^e$ maps can be produced if necessary.

A document briefly commenting each map will be available when maps are consulted on the server (if required, the user will be able to print the document).

Each map will indicate which service is responsible for the data, so that the user can contact it for additional information and details.

Furthermore, if people using standardised maps for an UTMP study in a specific area wish to obtain further information for in-depth analyses, they must contact the services responsible for this data for the relevant fields.

✓ ***List of maps for UTMP studies in a specific area :***

| | |
|---|---|
| **Diagnostic maps** | |
| Town planning / economy | • Land parcel management plan<br>• Population density<br>• Zoning defined in the land-use plan *Plan d'Occupation des Sols* (*POS*)<br>• Map of areas developed through co-operation between public and private sectors (*Zones d'Aménagement Concerté* (*ZAC*)<br>• Major infrastructures defined in the land-use plan<br>• Location of companies (indicating the number of employees)<br>• Location of businesses (shops, restaurants, major shopping centres) |
| Private cars and heavy goods vehicles | • Map of reduced speed area zones<br>• Areas with good car accessibility<br>• Map of areas affected by traffic noise<br>• Parking supply<br>• Flows of heavy goods traffic |
| Public transport and nonmechanical transport modes (bicycle, walking) | • Public transport network<br>• Areas with good public transport accessibility<br>• Hierarchical order of public transport supply<br>• Activity at public transport stops (number of people getting on / off)<br>• Use of public transport (number of journeys)<br>• Current cycle track network |
| **Maps for UTMP projects**[75] | |
| Projects prior to the Urban Transport Master Plan | • Master plan for development and town planning in the Lille metropolis<br>• Transport infrastructures included in the land-use plan<br>• Master plan for transport infrastructures to be provided by the year 2015, defining existing infrastructures to be maintained in working order, existing infrastructures to be developed or modified, infrastructures to be created,<br>• Plan of areas developed through co-operation between public and private sectors (*Zones d'Aménagement Concerté* (*ZAC*), |
| Projects for Urban Mobility | • Master plan for cycle routes, by defining routes for daily journeys rather than those for leisure purposes (pedestrians and cycles)<br>• Master plan<br>• Master road plan of local road networks : traffic calming areas<br>• Map of bus routes with very frequent services<br>• Map of park and ride facilities and multimodal connection points<br>• Map of public transport services on dedicated sites : off-road services (underground system, trains) and on-road services(bus and tram, others,…)<br>• Map of locations reserved for mobility infrastructures included in the land-use plan (*POS*) : roads (showing where traffic noise barriers are to be installed), public transport (bus lanes,…), routes for cyclists or pedestrians |

## IX.4 GEOCRAPHICAL DESCRIPTION OF THE SYSTEM

*LMCU*'s internal computer network provides connections to transmit to consolidated DB 2, linked to the GIS *MAPINFO* tool which are managed by the UTMP mission the updated information needed to produce UTMP specific area maps, knowing that data available in various data bases managed by *LMCU's* technical services (DB 1, DB 2,...) which is required to produce UTMP specific area maps is copied and stored in consolidated DB 2 in the premises where the UTMP mission personnel works :

[75] These maps, currently showing the Lille Urban Community territory, will be produced with a scale for districts, for an UTMP specific area study.

Data bases managed by the *LMCU*'s services and using the common geographical framework :

The provision of data requires human intervention (sending paper, diskette or e-mail versions of data, with various data formats), and if necessary extracting and preprocessing data before transmitting to the *ACCESS* data base, which stores the Urban Mobility Observatory's indicators :

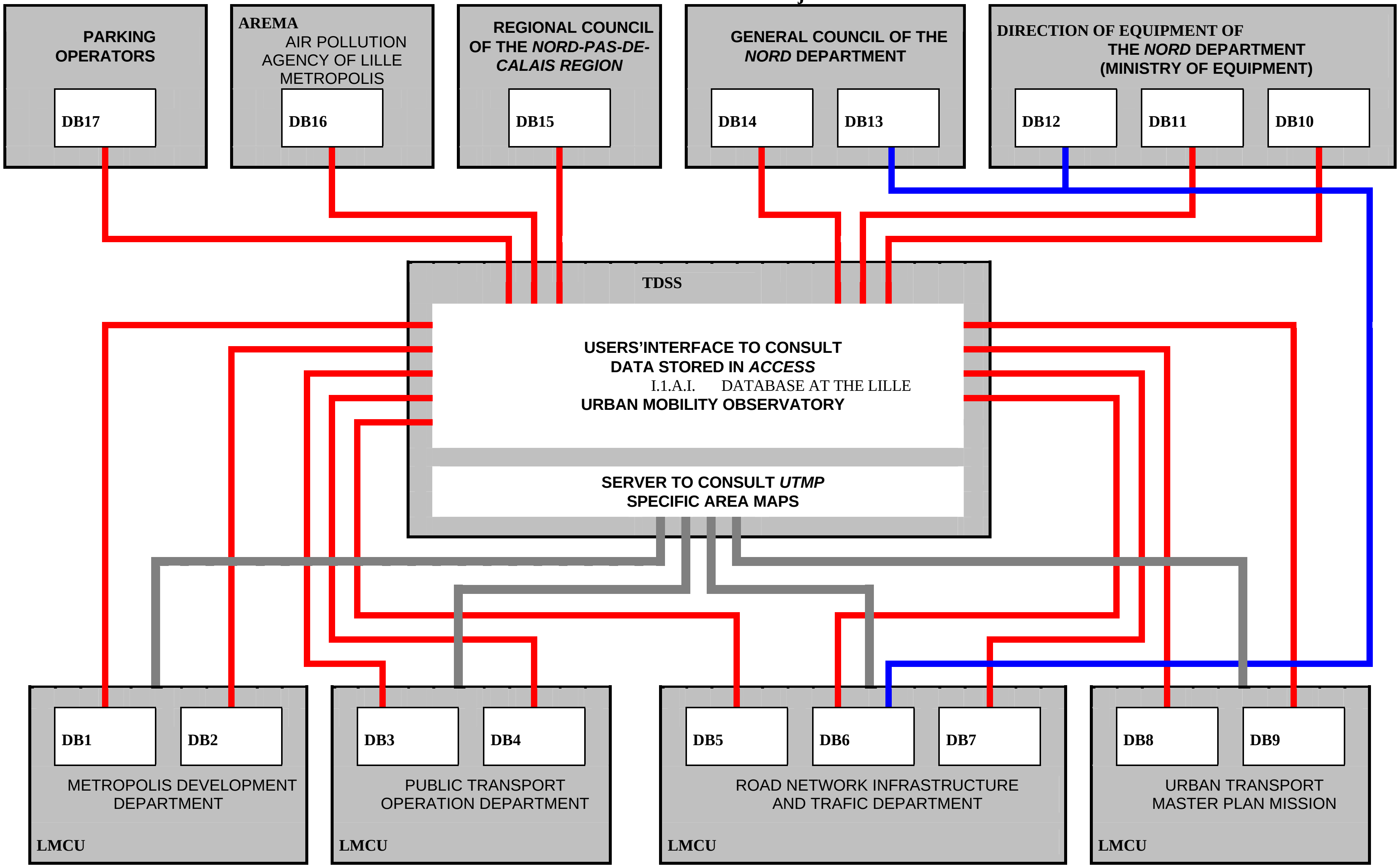



Figure IX.7: Geographical structure of the LMCU'system

| **Contents of the databases** | |
|---|---|
| DB 1 | Land-use data |
| DB 2 | Data provided by the census (*INSEE*) : homes, population, jobs |
| DB3 | Data concerning for the public urban transport network : routes, stops, service frequencies |
| DB4 | Public transport traffic database : frequency surveys, the kind of tickets and passes used,… |
| DB5 | Road network data file : 34,000 sections defined for 4,200 km of road networks in the Lille urban community, 2 400 km of which are local road networks (managed by *LMCU*) |
| DB6 | Central counting data file (centralizing data owned by *LMCU*, the County and State for counting operations carried out of their respective road networks) |
| DB7 | The *LMCU* accidents data file |
| DB8 | Data from the householders' mobility survey |
| DB9 | Opinion survey data |
| DB10 | Planning permission data (*SICLONE* file) – *Direction Départementale de l'Equipement du Nord* (The State's Public Works Department at the county level) |
| DB11 | Accident data for communes in the *Nord* county (*BAAC* file) – *Direction Départementale de l'Equipement du Nord* (The State) |
| DB12 | Traffic count data on motorways and trunk roads (*CDES* file) – *Direction Départementale de l'Equipement du Nord* |
| DB13 | Traffic count data on secondary roads (*CDES* file) - *Conseil Général du Nord* (*Nord* County Council) |
| DB14 | Data for school bus and interurban bus services - *Direction des Transports du Conseil Général du Nord* (the *Nord* County Council's transportation department) |
| DB15 | Supply and patronage data for the regional express train service : *Trains Express Régionaux* : *TER*, (the Regional Council and the *SNCF* : French railways) |
| DB16 | Air pollution data – measuring stations managed by the *AREMA* agency |
| DB17 | Data for parking supply and patronage (1 data base per manager) |

# IX.5 TEMPORAL DATA FLOW DIAGRAMS

Below are three examples of information flow chains, from raw data collection to its processing, so that it can be input at the Observatory.

## IX.5.1 ROAD SUPPLY INDICATORS

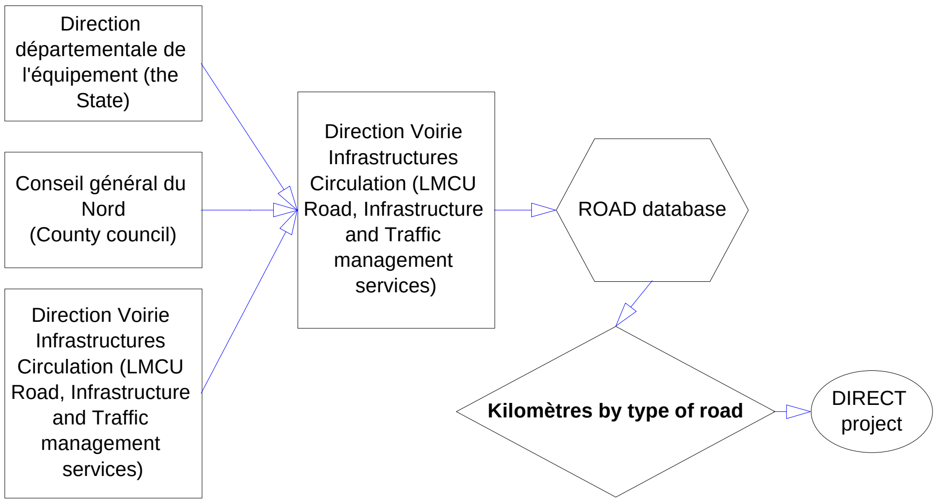



Figure IX.8: Data flows concerning the road supply

The three highways managers provide characteristics of their respective networks to the *LMCU*'s management services for highways, infrastructures and traffic in the Lille urban community. The *LMCU* has compiled a «road database» which includes all this information. This database can be used to calculate the length of types of roads in kilometres, according to definitions chosen by the Observatory.

## IX.5.2 AIR POLLUTION INDICATORS

The *AREMA* agency manages stations which measure the air quality, processes raw data and provides it in a format required by the Observatory.

***AREMA***

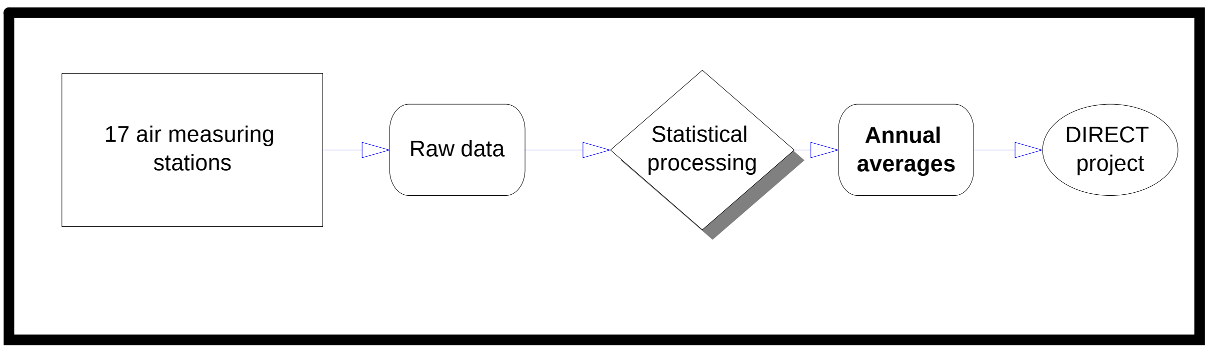



Figure IX.9: Data flows concerning air pollution

### IX.5.3 PUBLIC TRANSPORT PATRONAGE IN TERMS OF THE NUMBER OF JOURNEYS PER MONTH AND SUB-NETWORK

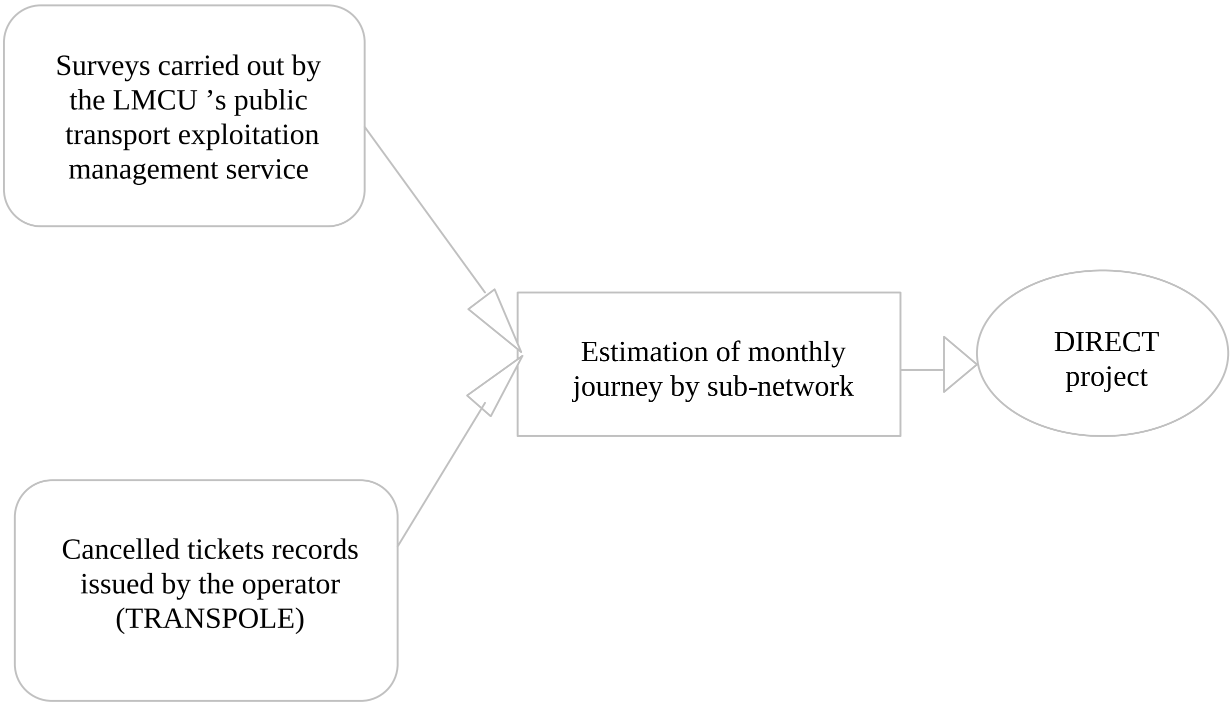



Figure IX.10: Data flows concerning the public transport patronage

The *LMCU*'s public transport operation management service carries out surveys in the Lille urban community on behalf of the *Syndicat Mixte des Transports Collectifs* (*SMTC*), a public-private public transport operator. The operator provides the obliterated tickets records.

# X. THE BARCELONA TRIP SERVER : EXAMPLE OF A TDSS BUILT FOR ON-LINE TRAFFIC MANAGEMENT PURPOSE

## X.1 CONTEXT

### X.1.1 OBJECTIVE

From the project perspective, the main objective, as stated in the Technical Annex, is "to implement the interfaces required to demonstrate the operational performance of a technologically advanced data sharing platform based on operators' developments of Internet-based systems", DIRECT, 1997).

From the local demonstration perspective, this leads to the formulation of the following main objectives:

- Implementation of two processes to:
  - Demonstrate data interchange between applications (Private T., Public T.).
  - Provide the citizens with tools for information and trip planning (Internet applications)
  - Provide the operators with an analysis tool allowing them to know the level of usage of their Internet application as well as its weak points and how to solve them (Monitoring).
- To integrate Parking and Road Network Conditions applications with a Public Transport trip planner, in a way that promotes a responsible use of the private car and enables drivers to obtain specific door-to-door information about public transport alternatives.
- When there will be a higher use of Internet, Monitoring will be used as semi-dynamic tool for Mobility surveys.
- To simulate the operation of parking spaces booking service by Internet.

### X.1.2 GENERAL OVERVIEW

To accomplish these objectives, the architecture, shown in the figure X.1 below, has been designed:

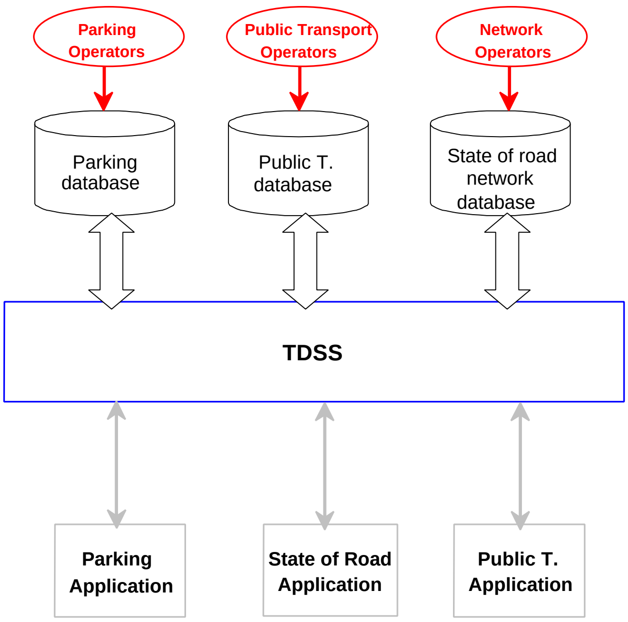


*Figure X.1 Description of Barcelona case*

The development of the Barcelona demo involves the following operators:

- SMASSA: Parking operator that will be in charge of the maintenance and updating of the Barcelona car parks database.
- TMB: Public Transport operator in charge of the maintenance and updating of the database containing information on public transport services (bus, metro, rail: FGC, RENFE) for Barcelona and 10 towns located within the metropolitan area.
- SVP: Local authority responsible of the road network of the city of Barcelona
- BTSA: is in charge of the implementation of the applications.

One part of the Barcelona demo has been implemented in Internet and one part in Intranet:

- INTERNET:
  - Parking Trip Planner: Where to Park?, Optimal routes (using historical data), P&R facilities.
  - Public Transport Trip Planner
  - State of Road network
- INTRANET
  - Parking booking
  - Optimal route in real time (Parking Trip Planner)

The development of the Barcelona demo has been realised in Internet : the TDSS is similar to an Internet server. The idea is to have a server containing the database of the different operators and applications enabling the end users to obtain transport information.

Currently, in Barcelona there are different Internet servers among which there is the TMB (Public Transport operator) server and the IMI (Barcelona City Council) server. This fact causes some institutional problems in having all the transport information in one server:

- Public Transport application belongs to TMB, and it has been implemented in its server.
- SMASSA (owner of the parking application) is a municipally owned company, and it has been obliged to implement its application in the IMI server, as SVP did with its application on road network condition.

Due to these institutional problems, transport data are distributed among different servers. Possible solutions to this problem are the following:

- To copy the Public Transport database in the IMI server: This solution will not be efficient, due to the fact that each time TMB will update its database then the IMI should copy again the updated database; this will need too much time and effort.
- Make good use of Internet: To work with separate databases, and implement links between the different Internet servers.

Considering that the best solution is the second one, in figure X.2 the needed servers as well as databases supplied by operators can be seen.

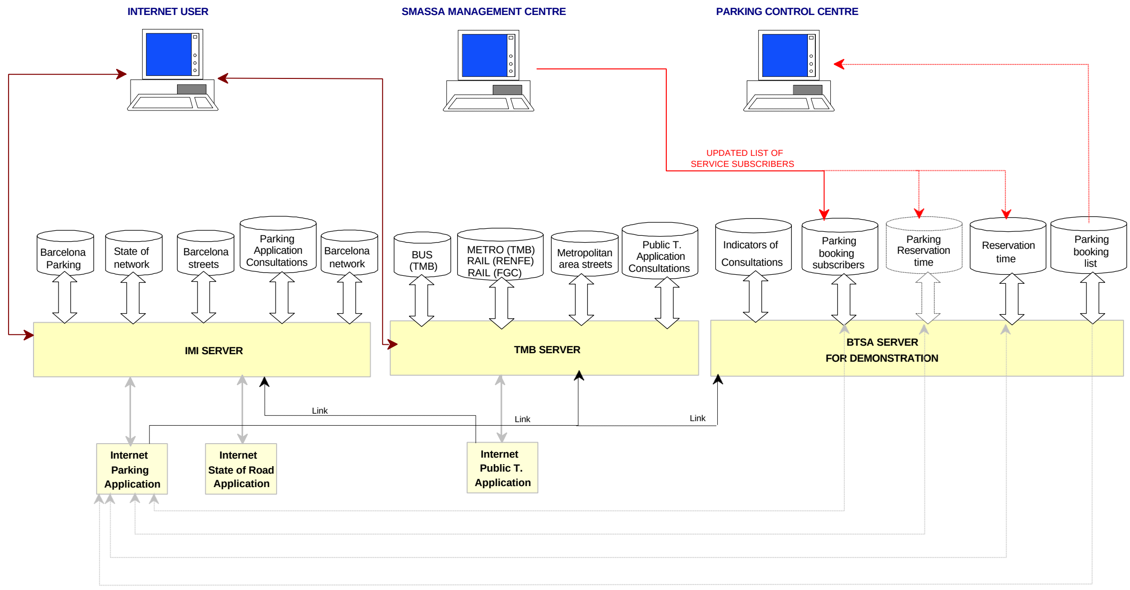



Figure X.2 Servers included in Barcelona Demo

- The IMI (Informatics Municipal Institute) server (Internet) will support the Parking and the Road Network Conditions applications, the databases stored in this server will be the following:
  - Barcelona parking: Information and characteristics of all car parks
  - Barcelona Streets: containing files with cartographic data of the city of Barcelona
  - Barcelona Network: database with information on the basic road network of the city of Barcelona
  - State of network: database containing information coming from the congestion detectors of the road network of Barcelona
  - Parking application consultations: database containing information on the users consultations to the Parking application

- The TMB server (Internet) will support the Public Transport application, the databases stored in this server will be the following:
  - BUS (TMB): database containing information on bus lines giving service to the 11 cities included in the application.
  - Metro, Renfe , FGC: database containing information on the different metro and rail lines (from different operators) giving service to the 11 municipalities included in the application.
  - Metropolitan area streets: containing files with cartographic data of the city of Barcelona
  - Public transport application consultations: database containing data on users consultations to the Public Transport application

- BTSA server (Intranet) stores the following databases (which in the future may be included in the former servers):
  - Parking booking subscribers
  - Parking reservation time
  - Reservation time
  - Parking booking list
  - Indicators of consultations: database containing statistics on consultations to Internet applications

### X.1.3 BARCELONA DEMONSTRATION USERS

Applications have to be accessed by several kinds of users, allowing a very large attendance for end-users[76].

✓ ***Internet Users***

- *Internet trip planner* applications don't have and will not have any kind of restriction for access to them : everybody will have free access to the applications.
- The *Parking application* have the options to reserve places and to buy parking products (every parking has its products), for these reasons in this application we will have types of users:
  - Parking subscribers
  - Parking non-subscribers

✓ ***Monitor Users***

- Authorised users have free access to data : operators that supply data to the TDSS (SMASSA, TMB, SVP).
- Users that only having access to data if they pay for the information

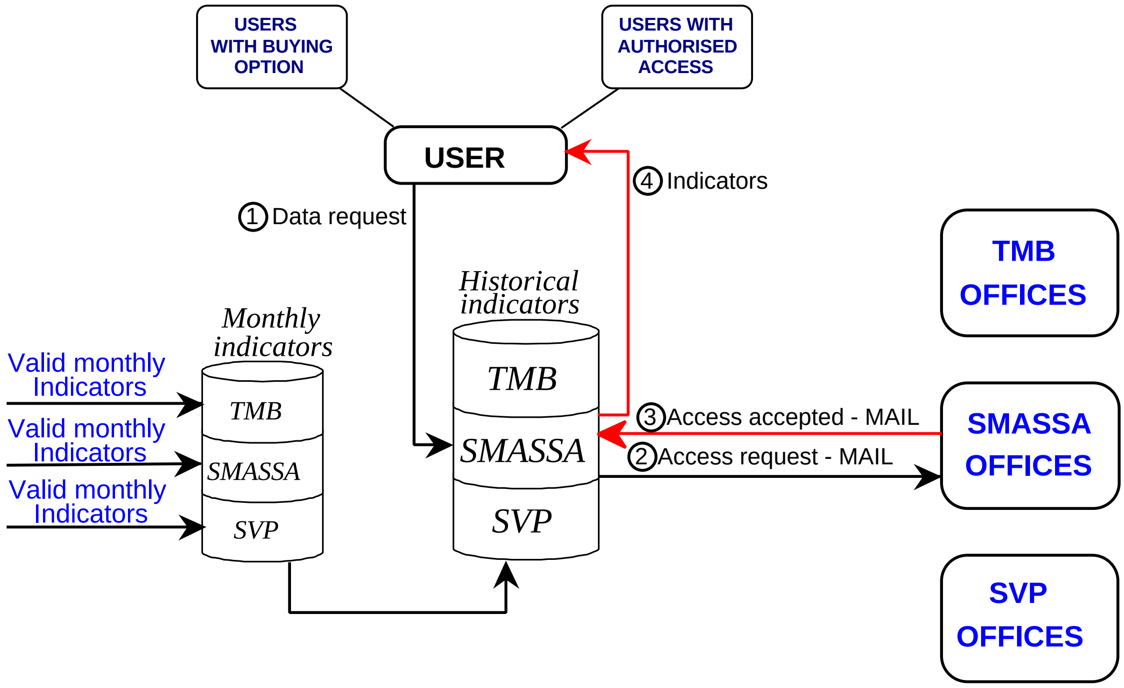



Figure X.3 Monitoring Application of Trip Planner Indicators

The valid monthly indicators are stored in the TDSS as we can observe in Figure X.3. There are two different databases in the TDSS :

- One of them storing the indicators of the current month
- The other database storing the indicators of the month before

The users will be able to access the monthly indicators database or the historical indicators database. When a user wants to access the TDSS, he will have to go through the following steps:

76 Remembering the new Barcelona architecture (Figure X.1) we have to distinguish between two different types of users: the users who make consultations to the Internet applications and the users who make consultations to the indicators generated by the monitor application.

① Type of data request by the user.
② Access request via E-mail to the owner of data.
③ Access accepted (as an authorised user or as a user with buying option) or not by the owner of data.
④ If the user has access, he can obtain the indicators.

All this process has to be off-line.

The monthly indicators database and the historical indicators database presents the following format:

- **INDICATORS**
  - ***PUBLIC TRANSPORT***
    - GENERAL
      - Exploitation results.xls
    - GRAPHICS
      - General.xls
      - Metro.xls
      - Bus.xls
      - Fgc.xls
      - Renfe.xls
  - ***PARKING***
    - GENERAL
      - Exploitation results.xls
    - GRAPHICS
      - General.xls
      - Smassa.xls
      - Parking Operator 2.xls
      - Parking Operator n.xls
  - ***STATE OF ROAD CONDITIONS***
    - Not defined – see section X.5

### X.1.4 USING INTERNET AND THE WEB

The Web gives access through a web browser (Netscape Navigator, Internet Explorer, ...) to information available under HTML format. This access could be given to anyone through Internet or restricted to a specific domain called Intranet. These information pages are static, we can only navigate through predefined links but by the means of CGI and/or Java scripts, the pages can be defined dynamically allowing then interactive exchanges with the reader.

Internet applications have interesting characteristics for the Barcelona demonstration purpose, such as:

- reaching easily a very large audience,
- providing standard mechanisms for diffusion, data capture and monitoring,
- connecting to other servers or applications in a seamless way for the end-user.

On the other hand, limited bandwidth on Internet has to be taken into account to ensure satisfying speed of response of the application.

## X.2 BARCELONA DEMONSTRATION ARCHITECTURE

### X.2.1 TDSS

The Barcelona prototype architecture consists of distributed TDSS, using *templates* located on each server to provide information on *entry points* that can be reached from any other server[77]. In that case, an application can be reduced to such an entry on a server.

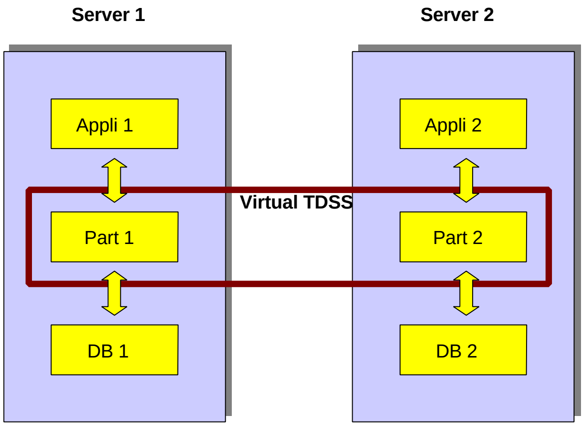



Figure X.4 Virtual TDSS

For Internet, each application has an entry point, so in order to compact the three applications a common access will be used from the IMI server as shown in the next figure:

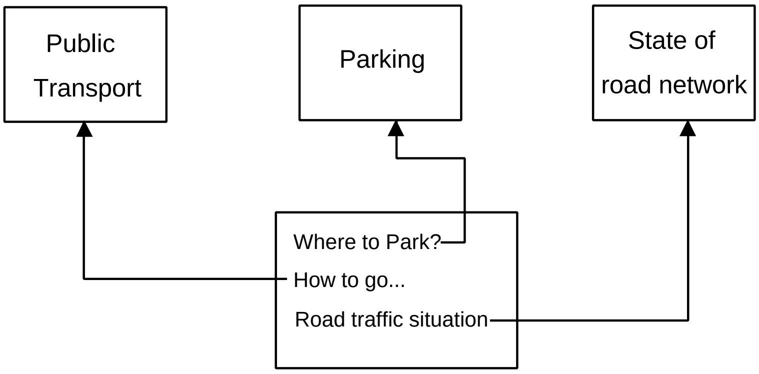



Figure X.5 Common access to Trip Planners

The Parking application is the main one, this is because:

- it is fed by state of road network data
- it transfers parameters of the Public Transport application for calculating alternative routes in Public Transport.

In the following figure, the final design of the TDSS for the Barcelona demo is shown. In order to simplify the figure and making it easy to understand, only the applications finally implemented in Internet are included. The part of spaces booking is not included in the figure, but is explained in section X.5.

[77] The solution consisting of providing access to the various servers involved in the demonstration by inserting an intermediate layer between applications and servers, in order to determine which server had to be contacted for each query submission has been firstly examined. This kind of solution has been rejected because it is not reaching the goal of a good time of response.

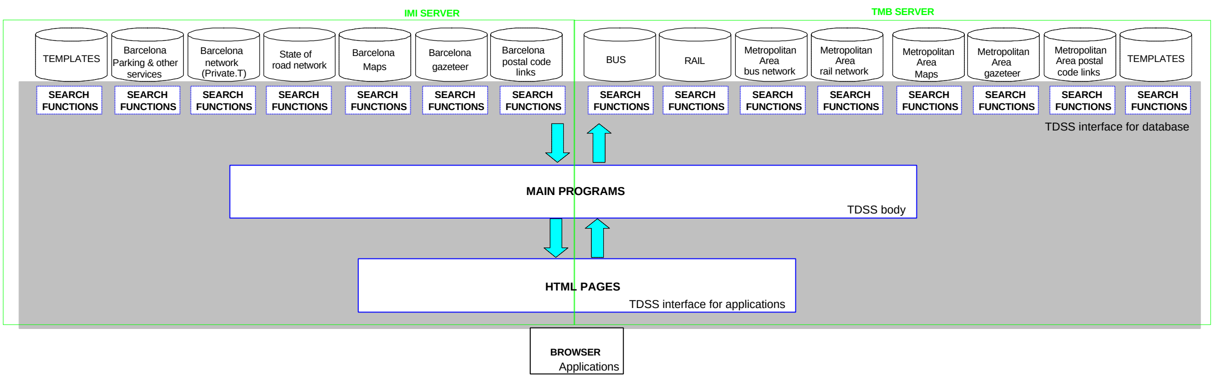



*Figure X.6 Barcelona TDSS architecture*

The following table provides the distribution of the files needed to implement trip planners according the databases defined in Figure X.6.

| | |
|---|---|
| **IMI SERVER** | |
| **Barcelona Parking & other services** | • Places of Interest file<br>• Parking operators file<br>• Parking file<br>• Parking Gates file<br>• Discounts file<br>• Tariffs file<br>• Parking Tariffs file<br>• Timetable file<br>• Parking timetable file |
| **Barcelona Network (Private T.)** | • Node file<br>• Link file |
| **Barcelona Maps** | • Maps file |
| **Barcelona Gazetteer** | • Streets file<br>• Corners file<br>• Cities file<br>• Synonyms |
| **Barcelona Postal code links** | • Sections File |
| **State of Road Network** | • File 1<br>• File 2 |
| **TMB SERVER** | |
| **BUS** | • Bus lines<br>• Bus frequencies |
| **Metropolitan Area bus network** | • Bus itineraries<br>• Bus Stops |
| **METRO** | • Metro frequencies<br>• Company description |
| **Metropolitan Area rail network** | • Metro itineraries (stations) |
| **Metropolitan Area Maps (Barcelona and rest of MA)** | • Maps file |
| **Metropolitan Area gazetteer (Metropolitan Area Without Barcelona)** | • Streets file<br>• Corners file<br>• Cities file<br>• Synonyms |
| **Metropolitan Area Postal code links (Metropolitan Area without Barcelona)** | • Sections File |

Table X.7 : distribution of the files needed to implement trip planner considering the databases defined in Figure X.6.

### X.2.2 TDSS FUNCTIONS

✓ ***Applications***

- NETSCAPE
- EXPLORER
- Other

✓ ***TDSS interface for application***

html pages containing the following functions :

- Entry data validation
- Generation of response pages

✓ ***TDSS interface for database***

- Databases searching functions (see TDSS Body)

✓ ***TDSS body***

| **IMI server main programmes** | |
|---|---|
| **Where to park (Parking Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches call:<br>• Destination search ⇨ BARCELONA GAZETTEER<br>• destination coordinates search ⇨ BARCELONA PPOSTAL CODE LINKS<br>• car parks near to destination search ⇨ BARCELONA PARKING & OTHER SERVICES<br>• maps search ⇨ BARCELONA MAPS<br>➢ Maps generation<br>➢ Call to response pages generation |
| **Car Park description (Parking Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches call:<br>• all available parking information search ⇨ BARCELONA PARKING & OTHER SERVICES<br>• Call to response pages generation |
| **Optimal routes (Parking Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searching call:<br>• Origin search ⇨ BARCELONA GAZETTEER<br>• origin coordinates search ⇨ BARCELONA POSTAL CODE LINKS<br>• search of nodes near origin and destination ⇨ BARCELONA NETWORK<br>• Search of all Private Transport network ⇨ BARCELONA NETWORK<br>• maps search ⇨ BARCELONA MAPS<br>➢ Optimal routes calculation<br>➢ Maps generation<br>➢ Call to response pages generation |
| **Zoom (Parking Trip planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches calls:<br>➢ Maps search ⇨ BARCELONA MAPS<br>➢ Call to response page generation |
| **Origin and Destination for Public Transport (Public T. Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches calls:<br>• origin search ⇨ BARCELONA GAZETTEER<br>• origin coordinates search ⇨ BARCELONA POSTAL CODE LINKS<br>• destination search ⇨ BARCELONA GAZETTEER<br>• destination coordinates search ⇨ BARCELONA POSTAL CODE LINKS<br>➢ Call to response pages generation |

| | |
|---|---|
| **Traffic (Road network condition Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches calls:<br>• segment colour search ⇨ STATE OF ROAD NETWORK<br>• maps search ⇨BARCELONA MAPS<br>➢ Maps generation<br>➢ Call to response page generation |
| **Zoom (Road network condition Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches calls:<br>• maps searches ⇨ BARCELONA MAPS<br>➢ Maps generation<br>➢ Call to response pages generation |
| **TMB server main programmes** | |
| **Origin and Destination (Public Transport Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches calls:<br>• Search of origin and / or destination in Barcelona ⇨ BARCELONA GAZETTEER<br>• search of origin and/or destination coordinate in Barcelona ⇨ BARCELONA POSTAL CODE LINKS<br>• Search of origin and / or destination outside Barcelona ⇨ METROPOLITAN A. GAZETTEER<br>• search of origin and/or destination coordinate outside Barcelona ⇨ METROPOLITAN A. POSTAL CODE LINKS<br>➢ Call to response pages generation |
| **Zoom (Public Transport Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches calls:<br>• maps search ⇨ BARCELONA MAPS<br>➢ Call to response page generation |
| **Optimal routes (Public Transport Trip Planner)** | ➢ Programme call validation<br>➢ Templates call<br>➢ Searches calls:<br>• search of BUS stops near origin and destination ⇨ BUS<br>• search of RAIL stations near origin and destination ⇨ RAIL<br>• search of all the BUS network ⇨ M.A. NETWORK BUS<br>• search of all the RAIL network ⇨ M.A. NETWORK RAIL<br>• Maps search ⇨ METROPOLITAN A. MAPS<br>➢ Optimal routes calculation<br>➢ Call to response page generation |

## X.3 DESCRIPTION OF INTERNET PUBLIC TRANSPORT TRIP PLANNERS

The aim of this application is to calculate optimal routes, in a specific date, between two points using Public Transport: metro, bus and combinations of both modes.

### X.3.1 USER POINT OF VIEW

This application (semi-dynamic) consists of a computing programme implemented in the TMB (Barcelona Metropolitan Transport operator) server. This programme is fed, on one side, by the IMI (Computing Municipal Institute) server which has Barcelona cartography data, and on the other side, by data from Public Transport operators.
At its commencement, the application only had data from TMB public transport, but later, other rail operators have been added such as FGC (Catalan Government Rail) and RENFE

(Spanish Rail). It is expected that when the service will be commissioned and extended to other cities of the metropolitan area, other private bus operators will be included.

When the user introduces origin and destination addresses, the application connects to IMI server to locate these addresses and show the optimal routes in a map.

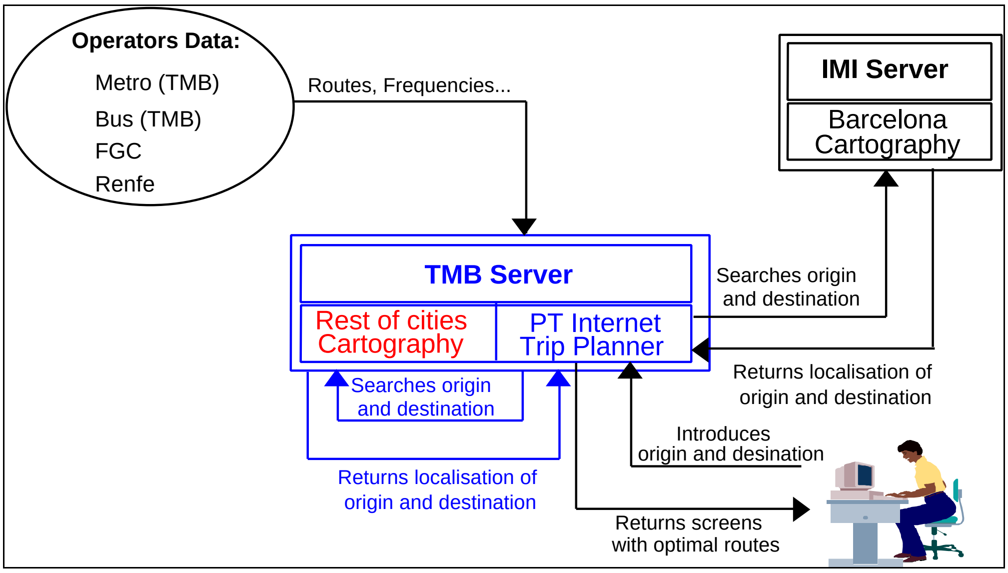


Figure X.8 Internet trip planner for Public Transport

The exchange of information between application and users can be very useful in order to know trip patterns generated in Barcelona and its metropolitan area.

Basically, the exchanged information is, on the side of users, trips origin and destination, and on the side of the programme (operators) the best Public Transport modes combination.

✓ ***Areas Included in the Application***

This application includes 11 municipalities, which form the Transport Metropolitan Entity of Barcelona. These 11 municipalities have been included because they constitute the area covered by TMB (owner of the application).

The other operators included in the application have not contributed with resources nor information, and this is the reason for which TMB has decided to include only the cities covered by its Public Transport network. The following figure shows the geographic distribution of the cities included in the application:

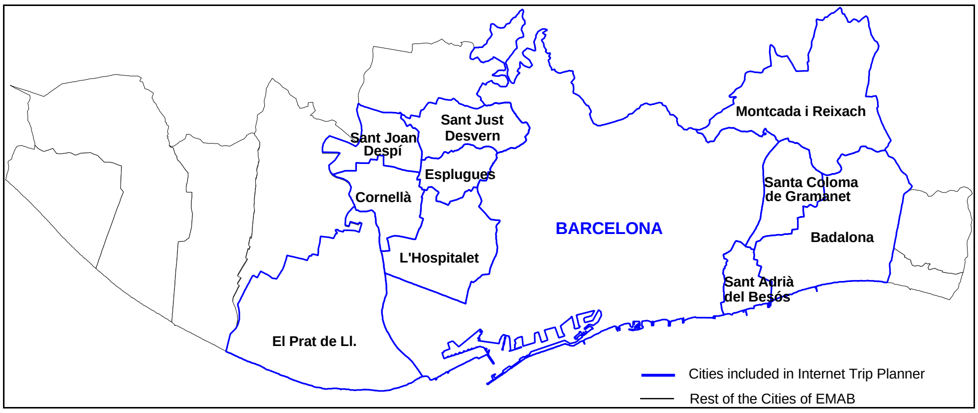



Figure X.9: Geographic distribution of the urban municipalities included in the application

✓ ***Selection of Origin and Destination by the user***

The Public Transport Trip Planner can be accessed from the TMB server as well as from the IMI server.

➢ *TMB Server*

There are two screens for selecting origin and destination (figure X.10) and a screen for confirmation ( once the user has introduced trip origin and destination).

There are three options to select origin and destination:

By address
By junction
By place of interest or Facility

In this Trip planner the user can also choose the desired transport modes among the following:

- *Metro (Metro TMB, FGC, RENFE)*
- *Bus TMB*
- *Handicapped mobility*

Other interesting data selected by the users are language and consultation date, that although not being very relevant, they can be useful to assess characteristics of the consulting people during the different months of the year. Currently, consultation languages are:

- *Catalan*
- *Spanish*
- *English*

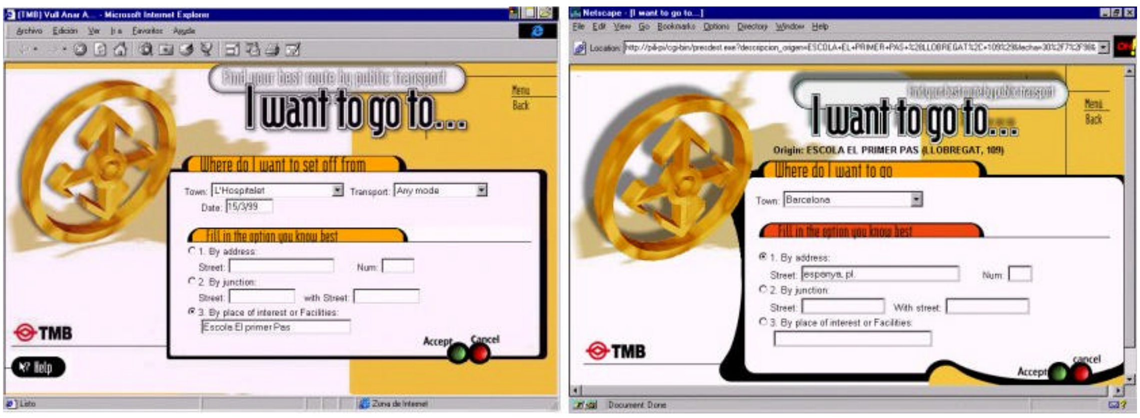



Figure X.10 "I want to go to.." Origin and Destination trip planner displays

There are secondary screens in case the user does not introduce the correct name of the street or the place of interest. These screens display a list of street names similar to the one introduced by the user, and he/she has to select the correct name (Figure X.11).


Figure X.11 Secondary screen

It has to be highlighted that the Barcelona streets are searched through a link with the IMI server since this is the only institution that has the Barcelona cartography. The other cities streets are searched in the same TMB server, since while developing this application the cartography of these cities has also been developed.

- *IMI server*

The access to the Public Transport Trip Planner from the IMI server is realised through other screens. In this case the selection of origin and destination (Figure X.12) has also three options:

Three options to select origin and destination:

By address
By junction
By place of interest or Facility

The language can also be selected:

- *Catalan*
- *Spanish*
- *English*

The only two differences in comparison with the direct access from the TMB server are:

- *The Public Transport mode cannot be selected*
- *Both origin and destination should be located inside Barcelona city.*

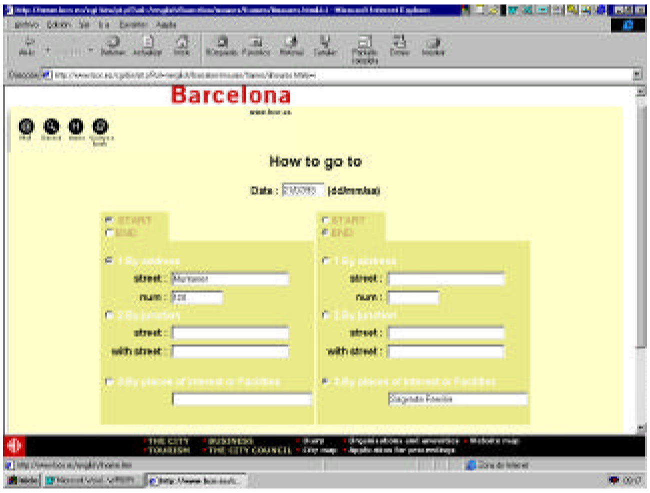


Figure X.12 Origin-destination selection screen from the IMI server

Once origin and destination selected, some items can be similar, and it is in the screen shown in figure X.13 where the user can select the correct item searched.

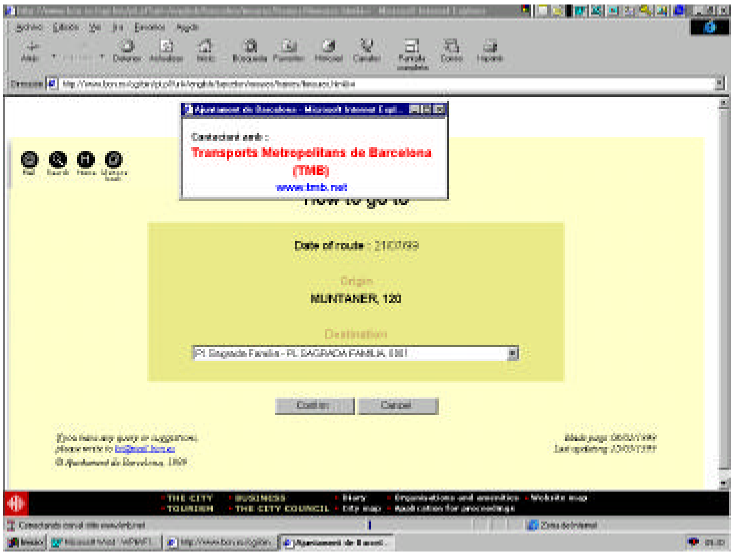


Figure X.13 Secondary screen from the IMI server

Once the correct items determined, the application will connect with the TMB server to obtain the optimal routes in Public Transport.

✓ ***Solutions shown by the Application to the user***

This application can give three types of solutions:

- Public Transport: whenever there is a quite good solution with a maximum of 2 modal interchanges (3 transport modes).
- Walking: when the distance between origin and destination is very short.
- There is no solution: when the solution in Public Transport is not good.

The application identifies all possible solutions in Public Transport, calculating a cost function for each of these solutions. In the screen of optimal routes only a maximum of 9 solutions are shown, with a maximum of 3 solutions per list Box (those calculated solutions with the lower cost function). The possible list box are the following:

- Bus only: bus combinations with a maximum of 2 modal interchanges.
- Metro only: metro combinations with a maximum of 2 modal interchanges.

- Metro and Bus: bus-metro combinations with a maximum of 2 modal interchanges.

As it can be seen in Figure X.14, besides the graphical description on the map of the optimal route, a written description of the trip with the different transport modes is also displayed.

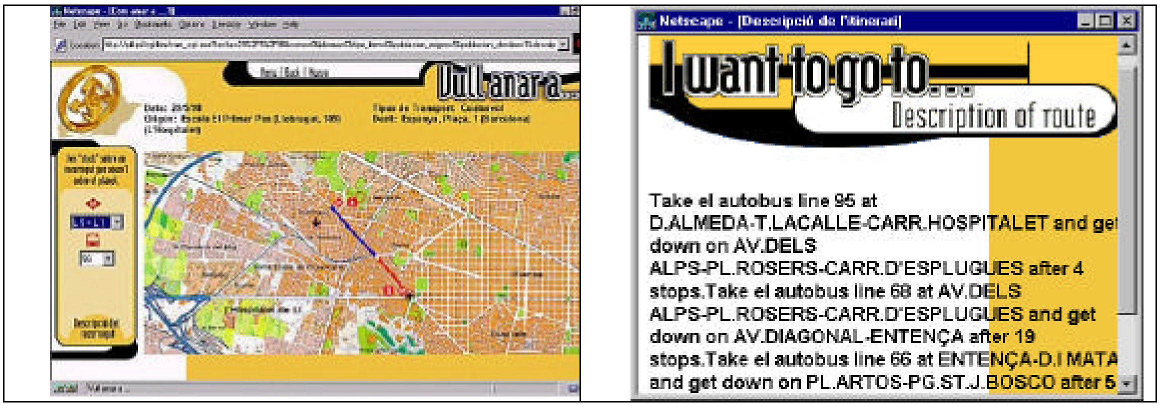



Figure X.14 Optimal route screens

### ✓ *Application Parameters*

The following table presents the parameters used in this application:

| Name | Description | Type |
|---|---|---|
| MAX_DISTANCE_WALKING | Maximum distance (m) to be covered by walking | float |
| RADIUS | Search initial radius (m) | float |
| RADIUS_INCREASE | % that radius will be increased in case that no optimal itinerary is found | float |
| WALKING_PENALISATION | Penalisation for walking | float |
| METRO_INTERCHANGE_PENALISATION | Penalisation for making an interchange in metro | float |
| BUS_INTECHANGE_PENALISATION | Penalisation for making an interchange in bus | float |
| BUS_METRO_INTERCHANGE_PENALISATION | Penalisation for making an interchange between bus and metro | float |
| BUS_METRO_PENALISATION | Penalisation of solutions or itinerary sections in BUS in front of the metro | float |
| FREQUENCY_WEIGHT | Weight that the average frequency of a line is going to have in the optimisation function | float |
| BUS_BUS_ALWAYS | Calculate always bus+bus solutions, although only bus solutions have already been found | 0 no<br>1 yes |
| METRO_METRO_ALWAYS | Calculate always metro+metro solutions, although only metro solutions have already been found | 0 no<br>1 yes |
| FIRST_OPTION | Indicates which is the first option to be shown in the results page | m metro<br>b bus |
| N_OPTIONS_METRO | Number of metro options to be shown | whole |
| N_OPTIONS_BUS | Number of bus options to be shown | whole |
| N_OPTIONS_METRO_BUS | Number of bus+metro or metro+bus options to be shown | whole |
| X_MIN_MAP | Minimum X UTM coordinate of the general map | float |
| Y_MIN_MAP | Minimum Y UTM coordinate of the general map | float |
| X_MAX_MAP | Maximum X UTM coordinate of the general map | float |
| Y_MAX_MAP | Maximum Y UTM coordinate of the general map | float |
| GIF_WIDTH | gif width of the general map where routes are going to be drawn | whole |
| GIF_HEIGHT | gif height of the general map where routes are going to be drawn | whole |
| GIF_ZOOM_WIDTH | Width of the enlarged map where routes are going to be drawn | whole |
| GIF_ZOOM_HEIGHT | Height of the enlarged map where itineraries are going to be drawn | whole |
| MAP_ROTATION | degrees in which the general map is rotated related to UTM coordinates | whole |
| GIF_VISUALISE_WIDTH | Width of map to visualise in visualise origin, destination, etc. | whole |
| GIF_VISUALISE_HEIGHT | Height of map to visualise in visualise origin, destination, etc. | whole |
| MAP_ROTATION _VISUALISE | degrees in which maps to be visualised are rotated related to UTM coordinates | whole |
| DIR_BASE | Base directory | text |
| DIR_MAPS | Directory where maps for Visualise origin, destination, etc. functions are | text |
| URL_IMAGES | URL where the images are | text |
| DIR_IMAGES | Directory where the images are | text |
| URL_OUT | URL where gif and htm temporary files are stored | text |
| LINK_MAP | link to Visualise | text |
| DESCRIPTION_SP<br>DESCRIPTION_EN<br>DESCRIPTION_CA | Spanish, English and Catalan descriptions of route or a part of it | text |

Figure X.15 Public Transport Trip Planner parameters

## X.3.2 TDSS POINT OF VIEW

✓ ***Access to the Trip Planner from the TMB server***

Work takes place in the TMB server, realising, if needed, connections to the IMI server (to obtain addresses and coordinates in Barcelona).

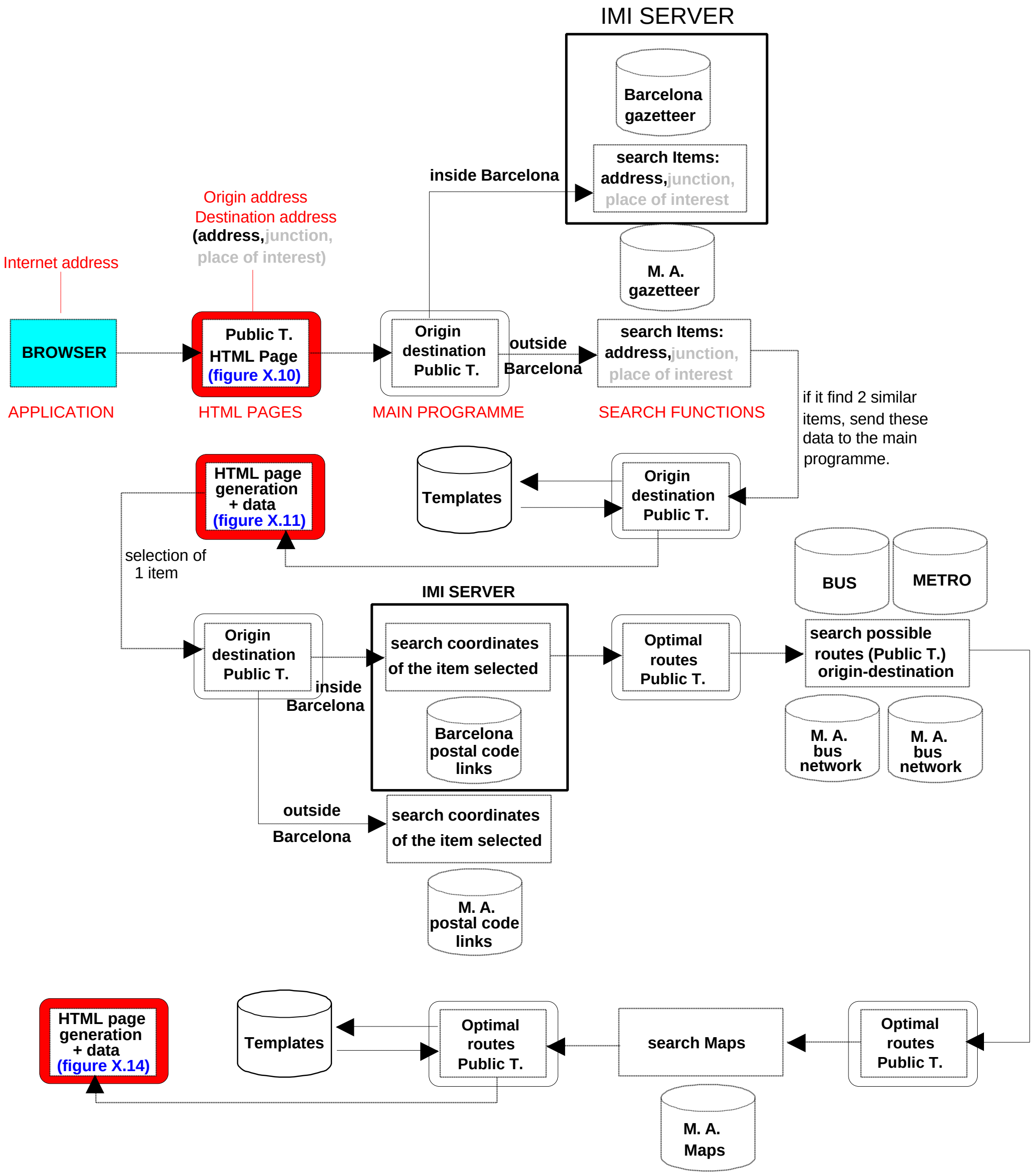



Figure X.16 TDSS working scheme (seen from inside TMB server)

### ✓ *Access to the Trip Planner from the IMI server*

Work takes place in the IMI server, connecting with the TMB server for optimal routes calculation.

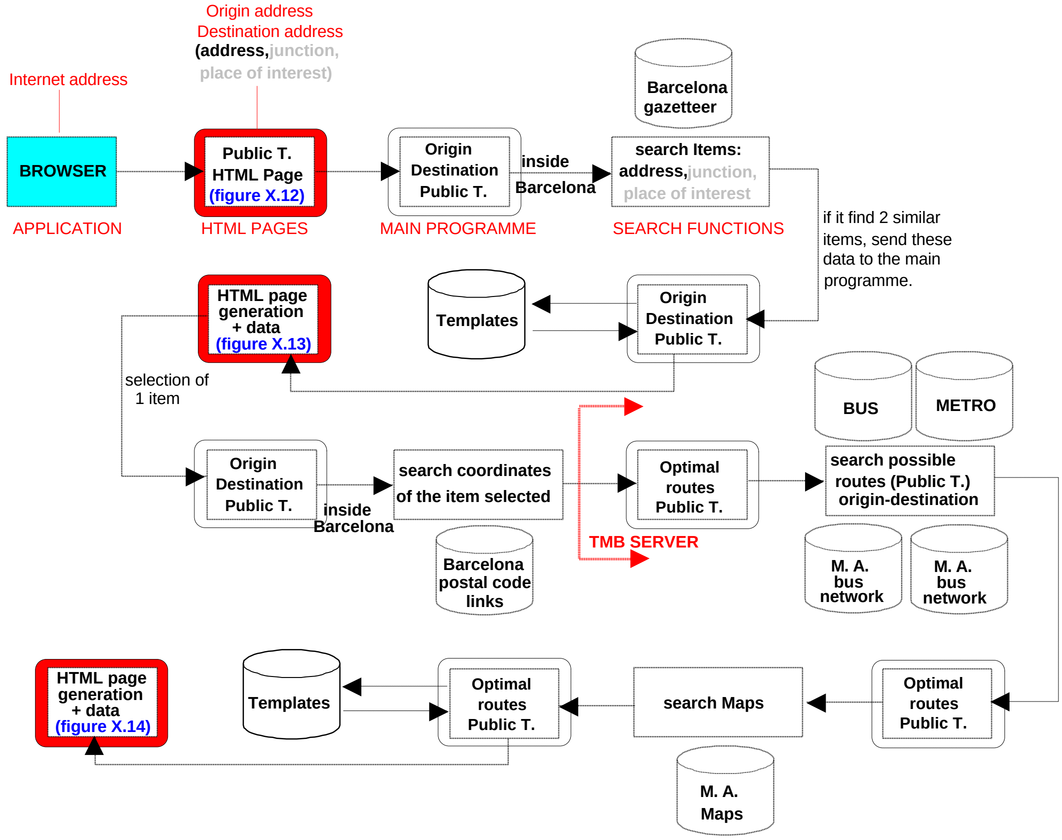



Figure X.17 TDSS working scheme (seen from inside IMI server)

## X.4 PARKING TRIP PLANNER

The objective of this application is to calculate optimal itineraries, in a determined date, between two points (being the destination point a car park closer to the final destination selected by the user) in private transport.

### X.4.1 USER POINT OF VIEW

This application consists of a computer programme, implemented at the IMI (Informatics Municipal Institute) server by BTSA and which belongs to SMASSA. The application is only fed by the IMI server (while PT application was fed both by the IMI and TMB servers).

It is a semi-dynamic application for which a database with 460 rotation car parks has been built, and in the next future it is foreseen to include 200 car parks of residents. In addition, for the application a network of private transport in the Barcelona city has had to be defined, this network has 5200 nodes and 6350 links (each link has a weight according to the type of road to which it belongs).

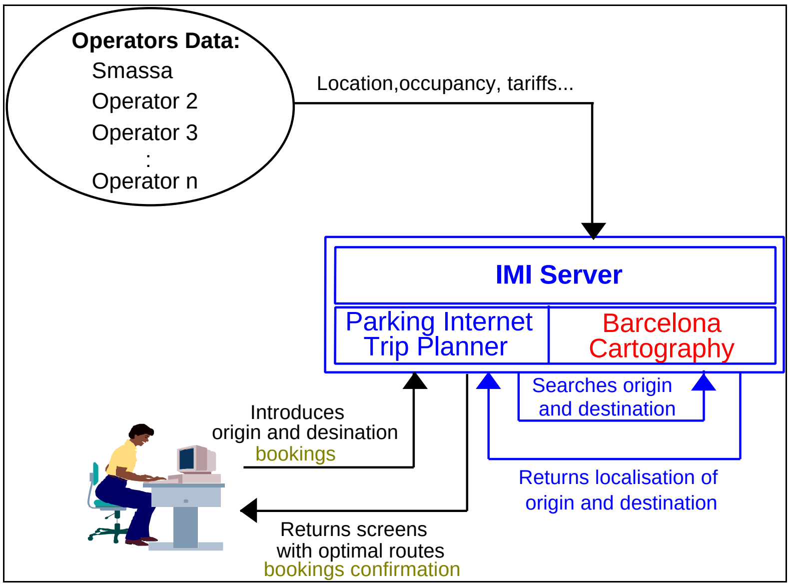



Figure X.18 Parking Internet Trip Planner

✓ ***Areas included in the Application***

This application will be limited to the Barcelona city area, since its aim is to inform the private car user about the car parks existing in the city in order to avoid incorrect parking operations and to reduce pollution.

In this application, besides the basic road network of Barcelona, the main entries to the city have been defined so as to allow people travelling to Barcelona by private car from areas outside the city to be informed about how to go and where to park. This means that solutions can be presented for all trip movements (External-internal and internal-internal) even though the road network is only developed for the area of the Barcelona Municipality.

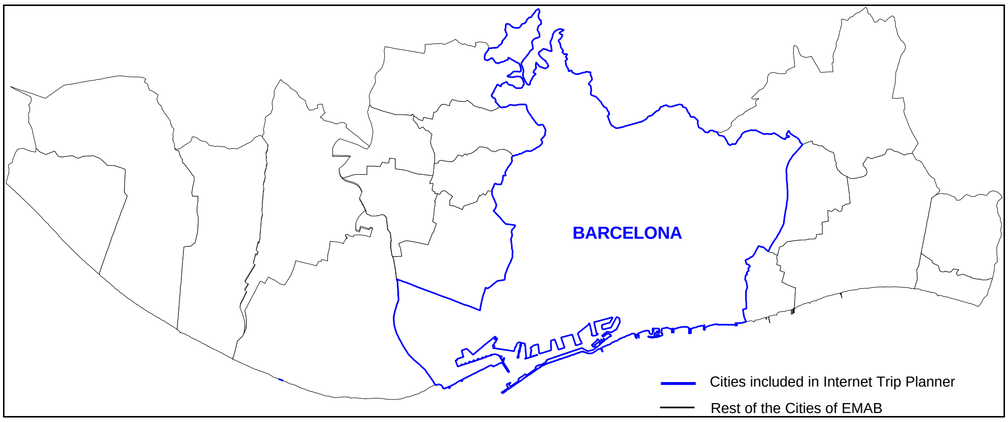



Figure X.19 Geographic location of the application zone

✓ ***Selection of Origin and Destination by the user***

Parking application has some differences with the Public Transport application related to origin and destination selection. In contrast to the Public Transport application, in this application the destination in Barcelona is firstly selected, and then the trip origin is indicated..

There are four options to select both origin and destination (Figures X.20 and X.21):

- By address
- By intersection
- By Point of Interest, or Facility
- By map

The following figure shows the screen to select an internal destination in Barcelona city. It is worth noting that the left-hand margin of the screen presents the user with a menu of integrated options for multimodal travel, and serves to remind the traveller of the options that the TDSS supports.

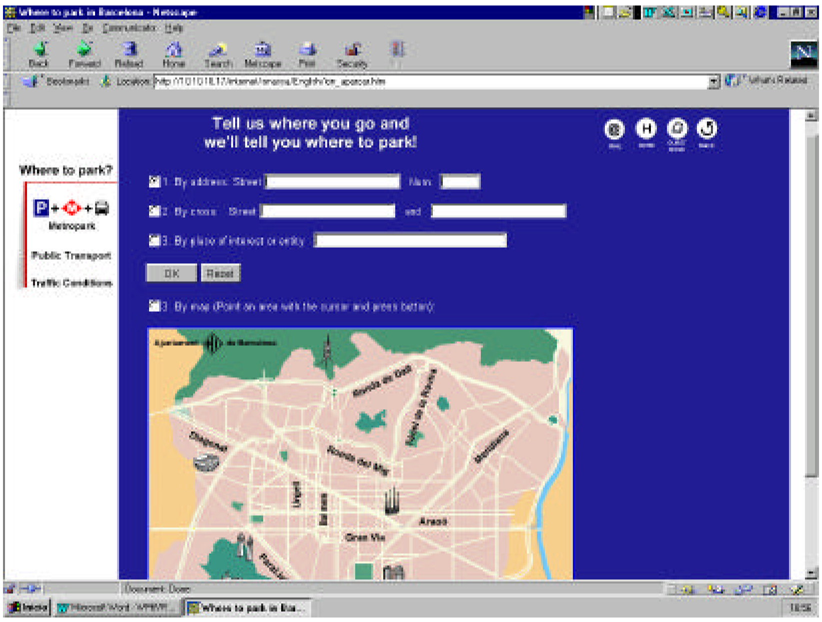



Figure X.20 Destination selection screen

Once a destination has been selected, then the next screen will appear (Figure X.21) showing the location of the entries of the car parks near to destination (in a radius of 500m). Putting the pointer on the car park icon, the name of the car park and the address of its entry will appear. On the other side, if we click on the car park icon, the screen showing the characteristics of the selected car park will be displayed (Figure X.22).

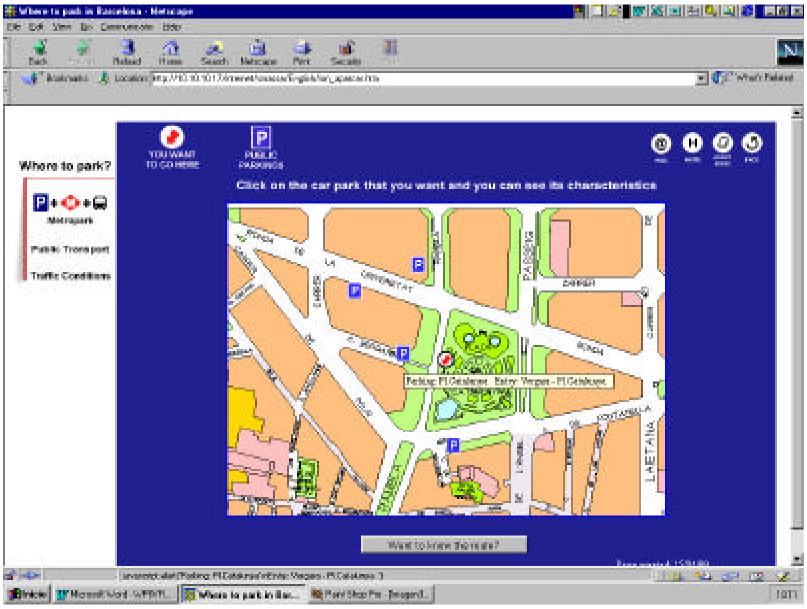



Figure X.21 Car parks near to destination

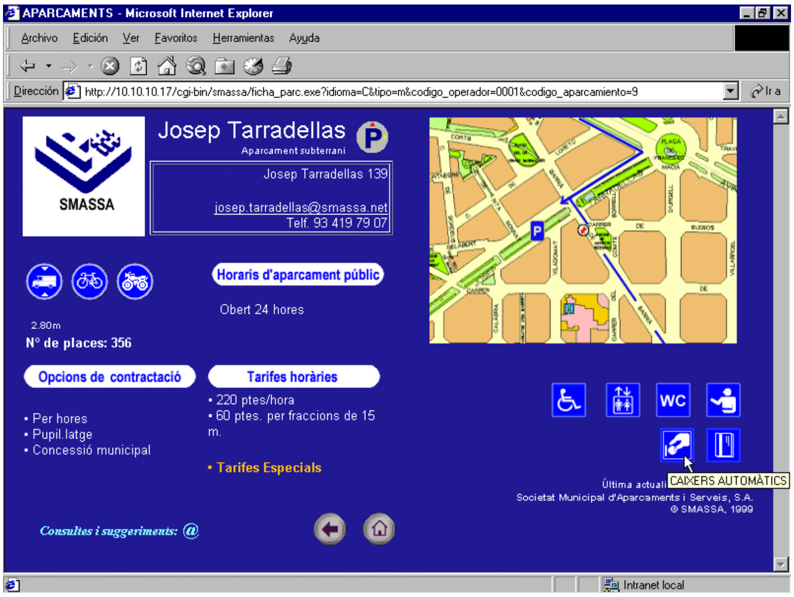



Figure X.22 Car park characteristics

From the screen showing car parks near to destination (Figure X.21), we can select the screen allowing to select trip origin (Figure X.23). In this screen the following items will be selected:

➢ *Trip origin*

- trips originated in Barcelona: origin can be selected by address, intersection, point of interest or map.
- trips originated out of Barcelona: origin will only be selected by map (the entry to Barcelona must be selected).

➢ *Car Park*

The names and addresses of the different entries of the car parks shown in Figure X.21 will appear in a scroll list. The car park and its entry up to which the optimal route is to be identified will be selected.

It should be noted that the options for searching for park & ride options has to be activated by the user (icons on upper right-hand side, Figure X.23). The fact that this option is not automatically triggered is a result of decisions agreed by the operator and the developer. The operator is primarily interested in seeing what usage will be made of the parking guidance application. The developer is committed, within this project, to developing a level of integration that facilitates public transport and private road searches in separate servers (note however, that the separate parts of park & ride searches are brought together – and the performance of this integration is also assessed – see Appendix 3).

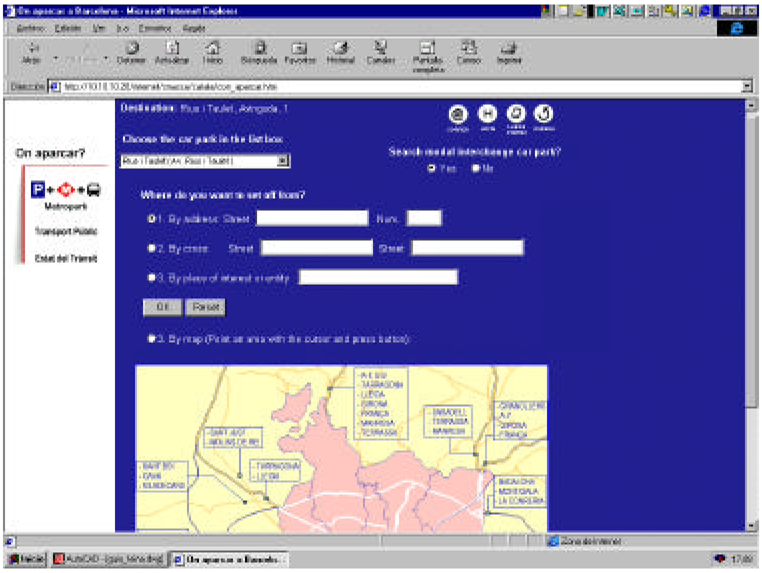



Figure X.23 Origin selection screen

As in the Public Transport application, there are secondary screens the objective of which is to help the user when he/she does not know exactly the name of the street or the point of interest (not used in case of map search). These screens present a list of street names similar to the one introduced by the user who has to select the exact name (Figure X.24).

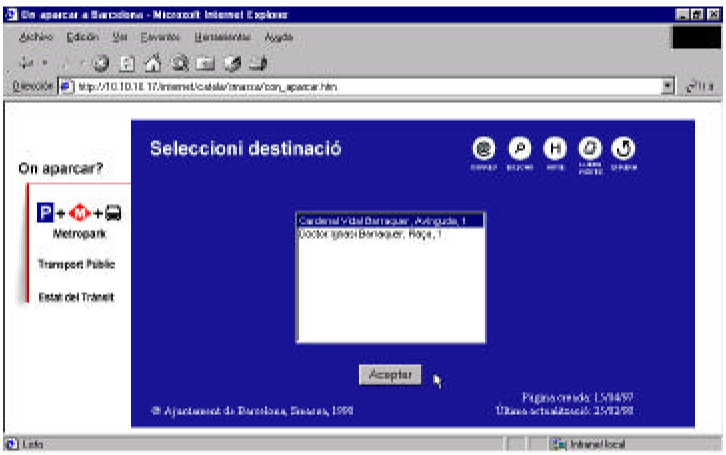



Figure X.24  Secondary screen to select right destination

Both origin and destination will be searched in the IMI cartography, since the Parking application only includes Barcelona city area.

✓ ***Solutions shown by the Application to the user***

This application can show two types of solutions:

- <u>If there is a car park near to destination</u>: the user will be shown those car parks near to destination, and he/she will have to choose one of them, and then the programme will calculate optimal routes from origin to chosen car park, at this stage two things can happen:
  - *If the origin is inside Barcelona*: in this case the programme will show a maximum of three routes (this is a parameter that can be modified depending on the SMASSA directions). The user will also be given the option to consult the route by public transport by clicking on the icon "How to go in Public Transport" at the Optimal Routes screen (Figure X.26).
  - *If the origin is outside Barcelona*: the programme will search the P&R facility nearest to the entry in the corresponding road network. Once the P&R is found, the application will look for solutions in private transport, from the origin to the P&R, and from the origin to the car park selected by the user. In parallel, the searching process of an optimal route by Public Transport is started, from the P&R facility to the real destination. This way, the response page will contain (Figures X.27, X.28):
    - up to 3 routes from the origin to the P&R facility, plus the 9 possible routes from the P&R to the destination by Public Transport (which can be visualised by clicking the icon of the corresponding P&R).
    - up to 3 routes from the origin to the car park in destination selected by the user.
- <u>If there is no car park near to destination</u>: in this case the programme will show the following options:
  - *P&R option*: if there is an optimal route from origin to the nearest P&R facility, the parking application will show a maximum of three optimal routes in private transport. Then, by clicking the corresponding P&R icon (parking application sends P&R and final destination coordinates to the Public Transport application while calculating route to P&R) a maximum of 9 routes in Public Transport (from P&R to final destination, if there is optimal route in Public Transport) will be shown. Figures X.27, X.28
  - *Public Transport Option*: in case that there is no P&R solution (a message stating that there is no solution in private transport and that the alternative solution is to take Pubic Transport), the parking application will directly connect with the Public Transport application (sending the coordinates of origin and destination selected by the user) which, if there is optimal route in Public Transport, will show a maximum of 9 optimal routes (from origin to destination).

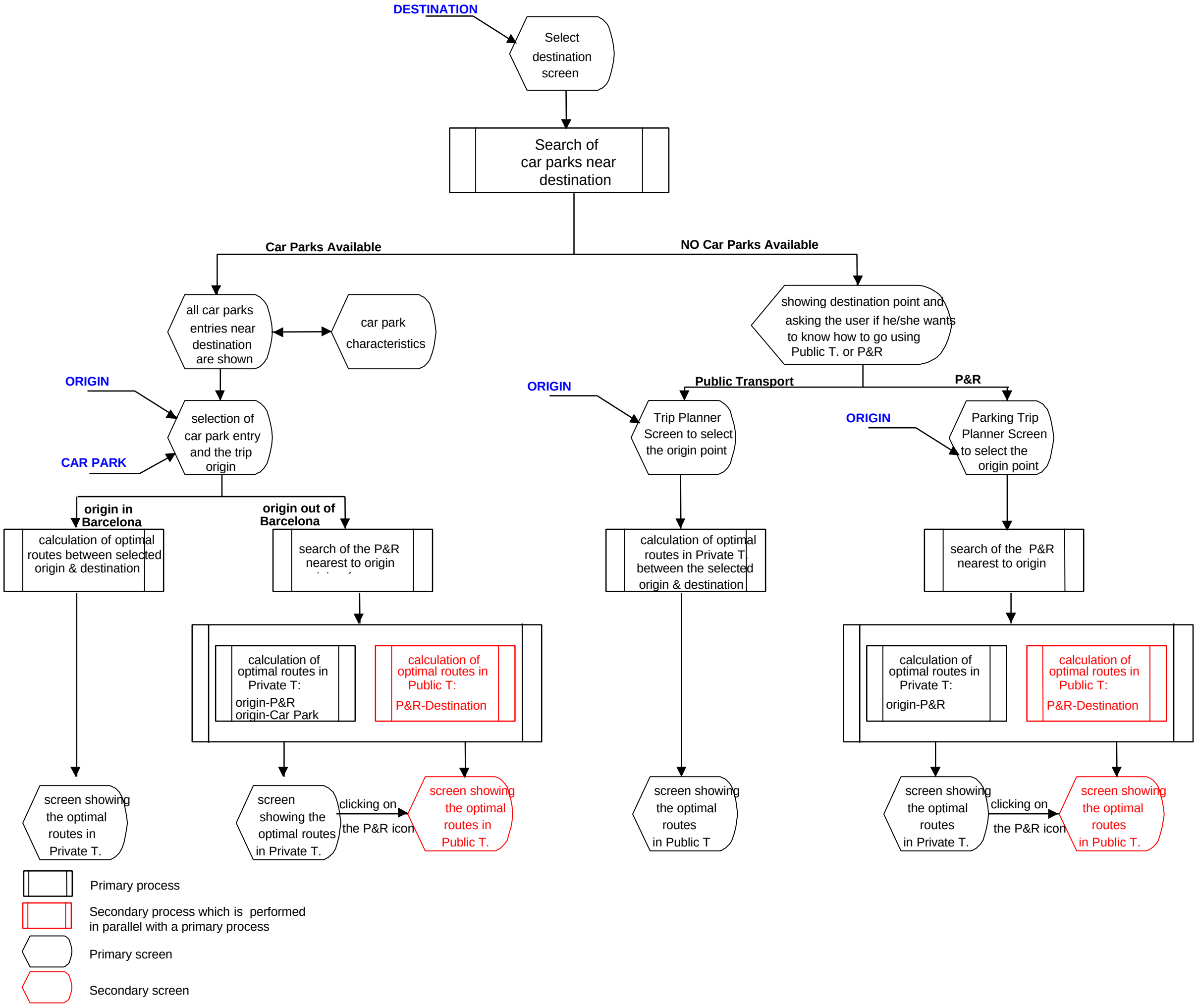



*Figure X.25 Solutions diagram*

For journeys with origin outside Barcelona, the Parking application will try to give a P&R solution in addition to possible solutions for selected car parks.

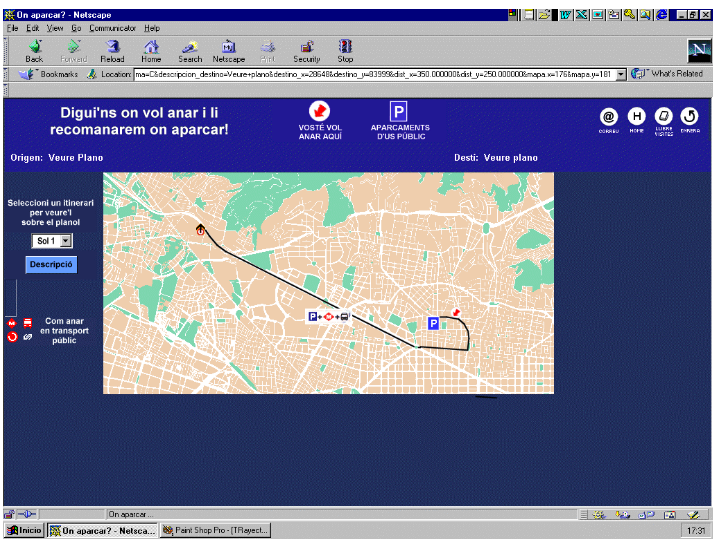



*Figure X.26 Route from Origin to Destination (Parking application).*

The Parking application, while calculating routes to P&R facility near to Origin, sends P&R and destination coordinates to the Public Transport application, so this last application can calculate routes in Public Transport. Then clicking on the corresponding P&R icon, the screen with routes in Public Transport will appear.

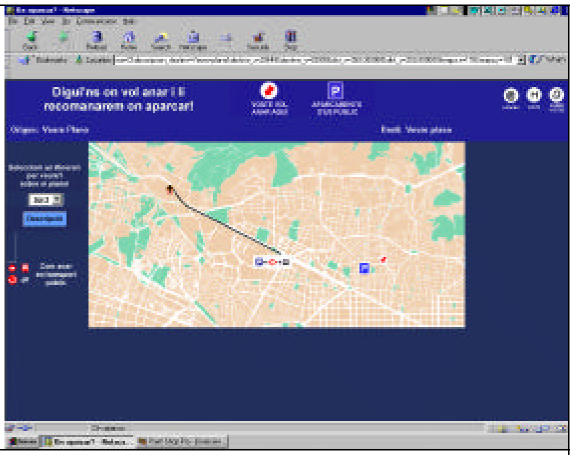



*Figure X.27 Route from Origin to P&R (Parking application).*

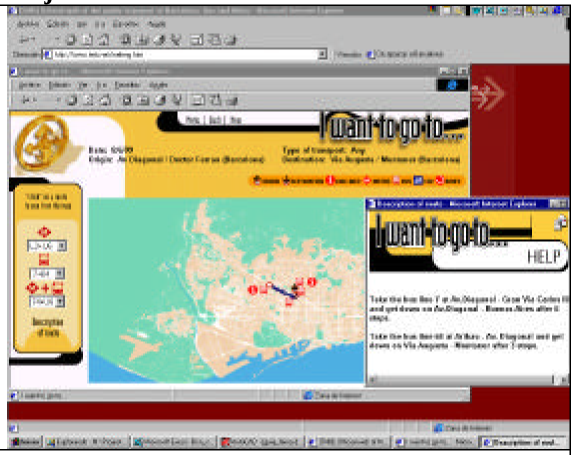



*Figure X.28 Route from P&R to destination (Public Transport application).*

## ✓ *Application Parameters*

| Name | Description | Type |
|---|---|---|
| MAX_DISTANCE_WALKING | Maximum distance (m) to be covered by walking | float |
| RADIUS_ORIGIN | Search initial radius (m) | float |
| RADIUS_DESTINATION | Search initial radius (m) | float |
| RADIUS_INCREASE | % that radius will be increased in case that no optimal itinerary is found | float |
| X_MIN_MAP | Minimum X UTM coordinate of the general map | float |
| Y_MIN_MAP | Minimum Y UTM coordinate of the general map | float |
| X_MAX_MAP | Maximum X UTM coordinate of the general map | float |
| Y_MAX_MAP | Maximum Y UTM coordinate of the general map | float |
| GIF_WIDTH | gif width of the general map where itineraries are going to be drawn | whole |
| GIF_HEIGHT | gif height of the general map where itineraries are going to be drawn | whole |
| GIF_ZOOM_WIDTH | Width of the enlarged map where itineraries are going to be drawn | whole |
| GIF_ZOOM_HEIGHT | Height of the enlarged map where itineraries are going to be drawn | whole |
| MAP_ROTATION | Degrees in which the general map is rotated related to UTM coordinates | whole |
| GIF_VISUALISE_WIDTH | Width of map to visualise in visualise origin, destination, etc. | whole |
| GIF_VISUALISE_HEIGHT | Height of map to visualise in visualise origin, destination, etc. | whole |
| MAP_ROTATION _VISUALISE | Degrees in which maps to be visualised are rotated related to UTM coordinates | whole |
| DIR_BASE | Base directory | text |
| DIR_MAPS | Directory where maps for Visualise origin, destination, etc. functions are | text |
| URL_IMAGES | URL where the images are | text |
| DIR_IMAGES | Directory where the images are | text |
| URL_OUT | URL where gif and htm temporary files are stored | text |
| WEIGHTING _COST | Factor with which the distance between origin and destination is multiplied to obtain the maximum cost level. | float |
| WEIGHTING _DISTANCE | Factor with which the distance between origin and destination is multiplied to obtain the maximum distance level | float |
| LINK_MAP | Link to Visualise | text |
| DESCRIPTION_SP<br>DESCRIPTION_EN<br>DESCRIPTION_CA | Spanish, English and Catalan descriptions of an itinerary or a part of it | text |

*Figure X.29 Parking trip planner parameters*

## X.4.2 TDSS POINT OF VIEW

The following diagrams explain the operation of the TDSS for the Parking trip Planner.

### ✓ *Destination selection*

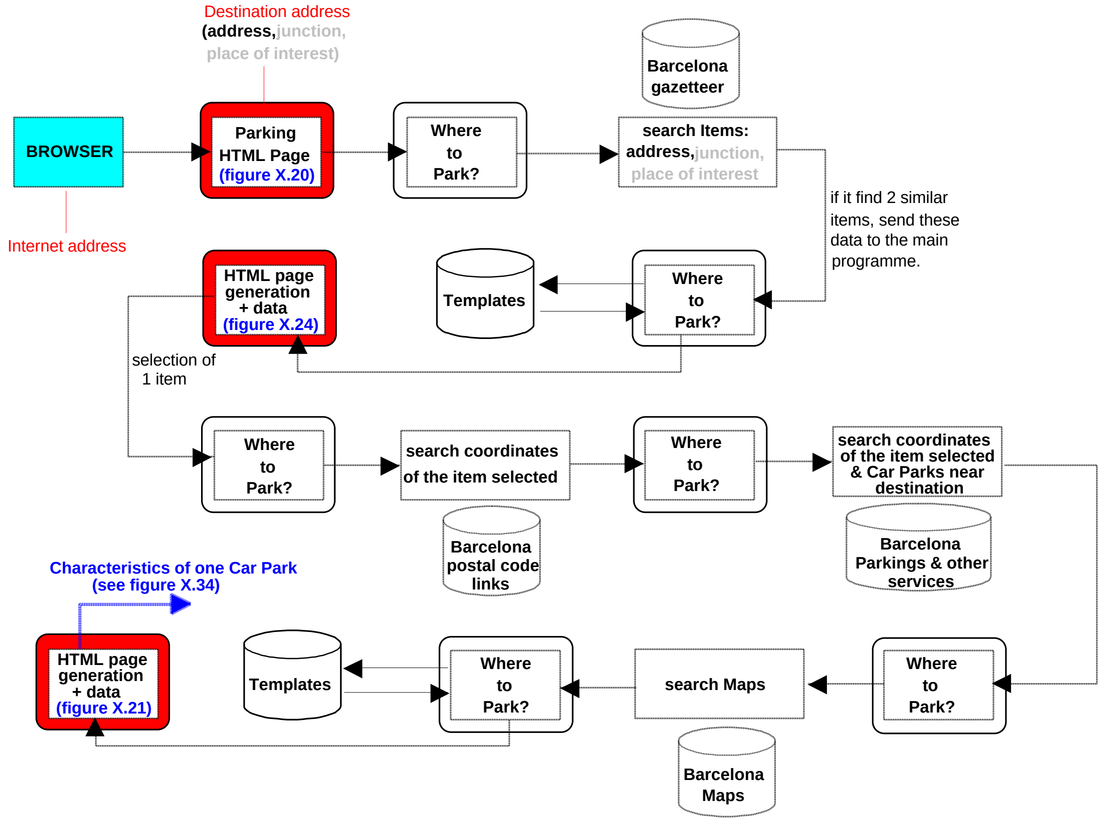



*Figure X.30 TDSS working scheme (seen form inside IMI server)*

### ✓ *Origin and Car Park selection and optimal routes calculation*

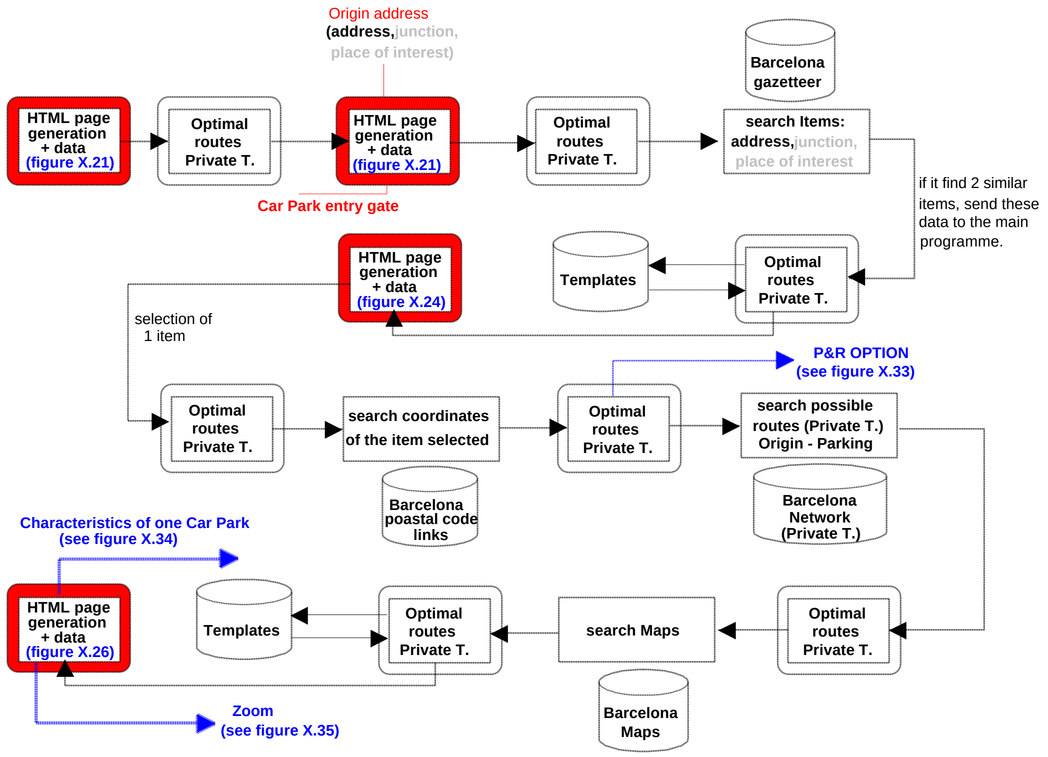



Figure X.31 TDSS working scheme (seen from inside IMI server)

### ✓ *Alternative route in Public Transport*

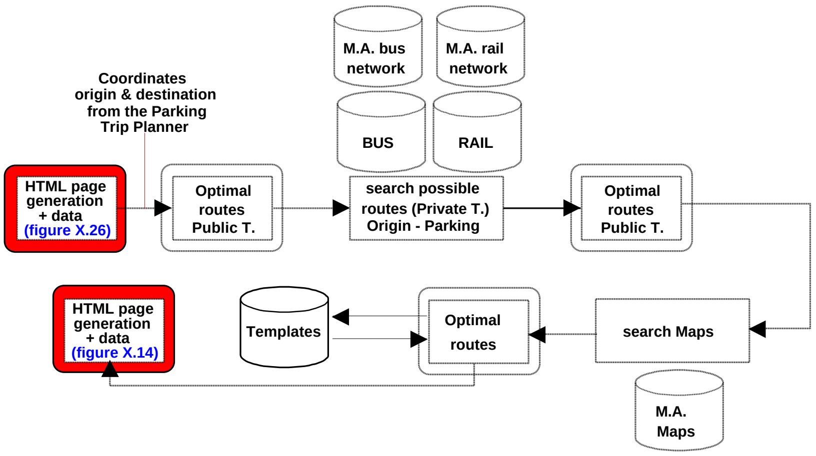



Figure X.32 TDSS working scheme (seen from inside IMI server)

### ✓ *P&R option*

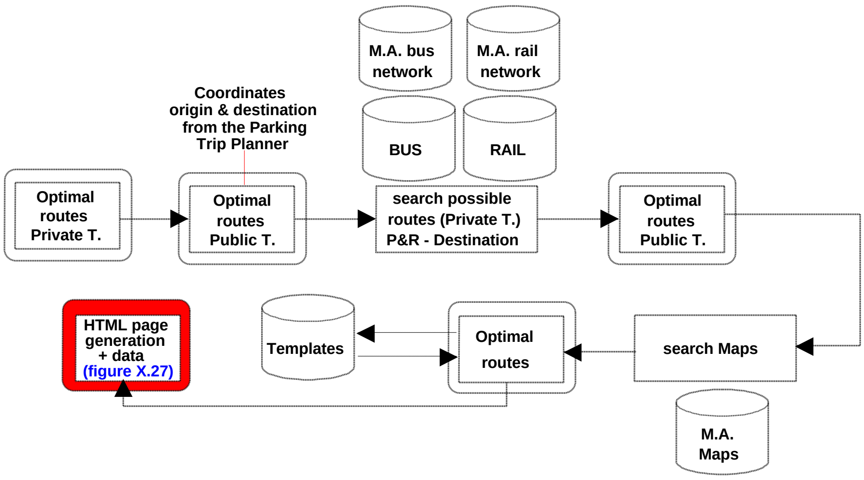



Figure X.33 TDSS working scheme (seen from inside IMI server)

### ✓ *Characteristics of a given Car Park*

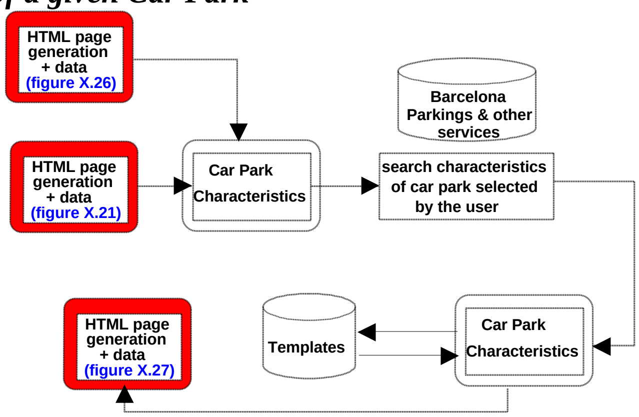



Figure X.34 TDSS working scheme (seen from inside IMI server)

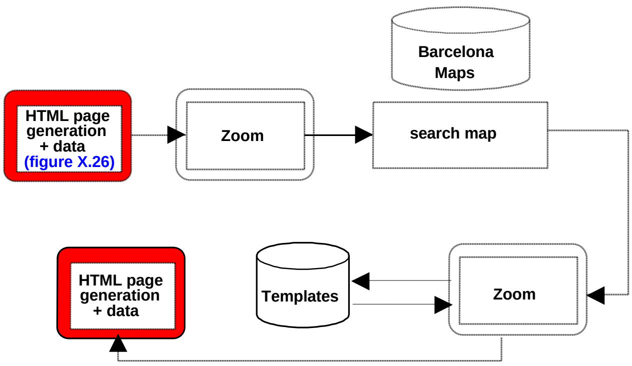



*Figure X.35 TDSS working scheme (seen from inside IMI server)*

## X.5 ROAD NETWORK CONDITIONS APPLICATION

The aim of this application is to provide the citizen with a tool of information on the status to the traffic in the basic road network of Barcelona which will allow him/her to make a more rational use of the private vehicle.

### X.5.1 USER POINT OF VIEW

This (dynamic) application has been implemented by the SVP (Traffic Authority of the City Council) in the IMI server. The programme is fed by data coming from the detectors located in the basic road network of Barcelona and from photographs taken by cameras installed at some junctions of the road network.

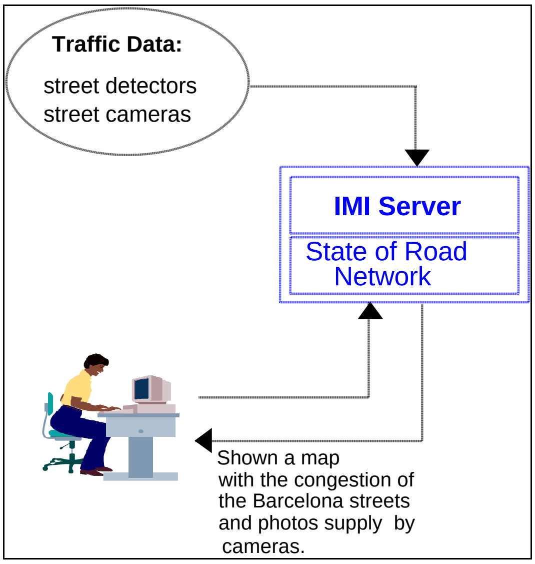



Figure X.36 State of road network application

✓ ***Areas Included in the Application***

This application is owned by the Barcelona City Council, this is why it only provides information for the city of Barcelona. The City Council has developed a plan to install detectors on the basic road network of Barcelona, and this is being used in this application for informing the private car user about the traffic congestion at every moment.

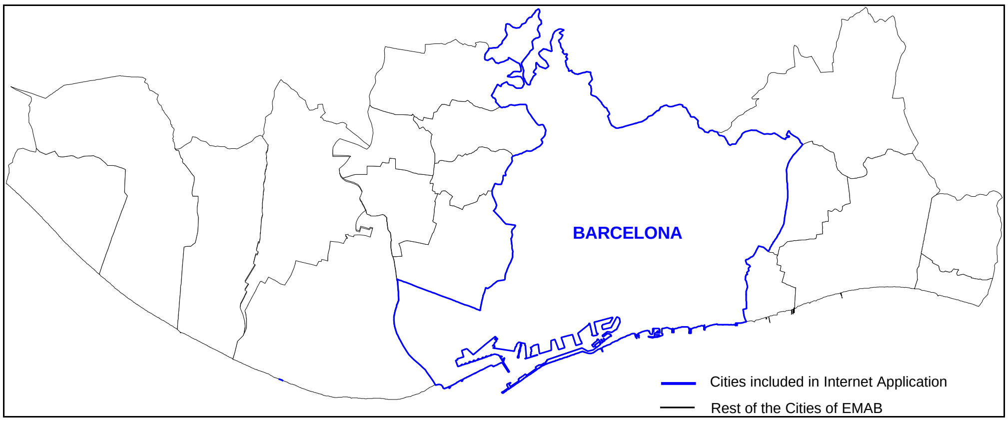


Figure X.37 Geographic location of the city included in this application

✓ ***Selection of Origin and Destination by the user***

This is not an interactive application, since the user declares neither the origin nor the destination of the trip; the application shows always the map reflecting the status of all the roads (equipped with detectors) of Barcelona. The user can make zooms for the zone of his/her interest, or take a look to the image provided by the traffic cameras in a determined moment.

Therefore, as it can be seen, this application is different to the two formerly described, but it is a frequently-visited application by car-orientated travellers and, by presenting the applications together, it is hoped to attract more car travellers to consider using the trip planner alternatives.

Being the more dynamic of the applications that are integrated, the work has also examined a technical design to integrate real-time road network information with semi-dynamic parking guidance.

✓ ***Solutions shown by the Application to the user***

The first screen found when entering the application is the one shown in Figure X.38, where the status of the roads of the basic network can be identified by the different colours in which they are drawn. On this map, the user can make zooms for detailed zones, this allows to see the status of other roads not belonging to the basic network.

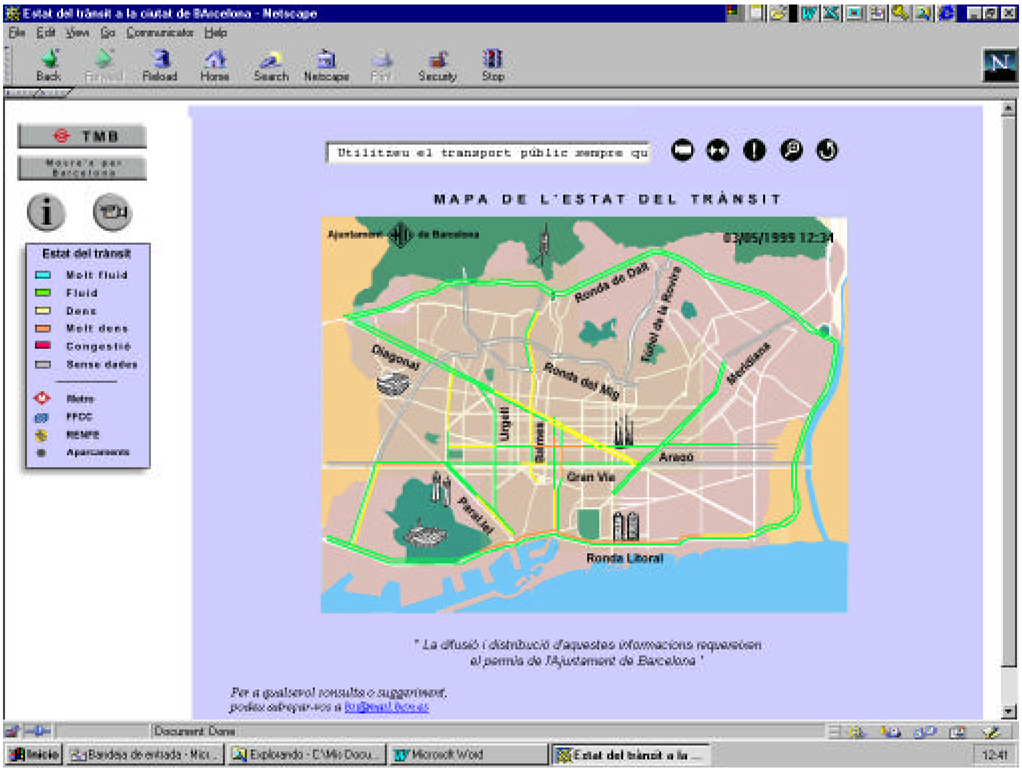



Figure X.38 Screen displaying basic network roads status

The different status colours correspond to parameters defined by the SVP, that is in charge of managing the Barcelona road network. The different status are:

- Very fluent
- Fluent
- Dense
- Very dense
- Congestion
- No data available

The values for each link are determined from occupancy information obtained from loop detectors. For each link, different thresholds are established to determine relevant ranges of status values. For certain links (Ring Road) the loop detectors also provide speed measurements and thresholds for these links are based upon occupancy and speed data.

On the other side, the application also shows photographs provided by the cameras located in specific points of the basic network of Barcelona (Figure X.39).

Currently, the following items are included in the application:

- images coming from 71 cameras and
- data coming from 146 points, supported by 446 detectors

As explained before, information coming from detectors located on the road is updated each 5 minutes; additional information on incidents occurring on any road of the city is also provided.

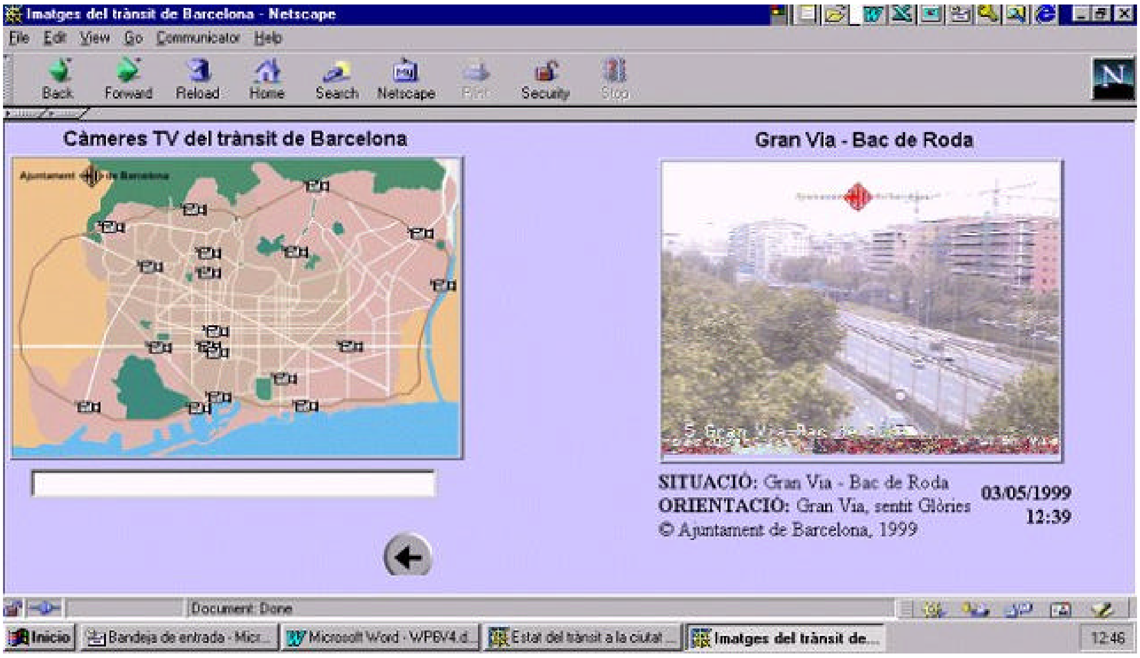


Figure X.39 Screen displaying photographs from traffic cameras

✓ ***Database definition***

This applications has not been implemented by BTSA, so we are not able to know exactly the fields names of the files contained in the road network status database, but we know that the database contains the following files:

- Links file
- Nodes file
- Maps file
- Detectors information file
- File with the photographs supplied each 14 minutes by the cameras

It is noted that the up-dating frequencies for this application are much more higher than those for the trip planner applications (minutes rather than days/weeks).

### X.5.2 TDSS POINT OF VIEW

✓ ***Direct access to the road network status application***

The access to this application will be done from the IMI server, or directly from the parking trip planner.

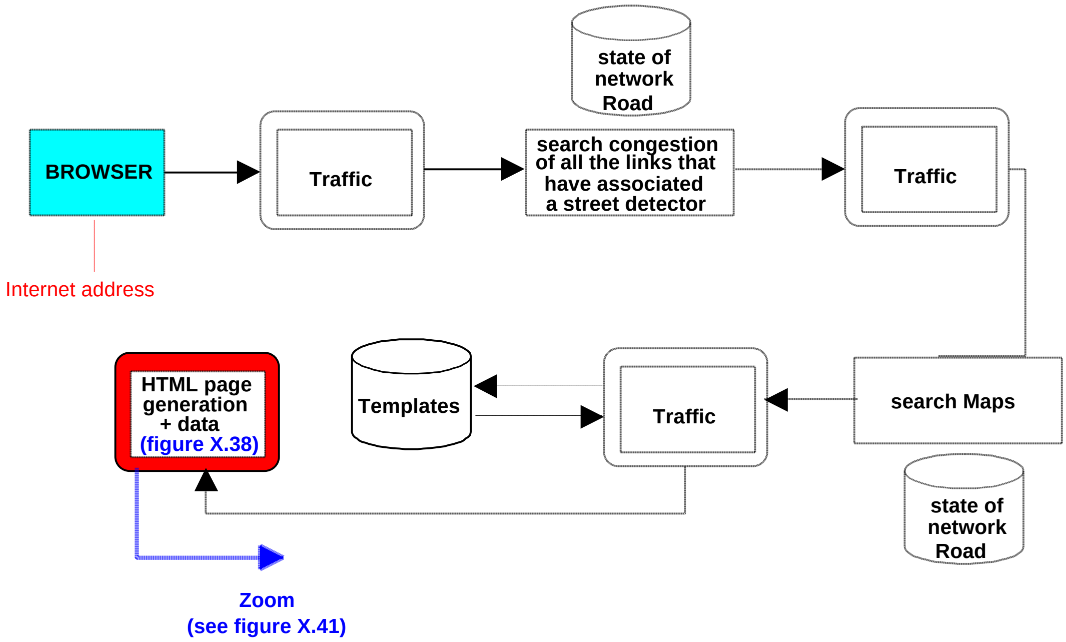



Figure X.40 TDSS working scheme (seen from inside IMI server)

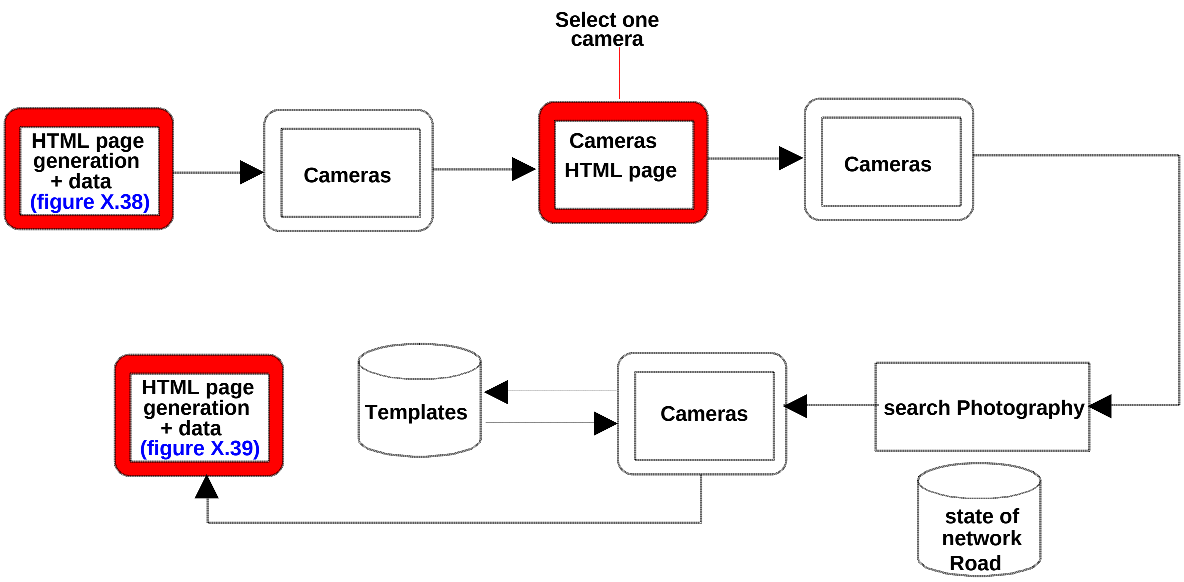



Figure X.41 TDSS working scheme (seen from inside IMI server)

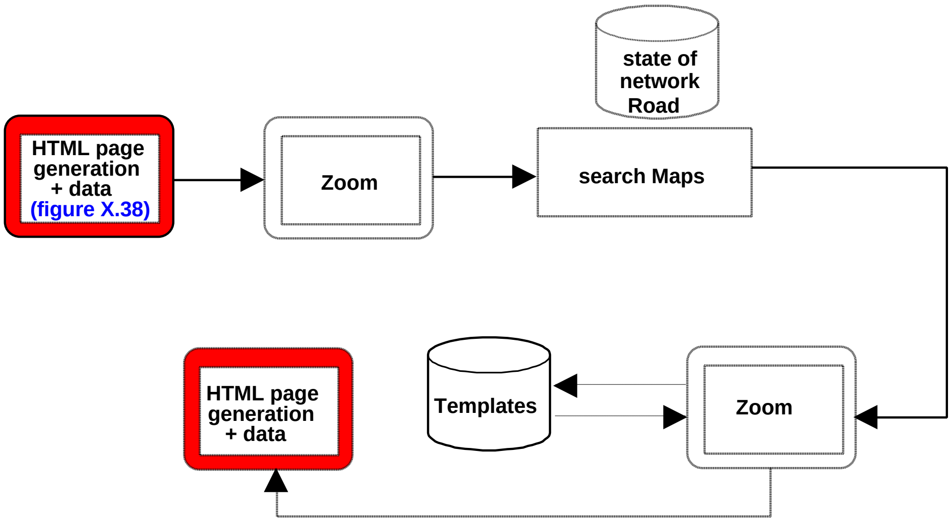



Figure X.42 TDSS working scheme (seen from inside IMI server)

### ✓ *Parking Trip Planner using congestion data*

The operators aim to provide the traveller with credible information about how to access and appropriate car park close to the destination. For this, routes proposed by the application should take into account the usual, relative congestion according to the time of the day when a trip is to be made.

Initially the idea was to incorporate link travel times from the Road Network Conditions application (see section X.5.1). This is only partially feasible (for Ring Road links) and additional data has had to be obtained from the TRAMPLAN traffic model (for remaining links). The application uses different travel times by links according to different periods of the day, and distinguishes between working days, Saturdays and feast days.

It should be noted that no attempt is currently made to supply the best route taking into account the actual conditions occurring in real-time. The provision of this information could act as an incentive to travel by private car. The provision of this detailed level of information requires sensor investments best made by the private sector. For these reasons, this part of the application development is beyond the scope of the DIRECT project demonstrator.

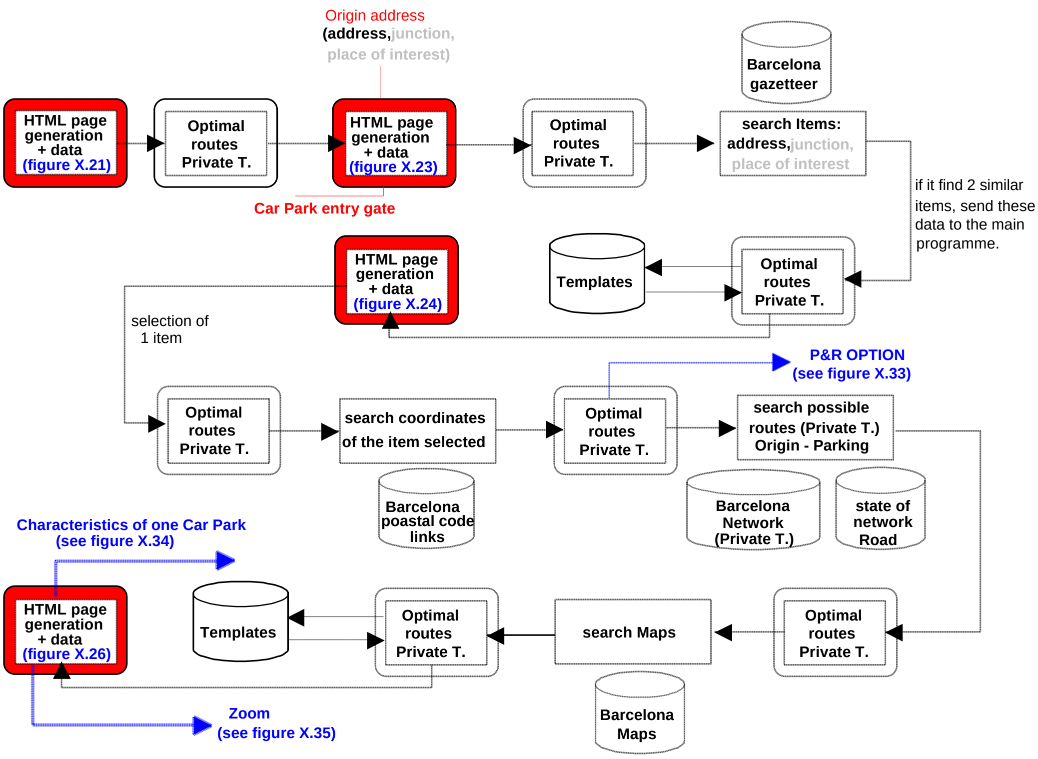



Figure X.43 TDSS working scheme (seen from inside IMI server)

Due to the complications explained before, this part of the Barcelona demo is a simulation basically consisting of quick modification of the road network file (both to cut roads and to modify the weight of the road according to the congestion at the moment).

To this aim, we have implemented an application for SMASSA to be able to manage the road network of the Parking Trip Planner. This application has consisted of the visualisation of all the road network segments, with their characteristics, so as to be able to identify the changes considered as convenient for each moment and thus to modify the road network file located in the IMI server.

At first, the changes will be made manually, but the idea is that in the future this application could obtain data directly from the sensors located in the road network, or from Transport Planning applications that describe historical profiles of the evolution of recurrent congestion over a certain type of day.

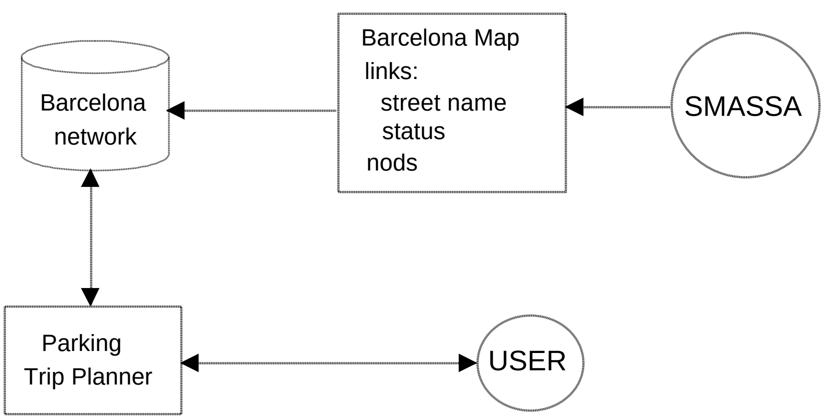
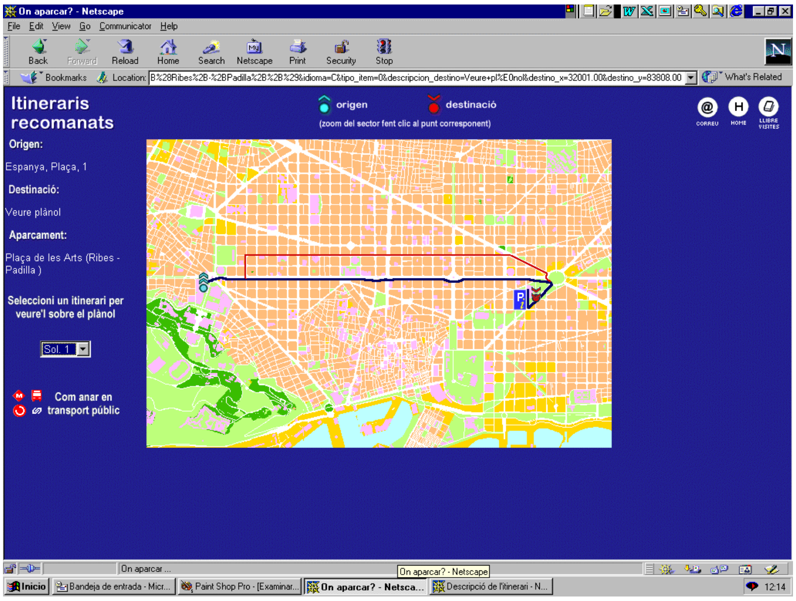



*Figure X.44 Application to integrate changes in road network conditions in the parking trip planner*

Here, it is worthwhile remembering that the building of the parking trip planner application is primarily to encourage those who drive to off-street car parks (promoting a municipal policy of liveable streets). It is not the purpose to realise a high level of integration such that drivers could avoid real-time congestion. If the demonstration in DIRECT results in a commitment to implement the trip planners as integrated in the demonstration, then it will be the task of the INTERCEPT project to check that the proposed routes are considered to be reasonable by recruited travellers (INTERCEPT, 1998). Figure X.45 shows how the built application could be used to provide guidance that allows for congestion (should the solutions demonstrated in INTERCEPT be considered as unsatisfactory).




- The route painted in black is the optimal route between the origin and the chosen car park when the traffic is fluent.
- In case there is a high congestion level or there are some street links cut by an accident in the black route, the parking trip planner will show to the user the route painted in red.

Figure X.45 Example of how real-time congestion data could be used to up-date – Proposed parking guidance solutions.

A more important issue for integrating real-time TDSS with trip planners is the requirement for on-line monitoring of the availability of bookable parking spaces. The development of a simulation of an Internet parking booking application is described in the next section.

## X.6 BOOKING IN INTERNET

A part of the Barcelona prototype will consist of realising a simulation of how to reserve and pay for parking spaces in off-street car parks on an hourly basis.

The objectives of this are:

- To clarify the operators' needs regarding system architecture and the data elements required to build a pilot scheme,
- To elicit information from travellers about their intended parking intentions –especially their intended duration of stay (this is needed to calculate tariffs for use in the INTERCEPT project), and
- To maximise the utility that the parking operator perceives of the work undertaken in the project in terms of preparing for pilot implementation.

### X.6.1 USER POINT OF VIEW

✓ ***Car Park Spaces Booking***

In this part of the Barcelona prototype, we have realised a simulation aiming to show its operation and to observe reactions from parking operators involved in the application.

Parking spaces booking is a complex issue, for instance the entry of a vehicle with booked space depends on the exit of the car which has parked before. For a car park where all parking spaces were available for reservation, the following technologies and features would be needed:

- Detectors in all the spaces
- Updating of information coming from detectors each minute
- Licence plates reader cameras (identification of vehicle with booked space)
- A centralised system being able to differentiate between two simultaneous booking operations
- Good use by users (car park entry and exit on time)

Nowadays, there is no car park accomplishing all these characteristics, and this is the reason for realising a simulation within the prototype so to show it to parking operators and take the opportunity to realise a pilot trial.

Spaces booking by Internet is a service that will be very interesting for car parks which in some days of the week and at determined hours have a high level of occupancy, in this sense it will be a service with low benefits for those car parks which never get to their total occupancy. If this service were to be made available for everybody, it would be necessary to have car parks perfectly equipped with licence plates reader cameras at the entry and exit points (to recognise the vehicle which has booked a space), plus detectors and parking spaces centralisation. At this moment, this is not possible. Thus this service will initially only be available for a limited number of spaces at selected car parks and for people who want to be subscribers.

Due to the fact that SMASSA has to be convinced about how best to include the parking booking application, the DIRECT project demonstration will be a simulation (in Intranet) of how a booking scheme with centralised booking could work in the Internet in the near future.

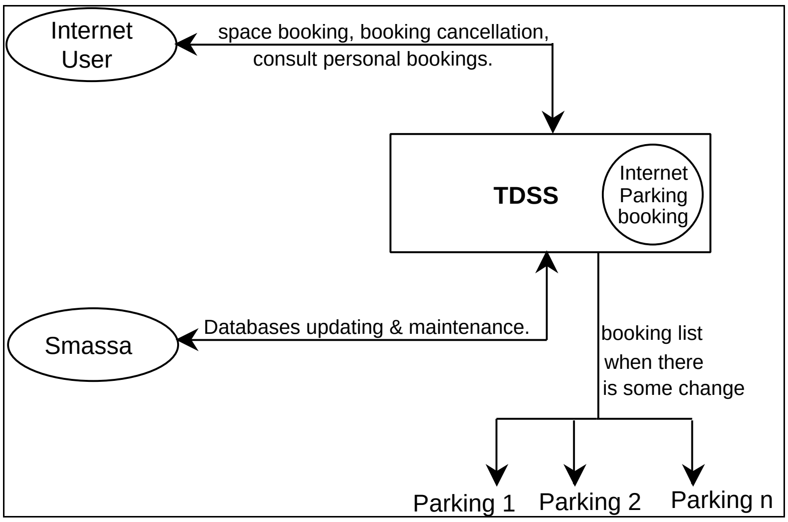



Figure X.46 Scheme of real time Parking booking

Figure X.46 shows the proposed scheme of the parking booking demo. But, due to the fact that the Smassa information system does not work on real time, then the parking booking service can not be implemented on real time, and due to that the actual demo will follow the scheme shown in Figure X.47.

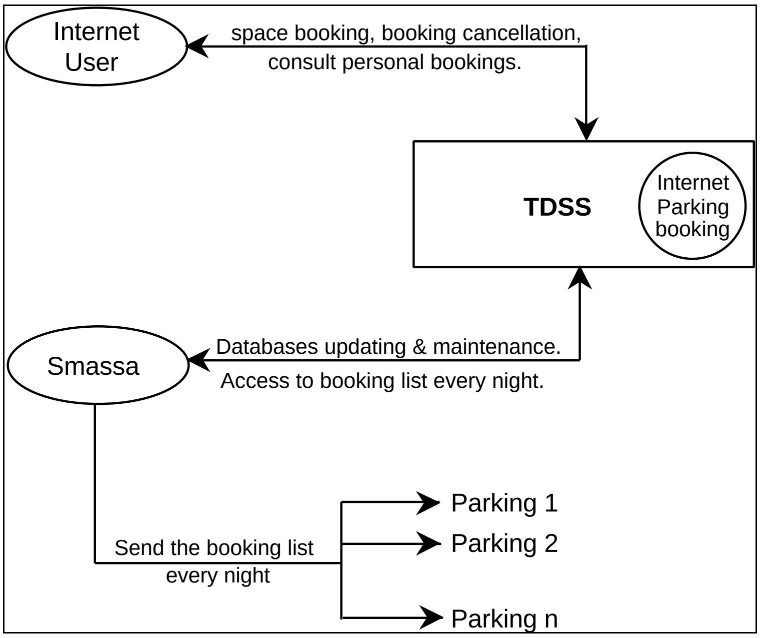



Figure X.47 Scheme of Barcelona Parking Booking demo

The following diagram explains the different access modes to spaces booking from the parking application:

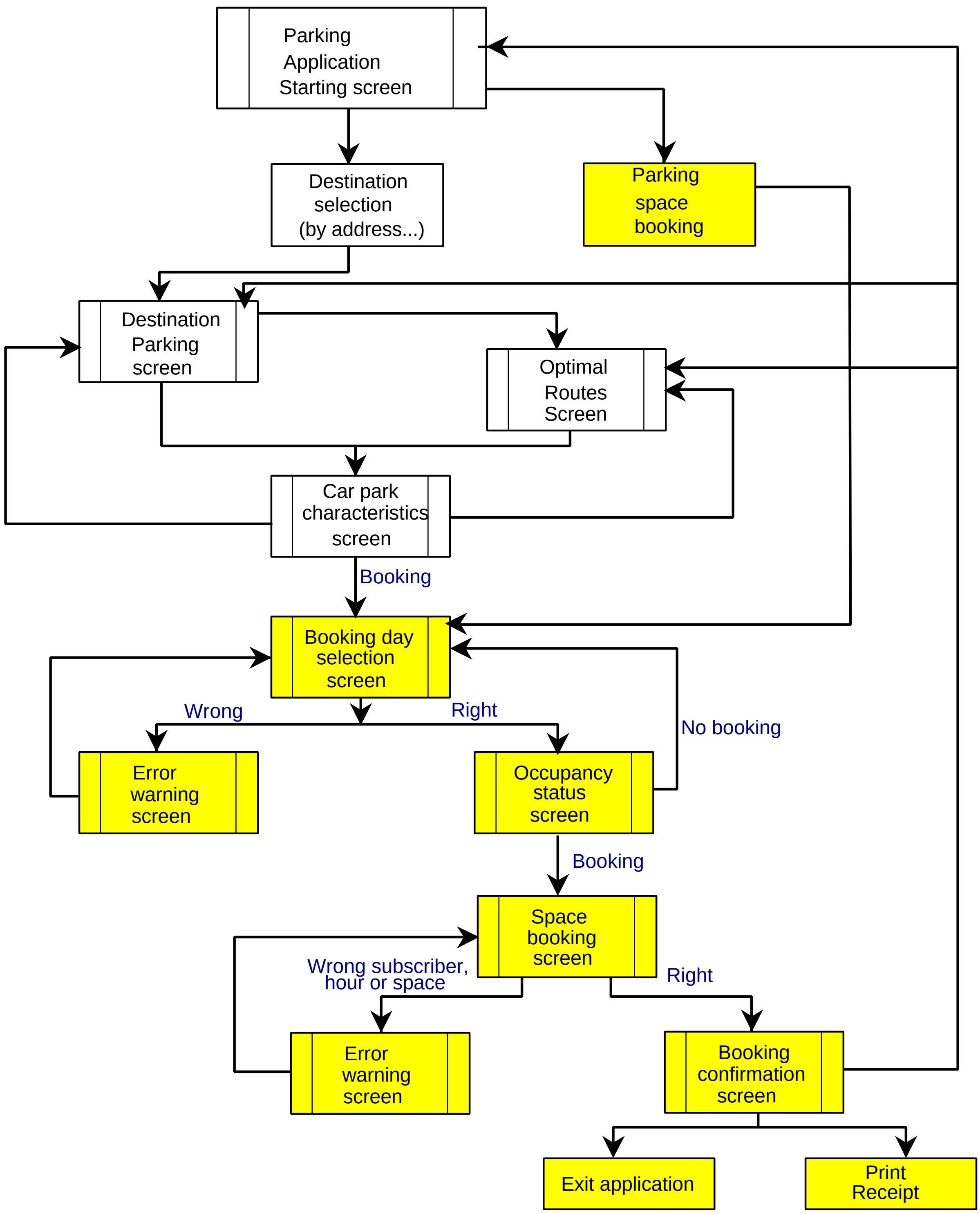



Figure X.48 scheme of parking booking screens

Once we know how to access to the spaces booking part and to the different required screens, then we are able to realise a first design of the screens useful to carry out the simulation.

➢ **Destination selection screen:**

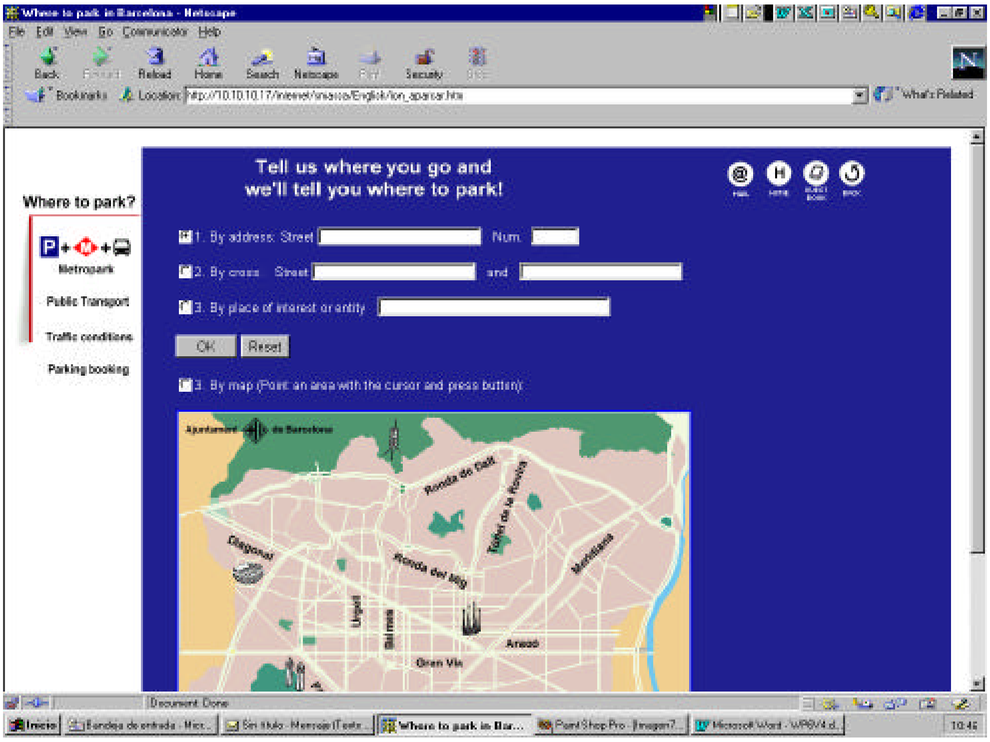



Figure X.49 Destination selection screen

In this screen besides the selection of a destination (by address, intersection, or point of interest), it is given the possibility to access Public Transport trip planner (TMB), Road Network condition trip planner (SVP) and it is allowed to access directly to the car park space booking feature (for those people already knowing where they are going to park, and not needing to know the optimal route to the car park).

➢ **Car park characteristics:**

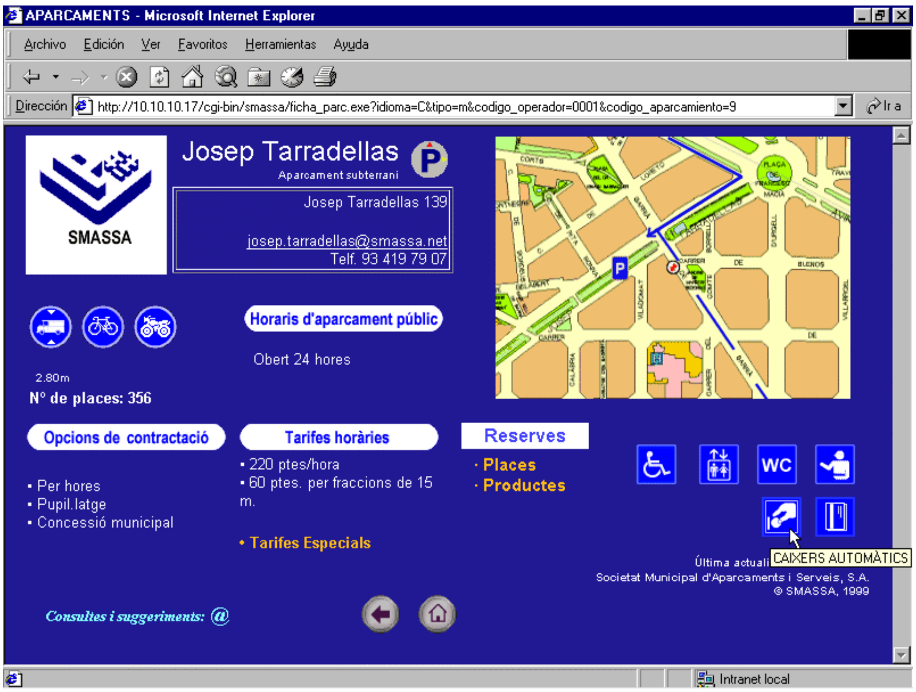



Figure X.50 Car park characteristics screen

From the car park characteristics screen (displayed if a destination is selected), besides consulting the characteristics of the car park, we can also access the space booking screens.

## ➢ Booking day selection screen:

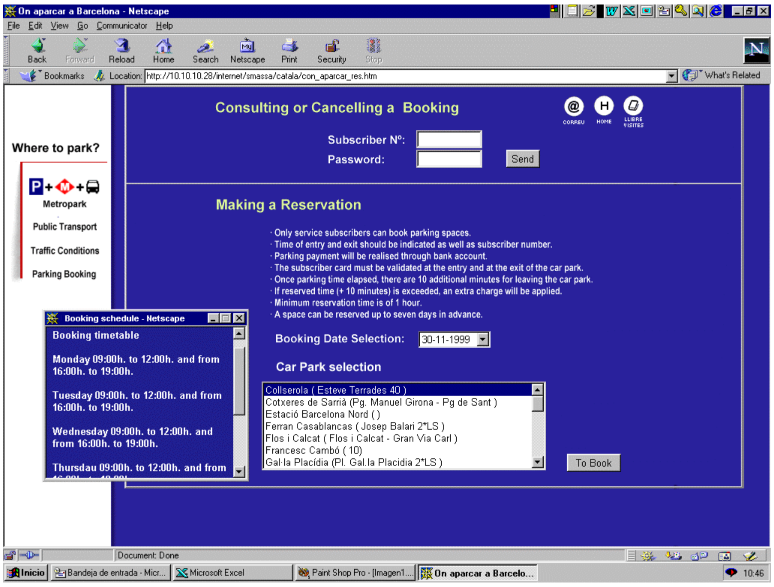



*Figure X.51 parking booking main screen*

This screen allows to:

⇨ Consult or cancel a reservation.

⇨ Inform the user about the service rules.

⇨ Select a car park, then a screen with the booking timetables for the different days of the week is displayed.

⇨ When a booking day and car park are selected then the following screen displaying the booking status for this day appears.

## ➢ Occupancy status screen:

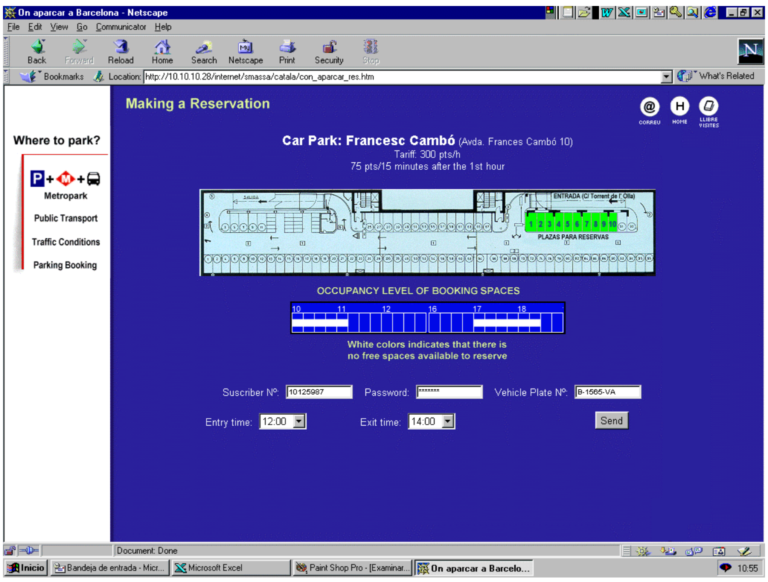



*Figure X.52 screen to make a reservation*

In this screen the user will be able to see the occupancy status of the spaces in the different time periods during which it is allowed to book spaces (time periods of maximum occupancy).

When the user clearly sees the time periods with free spaces, he/she will be able to book the space introducing the following information:

⇨ Service subscriber number
⇨ Password
⇨ Entry time
⇨ Exit time
⇨ Plate number

When designing this screen, it has already been taken into account that a time period of 15 minutes will be needed between booking operations, if we look at space number 1 we see that the booking time period is from 9.00 to 10.15 while the booking realised by the user is from 9.00 to 10.00 h.

➢ **Confirmation screen:**

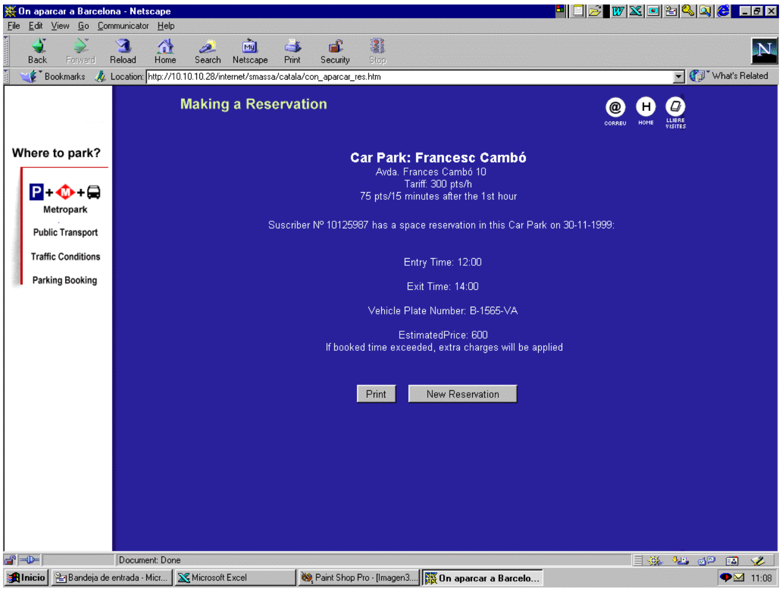



*Figure X 53 confirmation booking screen*

This screen confirms the booking to the user and gives him/her the option to print a receipt in case there is a problem when getting to the car park.

➢ **Screen to consult or cancel a reservation:**

The screen shown below, is useful for the users to:

- Consult car park spaces booked during this week
- Cancel the booking they have made. The user will have the possibility to cancel his/her bookings until 14.00 h. of the day before.

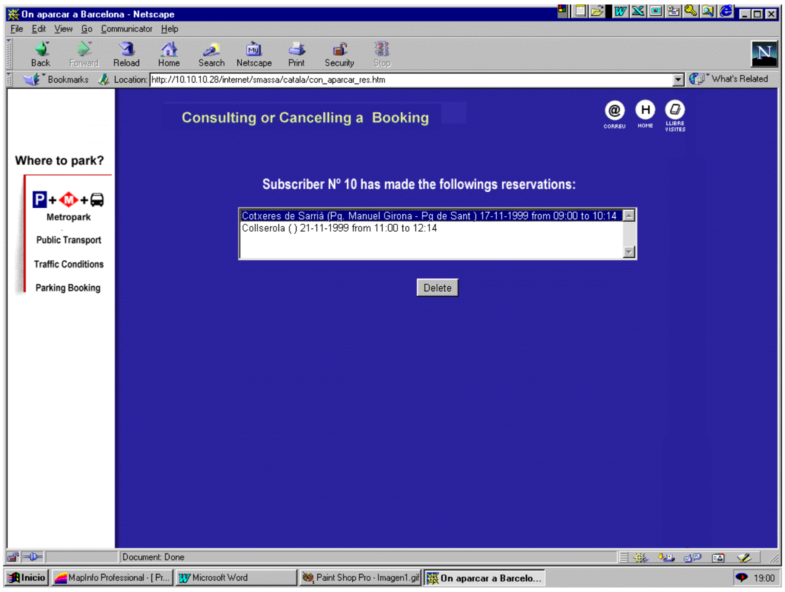



Figure X.54 Booking consultation or cancellation screen

- **Error screens:**


Figure X.55 Message generated by space availability check

This screen will appear when a user wants to book a space in a time period when it is already occupied.


Figure X.56 Bookings can only be realised by "subscribers"

This warning screen will appear when no subscriber number is indicated or a wrong number is introduced.

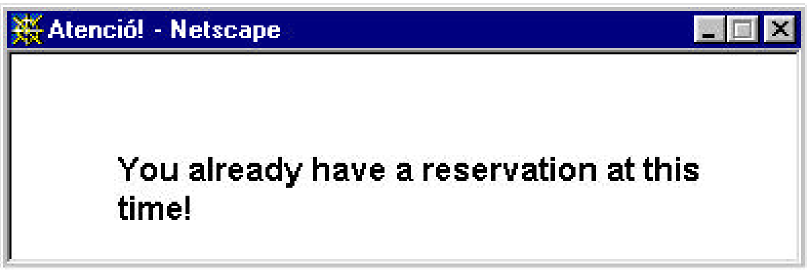



Figure X.57 Message generated by booking compatibility check

This screens warns the user that he/she has already a car space booked in this or other car park, at the same or overlapping time.

✓ ***Car park spaces booking protocol***

➢ *Aspects to be taken into account for realising the simulation*

- This service will only be available for Internet booking service subscribers: these subscribers will be given a card with a subscriber number, and when they book a space they will have to validate it both at the entry and at the exit points of the car park.
- Bookings will only be admitted during time periods of maximum occupancy of the car park (for doing so, the occupancy curve will have to be studied for each day of the week, and time periods for booking operations will have to be established).
- Every car park operator has to define the number of spaces destined for booking service. So the number of spaces will be a parameter of the algorithm.
- The number of booking spaces never will be the 100% of the total spaces in a car park.
- The minimum booked time will be of 1 hour.
- A new tariff will be established for this service (x pta. / hour, Y pta. /15 minutes after the first hour).
- Spaces booking can be made 7 days in advance
- No space booking can be made on the same day.
- A space booking can be cancelled until the day before at a determined time (14.00h. in the demo)
- Booked hours will be paid through bank account
- If booked parking time is exceeded, then a fine will be collected according to the time exceeded, and a black list will be created containing persistent offenders.
- Additional 10 minutes after foreseen exit time will be granted (after this time, the fine process will start).
- A 15 minutes time period between two consecutive booking operations will be considered for a given space.
- When a car park will be full, a message stating “subscribers and booking only” will be displayed to drivers wanting to enter.
- A subscriber (and a car) will not be allowed to make two booking operations in a same day if the time periods overlap.

➢ *Steps to be followed to realise a booking operation in Internet*

1) Screen showed in Figure X.49 : the car park and day of the week for which the user is interested in knowing the available spaces before booking are selected.
2) Screen showed in Figure X.50: the level of occupancy can be seen by time period of the day for all the spaces available for Internet booking (this screen information is supplied by the database: Parking booking list).
3) Once the available spaces status is known, a booking can be made by introducing: the day, subscriber number, password, plate number, entry and exit times (EntryH and ExitH : these data will be stored in the Parking booking list database)
   - Car park entry: will be read EntryH, Subscriber numb.
   - Car park exit: will be read ExitH, Subscriber numb.

   With these data, the car park control centre will be able to know the real time for parking operation and the final price.

4) Once booking data have been selected and introduced, the algorithm will realise a series of verifications, such as:
   - Subscriber number and password are right
   - Subscriber has not made any other booking in the same or another car park at the same time or in an overlapped time period.
   - License plate number introduced do not have another booking in the same or another car park for the same time or an overlapped time period.
   - A car park space is available for the selected time period.

5) If the system accepts the data introduced by the user, then it will show a screen for booking confirmation. The contents of this screen can be printed so the users can have a receipt of the parking hours sold.

If the system does not accept the data introduced by the user, then the corresponding error screen will be shown.

➢ *<u>Steps to be followed by the user to check or cancel booked car park</u>*

1) In the screen shown in Figure X.49, the user has to introduce his/her subscriber number and password.
   The system will verify if introduced data are correct, and if so the next screen will appear (Figure X.52).
2) In this screen (Figure X.52), the user can see a list with all the bookings made by him/her for the current week. If he/she wants to cancel one or several of this bookings, he/she must select from the booking list the ones to be cancelled and then click on the “delete” button.
3) Next, a sub-screen asking for confirmation of the cancellation(s) will appear.

➢ *<u>Payment mode for parking time</u> (by bank account)*

1) User arrives on time
   - Leaves on time: user will have to pay the tariff corresponding to the booked time period.
   - Leaves before booked exit time : user will have to pay the tariff corresponding to the booked time period
   - Leaves after booked exit time: user will have to pay the tariff corresponding to the booked time period plus an extra tariff (fine) for the exceeded time.

2) User arrives later than the booked entry time but within the parking booked time period:
   - Leaves on time or before booked exit time : user will have to pay the tariff corresponding to the booked time period.
   - Leaves after booked exit time: user will have to pay the tariff corresponding to the booked time period plus an extra tariff (fine) for the exceeded time.

3) User arrives before booked entry time: (Max. 10 minutes)

➢ If there is no car occupying the booked space, user will be authorised to enter; entry hour and booked parking time will be changed accordingly
   - Leaves on time or before booked exit time : user will have to pay the tariff corresponding to the booked time period.

- Leaves after booked exit time: user will have to pay the tariff corresponding to the booked time period plus an extra tariff (fine) for the exceeded time.

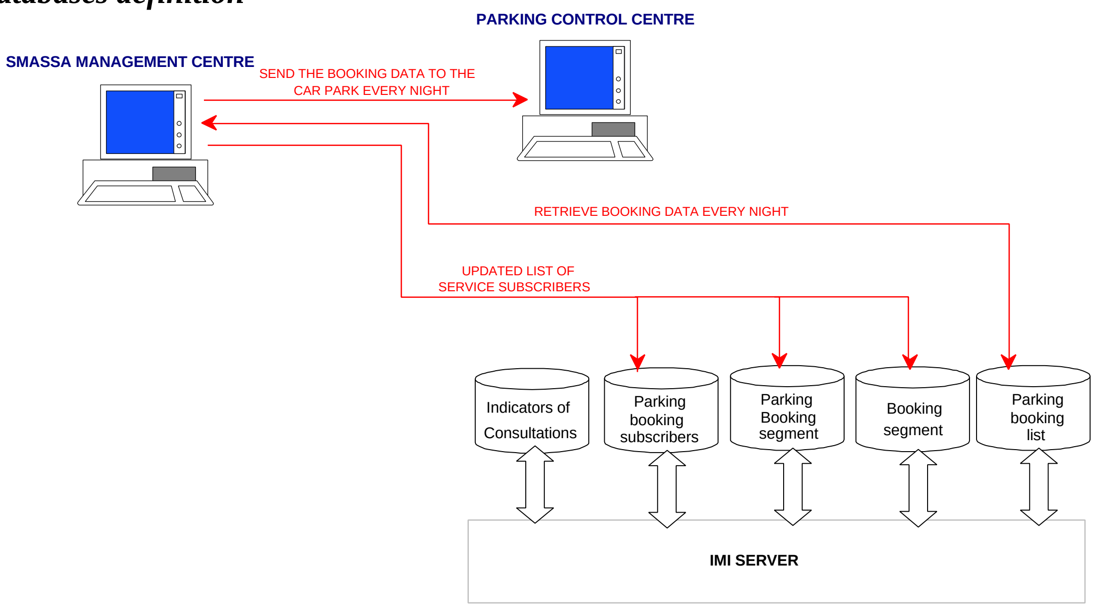
➢ If there is a car occupying the booked space, but supplementary space is empty and available until the booking exit time : he/she will be authorised to enter and entry hour and booked parking time will be changed accordingly

- Leaves on time or before booked exit time : user will have to pay the tariff corresponding to the booked time period.
- Leaves after booked exit time: user will have to pay the tariff corresponding to the booked time period plus an extra tariff (fine) for the exceeded time.

➢ If both booked and supplementary spaces are occupied, the user will be authorised to enter only if there is a free space, else he will be requested to wait until the booked entry time

- Leaves on time or before booked exit time : user will have to pay the tariff corresponding to the booked time period.
- Leaves after booked exit time: user will have to pay the tariff corresponding to the booked time period plus an extra tariff (fine) for the exceeded time.

✓ ***Databases definition***




FigureX.58 Parking-booking databases

- *Parking booking list*

| FIELD | TYPE |
|---|---|
| PARKING_ID | NUMBER |
| PLATE_NUMBER | VARCHAR10 |
| SUBSCRIBER_ID | VARCHAR10 |
| PASSWORD | VARCHAR10 |
| DATE | DATE |
| ENTRYH | NUMBER |
| EXITH | NUMBER |

Table X59 Parking booking list

This list enables to know the status of the spaces available for booking. It is updated each time a user books a space and sent to the corresponding car park.

- *Booking segment*

| FIELD | TYPE |
|---|---|
| SEGMENT_ID | VARCHAR2 |
| ENTRYH | NUMBER |
| EXITH | NUMBER |
| DAY_TYPE | NUMBER |

Table X.60 Booking timetables

This list contains the definition of booking timetables for the different days of the week. It will be updated by the management centre of SMASSA.

- *Car park booking segment*

| FIELD | TYPE |
|---|---|
| SEGMENT_ID | VARCHAR2 |
| CARPARK_ID | VARCHAR2 |

Table X.61 Timetable segments

To assign timetable segments (defined in the former list) to each car park where booking is allowed. This list will be updated by the management centre of SMASSA.

- *Parking booking subscribers*

| FIELD | TYPE |
|---|---|
| SUBSCRIBER_ID | VARCHAR10 |
| PASSWORD | VARCHAR10 |
| FIRSTNAME | VARCHAR10 |
| NAME1 | VARCHAR10 |
| NAME2 | VARCHAR10 |
| DNI (National identifier) | NUMBER |

Table X.62 List of Parking booking subscribers

This list contains data on the subscribers to the Internet car park spaces booking service. It will be updated by the management centre of SMASSA.

### X.6.2 TDSS POINT OF VIEW

The access to the option of car park space booking can be made at the beginning of the Parking Trip Planner or from the selected car park characteristics screen.

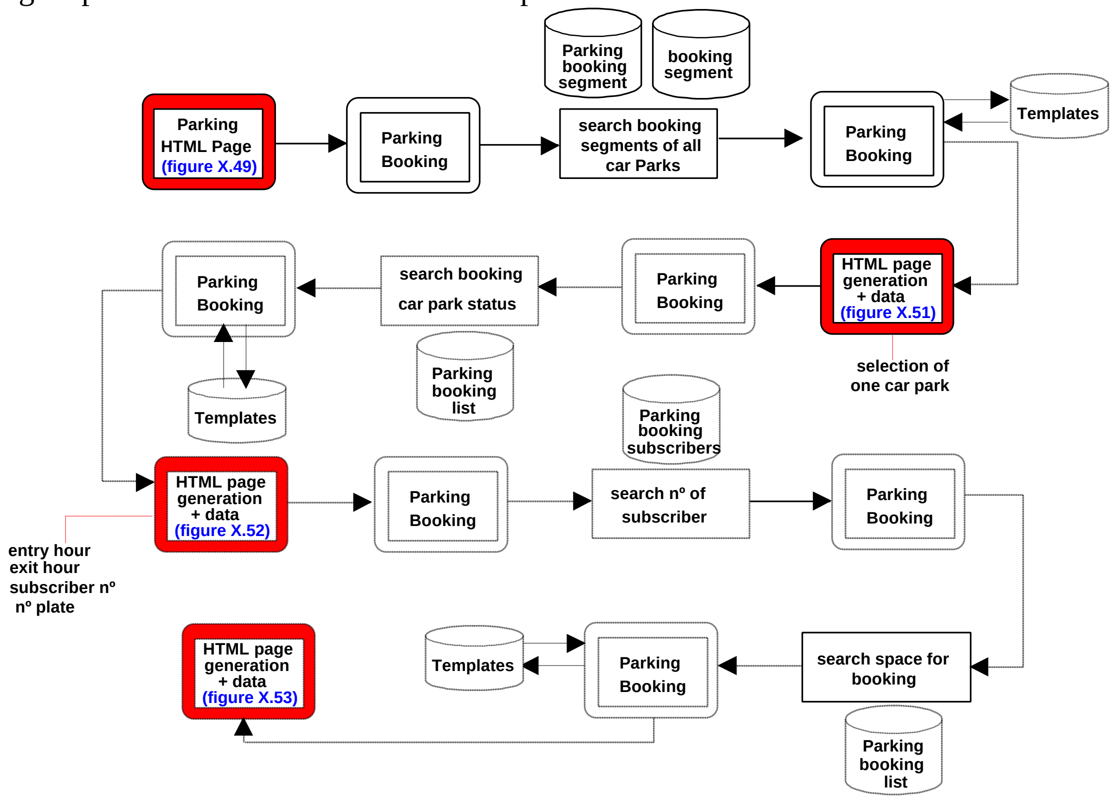



Figure X.63 TDSS working scheme (seen from inside IMI server)

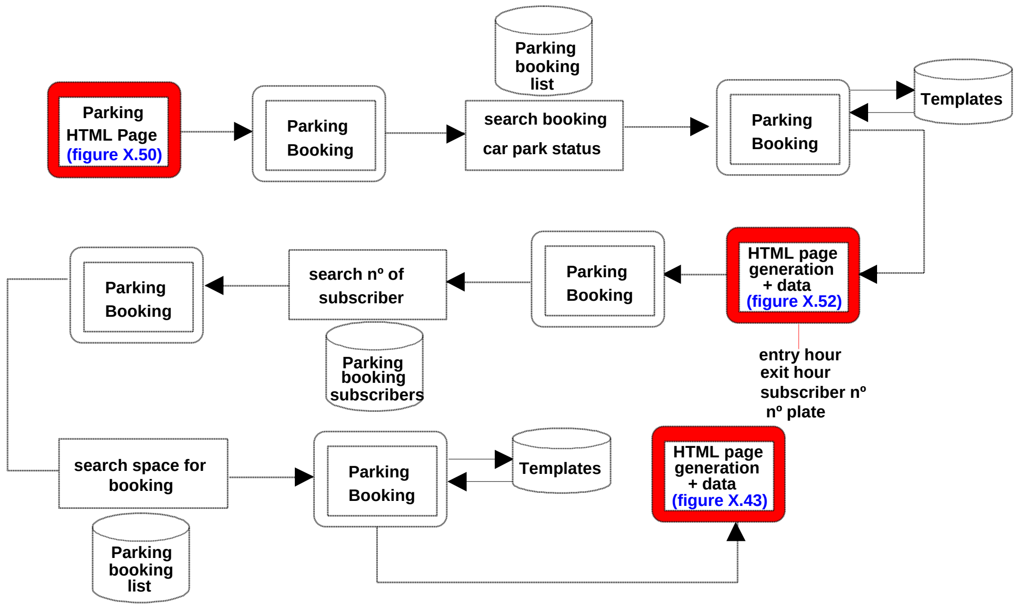



Figure X.64 TDSS working scheme (seen from inside IMI server)

# XI. CONCLUSIONS

At the outset of the DIRECT project it was thought that different stakeholders would cooperate to pool their data, and that the concept of a central database having common access would likely emerge. However, during the project tools enabling improved data exchange have started to enter the market and hardware costs have diminished. As a result, one can detect a trend towards distributed architectures that enable each stakeholder to remain responsible for his/her own data - this being the more likely means of ensuring good data quality and updating.

The trend towards distributed TDSS architecture is seen for all three application areas. From the analysis undertaken it appears that tools and standards are most developed for road-based Traffic Management. The utility of real-time data exchanges will not be fully realised until multimodal aspects are developed. This is likely to require the development of new standards for data elements - and this may develop from the tools currently being used to develop Internet trip planning applications. However, new technologies are emerging, and the area of Traveller Information can be expected to generate a new order of magnitude in the precision of data that can be used to build TDSSs. As the key technologies penetrate, the justification for integrating the TDSSs of the different application areas can be expected to increase.

In the DIRECT project there has been considerable discussion about when and how to integrate real-time elements of TDSS with less-dynamic data elements. The status of evolution in the three application areas enables us to note that:

- Real-time data exchange already features as a part of incident response for Road Traffic and Network Management, but not for T multimodal messaging.
- The utility of Floating Car Data has been demonstrated (in Rotterdam) and the further utility of integrating this information with other network management data has been demonstrated in Paris.
- Whilst real-time trip planner information exists in a few cases as a city-wide application[78], it is not yet integrated with Road Traffic and Network Management applications.

This latter remark merits further explanation. It appears that, either the telematic messaging capability exists (as in the Marseille example) but the physical infrastructure of parking interchanges does not, or the physical infrastructure exists but the telematics infrastructure does not (the Barcelona situation), or both do not exist (the typical situation).

In developing the DIRECT Barcelona prototype, in the absence of a real-time computer system able to exchange information about car park occupancies, two developments were undertaken. First, the public transport and parking guidance applications were “integrated” with the road congestion map of the IMI server – with the integration enabling those viewing the congestion map to pass to the trip planner applications so as to investigate alternatives to car usage – but with no deeper level integration. Second, a booking application has been built based upon a clearing concept such that a reduced number of parking spaces need to be controlled in selected car parks so as to optimise the infrastructure investment needed to realise a full implementation of a booking facility.

[78] notably the GOTIC system in Gothenburg – see CODE, 1999

A deeper level of integration was not feasible due partly to difficulties encountered with the quality of the loop data (used to generate the congestion map), but also because a deeper integration was considered unnecessary until end-users have validated the reasonableness of the route guidance[79]. Furthermore, it is becoming evident that real-time messaging strategies must be generated at the level of trip-ends and paths (rather than the links level used to generate TM messages) – and hence the data integration must also occur at this level. This notably means integrating Floating Car Data-type data with the Transport Planning applications.

[79] see INTERCEPT project

# XII. DIRECT DISSEMINATION

## XII.1 DIRECT WEB SITE

DIRECT products are available on the DIRECT web site :

www.simulog.fr/us/html/directweb/direct.html

## XII.2 DIRECT PRESENTATIONS & PAPERS

DIRECT achievements have been advertised at following conferences:

- ITS world congress, Toronto, Canada, November 1999
- Dutch DVM (Dynamic Traffic management) Congress, Noordwijkerhout, The Netherlands March 1999
- Mobicity fair, Paris, France, June 2000
- UITP annual meeting, Hannover, France, ???
- 7$^{th}$ World Congress on Intelligent Transport Systems, Turin, November 2000
- Congrès International Francophone ATEC 2001, Paris, France, January 2001

Titles of the papers and presentation were as follows :

- Vanderschuren Marianne : DIRECT, Data Integration Requirements of European Cities for Transport, Dutch DVM(Dynamic Traffic management) congress, Noordwijkerhout, March 1999
- Vanderschuren Marianne : Organisation of transport data sharing in urban areas, ITS world congress, Toronto, November 1999
- Richard Redfern Richard, McDonald Mike, Vanderschuren Marianne : DIRECT: Data Integration Requirements of European Cities for Transport, ITS world congress, Toronto, November 1999

# XIII. GLOSSARY

| | |
|---|---|
| **ADSL** | Asymmetric Digital Subscriber Line |
| **Application** | The program allowing to send requests to the databases |
| **ATM** | Asynchronous Transfer Mode |
| **CGI** | Common Gateway Interface |
| **Client** | Another term to define the application, often used in architecture description. |
| **COM** | Component Object Model |
| **CORBA** | Common Object Request Broker Architecture |
| **DATEX** | |
| **DBMS** | Data Base Management System |
| **DCOM** | Distributed Component Object Model |
| **DIRECT** | Data Integration Requirements for European Cities in Transport |
| **DKNF** | Domain Key Normal Form |
| **EDI** | Electronic Data Interchange |
| **EJB** | Enterprise Java Bean |
| **E-mail** | Abbreviation for electronic mail |
| **Frame Relay** | Frame relay is a telecommunication service designed for cost-efficient data transmission for intermittent traffic between local area networks (LANs) and between end-points in a wide area network (WAN). |
| **Functions** | Collection, broadcast, messaging, repository, sharing, workflow |
| **HTML** | Hyper Text Mark-up Language |
| **HTTP** | Hypertext Transfer Protocol |
| **IIOP** | Internet Inter-ORB Protocol |
| **IP** | Internet Protocol) |
| **ISDN** | Integrated Services Digital Network |
| **ISO** | International Organisation of Standards |
| **ISP** | Information Service Provider |
| **ITS** | Intelligent Transport System |
| **JDBC** | Java Database Connectivity |
| **Jini** | Jini (pronounced DJEE-nee like the Arabic word for "magician") is a new idea that Sun Microsystems calls "spontaneous networking." Using the Jini architecture, users will be able to plug printers, storage devices, speakers, and any kind of device directly into a network and every other computer, device, and user on the network will know that the new device has been added and is available. |
| **JNI** | Java Native Interface |
| **JVM** | Java Virtual Machine |
| **OAMP** | Operations, Administration, Maintenance and Provision |
| **OD** | Origin-Destination |
| **OMG** | Object Management Group |
| **ORB** | Object Request Broker |
| **Organisations** | Ticketing, priority, observatory, park+ride, modeling, information, coordination, planning |
| **OSI** | Open Systems Interconnection |
| **NTR** | Non technical recommandation |
| **PDA** | Personal Digital Assistant |
| **PFE** | Path Flow Estimator |
| **PGP** | Pretty Good Privacy, cryptography method using a system of a public key |

| | |
|---|---|
| | and a private key to code/decode a message. |
| **PSDN** | Packet Switched Data Network |
| **PT** | Public Transport |
| **RADEF** | Road Administration Data Exchange Format |
| **RDBMS** | Relational Database Management System |
| **Roles** | decision maker (stakeholder), process owner (primary user), technical staff (OAMP) |
| **RMI** | Remote Method Invocation |
| **Servlet** | A servlet is a small program that runs on a server |
| **Sites** | Lille, Lyon, Turin, Southampton, Barcelona, Brussels and Rotterdam |
| **TCP** | Transmission Control Protocol |
| **TDSS** | Transport Data Sharing Structure |
| **TR** | Technical recommendation |
| **TTML** | Markup language for Nokia devices |
| **Types of Information** | structured : geo-reference, traffic, events, supervision, mobility, finance, others. Unstructured : reports, notes, forums, image, voice |
| **UN/EDIFACT** | United Nations Electronic Data Interchange for Administration, Commerce and Transport |
| **User** | See application, it does not necessarily consist in a physical person. |
| **VMS** | Variable Message Sign |
| **VoxML** | Markup language for Motorola devices |
| **WAP** | Wireless Application Protocol |
| **WML** | Wireless Markup Language (formely HDML) |
| **XML** | eXtensible Markup Language |

# XIV. BIBLIOGRAPHY

## XIV.1 STATE OF THE ART


- Quinn, M., (1997) «The Development of Regional Traffic Control Centres For England - A Public Private Partnership» 4th World Congress on Intelligent Transport Systems. Berlin 1997.
- Wren, A. C., & Laughlin, K. G. (1997) «ROMANSE - Monitoring and Evaluating ITS» 4th World Congress on Intelligent Transport Systems. Berlin 1997.
- ROMANSE «Applications of ATT in Southampton: System Architecture Description» Commission of the European Communities R&D Programme Telematics Services in the area of Transport (DRIVE II) Report TR1023..
- DETR Consultation Document (1997) «A Policy For Using New Telematic Technologies For Road Transport» Department of the Environment, Transport and the Regions.
- Télématique routière et normalisation, Bureau de Normalisation de l'Exploitation de la Voirie et des Transports, CERTU - SETRA, 1996, 116 p.
- INFOPOLIS, deliverable D3, state of the art of public transport information systems ,
- CEC-DG13-RTD-TAP, 01/07/96.
- Marc Gilles & associés, groupe Predit " nouveaux services aux usagers ", Rapport de synthèse " attentes et besoins des usagers en matière d'information multimodale ", 01/03/97.
- JF Bedeaux, Priorité des transports en commun aux carrefours à feux, CERTU, to be published in 1998.
- Cordis Internet Page: www.cordis.lu/info
- TELTEN2
- Dec 1996/Jan 1997 «DATEX: Data Exchange in Europe» Traffic Technology International PP 50-52.
- Feb/May 1997 «EDEN - in search of harmonious exchange» Traffic Technology International, PP 41-43.
- EUROSCOPE Internet link: www.eranet.gr/euroscope/
- US ITS Architecture.
- Japan Internet link: www.rihon.net/ITS/
- Les enquêtes de stationnement, guide CERTU, 1997.
- Évaluation des transports en commun en site propre : indicateurs transport pour l'analyse et le suivi des opérations, guide CERTU 1997.
- Péage urbain : vivre et se déplacer en ville, CETUR, 1994, 144 p.
- Perspectives de convergence entre systèmes de télébillettique et télépéage, conclusion du groupe de travail ATEC, 01/11/97.
- INFOPOLIS, deliverable D3, state of the art of public transport information systems, CEC- DG13-RTD-TAP, 01/07/96.
- Marc Gilles & associés, groupe Predit " nouveaux services aux usagers ", Rapport de synthèse " attentes et besoins des usagers en matière d'information multimodale ", 01/03/97, in french.
- L. Dablanc, Transport de marchandises, thèse de doctorat, ENPC-LATTS, 1997.
- Programme « transport des marchandises dans la ville », dossier du CERTU n°64, 1994, 100 p.
- VDV Schriften, Data Model 5.0,"Interface Initiative" VDV Standard Interface Network / Timetable, Version 1.0, 452, 1/99, OPNV, Verband Deutscher Verkehrsunternehmen (VDV), Koln.

## XIV.2 USERS'REQUIREMENTS


- Linda Macaulay, Requirements engineering, Springer, 1996.
- JM Robert et. al., Project CODE TR1103, Guidebook for users needs analysis, version 3, telematics application programme, co-ordinated dissemination in Europe of Transport Telematics, AF5329/D0040 issue 03, February 1998.
- M.J. Martens, E.J. Verroen (TNO); N.J. Paulley, K. Sharman (TRL), 98/NV/011 : 1998-004, DGVII. Project SESAME, Deliverable 4, Urban form and Mobility, 29/1/98.
- Project DIRECT, DGVII, Deliverable 1, State of the art, Transport Research Group, University of Southampton, 1998.
- CONVERGE, EC-project TR1101, architecture guidelines, DSA 2.2, 11/96.
- Information for clients of TIC-Nederland : technical, organisational and legal specifications, TIC-NL project, RWS-KLPD, TICD7400.D2, January 98.
- DATEX-Net Specifications for interoperability (Version 1.1, December 1996) contains out of 4 parts:
- *"DATEX-Net Specifications for Interoperability - version 1.1"* (CORDEX Project Deliverable AC23-Part 2.0)*;*
- *"DATEX-Net Specifications for Interoperability - version 1.1 - Annex 1: Conceptual Data Models"* (CORDEX Project Deliverable AC23-Part 2.1);
- *"DATEX-Net Specifications for Interoperability - version 1.1 - Annex 2: DATEX EDIFACT format messages"* (CORDEX Project Deliverable AC23-Part 2.2). Contains specifications of TRAVIN, TRAILS, TRALOC, TRAVAK, TRAREQ, TRACAT.
- DATEX Traffic/Travel Data dictionary, version 3.0, December 1996.
- Geographic road database Location Referencing : Part 1: Location referencing rules for Radio Data System - Traffic Message Channel (RDS-TMC) Version 1.2, prENV/278/7/3/006.
- Dutch translation of the tables from the Datex Data Dictionary version 3.0, TIC-D761a.D1.
- Groupe de suivi 4ème PCRD, thème n°3 : échanges de données, CERTU - SETRA, January 98 (In French).
- Datex-Net preliminary draft report, Users requirements, CORD project, Drive2, deliverable AC12, part 11, Mars 95.
- European Memorandum of Understanding on the use of interoperable mechanisms for international exchange of traffic and travel data/information between road traffic centres, 2/10/97.
- Review of existing land-use transport models, Final Report, ESTEEM Project / DGXII / WP 3.2, November 1996, CERTU, STRATEC..
- G. Jansen et. al., TNO-Inro, Transport networks and mobility : a comparative analysis of the Randstad, the Rhein-Ruhr area and the Antwerp-Brussels-Ghent Region, presented at Fourth NECTAR Euroconference, Israel, April 1998.
- T. Redman, Data quality for the information age, Artech House, 1996.
- R. Margiotta, SAIC for FHWA, ITS as a data resource, preliminary requirements for a user service, Office of Highway Information Managemenbt, April, 1998.
- J.C. Miles and A.J. Walker, ARTTIC in Brussels, The WELL-TIMED study, West-European Local Legal arrangement for Transport Information Management and Exchange of Data, a report prepared for the EC-HLG on RTT, Main Report (Vol. 1), National Reports (Vol. 2), EC-DG XIII C6, TAP-Transport, ANIMATE project.
- Existing and emerging techniques for the automatic collection of data for transport modelling, HA024D002/1.0, Smith Co. Engineering, 1997, study conducted for the UK

DETR.

- Henry Thams, Analyse fonctionnelle d'intégration et de partage des données de transport urbain, rapport de travail de fin d'études, (in french), ENTPE / CERTU , 82 pages, June 98.
- Len Bass, Paul Clements and Rick Kazman, Software architecture in practice, SEI series in software engineering, Addison-Wesley, 1998.

## XIV.3 TECHNICAL ISSUES

- CONVERGE Guidelines for the Development and Assessment of Intelligent Transport System Architectures, February – 98 Issue 1.0
- CORDEX deliverable AC 23 parts 1, 2.0, 2.1 and 2.2 and 3.0 (DATEX Data Dictionary), December 1996
- DATEX-Net Specifications for Interoperability, version 1.1
- Guidelines for using XML for Electronic Data Interchange, version 0.05, 25th January 1998
- Introductory User Guide to DATEX-Net Specifications for interoperability, version 1.1
- Standards for Road Transport and Traffic Telematics (RTTT), ICT Standards Board, CEN/TC 278, ICTSB16(99)06, 17 June 1999
- Technical annex DIRECT, 1 December 1997

## XIV.4 NON TECHNICAL ISSUES

- Argyris C., R. Putnam & D.M. Smith, *Action science: concepts, methods and skills for research and intervention*, The Jossey-Bass social and behavioural science series, San Francisco, CA: Jossey-Bass, 1985
- Argyris C., *Overcoming organisational defences: Facilitating organisational learning*, Boston: Allyn and Bacon 1990
- Bruijn J.A. de & E.F. ten Heuvelhof, *Netwerkmanagement, Strategieën, instrumenten en normen*, Delft, 1 juni 1995
- Bruijn J.A. de, P. de Jong, A.F.A. Koster & W.P.C. van Zanten, *Grote projecten, besluitvorming & management*, Alphen aan den Rijn, 1996
- Bruin, J.A. de, E.F. ten Heuvelhof & R.J. in 't Veld, *Proces Management, over proces-ontwerp en besluitvorming*, 1998
- European Commission, *Public Sector Information: a key resource for Europe, Green paper in public sector information in the information society*, COM(1998)585, 1998
- Fukuyama f., *Trust: social virtues and the creation of prosperity*, New York: Free Press, 1995
- Gifford J.L., *Remaking Transportation Organisations for the 21st Century:Learning Organisations and the value of Consortia*, George Mason University, Virginia, paper for the 78th Transport Research Board, Washington 1999
- Hakala Jorma, *Institutional aspects in public transport telematics applications*, Paper for the ITS world conference 1996
- Haris, Ph. R. and R.T. *Morgan, Managing Cultural Differences, High-performance Strategies for a new World of Business*, Houstan, Texas, 1991
- Hofstede G., *Allemaal andersdenkenden, Omgaan met cultuurverschillen,* Amsterdam 1998
- ITS City Pioneers Consortium, *ITS Planning Handbook*, 1998

- Jalasto P. & Lähesmaa J., *FIST Co-operation program for comprehensive development of travel and traffic services*, Paper for the ITS world conference 1997

- Jong, M. de, *Institutional translation, how to adopt good transport infrastructure decision-making ideas from other countries*, Delft 1999
- Klein H.K., *Operation Timesaver: A Political and Institutional Analysis*, Paper for the ITS world conference 1996
- Lindquist, Eric, *Institutional Barriers to Implementing ITS Technologies Along the Texas - Mexico Border*, Paper for the ITS world conference 1996
- Loyaerts, Yvon, *Institutional issues in ITS deployment: International lessons learned*, Paper for the ITS world conference 1997
- Mahler J., *Organisation, Learning and Culture*, Unpublished paper, George Mason University, Verginia, 1995
- Marquardt M., *Building the learning organisation: a systems approach to quantum improvement and global success*, New York: McGraw-Hill, 1995
- Potgraven, P., T. Volk, *Traffic information center; startdocument*, TIC-D790.D3, 1997
- Qiunn M., *The development of regional traffic control centres for England, a public-private partnership*, Paper for the ITS world conference 1997
- Ray M., *Challenges of ITS applications in economies in transition, recommendations*, Paper for the ITS world conference 1997
- Senge P.M., *The fifth discipline: the art and practice of the learning organisation*, New York: Double/Currency, 1990
- TIC, *Dutch translation of the tables from the Datex Data Dictionary version 3.0*, Documentcode: TIC-D761a.D1
- Vries, B. de, *Information for clients of TIC-Nederland; Technical, organisational and legal specifications*, TIC-D7400.D2, 1997.
- Weggeman M., *Kennismanagement, Inrichting en besturing van kennisintensieve organisaties*, Scriptum, Schiedam, 1997

# XV. APPENDIX 1 : IDENTIFICATION OF THE INPUT DATA

Tables XV.1 – XV.3 provide a list of 'raw' data referenced by themes and data type[80], which has been built in accordance with various European sites within the DIRECT consortium and represents a comprehensive list.

**TABLE XV.1: LAND-USE DATA**

| THEME | DATA TYPE | DATA |
|---|---|---|
| Population | S | Commune,"statistical sector" |
| | S | Number of inhabitants |
| Area | S | Commune, «statistical sector» |
| | S | Type of building permit (home, business, combined use,...) |
| | S | Number of buildings permits |
| | S | Surface |
| Housing | S | Commune, «statistical sector» |
| | S | Type of housing (house, apartment,..) or type of building permit |
| | S | Range of housing surface |
| | S | Individual housing or collective housing |
| | S | Number of household |
| | S | Building permit number |
| Employment | S | Commune, geographical sector |
| | S | Activity sector |
| | S | Number of jobs |

**TABLE XV.2: ROAD SUPPLY DATA**

| THEME | DATA TYPE | DATA |
|---|---|---|
| Road supply | S | node identification |
| | S | node coordinates |
| | S | node commune, "statistical sector" |
| | S | link Alphanumeric name |
| | S | link Numerical identification |
| | S | link type of infrastructure (road at ground level, tunnel, viaduct,...) |
| | S | link capacity index |
| | S | link operator |
| | S | length of this link (in metres) |
| | S | link width (in metres) |
| | S | link number of lanes |
| | S | junction identification of link |
| | S | link average link speed (in kilometre per hour) |
| | S | link speed-flow curve : speed at free flow(in kilometre per hour) |
| | S | link speed-flow curve : speed at capacity(in kilometre per hour) |
| | S | link speed-flow curve : maximum flow at which free-flow conditions hold |
| | S | link speed-flow curve : saturation flow (at capacity) |
| | SD | type of events on the link (forecasted events) |
| | SD | calculated average occupancy rate in the loops |
| | SD | forecasted level of service |
| | SD | calculated average link speed (in kilometre per hour) |
| | SD | link stacking capacity restriction |
| | SD | link road side equipment identification (type of information panel, camera... ) |
| | SD | link type of information disseminated (number of characters, |

[80] S= Static data; SD = Semi-dynamic data; D = Dynamic data

| | | |
|---|---|---|
| | | strategy of display :pure information, advises...) |
| | SD | link status of tunnel traffic lights (cleaning, working,...) |
| | SD | junction number of links |
| | SD | junction saturation flow of turn |
| | SD | junction turn priorities |
| | SD | junction type of traffic lights (independent with adaptive timings, independent with fixed timing, connected to a traffic control centre, co-ordinated with adaptive timings, co-ordinated with fixed timings, other) |
| | SD | junction signal data : timing chart, duration of stage (minimum, maximum, average), duration of inter-green (seconds) |
| | SD | junction coordination plan : route description |
| | SD | junction coordination plan : coordinated speed |
| | SD | pricing route description |
| | SD | pricing type of day (working day, week-end day, holiday) |
| | SD | pricing period of the day (morning peak, evening peak, off peak) |
| | SD | pricing cost function parameters |
| | SD | pricing cost coefficients |
| | SD | revenue of pricing accounting period |
| | SD | pricing type of operator (local, regional, private) |
| | SD | pricing revenue |
| | SD | expenses accounting period |
| | SD | expenses type of operator (local, regional, private) |
| | SD | expenses type 1 (operation of network/equipment) |
| | SD | expenses type 2 (maintenance of network/equipment) |
| | SD | investment accounting period |
| | SD | investment lifetime |
| | SD | investment type of operator (local, regional, private) |
| | SD | investment type (network / equipment) |
| | SD | subsidies accounting period |
| | SD | subsiding type of authorities (local, regional, national,..) |
| | D | type of events on the link (real time camera status) |
| | D | real time occupancy rate in the loops |
| | D | real time level of service |
| | D | real time link speed (in kilometre per hour) |
| | D | information equipment display (status + message) |
| | D | status of tunnel traffic lights |
| | D | junction signal data : on line chart of the time periods, duration of stage, duration of inter-green (seconds) |
| | D | status of traffic lights |

## TABLE XV.3: PUBLIC TRANSPORT SUPPLY DATA

| THEME | DATA TYPE | DATA |
|---|---|---|
| Public transport supply | S | Node alphanumeric name (stop name) |
| | S | Node identification |
| | S | Node coordinates |
| | S | Node commune or «statistical sector» |
| | S | link alphanumeric names |
| | S | link numerical identification |
| | S | link distance |
| | S | link commercial speed |
| | S | Junctions (if specific public transport signal data) |
| | S | Junction alphanumeric name |
| | S | Type of junction |
| | S | Junction number of link |
| | S | Junction identification of link |
| | S | Junction turn priorities |
| | S | Services numerical identification |
| | S | Service : type of day (working day, week-end day, holiday) |
| | S | Service : period of the day (morning peak, evening peak, off peak ) |
| | S | Service headway (morning peak, evening peak, off peak) |
| | S | Service mode (metro, tram ,bus) |
| | S | Service route description (link identification) |
| | S | Service : operator |
| | S | Service : number of stops |
| | S | Vehicle capacity (number of places) |
| | S | Number of vehicles, trains |
| | S | Pedestrian transfer link distance |
| | S | Pedestrian transfer link speed |
| | SD | Stop equipment (type of panel information, type of vocal message) |
| | SD | Stop type of information disseminated |
| | SD | Stop infrastructure ( intermodal node, parking,...) |
| | SD | Stop safety equipment (camera,...) |
| | SD | Stop time schedule (as stated in time tables) |
| | SD | Stop time schedule reliability (average late arrival rate, average delay between time schedule and real time,...) |
| | SD | Average speed between stops |
| | SD | Junction number of links |
| | SD | Junction identification of link |
| | SD | Junction turn priorities |
| | SD | Junction specific public transport signal data : timing chart, duration of stage, duration of inter-green (seconds) |
| | SD | Services numerical identification |
| | SD | Type of bus |
| | SD | Route description by type of day (working day, week-end day, holiday) |
| | SD | Route description by period of the day (morning peak, evening peak, off peak |
| | SD | on board equipment (type of panel information, type of vocal message) |
| | SD | on board type of information disseminated |
| | SD | fare : type of day (working day, week-end day, holiday) |
| | SD | fare : period of the day (morning peak, evening peak, off peak ) |
| | SD | fare : types of ticket |
| | SD | fare : description of constraints to ticket use (age, purpose, group size,..) |

| | | |
|---|---|---|
| | SD | fare cost function parameters |
| | SD | fare cost coefficients |
| | SD | Revenue |
| | SD | Revenue accounting period |
| | SD | Revenue by operator |
| | SD | Revenue by mode |
| | SD | Expenses accounting period |
| | SD | Expenses by operator |
| | SD | Expenses by mode |
| | SD | Charge/km ( vehicle maintenance, tyres, energy,...) |
| | SD | Charge/hours (wages,..) |
| | SD | Investment accounting period |
| | SD | Investment lifetime |
| | SD | Investment by operator |
| | SD | Investment by mode |
| | SD | Type of investment (vehicle, infrastructure, equipment) |
| | SD | Subsidies accounting period |
| | SD | Type of subsidy (investment, operation) |
| | SD | Subsidies by subsiding authorities (local, regional, federal,..) |
| | D | Status of stop equipment (type of panel information, vocal message in the coach... ) |
| | D | Stop status of information disseminated |
| | D | Stop status of parking |
| | D | Stop safety equipment (camera) status |
| | D | Stop on line time schedule |
| | D | Stop on line time schedule reliability (on line late arrival rate, on line delay between time scheduled and real time,...) |
| | D | on line travel time between stops |
| | D | Junction specific public transport signal data : on line chart of the time periods, duration of stage, duration of inter-green (seconds) |
| | D | Service numerical identification |
| | D | Type of bus |
| | D | on line route description |
| | D | on board status of equipment (type of panel information, type of vocal message) |
| | D | on board information disseminated |

## TABLE XV.4: PARKING SUPPLY

| THEME | DATA TYPE | DATA |
|---|---|---|
| Parking supply | S | Parking identificator |
| | S | off street parking operator (public, private) |
| | S | off street parking operator type 1 (free, priced) |
| | S | off street parking operator type 2 (long time, short time) |
| | S | off street parking capacity |
| | S | on street parking operator (public, private) |
| | S | on street parking type 1 (free, priced) |
| | S | on street parking type 2 (long time, short time) |
| | S | on street parking capacity |
| | SD | Parking identificator |
| | SD | parking type 1 (off street, on street) |
| | SD | parking type 2 (free, priced) |
| | SD | parking type 3 (long time, short time) |
| | SD | parking capacity |
| | SD | off street parking car park equipment (information panel, camera, ... ) |

| | | |
|---|---|---|
| | SD | off street parking type of disseminated information (real time information,...) |
| | SD | off street parking safety equipment available(camera,..) |
| | SD | off street parking car park status (open, close) |
| | SD | fare : type of day (working day, week-end day) |
| | SD | fare : period of the day (morning peak , evening peak, off peak |
| | SD | fare description of constraints of use (group, member..) |
| | SD | fare cost function parameters |
| | SD | fare cost coefficients |
| | SD | expenses accounting period |
| | SD | expenses type of operator (public, private) |
| | SD | operation expenses |
| | SD | maintenance expenses |
| | SD | investment accounting period |
| | SD | investment lifetime |
| | SD | investment type of operator (private/ public : local, regional, federal,..) |
| | SD | investment level |
| | SD | subsidies accounting period |
| | SD | subsiding authorities (local, regional, federal,..) |
| | SD | subsidies level for investment |
| | SD | subsidies level for operation |
| | D | parking identificator |
| | D | off street parking status of equipment (information panel, camera, ... ) |
| | D | off street parking information disseminated (real time information,...) |
| | D | off street parking safety equipment (camera,..) status |
| | D | off street parking car park status (open, close) |

## TABLE XV.5: PASSENGER SOCIO-ECONOMIC DATA & PASSENGER TRIP DATA

| THEME | DATA TYPE | DATA |
|---|---|---|
| Passenger socio-economic data | S | household identification |
| | S | house geographic location |
| | S | household size |
| | S | household composition |
| | S | house type |
| | S | household head |
| | S | household member identification |
| | S | household member sex |
| | S | household member age |
| | S | household members' level of education |
| | S | household members' level of scholarship |
| | S | household members' working status (full time work, part time work, half time work, non working) |
| | S | household members' working place (at home, not at home) |
| | S | household members' working geographic location |
| | S | household members' working time schedule (start time, end time) |
| | S | household members' professional status (independent, employee) |
| | S | household members' professional sector (public, private) |
| | S | Household members' professional activity sector/ non working status |
| | S | Household members' income level |

| | | |
|---|---|---|
| | S | House owner, leaseholder |
| | S | Level of housing charge per month |
| | S | Household number of vehicles |
| | S | Vehicle equipment |
| Passenger trip data (concern all trips, travelled in one day ) | S | Number of trip in one day |
| | S | Trip mode (car, public transport, bicycle, by foot) |
| | S | Trip origin location |
| | S | Trip departure time |
| | S | Trip destination location |
| | S | Trip arrival time |
| | S | Trip purpose |
| | S | Trip frequency |
| | S | Trip route description (mode, Services) |
| | S | Car use rate |
| | S | Bicycle use rate |

## TABLE XV.6: GOODS HAULIER CHARACTERISTICS & FREIGHT TRIP CHARACTERISTICS

| THEME | DATA TYPE | DATA |
|---|---|---|
| Goods haulier characteristics | S | Haulier name |
| | S | Haulier reference number |
| | S | Haulier number of operated vehicles |
| Freight trip characteristics (concern all transport performed in one week) | S | Vehicle operation period |
| | S | Date +day |
| | S | Goods nature |
| | S | Gross weight |
| | S | Loading unit |
| | S | Trip frequency |
| | S | Loading time |
| | S | Unloading time |
| | S | Loading location |
| | S | Unloading location |
| | S | Loading terminal type |
| | S | Unloading terminal type |
| | S | Total trip distance, loaded truck |
| | S | Total trip distance, empty truck |

## TABLE XV.7: PUBLIC TRANSPORT COUNTS

| THEME | DATA TYPE | DATA |
|---|---|---|
| Public transport counts | S | Stop node alphanumeric name (stop name) |
| | S | Date |
| | S | Time |
| | S | Mode |
| | S | Number of vehicles |
| | S | Boarding passenger |
| | S | Alighting passenger |
| | D | Stop identificator |
| | D | Date |
| | D | Time |
| | D | Mode |

| | | |
|---|---|---|
| | D | Number of vehicles |
| | D | Boarding passenger |
| | D | On line alighting passenger |

## TABLE XV.8: ROAD COUNTS & SPEED MEASUREMENTS

| THEME | DATA TYPE | DATA |
|---|---|---|
| Road counts | D | Screen line description |
| | D | Location of counting stations |
| | D | date & time |
| | D | number of vehicle counted (breakdown by type of vehicle) |
| | D | vehicle speed |
| | D | vehicle occupancy |
| Speed measurement | S | Route description |
| | D | date & time |
| | D | Ending time |
| | D | distance travelled |
| | D | Average speed |

## TABLE XV.9: PARKING COUNTS

| THEME | DATA TYPE | DATA |
|---|---|---|
| Parking counts | S | Alphanumeric names |
| | S | Numerical identification |
| | S | number of vehicles |
| | S | number of vehicles in authorised parking places |
| | S | number of vehicles in non authorised parking places |
| | S | number of non occupied parking places |
| | S | average parking duration per vehicle |
| | D | parking identification |
| | D | number of vehicles arriving |
| | D | number of vehicles leaving |
| | D | average parking duration per vehicle |

## TABLE XV.10: ACCIDENTS

| THEME | DATA TYPE | DATA |
|---|---|---|
| Accidents | S | Numerical identification |
| | S | Year |
| | S | Date |
| | S | Time |
| | S | Mode(s) |
| | S | Geographical location |
| | S | Degree of severity |
| | S | Number of persons involved |
| | S | Number of people killed |
| | S | Number of people injured |
| | S | Personal injuries |
| | S | Reason of accident |
| | S | Weather conditions |
| | S | Light conditions |
| | S | Aspect of the road surface |
| | S | Type of declaration |
| | S | Person in charge of the declaration |
| | D | numerical identification |
| | D | Date |
| | D | Time |

| | | |
|---|---|---|
| | D | mode(s) |
| | D | geographical location |
| | D | degree of severity |
| | D | number of persons involved |
| | D | number of people killed |
| | D | number of people injured |
| | D | personal injuries |
| | D | reason of accident |
| | D | weather conditions |
| | D | light conditions |
| | D | aspect of the road surface |

## TABLE XV.11: AIR POLLUTION

| THEME | DATA TYPE | DATA |
|---|---|---|
| Air pollution | S | Year |
| | S | Date |
| | S | geographical identification |
| | S | Time |
| | S | type of pollutant (NOx, So2, Co) |
| | S | level (µg/m³) |
| | D | Date |
| | D | geographical identification |
| | D | Time |
| | D | type of pollutant (NOx, So2, Co) |
| | D | level (µg/m³) |

## TABLE XV.12: NOISE

| THEME | DATA TYPE | DATA |
|---|---|---|
| Noise | S | Year |
| | S | Date |
| | S | geographical identification |
| | S | Time |
| | S | level (db) |
| | D | Date |
| | D | geographical identification |
| | D | Time |
| | D | level (db) |

## TABLE XV.13: WEATHER CONDITIONS

| THEME | DATA TYPE | DATA |
|---|---|---|
| Weather conditions | S | Year |
| | S | Date |
| | S | Time |
| | S | Location |
| | S | Weather conditions |
| | S | Lighting conditions |
| | S | Status of the road surface |
| | D | Date |
| | D | Time |
| | D | Location |
| | D | weather conditions |
| | D | lighting conditions |
| | D | status of the road surface |

# XVI. APPENDIX 2 : PROPOSED CHECK LIST FOR USER INTERVIEW FRAMEWORK

***User definition***

- ✓ site : (city)
- ✓ user name : (system or staff)[81]
- ✓ organisation name (and department within organisation)
- ✓ person interviewed (name, position in organisation)

***Description of organisation***

- *Role*
  - ✓ public authorities : EU, national, regional or urban transport authorities and administrations
  - ✓ transport network operators : railways, urban PT, urban roads and motorways, taxis, parkings
  - ✓ service operators : information services, freight operators, etc.
  - ✓ end-users, both general public and companies
  - ✓ research organisations
  - ✓ system providers : including software providers
  - ✓ others...

- *Size*
  - ✓ staff number, resources, ...

- *Major activities and trends*

***Existing system***

We recommend one interview for each system ; even if several systems are used within one organisation, they should be considered as separate users of the TDSS.

Here fits a description from the point of view of data sharing (we do not need here a detailed description of all functions and technical features of the systems, but of key aspects related to data exchange with third party users). This paragraph should be adapted to whether the user considered is the system itself (in which case its users should be also described as secondary users of the TDSS), or the people who « connect » to the TDSS (in which case the systems, databases or applications they use in their organisation are mentioned - as secondary users of the TDSS)

For actually exchanging or sharing data between 2 (or more) systems, several levels are needed :

- contractual level (institutional, financial, commercial, legal aspects)
- procedural level (organisation of people for operating the TDSS)
- technical level (protocols, formats, networks used, including data dictionary and metadata - i.e. catalogue of data available to the TDSS)

81 As said earlier, a TDSS user is either an existing (or planned) system with an automated interface to the TDSS, or staff that accesses third-party transport data, or sends transport data to other partners. The user should be given a name and be clearly identified.

These three levels should be addressed in the description of available systems and data in this paragraph (constraints), and also in the next paragraph describing data needed and potentially available (expectations).

<u>*context*</u>

- ✓ mission
- ✓ domain[82] : operations (traffic and event monitoring for co-ordinated incident management or traffic control, parking management, etc.), sales (ticketing, electronic fare collection), information (pre-trip, on-trip), studies (modelling, statistics), observatory (graphics and maps, strategic monitoring and evaluation)
- ✓ time-scale : (strategic) planning, (tactical) planning, (real-time) operations, statistics
- ✓ size : number of people using the system in the organisation, resources invested
- ✓ other organisations connected to the system or using its data (with or without a software interface)
- ✓ relevant technologies and standards

<u>*data made available and information sharing*</u>

- ✓ data description (domain, format, update frequency, etc.)
- ✓ purpose (function) of data exchanged
- ✓ contractual and procedural aspects
- ✓ example(s) :
  - ➢ give one (or more) detailed use scenario(s) of existing data sharing
  - ➢ state the problems with current solution

***Wish list for the TDSS***

A major difficulty in expressing TDSS requirements is the diversity of situation from site to site, and also from system to system (or user to user) within one site. In particular, the level of implementation varies greatly : some users share data with other systems in a fully operational way since years, other users plan to exchange diskettes, others have set up experimental exchange system or procedures, or still develop them... What's important is to clearly state the existing (operational) situation, the actual needs or plans for the user / system interviewed, even if they include dysfunction, ill-defined features and partly « manual » actions.

<u>*data needed*</u>

- ✓ from which other user or system
- ✓ for which purpose (function), integration with existing or planned application(s)
- ✓ importance of need : degree of priority, expected date
- ✓ non functional requirements (e.g. performance, availability, etc.)

<u>*data potentially made available*</u>

- ✓ data description, availability (how, when)
- ✓ to which other users
- ✓ for which purpose (function)
- ✓ availability : expected date, reasons of current non-availability :

82 As we study TDSS here, we don't mention here other domains such as staff management, accounting, or equipment / system management.

- data available but contract or procedures not ready, exchange mechanism to be developed, data description (metadata) not available, no third-party users ready yet to collect data
- data not available but collected soon
- system under development or planned

*example*

✓ give one (or more) detailed use scenario(s) of wished data sharing

***Perceived benefits of the TDSS***

institutional, technical, financial, commercial, legal

***Perceived barriers to the TDSS implementation***

institutional, technical, financial, commercial, legal

# XVII. APPENDIX 3 : DETAILED DESCRIPTION OF THE TDSS TECHNICAL ASSESSMENT CRITERIA

The objective of this appendix is to define the technical criteria summarised in section 4.5.2.1.

## XVII.1 ARCHITECTURE AND PRODUCT CHOICE

The first point of technical evaluation of an application should be the validation of the architecture choices against the objectives of the project.
The following matrix shows the different solutions, as described in the paragraph of Deliverable D4.

| **Application field objective** | **Chosen architecture** | | |
|---|---|---|---|
| | ***Local database*** | ***Intranet / Internet architecture*** | ***Distributed objects architecture*** |
| Transport Planning | **Best choice** | Could be a good choice if a light product is selected (ex Oracle WebDB) | *Bad choice* |
| Traveller information, Trip planning | Difficult to publish the data, low scalability | **Best choice** | Could be a good choice, but implies high development costs, and a web interface |
| Traffic management | *Bad choice* | Could be a good choice, but implies a very powerful configuration | **Best choice** |

**Table XVII.1 : Architecture choice validation matrix**

The tools choice is also due to cost reason. Depending on the budget allocation, some tools and/or architectural choices may be rejected.

Another important criterion may be the diffusion of tools for future integration of other tools. If the chosen tool is widely distributed, it ensures that it will be maintained and that other software applications will easily be integrated.

## XVII.2 SCALABILITY OF THE SOLUTION

The scalability of the chosen solution should be an important point in the technical validation of the project.

The choices have to be compatible with the current needs of the users, but have also to be compliant with the future evolutions of the project. Depending on the technical choices, the project could be easily upgraded or not.
To be able to evaluate the scalability of the project, we have to take into account the following parameters:

- Hardware platform: even if the hardware platform can be changed if the OS supports several processors, this would imply a complex manipulation and would probably cost a lot. For this reason, the initial choice remains important.
- Operating system: an open system, which is available on several hardware platforms would be a benefit for the future of the project.
- Programming tools / languages: The level of standardisation of the chosen language is an important point for the scalability of the project. A proprietary language, available on only one operating system could become a great drawback.
- Architecture: the architecture of the system also impacts the scalability: a monolithic system will be less scalable than a distributed one.

The following table can help in the evaluation of the scalability of the solution:

## XVII.3 PERFORMANCE EVALUATION

The main technical criterion for an end-user remains the response time of the application. However, the response time is due to the accumulation of several response times, each one concerning an independent aspect. We can consider:

- access to data bases,
- network performance,
- algorithmic performance,
- generation of user interface screens,
- displaying information screen on the client side.

All these parameters can be grouped into three main categories that are data access, presentation process and user consultation

The two first domains are in the scope of the TDSS and are under the responsibility of suppliers and developers who can be the same or two distinct entities.

The last domain concerns the client and depends directly on the performance of his configuration (hardware, transfer rate, PC or terminal…).

Several system cases can be identified:

- The application works on a local area network : This case matches with the single database and local access architecture. In this case, the performance depends mainly on the hardware of the server, and the software code.
- The application is accessed via an Intranet : the most important parts in terms of performance are the database server, the application server and the network. The database server should be able to perform the queries in a good response time. The application server should generate the HTML pages, and publish them on the network in good conditions. For Intranet architectures, the network can be the main problem. But it is always possible to define a specific TCP/IP network from the application server to the client workstations, in order to improve the global performance.
- The application is provided to the public via Internet: The global response time greatly depends on the network access of the client workstation, and, as it is on Internet, there is no possible action to improve the performance. Nevertheless, we have at least to check that the server side is correctly sized. The two important points are the data server and the application server.

Some rules[83] should be applied to this kind of system:

- The size of the HTML pages, and the size of the images included in these pages should be reasonable. In fact, the images sizes impact drastically the load time for end-users. In the case of a public access through Internet, the transfer capability is limited to several kb/s. It implies that the loaded HTML page must not exceed 50 kbytes. If the size is larger than the recommended size, it could be very useful to provide a simplified page without heavy images in order to improve access time. Obviously, the complete HTML page remains available for users accepting to spend time for loading.
- The image loading must be, as much as possible, performed at the end of the HTML page loading.
- The use of applets must be limited since their execution is time consuming.
- The time of generation of a page should be very short and no longer than 3 seconds because this time is added to the HTML page loading time which can itself reach almost 10 seconds.

In each case, depending on the chosen architecture, it is possible to measure the actual performance of a system, and predict the future performance with a greater load with some tools which use mathematical models.

## XVII.4 AVAILABILITY

The availability of the system can be a key point if the users are safety services (police, …).

Availability is then to be considered for the hardware aspects (what happens when some components or resources are not available), but also for the software aspects.

Basically, if no particular availability constraint has been established during the requirement definition, the system may be supported by only one server. Then, in case of failure of this server, the whole system becomes unreachable for any user.

It is of huge importance that these availability constraints are carefully detailed during the user’s requirement definition phase.

Concerning hardware aspects, high availability systems are usually implemented as clusters, allowing the failure of one of the machines without stopping the service, even if the response time are not as good as in normal mode. The main drawback of such a system is a heavy implementation and maintenance cost. Various aspects should there be examined.

For example, sorting functions according to their importance allows low importance functions to be temporary disabled

It is also useful to sort clients by priority to restrict system access in case of problems. For instance, safety services access is considered mandatory, and public transport management has a higher priority than “ordinary users”. Anyway, defining an acceptable degraded functional mode can give the system designer some indications that may influence some important choices to be taken during the design phase of the application.

83 These rules are less critical in the case of intranet access because network performance between servers and client are better than for internet access.

Concerning software aspects, critical components should be identified, allowing to apply adapted quality insurance criteria to the related parts of the software, as developed in next section.

## XVII.5 QUALITY ASSURANCE

Quality insurance addresses the following issues :

- Data model : The data model should be compliant with the Domain Key Normal Form (DKNF). This normalisation form is the standard normalisation level for relational database projects. Nevertheless, for an optimisation purpose, a limited "denormalisation" can be accepted.

- Source code : The source code should be well commented. Depending on the language used, the requirements in terms of comments are different :
  - Procedural languages : The source code developed using procedural languages, object oriented or not, like C, C++, Java, PL/SQL, should include at least a comment in the header of each file, and in the header of each function/procedure/method.
  - 4GL : The usage of a 4$^{th}$ generation language (4GL), as Powerbuilder, Delphi, Access, sometimes does not allow to write comments in the same place as other languages. In addition, these languages use an event-based model. Depending on the tool, comments should be written at least for each method/call back linked to an event.
  - HTML: An HTML page does not allow for a lot of comments. Indeed, the objective of an HTML page is to be loaded. In order to reduce to the maximum the loading time of this page, we have interest to avoid unnecessary characters increasing the code weight. However, it is possible to define some "metas", to allow search tools to find easily the page. Anyway, HTML pages of an application are usually not static, but dynamically generated by the application server using another language (C, C++, Java, …), and this code has to be commented.

- Documentation : For ensuring the good quality insurance of a project, the documentation is a key aspect. Chapter 2 of Deliverable 4 describes on the one hand the following phases of a project such as TDSS implementation and on the other hand the related documentation. Taking into account limitations due to the prototype quality level, we can however enumerate some mandatory documents. The documentation of the prototype should at least include the following documents:
  - A summary of user specifications, to define clearly the objectives of the project
  - An installation and configuration guide, to allow somebody to install the application in another place

The following documents or reports are of essential interest for the future project:

- A technical specifications document
- A design document, that describes the architecture and the detailed design of the application
- A test plan, that describes all the necessary tests to be applied to the project
- The test report, that describes the test results
- A user manual

## XVII.6 IMPLEMENTATION AND MAINTENANCE COST

The implementation cost includes:

- The cost of the hardware development and test platform
- The cost of the development tools
- The cost of the manpower for the development process, including the project management and the quality assurance

In the maintenance, we have to take account of the following points:

- Maintenance and support for the hardware
- Maintenance and support for the software (programming tools, operating system)
- Manpower cost for the maintenance of the system

# XVIII. APPENDIX 4 : DATA FORMAT AND MAJOR EXISTING STANDARD APPROACHES

## XVIII.1 CURRENT TECHNOLOGIES

Several projects in the field of Transport and Traffic worked on the definition of data format. Some of these formats may be called de facto standards because they are widely admitted even if they are not official standards. As an example for CAD data, the DXF standard has been developed by AutoCAD and is used by a large part of CAD systems.

In this clause, we describe rapidly some of the formats that are still used in several European initiatives. For instance, RDS-TMC may be very helpful for a large distribution of relevant information to individual vehicle users. In the same way, future implementations of TDSS should use Internet facilities, and so, the XML solution should be used.

### XVIII.1.1 RDS-TMC

Twenty years ago the development of **RDS** (*Radio Data System*) started. The **EBU** (*European Broadcasting Union*) wanted especially car radios to be more comfortable. Since 1987 introduced at the European market RDS has its ourdays comeback because of the new RDS-group **TMC** (*Traffic Message Channel*).

Topical traffic and travel messages collected by traffic information centres are digitally coded and finally broadcasted without interrupting the normal radio program by the FM transmitters. Radio receivers fitted with an **RDS-TMC** decoder can transform the code in plain text and display the traffic and travel information.

The traffic message channel is introduced across Europe. The messages are generated in code according to the standard protocol for **TMC**, using a standard list to describe the event (the ***event table***) and a location database (***location table***) to identify where the event has taken place. Because messages are coded, the end-user can choose the language in which messages are presented. Even in foreign countries, traffic messages are displayed in the chosen language. Routing filters allow limiting the traffic information to the selected routes.

#### Projects using RDS-TMC

**ECORTIS** co-ordinates the implementation phase of radio messages in the driver's own language for events occurring on the selected route using RDS-TMC (Radio Data System - Traffic Message Channel). This will offer a high-quality, cross-border user information service throughout Europe. It is a four-year project (1995-98) involving 11 of the 15 EU Member States. The main objectives of the project are to deal with political and strategic issues, to set up a technical platform ensuring the coherence of all technical developments and to co-ordinate national plans in line with a pan-European perspective on RDS-TMC services. First services have started in Germany, France and the Netherlands in 1997.

**CENTRICO** co-ordinates the implementation plans for traffic management and user information services for countries centrally located in Europe: Belgium and Luxembourg, and parts of France, Germany and the Netherlands. During 1995 and 1996 a common action programme has been prepared focusing on monitoring, cross-border traffic management and re-routing, traffic information exchange, co-ordination of traffic centres, the implementation of ITS in conurbation's, on-trip information through RDS-TMC and interoperability of electronic fee collection.

**SERTI** co-ordinates the implementation of traffic management and user information services covering the southern region of Europe: adjacent parts of France, Germany, Italy and Spain. During 1996 studies have been conducted and co-ordinated to define a common action programme covering monitoring, organisational problems, data exchange, traffic management using VMS, RDS-TMC traffic information services, and pre-trip information services.

**VIKING** co-ordinates national and bi-lateral traffic management and ITS implementation projects in the northern part of Europe: Denmark and parts of Finland, northern Germany, Sweden and Norway. The co-ordination ensures continuity and a high quality of ITS services, and gives special attention to intermodal aspects - to support personal travel and freight haulage. The project started in Autumn 1996 with preparatory steps already taken: consensus on traffic management on the northern part of the trans-European network, definition and harmonisation of services, information management and data exchange, RDS-TMC traffic information services, electronic fee collection and demand management, and traffic management in the urban and peri-urban areas.

**CORVETTE** co-ordinates regional, bi-lateral and multi-lateral ITS implementation projects in the Alpine area covering Austria, part of Germany, and the northern part of Italy. The project started in autumn 1996. The main domains have been identified: traffic data collection and monitoring of conditions, data exchange, traffic management using VMS, RDS-TMC traffic information services and electronic toll collection.

### XVIII.1.2 UN/EDIFACT

The expanded name is United Nations Electronic Data Interchange for Administration, Commerce and Transport and it covers the area of EDI messaging standards for various sectors.

The UN/EDIFACT standards are published by the United Nations as the United Nations Trade Data Interchange Directory (UNTDID) and maintained under internationally agreed, consensus-based procedures. They include standards related to both batch and interactive UN/EDIFACT. UNTDID includes the UN/EDIFACT Syntax Rules published by ISO as:

- *ISO 9735:1998 Electronic data interchange for administration, commerce and transport (EDIFACT) -- Application level syntax rules (Syntax version number: 4)*
  - ✓ Part 1: Syntax rules common to all parts, together with syntax service directories for each of the parts
  - ✓ Part 2: Syntax rules specific to batch EDI
  - ✓ Part 3: Syntax rules specific to interactive EDI
  - ✓ Part 4: Syntax and service report message for batch EDI (message type -- CONTRL)
  - ✓ Part 5: Security rules for batch EDI (authenticity, integrity and non-repudiation of origin)
  - ✓ Part 6: Secure authentication and acknowledgement message (message type - AUTACK)
  - ✓ Part 7 (DIS): Security rules for batch EDI (confidentiality)
  - ✓ Part 8: Associated data in EDI
  - ✓ Part 9: Security key and certificate management message (message type- KEYMAN)

and related guidelines and directories, including:

- *Syntax Implementation Guidelines*
- *Message Design Guidelines*
- *Version/release Procedures*
- *UN Directories*
  - ✓ The UN/EDIFACT United Nations Standard Messages (UNSMs) Directory
  - ✓ The UN/EDIFACT Standard Segments Directory
  - ✓ The UN/EDIFACT Composite Data Elements Directory
  - ✓ The UN/EDIFACT Data Elements Directory
  - ✓ The UN/EDIFACT Code List
- *Uniform Rules of Conduct for the Interchange of Trade Data by Teletransmission (UNCID)*
- *Additional explanatory material*

The UN/EDIFACT Data Elements Directory is a subset of ISO 7372:1993 United Nations Trade Data Elements Directory (UNTDED).

**Characteristics/description**

UN/EDIFACT is a set of internationally agreed standards, directories, and guidelines for the electronic interchange of structured data between computerised information systems. Traditionally this has been related to trading of goods, although increasingly it is being used in other environments such as finance, insurance, health, statistics, administration, etc.

The building blocks of UN/EDIFACT are the data elements and the syntax rules (see below). Data elements are the atomic units of an EDI exchange. The specification of a data element reflects the semantics of the equivalent unit of data in the user application.

In UN/EDIFACT, individual (simple) data elements can be combined into composite data elements. Simple data elements and/or composite data elements are structured together into segments. Both segments and composites allow qualification, which enables the creation of very generic components. This genericity is one of the key differences between UN/EDIFACT and TDI.

Messages are the "end-products" of the UN/EDIFACT process. A UN/EDIFACT message describes a particular business process that often corresponds to a traditional paper document (examples of UN/EDIFACT messages range from invoicing (INVOIC) to medical service request (MEDREQ). The structure of a UN/EDIFACT message is defined by a collection of segments -- generally organised into groups. The message specification includes the maximum number of occurrences of the individual segments, segment groups and their component segments, as well as their statuses (mandatory or conditional).

The EDIFACT Syntax Rules define the structuring of (simple) data elements, composite data elements, segments, and messages. The principal characteristics of the EDIFACT Syntax Rules are:

- *Hierarchical structuring*
- *Implicit data element identification*
- *Flexible length data structures*

- *Mandatory or conditional status of data elements, segments and segment groups.*

**Technical description**

Many people use the term EDI to refer to the set of messages developed for business-to-business communication as part of the United Nations Standard Messages Directory for Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT). EDIFACT messages are transmitted in compressed form, using predefined field identifiers, which must occur in a predefined sequence. The basic unit of information in an EDIFACT message is the *data element*. Data elements can be grouped into *compound data elements*, and data elements and/or compound data elements may be grouped into *data segments*. Data segments can be grouped into *loops*; and loops and/or data segments form *business documents*.

The EDIFACT standards define whether data segments are mandatory, optional, or conditional, and indicate whether, how many times, and in what order a particular data segment can be repeated. For each EDI message, a *field definition table* exists.

For each data segment, the field definition table includes a key field identifier string to indicate the data elements to be included in the data segment, the sequence of the elements, whether each element is mandatory, optional, or conditional, and the form of each element in terms of the number of characters and whether the characters are numeric or alphabetic.

Similarly, field definition tables include data element identifier strings to describe individual data elements. *Element identifier strings* define an element's name, a reference designator, a data dictionary reference number specifying the location in a data dictionary where information on the data element can be found, a requirement designator (either mandatory, optional, or conditional), a type (such as numeric, decimal, or alphanumeric), and a length (minimum and maximum number of characters). A *data element dictionary* gives the content and meaning for each data element.

For a practical description, reader can see 0 which can be considered as a description of EDIFACT data segments in the case of DATEX usage.

**Usage (Market segment and penetration)**

Since the approval of the Invoice Message (INVOIC) in 1988, UN/EDIFACT has been widened to cover a multitude of sectors. Messages have two statuses: United Nations Standard Messages (UNSMs) and Messages in development (MID).

Sectorial areas covered by UN/EDIFACT messages and examples of the active EDI communities involved include:

- *Trade -- CEFIC (chemical industry), EAN International (retail), EDIFICE (computing, electronics and telecommunications), EDItEUR (book sector), EDITEX (textile), ETIS (telecommunications), ODETTE (automotive)*
- *Transport (DATEX)*
- *Customs and Taxation*
- *Finance -- SWIFT*
- *Architectural/Engineering/Construction*
- *Statistics -- Eurostat*

- *Insurance -- RINET (re-insurance)*
- *Travel, Tourism and Leisure -- IATA (airlines), Travel Technology Initiative (TTI), UIC (railways)*
- *Healthcare - EMEDI*
- *Social Administration*
- *Employment and Education*
- *Legal and Accountancy -- EDIFICAS (accountancy)*
- *Public procurement -- public sector procurement initiatives (e.g. European Commission DG XV's SIMAP)*

Since its inception in 1988, use of UN/EDIFACT has increased considerably in Europe, as well as in other parts of the world. Many EDI communities who adopted proprietary EDI standards have now (partially) migrated to UN/EDIFACT (e.g. IATA, ODETTE, SPEC 2000M, SWIFT, UNICORN, the TDI community).

It should however be noted that user communities might exchange EDIFACT messages use different directories and indeed different versions of the Syntax Rules. Implementation of EDI needs to be agreed in advance between the EDI partners in the form of an Interchange Agreement and, in relation to individual message types, specific Message Implementation Guidelines (MIGs).

In Europe EBES, a workshop within CEN/ISSS, acts as the European entry point for the UN/EDIFACT process. Specifically, EBES processes European DMRs (Data Maintenance Requests) on behalf of is member organisations.

### XVIII.1.3 DATEX

#### Overview

The exchange of data and information between traffic and travel information centres and between other related centres are important for high quality traffic management, safety and user information services. In addition, this data/information forms a key element in the infrastructure for many free and commercial traffic and travel services.

The European Union R&D programmes have successfully integrated different approaches for the exchange of traffic and travel data/information into an interoperable solution that is known as the DATEX-Net specifications Key elements within the specifications are a data dictionary, data models, location referencing rules and a message exchange format.

The specifications have been submitted to the relevant standardisation body [European Committee For Standardisation (CEN) Technical Committee Working Group 8].

Furthermore, through five large-scale projects and many other smaller initiatives the DATEX-Net specifications are being implemented on a European-wide basis.

The DATEX-Net specifications can be used to exchange a wide range of traffic and travel data/information, including traffic data, situation/event descriptions, status information and weather data.
The DATEX Helpdesk is supported through the ASSISTEN-T project by the European Commission, Directorate General VII. The Helpdesk is a facility available to all parties interested in using the DATEX-Net Specifications.

## General Architecture

DATEX-Net will allow different systems to exchange traffic data between different regions and countries. The peculiarity of DATEX-Net is that each system adopting this solution will be free to implement its own functionalities that may be different from region to region according to the local user requirements.

The traffic information centre system comprises of a number of sub-systems with various interfaces:

- *Application Interface;*
- *Operator Interface;*
- *Communication Interface;*
- *Database Interface.*

This DATEX-Net specification deals only with communication interface. DATEX-Net specifications specify the data exchange across this interface, where the characteristics of the data exchanged are specified in the DATEX Data Dictionary.

DATEX-Net enables the communication between two or more traffic centres implementing a data exchange system. In order to achieve interoperability between centres, it is required to agree upon several options and choices which must be fixed in an Interchange Agreement, which contains a checklist of items to be considered.

The specifications offer a number of different modes of operation, with different levels of complexity and message management features.

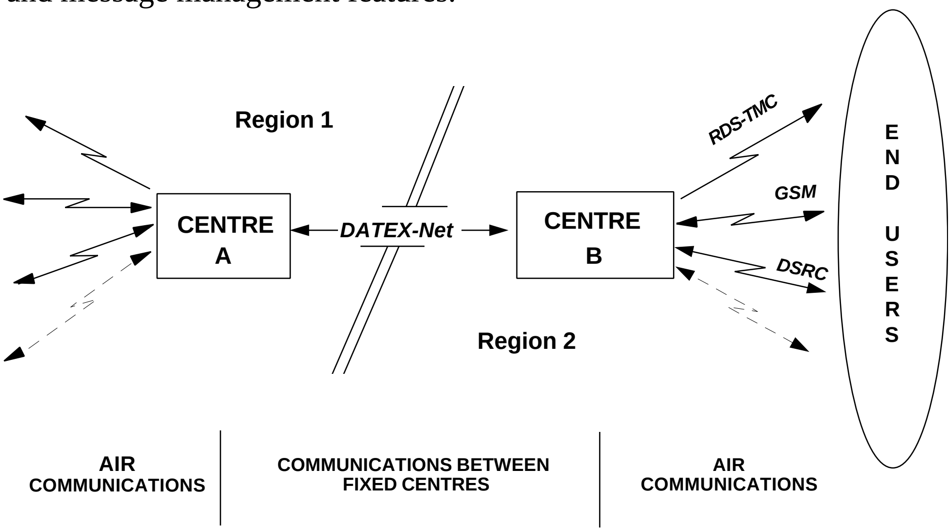



Figure XVIII.1 - DATEX Objective

## Description

*Representation of traffic/travel situations*

DATEX focuses on traffic and travel information between traffic control centres, traffic information centres, road operators…

Traffic and travel situations and events are traffic/travel circumstances that apply to a common set of locations.

These situations comprise Events and Status reports and each situation is described by one or more elements, each element describing a traffic/travel circumstance. The element description is made by using a descriptive phrase positioned by one known location.

Each element is uniquely identified by the message sender identification i.e. the information distributor, the identification of the situation and the identification of the element within the situation.

For example, an accident has two constituent parts. The first element is the phrase code ACI indicating there is an accident and the second is the phrase code LS1 indicating the stationary traffic due to the accident.

*Updating situation information*

Obviously, a situation is modified during the time this situation exists. Consequently, the information describing this situation must also be modified and then the description elements must be updated.

There are two manners for updating information: single element updating and all element updating. Theses two methods can support a version number for the situation which is considered as a whole (version number would be incremented by one).

Single element updating

Supplier sends only those elements that contain new or updated information. Each new or updated element will be transmitted once the supplier has altered the information. In this case, it is assumed that all the other information is unchanged.

All element updating

A full description of the situation is sent with each update. The supplier sends all the elements when sending an update, including those elements that have ended. It ensures that the client will identify correctly the current status of all elements relating to a situation.

The single element updating is the recommended method from a performance point of view. On other side, the constraint for the client in order to know the full description of the current status of the situation is to look in the client database for getting the latest versions of elements.

In the opposite, the full description given by the all element updating allows to know the complete description of the situation but is load expensive and then less efficient.

*Example*

We consider that an accident occurs on a road. Immediately this accident causes a traffic jam. The highway safety service clears the accident area and only after the traffic starts again but the traffic stays slow and becomes normal at the end. This scenario is described in Figure XVIII.2.

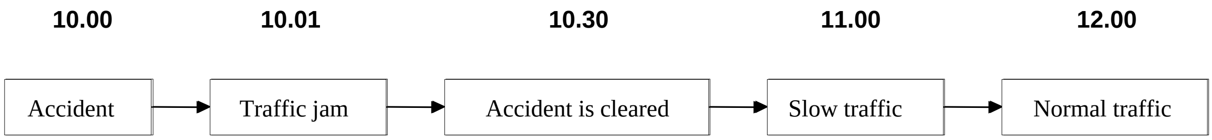



Figure XVIII.2 : Linear description of an accident and alterations to the traffic fluidity

If we use the single element updating (see Figure ), the first sent report contains two elements about this situation (referenced): a phrase code ACI indicating an accident occurred (element 1) and LS1 indicating that this accident caused a traffic jam (element 2) (1).

At 10.30, the accident is cleared and then a new message concerning the element 1 (accident) is sent, informing that the status of the accident (2: the "accident" element is ended). As only one element is modified only one message is sent.

At 11.00, the traffic starts to move again and a new message (3) is sent for element 2 (traffic): traffic status changes from 1 (stationary traffic) to 3 (slow traffic). Once again, only one message is sent for the same reason as previously.

At 12.00, all is normal and a last message (4) is sent ending the element 2.

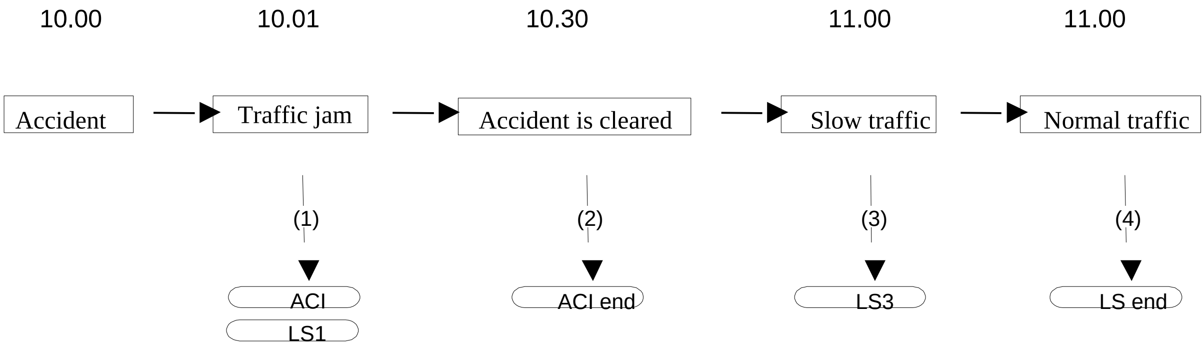



Figure XVIII.3 : Single element updating

Figure XVIII.4) reacts in the same manner when the first report is created (1).

After, at 10.30, a message informing the accident is cleared is sent but also a message for the traffic jam, even if the situation of this element is unchanged (2).

At 11.00, the message sent at 10.30 about the accident is resent and the message about element 2 is sent informing that the traffic moves (3).

For closing the situation, two messages are sent for ending the two elements (accident and traffic) (4).

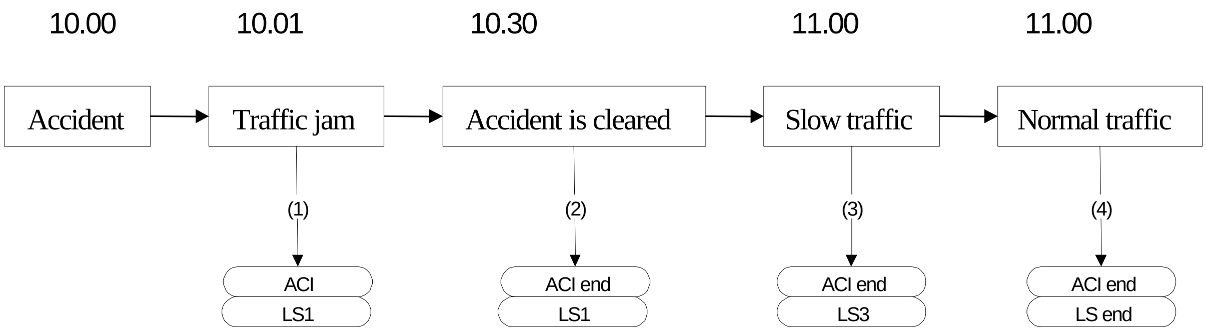



Figure XVIII.4 : All element updating

From this short example, we clearly see that the communications are reduced to the maximum with the single element updating (only 5 messages). In opposite, the all element updating is more expensive in communication cost because it needs 8 messages for describing the same simple example. However, the all element updating is more safety because, if a message has been corrupted during a communication, the following update will send this message again, allowing getting it clearly. With single element updating, if the message is not well received, it will not be sent again and the information is lost.

The choice between the two methods depends on the security level of communications and the amount of these communications. If a large amount of situations are described and very frequently, the communication-saving solution of single element updating is the most appropriate.

*Ending situations*

Two methods can be used for ending traffic/travel situations.
First method consists in using end indicator for each element.

The second method uses an expiry time. This delay is applied to element information if the element information has not been superseded by a more recent value. In this case, once the expiry time has passed, it is assumed that the information is no longer valid.

*Measurement point*

As we saw previously, DATEX can define any traffic information (events like accidents, works, snowstorm… and information like speed, vehicle length, height, queue length, wind speed…).

Data are measured by fixed roadside equipment using fixed parameters. Traffic information is referred to the points where captors are. These points are called "measurement points".

One measurement point defines one data object, one measurement unit, one vehicle class, one measurement period, one direction, one or all lanes. All this information is provided in a data catalogue.

For a best exchange performance, only the reference of the measurement point, the date and time and the values are transmitted. This allows faster and cheaper exchanges which are critical for real-time traffic data exchanges.

*Public transport data*

Public transport situations are dealt with the DATEX data dictionary (TRAINS) and EDIFACT. Disturbances or status of public transport or multi-modal transport (park and ride) are covered.

However, static or slow-evolving information is not tackled by DATEX. For instance, timetables are not treated due to a lack of user requirements.

We can note that some standard initiatives are currently being talked about.

**Decomposition**

9 types of EDIFACT messages are currently defined.
These messages are summarised in the following table:

| Name of message | Scope of the schema | Examples of contents |
|---|---|---|
| TRAVIN | Information related to one traffic situation | Accident, road works, public transport delay, snowstorm |
| TRAILS | Data related to one or more locations in a traffic network in order to support traffic/travel planning, management and/or intelligent navigation systems | Flows, speeds or times |
| TRALOC | One or more location definitions which support related traffic/travel messages by giving details | The names and location codes of highways, public transport routes, road junctions, stations, route guidance links, towns, cities, areas or regions |
| TRAVAK | Acknowledges another traffic/travel-related message | |
| TRAREQ | Requests or orders of traffic/travel information according to one or more selection criteria | |
| TRACAT | Catalogue of traffic/travel information which can be provided by the Supplier | |
| TRAINS | Information relating to a public transport timetable | |

| Name of message | Scope of the schema | Examples of contents |
|---|---|---|
| TRADIN | Details of a means of transport and/or individual travellers | A position report, a breakdown report or an emergency call |
| TRADES | One or more traffic/travel description definitions which support related traffic/travel messages | Details such as the text of a phrase and/or its attributes, which form the basis of traffic/travel situation descriptions |

Table XVIII.5 : EDIFACT messages defined for DATEX

**Example: explanation on TRAILS message**

We show in the following example how one of the DATEX messages is built.

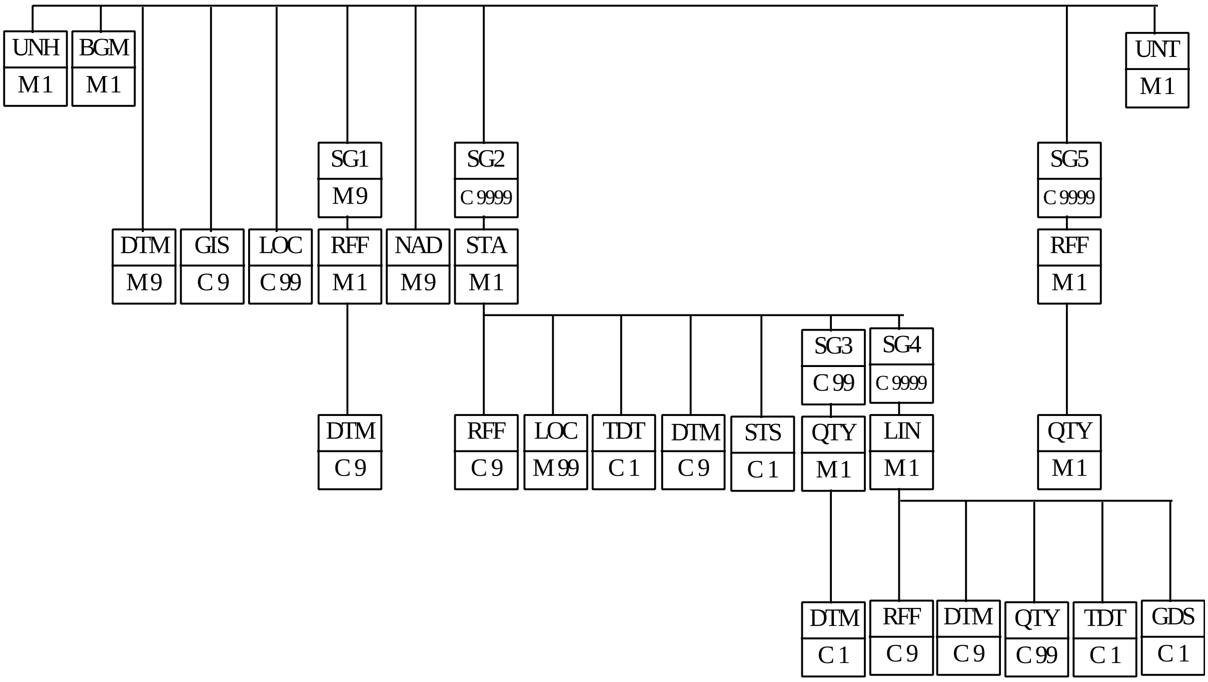



Figure XVIII.6 : Branching diagram for TRAILS message

**UNB**: identifying an interchange
sender, recipient, date, time
**UNH**: identify a message
message reference, type, version, and release
**BGM**: indicate the message type/subtype
message type (code), version of code list
**DTM**: used to time-stamp the message (the input time and message sending time)
**GIS**: indicate various items which refer to the message
value and qualifier of the indicator
**LOC**: distribution and/or presentation areas of the message

**<u>Segment Group 1</u> (included for compatibility)**
**RFF**: reference qualifier and its value
**NAD**: name and address

**<u>Segment Group 2: gives traffic data for a specific location (contains SG3 & 4)</u>**
**STA**: indicate the type of data given in this segment group

values possible: measurement point data, current data, polyline, B-spline…

**RFF:** indicate direction and/or lane position for traffic data

**LOC**: to define a location about which details are given

**TDT**: specify the vehicle class

**DTM**: date time period

**STS:** Status report

**Segment Group 3: link speed (for use with route guidance systems) with DTM data relate to a specific time in the future**

**QTY**: quantity and qualifier
Link speed, link speed adjustment, accuracy, speed reduction, measurement length, average speed…

**DTM**: date time period

**Segment Group 4: time delay relating to a specific time in the future or a table of periodic traffic data or a table of individual vehicle data**

**LIN**: line item, used once to number the set of data

**RFF**: indicate lane number and/or direction for individual data
reference qualifier (LNP lane position or DIRection) and value

**DTM**: date time period, indicate the beginning time or end time of the period described by the line, also used to indicate a prediction interval for route guidance applications

**QTY**: qualifier and quantity
average speed, vehicle flow value (vehicle/day), queue length…
also for individual vehicle data: vehicle length, height, width, axle weight, distance gap, number of axles…

**TDT**: details of transport
vehicle class, and/or ID of an individual vehicle

**GDS**: nature of cargo (Oil…)

**Segment Group 5: one value for a specified measurement point**

**RFF:** reference of measurement point

**QTY**: quantity associated to the measurement point

**UNT**: ends a message
number of segments in the message
message reference number

**UNZ**: ends and checks the completeness of the interchange
interchange control count and reference

## XVII.2 CURRENT TECHNOLOGIES AND PROMISING WAYS

All the user needs expressed during first phases of DIRECT project (see Deliverables 2 & 3) are not covered by DATEX protocol. However, DATEX is appropriate for real-time data exchange and this experience should be token into account for future development.

However, one of the objectives of TDSS that we must keep in mind is to give relevant information to the transport end-users, i.e. people using personal vehicles, public transport, people wanting to plan trips…

For doing this, a new emerging standard may be helpful. Its name is XML, eXtensible Markup Language. First we explain the main goals of XML and how it is decomposed into several recommendations about its different parts.

### XVII.2.1 XML: INTRODUCTION AND MAIN GOALS

XML (Extensible Markup Language) is used to create custom TAGS and elements using a subset of SGML, the grandfather of HTML. The tags themselves provide information about the content *within* the tags. XML is an efficient way to really separate style from data, and actually even from HTML.

In HTML, both the tag semantics and the tag set are fixed. A <h1> is always a first level heading and the tag <direct.xml> is meaningless. The W3C, in conjunction with browser vendors and the WWW community, is constantly working to extend the definition of HTML to allow new tags to keep pace with changing technology and to bring variations in presentation (stylesheets) to the Web. However, these changes are always rigidly confined by what the browser vendors have implemented and by the fact that backward compatibility is paramount. And for people who want to disseminate information widely, features supported by only the latest releases of Netscape and Internet Explorer are not useful.

XML specifies neither semantics nor a tag set. In fact XML is really a meta-language for describing markup languages. In other words, XML provides a facility to define tags and the structural relationships between them. Since there's no predefined tag set, there can't be any preconceived semantics. All of the semantics of an XML document will either be defined by the applications that process them or by style sheets.

XML is defined as an application profile of SGML. SGML is the Standard Generalised Markup Language defined by ISO 8879. SGML has been the standard, vendor-independent way to maintain repositories of structured documentation for more than a decade, but it is not well suited to serving documents over the web. Defining XML as an application profile of SGML means that any fully conformant SGML system will be able to read XML documents. However, using and understanding XML documents *does not* require a system that is capable of understanding the full generality of SGML. XML is, roughly speaking, a restricted form of SGML.

In order to appreciate XML, it is important to understand why it was created. XML was created so that richly structured document could be used over the web. The only viable alternatives, HTML and SGML, are not practical for this purpose.

HTML, as we've already discussed, comes bound with a set of semantics and does not provide arbitrary structure.

SGML provides arbitrary structure, but is too difficult to implement just for a web browser. Full SGML systems solve large, complex problems that justify their expense. Viewing structured documents sent over the web rarely carries such justification.

This is not to say that XML can be expected to completely replace SGML. While XML is being designed to deliver structured content over the web, some of the very features it lacks to make this practical, make SGML a more satisfactory solution for the creation and long-time storage of complex documents. In many organisations, filtering SGML to XML will be the standard procedure for web delivery.

## Other XML usage

Although XML was created so that richly structured documents could be used over the web; it could be used for other activity. XML can be used as a format instead of specific protocol to exchange small amount of data. It can be used with a DTD to exchange formatted data. It can also be used without DTD to store or exchange partially (or incomplete) defined data.

For storing XML information, there is no current solution. Database constructors will develop adapted solutions in the near future. Some specific solutions exist.

## Summary

| Publication | Origin | State | Summary |
|---|---|---|---|
| XML | W3C | Recommendation | Physical format |
| Associating Style Sheets with XML | W3C | Recommendation<br>*Supported by few XML tools* | Like style Sheets (CSS) for HTML. |
| XSLT | W3C | Working Draft in last call<br>*Implementation exist* | XML Transformation with specific style Sheets. |
| Xpath | W3C | Working Draft in last call | Path to an XML entity |
| Xpointer | W3C | Working Draft<br>*Just begin to be supported by XML tools* | Pointer on entity in an XML File |
| Xlink | W3C | Working Draft<br>*Just begin to be supported by XML tools* | Hypertext link |
| XML-QL | W3C | Submission<br>*Not supported by XML tools* | Query in XML File |
| XQL | Microsoft[84] | *supported by few XML tools* | Query in XML File |
| DOM | W3C | Recommendation<br>*implementation exist* | XML API |
| DTD | SGML | *supported by XML tools.* | Optional data model |
| XML Schema Requirements | W3C | Working Draft | |
| XML Schema Part 1 | W3C | Working Draft<br>*Not supported by XML tools* | Data model defined in XML.<br>(include an XML form for a DTD XML). |
| XML Schema Part 2 | W3C | Working Draft<br>*Not supported by XML tools* | Basic type for XML Data Model |

Table XVIII.6 – Summary of W3C publications about XML

[84] XQL is another query language than XML-QL. This language is managed by Microsoft and is already implemented in Internet Explorer 5.

## XVIII.2.2 EDI / XML

### 3 *Objectives*

Combining XML and EDI to develop XML/EDI suggests that the main method of capturing and coding EDI information will be through XML-coded electronic forms. To allow interaction with existing systems the XML/EDI Guidelines show how EDIFACT messages can be generated from XML/EDI forms, and vice versa.

XML/EDI is not creating a new standard. XML/EDI is defining how companies can use current standards to solve their business problems.

### 3 *Why use XML?*

XML will be native language for the next generation of most of the popular WWW browsers. XML/EDI seeks to take benefit from this work and support (technically and financially) which XML is receiving. With traditional EDI, the infrastructure was built from the ground up, without being able to share resources with other programs. This paradigm is no longer appropriate in today's world of shared software development. By adopting XML/EDI, the EDI community can get to share the cost of extension and future development.

In July 1996 the World Wide Web Consortium (W3C) set up a working group to study how SGML could be simplified to allow for its efficient use over the Internet. The result was the development of an Extensible Markup Language (XML) that combined the expressive power of SGML with the Internet-aware functionality of HTML.

XML provides an ideal methodology for electronic business because:

- XML allows message type creators to clearly identify the role and syntax of each piece of interchanged data using a definition that is both machine processable and human interpretable,
- XML allows message type creators to identify the source of each shared structure using an Internet Uniform Resource Locator,
- XML allows message type creators to optionally identify which pieces of information should occur in each interchanged set of data and, where relevant, the order in which individual fields should occur in a particular message stream,
- XML documents can be given metadata fields that can be used to identify who is responsible for creating, transmitting, receiving and processing each message, and can have built-in facilities for identifying the storage points of programs that should be used to control processes,
- XML can make use of facilities provided by the latest version of the Internet Hyper Text Transfer Protocol (HTTP), which can identify when a message should be moved from one stage of the interchange process to another, and to check that the relevant forms of interchange have taken place.

### 3 *Base Technologies of XML/EDI*

XML/EDI is a synthesis of many concepts. Indeed, XML/EDI:

- *uses the XML protocol as its "data interchange modelling" layer,*
- *uses the XSL protocol as its "presentation" layer,*
- *can be integrated with traditional methods of Electronic Data Interchange (EDI),*

- *can be used with all standard Internet transport mechanisms such as IP routing, HTTP, FTP and SMTP,*
- *allows for document-centric views and processing methodologies,*
- *uses modern programming tools such as Java and ActiveX to allow data to be shared between programs,*
- *uses agent technologies for data manipulation, parsing, mapping, searching...*

XML/EDI can be seen as the fusion of five existing technologies:

- *Web data interchange based on the new XML specification,*
- *Existing EDI business methods and message structures,*
- *Knowledge templates that provide process control logic,*
- *Data manipulation agents (DataBots) that perform specialist functions,*
- *Data repositories that allow relationships to be maintained.*

### 3 *Integrating XML with EDI*

XML can be integrated with existing EDI systems by:

- *providing application-specific forms that users can complete to generate EDI messages*
- *generating EDI message formats for transmission between computers over the Internet, or through existing value-added networks (VANs)*
- *allowing data received in EDI format to be interpreted according to sets of predefined rules for display by the receiver on standardised browsers using a user-defined template, rather than having to rely on specially customised display packages.*

XML can extend existing EDI applications by:

- *allowing message creators to add application-specific data to standardised message sets where required*
- *allowing message creators or receivers to display the contents of each field in conjunction with explanatory material which is specific to the application and the language preferences of the user*
- *allowing system developers to customise the help information associated with the data for each field*
- *allowing field value checking to be integrated with checks on the validity of the data with respect to information stored on local databases.*

### 3 *Oasis organisation*

**OASIS**, the Organisation for the Advancement of Structured Information Standards, is a non-profit, international consortium dedicated to accelerating the adoption of product-independent formats based on public standards. These standards include SGML, XML, HTML and CGM as well as others that are related to structured information processing. Members of OASIS are providers, users and specialists of the technologies that make these standards work in practice.

## XVIII.2.3 HOW TO IMPLEMENT THE EDI/XML

This paragraph shows the problems due to the use of XML for Electronic Data Interchange, and particularly in the case of DIRECT project, which problems must be solved if we want to reuse DATEX previous works with the XML formalism.

The following stages are involved in using XML for the interchange of commercial EDI messages:

- *identification of suitable data sets for electronic business transactions*
- *development of XML document type definitions (DTDs) that formally define the relationships of the fields that are to form a particular class of EDI messages*
- *definition of application-specific extensions to standard message types*
- *creation of instances of specific types of electronic business message*
- *validation of the contents of messages*
- *transmission and receipt of electronic business messages*
- *processing of electronic business messages using DataBots.*

An application does not need to use all of the levels of processing and the above list: it can stop at whichever level in the hierarchy suits it. For example, an application can confine itself to checking incoming and outgoing EDI messages using a document object model that has been formally defined in an XML DTD.

## 3 *Identifying data sets*

Identification of data sets for electronic business transactions will often be the responsibility of industry associations and various standardisation bodies such as UN/EDIFACT and EBES (the European Board for EDI Standardisation).

Whereas existing EDI definitions are primarily concerned with the way in which a set of fields forms a message, the concepts required for XML/EDI are based more on the definition of independent classes of information that can be combined together with other classes of information to form interchangeable messages. Such concepts are more akin to the idea of a Basic Semantic Repository (BSR) being proposed by ISO, and of the Business Systems Interconnection (BSI) proposal from University of Melbourne.

There is, however, one basic difference between using XML/EDI for defining data classes and using the BSR or BSI methodologies. In XML/EDI the order and number of subclasses of a data class can be altered by message creators without having to formally register that fact with any centralised organisation. For example, if it was necessary for an application to separate building numbers or names from information about the street the building is located, XML/EDI would allow system developers to define two new subclasses that would be combined to provide the information needed for an existing EDI address component.

One of the advantages the accrues from XML/EDI's ability to subclass fields is that such fields can be developed interactively using information supplied from more than one location. For example, telephone order processing systems in today's world of electronic business transactions often start by asking users for their postcode. This tells the system which region, town and street the user is located in, but not which building they are in. To find this out you need to ask the user for a number or name that uniquely identifies the building within the street identified by the postcode. Using these two related pieces of information it is possible to interactively complete a standardised class of information, an address, that can then be shared by an order, its delivery note, and the invoice required for settlement.

Once information has been captured once, and used to create an instance of the relevant class of data, it should not be necessary to recreate the information each time it is required. All that should be needed is that business processes using this information reference the point at which the data was originally captured, e.g. the address associated with the order for the goods.

An essential precursor to the design process of an XML/EDI application is a study of how business processes re-utilise stored information. When suitable business models already exist, these can be represented in XML form. When there are no existing model, or the existing models do not meet the requirements of the trading partners for some reason, developers should perform a full analysis of the relevant business processes, and seek to identify similarities between these processes and those already formally documented for use by other applications. Knowledge of the source and contents of public repositories of reusable data segments will help to simplify this process. Therefore, one of the goals of XML/EDI is to encourage the setting up of such repositories of knowledge.

To ensure that users can guarantee the long-term maintenance of data set components, repositories of formal XML definitions will need to be created, and unique object identifiers will have to be assigned to each set of components. While initially testing can be done using system identifiers that resolve to Internet Unique Resource Locators (URLs), in the longer term a mechanism for identifying shared data sets using formally registered SGML public identifiers associated with URLs will need to be developed. A system for resolving public identifiers to obtain copies of the registered definitions will also be required.

## 3 *Developing DTDs*

Messages that pass between systems will typically conform to a previously agreed XML document type definition (DTD) that formally describes, in terms interpretable by both humans and computers, an internationally accepted message type.

Note: The structure of XML DTDs and document instances is formally defined in Extensible Markup Language (XML)[85]. A brief introduction to the components of XML can be found in An Introduction to the Extensible Markup Language[86]. More complete information on the structure of SGML DTDs, including those that implement the Web SGML extensions, can be found in Web SGML and HTML 4.0 Explained[87], which contains examples of the use of each of the constructs used in SGML and XML, and explains how these facilities are used within HTML.

XML DTDs can be developed by:

- *international standards bodies wishing to develop standardised sets of interchangeable data*
- *industry associations wishing to develop agreed procedures for interchanging messages between members*
- *one of the members of a multilateral or bilateral agreement to share information*
- *a company wishing to supply information to a number of suppliers or customers*
- *a company wishing to obtain information in a known format from a number of suppliers or customers.*

[85] www.w3.org/TR/PR-xml-9771208
[86] www.sgml.u-net.com/xmlintro.htm
[87] www.sgml.u-net.com/book/home.htm

Declarations that form a standardised XML DTD will typically be stored in separate files, which can be referenced, as an XML external subset, by those wishing to use it through the Internet Uniform Resource Locator that its originator has assigned to a publicly available copy of the data. Alternatively, if public access is to be restricted, the document type definition can be stored as the internal subset within the document type definition sent with the message.

Where the document type definition is based on classes of information shared by more than one message, each class of information can be defined in a separate file, known in XML as an external entity, these files being referenced in a suitable sequence from within the external or internal subset of the XML DTD.

For example, an XML DTD could have the form:

```
<!ENTITY % address SYSTEM
"http://www.myco.org/messages/XML/address.xml" >
<!ENTITY % items SYSTEM
"http://www.edifact.org/messages/XML/items.xml">
<!ENTITY % data "(#PCDATA)">
<!ELEMENT order (order-no, deliver-to, invoice-to, item+) >
<!ELEMENT order-no %data; >
<!ELEMENT deliver-to (address) >
<!ELEMENT invoice-to (address) >
<!--Import standard address class-->
%address;
<!--Import standard item class-->
%items;
```

This DTD fragment defines two external and one internal parameter entity, four locally defined elements and contains two parameter entity references (`%address;` and `%items;`) that call in the contents of the external entities at appropriate points in the definition. Both of the parameter entity references are preceded by explanatory comments.

Note that the source of each class of information is identified not in the call to the class itself (`%address;`) but within a formal definition of the data storage entities required to process the class definition references (e.g. the first two lines of the DTD). This technique allows files to be moved without having to change the main definition of the DTD.

Typically the entity definitions will be stored outside the DTD, which will contain a reference to the URL of the point at which the latest details of library file locations can be found. For example:

```
<!ENTITY % library SYSTEM
  "http://www.myco.org/messages/XML/library.ent">
%library;
<!ELEMENT order (order-no, deliver-to, invoice-to, item+) >
<!ELEMENT order-no %data; >
<!ELEMENT deliver-to (address) >
<!ELEMENT invoice-to (address) >
<!--Import standard address class-->
%address;
<!--Import standard item class-->
%items;
```

where `%library;` references a file containing the entity definitions given at the start of the previous example.

XML provides (experimental) facilities for ensuring that data modules taken from libraries do not introduce name clashes in their elements. The names of elements within each module can be qualified by a module (namespace) identifier. Each namespace identifier can be associated with a URL that uniquely identifies where the module is formally defined. For example, the contents of the library file referenced above could be defined as:

```
<?xml-namespace href="http://www.ebes.org/XML/EDI-address.xml"
as="address"?>
<?xml-namespace href="http://www.ean-fora.org/XML/order-
items.xml" as="items"?>
<!ENTITY % data "(#PCDATA)">
<!ENTITY % address "
<!ELEMENT address (address:company, address:street,
address:town,address:region, address:postcode)          >
<!ATTLIST address id ID #IMPLIED >
```

```
<!ELEMENT address:company %data; >
<!ELEMENT address:street %data; >
<!ELEMENT address:town %data; >
<!ELEMENT address:region %data; >
<!ELEMENT address:postcode %data; >
<!ELEMENT same-as EMPTY>
<!ATTLIST same-as idref IDREF #REQUIRED >
">
<!ENTITY % items "
<!ELEMENT item (item:identifier, item:name, item:quantity)>
<!ELEMENT item:identifier %data; >
<!ELEMENT item:name %data; >
<!ELEMENT item:quantity %data; >
">
```

## 3 *Application-specific extensions*

XML permits entities and attributes that are defined in the external subset to be redefined in the internal subset. This facility allows XML/EDI users to develop locally significant subclasses. It can also be used to create subsets of messages by removing unused fields from the data model.

For example, the internal subset of a DTD based on the above standardised DTD could contain the following local redefinition for the `%items;` parameter entity:

```
<!ENTITY % items "
<!ELEMENT item (item:identifier, item:name, item:quantity)>
<!ELEMENT item:identifier (item:database-key?, item:EAN) >
<!ELEMENT item:database-key %data; >
<!ELEMENT item:EAN %data; >
<!ELEMENT item:name %data; >
<!ELEMENT item:quantity %data; >
">
```

In this case the optional `item:database-key` field could contain a direct pointer to the database entry from which the EAN and associated product name were obtained. This key could be used by a DataBot to process the item information without having to generate a query based on the EAN normally provided by the `identifier` field as the basis for a slower-to-process database query.

## 3 *Creating message instances*

An XML/EDI electronic business message consists of a pointer to the document type definition, any definitions required in the internal subset of the DTD, and entries for each of the fields required for the message. For example, the following document type declaration could be used to extend the external DTD shown in the first of the examples shown above, which is identified by its Internet Unique Resource Locator:

```
<!DOCTYPE order SYSTEM
  "http://www.myco.org/messages/XML/message1.xml" [
<!ENTITY % items "
<!ELEMENT item (item:identifier, item:name, item:quantity)>
<!ELEMENT item:identifier (item:database-key?, item:EAN) >
<!ELEMENT item:database-key %data; >
<!ELEMENT item:EAN %data; >
<!ELEMENT item:name %data; >
<!ELEMENT item:quantity %data; >
">
```

```
]>
<order>
<order-no>123456</order-no>
<deliver-to>
<address id="SGML154">
<address:company>The SGML Centre</address:company>
<address:street>29 Oldbury Orchard</address:street>
<address:town>Churchdown</address:town>
<address:region>Glos.</address:region>
<address:postcode>GL3 2PU</address:postcode>
</address></deliver-to>
<invoice-to>
<same-as idref="SMGL154"/>
</invoice-to>
<item><item:identifier>
<item:database-key>key151235</item:database-key>
<item:EAN>15356378797</item:EAN></item:identifier>
<item:name>Special Offer 16</item:name>
<item:quantity>12</item:quantity></item></order>
```

Note that, because of the prioritisation SGML gives to local definitions, the definition for the `%items;` parameter entity provided in the local subset will replace the reference to the external source for the same entity provided as part of the file referenced using the external subset.

## 3 *Validating messages*

XML/EDI messages can be validated by a validating XML document instance processor (known as an XML parser) to ensure they contain all required elements from the specified data set, and that the fields are in the required sequence. When the document is found to be valid the parser can generate a document tree that conforms to the rules laid down in the Document Object Model (DOM) specification that provides a standardised API between XML parsers and browsers and other forms of program.
XML elements can be assigned attributes that point to processors that can undertake relevant data validity checks. This can be done either by associating notation processors with an element, or by associating an ECMAScript[88] specification with the element as part of an XSL "action" associated with the specific element types used in specific contexts, or with particular attribute values.

Where the XML Style Language (XSL) is not being used (e.g. because the browser does not yet support it) the basic XML language allows user-defined notation processors to be used to validate the contents of specific XML elements. This is done by adding definitions of the following form to the external or internal subset of the DTD:

```
<!NOTATION EAN-vailidator SYSTEM
  "http://www.myco.org/messages/validate/EAN.cgi">
...
<!ATTLIST EAN check NOTATION (EAN-validator) #FIXED "EAN-
  validator">
```

[88] ECMAScript is a standard script language, developed with the cooperation of Netscape and Microsoft and mainly derived from Netscape's JavaScript. The standard was developed under the auspices of a European standards organisation, ECMA (which is the name of the organisation and not an abbreviation). Having the ECMAScript standard will help ensure more consistency between Netscape, Microsoft, and any other Web script implementations.

The predefined `check` attribute of the `EAN` element will cause the contents of the element to be passed to the program identified by the declaration for the notation assigned the local name `EAN-validator` which is stored at the location indicated by the URL given in the notation declaration. This processor would typically pass back a message indicating whether or not the EAN is valid within the context of the relevant message.

XSL provides an alternative, and more generally applicable method that allows ECMAScript to be used to validate the contents of XML elements. Details of this method are given below under the heading "Processing messages".

*Note: In December 1997 an extension to SGML allowed typed data attributes to be used in standard SGML files. As soon as this new functionality is absorbed into XML it will be possible to greatly simplify the validation of message contents.*

## 3 *Exchanging messages*

Data captured in XML/EDI messages can be exchanged:

- *in the form of an XML file (which can be encoded in any way required, but would normally be transmitted using the UTF-8 encoding of the UCS-2 data set by default) interchanged using the HTTP protocol, or one of its derivatives (e.g. Secure HTTP)*
- *in the form of a multipart Internet e-mail message (MIME or Secure MIME encoded)*
- *in the form of a zipped (or otherwise encoded) file transferred using the Internet File Transfer Protocol (FTP)*
- *as a compressed (but not otherwise encrypted) set of extensions to an HTTP POST message that conforms to Internet's Common Gateway Interface (CGI) specification*
- *in the form of an EDI message (created by processing the XML file at source using a special conversion program).*

When conversion into a known EDIFACT format is required the DTD can be extended to provide additional attributes that can guide the transformation process. For example, the following additional properties could be added to the list of attributes assigned to the `EAN` element:

```
<!ATTLIST EAN check NOTATION (EAN-validator) #FIXED "EAN-
    validator"
   EDI-prefix CDATA  #FIXED "LIN+1++"
   EDI-suffix CDATA  #FIXED ":EN'" >
```

Messages exchanged as XML/EDI files can be re-validated on receipt by running them through an XML/EDI validating parser. Where messages have been converted into non-XML files prior to transmission the conversion should be reversed to allow re-validation of the received message.

During re-validation any linked parts of messages should be retrieved to ensure that the full contents of the message have been checked. When re-validation has been confirmed the Document Object Model created as part of the validation process can be used to create an audible copy of the received message in a message store/database.

## 3 *Processing messages*

The way in which a received message would be processed would depend on which of the available methods for exchanging messages was chosen. If the message was received in a format that provided the XML/EDI message generated by the originator, the XML Style Language (XSL) can be used to associate different processes with individual element classes so that elements can be processed by one or more local processors.

XML/EDI message instances are specifically designed to make the selection of data fields and classes at the receiver as easy as possible. Each field starts with a "start-tag" that clearly identifies the class (element type in SGML/XML parlance) of the following data or embedded subelement set, and specifies any non-default properties to be associated with the data. The end of each data element is clearly identified by an "end-tag", which consists in the name of the element (class) preceded by a slash between a matched pair of outward pointing angle brackets. Fields that contain no data, and no embedded subelements, (e.g. fields that are only present to point to other data sources) have the slash indicating their end point immediately before the last angle bracket of the start-tag rather than immediately after the first one of the end-tag. (See the example for the `<same-as/>` element above.) Classes that contain subclasses of information have embedded elements between their start-tag and end-tag.

XSL allows sets of *actions* to be associated with particular XML elements. Actions can be defined in terms of values to be assigned to a set of data presentation attributes (*styles*), or in terms of a data processing *script* that users can define using a *define-script* object. XSL scripts are defined using the ECMAScript language used for exchanging Java programming modules.

Which actions are associated with which elements can be defined using XML element sets known as XSL *rules*. A simplified set of *style-rules* allows presentation properties to be *applied* to element classes. Rules can be associated with elements that have been assigned a unique identifier (`id`) attribute or that have been assigned a particular value for a `class` attribute.

Sets of rules and actions can be defined in *macros*. Macros can be associated with style processing attributes associated with specific instances of an element. The default set of style properties defined in XSL can be extended using *define-style* objects

The component parts of an XML Style Sheet can be:

- *defined in separate file(s) referenced using Internet URLs*
- *associated with the definition of elements in the DTD*
- *appended as a header to the document instance, or*
- *associated with a specific instance of an element.*
  *A typical XML/EDI XSL description will contain:*
- *a `<define-script>` element that contains ECMAScript definitions of the variables and functions required to process the document (in addition to the default function set provided by XSL)*
- *a set of `<define-macro>` elements that provide named sets of predefined actions*
- *a set of `<define-style>` elements that define properties that are to be used to control style processing*
- *a set of `<rule>` elements that contain within them:*
- a **`<target-element>`** that indicates which type of element the rule is to apply to, or
- an **`<id>`** element that identifies the unique identifier of the particular instance of an element the rule applies to, or
- a **`<class>`** element that identifies which class of elements the rule is to apply to
- 
- an **`<element>`** element that defines ancestors and descendants of the targeted element that

must be present for the rule to apply (ancestors are defined by **<element>** elements that surround the targeted element definition, descendants are defined by **<element>** elements nested within the definition of the target element)

- an **<attribute>** element that identifies which attributes the selected element(s) must have before the rule applies
- an **<invoke-macro>** element, which may have embedded within it a set of **<arg>** (argument) control elements, that indicates which macros are to be associated with the rule
- a set of actions that must be processed/evaluated when the rule pattern is matched
- *a set of <style-rule> elements that show which presentation styles should be associated with particular element types/classes/instances.*

XSL actions are typically associated with the way in which objects should be presented to users. This process is controlled through the use of *flow objects*. XSL provides two default sets of flow objects, one based on the elements found in HTML files, and the other based on the flow objects defined in ISO/IEC 10179 (DSSSL). The set of DSSSL flow objects supported by XSL includes:

- *scroll - used for control of scrollable screen displays*
- *paragraph - used to create blocks of text*
- *line-field - used to control the presentation of lists*
- *table, together with associated controls for table-part, table-column, table-row, table-cell and table-border - used to control the presentation of tables*
- *simple-page-sequence - used for creating multi-page documents*
- *sequence - used for specifying inherited characteristics*
- *link - used to control the presentation of hypertext links.*

The `<eval>` element can be used to indicate points at which macros and scripts are to be evaluated as a result of applying a rule.

For an example of the use of XSL specifications based on the use of HTML flow objects refer to Appendix A.

## 3 *Activating rules*

The XML link process can be used to associate XML/EDI rules with a file. Normally the Simple Link format will be used to identify one or more files containing the relevant rules. Typically this will result in a processing instruction of the following form being added to the start of the document instance:

```
<?xml-edi-rules-template
  HREF="http://www.myco.org/XML/EDI/Rules/orders.xml"?>
```

# XIX APPENDIX 5 : EVALUATION OF THE BARCELONA AND LILLE PROTOTYPE

## XIX.1 EVALUATION OF THE BARCELONA PROTOTYPE

### XIX.1.1 DEFINITION OF USER NEEDS

Currently there are two TDSS in Barcelona, one corresponding to the IMI (Municipal Computing Institute) and one corresponding to TMB (Metropolitan Transports of Barcelona). These TDSS are two Internet servers, the IMI server has a great quantity of databases referred to Barcelona and TMB server contains information on Public Transport of the Metropolitan area (metro, bus, FGC and RENFE rail).

At the beginning, it was intended to have only one TDSS including all Public Transport data in the IMI server, but institutional questions led to the maintenance of the TMB server. This is the reason for the Barcelona demo having two TDSS (at the IMI and at the TMB) which will exchange information between them through links between the implemented applications (Parking, Public Transport, Monitor). It is also possible to consider the two TDSS as if they were only one – one TDSS with distributed architecture so to present it with the format agreed at the DIRECT meetings. Furthermore, the development of these applications has originated the dialogue among the main institutions involved (SMASSA, TMB, IMI, SVP) in order to agree the information needed from each of them.

As a consequence, the Barcelona prototype should cover the following needs:

- to develop the Public Transport application in the TMB server allowing end the users to get information on the best public transport routes in for their journeys.
- to develop a Parking application in the IMI server allowing the users to get information on the best routes to reach car parks close to their destination. This application will additionally exchange information with the Public Transport application (at the TMB server) concerning P & R options.
  This application will be implemented to promote off-street parking and to obtain trip-end information from car-orientated travellers so as to provide them with door-to-door public transport alternatives.
- to implement a Monitor feature which will enable to analyse consultations made to the former applications and obtain mobility data from the people using these tools for planning their trips. Besides, the Monitor will help the owners of the applications to analyse their use and operation.

### XIX.1.2 DESCRIPTION OF THE BARCELONA PROTOTYPE TO BE ASSESSED

The following table presents the key characteristics which will allow to make an effective evaluation plan for the Barcelona prototype:

| **Application** | **Technologies** | **Function or service** | **Demonstration sites** | |
|---|---|---|---|---|
| P. T. Application | Internet, Databases | Programme calculating optimal routes in Public Transport given an origin and a destination (Intranet response time; Internet response time) | Barcelona and 10 adjacent municipalities of the metropolitan area | |
| Parking application | Internet, Databases | Programme calculating optimal routes to the car park nearer to destination introduced by the user. This application will work more on-line than the former (on-line network classification and parking booking simulation). | Barcelona | |
| Monitor | Access, Excel, GIS tools, Databases | To generate indicators of consultations realised by the users. (daily, weekly, monthly indicators). | Barcelona (Parking) | Barcelona and 10 adjacent municipalities of the metropolitan area (Public Transport) |
| Parking booking | Internet | Simulation | Selected car parks, Barcelona | |

*Table XIX.1.1 Summary of applications built and demonstrated, Barcelona*

### XIX.1.3 FORMULATION OF ASSESSMENT OBJECTIVES

| Application | Decision maker | Assessment objectives |
|---|---|---|
| P. T. Internet application | TMB | • to create a database with information on main Public Transport operators of the Barcelona metropolitan area.<br>• To develop cartography (up to now, there were only maps of the Barcelona city owned by the IMI) for the cities belonging the Barcelona metropolitan area.<br>• To inform Public Transport users on the best routes to realise their trips (with modal shifts) as well as on tariffs, passage frequencies, etc. |
| Parking Internet application | SMASSA, IMI | • To create a database with information on car parks of SMASSA and of the rest of operators of the parking sector of Barcelona.<br>• To define the private transport network of Barcelona, weighting links according to the network type they belong (primary, secondary or local).<br>• To use the file generated by the road network situation file for classifying the network in real time.<br>• To inform the citizens on the car parks nearest to their destinations showing them the best routes, and advising them when it is convenient to use Public Transport or P&R (data exchange with Public Transport application).<br>• To introduce the possibility of selling products and booking car park spaces by Internet (this will be a simulation) |
| Monitor application | TMB, SMASSA, BTSA | • To supply Internet applications owners with a tool enable them to know the level of use and weak points of their applications.<br>• To produce monthly reports for parking and public transport operators.<br>• To have a tool which in the future (when Internet usage will increase) will allow to compute monthly or yearly mobility indicators. |
| Parking booking | SMASSA | • precise used needs in detail. |

*Table XIX.1.2 Assessment Objectives by Application*

### XIX.1.4 DEFINING EXPECTED IMPACTS OF THE BARCELONA TDSS AND APPLICATIONS

The following table indicates the impacts expected for each main target group and shows the likely qualitative or quantitative magnitudes:

| Impacts expected | Target groups | System | Impact |
|---|---|---|---|
| Improvement of Public Transport and Parking information given to citizens. | Citizens | P. T. Application<br>Parking Application<br>Monitor application | ++<br>++ |
| Improvement of the city mobility. | Citizens | P. T. Application<br>Parking Application<br>Monitor application | +<br>+ |
| Benefits for the different operators and for the users. | Operators supplying data and users. | P. T. Application<br>Parking Application<br>Monitor application | ++<br>++ |
| Car park spaces booking by Internet | Parking operators and users | P. T. Application<br>Parking Application<br>Monitor application | <br>+ |
| Improvement of data exchange | Operators supplying data and users. | P. T. Application<br>Parking Application<br>Monitor application | +<br>++ |
| More dynamic mobility statistics. | Parking and Public Transport operators. | P. T. Application<br>Parking Application<br>Monitor application | +<br>+<br>+ |

Key: ++: very positive impact; +: positive impact

*Table XIX.1.3 Expected Impacts*

Both the parking and the public transport will produce a positive impact on citizens regarding information since the implemented applications provide them with more comprehensive and up-to-date information than that provided by the (paper-based) guides.

It is estimated that the Public Transport application will not have a very big impact in the short term, but in the medium term it is expected that it will help to increase Public Transport usage. The parking application is neither expected to have a big impact in a short term, but in a medium term it is calculated that it will be useful to reduce the agitation traffic (traffic generated by car park space search) and with the inclusion of vehicles on-board computers the possibility to guide drivers by the less-congested roads is opened.

Internet has a great impact on the operators both for parking and for public transport so as to give publicity to their different products, and in some cases for allowing their selling, on one hand this improves their company image and, on the other, increases the comfort for the users. Internet car park spaces booking is a step beyond in this action line which in addition will allow a greater segmentation of clients. In short term, it is intended to show the booking feature to make a prospective on operator acceptance.

With the Barcelona prototype not only the data exchange through TDSS is going to be demonstrated, but also how information can be exchanged between different TDSS, this will be of great utility in the near future.

The Monitor can have a positive impact for analysing the good operation of the applications (changes of parameters, introduction of upgradings such as socio-economic data, etc.). One of the DIRECT objectives is to integrate applications data with those of planning on real time.

## XIX.1.5 ASSESSMENT METHODOLOGY

This section, presents the specific Barcelona assessment methodology key steps, based on the general procedure defined in the CONVERGE project (CONVERGE, 1999):

- Selection and definition of indicators:

| Category assessment | List of indicators |
|---|---|
| Technical assessment (functional aspects) | • Number of TDSS applications<br>• Number of Internet servers<br>• Number of applications in each TDSS<br>• Type of available information through the TDSSs.<br>• Number of types of information made available through the TDSS. |
| Technical assessment (non functional aspects) | • Architecture and technical choices<br>• Evolutivity<br>• Performance<br>• Availability<br>• Quality assurance<br>• Implementation and maintenance cost |
| Institutional, legal and organisational aspects assessment | • Number of operators involved in Barcelona prototype.<br>• Agreements for databases maintenance.<br>• Agreements to exchange data between the TDSS.<br>• Agreements to exploit data obtained from internet users consultations (monitor). |
| User's requirements satisfaction | • Internet Applications response time (taking into account the internet saturation level in different daytime periods).<br>• Clear representation of calculated routes<br>• Operators acceptance of parking booking simulation. |

*Table XIX.1.4 Indicators used to validate the demonstrated applications*

- Reference case

The validation of Barcelona will be carried out taking into account the existing situation. This is the reason why our validation will not only be addressed to validate the functionality of a TDSS (there are already two: IMI and TMB in Barcelona), but it will be basically focused to validate the communication and exchange of data between the TDSSs and the benefit that the extension of the implemented applications will suppose to operators and Barcelona citizens.

- Measurement plan

The Barcelona demonstration will have two parts, one which can be defined as real (implementation of the internet parking and public transport applications in different servers, how each application is fed by different databases and how they exchange information through different TDSSs) and one which will be a demo (car park spaces booking and products sale by Internet). The part of car park spaces booking is planned to be implemented as a pilot in order to clarify the parameters and with the idea of implementing in the near future the tested system.

In consequence, it is planned to evaluate the real applications impacts at the end of September. The part of the car park spaces booking will serve to checkout the possibilities that Internet offers on this subject and to analyse the operators interest in the extension of this functionality.

### XIX.1.6 ASSESSMENT RESULTS

✓ ***Technical assessment***

FUNCTIONAL ASPECTS

- Number of TDSS applications: In Barcelona prototype, the applications are all the programmes that allow the users to have an Internet connection (explorer, netscape,...).

- Number of Internet Servers: As explained in previous deliverables, the Barcelona demo is developed in Internet, because of this we consider interesting to define the number of servers to be used. The TDSS will include two servers: IMI server (Barcelona City Council) and TMB server (Barcelona Public Transport operator). So, Barcelona demonstration works with distributed databases.

- Number of types of available information through the TDSS:
  - Optimal Routes in Public T. (Origin - Destination)
  - On-line Optimal Routes in Private T. (Origin – Parking).
  - P&R (On-line Private T.: Origin – Parking; Public T. – Destination)
  - On-line Parking Booking: Information on parking spaces availability
  - Car Parks Information (services, fees, products, accesses)
  - Public T. lines Information (fees, products, lines, stops, passage frequency)
  - Road Network Condition Information (on-line)
  - Private Transport network
  - Public Transport network
  - Coordinates: Public Transport stops and car parks
  - Cartography: Barcelona and metropolitan area

NON FUNCTIONAL ASPECTS

- *Architecture and technical choices*

Barcelona TDSS databases and functions are located over two separate servers, mainly depending on the ownership of the applications (for further details, see section).
Those two servers are implemented with different DBMS:

- The IMI server (municipality) relies on an ORACLE database (current version is 7.3.4) and an ORACLE application server (current version 3.0.2).
- The TMB server (public transport) relies on an INFORMIX database and does not use any application server.

Both servers use JavaScript, CGI processes and dynamic HTML pages to format and export information for the end users. CGI processes have been developed in C language on Sun Unix workstations (running Solaris 5.5.1 Operating System).
The main objective of the prototype is to give access to information related to travel conditions for the largest audience. According to the criteria defined in section 6.2 of

DIRECT Deliverable 4 (DIRECT, 1999b), an Internet/Intranet architecture is a good choice to implement this type of application.

➢ *Scalability*

- Hardware and Operating System:

Sun/Solaris workstations are commonly used for supporting DBMS. They provide for a secure development platform, and also offer guarantees of perenity and evolutivity.

- Programming tools and languages:
  - ORACLE:

  This DBMS is available on lots of platforms (Unix, Windows, …), so that it can be easily adapted to any hardware evolution. Moreover, it correctly handles load and/or data volume increase.
  - JavaScript:

  JavaScript is commonly used to include components into Web pages, so we may assume that it will be supported by most browsers for a long time. It does not show up any problem of performance.
  - CGI processes (C language) :

  CGI processes have become a *de facto* standard a few years ago. As a matter of fact, they provide a simple mechanism for generating dynamic HTML pages. The main drawback of this solution is that performance drastically decreases when the number of connections increases. For this reason, using an application server (frequently based on Java technology) would probably be preferable.
- Architecture:

By using several servers, Barcelona prototype architecture allows local updates and evolutions on parts of the system, provided that the design preserves the dependencies between parts. In the case of the Barcelona prototype, these dependencies have been formalised using template files containing URL addresses allowing access to usable functions of each server.

➢ *Performance*

As performance is of high importance for Internet/Intranet applications, this topic has been taken into account from the beginning of the system architecture definition. Solutions avoiding "chain connections" between servers to manage data exchange have been preferred. Performance has then been studied in detail as a part of section, since it does not make much sense to propose interactive Intranet/Internet applications that take several minutes to answer one request. Therefore, every part of the system must be correctly sized (hardware, network, …) and optimised (algorithms, fine tuning of tools or products) in order to ensure acceptable response time.

➢ *Availability*

Distributed architectures present the characteristic of separating data and functions over several servers and/or sites. Obviously, this property may increase the availability of parts of the system which do not require that all servers are actually running (see section 6.5 of Deliverable 4). However, this implies that dependencies between functions and servers are reduced to the maximum otherwise no particular availability property will be obtained.

In the specific case of the Barcelona prototype, availability is not a major concern since no critical functions have been identified during the user's requirement analysis. However, it is important that the system has a high availability ratio in order to ensure end users satisfaction and therefore reach a large audience in the middle and long term.

The Barcelona prototype architecture seems to be well adapted to this characteristic, even if some functions require that both servers are running.

➢ *Quality*

Several aspects related to software quality have been presented in chapters 2 and 6 of Deliverable 4. Even if we consider the fact that a prototype usually does not have to comply with strict quality insurance criteria, the following points have to be noted:

- Data model: no documentation is available
- Source code:
  JavaScript programs have a low level of comments. Source code of CGI programs (C language) has not been made available for analysis.
- Documentation:
  The only documentation available in English is this deliverable. One can understand that, due to the ease of using Internet application, no specific user manual has been written.
  Nevertheless, considering the complexity of the system, featuring heterogeneous DBMS, several servers, various programmation languages, it would be helpful for people in charge of the maintenance to make available specific documentation describing architecture and detailed design, installation and configuration of the software, as well as test plan and report. This recommendation should be highlighted due to the fact that people in charge of the maintenance will possibly not be the same as those who developed the system.
- Implementation and maintenance costs
  - Hardware development and test platform :
    Medium, as a Unix workstation has a high cost compared to a “top level” PC configuration,
  - Development tools :
    Medium, as chosen DBMS tools allow reasonable development costs,
  - Manpower for development:
    A consistent time scale for implementing such a project is from several man-months to a few man-years, which is a “medium” manpower cost.
  - Hardware maintenance:
    Medium (part time system administrator, need for hot line support),
  - Software and tools maintenance:
    Medium (part time DBMS administrator, need for hot line support),
  - Maintenance of the system:
    Barcelona TDSS maintenance will consist of, on the one hand, the maintenance of the Internet servers and, on the other hand, the maintenance and updating of the databases and algorithms.
    - Servers maintenance will be carried out by the owner of each server (IMI and TMB).
    - Databases maintenance and updating:
      - SMASSA: Car Parks, Private T. network
      - TMB: Public T., Public T. network, metropolitan area cartography
      - IMI: Barcelona cartography
      - SVP: road network condition

Summary table

| Criteria | Observation |
|---|---|
| Architecture / tools | Best choice |
| Scalability (hardware and OS) | High |
| Scalability (programming tools) | From low (CGI processes) to high (ORACLE) |
| Scalability (architecture) | High |
| Performance | *Detailed in section* XIX.1.6 User's requirements satisfaction |
| Availability | Not critical, however good |
| Quality (data model) | Not checked |
| Quality (source code) | Low or not checked |
| Quality (documentation) | Low (but this is a prototype demonstration) |
| Implementation cost | Medium |
| Maintenance cost | Medium |

*Table XIX.I.5 Summary of non-functional aspects assessment*

✓ ***Non Technical aspects: Institutional, legal and organisational aspects assessment***

➢ Number of operators involved in Barcelona Prototype

The Barcelona prototype development has been carried out by BTSA, in collaboration with TMB (Public Transport operator), IMI (Municipal Computing Institute), and SVP (public authority in charge of Barcelona road network management).

➢ Agreements for databases maintenance

*Each operator will be in charge of the maintenance of their own database, making the maintenance and updating directly from their offices.*

➢ Agreements to exchange data between the TDSS

Agreement for data exchange is reflected in the willingness of the operators to run the applications on the servers of their companies. The agreement with the public transport operator also covers modifications to upgrade the application. There is an agreement between BTSA and SMASSA and TMB to exploit the files obtained from the users consultations to Parking and Public Transport Trip Planners.

➢ Agreements to exploit data obtained from Internet user consultations

Within the DIRECT project, a verbal agreement has been achieved both with TMB and SMASSA, for BTSA to exploit data from consultations to both trip planners.

As an example, we proceed now to explain how the Public Transport Trip Planner consultations have been exploited.

In order to make a consultation in the Public Transport application, the user will have to introduce the following data:

| FIELD | TYPE |
|---|---|
| Consultation Date | DD/MM/YY |
| Consultation Language | Select before to start the application |
| Select Transport mode | Select in the list box |
| Origin Town | Select in the list box |
| Origin address | Text |
| Destination Town | Select in the List box |
| Destination Address | Text |

*Table XIX.1.6 Monitor data input by travellers*

Consultations realised to the Public Transport application are stored in text files which are weekly extracted. As explained in Deliverable 3 (DIRECT, 1999[a]), each week two files are extracted, one is the file containing data introduced by the user to make the consultation (INPUT), and one is the file containing the solutions calculated by the application (OUTPUT).

The fields contained in each of these files are presented in the tables below:

***INPUT***

| FIELD | TYPE |
|---|---|
| ID_Consultation | I4 |
| Transaction Date | A16 |
| Consultation Date | dd /mm /yy |
| Consultation Language | A2 |
| Origin Town | A10 |
| Origin Address | A30 |
| Origin X coordinate | 99999.99 |
| Origin Y coordinate | 99999.99 |
| Destination Town | A10 |
| Destination Address | A30 |
| Destination X coordinate | 99999.99 |
| Destination Y coordinate | 99999.99 |
| Navigator | I1 |
| Nº of Proposed solutions | I2 |

***OUTPUT***

| FIELD | TYPE |
|---|---|
| ID_Consultation | I4 |
| Solution Number | I1 |
| Number in modal chain | I1 |
| Operator | I3 |
| Line | A3 |
| Origin Stop | A50 |
| Origin Stop X coordinate | 99999.99 |
| Origin Stop Ycoordinate | 99999.99 |
| Destination Stop | A50 |

| | |
|---|---|
| Destination Stop X coordinate | 99999.99 |
| Destination Stop Y coordinate | 99999.99 |
| Total number of stops (for each transport) | I2 |

*Table XIX.1.7 Monitor data generated by trip planner application*

With the data of these files we can obtain a series of indicators which will allow us to analyse the use and the operation of the application as well as to adjust its parameters.

To create the indicators, we will generate two types of forms: one containing the numeric indicators and one containing the graphic indicators.

- Numeric indicators:

  For the realisation of these indicators we will work with three different areas:
  - AI1: The 11 municipalities currently included in the application
  - BCN: the city of Barcelona
  - Rest AI1: All the municipalities of the application except Barcelona

  Therefore the areas groups will be:
  - AI1-AI1
  - BCN-BCN
  - BCN-Rest AI1
  - Rest AI1-BCN

  With these area groups we will define the following indicators (for more detail, see Annex 1):
  - General data (type of solutions, language selection, transport mode..)
  - Utilisation of Public Transport by modal chain
  - Origin-destination matrix of consultations
  - Origin-destination matrix of proposed trips
  - Modal chains
  - Language per origin city
  - Origin-destination matrix of consultations (in English)
  - Origin-destination matrix of proposed trips (in English)
  - Consultations per day of the week
  - Proposed transport mode per trip
  - Selected transport mode per origin city
  - Time periods consultations
  - Ratios

- Graphics:

  We will have different forms:
  - General graphics of realised consultations
  - Metro graphics
  - Bus graphics
  - FGC graphics
  - Renfe graphics

The Public Transport application generates each week two files (consultations and solutions) which are sent via e-mail to the TMB web. This web is programmed for it to be able to store files of two consecutive weeks, deleting the older one when a new file is generated. These files are weekly stored in a database, and through a programme implemented in C language we put together files corresponding to each month, and we store them in another database. These files have some fields numerically coded.

The file corresponding to a determined week or month is decoded and analysed through an Access database. This database is formed by the following tables:

- Linked tables
  - INPUTS: Table linked to consultations
  - OUTPUT: Table linked to solutions
- Decoding tables
  - Languages
  - Cities_O
  - Cities_D
  - Operator
  - Transport
  - Navigator

Figure XIX.1.1 shows the resulting Access form in which all the information generated by one consultation can be seen.

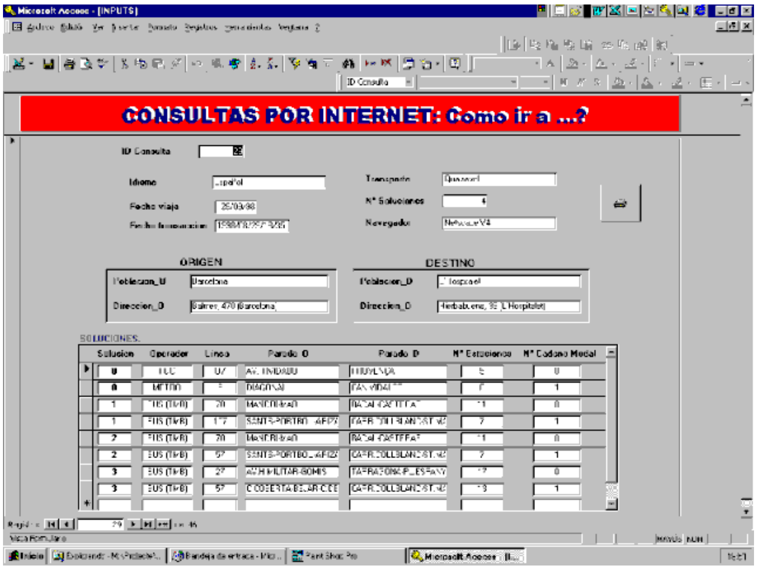



*Figure XIX.1.1 Screen with data of a consultation*

Making good use of the capacity of ACCESS for dissaggregate information, we generate a series of consultations, which later using macros are imported to EXCEL. These tables (statistics table and PT lines) will be linked to some pre-defined forms which will generate the indicators.

Monthly data will be analysed and processed with the aim of obtaining a series of mobility indicators (mainly about Public Transport). Monthly data received by the Monitoring, before to be processed, should be analysed in order to know if they are useful as a sample for obtaining indicators. Data validation should be carried out qualitatively as well as quantitatively:

- <u>Qualitative validation</u>: Before to go through any type of analysis, the quality of data coming from Trip Planner applications should be verified, and the points to be checked are the following:
  1) Nº Solutions (INPUTS) = Σ Nº Solution (OUTPUT)
  2) Operator (OUTPUT) = BUS or METRO or FGC or RENFE
  3) If modal chain is complete: ---, Bus, Metro

Any consultation not fulfilling one of these conditions should be considered as a non-complete consultation and should be eliminated from the file.

In order to improve the quality of data, we think that some screens have to be introduced before to start the application:
- Screen with socio-economic data
- Screen with trip purposes
- Screen to select a solution: solution chosen by the user for realising the trip

- Quantitative validation: After the qualitative validation through which non-complete consultation will have been eliminated, we will realise the quantitative validation which will basically analyse the following aspects:

1) Sample size (sample error)
2) Comparison with real data: % travellers/day

In case that data are not useful, two things can be done:
- To discard them: if consultations are not complete
- To recycle them with those of next month: if the sample size is not enough

Currently, Internet users' are a quite small and specific part of the population, this means that they are not a representative sample of the total population of Barcelona. Due to this fact, indicators obtained from the consultations are not supposed to be indicators for the Barcelona mobility, but simply indicators for a population segment (Internet users). This is why the quantitative validation part can only give a first indication of the utility of such trace data for Transport Planning purposes.

On the other hand, the sample of Internet users will be progressively more representative of the total population due to its growth rate, and it is expected that in a few years it will be possible to consider these indicators as indicators for the mobility of the total population.
In this sense, it is important to highlight that the Public Transport Trip planner has had an increased number of daily consultations, from 50 at the commencement of the year to 130 in October.

Nevertheless, the monitor application has already enabled a number of interesting results to be elaborated. Figure XIX.1.2 presents a summary of the trip-ends of requests made to the public transport trip planner over the last six months (since the monitor was established). This shows that very few of the consultations are being made from the hinterland areas where car usage is highest (Area 3 is the area beyond the Barcelona Municipality boundary). Since Internet access is likely to be distributed with higher penetration in the hinterland, the low level of interest in trip planning in the hinterland is an interesting result. It may be that it reflects the resistance to travellers whose journeys can only be achieved through the connection of two or three public transport services, ie: a reflection of a resistance to intermodality.

*Origin - destination by areas*

| | Value | Percentage |
|---|---|---|
| AREA1 - AREA1 | 276 | 16% |
| AREA1 - AREA2 | 345 | 21% |
| AREA1 - AREA3 | 51 | 3% |
| AREA2 - AREA1 | 288 | 17% |
| AREA2 - AREA2 | 492 | 29% |
| AREA2 - AREA3 | 75 | 4% |
| AREA3 - AREA1 | 59 | 4% |
| AREA3 - AREA2 | 65 | 4% |
| AREA3 - AREA3 | 31 | 2% |
| TOTAL | 1682 | 100% |

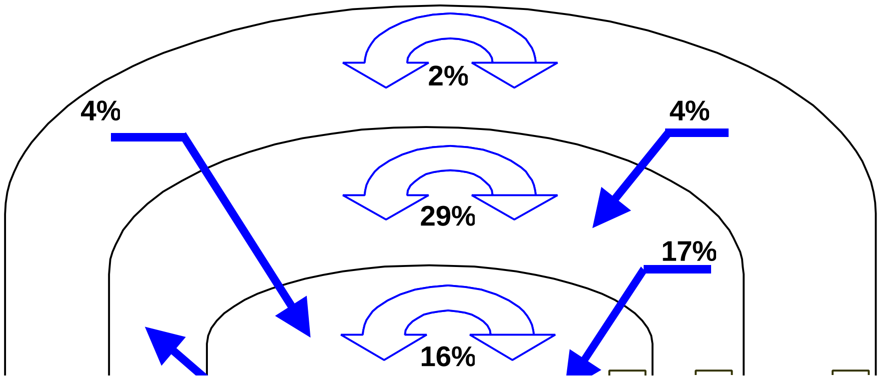



*Figure XIX.1.2 Frequency of consultation by trip-end type (Barcelona trip planner monitor)*

## XIX.1.6 USER'S REQUIREMENTS SATISFACTION

➢ Internet Trip Planners response time

In this section, the study of response time of the different trip planners (Parking, Public Transport and P&R) carried out is explained. To realise the analysis we have to differentiate between response time in Intranet and in Internet:

***I) During one week for each weekday and for different time periods of the day, we have collected the response time in Internet for the different trip planners with the following calculation conditions:***

- Public transport trip planner:
  Total response time (both for Internet and for Intranet) has been calculated by adding the following partial times:
  **t1**= time of origin and destination search (from the introduction of the origin and destination until the display of the confirmation screen)
  **t2**= time of optimal route visualisation, including time of web unloading, time of routes calculation and time of presentation (from the confirmation screen until the optimal routes visualisation).

The optimal routes screen can present from 1 to 3 list boxes with a maximum of three different solutions each. List boxes can contain the following Public Transport combinations:

| List Box 1 | List Box 2 | List Box 3 |
|---|---|---|
| BUS | METRO | BUS+METRO |
| BUS+BUS | METRO+METRO | BUS+METRO+BUS |
| BUS+BUS+BUS | METRO+METRO+METRO | BUS+METRO+METRO |
| | | METRO+BUS |
| | | METRO+BUS+METRO |
| | | METRO+BUS+BUS |

Depending on the list box and the solutions included in each list box, more or less maps will be generated, this will affect the response time:

- 1 list box: 1 to 3 maps are generated
- 2 list boxes: 2 to 6 maps are generated
- 3 list boxes: 3 to 9 maps are generated

Therefore to calculate the time of response we have collected data from three pre-defined routes (1 list box, 2 list boxes, 3 list boxes) and then we will apply to the obtained times the probability that 1, 2 or 3 list boxes appear:

| | | |
|---|---|---|
| $P_1$ | 0.24 | Probability 1 list box appears |
| $P_2$ | 0.50 | Probability 2 list boxes appear |
| $P_3$ | 0.26 | Probability 3 list boxes appear |

These probabilities have been obtained after the analysis of the consultations to the Public Transport trip planner for 3 months.

Routes definition:

- Route 1: Solution with just one list box (3 solutions)
- Route 2: Solution with two list boxes (6 solutions)
- Route 3: Solution with three list boxes (9 solutions)

The following table shows the collected data:

| 4/10/99 – 8/10/99 | | Response Time (seconds) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PT | | Monday | | | Tuesday | | | Wednesday | | | Thursday | | | Friday | | | |
| Time | Route | t1 | t2 | tr | t1 | t2 | tr | t1 | t2 | tr | t1 | t2 | tr | t1 | t2 | tr | tr (mean) |
| **10:00** | **1** | 15 | 47 | 62 | 17 | 33 | 50 | 19 | 38 | 57 | 15 | 30 | 45 | 15 | 27 | 42 | **51** |
| | **2** | 14 | 66 | 80 | 16 | 63 | 79 | 17 | 76 | 93 | 12 | 72 | 84 | 11 | 76 | 87 | **85** |
| | **3** | 22 | 75 | 97 | 14 | 75 | 89 | 17 | 80 | 97 | 17 | 77 | 94 | 14 | 78 | 92 | **94** |
| | **mean** | 16 | 64 | 80 | 16 | 59 | 75 | 17 | 68 | 85 | 14 | 63 | 77 | 13 | 65 | 78 | **79** |
| **12:00** | **1** | 21 | 32 | 53 | 23 | 61 | 84 | 19 | 59 | 78 | 12 | 55 | 67 | 19 | 52 | 71 | **71** |
| | **2** | 16 | 51 | 67 | 22 | 74 | 96 | 23 | 61 | 84 | 12 | 63 | 75 | 17 | 70 | 87 | **82** |
| | **3** | 11 | 64 | 75 | 26 | 83 | 109 | 12 | 79 | 91 | 14 | 71 | 85 | 17 | 81 | 98 | **92** |
| | **mean** | 16 | 50 | 66 | 23 | 73 | 97 | 19 | 65 | 84 | 13 | 63 | 76 | 17 | 69 | 86 | **82** |
| **14:00** | **1** | 14 | 36 | 50 | 25 | 43 | 68 | 22 | 40 | 62 | na | na | na | 17 | 73 | 90 | **68** |
| | **2** | 12 | 65 | 77 | 14 | 54 | 68 | 17 | 63 | 80 | na | na | na | 17 | 73 | 90 | **79** |
| | **3** | 14 | 70 | 84 | 14 | 70 | 84 | 16 | 74 | 90 | na | na | na | 14 | 77 | 91 | **87** |
| | **mean** | 13 | 59 | 72 | 17 | 56 | 72 | 18 | 60 | 78 | na | na | na | 16 | 74 | 90 | **79** |
| **16:00** | **1** | 14 | 35 | 49 | 14 | 30 | 44 | na | na | na | 14 | 65 | 79 | na | na | na | **57** |
| | **2** | 12 | 77 | 89 | 16 | 80 | 96 | na | na | na | 15 | 70 | 85 | na | na | na | **90** |
| | **3** | 16 | 102 | 118 | 12 | 95 | 107 | na | na | na | 11 | 79 | 90 | na | na | na | **105** |
| | **mean** | 14 | 73 | 87 | 14 | 72 | 86 | na | na | na | 14 | 71 | 85 | na | na | na | **86** |
| **18:00** | **1** | 18 | 55 | 73 | 17 | 60 | 77 | na | na | na | 14 | 53 | 67 | na | na | na | **72** |
| | **2** | 15 | 96 | 111 | 17 | 85 | 102 | na | na | na | 12 | 61 | 73 | na | na | na | **95** |
| | **3** | 13 | 108 | 121 | 15 | 99 | 114 | na | na | na | 9 | 90 | 99 | na | na | na | **111** |
| | **mean** | 15 | 89 | 104 | 16 | 83 | 99 | na | na | na | 12 | 67 | 78 | na | na | na | **94** |
| **20:00** | **1** | 14 | 30 | 44 | 12 | 29 | 41 | 18 | 25 | 43 | 14 | 32 | 46 | na | na | na | **44** |
| | **2** | 10 | 48 | 58 | 13 | 58 | 71 | 20 | 40 | 60 | 14 | 57 | 71 | na | na | na | **65** |
| | **3** | 11 | 50 | 61 | 21 | 60 | 81 | 17 | 61 | 78 | 18 | 65 | 83 | na | na | na | **76** |
| | **mean** | 11 | 44 | 55 | 15 | 52 | 66 | 19 | 42 | 61 | 15 | 53 | 68 | na | na | na | **63** |
| **mean** | | **13** | **62** | **78** | **17** | **66** | **83** | **18** | **59** | **77** | **13** | **63** | **77** | **15** | **69** | **85** | **80** |

Table XIX.1.8 Internet response times for Public Transport Trip Planner

➢ Intranet Trip Planners response times

The parameters for public transport are those previously defined for Internet response measurement.

- Parking trip planner:

  Total response time is calculated by adding the following partial times:

  **t3**= time of destination and near car parks search (from the introduction of destination until the display of the screen of origin and car park selection)

  **t4**= time of optimal route visualisation, including origin search time, web unloading time, routes calculation time and presentation time (from the origin introduction and car park selection).

- P&R trip planner:

  Total response time is calculated by adding the following partial times:

  **t3**= time of destination and near car parks search (from the introduction of destination until the origin and car parks selection screen)

  **t5**= time of optimal routes in Private Transport (Origin-Car Park) and in Public Transport (Car Park - destination) visualisation including the origin search time, web unloading time, routes calculation time and presentation time (from the origin introduction and the car park selection).

- Parking booking:

  $\mathbf{t_6}$ =time from the introduction of consultation booking day and car park until the display of the screen to make a reservation.

  $\mathbf{t_7}$ = time from introduction the subscriber data for a space reservation until the display of confirmation booking screen.

***II)*** ***To calculate response times in Intranet, 10 different routes have been selected. The calculation of the response times has been done with the following conditions:***

- We use Oracle 8
- Computer: Pentium 2 (164M)

The obtained results are shown in the following table.

| | Response Time (seconds) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Public Transport | **Route 1** | **Route 2** | **Route 3** | **Route 4** | **Route 5** | **Route 6** | **Route 7** | **Route 8** | **Route 9** | **Route 10** | **Mean** |
| $T_1$ | 5 | 4 | 4 | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 5 |
| $T_2$ | 6 | 8 | 14 | 7 | 9 | 13 | 9 | 10 | 13 | 11 | 10 |
| $t_r$ | 11 | 12 | 18 | 12 | 14 | 18 | 13 | 14 | 18 | 16 | 15 |

| | Response Time (seconds) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Parking | **Route 1** | **Route 2** | **Route 3** | **Route 4** | **Route 5** | **Route 6** | **Route 7** | **Route 8** | **Route 9** | **Route 10** | **Mean** |
| $T_3$ | 10 | 8 | 7 | 9 | 7 | 9 | 8 | 8 | 10 | 10 | 9 |
| $T_4$ | 20 | 20 | 5 | 20 | 20 | 20 | 6 | 20 | 5 | 20 | 16 |
| $t_r$ | 30 | 28 | 12 | 29 | 27 | 29 | 14 | 28 | 15 | 30 | 24 |
| $T_{optimal}$ sol | 16 | 19 | 4 | 15 | 18 | 15 | 5 | 1 | 3 | 15 | 11 |

| | Response Time (seconds) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| P&R | **Route 1** | **Route 2** | **Route 3** | **Route 4** | **Route 5** | **Route 6** | **Route 7** | **Route 8** | **Route 9** | **Route 10** | **Mean** |
| $T_3$ | 10 | 11 | 10 | 11 | 10 | 11 | 10 | 11 | 12 | 9 | 11 |
| $T_5$ | 21 | 14 | 12 | 12 | 11 | 24 | 20 | 25 | 20 | 22 | 18 |
| $t_r$ | 31 | 25 | 22 | 23 | 21 | 35 | 30 | 36 | 32 | 31 | 29 |

| | Response Time (seconds) | | | | | |
|---|---|---|---|---|---|---|
| Parking booking | **Booking 1** | **Booking 2** | **Booking 3** | **Booking 4** | **Booking 5** | **Mean** |
| $T_6$ | 10 | 9 | 10 | 10 | 9 | 9 |
| $T_7$ | 3 | 5 | 4 | 4 | 3 | 4 |
| $t_r$ | 13 | 14 | 14 | 14 | 12 | 13 |

*Table XIX.1.9 Intranet Response Times for all demonstrated trip planner applications*

With data from the above tables, the following summary of results is obtained:

| | **Response Time (seconds)** | |
|---|---|---|
| **Algorithm** | **Intranet** | **Internet** |
| Public Transport | **14.6** | **79.46** |
| Parking | **24.2** | **na** |
| P&R | **28.6** | **na** |
| Parking booking | **13.4** | **na** |

*Table XIX.1.10 Summary of average response times achieved by trip planner applications*

NOTE: It has to be highlighted that these response times (calculated from the BTSA office) are only reference times obtained under determined circumstances. Factors influencing the times calculation, both in Internet and Intranet, are so many that the interesting point of these calculated times is the proportion between Internet and Intranet times.

- Trip Planners Routes (calculation by distance and congestion, representation)

In this section, we will proceed to verify that the routes and information shown to the users are on the one hand reliable and on the other clear.

***I) In reference to reliability of routes proposed by trip planners:***

- Trip Planners routes:
  a) For Public Transport Trip Planner, routes proposed by the programme were verified manually. This way possible errors of the network were eliminated and programme parameters adjusted.
  b) For Parking Trip Planner, manual verification of routes were also realised to detect possible errors in the network, adjust links weights and adjust programme parameters.

- Information:
  Operators have verified that the information of Public Transport (lines, passage frequencies, stops, fees, products, services..) and Car Parks (accesses, fees, services, products) given to the users is correct.

***II) In reference to clearness, the following table gives rates of the different characteristics:***

| | Public Transport | Parking |
|---|---|---|
| Searching screens (origin, destination, parking) | ++ | ++ |
| Route description | ++ | ++ |
| Route drawn in the map | ++ | ++ |
| Route visualisation with zoom | no | + |
| Facilities localisation (Car parks, Public T. stops) | + (No metro stations entrance) | ++ (Entries) |
| Real time | no | + (Simulation) |
| Internet booking | no | + (Simulation) |

++ Very good; + Good

*Table XIX.1.11 Summary of Operator's Valuation of demonstrated trip planner features*

It is noted that the operator is satisfied with the routes proposed by the parking guidance application (no further development of a link to real-time congestion is currently envisaged).

➢ Parking booking simulation

At the outset, this demonstration was planned to be applied in a small number of SMASSA car parks. However, the communication network between car parks is not yet centralised and there is no possibility to communicate parking bookings to the car parks (so as to enable them to introduce booking reservation into the locally-generated variable message displays indicating the number of available spaces). (This was the original idea described in the Technical Annex (DIRECT, 1997).

Whilst the operator has participated actively in determining the needs of the internet parking guidance application, the enthusiasm for defining the needs for parking booking was less evident. There is clearly a limit to the amount of development work that can be done in one block, and the operator appears to be cautious about launching a booking facility before putting in place the communications network needed to support it (SMASSA also wants to see the impact of the parking guidance application before going ahead with further internet developments). As a consequence, the work carried out has been based on their current information system (which does not work in real time), and for which a clearing house concept of parking booking has been developed as a simulation. This has enabled the operator's needs to be detailed and demonstrated – but without any commitment to implement. Thus, the parking booking demonstration developed for the DIRECT project is a first step to be able to realise a pilot trial allowing to promote the system and analyse its acceptance level among the users.

Taking into account that SMASSA is studying how to improve their information system, and that in the future the highest interest is to have a car park spaces booking system in real time, the simulation that has been developed leads to a proposal for a series of improvements that could be introduced to make the potential service attractive to clients: These are:

- Besides accepting reservations up to a week in advance (as demonstrated), the system should allow:
  - → Fixed reservation in a day of each month.
  - → Reservation with the purchase of tickets for shows
  - → Reservation for the same day.
- All the car park spaces have to be available for reservation, and the algorithm has to manage them according to the evolution of the occupancy level over the hours of operation (spaces were limited during the demonstration as a way to overcome the lack of a real-time management system, but this restriction could cause the service not to be taken up).
- Car park space reservation should be allowed at any time of the day.
- Car park spaces reservation during off-peak hours could be useful to promote off-street parking; discounts should be considered for users who reserve a space during these time periods.
- The service could be extended to the general public, by allowing to make reservations through credit or debit card (subject to successful piloting with subscribers).

In reference to the works realised for the demonstration, we have to highlight above all the definition of screens and the development of the algorithm for car park spaces assignment. The design of the screens is totally valid, and only a few modifications should be made in the programme to include the improvements proposed, even allowing for the possibility to work with SMASSA information systems in real time.

For the car park spaces assignment algorithm the relevant thing is that the number of spaces available for reservation in each car park is determined by a parameter. This should enable the number of spaces available for reservation to be calculated for each car park at any moment according to the occupancy level (rotation by clients, subscribers,..).

As a conclusion, it can be said that the realised parking booking demo can be rated as a positive development, which can be improved, and that a next-step pilot would be more complete and operative if it can be based on information systems working in real time.

## XIX.2 EVALUATION OF THE LILLE PROTOTYPE

To enable comparisons, the process for the assessment of the Lille TDSS and applications prototype will use the guidelines of the CONVERGE project[89] as a framework to be adapted to the local context.

As for the Barcelona prototype, the seven key stages identified by the CONVERGE project are as follows :

- determination of user needs,
- description of the prototype to be assessed,
- formulation of assessment objectives : technical assessment, users' requirements satisfaction assessment, financial assessment,
- initial estimate of the expected impacts of the prototype, in order to clarify the impacts which will be assessed at the end of the project,
- choice of assessment methods,

- data analysis,
- reporting of results.

Technical assessment will be performed in accordance with the recommendations defined in WP4 which consider criteria such as architecture and technical choices against objectives, scalability, performance, availability, quality (data model, documentation, source code), implementation and maintenance costs. Please refer to section 6 of deliverable 4 for more in depth description.

The first two key stages identified by CONVERGE constitute chapters 1 and 2 of deliverable D7.

### XIX.2.1 FORMULATION OF ASSESSMENT OBJECTIVES

WP3 provided a table showing a synthesis of the assessment objectives :

| Application | Decision maker | Assessment objectives |
|---|---|---|
| Urban mobility observatory | *Lille Métropole Communauté Urbaine* | • improving data exchange between the different partners involved in the Lille Urban Transport Master Plan,<br>• observing the evolution of the urban transport system in regard to the strategic directions defined in the urban transport master plan,<br>• enabling comparisons with other French urban areas<br>• producing a yearly report presenting some statistics and analysis about the urban transport evolution |
| Urban transport diagnostic maps | *Lille Métropole Communauté Urbaine* | • providing the institutional actors involved in the Lille Urban Transport Master Plan with the necessary urban transport data to carry out studies for limited geographic zones of the Lille urban area :<br>• providing location maps of the urban transport master plan projects, with their main characteristics,<br>• providing thematic maps of the existing urban |

89 *Guidebook for assessment of Transport Telematics Applications : updated version* - Deliverable D2.3.1., CONVERGE Project TR 1101 - Telematics Applications Programme - Transport Sector, ERTICO, prepared September 1998,

| | | |
|---|---|---|
| | | transport system situation, |

Only the assessment of the database prototype has been addressed.

The Urban Transport Master Plan project has just been approved by the *LMCU*. Its implementation has not yet commenced. Therefore, it is impossible to assess, at this moment in time, the prototype compared with the Observatory's initial objective, namely the monitoring of this implementation.

It is also not possible to assess the pertinence of the type of indicators chosen, compared with this principal objective.

Thus, the assessment presented in this document concerns :

- the achievement of the objective to develop the exchange of information between the public authorities' technical services (at State, Region, County and *LMCU* levels),
- the compliance with the technical specifications defined on the basis of the objectives detailed in the terms of reference
- the software ergonomics, using a test produced by several potential users of the Observatory's service.

### XIX.2.2 DEFINING EXPECTED IMPACTS OF THE LILLE TDSS AND ITS APPLICATIONS

The main expected effects were presented in WP3 and synthesized in the table below :

| Impacts expected | Target groups | Applications | Impact |
|---|---|---|---|
| A city and its transport network which more synergistically evolve | Public authorities and urban planners | Urban mobility observatory<br>Urban transport diagnostic maps | +<br>+ |
| A more global and coherent public action | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | ++<br>+ |
| A better knowledge of the global transport system, including all modes of transport | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | +<br>++ |
| A better co-operation between the local public institutions | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | +<br>+ |
| Dissemination of the results of the assessment of the impacts of the urban transport master plan actions | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | ++ |
| Dissemination of the results of the assessment of the impacts of the urban transport master plan actions | End users | Urban mobility observatory<br>Urban transport diagnostic maps | ++ |
| Improved data exchanges | Urban transport data providers and users | Urban mobility observatory<br>Urban transport diagnostic maps | ++<br>+ |
| Improved transport modelling tools | Public authorities | Urban mobility observatory<br>Urban transport diagnostic maps | +<br>+ |

Key : ++ : very positive impact; + : positive impact

### XIX.2.3 ASSESSMENT METHODOLOGY

This section presents the specific Lille assessment methodology key steps, based on the general procedure defined in the CONVERGE project.

- **Choice and definition of indicators :**
  The following table, taken from WP3, shows a list of the chosen assessment indicators.

| Category of assessment | List of indicators |
| --- | --- |
| Technical assessment (functional aspects) | • number of applications of the TDSS[90]<br>• number of domains for which data are integrated in the TDSS<br>• number of types of information made available through the TDSS<br>• number of functions of a generic TDSS implemented in the Lille site[91]<br>• quality of the functions made available in Lille : security, data quality checks, archive / storage facilities, format conversion, traceability, export,…<br>• OAMP[92] activities |
| Technical assessment (non functional aspects) | • architecture and technical choices<br>• scalability<br>• performance<br>• availability<br>• quality (data model, documentation, source code)<br>• implementation and maintenance costs |
| Institutional, legal and organisational aspects assessment | • number of organisations / services involved in the TDSS[93]<br>• existence of a maintenance agreement for the TDSS : quality of data updating procedures<br>• existence of data sharing / providing agreements for the TDSS and its applications |
| Financial assessment | • initial investment costs (in Euros)<br>• yearly OAMP costs (in Euros) |
| Users' requirements satisfaction | • monitoring the Lille Urban Transport Master Plan : for each strategic direction of the Lille Urban Transport Master Plan passed in December 1998, number of indicators defined and stored in the urban mobility observatory<br>• clear and understandable data representation (maps, graphs, indicators)<br>• quality of human – machine interface : measurement based on a questionnaire to be filled by the sample of users who will test the prototype |

- **Reference case :**
  The Lille prototype will be locally assessed in regard to the existing situation, in a "before and after" approach. Moreover, in order to provide guidelines for WP 8, a comparison with the technical and non- - technical recommendations for the implementation of a generic TDSS (outputs of WP 4 and WP 5) will be carried out.

- **Measurement plan :**
  The TDSS and the applications which are assessed in Lille are only prototypes. Especially, considering the urban mobility observatory, it means that the application will have to be improved in the future, both considering the indicators and data providers.

---

90 See page 67 of Deliverable 2 -*Users' requirements analysis*, for a detailed list of the considered applications of a generic TDSS

91 See pages 72-73 of Deliverable 2 -*Users' requirements analysis*, for a detailed list of the considered functions of a generic TDSS

92 Operations, Administrations, Maintenance and Provision

93 See page 68 of Deliverable 2 -*Users' requirements analysis*, for a detailed list of the considered organisations involved in transport information exchange of a generic TDSS

### XIX.2.4 ASSESSMENT RESULTS

#### XIX.2.4.1 Technical assessment

A. FUNCTIONAL ASPECTS

- Number of TDSS applications : **2**
- Number of domains for which data are integrated in the TDSS : **15**
- Number of functions of a generic TDSS implemented in the Lille site :
  - Exchange functions : **2** (collection, repository).
  - Other functions : **5** (search, check, log in, store locally, export, ).
- Quality of the functions made available in Lille :
  - security : only authorised users (information is protected by a password) can access the database. The three different defined users can, in theory, prevent unauthorised users from modifying data but, seeing that the base is developed using *ACCESS*, it is relatively easy to bypass these protective measures.
  - data quality checks. Two kinds of checks are carried out :
    - checking the validity of data in a digitised checking format (data within a lower and upper limit must be used),
    - checking the exhaustiveness of data; the software checks, as soon as an indicator value is input for a year and a area which are part of the division used for the indicator, that the indicator values are input for this specific year in all the areas included in this division.

    Validity data checks are not sufficient, additional checks must be made.
  - archive / storage facilities : there are three acceptable ways to input data in the base (directly, by area, by indicator); due to the procedures used, one cannot accidentally overwrite data (there is a distinction between procedures for adding and modifying data, a warning message appears if one tries to modify data); data checking is carried out afterwards (using the *contrôle format* function),
  - conversion format : there are no data format conversion procedures, conversions are made before inputting data in the base; generally, basic data processing into the format required by the Observatory is carried out without the software, in the future, data importing procedures will have to be developed,
  - traceability :
    - the organisation who supplies and manages the data required to constitute each indicator is defined in the base,
    - only an indicator's modification or creation date is saved; it will be worthwhile extending this possibility to indicator values (saving the value input or modification date in the VALUES table),
  - exporting : the software can be used to export data to *EXCEL* either automatically (using a "dynamic table"), or by the "copy and paste" procedure; some data can also be exported to this software using the *MAPINFO* link; lastly, all or some of the data can be exported to other *Microsoft* software (*WORD*, *EXCEL*, *ACCESS*) or other text files, using the "copy and paste" procedure; these different possibilities appear to be sufficient, even if they will have to be facilitated.

B. NON FUNCTIONAL ASPECTS

- architecture and technical choices against objectives :
  Chosen architecture is based on a single database. It is providing access to low volume static data with a low development and maintenance cost. We can therefore consider that it fits the users' requirements in terms of architecture.
- scalability :
  - hardware and Operating System :
    Targeted platform for the Lille prototype is a PC running under Windows NT, 95 or 98. This platform currently runs several low end DBMS, but would probably cause problems when adding new functions if required. Thus, it may be considered as a solution of "average" level scalability.
  - programming tools and languages :
    MS/Access does not allow the management of large databases. The maximum amount of data which can be dealt with is about 30 megabytes. Otherwise problems of data integrity may occur and performance dramatically decreases. Moreover, all the source code uses MS/Access internal language, so it may not be portable, even for future versions of MS/Access (for instance, compatibility problems between Access 2.0 code and MS/Access 95).
    All these elements make us consider that the scalability of the programming tools is low.
  - architecture :
    The prototype uses some kind of monolithic architecture. This allows limited scalability depending on the evolution of the performance of the machine.
- performance :
  All response times are very good, except for table's consistency checking. This action can take up to 10 minutes on a Pentium III, but it has to be used only when modifications have been performed on data.
- availability :
  Availability is not a critical issue for the prototype since it is designed to provide tools for long time transport planning and it does not deal with dynamic data. Anyway, the application is quite easy to reinstall in case of failure.
- quality :
  - data model :
    data model is clearly described in section 2.2 of chapter IX of this document and does not show any inconsistency.
  - documentation :
    A summary of the objectives of the project is included in section 1 of chapter IX of this document. A "programming report" (in French, "Dossier de programmation") was also provided, describing both installation and detailed design aspects.
  - code :
    Source code of the MS/Access base is well commented except for header comments that are missing. These header comments give general information such as file name, purpose, creation date, author name (e-mail address or phone number if possible) and also for each modification author name, date and purpose.
- implementation and maintenance cost :
  Since the application uses cheap hardware and software solutions, implementation costs

related to the development platform remain very low as compared to other solutions presented in section 4 of Deliverable 4.
Costs related to manpower effort are specifically detailed in a dedicated section.
Maintenance costs include support for the hardware, which are very low for the targeted platform, and support for the application which should remain very low for the corrective aspects (evolution aspects been considered in paragraph *scalability*).

Summary of technical assessment criteria evaluation :

| Criteria | Observation |
|---|---|
| Architecture / tools | Best choice |
| Scalability (hardware and OS) | Average level (PC only but widespread) |
| Scalability (programming tools) | Low (data volume limitations, function improvement can be difficult) |
| Scalability (architecture) | Low (relies on platform evolution) |
| Performance (data server) | Not relevant |
| Performance (application server) | Not relevant |
| Performance (client) | Very good (except data consistency checking) |
| Availability | Not critical, however good |
| Quality (data model) | Consistent, clearly described |
| Quality (source code) | Good comment level, except file headers |
| Quality (documentation) | Good, complete |
| Implementation cost | Dramatically low |
| Maintenance cost | Low, except for future possible evolutions (see *scalability*) |

### XIX.2.4.2 Users' requirements satisfaction

The assessment of users’ requirements satisfaction only concerns the first application developed in the DIRECT project framework, namely using the *ACCESS* database and its link with *MAPINFO*. The second application is not yet available for consultation.

A. METHODOLOGY

In compliance with recommendations of the CONVERGE project report, assessment objectives were defined on the basis of users’ requirements and in the following perspective : to which key questions do users involved in the project need a reply to?

In concrete terms, the assessment was carried out by comparing specifications in the initial terms of reference with the final prototype’s performances. Four potential users in LMCU and the County Council have tested the DIRECT prototype functions to give their qualitative opinion on answers to technical requirements provided by the system and the initially expressed objectives.

## B. ASSESSMENT CONCLUSIONS

**INSTALLING THE PROTOTYPE :**

No particular comment, no difficulties.

**DEFINITION OF THE INDICATORS, DIVISIONS AND OTHER PARAMETERS IN THE DATABASE**

Bearing in mind that these tasks are carried out by the database manager, the proposed procedures are satisfactory. It is worthwhile considering improving the procedure to differentiate between inputting new data and modifying existing data.

However, a major problem has emerged concerning zoning, the grouping of areas and the relationship between the different zoning measures. Indeed, there is only one procedure to manage both the zoning definition and the relationship between different zoning measures, and this is not very clear to the user.

**COMPILING THE DATABASE**

The terms of references defined two main objectives :

- On the one hand, the possibilities of storing information in the database, which has been extracted from other bases and using other formats;
- On the other hand, setting up checking procedures for the quality of input data.

Furthermore, users also assessed the various data input procedures.

- **The possibility of storing information extracted from other databases and using other formats**

  The terms of reference specified that the prototype should include the possibility of harmonising and converting data from other sources into a standard format.

  At present, it is only possible to input data manually, this means that the different indicators are manually converted before they are input into the database.

- **Checking the quality of data input in the database**

  In compliance with the terms of reference, three data checking procedures were provided. Their respective efficiency has been assessed in the following manner :

  **The *contrôle composition* function: checking failure for data input by indicator**

  This function checks that the elementary indicators have been compiled for all the division areas and the relevant years.

  It appears that the *contrôle composition* function works well when data is input directly, but does not work well when inputting data by indicators: indeed in this latter case, the application uses 0 by default to initialise values for the indicator and relevant year, as a result, no value appears to be missing when checks are carried out.

In order that the *contrôle composition* function works correctly in this particular case, *NULL* can be used to initialise values for the indicator and year to be input.

**The *contrôle format* functio*n: checking failure for certain percentage values***

The *contrôle format* function checks that an indicator's values comply with the format defined for this indicator.

The checking procedure does not work when the user inputs percentage values for indicators which are negative or higher than 100.

**The *contrôle table MAPINFO* function**

No particular comment concerning the *MAPINFO* table checking procedure.

- **Inputting data**

**The** *saisie directe* **function : the warning messages lack clarification**

The *saisie directe* function is used to directly input the indicators, value by value. The users find they have a difficulty because there is no summary of previously input data: indicator, area, year and corresponding value, (even though it is impossible to have the same data twice, thanks to *ACCESS* software operating rules).

**The *saisie par zone* and** the *saisie par indicateur* **functions :**

When inputting data by area and by indicator, the values must be initialised using *NULL* instead of 0, in order that the *contrôle composition* function is really effective. (see above).

**The *modification* function *:* no particular comment**

**The *recalculer* function : the processing time is long**

This function is used to recalculate all the indicators defined by a formula, as well as the addition of indications in consolidated divisions. The users consider that this procedure is too long.

- **Data exploitation**

The terms of reference included three essential factors defined by the users :

1. To be able to use data extracted from the Observatory with different users' tools which, from a technical point of view, meant that the choice of export files had to be left open.

When using the prototype in its present state, files are exported mainly to *EXCEL* or *MAPINFO* software, so that users have a wide range of processing procedures.

2. To meet the users' processing requests meant that on the one hand, they would have to be provided with calculation tools and on the other hand, possibilities of choosing areas within the Lille Urban Community area must be provided and lastly, the possible geographic consolidation of the same type of data must also be provided.

On this particular point, specifications in the terms of reference have been observed; the users have mainly analysed the different types of data exploitation and the user handbook.

**The *recherche multicritères* function *:* a complex formula**

Users found that the size of fields in the multicrition search is too small and prevents the indicators, areas or divisions with long names from being clearly identified.

Furthermore, to simplify the multicriterion search, a suggestion was made that scrolled lists should be used for areas, indicators,…….

**The *analyse croisée* function *:* considered very useful for cross-reference data exploitation analyses, but an extensive RAM is needed**

Indeed, this data exploitation requires that *ACCESS 97* and *EXCEL 97* must be opened simultaneously, requiring extensive resources.

Furthermore, users consider that updating the cross-reference table can take a long time when a great amount of data has to be displayed.

It was also found that in the cross-reference analysis, insignificant totals of line and/or columns were displayed.

Finally, as the indicators are not classified, it is difficult to choose those which have to be displayed or blocked out in the dynamic cross-reference table and complicates the use of the cross-reference analysis function.

**The *analyse thématique* and *camembert* functions *:* implementation difficulties and a need to provide more details in the user handbook.**

The remarks particularly address the pie chart analysis function, the definition of which is considered complex.

The user handbook is not enough explicit with regard to the procedure to follow: it does not explain that before choosing divisions and years, the user must first choose the indicators.

Lastly, an undefined error message appears when the user wishes to commence a new thematic analysis or a new pie chart analysis, if the user is still in *MAPINFO* mode.

With regard to the user handbook, generally speaking, users asked for more operating examples to be included in it, as well as a short presentation of *EXCEL* procedures, so that they can use all the possibilities available in the cross-reference analysis function.

3. To be able to export data to statistical tools and geographical information systems.

The prototype provides links to *EXCEL* and *MAPINFO*. These links are considered satisfactory by the users if, when using *EXCEL*, they can easily export data to other brands of software.

- **Storing and archiving data**

The objective defined in the terms of reference was to carry out chronological analyses from a 0 date (namely 1998, to monitor the UTMP implementation). In the database, the reference year of each value is indicated and the link to *EXCEL* makes it possible to carry out chronological analyses.

### XIX.2.4.3 Organisational and legal issues

*A posteriori*, and as no contract has been agreed by the partners, it has been found that the implementation of a database such as DIRECT raises many legal questions. These do not specifically concern the DIRECT database but also illustrate difficulties that arise when a database is not developed within a legal framework which has been properly defined by an agreement. The three main questions stemming from the DIRECT project, which are also a matter of concern for other databases, are the following: what is the status of data which are used to compile the base, what is the status of the database itself, what are the possible uses of results provided by the database, in what form and under which conditions ?

Indeed, all project partners must have a clear understanding of the rights or obligations associated to their contribution in developing the database. Therefore, the following paragraph contains a series of questions, which should preferably be clarified by a contract.

A. WHAT IS THE STATUS OF DATA USED TO COMPILE THE BASE ?

This is to determine whether the data used to compile the base are themselves legally protected, therefore restrictions apply to for their use. There are two possible situations :

- **Data provided by a private organisation**

  In this case, an agreement controls the possibilities of data being used and disseminated, and even the remuneration to be paid.

- **Data provided by a public organisation:** right of access to administrative documents, but restricted conditions for their use.

  Law n° 78-753 of 17th July 1978 specifies access conditions to public services data : the general rule is that public services are obliged to communicate, free of charge, by acknowledging that everybody has access rights to these documents.

  All individuals and legal entities have right of access to public services documents when access do not concern documents of a nominal nature, or documents whose are consultation or communication could breach "secrets of a commercial and industrial nature" (article 6).

Nevertheless, conditions for using public services data are limited :

- Article 10 paragraph 2 of the law dated 17th July 1978 specifies that « exercising the right to communicate excludes, for its beneficiaries or third parties, the possibility of reproducing, disseminating or using the documents communicated, for commercial purposes »,
- the use of data provided must remain compatible with the possible confidential nature of the data. Therefore, if certain public bodies can have access to detailed, public services data, they must sign an agreement with the data supplier, which defines their obligations so that nominal data and the processing of statistics provided to them remain completely confidential.

With regard to data from this source, there are two possibilities :

- Raw data is used
  - in the state they were collected
  - they have to be considered as "elementary raw data without an original presentation" (French decree of 14th February 1994).

**<u>LEGAL CONSEQUENCES</u>** : these data are considered as public property and therefore can be used without restraint by all and are free of charge.

- The data used have been enhanced
  - "processed data which have been enhanced and have acquired an added value" (French decree of 14th February 1994).
  - the layout of data has been changed
  - the change in layout meets the originality criterion required by the French Code for intellectual property :

Thereby :

- the added value shows proof of the author's personal contribution
- it now constitutes a new piece of work

**<u>LEGAL CONSEQUENCES</u>** : these data are protected by copyright. Data reproduction, adaptation, distribution and marketing remain the author's prerogatives. Thereby access to or use of the data without authorisation (and possibly without prior remuneration) is forbidden.

The question arises particularly for data provided by LMCU, who does not manage them and which it acquires from a third party : data from *I.N.S.E.E.* (the French national institute for statistics and economic studies) for example, may be protected by copyright if they have not been covered by an agreement defining their conditions of use and authorising their dissemination.

This also has implications regarding the status of the database as explained hereafter.

B. WHAT IS THE STATUS OF THE DATABASE ITSELF

The databases can be legally protected in two different ways : the database creator can be protected by copyright. The database producer is more specifically protected regarding the database content. Both legal systems are independent of each other, which means that both guarantees can be used simultaneously or independently of each other.

**Is the DIRECT database protected by copyright ?**

The French law dated 1st July 1998 has transposed the European directive 96/9/EC to the intellectual property code. It states that databases which, by the choice or layout of material, constitute an intellectual creation, distinctive of their author and are protected as such by copyright.

Therefore, to be protected by copyright :

- ♦ The database's composition must be original
- ♦ Namely, comprising a set of structured, integrated and organised data, in accordance with a precise and original nomenclature.

Conversely, the simple compilation of information will not be considered as a literary and artistic work able to benefit from protective measures. With regard to the prototype developed in the DIRECT project framework and any other database, the main question is, therefore, to know if the composition of the database which has been created is original.

**If the database is protected by copyright, who is the copyright holder?**

According to French law, the copyright law seeks to protect the creator, as a physical person. Nevertheless, French law accepts (exceptionally) that a legal entity can be a copyright holder. There are three possible applications of this exception with regard to database development:

**Is the database creator the copyright holder ?**

With regard to the DIRECT project for example, is the *CETE Nord Picardie* the copyright holder ?

**Sharing the copyright between the different participants who have created the database : the hypothesis of collective work.**

Work is considered as collective if :

- a legal entity has taken the initiative to create and manage it, including producing and publishing it under its own name,
- **<u>AND</u>** the outcome of different authors' contributions make it impossible to attribute to each of them a distinct right to the complete work.

With regard to the DIRECT project prototype, legal difficulties arise regarding who took the initiative and who managed the prototype's creation ?

- The DIRECT project research team ? (which does not have legal status)
- The *CETE Nord Picardie* ?
- *Lille Métropole Communauté Urbaine ?*
- A combination of the three ? (without legal status)

**Is it really impossible to distinguish the contribution of each author ?**

Therefore, the copyright holder(s) cannot be clearly identified when no agreement has addressed the question of copyright ownership.

**Cascading copyrights in the event that "joint work", defined in article L 113-2 of the French Intellectual Property law, whereby it is considered that "joint work" belongs to the author who produced it, subject to copyright status for pre-existing work".**

Therefore, an organisation responsible for a database that develops by-products with initial data, for which it has acquired user's rights from the database owner, will be able to obtain a specific copyright for these new products. But this copyright will have to respect the supplier's rights.

The extent of copyright protection : restricted protection for the container but which does not cover the content :

- The legal protection system for a database by copyright, guarantees that the author has the monopoly to reproduce, adapt, disseminate and market the database.
- What is protected by copyright in a database is the container, namely the database structure, and not the content, therefore not the data themselves. This important restriction stems from a European Community directive dated 11th March 1996 which institutes specific protection for databases.

**Copyright protection for database producers : this protects the database contents and the necessary investments made for its creation.**

Such protection, instituted by European Community directive dated 11th March 1996, has been transposed to the French law dated 1st July 1998, concerning the legal protection of databases.

**Who is the database producer ?**

The database producer is the person who takes the initiative and risks in the relevant investments. This is a **database manufacturer** who has made a substantial financial, material or human investment (the investments is measured qualitatively or quantitatively).

The manufacturer has the right to forbid the extraction or re-use of all or a substantial part of the database content:

- Extraction : the permanent or temporary transfer of all or a substantial part of a database contents to another medium by whatever means or in whatever form.
- Re-use : any form made available to the public of all or a substantial part of the database content.

## C. WHAT ARE THE POSSIBLE USES OF RESULTS FROM THE DATABASE, IN WHAT FORM AND UNDER WHAT CONDITIONS ?

The different partners' rights to use database results must be defined in **a contract**. With regard to administrative data; specific rules must also be respected.

**What items must be included in the contract ?**

- the nature and scope of the rights granted

It is most important to specify, in contracts for data use, the authorisations granted by the data owner.

Generally, the rights to use data mentioned in agreements concern :
- a right to use data for one's own purposes,
- a right to digitise an existing map with the intention of producing thematic maps,
- the right to use and disseminate data for commercial purposes
- the right to create by-products using original data and / or disseminating them,
- the right to sub-grant user rights to third parties that have been appointed and approved by the original data producer.

It is also preferable that the contract mentions the legal principle according to which the granting of rights, mentioned in contracts do not, under whatever circumstances, permit the complete or partial transfer of intellectual property rights.

- the financial conditions for granting right of access

- the respective responsibilities of data suppliers and users.

**Specific rules for the use of administrative data**

If the data originates from public services, they are subjected to dissemination conditions, particularly with regard to payment - which is addressed in the circular of 14th February 1994 concerning the dissemination of public services data[94].

The circular of 14th February 1994 concerning the dissemination of public data provides a legal framework to public services to define exploitation and marketing conditions for the public service data they have collected.

The State and all public bodies involved in the information market must, moreover, respect the current economic legislation principles applied in France and more specifically the edict of 1st December 1986 concerning the liberty of prices and competition. This edict particularly indicates that « the rules defined apply to all production, distribution and service activities, including those carried out by public persons ». Amongst of the measures likely to be used for processing geographical data, the following may be mentioned concerning :
- the obligation to makes one's charges available
- the refusal to sell
- discriminatory practices

94 Public services data is defined as data collected or produced by a public service, in the course of its work, using public funding.

To disseminate public data covered by the circular of 14th February 1994, a difference must be made when public data is disseminated to provide a public service and its dissemination when this is not a public service.

### The example of disseminating public data to provide a public service

In this case, rules for competition must be used as well as required by French public law. In this manner, the provision of data to a third party distributor can be refused if it threatens the service's existence.
Rules to be used with regard to charges are mentioned below. When data collection and elaboration are carried out for public service purposes by public bodies, the latter must only charge the costs to compose, print and distribute publications, the organisation, updating and the retaining of computer files, data extraction and making aids available (paper, diskettes, CD-ROM,...) as well as telecommunications services when, for example, this concerns digitised data.

### The example of public data dissemination which it is not a public service in the strict sense of the word

In this case, competitive rights must be respected according to common law conditions, and not lead to abusive practices which, for example, prevent a private company who is a competitor from establishing itself in the same market.

The costs for collecting and producing data must be taken into account to define the rules for charges, when these activities are not strictly in the framework of a public service provided by the public body concerned.

#### Principles for charging

The principle of systematically disseminating public data free of charge raises problems. It prevents private companies from competing, it means that the entire community pays for data elaboration and dissemination which is available to only a few users and additional public funding is needed for operating costs incurred by supplying data requested by users.

Consequently, the French circular of 14th February 1994 considers it is legitimate that one must pay for the dissemination of public data, particularly to compensate all or part of the expenses incurred. It limits the charge levels of the global cover of costs for disseminating the products : therefore, the public services charges are not of a profit-making nature.

With establishing charge levels, the circular makes a distinction to take into account the type of information and its consequent use :

- information which is exclusively disseminated by the public service (for example, legal population figures, identification details of companies and private individuals,...), it is recommended that such information must be paid for, even if the price is low,
- information which is disseminated and may be done in a competitive manner when all dissemination costs have already been paid for out of a public budget : access to this information by private competitors must charged at the marginal cost incurred for making it available,

- furthermore, for the final use of data, namely used by the data addressee for his own purposes, the circular recommends the expenses must be invoiced including, in all cases, a charge for the « right of access » to data, which is variable according to the kind of data, how often it is updated and how much work is required to update it,
- when data is used with a view of re-disseminating it in the future, whether it be free or paid for, the circular indicates the addressee might be subjected to the following obligations : obtain permission to extract data, the exploitation conditions must be of general interest and in particular, any excessive simplification or distortion is forbidden, the payment of royalties (the fixed annual amount, percentage of the access right which the final user has to pay, a percentage of the re-distributor’s turnover,...).

The circular foresees that particular measures which are more favourable to data users can be granted, in accordance with objective criteria and in relation to the service’s finality, in favour of certain categories of addressees : co-producers or donors, research workers, distributors of public body publications, a sector of the press if it plays an active role to circulate ideas, ...

If the TDSS involves several public bodies, it can be considered that the conditions are met for one of the examples where these particular measures apply, between co-producers of the TDSS.

### XIX.2.5 CONCLUSIONS ABOUT THE LILLE PROTOTYPE

Seeing that the period from installing the DIRECT prototype to its evaluation was very short it is only possible, at present, to provide partial conclusions.

With regard to the computer tool itself, a global, positive assessment can be given on its functionality. The only outstanding major problem concerns the divisions and areas. From a general point of view, the product can be reproached because it is not entirely user-friendly. However, it should be noted that it will be used by people who are accustomed to using *ACCESS* and *MAPINFO* software. In spite of these two reservations, which can easily be overcome, the product meets requirements stipulated in the terms of reference.

It would also be helpful to examine more closely how indicators are chosen. There is a great number of indicators in the database at present. It might be preferable to reduce the number and only retain those which can be useful in the framework of, for example, the monitoring of a transport master plan.

If the database is perpetuated, there will probably be an unavoidable evolution of indicator definitions: indeed, it is imperative that a specific indicator is always defined in the same manner, whatever its source may be. Nevertheless, the objectives and needs of a data manager to calculate an indicator are not necessarily those required by database managers and users. Work will have to be standardised in this respect.

Lastly, with regard to organisational aspects, at present there is no contract between the different partners. It is imperative that a contract is used if the prototype becomes operational and the additional relevant investments should be borne in mind. This would enable, on the one hand to settle the legal questions mentioned above and on the other hand, to perpetuate the structure by officializing the suppliers’ data transfer.

# XX. APPENDIX 6 : EVALUATION OF 5T, ROMANSE AND ROTTERDAM TRAFFIC CENTRE INFORMATION

## XX.1 5T

### XX.1.1 TURIN AND 5T

The city of Turin, in the year 1991, decided to launch the 5T project, a private-public co-operation, with the aim of assessing, in a large scale urban demonstration, the effectiveness of Transport Telematics applications.

The strategic goals were clear: increasing efficiency while reducing energy consumption and pollutant emissions. To achieve these goals, telematic solutions had to contribute to a better balance between demand and supply, as well as between the different modes. Favouring public and multimodal transport was the key issue.

A private-public company (5T) was incorporated in 1992 and the different demonstrators were built (1992-1996). **5T - T**elematic **T**echnologies for **T**raffic and **T**ransport in **T**urin - is both the name of the demonstration project and the private/public Consortium responsible for the project. From 1992 - 1996 5T designed and installed an integrated telematic system and in 1996 - 1997 experimentally tested its performance.

The total budget for 5T has been around ITL 23.6 billions of which about 1.8 billions was spent on testing.

5T whose experimental phase was completed in December 1997 is now operative and has entered the management phase

### XX.1.2 5T OBJECTIVES

The main goal of 5T, with respect to the private traffic is that of reducing congestion and the related effects on the environment (pollution). All the implemented functions are aimed at co-operating to achieve this goal; this is particularly true for at least four of the 5T systems: UTC (traffic control), VDS (collective guidance), DRG (individual guidance), and the Supervisor: indeed, main actions can be performed by routing and managing traffic in the best way.

All congestion types are included in the 5T perspective: predictable congestion, which can be anticipated by adequate prediction and modelling and removed through information to users; unpredictable, network wide congestion, which has to be tackled by feed-back at the area level, as well as local disturbances, which local feedback must avoid.

Extended over the whole urban area, 5T has to grant:

- **a 25 % reduction of the average origin-destination travel time;**
- **a 18 % reduction of the mobility related air pollution and energy consumption;**

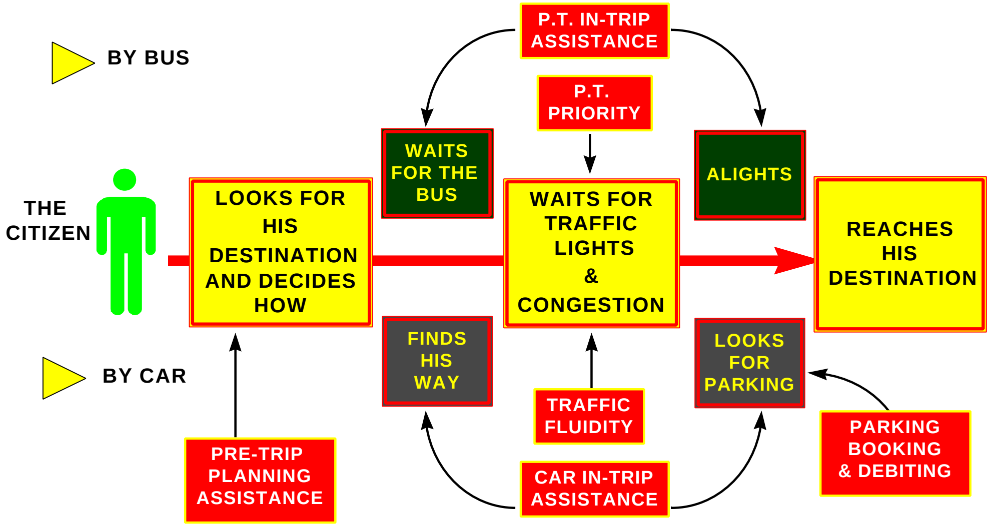
and improve modal split towards the public transport.

## XX.1.3 THE CITIZEN AND 5T

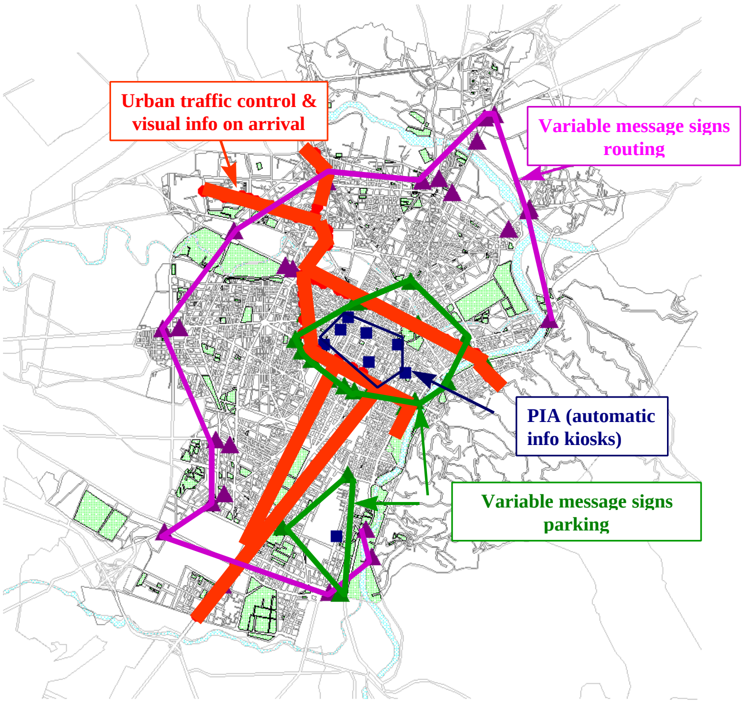
In the area where 5T is operating the citizen can get these services :

- Before making his (or her) trip he (she), or she, can get advice on the alternative or integrated use of the car or public transport, and on the best way to reach his destination. He can then reach the appropriate stop, if he uses public transport. At the stop he is provided with the information on his waiting time, and is alerted in case of large service perturbations so to make possible different choices. His trip is faster thanks to the public transport priority at traffic lights, and he is informed all along the way on the next stop.

- If he drives the car, he travels in a faster way as a consequence of the street side information, and/or the onboard information on the most effective route, and of the traffic fluidity generated by the traffic control system. He gets information on the occupation of the off-street parkings, where he is automatically debited of the cost not even having to stop.



## XX.1.4 5T EXTENSION ON THE CITY AREA

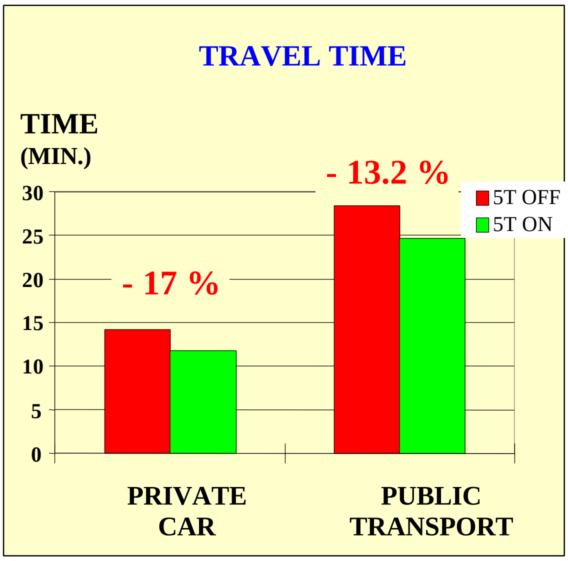



## XX.1.5 5T RESULTS

The Project was tested during a two years experimentation phase, ended in 1997.

The experimentation has been realised by observations and evaluations at the centre of the subsystems, by extensive on the field time campaigns of measurements, and interviews, and by a telephone survey on a panel of 500 citizens resident in the area of application of the system.

1. TRAFFIC AND PUBLIC TRANSPORT MANAGEMENT IMPROVEMENTS

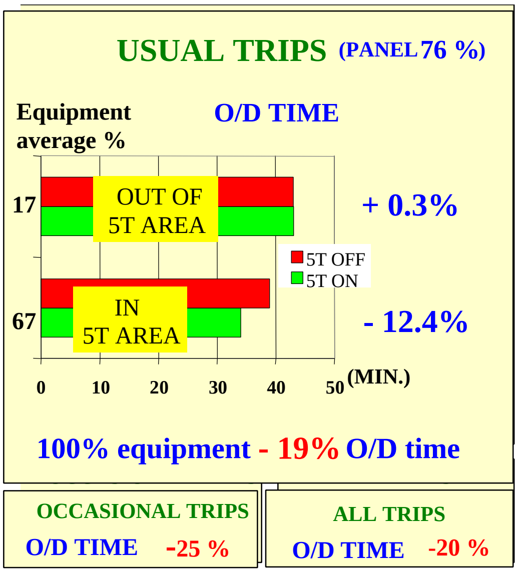



Trials have been carried out on 2 fixed routes (the whole public transport line 3 and part of line 4).
360 trips have been made both by car and by public transport, in scenario 1 (5T Off, that is 5T strategies not operating) and 2 (traffic control "on").

2. MANAGEMENT IMPROVEMENTS AND CITIZENS INFORMATION EFFECT

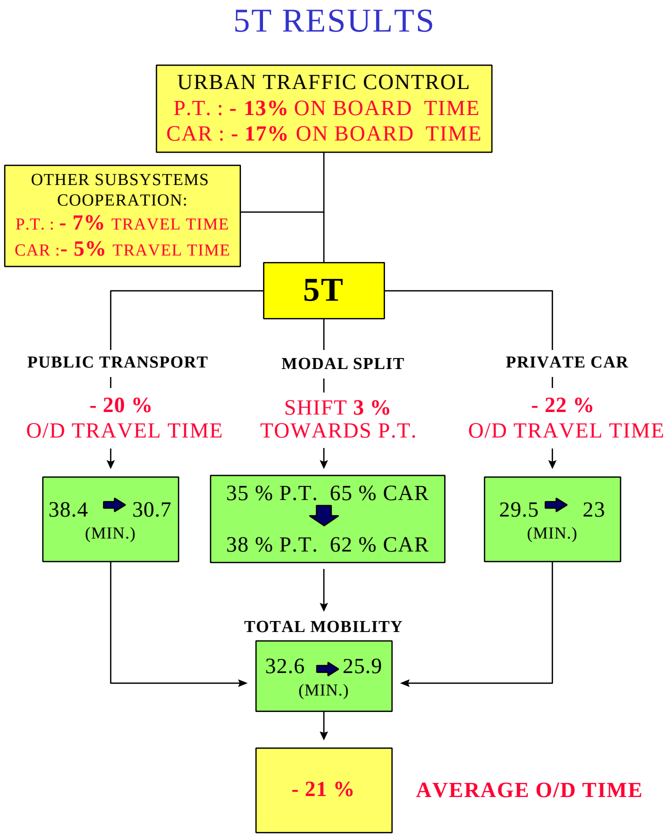
Private car

Public transport




Trials have regarded on 9 Origin/Destination pairs. 1020 trips have been made by public transport and 920 trips by car both in scenario 1 (5T Off) and 3 (5T On, that is with all the supervision, management, and information strategies operating). About 30% of the trips carried out in scenario 1 had the destination assigned just before the departure, simulating the "occasional trips". The results have been separately computed for the O/D pairs mainly out of the area controlled by 5T, and O/D pairs mainly within the 5T area, and for these last expanded by the degree of influence of 5T to represent the "full coverage" achievement. The effect is a *reduction of the average O/D time by 22% for the use of the car and 20% for the use of public transport.*

## 3. TELEMATIC TECNOLOGIES IMPACT




A panel of 500 citizens has been interviewed in the scenarios 1, 2, 3. Their trips show and increase of 3,3% of modal split in favour of the public transport.
On the basis of this figure and of the previous reported effects, the general impact of the 5T system can be stated as a *decrease of the average O/D trip time by 21%, equivalent to about 7 minutes per trip*.
The panel has perceived the public transport service quality improvement and has judged particularity well the passenger information subsystem.

The tests were carried out in the following conditions:

- Reference (Base) Scenario (or scenario 1): traffic lights regulated at fixed times, with local co-ordination along the arteries, but without priority for public transport vehicles (a scenario representative of the situation in most Italian cities);
- 5T Scenario (or scenario 3): dynamic and optimised traffic light regulation (SPOT-UTOPIA) with priority for public transport;
- Alternative Scenario (or scenario 2): optimised traffic light regulation (SPOT-UTOPIA) without adjustment for public transport priority

Results may be summarised as follows:

*Between the reference scenario and 5T scenario:*
- a decrease of about **17%** in travel time of private vehicles along the artery at peak time
- a decrease of **14.4%** in travel time of public vehicles along line 3
- no significant perturbation to cross-flow traffic, neither private nor public.

*Between the 5T and the Alternative Scenario*
- the commercial speed of public transport vehicles returned to the values observed in the reference scenario (with a loss, therefore, of 14.4% in travel times on line 3)
- the commercial speed of private vehicles increased, but only by 1%, showing that, with an optimised system, the impact on private traffic of giving priority to public transport is practically null.

It should be noted that these highly significant results were obtained with absolute parity of conditions between the various scenarios (e.g. with the same structure of traffic light cycles).

## 4. SUMMARY OF THE ASSESSMENT OF THE NON-TECHNICAL ASPECTS

| | **5T Consortium** |
|---|---|
| ***Institutional*** | |
| Co-operation | Yes, but there are no specific rules obliging actors to respect particular agendas. |
| Need for agreement | In the initial phase, it is essential to avoid the following situations:<br>• Lack of clear rules or specific responsibilities<br>• Lack of clarity in the relationships between partners in the consortium who are suppliers and those who are system operators. |
| Public-private partnership | For 5T, the public sector has involved the private sector, resulting in positive collaboration during the design and trial phases. |
| Responsibilities | Where there are a variety of actors involved, it can be difficult to determine the terms of responsibilities and the boundaries between them; it is also difficult to ensure that they are respected.<br>A structure is needed that defines responsibilities in the minutest detail. |
| Create a framework/strategy | In a horizontal type consortium structure like 5T, the strategy adopted is not managed as proposed by the DIRECT project. |
| ***Legal*** | |
| Ownership | The data collected and processed by 5T are available to other public bodies on request. The profits of 5T are indirect and are expressed in terms of benefit for the citizen.<br>Certain specific Public Transport information will be made available (via the new telecommunication technologies) to individual users, as a service for which a fee will be levied. |
| National differences | Existing legislation only regulates general relationships between several partners of a consortium. The internal statutes of the consortium are specific for the purposes of the consortium itself. |
| Privacy | No personal data is processed at the moment. Personal data, defined as "sensitive " by the Italian law on privacy, is in any case subject to particular safeguards and restrictions. |
| Copyrights | Accessibility to 5T data is reserved. No external body can access the data to alter it or use it improperly. |
| Liability | The reliability of the data supplied to the users (for the various levels) is a fundamental prerequisite for the system.<br>Each subsystem supplying data is responsible for the quality of that data. |
| Binding contracts | The contract stipulating terms between the various partners of the 5T Consortium is the statute signed when the Consortium was founded.<br>For higher levels of responsibility, the relevant laws of Italy provide the point of reference. |
| Data files clearly evident | Records and archives maintained. |
| Roles clearly identified | The roles of the partners must be clearly defined.<br>The events planned and any emergencies that may be foreseen must follow precisely defined procedures. |
| Conditions for new parties | The inclusion of new parties within the Consortium is not foreseen during the first life cycle. |

| | |
|---|---|
| ***Financial*** | |
| Raising funding | The operational management of the system is financed by the members of the consortium on the basis of a percentage stipulated in the contract.@@@ |
| Private finance | The private members finance a minimum part of system operation.@ |
| Income from data sales | Future developments of 5T include the provision of information services at a fee for citizens, as a way of financing the system. |
| Value for money | The value of the information lies in the following results:<br>- Reduction of time spent on board vehicles,<br>- Trip planning and consequent optimisation<br>- Reduction of congestion with less pollution and fuel savings as a result. |
| ***Organisational*** | |
| Project management | Management of the project has been delegated to a single co-ordinator. The co-ordinator, together with the steering and technical committees have the task of monitoring and managing the system.<br>In the near future there will be a private body in charge of the entire management and development of the system. |
| Process management | Process management is performed by the technical committee. |
| User needs | User needs must be regularly reassessed, as new needs may arise. |
| Responsibilities and roles | The responsibilities of individual consortium members are not clearly defined. |
| Estimating uncertainties | Lack of careful system verification and declining of responsibilities among the various actors have the effect of degrading resources, and this, in turn, has a rapid negative effect on system functionality indices. |
| One leader | For the reasons given above, an authoritative figure or body is essential for providing a point of reference. |
| Administration hierarchy | The administration hierarchy consists of the President of the Consortium and the steering committee. |
| Blocking powers | Predominant positions in the consortium can only generate situations where decisions are delayed and have a negative influence on the general progress of the service offered. |

### XX.1.6 CONCLUSION

This section presents the results of a large scale demonstration of an Integrated Traffic Management System implemented in Turin in recent years. In the system, Guidance and Information are provided to users, via different means, with the explicit goal of contributing to better traffic management. To this end, new methods for integrating Control, Information and Guidance in a consistent and user acceptable set had to be defined, designed and implemented.

The full evaluation has shown not only that large scale application is feasible, but also that the guidance and congestion avoidance strategies have a very high potential for increasing the efficiency of the transport network

It has been established that not only these systems have achieved the most favourable cost/benefit ratio, but also they form the "backbone' for integration with information from other systems.

The design process led to a hierarchical scheme, in which a new system at the upper level (the

Transport and Traffic Supervisor) defines in real time a feasible set point for the network, which is then used as reference by all lower-level systems.

It is concluded that TDSS has to be the active interface between those two levels that can live independently.

It allows the creation and management of a series of value added services that could be provided (on payment) by private operators using the information base provided by the integrated system. This arrangement would guarantee economic cover and develop capability for all system levels.

## XX.2 ROMANSE

Overview of the score of the main criteria for the non-technical aspects

| | **ROMANSE control centre** |
|---|---|
| ***Institutional*** | |
| Co-operation | Yes, with clear agendas for each actor. |
| Need for agreement | Institutional barriers causing monitoring problems (pollution information i.e.)<br>Such co-operation extends to agreements between local service providers as demonstrated by the private-public partnerships in the UK. |
| Public-private partnership | Yes, for example Siemens is involved in the ROMANSE control centre. |
| Responsibilities | No, a clear leader does not exist and responsibilities remain unclear. |
| Create a framework/strategy | A TDSS framework as proposed in the DIRECT project is not used. |
| ***Legal*** | |
| Ownership | Public transport operators provide data. ROMANSE is a public body and will not pay for information. Only charges by profit making organisations. |
| National differences | In the ROMANSE case the co-operation between partners is recorded in a juridical framework. This large juridical framework is lacking. |
| Privacy | Some personal data is collected (CCTV) plus surveys undertaken. All controlled under data protection act. |
| Copyrights | Strict laws control data and information can not be altered. |
| Liability | If the actors do not stand by the system, the system will not work to its optimal level as has been experienced. |
| Binding contracts | The ROMANSE project operates with no such contracts. |
| Data files clearly evident | Records and archives maintained. |
| Roles clearly identified | Minimal designation of roles within complex operating environments. |
| Conditions for new parties | The conditions for existing and new parties joining the system, are not clear |
| ***Financial*** | |
| Raising funding | European and local authority funding. DETR and Public-Private Partnerships assist operations. |
| Private finance | Private Finance Initiatives exists. |
| Income from data sales | Only sell data to profit making organisations or private purchasers. ROMANSE has obligation to provide data and information free of charge. |

| | |
|---|---|
| Value for money | Timesaving, reduction of congestion and incidents results from considerable financial investment. |
| ***Organisational*** | |
| Project management | Consists of Hampshire County Council and Southampton City Council. |
| Process management | Informal agreements and internal ROMANSE organisation. |
| User needs | Requires assessment for each individual user group or data user. |
| Responsibilities and roles | Unclear boundaries and not formally outlined. |
| Estimating uncertainties | In the Southampton case there was an uncertainty in the way the actors would co-operate. This seemed to be a problem that could be solved along the way, but in the end this lack of co-operation is the reason why the project is working below expectations. |
| One leader | See above. |
| Administration hierarchy | Generally lacking at present within consortium. |
| Blocking powers | In the ROMANCE case we can see that blocking power is a real problem if the project has to continue. If some of the actors use their blocking power, the whole project could slow down.<br>The lack of formal agreements or responsibilities could hinder project performance. |

## XX.3 TRAFFIC INFORMATION CENTER OF ROTTERDAM

Overview of the score on the main criteria for the non-technical aspects

| | **TIC-Nederland** |
|---|---|
| ***Institutional*** | |
| Co-operation | Yes, many suppliers of data which is integrated by TIC-NL |
| Need for agreement | Only two main parties who made an overall strategy |
| Public-private partnership | In the first negotiations that led to the TIC as it is now, there were three parties involved, next to the KLPD and the Ministry of V&W, there was the ANWB. In a later stage, the ANWB realised that it would rather like to be a service provider and it changed it's role to being one. Combination of public-and private organisations for the provision of general traffic information is not expected within Europe (at the moment). |
| Responsibilities | For TIC-NL the responsibilities of all partners are clear. Within the Netherlands regional TIC are not established yet because of responsibility problems |
| Create a framework/strategy | TIC-NL has a clear strategy but a TDSS framework as proposed in the DIRECT project is not used. |
| ***Legal*** | |
| Ownership | All data is collected by public organisations and the data is considers public. The service providers only pay for the transmission of the data (communication costs). |
| National differences | The co-operation between the partners is based on a large number of agreements between the partners. |
| Privacy | The information used by TIC-NL is not in conflict with Dutch privacy rules (an individual can not be traced). |
| Copyrights | The information provided by TIC-NL can be used, added up etc. by the service providers. Nevertheless they are not allowed to change the information. |

| | |
|---|---|
| Liability | Concerning the data collection many actors are providing data (even fuel stations). TIC-NL informed the service providers that the 'picture' of the traffic situation they get, is the most accurate, given the received information. |
| Binding contracts | TIC-NL has tightly controlled agreements. |
| Data files clearly evident | Records and archives maintained. |
| Roles clearly identified | In the TIC case the roles of the different owners and users have been clear from the beginning, there have been some changes, but the responsibilities have always been clear. |
| ***Financial*** | |
| Raising funding | In the TIC case the national government did want to have a Traffic information centre and control the information provided. The government itself raised the needed funds. |
| Private finance | TIC-NL does not have private investors. |
| Income from data sales | Public information can not be sold in a commercial way. The costs for Service providers are only for the communication between different systems. |
| Value for money | In the case of TIC-NL it is not clear yet if the information will be value for money. As the quality of the information will improve (expected in the near future), the value for service providers will become clear (which can be measures by the number of SP involved). |
| ***Organisational*** | |
| Project management | The governmental ideas are realised. Investigation of the user needs was not done. |
| Process management | In the TIC example, a lot of agreements between the partners have been made, so that the processes are clear. In this way it is easier to manage these processes. |
| User needs | Requires assessment for each individual user group or data user. |
| Responsibilities and roles | All roles and responsibilities have been separated from the start. |
| Estimating uncertainties | *This information is not available.* |
| One leader | V&W and the KLPD found TIC-NL. V&W is the leader and provides the budget required. TIC-Nederland has an independent status. During the start of TIC-Nederland V&W provided a so-called hero who had the passion and energy to realise TIC-Nederland in a short period[95]. |
| Administration hierarchy | *This information is not available.* |
| Blocking powers | The founders of TIC-NL have many possibilities to use blocking power. For other actors this is hardly possible. |

95 The realisation of systems in general shows that a hero is needed to make plans coming true.

# XXI. APPENDIX 7: EXISTING NATIONAL LEGISLATIONS ON THE USE OF DATA SOURCE

The European Commission is initiating a lot of legislation and guidelines on the use of data sources and the protection of the conductors of data sources. Most member states take over the legislation/guidelines suggested by the European Commission. Nevertheless there are many differences in the member states. These differences can be explained by the different timing in different States. Moreover the European Commission also improved the legislation over the years and the legislation within the member states might be based on different European Laws.

This appendix gives an overview of the situation in the member states participating in the DIRECT project.

## XXI.1 FRANCE

This section gives a summary of the laws and guidelines concerning data protection and data sharing. Nevertheless, the use of Data sources in France is not completely clear. Many problems on copyrights i.e. have been identified during the Lille pilot.

**Data status**

Any data exchange and storage system designer must first ascertain the legal status of data which they wish to integrate and process. They must check that:

- the data does not belong to a third party, particularly one who holds the copyright,
- the data complies with specific rules, in cases where this involves data from administrative (government services) sources.

**Protection by copyright**

A copyright provides the most general protective system used. There are two kinds of public data, with different implications with regard to protection:

- raw geographical data, unprocessed after the information has been collected, can be considered as being in the public domain, namely it can widely used by all and it is free, as long as it retains its raw state;
- information which is edited, representing something (in map format, a graph, etc.) and if this representation meets the originality criterion required by the intellectual property law, can become subjected to an appropriation which forbids unauthorised access and use without authorisation and possibly without prior payment of remuneration.

Article L. 112-2 in the intellectual property law defines the originality criterion of such representations as the mark of the author’s personal contribution, permitting the representation to become a new item in its form[96]. This category includes " illustrations, geographical maps, plans, sketches and works concerning geography, topography, architecture and science ”.

[96]As an example, the originality of a map may be how it is presented, the choices used for theroad networks, the colours used,....

### Protection of the database

Taking into account the digitisation process for geographical information and the creation of numerous specific databases, the legal debate in France has progressively moved from the protection of data itself to the protection of databases.

*Protection by copyright*

It is claimed that a database can be protected by copyright when it comprises a set of structured, integrated data, which is organised following a specific and original nomenclature.

The producer's prerogatives for the base concern the monopoly to reproduce, adapt, distribute and market the database. Exceptions from protection by copyright concern reproduction for private purposes, or its use to illustrate educational or research presentations. The duration of protection by copyright is 70 years.

On the other hand, the simple compilation of information is not considered as a literary and artistic item of work and therefore, cannot be protected by copyright. In particular, there is no protection by copyright when information contained in the base is stored in a purely automatic manner. Today, protection of the database by copyright only concerns the container (the architecture base) and not the content (the data itself).

### Specific means of protection

In order to remedy copyright restrictions which do not protect the data itself, the European Commission presented, on 15$^{th}$ April 1992, a proposal for a European guideline concerning the legal protection of databases: this item, modified on 4$^{th}$ October 1993, created another specific exclusive right, covering the database's content and providing the protection of essential investments made to create it.

If significant investments have been made to create the database, the database producer can enjoy specific protection, during a 15 year period. They have the right to forbid the unauthorised extraction or reuse of all or a substantial part of the database, for commercial purposes.
Users' access rights to the database are then restricted to:

- the extraction or reuse of non-substantial parts of the database, including its use for commercial purposes (if users indicate the source of information);
- the extraction or reuse of a substantial part of the database for private purposes (if the database's format is not electronic), or for non-commercial purposes, to illustrate educational or research presentations.

### The copyright holder

Once the principle of protection by copyright is accepted, the holder of this right must then be defined. However, copyright in France is oriented to the protection of the creator (an individual), a legal entity (company, public service, ...) *a priori,* is not considered capable of accomplishing an intellectual creation.

*The example of collective work*
It is exceptional when a legal entity is entitled to a copyright : this is for “ collective work ”, a legal notion which appears appropriate for the TDSS, when the criteria which consider that the work is collective are:

- the creation of work when the initiative is taken and under the work is conducted by a legal entity who will edit and divulge the work using its own name,
- the amalgamation of contributions from various authors who participate in the creation of the work to the extent that it is impossible to attribute to each of them a distinct right for the complete work.

*The example of composite work*
Another legal notion, defined in article L. 113-2 of the intellectual property law, can used for the TDSS : it is for composite work defined as “ new work, which incorporates pre-existing work, in which the author has not collaborated ”.

Article L. 113-4 of the intellectual property law specifies that “ the composite work is the property of the author who has produced it, with reservations concerning the copyright for the pre-existing work". In fact, one of the characteristics of data integrated in the TDSS is that data will no doubt be enhanced and modified when it is exchanged between different parts, each becoming in turn supplier and user. In this manner, it is probable that the TDSS will be considered as composite work.

However, in order to exercise rights for composite work, the wishes of the original suppliers of the work containing the initial data must be respected. The exploitation of this work is therefore only possible with the consent of original data owners who can then insist on being linked to the exploitation results through the payment of royalties. With the example of the TDSS, it is possible that multiparty agreements will have to be signed to exploit the original databases, these agreements will specify dissemination rights for products resulting from the exploitation of the TDSS.

**Other means of protection**

Apart from copyrights, France has other legal measures to provide data protection. However, it only provides indirect protection which does not attribute a private right: the victim will have to provide proof that a fault, or damages, or a causality link exists between the fault referred to and the prejudice sustained. Protection is possible through unfair competitive legal actions or by signing contracts, if exploitation monopoly normally granted to the owner is dismissed.

**Access and processing restrictions for certain types of data**

Certain types of data are subject to access and processing restrictions, either because it concerns nominal data, or it concerns commercial or industrial secrets.

*Public services data*
Law n° 78-753 of 17$^{th}$ July 1978 specifies access conditions to public services data: the general rule is that public services are obliged to communicate, free of charge, by acknowledging that every body has access rights to these documents.
However, this principle for the liberty of communicating public services data is restricted when access to specific data is required, due to its nature (data which could involve national

security), or how it can be used. All individuals and legal entities have right of access to public services documents when access do not concern documents of a nominal nature.

Furthermore, conditions for using public services data are limited.
Article 10 paragraph 2 of the law dated 17th July 1978 specifies that " exercising the right to communicate excludes, for its beneficiaries or third parties, the possibility of reproducing, disseminating or using the documents communicated, for commercial purposes ".

The use of data provided must therefore remain compatible with the data's confidential nature. For public bodies to have access to detailed public services data, they must sign an agreement with the data supplier, which defines their obligations so that nominal data and the processing of statistics provided to them remain completely confidential.
To conclude, the right to access public service documents can be subjected to other restrictions. Article 6 of the law dated 17th July 1978 authorises public services to refuse the right to divulge public services documents when consulting or making them available would breach, in particular, " commercial and industrial secrecy ".

## XXI.2 ITALY

There is no information available about legislation of the use of data sources in Italy. The general Transport and Traffic laws are given in this section.

### The Law of 15th March 1997 n. 59

The law involves the amending of the Public Administration and the administrative simplification. It foresees that the planning and the management of public transport services is delegated to the regions. In particular, the regions have to define the minimum level, both qualitative and quantitative, of public services in order to satisfy the demand of the citizen mobility.

The costs of further services, with regard to the minimum level of services, are to the account of local authority. Each region has to make programme agreement with the Ministry of Transport; then they have to regulate the public service through public service contracts. The contracts force the transport companies to achieve a ratio, between traffic revenues and operating costs, at least of 0.35.

Moreover, the law foresees that the Government will define the way to introduce competition rules in the mass transport sector and will establish evaluation systems of public services, as the citizen's charter commitment, involving the user associations in defining and evaluating the results achieved.

### The Legislative Decree of 19th November 1997 n. 422

In compliance with the law above mentioned, the decree fixes the functions and the tasks, with regard to regional and local transport services, awarded to the regions and local authority (provincial administrations, communes and so on) and the criteria to determine the minimum services.

The transport services mentioned in the decree are:
- All the public transport services of people and goods inside a region

- Regional railway services not in concession to the National Railway Company (F.S. S.p.A.)

The regions draw up the transport regional plans considering the planning of: provincial administration, metropolitan areas, local authorities with the aim to improve the intermodality and the employment of means of transport with the lowest environmental impact.

Moreover the regions draw up triennial plans of public transport local services that fix:
- the network and the organisation of transport services
- the modal and fare integration
- the modality of fare definition
- the modality of carrying out the public service contracts
- the monitoring system of the services
- the economic resources for public services
- the ways to reduce congestion and environmental pollution

In order to usher the competition rules in the management of regional and local transport services, the regions and local authority have to make use of examination procedures.

The decree states that the service contracts, which the law above mentioned refers to, can't have a duration higher than nine years. In particular the contracts fix:
- the period of validity
- the characteristics of the services offered and the running programme
- the minimum qualitative standard of the service (e.g. the age, the maintenance, the comfort and the cleanness of vehicles and the service regularity)
- the tariff structure

**The Regional Law concerning regional and local transports**

The law has still to be settled by the regional council; the proposal of the law foresees that the regional public transport system will be structured in this way:
- regional services and networks (connection among the main centres of the Region)
- provincial services and networks (traffic basins: the Piedmont is divided into seventeen basins)
- urban services and networks
- integrative or substitutive of scheduled services (low density areas)

The law establishes the minimum services in relation to the integration among transport networks, school and working commuting, access to administrative-sociomedical-cultural services, reduction of congestion and air pollution.

The expenses of all the services over the minimum level are debited to the local authority that has authorised the services. The local authority can also authorise transport services operated by third parties in a free market system; in this case no subsidy by local authorities has foreseen.

**The Regional Law 23 rd January 1986 (general law on transports and traffic)**

The law plans the transport system in order to:
- foster the mobility of people and goods

- qualify the productive system
- encourage the energy conservation
- protect the habitat
- control the public expense

In order to plan the regional transport the law forces the region to predispose the regional plan of transports; the plan is the main tool for indicating and synthesising the regional policy in transports. In particular the plan fixes the general lines of tariff policy, the modality to determine the economic cost and the assignation criteria of services to the basins of transport.

The plan co-ordinates and integrates the schemes of provincial plans that, in their turn, include the running integrated programmes; they contain, for each basin of service, technical and tariff parameters that characterise the service.

The plan helps in drawing up the national transport plan too. The plan has to be respected by all the provinces, cities, communes.

The law fixes four functional ranges of communication:
- international and national (airports, main road and railway networks)
- regional
- of basin
- local

and classifies the services in urban, suburban and interurban.

The region delegates to the provinces:
- administrative functions related to tramways, underground lines, bus and trolleybus lines
- concession of building and running of transport lines
- approval of the timetables and tariffs
- supervision on the regularity of transport services

Moreover, the law establishes the regional committee to co-ordinate transports and mobility: it has the task to aid in drawing up the lines for the regional plan of transports.

**The circular of 8th August 1986 n. 2575 concerning road traffic in highly congested urban zones**

The circular, issued by the Italian Ministry of Public Works in order to rationalise the urban road traffic, has established the Urban Plan of Traffic: this Plan, updated every two years, is a complex and articulated totality of co-ordinated interventions in order to:
- foster the transit of public means of transport
- insure the flow of the private traffic
- reorganise the parking management
- reduce the noise and air pollution
- improve the traffic safety
- increase the pedestrian precincts
- equip cycle tracks both for free time and job displacements

The main operating criteria are:
- the division of the parking flows from the traffic flows

- the hierarchical and functional road classification
- the adaptation of the intersections to traffic flows
- the parking organisation
- the priority to the public transport means

The Plan defines the interventions on the grounds of the indications of the Town Planning Scheme.

In accordance with the Highway Code (Legislative Decree of 30th April 1992 n. 285), the functions to be assigned to each road are:
- flowing, for the crossing of the city
- quarter, for the mobility between and inside the quarters
- local, for the accessibility to the street services.

As regards the City of Turin, the Municipality has conceived the Plan as an operating programme that prearranges the guidelines of the future Mobility Plan extent to the metropolitan area, that will be a kind of town-planning scheme to made the detailed sector plans.

In the current Plan the Municipality of Turin has pursued these aims:
- interventions on the road and public transport networks so that the traffic, both public and private, can flow freely and more safely
- management of the mobility demand in the urban zones where the problems related to both the congestion and parking availability are more relevant

The actions undertaken have been, respectively:
- protection of the public transport lines and surveillance, with data processing systems, of the respect from private traffic; identifying the main roads across the city in order to make the traffic free; reduction of the traffic in the town centre
- increase in the intermodality and paying car park
- In particular the Urban Traffic Plan strengthens the role of the 5T Project in traffic control and in giving priority to the public transport means.
- With regard to parking policies, the Municipality of Turin has drawn up the Urban Parking Programme; actually the Programme is applied only to the car parks in the city, but the aim of the Municipality is to drawing up an Urban Parking Plan involving all the municipal territory.
- Finally, the Italian Ministry of Public Works is fixing the Directives in order to draw up a new Urban Traffic Plan: the Mobility Plan mentioned above; the current proposal foresees three design levels:
    - General Urban Traffic Plan
    - Detailed Traffic Plan

## XXI.3 GREAT-BRITAIN

In general Britain follows the European legislation. The main document on legislation in Britain is the White paper available hereafter.

**United Kingdom DETR Policy Document (Summary of Key Sections)**

*"A New Deal for Transport: Better For Everyone - The Governments White Paper for Transport"*

## A1 Background

The UK government published their White Paper on the future of transport in August 1998. The document outlines the aims and objectives of the DETR and identifies the institutional, organisational, financial and legal issues that are required to achieve them. In doing so the government fulfilled their manifesto commitment to create a better, more integrated transport system. The White Paper is not just about national policy, as Local transport plans will create a partnership between local councils, businesses, operators and users. Furthermore a new Commission for Integrated Transport will bring together transport users, the private sector, local authorities and others to make recommendations to Ministers. A review of the main issues from the White Paper identifies the non-technical issues within which a TDSS would have to operate.

## A2 Institutional Issues

**Integrating Transport And Planning In The English Regions**
Proposals for modernising the planning system in England highlight the importance of planning at the regional level. Regional planning conferences (SERPLAN) or similar groups of local planning authorities have a key role in advising on the most sustainable way of meeting the demand for new housing in their regions. Earlier this year, a consultation exercise was undertaken on a package of proposals for reforming Regional Planning Guidance (RPG). A key proposal is for RPG to include a regional transport strategy. Proposals for improving RPG and promoting greater ownership have been widely welcomed.

**Regional Transport Strategies**
In England, regional planning conferences or similar groups of local authorities working with the Government Offices for the Regions, in partnership with RDAs, will have direct responsibility for preparing the new RPG in draft and for consulting widely on it. This replaces the current arrangement in which planning conferences give advice to the Secretary of State. This means that regional conferences will be responsible for the development of long term regional transport strategies, giving people a greater say in what happens in their region.

In approving RPG, the Secretary of State will need to be satisfied that the transport strategy does not conflict, without good local reason, with national policies. The regional conferences will use RPG to integrate the planning of major new development at the regional level and the identification of regional transport investment and management priorities. In doing so, the conferences will need to consider including in RPG:

- public transport accessibility criteria for regionally or sub-regionally significant levels or types of development, to be set out in development plan policies to guide the location of development;
- guidance for development plans on the approach to be taken to standards for off-street car parking provision, relating these to accessibility by public transport;
- a strategic steer on the role of airports and ports in the region in the light of national policy;
- regional priorities for transport investment and management to support the regional strategy, including the role of trunk and local roads;

- traffic management issues which require consideration either regionally or sub-regionally;
- guidance to local authorities on the strategic context for introducing measures such as road user charging and parking levies.

In developing the regional strategy, conferences will also have to liase closely with transport operators and infrastructure providers in their regions, the Highways Agency and the Strategic Rail Authority.RPG will also need to take into account the implications at a regional level of EU policies, including the evolving European Spatial Development Perspective (ESDP).

**Strategic Rail Authority**

A new rail authority will be established to provide a clear, coherent and strategic programme for the development of UK railways. The Environment, Transport and Regional Affairs Committee of the House of Commons has supported the plan for a Strategic Rail Authority as a practical way of addressing the problems of the restructured railway. The new authority will be a statutory body with board members appointed by Ministers. It will be subject to instructions and guidance laid down by Ministers in accordance with the new integrated transport policy.

The authority will consult the devolved administrations in Scotland and Wales about the exercise of its functions as they relate to their interests and will play an active role in the new arrangements for regional planning in England.

The Strategic Rail Authority will provide a focus for strategic planning of the passenger and freight railways with appropriate powers to influence the behaviour of key industry players. This will provide a better means of influencing the use of the significant amounts of public funds that are provided to the industry. The Authority will:

- promote the use of the railway within an integrated transport system;
- ensure that the railways are planned and operated as a coherent network, not merely a collection of different franchises;
- work closely with local and national organisations, including local authorities, Regional Planning Conferences, Regional Development Agencies, transport operators and the Highways Agency and the equivalent organisations in Scotland and Wales to promote better integration;
- participate actively in the development of regional and local land use planning policies, and ensure as far as possible that decisions on the provision of rail services dovetail with these policies;
- ensure that rail transport options are assessed in a way which constitutes good value for money and optimise social and environmental gains;
- take a view on the capacity of the railway, assess investment needs, and identify priorities where operators' aspirations may conflict with one another;
- promote the provision of accessible transport for disabled people.

The authority will take over responsibility from the Office of Passenger Rail Franchising (OPRAF) for the management of passenger rail franchises and the administration of subsidy for passenger services.

**Role of Passenger Transport Authorities**

The six English Passenger Transport Authorities and their Executives (PTAs/PTEs) (ie Greater Manchester, Merseyside, South Yorkshire, Tyne and Wear, West Midlands and West Yorkshire) and Strathclyde in Scotland are responsible for securing public transport services for some 14 million people in major urban areas outside London.

PTA/Es are important in developing integrated transport in metropolitan areas through:

- providing a more strategic approach to passenger transport issues in urban areas where there is a heavy reliance on public transport;
- securing tendered bus services;
- as joint signatories to rail franchise agreement, specifying and funding local rail services;
- a strong role in promoting integrated public transport services;
- close joint working with highway authorities and others, for example, in working up package bids with district councils which provide the framework for decisions on bus lanes and other priority measures.

**Local transport plans**

New local transport plans will be a centrepiece of many proposals. Local authorities outside London will set out in these plans their proposals for delivering integrated transport over a five-year period. The detailed arrangements in Scotland, Wales and Northern Ireland will be set out in the Scottish Integrated Transport White Paper and the transport policy statements for Wales and Northern Ireland. Local transport plans will have three key roles:

- local transport plans will be key to the delivery of integrated transport locally;
- local authorities will draw up 5 year plans, consulting widely with local people, businesses, transport operators and community groups;
- will include future investment plans and propose packages of measures to meet local transport needs.

**The plans will:**

- cover all forms of transport;
- co-ordinate and improve local transport;
- set out strategies for promoting more walking and cycling;
- promote green transport plans for journeys to work, school and other places;
- include measures to reduce social exclusion and address the needs of different groups in society;
- set out proposals for implementation, including bus Quality Partnerships, traffic management and traffic calming, proposals for road user charging and PNR parking charges and freight Quality Partnerships.

**Local transport plan targets could include**

- air pollution-to improve local air quality;
- traffic reduction-from the Road Traffic Reduction Act 1997;

- cycling-eg to increase the number of cycle trips or to increase the proportion of journeys made by cycle;
- walking-eg to reverse decline in walking or to increase walking journeys to school;
- use of public transport-eg to reverse the decline in patronage and to achieve a shift from car to bus;
- road safety-eg to reduce number of road casualties;
- green transport plans-eg for the preparation of plans by major local employers or for

reducing journeys to school by car.

**Technology - Research And Development**
Technological development offers many new and better opportunities for integrating transport. The private sector is expected to play a full part in bringing to the market transport technology that supports integration. The DETR will seek to remove institutional and other non-technical barriers to the use of technology, in partnership with others.

The DETR’s main aim is to identify and assess all the implications (including the safety, environmental, social and financial implications) so that the likely effects of implementing a specific technology or group of technologies are identified. Although the development and deployment of some technologies are likely to occur in the normal course of business, action will be taken when necessary to promote progress. For example, the DETR will:

- consult widely on technology development and research needs;
- support research and development of relevant promising technologies-through either wholly funded research and Seedcorn programmes or collaborative schemes such as a LINK programme;
- support trials, demonstration and validation projects and pilot implementation projects;
- oversee the dissemination of research results and promote good practice;
- facilitate public-private partnerships with clearly defined roles;
- provide incentives to promote the use of cost-effective technology through fiscal and regulatory measures, and promote discussions on the way forward;
- ensure that the aims and objectives of the White Paper are fully integrated into the new Foresight 2000 initiative.

Research and development into technology is carried out by many organisations: the European Commission, local authorities, research councils, the science base and industry. A partnership approach will often provide the best way forward. The DETR is working with other European partners, to ensure that the EU Fifth Framework Research and Development Programme supports research relevant to integrated transport and will complement national research.

## A3 Legal Issues

**Local Bus Service Deregulation**
Local bus services outside London are currently provided under the framework established by the Transport Act 1985. Bus operators are required to meet the criteria for grant of an operator's licence by the local Traffic Commissioner: they must be of good repute, have sufficient funds to run their business, and have adequate arrangements for maintaining their vehicles. Decisions on which services to run on a commercial basis are made by operators, subject only to the requirements that services have first to be registered 42 days in advance with the Traffic Commissioner and have thereafter to be operated as registered. In addition to commercial services, local authorities are able, after competitive tender, to subsidise socially necessary services not already being provided commercially (16 per cent of total bus mileage outside London is subsidised in this way).

Deregulation of the local bus market, outside London, caused substantial upheaval because of 'bus wars' and confusion over changing service patterns. Although there have been some good examples of innovation, frequent changes to bus services, poor connections and the reluctance of some bus operators to participate in information schemes or through-ticketing has undermined bus services. In this climate, it was not easy for buses to match the levels of comfort, reliability and access offered by the private car.

Deregulation has not broken the spiral of decline in local bus use. Since 1986 bus use has fallen by about a quarter - by about one billion fewer journeys a year; in contrast with London, within a regulated market, where use has held up. More recently, there have been good examples of bus companies and local authorities working together in Quality Partnerships to change the image of bus services and stem, sometimes even reverse, the decline in patronage.

**Rail Privatisation**

The previous Conservative Government supported the progressive liberalisation of access to the rail network by passenger train operators, who would compete with those already providing services. The Rail Regulator is legally committed to introduce greater competition from 1999. But open access with inadequate safeguarding of the public interest could lead to a loss of network benefits in areas like ticketing and timetabling. The Rail Regulator has therefore set in hand arrangements to introduce limited competition subject to strict safeguards. Competition will not be allowed if it would undermine existing services supported by the taxpayer or reduce network-wide passenger benefits. The Strategic Rail Authority will be able to set the longer term policy framework for competition, ensuring continuing safeguards against erosion of a properly integrated network.

**International and National Targets and Standards**

There exist international and national targets for protecting the environment. The Royal Commission on Environmental Pollution has produced two comprehensive reports on reducing transport's impact on our environment and proposed targets to drive the process. Challenging targets are helping to focus attention on reducing greenhouse gas emissions, improving local air quality and road safety, boosting rail freight and encouraging more cycling.

Current targets include:

- greenhouse gases - legally binding target to reduce emissions to 12.5% below 1990 levels by the period 2008 to 2012 and a domestic aim to reduce CO2 emissions by 20% by 2010;
- air pollution - National Air Quality Strategy, encompasses health-based objectives for a range of air pollutants to be met by 2005;
- EU vehicle and fuel quality standards - to reduce toxic emissions and noise from new vehicles;
- cycling - from a 1996 base, double cycling by 2002 doubling again by 2012 (from the National Cycling Strategy);
- road safety - existing target for 2000, new target for 2010.

Targets for the future include:

- freight on the railway - endorsement of the industry's targets for growth;
- EU vehicle standards - target to improve fuel efficiency and reduce CO2 emissions by more than a third before 2010;
- health - proposed targets in "Our Healthier Nation" for reducing all accidents by a fifth by 2010 and reducing death rates from heart disease and strokes amongst people under 65 by a third by 2010;
- green transport plans - for HQ/other key Government buildings by 1999/2000;
- walking - targets being prepared to reverse the decline in walking;
- public transport - targets to encourage more use of public transport;

- road traffic - assess impact of measures in this White Paper and consider national targets for the level of road traffic.

Following the Kyoto climate change conference in December 1997, the UK has a legally binding target to reduce greenhouse gas emissions to 12.5% below 1990 levels by the period 2008 to 2012. This means a reduction equivalent to 27 million tonnes of carbon. There is also a domestic aim to reduce $CO_2$ emissions in the UK to 20% below 1990 levels by 2010.

## A4 Financial Issues

**Funding Transport**
Planned expenditure on transport during 1999 includes some £1.6 billion on railways in Great Britain, around £3 billion on local transport in England and £1.3 billion for the English trunk and motorway network. In addition, through partnership with the private sector, the level of privately-financed investment in transport will increase by at least a half over the next three years. New sources of finance to relieve the burden on the taxpayer will include:

- public-private partnership for London Underground, bringing in some £7 billion of investment, and for the Channel Tunnel Rail Link with some £6 billion of investment;
- public-private partnership for air traffic services to secure future investment needs;
- local authority airports-relaxation of public sector borrowing controls;
- dedicated income streams from road user charging and parking levies to fund local transport packages;
- pilot charging schemes for motorways and trunk roads;

advice from the Commission for Integrated Transport on the costs and benefits of transport.

**Sources Of Local Authority Funding**
Current expenditure on local transport is supported by central Government through the local government finance system. There is a standard spending assessment (SSA) which recognises maintenance of local roads and authorities' support for local bus services and concessionaire fares. The DETR pays a special grant to passenger transport authorities (PTAs) in relation to the franchised rail services in metropolitan areas.

The DETR supports local authority capital expenditure through allocations of grant, and by issuing credit approvals which permit authorities to finance expenditure through borrowing or other forms of credit. The DETR provides capital resources to local authorities through the transport policies and programmes (TPP) system. Funding for transport projects under the Capital Challenge pilot scheme, administered by the Government Offices for the Regions, was started in 1997-98. Support for the projects selected is being given over a three-year period, 1997-2000.

**Private Finance Initiative (PFI)**
The Private Finance Initiative the Treasury has agreed a £250 million initial budget for the capital element of English local authority contracts for assets and services on a design, build, finance, operate (DBFO) basis. For 1998-99 a budget of £500 million has been agreed. This will permit revenue support to local authorities that bring forward schemes. Local transport schemes can benefit under this provision.

Local authorities are developing private finance proposals for public transport infrastructure, roads and other transport schemes such as bridges, ports, airports and further street lighting projects.

**Railways fares**
One of the most obvious failures of rail privatisation has been the perceived lack of a clear, understandable national fare structure. Some key fares are regulated by the Franchising Director and from 1999 until 2003 fare increases will be restricted to Retail Price Index minus 1%-a fall in real terms.

Fares are only one of many key decisions that are currently reflected in franchise agreements with train operators. A number of franchises expire in 2003/4**.** In seeking new operators, the Strategic Rail Authority will have the opportunity to specify service levels and passenger benefits which fully reflect an integrated transport policy. The capability for the public sector to take over franchises as a last resort, for example, if there are no acceptable private sector bids, will be retained.

**Funding bus services**
Effective local bus services will be an essential part of the new policy. Better bus services in urban and rural areas will help to improve alternatives to the car and reduce social exclusion.
The bus industry will benefit significantly from proposals to strengthen the role of the bus. At present around one-quarter of the seats on a bus are occupied on average. An average increase of only two passengers per bus, typically achieved by a Quality Partnership, could generate up to £400 million in revenue for the industry. Such initiatives can also reduce operating costs by improving reliability. In addition, the industry receives a significant level of support-around £1 billion in total this year-through fuel duty rebate (£270 million), direct subsidy (outside London, local authorities spend some £230 million on bus services), and concessionaire fares (around £440 million). Taken together, this should produce much greater financial certainty than the industry has had for many years which, together with increasing patronage, will transform the economics of the bus industry.

The Audit Commission is currently looking at local authority revenue support in England and Wales for local transport and travel, including expenditure on locally subsidised bus services and (in the Passenger Transport Authority areas) rail services, home-to-school transport and concessionaire fares.

## A5 Legal and Financial Issues

The DETR is preparing the following proposals for new legislation.

i. Local Authorities (Transport Charges) Regulations, to authorise local authorities to impose various charges for their own administrative work on highways, road traffic regulation and travel concessions. These Regulations were laid 9 February 1998.
ii. In connection with the Private Finance Initiative, a Contracting Out (Highways Functions) Order to enable local highway authorities to authorise other persons to exercise certain of their functions in relation to maintenance and improvement of highways.
iii. A special grant report for the payment in 1998-99 of grants to support metropolitan passenger rail services.
iv. An Order under the Humber Bridge (Debts) Act 1996 to provide that the Humber Bridge Board will not have to meet a proportion of its current debt or, on the residual

debt, a proportion of the interest that would otherwise be due. This is intended to make it possible for the Humber Bridge Board to discharge its remaining obligations.

**Investment In Rail**
Passenger train operators are required under the terms of their franchises to make substantial investment, notably in ordering new rolling stock. So far, these have translated into commitments for nearly £1.6 billion worth of new or re-bodied stock as well as other contractual commitments to improve services to passengers, for example, through station improvements, which will represent additional investment.

## A6 Organisational Issues

**Commission for Integrated Transport**
A new independent body, the Commission for Integrated Transport (CfIT), will be established to provide independent advice to Government on the implementation of integrated transport policy. It will also monitor developments across transport, the environment, health and other sectors and review progress towards meeting policy objectives. This represents a new phase in the organisational structure of transport in the UK. The CfITs' remit will include:

- reviewing and monitoring progress towards objectives and targets set out in the White Paper;
- continuing and refreshing the transport policy debate;
- fostering consensus among practical providers;
- advising on developments in Europe, including relevant EU initiatives;
- advising on the role of existing and emerging technologies.

The European Commission will be asked to advise on:

- setting national road traffic and public transport targets;
- lorry weights and the development of rail freight;
- the review of transport safety arrangements;
- progress on the take-up of green transport plans;
- how to secure best value from public subsidy for the bus industry in the longer term;
- public expenditure priorities for integrated transport in the longer term;
- research, in particular with a view to gaining a better understanding of the costs and benefits of transport and how these relate to the costs faced by users.

The CfIT will be required to consult widely with providers and regulators, central and local government, regional bodies, interest groups, trade unions, business and users. It will also draw on the expertise and resources of other organisations and individuals drawn in for work on particular topics. The CfIT will make recommendations to Ministers and prepare an annual report on the implementation of the new approach, including progress towards meeting targets, the impacts of key policy initiatives and priorities for further action.

## XXI.4 SPAIN

There is no information available about legislation of the use of data sources in Spain.

## XXI.5 THE NETHERLANDS

The last changes in the Dutch legislation on data sources derive from 1998. The Netherlands follows the European Legislation/guidelines. In 1998 a new law on the protection of data sources and the conductors of data sources passed (26 108, “vergaderjaar” 1997-1998). This law was based on the European Guidelines (96/9/EG).

## XXI.6 BELGIUM

In Belgium the following laws are dealing with the legislation of the use of data sources:

- Article 107 quater Constitution : the "lois speciales" determine the regional matter
- Article 6, 1st §, X of the "loi spéciale" of 8 August 1988 : regional competence in transport matter
- Article 45 and 46 of the "loi spéciale" of 12 January 89 : power of Federal State to defer the decision of the Brussels-Capital Region
- Article 159 of the Constitution : power of Courts and Tribunals to defer the illegal acts of the administration related to a specific lawsuit
- Article 92bis, 3rd § of the "loi spéciale" of 8 August 1988 : obligation of the state and regions to sign the co-operating agreements related to data storage and exchange

- Law of 8 December 1992 : protection of the private life (Regional competence)
- Directive 96/9 of the Council of Europe of 11 March 96 and Belgian law of the 1st January 1998 related tot he protection of data bases.