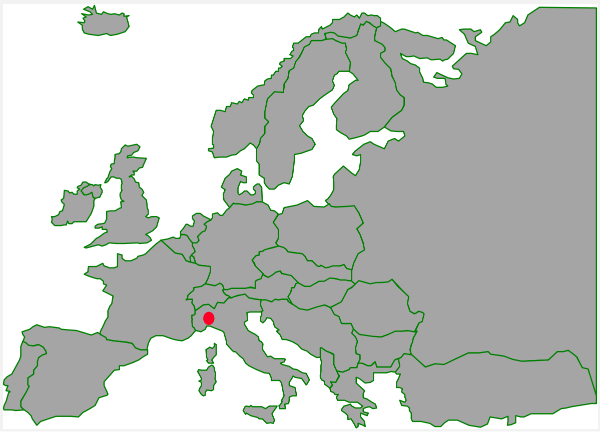
DEMONSTRATION SITE:	TURIN/ITALY 
NAME OF THE DEMONSTRATION PROJECT (CASE STUDY):	MOBILITY TELEMATICS APPLICATION IN TURIN: THE PROJECT 5T
DURATION OF THE PROJECT:	JULY 1992 – DECEMBER 1997
NAME OF THE TAP PROJECT:	5T TELEMATIC TECHNOLOGIES FOR TRANSPORTS AND TRAFFIC IN TURIN

URBAN PROFILE

Turin is the fourth largest urban area of Italy. The city can be inscribed within a circle of 10 km radius, while the metropolitan area within a circle of 20km. As the first capital of Italy, the city of Turin has grown in the twentieth century as a center of development of industry and innovation.

With 1.2 million inhabitants, the city reached its maximum population in the mid seventies. Since then there has been a continuous decrease of population of the city. Today about 900.000 inhabitants live in Turin. The metropolitan area itself has decreased from 1.7 million in 1979 to 1.5 million at present. In 20 years there has been a decrease of about 25% of the city population, and the population of the surrounding area has increased from 30% to 40% of the metropolitan area.

In the same period, personal motorized mobility has increased by about 65% (up to the present level of 1.97 trips/day) and the modal split of the private car has risen up to 73% (modal split of public transport: 23%). The motorization rate has increased by about 50% in the period, to the present value of about 1,5 cars per household.

ABSTRACT

The city of Turin started a large-scale project in transport telematics in 1992 named 5T (Telematic Technologies for Transports and Traffic in Turin), which embodies the conceptual framework of the EU financed QUARTET Project and the "Environment and Traffic project" financed by the Italian Environment Ministry.

The Turin 5T System has been developed and implemented right across the city of Turin. It comprises nine subsystems (Urban Traffic Control, Public Transport Management, Environment Control, Parking Control, Information Media Control, Collective Information (VMS), Automation Debiting, Maximum Priority, Route Guidance), together with an overall City Supervisor, which integrates all the other sub-systems actions into a general mobility/environment strategy.

Turin' s involvement in QUARTET PLUS has focused on a comprehensive evaluation of the IRTE (Integrated Road Transport Environment) system. The 5T project was tested during a two year experimental phase which ended in 1997. The measured effect of the 5T System was a reduction of the average O/D trip-time by 21% for the resident in the area affected by the system.

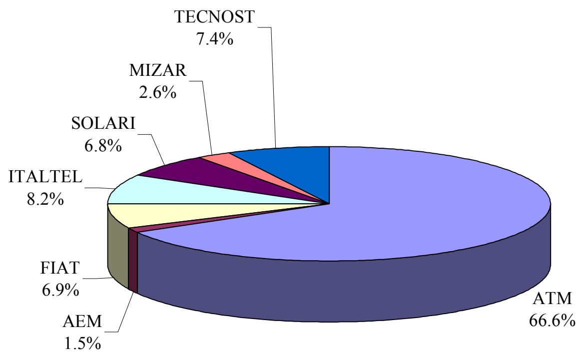
BACKGROUND AND OBJECTIVES

In the early 90's, when the problems of rising car use became clear and known, a re-orientation of the local mobility policy with the following key objectives was decided:

- calling for an integrated intervention strategy, both on private and public transport;
- aiming at the substitution of a large part of private car trips by the use of public transport;
- requiring a better public transport service quality in order to reach the above objective;
- recognizing the need of the development of public transport infrastructure interventions in the long term, and of transport telematics applications in the short term.

The city of Turin decided in 1992 to start a large scale project of transport telematics named 5T (Telematic Technologies for Transport and Traffic in Turin). In order to manage the project, a homogeneous consortium was created.

5T CONSORTIUM



The total cost of the realization of the 5T Project has been 23.6 billion Lire (12.2 million Euro). The consortium partners have provided 14.2 billion Lire (7.4 million Euro) while a contribution of 3.7 billion Lire (1.9 million Euro) was made by the Italian Ministry of the Environment ("Environment & Traffic in Turin" project). The European Union has contributed 5.7 billion lire (2.9 million Euro) to the Project ("QUARTET" project, its extension, and "QUARTET PLUS" project).

The 5T Consortium has seven partners. The public partners ATM, the Turin public transport company, and AEM, the Turin energetic company, have a share of 68%. The city of Turin has conferred 1.5 billion Lire (about 0.8 million Euro) to support the ATM effort.

The aims of the 5T Project were the following:

- Development of a strategic supervisory system for all Transport Telematics sub-systems
- Extension of the existing Urban Traffic Control and bus priority facilities over a wider area of the urban network.
- Extension of the functions of the Public Transport Management System to include user information and passenger counting.
- Development of a system for keeping citizens better informed on mobility services.
- Functional integration of traffic and transport control systems with the environmental monitoring and forecasting system.

Through 5T activities, the city of Turin wanted to achieve :

- a reduction of the average origin-destination travel time by 25%
- a reduction of mobility related air pollution and energy consumption and an improvement of the modal split towards the public transport by 18%

PRESENT STAGE OF IMPLEMENTATION

The 5T System in Turin has come out of the integration of pre-existing and newly developed subsystems. The System has been designed with an open architecture, to fit with all existing development and to allow extension with further applications.

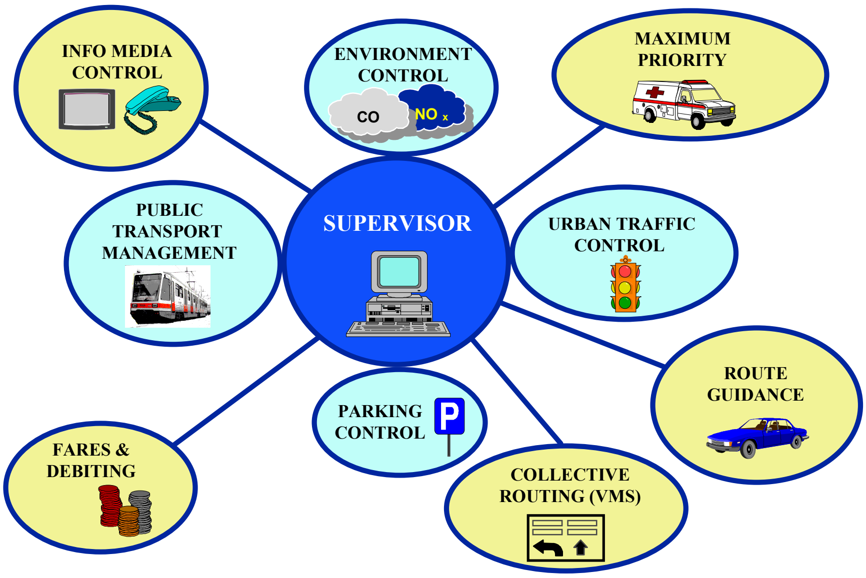
The basic choices characterizing this architecture have been:

- to have autonomous systems co-operating through a data network and a common data dictionary;
- to save costs by sharing common facilities;
- to implement a supervisory function in order to grant a common mobility/environment strategy to the action of all subsystems.

The 5T System integrates 10 transport telematics sub-systems:

- City Supervisor
- Urban Traffic Control
- Public Transport Management
- Environmental Control
- Parking Control
- Informative Media Control
- Collective Information (VMS)
- Automatic Debiting
- Maximum Priority
- Route Guidance

The last two subsystems, after having been fully tested, have not been retained in the configuration of 5T which is presently operating.



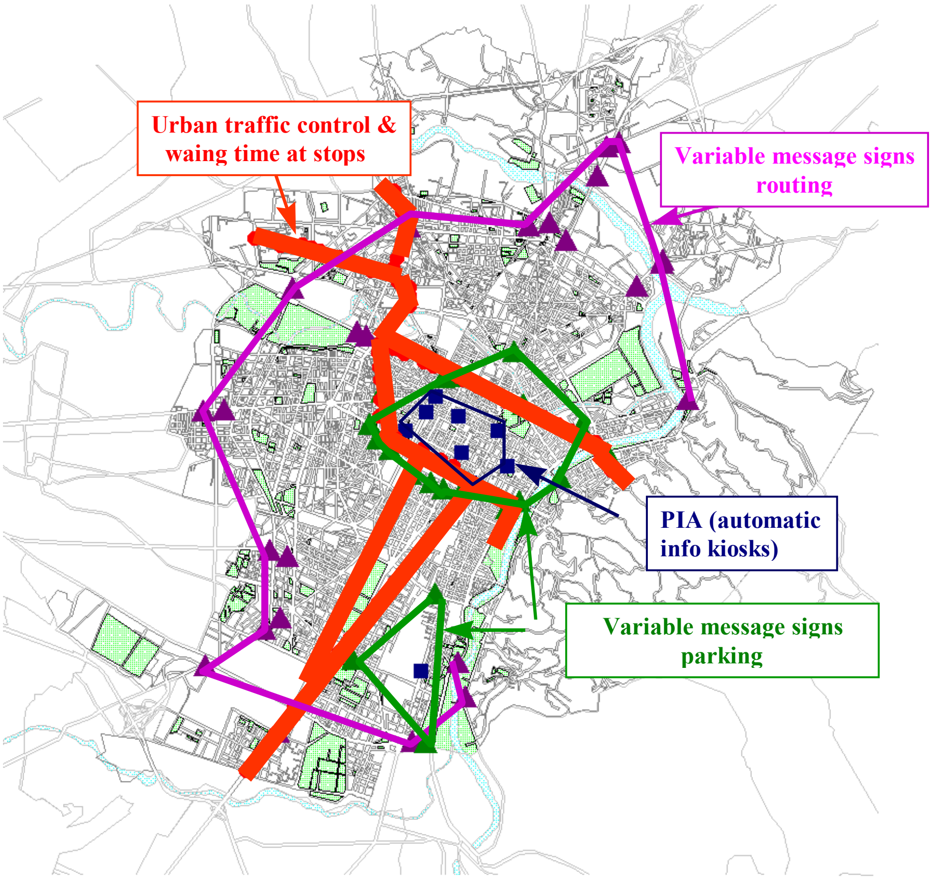
The subsystems of 5T

Actions within all the subsystems are co-ordinated by the "City Supervisor". The 5T "City Supervisor" is the subsystem in charge of monitoring and estimating on-line the mobility and environment state-of-the-art of the city of Turin and to provide a feasible and common control strategy to the other 9 subsystems of 5T that can influence directly the traffic behavior.

For the Integrated Road Transport Environment (IRTE) in Turin it is considered to be essential to have efficient and consistent monitoring of the status of the traffic and transport system, for use in traffic control, information, demand management and network design.

The three principles for establishing the IRTE were:

- **Co-operative monitoring** of the state of traffic and transport. An efficient and consistent analysis of the state of traffic and mobility is best performed through an overall assessment of data from various sources.
- **Co-operative equilibrium**. The point of optimal mobility distribution, that takes into account both user mobility needs and the state of the transport network must be the sole reference point for the whole integrated system.
- **Co-operative control**. The reference values calculated on the basis of the co-operative equilibrium principle must be used by application to elaborate joint control actions that reduce the difference between the equilibrium reference point and the observed traffic and transport state.



5T activities have been realized in the whole city area. However, the 5T application area, where the system effects are more intensive, includes about 30% of the city residents.

The 5T system is currently operative, after having been extensively tested in 1996/97, and maintained in operation under contract with Turin City Council in 1998-1999.

The Subsystems and Functions

The *City Supervisor* ensures the subsystems integration in order to generate the best service to the citizens' mobility together with urban environment protection. It is the most innovative development of the entire project.

Thanks to subsystems co-operation, every few minutes it manages traffic monitoring, generates an hourly mobility forecast, tests the air pollution effects, and decides a general strategy for the following period in order to achieve and maintain user equilibrium, compatible with the environmental protection constraints. The subsystems cooperate with the general strategy, taking the Supervisor's decisions into their specific operating strategies.

The *Public Transport Management* subsystem guarantees, through SIS (the operation aid system of ATM, operating since 1994 on the whole fleet of 1350 vehicles), public transport commercial speed and regularity thanks to position monitoring and traffic light priority, within the Supervisor strategies. The system manages 200 waiting time information displays at stops, 100 on-board devices announcing next stop and 100 passengers weighting-counting equipment.

The *Urban Traffic Control* subsystem manages the traffic lights through traffic-responsive regulation according to the on-line local measurements and the area policies suggested by the Supervisor; and contextually provides traffic light priority to public transport.

It manages 150 crossings in the urban area, with about 700 traffic sensors.

The *Environment Monitoring and Control* subsystem, using weather forecast and data coming from 11 pollution detection stations and the traffic data, foresees short term environmental conditions and makes them available to the Supervisor so that this can adopt the mobility policies compatible with the safeguard of the environment.

The *Parking Control and Management* subsystem, in connection with 8 parking lots with automatic barriers, supplies forecasts on place availability and enables tele-booking by Videotel to clients provided with smart cards.

The *Variable Message Signs* subsystem provides collective dynamic guidance to the different city districts, and supplies real-time information on the available places at the automatic parking lots. It operates with 26 routing-panels and 23 parking panels.

The *Information Media Control* subsystem supplies, by Videotel (now dismissed) and Teletext (and in the experimentation phase Internet), real-time information on the state of public transport, traffic, parking and environment. It helps people with on-line information to make their pre-trip planning on the best mode and the best route through 10 PIA (automatic information kiosks) installed at different points of the city.

The *Fares and Debiting* subsystem ensures that payments can be made without stopping at barriers to the drivers provided with smart cards of 150 equipped cars. It also enables, through smart card use, the purchase of public transport tickets at the parking lots.

The *Maximum Priority* subsystem assists ambulances navigation through the urban network and allows clearing of traffic light intersections along the chosen route. It operates for 15 ambulances of the regional emergency call number “118”.

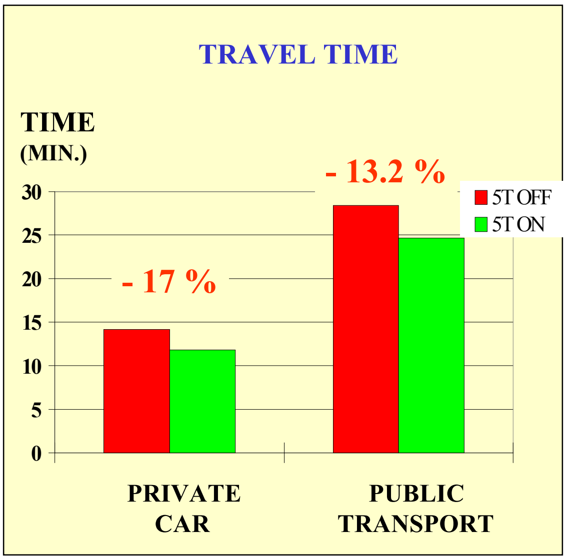
The *Route Guidance* subsystem helps the driver of a specifically equipped car in navigating trough the route network, in order to optimize the trip time within the real traffic conditions. It operates over 5 intersections and 50 equipped cars.

RESULTS AND IMPACTS

The project was tested during a two year experimentation phase, ending in 1997, with a cost of 1.8 billion Lire (something more than 0.9 million Euros). The experimentation has been realized by subsystems observations and evaluations at the center, by extensive field studies of time measurements and on site interviews, and by a telephone survey of a panel of 500 citizens resident in the area of application of the system.

A special analysis of costs and benefits was conducted by evaluating the economic benefits of introducing traffic light priority, both for users and the public transport system along PT tram line 3. If only the economic benefits for the public transport company due to the reduced number of vehicle shifts and driver shifts are considered, the investment return time would be 1,296 days. If time-saving benefits are included (PT passengers and car-drivers), the investment return time would be **131 days**.

Traffic and Public Transport Management Improvements

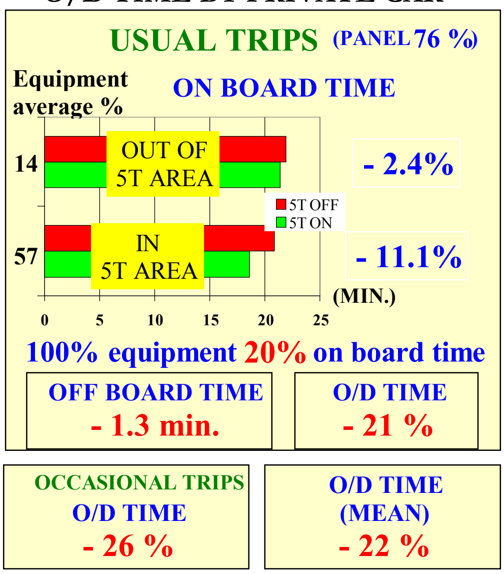


Trials have been carried out on 2 fixed routes (the whole tramway line 3 and part of line 4).
360 trips have been made both by car and by public transport, in scenario 1 (5T „off“ that means: 5T strategies not operating) and in scenario 2 (traffic control “on”).
The measured effect has been *a decrease of the trip time of 17% for car traffic and of 13% for public transport.*
Reduction of waiting time at traffic lights and greater efficiency in travelling conditions causes a decrease of exhaust emissions and fuel consumption.
The computed effect has been a *reduction of 6% in carbon monoxide emissions and 8% in fuel consumption.*

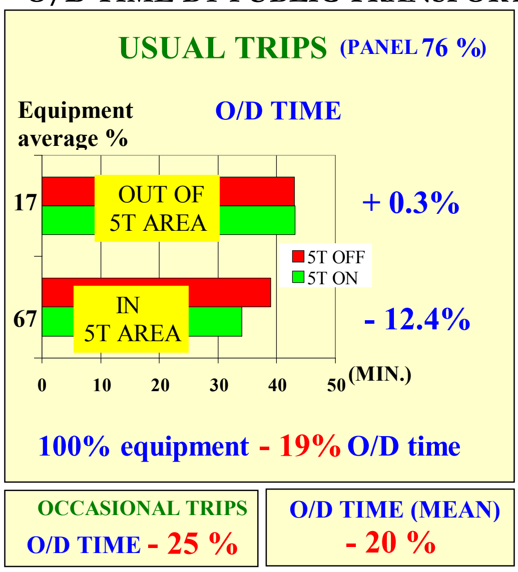
Management System Improvements, Routing and citizens information effect

In trials 9 Origin/Destination (O/D) pairs have been considered. 1020 trips have been made by public transport and 920 trips by car both in scenario 1 (5T Off) and scenario 3 (5T On, that is with all the supervision, management, routing 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. 80% of the people interviewed declared that VMS is very useful

O/D TIME BY PRIVATE CAR



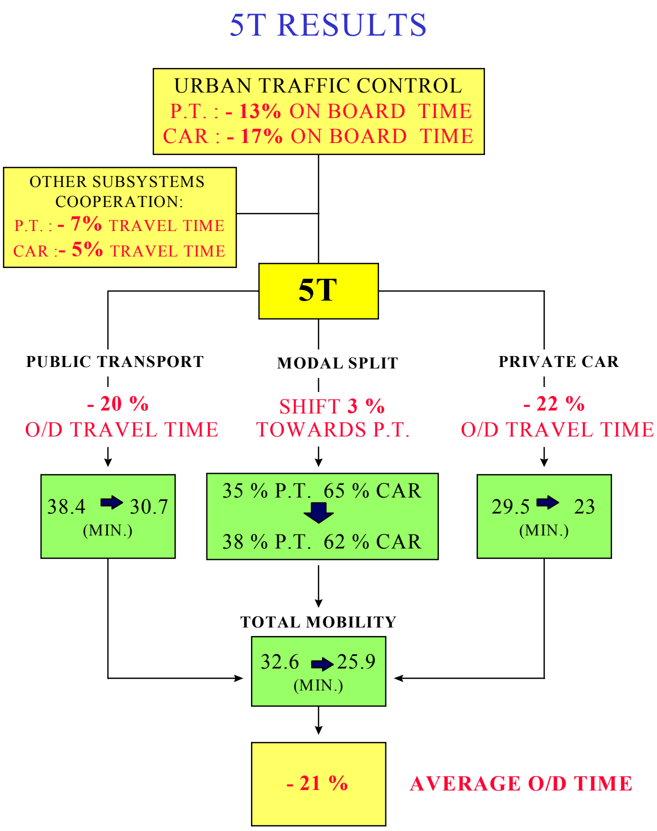
O/D TIME BY PUBLIC TRANSPORT



The overall effect has been a reduction of the average O/D time by 22% for the use of the car and 20% for the use of public transport.

As regards air pollution, the routing strategy has an additional effect on the control system only. The overall effect of the management system and the routing and information strategy has been simulated with real data from 5T systems. Concentration in critical links has decreased by 18%. The average concentration over the whole city has decreased by 7.5%.

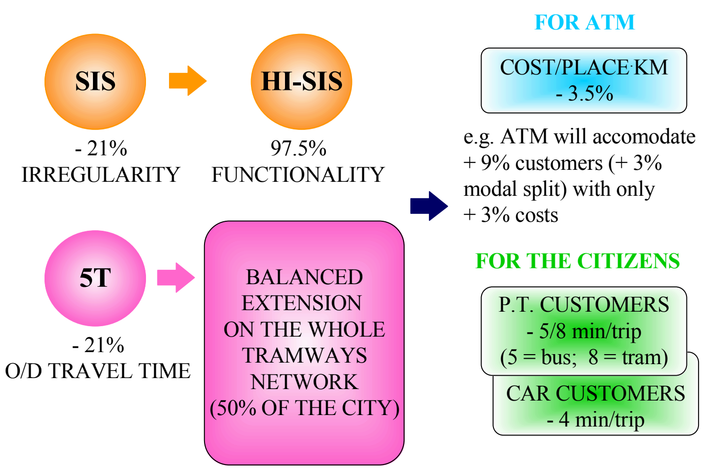
Telematics Technologies impact



A panel of 500 citizens has been interviewed in the scenarios 1, 2, 3. Their trips show an increase of 3% of modal split in favor of 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 with particular favor the passenger information subsystem.

The general impact of 5T at the city level on the environment taking into account also the modal split effect, can be stated as *decrease of 10-11% of pollutant emissions.*

Projects for further expansion



At the end of the trials, the 5T Project has been consolidated into a configuration capable of maintaining the results achieved at reduced cost. Two subsystems (Route Guidance and Maximum Priority) and a few functions (Videotel, parking payments without stopping) have been stopped.

The development of HI-SIS, a new release of the public transport operation aid system SIS, and a further expansion of 5T to give priority and information on the whole city tramways network, can generate a sizeable decrease in unit costs for public transport operation, together with perceptible improvements of trip time and service quality for the citizen.

The expansion of the system has been proposed by a specific project presented to the Italian Ministry of Environment for financial support.

The project calls for a new investment of 21 billion Lire (almost 11 million Euros) to extend UTC to 50% of the city's traffic lights, add 400 VIA at stops and install 100 more VMS. Further extension of 5T, estimated to require in the order of 30 billion Lire (more than 15 million Euros), will allow the expansion of the Supervisor and the Environment Control over the metropolitan area, further increase the number of traffic lights controlled by UTC, the integration of the peripheral highway for VMS traffic routing and the development of a smart card mobility payment system.

A prerequisite of all these developments, financial capability aside, is the creation of a new 5T company. The city has started the process of the transformation of the 5T Consortium into a new body that will be in charge of the management, integration and development of mobility telematics in the area of Turin.

TRANSFERABILITY

QUARTET PLUS has validated technical approaches and systems that can be applied throughout Europe, contributing in this way to the standardization and harmonization that will lead to a pan-European market for telematic systems supporting the Common Transport Policy.

Since its inception in the DRIVE II QUARTET Project, the Turin system has served as a reference model and other types of IRTE have been designed and developed. Both Gothenburg and Stockholm have mapped the 5T architecture onto the broader scale of urban/regional traffic management. The 5T City Supervisor is being studied for application in Stockholm and 5T's Multifunctional Outstations have been installed in a number of Swedish, Norwegian, Dutch and Italian cities. The first city equipped in the USA was Omaha (Nebraska) in June 1998. The SPOT unit is currently being marketed extensively in Europe and the USA. Interest has been shown by Sarajevo for SIS and UTC techniques developed in Turin.

The research results have also stimulated other Italian cities to adopt the same approach used in Turin. Implementations started in Bologna, Rome, Trento and La Spezia. Also, Napoli expressed its interest in implementing the integrated traffic management and control system.

LESSONS LEARNED

5T and the similar mobility telematic systems developed and tried under UE research contracts have demonstrated :

- that the shift of mobility toward public transport, needed by all european cities choked by traffic, can be encouraged by mobility telematics both by improving public transport performances and by enhancing the citizen's perception of this improvement.
- that however even the most successful and comprehensive telematics mobility projects such as this one cannot be expected to bring immediate miracles in modal shift towards PT (3% in this case), as long as they do not implement major and deliberate capacity transfer from car to PT traffic. The continuous approach here is to maintain mobility and generate extra capacity through more efficient management, which is then transferred to public transport.
- telematic management systems, able to perform dynamic traffic-responsive regulation, are powerful tools in reducing congestion and pollution and improving convenience for the travellers;
- demand itself must be included in generating and keeping the best equilibrium solution by providing travellers the necessary information made available by mobility telematics.

Several problems of course have arisen during the 5T experience: longer times, some developments below expectations, early termination of some applications and two systems stopped right after the experimentation.

The main cause of delays, misunderstandings and low profile participation by some parts can be found in the incorrect interpretation of the user needs and in the under estimation of the level of agreement necessary to reach the goals.

The first lesson is that complex systems like the mobility telematics ones can't be developed against the will of anyone of the actors. A common understanding is as necessary as the financial resources to generate integrated systems.

As anywhere, some parts of the project have been led by technology, and it has become clear that this type of approach can be a wasteful exercise of very little practical value for the city.

A third lesson learned in this 5T is not to make the application on too small a scale, because they have a high probability of failing and an easy justification of the failure in their "laboratory size". If they don't fail they have anyway difficulties in being kept alive; and if they are kept alive they will in any case be hardly significant.

Steering and coordinating the Consortium 5T toward its objectives has been quite a difficult experience, from which it has become clear that the implementation of mobility telematics must be made as simple and clear as possible by avoiding the splitting of responsibilities for single tasks, and conferring real decision power and effectiveness where needed.

Complex systems must be continuously monitored to understand if they fulfill their promises in terms of performance. Even if this concept was stated from the beginning, a large effort has been necessary to implement it in the 5T subsystems.

Finally each system must foresee a maintenance phase after realization and set a period after which the manufacturer is called to maintain systems and equipment up to their specified performances levels. After such a phase somebody predefined should emerge in charge of the maintenance and development of the system, otherwise all the efforts to develop it will be wasted.

Quartet Plus as a project has demonstrated, even in quantitative terms, that impacts on traffic (more than 20% in travel time reductions, 10% emission reduction...) are of the same order as that of new road infrastructure. Thus, investments in Transport telematics can be seen as possible substitutes of investments in infrastructure. But it is also true that these benefits could attract more demand, with a devastating effect; moreover, Transport Telematics could increase the appeal of individual cars.

In conclusion, early and continuous decisions of Public Authorities on the final goal of the system are strictly needed. In all the Quartet Plus sites, the (expressed) tendency is toward strategies which foster the use of Public Transport. Other strategies could be decided in different conurbations; what should be stressed is that it is very important that such policies are agreed and stated.

ADDITIONAL INFORMATION

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Information found on web-sites: http://www.transport.ntua.gr/qrtplus

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