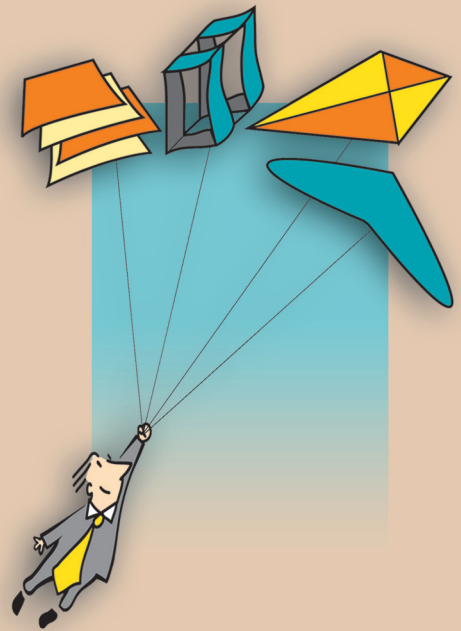




Ente per le Nuove tecnologie  
l'Energia e l'Ambiente



# Demand Responsive Transport Services: Towards the Flexible Mobility Agency



Edited by  
G. Ambrosino, J.D. Nelson,  
M. Romanazzo



Demand Responsive Transport Services:  
Towards the Flexible Mobility Agency

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*Edited by G. Ambrosino, J.D. Nelson, M. Romanazzo*

2003 ENEA  
Italian National Agency for New Technologies,  
Energy and the Environment

Lungotevere Thaon di Revel 76  
00196 Rome (ITALY)

ISBN 88-8286-043-4

The opinions expressed in this volume do not necessarily represent the policies of any of the funding bodies

**Demand Responsive Transport Services:  
Towards the Flexible Mobility Agency**

*Edited by G. Ambrosino, J.D. Nelson, M. Romanazzo*



*ENEA, the Italian National Agency for New Technologies, Energy and the Environment, is a public undertaking operating in the fields of energy, the environment and new technologies to support competitiveness and sustainable development. ENEA is mainly called upon:*

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*The book “Demand Responsive Mobility services Towards to the Flexible Agency” is one of the products and results of the FAMS project (IST-2001-34347). In particular it was developed under the WP06 - Dissemination and Exploitation activities and is part of deliverable D9 “The FAMS Hand Book” collecting the best practices and recommendations.*



*Besides illustrating the experience and lessons learnt in the projects SAMPO (TR-1046) and SAMPLUS (TR-4023), carried out in the context of the European Telematics Applications Programme (TAP), this volume presents some results and achievements of the project INVETE (IST-1999-10311) and the approach followed in the FAMS (IST-2001-34347) project. INVETE and FAMS have been undertaken in the EU’s Fifth Framework Programme for Research and Technology Development, Information Society Technologies (IST) thematic programme.*



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*“With DRTS now we are moving from charity to business”*

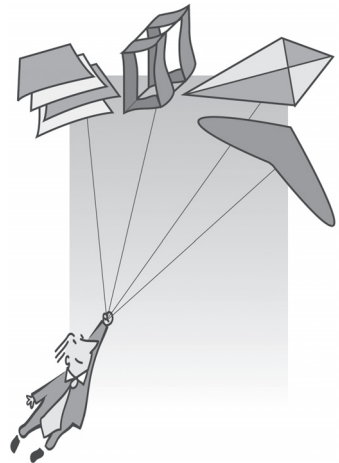
Timo Korsisaari, Korsisaari Group, Finland

*“Taking DRTS from the margins to the middle”*

Brendan Finn, Ireland

*“Flexible Mobility Agency as social cohesion tool”*

Giorgio Ambrosino, Italy



*We are grateful to Diana Savelli and Giuliano Ghisu  
(ENEA, Public Relations Department - Communication Unit)  
for their advice and contribution to the realization of this edition.*



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The transport system is the connective tissue of virtually all fields of today's social life. It has a complex structure due to many factors that affect its operation and services: from the end user to land and economic development agencies, to the political decision makers, to the available transport and vehicle technologies. Transport processes are hard to define theoretically and is even harder developing solutions able to increase efficiency and reduce environmental impact, while traffic volumes are rising and their impacts on the environment and on the quality of life are becoming more and more unsustainable.

When focusing on urban transport, one can notice that, at a European level, the last decade has been characterised by the following main trends:

- substantial increase of mobility of people, accompanied by the growth of private car use and no change in public transport volumes;
- final energy consumptions (people + goods) increasing more than the 20%, even if consumptions per unit in public transport have been reduced as a result of improved energy performance of vehicles;
- uncontrolled growth of greenhouse gas emissions, that are now substantially diverging from Kyoto obligations;
- unsustainable congestion and pollution levels in urban areas and, as a consequence, increased risks for the citizens' health.

To solve such problems, courageous and sometimes unpopular mobility management policies are necessary, together with the realisation of relevant measures on urban infrastructures – particularly as regards collective public transport – and the adoption of technological innovations. The challenge for a more sustainable urban environment is first of all a cultural challenge: without any new and innovative organisational model it will be hard to find out effective solutions.

It is no surprise, then, that ENEA, the New Technologies, Energy and Environment Agency and the Italian organisation having the institutional mandate to address research and innovation tasks in energy and environment at the national as well as European level, is involved for more than a decade in transport research and development initiatives, both as regards passenger and freight transport systems.

The main tasks carried out by ENEA include:

- to promote and implement basic and applied research and technological innovation activities, including the realisation of prototypes and the industrialisation of products, with special attention to energy and environmental protection;
- to disseminate and transfer the results achieved, facilitating and encouraging their take up and exploitation for productive and social purposes;
- to provide public as well as private organisations with technological value added services, studies, research, experiments, measurements, assessments and evaluations.

The sustainable mobility theme cannot remain closed within the research laboratories, or in theoretical studies mainly concerned with mathematical modelling or, eventually, in purely experimental activities addressing new and more efficient engine systems. The urgency is too high and so is the pressure of the international community and the commitments taken within the relevant bodies and agencies to reduce greenhouse emissions and the emissions of polluting gases. The complexity of the problem requires a conscious and realistic approach, one which avoids holistic solutions of an excessively theoretical nature and pays due attention to the roles that specific actions and measures are able to play, at least in the short and mid term, on specific issues and elements of the complex ‘mosaic’ of urban and periurban mobility systems.

This book provides an account of a particular class of such solutions. Particularly, as regards the main theme addressed in the book – the flexible and intermediate collective transport schemes as elements of the overall public transport and mobility system – ENEA has a longstanding involvement in research and experimental work aimed at offering mobility solutions (car sharing, car pooling, flexible transport, improved bicycle and pedestrian mobility schemes, etc.) as true alternatives to the car.

This publication represents for us a welcome opportunity to join the researchers and institutions of other European countries in this exciting field and to co-operate with them in a fruitful exchange of ideas, technological experiences and results. With the hope, which I personally believe well founded, to see other research and publishing initiatives such as this one multiplying in the near future.

Maurizio Romanazzo

*Responsible of “Technologies for rational use  
of energy in transport” Department, ENEA, Italy*

This report offers a welcome insight into the issues, challenges and realities that Demand Responsive Transport faces internationally.

The opportunities that new technology and vehicle types present coupled with a growing international awareness of the importance of DRT makes this comprehensive review of the issues required reading for Governments, local authorities and operators alike.

It is extremely encouraging to see the range of initiatives in place today along with the innovation that is so necessary to kick start projects of this type.

As the world focuses more closely on social inclusion and providing real alternatives to the car, the success of the initiatives reported here will encourage others to develop solutions of their own.

The examination of every conceivable facet of a DRT initiative detailed here will enable future projects to start from a sound base and speed up the growth of new markets serving new and deserving customers.

Professor David Begg  
*Chairman Commission  
for Integrated Transport, UK*



In the European Union countries, in thirty years from 1970 to 2000 the modal share of the car has increased by 4.5 % from 73.8% to 78.3% while the public transport modal share has decreased by 8.7% from 24.6% to 15.9%<sup>1</sup>.

This relative reduction of public transport ridership is the result of major sociological and politico-economic changes. It corresponds to changes in lifestyles, characterised by a new relationship towards time and more flexible schedules, an increasing share of leisure activities. It is also the consequence of urban sprawl with the dispersion of the origins and destinations of the journeys, a high increase of journeys from suburb to suburb, and on longer distances.

The increasing use of cars has been also strengthened by political decisions in favour of private modes, which led to an increasing pressure on public budgets and insufficient financial investment for public transport.

The management of mobility has never been as difficult as today. The demand for mobility has become more complex and can not be satisfied by traditional modes of public transport. Against this background, mobility actors and stakeholders have started to provide flexible solutions. They constitute an essential link in the whole mobility chain, either as a complement or as a substitute of traditional public transport. The challenge is therefore to implement innovative solutions to meet the needs for public transport when demand is low. In this context Demand Responsive Transport (DRT) plays a fundamental role.

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<sup>1</sup> European Commission, “EU Energy and Transport in figures, Statistical pocketbook 2002”.

Absolute figures:

- Cars: increase from 1,582 million person kilometers to 3,789 million person kilometers
- Public transport: increase from 527 million person kilometers to 769 million person kilometers

## **The Challenge of Public Transport by Low Demand**

Most of the discussion of public transport, and the benefits it brings to society and modern living, concerns the problems which occur in urban areas – congestion, pollution, access, economic well being of the central business district and so on. Also well covered is the role of public transport for inter-urban travel, where good train services can compete very effectively with the private car, both in terms of comfort and speed.

In some countries the provision of transport in urban areas or between urban centres is a market led activity, with the operator providing the service doing so on the basis that income from passengers and remuneration for social services (such as concessionary fares) will exceed the cost and therefore a profit will be achieved. There is no doubt that the discipline of the market has been beneficial, within the right framework, and operators who have adopted a consumer led approach have been successful.

However, there is one area of provision where the market is unlikely to be able to provide traditional public transport, without the intervention and financial backing of the organising authorities. This is where demand is low, because the market available is sparse.

### ***1. The increasing needs for public transport by low demand***

Often considered for reason of location, notably in rural areas, increasing needs for public transport by low demand exist for reasons of time or category of passenger.

Although most of the population lives in urban areas, a significant proportion does not. According to United Nations studies<sup>2</sup>, the rural population is 26.4% in Europe, with important differences between the Netherlands 10.4 %, United Kingdom 10.5%, Germany 12.4%, Spain 22.2%, France 24.5%, Italy 32.9%, Poland 37.5% and Finland 41.5%. Other categories of population who constitute a small market are those with a mobility disability – often thought of as wheelchair users but in reality comprising a much wider range of the population, those who might be sight impaired, have difficulty walking, or who need some form of ‘carer’ whilst travelling.

In the UK and in France there have been large demonstrations by people in these categories, protesting at what they feel is a lack of government action to address their particular problems, and whilst these demonstrations have covered a wide range of issues, the lack or unsuitability of transport is included.

In addition, in a modern society, it is recognised that there has to be some attempt at providing equality for all sections of the community, accepting that this is not always possible or even desirable. Consequently, the person who is in one of the categories above – a rural dweller, a person living in a small town, or someone with reduced mobility, or traveller during off peak hours or at night – has the same rights of access to

services as those who live in urban areas. These people pay the same taxes – indeed in some rural areas, the level of taxation is even higher – and therefore increasingly demand better services and access to them.

Although in rural areas the quality of life, in terms of cleaner environment and tranquillity, is usually greater, so too are the living costs, almost always transport related, be it the cost of travel to a town, or the cost of having goods and services delivered.

## **2. Cross sector benefits**

Research in the UK has shown that good public transport can bring wide social benefits to those who would otherwise depend much more on public financing to maintain an acceptable lifestyle.

For example, if an elderly person can travel into the town to visit friends, social activities, a doctor or just for recreation to meet with others, then they are much less likely to need the help in their own home from social care agencies. It means too that for much longer they will be able to remain in their own home, which is important because this adds to the feeling of being a valuable part of society. For all these reasons, the cost of providing these people with good public transport is more than recouped by the benefits, which accrue not only to the individual but to public expenditure in general.

## **3. Synergies**

If demand for public transport is low then it is often the case that demand for other activities is low, and the cost of providing those services is disproportionately high. In rural areas, deliveries of post etc. is high cost. With increasing use of e-shopping, deliveries to rural areas cost more and often the rural dweller has to pay an additional charge to reflect his isolation.

Those who live in small towns, or people who are disabled and find it less easy to move around, can also be penalised by the cost of transporting things to them. Someone living in a large urban area who cannot for reasons of disability carry their shopping with them has to have it delivered, and delivery is often charged by the supplier.

For these reasons, when considering public transport to meet low demand, it is worth keeping in mind that many of the problems, which the low demand produces, apply also to movement of goods. A solution to the public transport demand problem may be found by combining with the movement of goods.

Clearly there are a number of possible solutions, and these must be tailored to local circumstances and legislative frameworks.

## **4. Insufficient provision of passenger transport to serve low demand**

Traditionally, areas of low demand have been served by conventional public transport, where they have been served at all. Usually this has been the conventional bus service,

running at low frequency – maybe as little as one return journey each day or even each week, which is only suitable to meet the most basic of demands to go shopping in the nearest town. Such services are of no value for travel to work, for training, for education, for medical, social or recreational journeys. Consequently, people either have to be provided with special services (for travel to a hospital, a special vehicle, at very high cost to the public sector), or they simply do not make the journey at all and become excluded from mainstream society.

In some states, the use of minibuses has reduced the cost of providing transport for low demand, but even so, with most of the cost being that of paying the driver, the cost per passenger is still high.

Taxis can be used to deal with low demand, and in many ways they are the ultimate in public transport, providing a door to door service integrated with the regular network, on demand, 24 hours a day. However, the cost of a taxi journey is high, especially if distances are significant, and in rural areas, taxis are unlikely to be found unless there is positive action by organising authorities. In sustainable terms, conventional taxis are not efficient, for it is almost always the case that they make one leg of a journey empty.

There are instances of self-help schemes being set up to provide transport for low demand, and these are usually very highly valued by the users. The drawback is that they often depend on a degree of voluntary work, and therefore cannot be totally relied upon to give the continuity of service, which is required. Furthermore, they are only sustainable when there is commitment by the local community, and this is not always possible.

### ***5. The high potential of development of public transport by low demand***

Against the increased needs and the lack of provision of services by low demand, the potential of developing adapted services is very high. The challenge facing organising authorities and operators therefore is to find a way of providing good quality, affordable, accessible and relevant public transport at times and in places when demand is low. This is especially important when questions about value for money, and the cost of transport have to be answered.

### **Better understanding leading to better action**

If authorities and operators want to contain the pre-eminence of the car, they need to consider the whole chain of mobility and reposition public transport to fill in the gaps left by conventional services. The request is for door-to-door seamless travel by providing the market with one public transport offer that integrates different products from conventional public transport to demand responsive solutions, regardless of the type of providers. It is to be stressed that the implementation of Demand Responsive Transport (DRT) is highly facilitated by the development of new information and communication technologies, which enable a greater flexibility of operation.



I strongly recommend the reading of this volume to mobility actors concerned with the improvement of public transport services. The thorough state-of-the-art drawn by the authors and their conclusions, enable us to have a better knowledge of advanced public transport systems and a good understanding of successful implementation of Demand Responsive Transport.

David Whiteside

*Chairman of the UITP working group  
on Public Transport by Low Demand*



## Introduction

*G. Ambrosino, J.D. Nelson, M. Romanazzo*

The publication of the European Commission White Paper on transport (EC, 2001) provided a timely summary of the challenges currently facing the transport sector. Between 1970 and 2000 the number of cars in the European Union (EU) tripled from around 62.5 million to 175 million. Although the rate of growth has decreased it continues at around 3 million per annum and will be greater after enlargement of the EU. At a European-level more than half of the oil consumed by transport is accounted for by private cars and in 1998 transport was responsible for 28% of CO<sub>2</sub> emissions. Road transport alone was responsible for 84% of CO<sub>2</sub> emissions from the transport sector. Traffic congestion has been identified as a serious threat to European competitiveness – the external costs of road traffic congestion amount to some 0.5% of EU GDP and it is estimated that (without intervention) the costs attributable to road congestion will reach EUR 80 billion by 2010 or 1% of GDP (EC, 2001).

The work assembled in this volume is concerned primarily with the potential contribution of advanced public transport systems to sustainable mobility. The decline in use of conventional public transport relative to private car use over the last 50 years has been well documented and the causes of the spectacular growth in acquisition and use of private cars is increasingly understood. Recent research findings suggest that it is timely to advocate a new emphasis on a previously under-utilised and often misunderstood form of transport which is at one and the same time demand-responsive, customised and collective. Consequently, this volume focuses on the concept of Demand Responsive Transport (DRT) and what is entailed in its successful implementation in the context of an overall programme of mobility management.

## **An introduction to Demand Responsive Transport (DRT) Services**

Over the last decade Demand Responsive Transport (DRT) services have grown in popularity for several reasons including: the lack of the adaptability of conventional regular bus and taxi services; shortcomings of special transport services; and new developments in community transport. Traditional dial-a-ride services have often been criticised because of their relatively high cost of provision, their lack of flexibility in route planning and their inability to manage high demand. The potential for overcoming these limitations may be realised through the introduction of telematics-based DRT and this has been widely demonstrated, for example, in recent research funded by the European Commission (e.g. the DGXIII-funded SAMPO and SAMPLUS projects). The material assembled in this book provides an introduction to the concept of telematics-based DRT services – in its widest context – and presents the results of the latest research and development findings from this domain.

Demand Responsive Transport (DRT) services provide transport “on demand” from passengers using fleets of vehicles scheduled to pick up and drop off people in accordance with their needs. DRT is an intermediate form of transport, somewhere between bus and taxi which covers a wide range of transport services ranging from less formal community transport through to area-wide service networks. In recent years, the ability of DRT concepts to provide efficient, viable transport services has been greatly enhanced by the use of transport telematics and its successful demonstration in a variety of environments in EC-funded R&D projects such as SAMPO (System for Advanced Management of Public Transport Operations) and SAMPLUS (System for Advanced Management of Public Transport Operations Plus) (see Nelson and Mageean, 1999). Many important lessons can be learned from the evaluation of DRT technologies and operations with a view to identifying the key issues that influence the introduction of DRT services.

The potential of DRT has been further endorsed by the European Conference of Ministers of Transport (ECMT) in its resolution on accessible transport (July 2001). Experience from Europe shows that DRT is more strategically straightforward to implement in more regulated environments as there is less conflict with other public transport modes. Thus it is significant that DRT has progressed more rapidly on the continent than in the UK, where new legislation to remove constraints on the development of flexibly-routed bus services (e.g. route registration and the provision of fuel rebate to flexibly routed local bus services) is only just in preparation (June 2003). At a European level a greater awareness of the potential for flexible public transport services to help to break down social exclusion has been developing over several years (for the British case see DETR, 2000b, for Ireland see ADM, 1999) and this, together with the successful widespread demonstration of DRT services confirms this new interest in flexible forms of transport.

The findings presented here have been assembled from the outcome of a variety of important R&D projects. The overall objective is to provide an introduction to the concept of telematics-based DRT services and analyse the results of the evaluation of a set of DRT technologies and operations at urban and rural sites across Europe while providing an informed insight into the next generation of DRT services.

## Recent developments in Demand Responsive Transport (DRT) Services

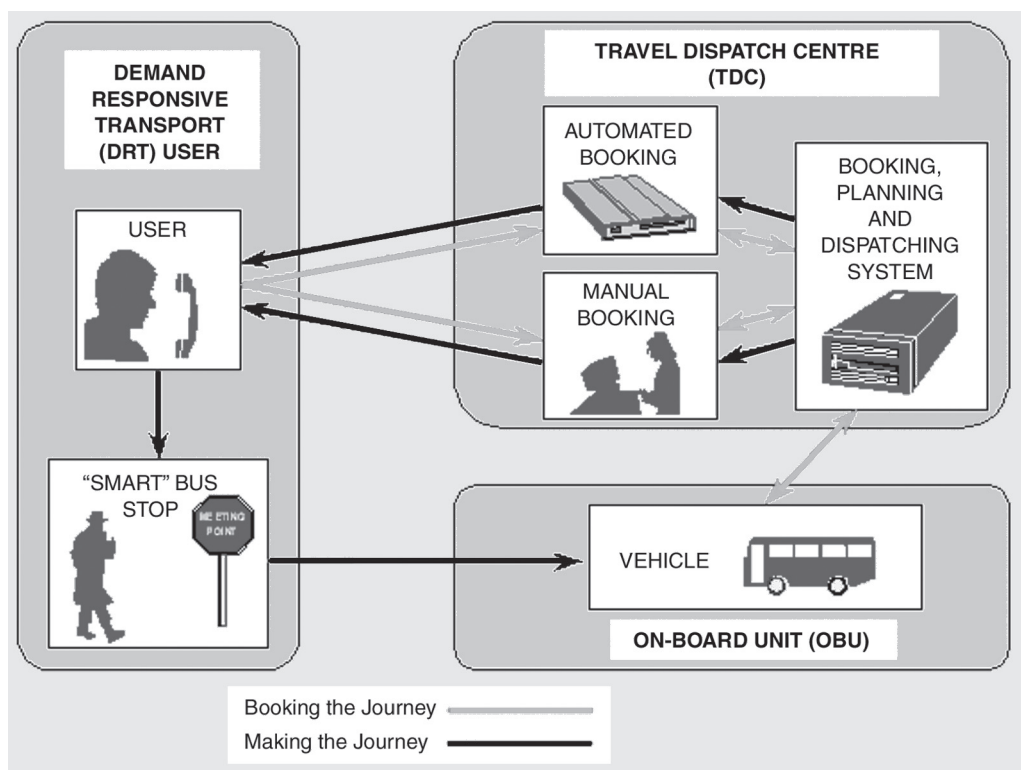
DRT is not a new concept. The original objectives of Dial-A-Ride were to cater for widely dispersed trip-patterns and to provide a service in low-density suburban areas for mainly non-work journeys. Interested users would telephone in their requests some days before they intended to travel and the operator would plan the service the day before the trip. Very few of these initial schemes met with widespread success and traditional dial-a-ride services have often been criticised because of their relatively high cost of provision, their lack of flexibility in route planning and their inability to manage high demand. Some schemes did develop moderate customer bases and considerable international experience in special needs transport was gained (see for example, Ashford and Bell, 1978). The central thesis of this book is that the potential for overcoming these limitations may be realised through the introduction of telematics-based DRT.

DRT services are undertaken on a variety of modes, i.e. buses, coaches, taxis, adapted taxis and minibuses and can be supplied by a variety of service providers (including bus, taxi and private hire operators, community transport, local authority and ambulance vehicles and even car-club members). Services can be free-standing or integrated between different modes, for example as feeder services for bus, tram and rail services. The development of communications and optimisation systems has enabled the evolution of new forms of flexible public transport services which can be placed at some point along a continuum between conventional fixed route shared bus services at one end and highly flexible non-shared taxis at the other. A further advantage of a telematics-based DRT system is the opportunity to draw from the spectrum of booking opportunities ranging from those based on advance reservation to those systems which include immediate response to a request for travel. A number of different service dimensions for DRT may be identified and are discussed by D'Este *et al* (1994). The key characteristics that delineate service types are the route (by flexibility and density of linkages between origins and destinations), the schedule (fixed or flexible), the method of collecting passengers and quality factors.

Westerlund *et al* (2000) have reported a number of DRT service concepts based around careful definition of stopping points and route flexibility. Stopping points may be *end stop points* (terminals), *fixed intermediate stop points* such as conventional bus stops, *predefined stop points* (recognised meeting places) and *non-predefined stop points*

which are generally the doorstep of the user – the latter two requiring pre-booking. Route flexibility is characterised by either *semi-fixed routes* or *flexible routes* for which the DRT service departs from an end stop point (possibly a terminal) at prescribed times; or *virtual flexible routes* with no fixed end or intermediate stop points and no fixed times.

Telematics-based systems are based upon organisation via Travel Dispatch Centres (TDCs) using booking and reservation systems which have the capacity to dynamically assign passengers to vehicles and optimise the routes (see Figure 1). Automated Vehicle Locationing (AVL) systems are used to provide real-time information on the status and location of the fleet for the route optimising software. Integrated DRT services are achieved when multi-modal options can be generated and managed for passengers. The application of advanced technologies to DRT has been considered by Finn and Ambrosino (2002), Glazebrook (1993), Glazebrook and McCombie (1995) and Teal (1994) whilst case studies of telematics-based DRT services may be found in Australia (Radbone *et al*, 1994), the UK (Grosso *et al*, 2002) and the USA (White, 1995). European examples include the SAMPLUS demonstrations in Belgium, Finland, Italy and are described in detail in Chapter 7.



28 Figure 1: Schematic Representation of Telematics-based DRT Services

The recent UK experience warrants special attention due to the widespread and rapid introduction of DRT applications in rural areas as diverse as Gloucester, Wiltshire, Lincolnshire, Northumberland, West Sussex and Surrey (Jones, 2002; Grosso *et al*, 2002). There is also widespread interest within the UK in potential urban applications (see Nelson, 2002). This shows that there is clear potential for DRT services to offer greater flexibility in time and location than conventional public transport in meeting many aspects of travel demand. Indeed current EC-funded research (the FAMS and EMIRES) projects is developing the next generation of DRT services which will offer a package of value-added services through the collaboration of multiple service providers (see Finn and Ambrosino, 2002). Detailed attention is given to FAMS – the Flexible Agency for collective demand responsive Mobility Services in Chapters 12-15.

### **Structure of the chapters**

The starting point of the research findings presented here is that User Needs Analysis is a fundamental building block in any project concerned with the provision of transport services and this is the subject of CHAPTER 1 in the context of DRT. User Needs Analysis allows a project team to understand their users, and to use this knowledge to design a system to meet these needs. The outputs of this analysis should identify the key markets, the services and features that they need, and requirements for communication and information after services are implemented.

CHAPTER 2 develops a set of service typologies and scenarios for DRT. DRT services will fill the gap between individual transport and scheduled conventional transport and new concepts of flexible collective transport can be developed starting from two different points of view: the taxi and the scheduled conventional public transport. Setting up a DRT service requires a number of design decisions and operational choices taking into account the typology of the region, the objectives of the operator or authority, the characteristics of the user groups, and the type of demands for mobility.

The organisation of DRT services on a reasonably large scale, and according to the concepts introduced in Chapter 2, is only possible if accompanied by a telematics-based system. The booking procedures and the real-time optimisation of the service are two important differences from a traditional service that is fully planned in advance. CHAPTER 3 provides an overview of DRT system architecture. This description is derived from the main results of the EC SAMPO and SAMPLUS projects. It is essential that the systems architecture is implemented with appropriate technologies.

CHAPTER 4 discusses how modern Information and Communication Technologies (ICT) offer a wide range of possible technological options for the development of DRT system modules: localisation and navigation systems (GPS, dead reckoning...), Internet network, wireless communication systems (GPRS, UMTS, PRN etc.), on-board units,

mobile terminals, real-time booking systems, GIS etc. In recent years, the technological architecture of the different European DRT experiences has underlined a wide range of technical and architectural solutions. This chapter summarises the main technologies and standards involved in the development of DRT systems with case-studies from Belgian, Finland and Italy.

In CHAPTER 5 the important role of in-vehicle technologies in the efficient operation of DRT services is explained. This equipment may include: ticketing machines, an in-vehicle terminal, long range communication for voice and data, location devices (e.g. GPS and odometer), short-range communication devices (for communication inside the depot), external and internal passenger information displays, and video for security. The chapter discusses the technologies for communication both externally (long range with the Travel Dispatch Centre) and internally (i.e. with other on-board telematic devices), and the in-vehicle terminal drawing on the results of the EU-funded SIPTS and INVETE projects. There has long been a documented need for better vehicles for the taxi- and Special Transport Services (STS) segments in many countries where great effort and expenditures are spent on mobility services for people with special needs. CHAPTER 6 discusses how recent developments in flexible public transport and STS have increased the need for accessible vehicles of different sizes. The design and development of Multi-Purpose Vehicles (MPV) studied in two different but related projects in Sweden between 1997 and 2000 are considered in detail. Chapter 6 concludes that there is a continued need for research and development of suitable vehicles for various user purposes and calls for better knowledge of how to best combine such uses for efficient utilization over the day.

CHAPTER 7 provides a detailed analysis of the experience gained through different applications of DRT services across Europe. The SAMPLUS sites in Belgium, Finland and Italy are considered in detail and supplemented with additional findings from Italy and the UK. The lessons learned from this widespread demonstration highlight the need for an efficient co-operation between operators, IT suppliers and authorities to support deployment and take-up of this innovative form of collective transport services. This practical experience shows that the development of DRT services and systems in Europe should be based on EU, national and local transport policy, strategies and needs.

Institutional, organisational and regulatory aspects of DRT are the subject of CHAPTER 8 which emphasises that since there may in some cases be a need to alter the existing national transport policy and strategies for public transport the institutional and organisational barriers are often greater than technological barriers.

CHAPTERS 9, 10 and 11 focus on two other important manifestations of DRT, namely collective taxis and car sharing. It is commonly accepted that in the public transport sector it is the taxi that offers the better service although its high cost makes it less attractive. As part of the family of DRT (Demand Responsive Transport) systems,



the collective taxi offers a service similar to that of the taxi but at a much lower price. Savings are obtained through users sharing their trips with others. In this work the collective taxi is defined as a good quality DRT service that presents the same features of the conventional taxi, which are absent from conventional public transport, but using comfortable vehicles with limited capacity (shuttle buses with 8-10 seats, in certain cases the same vehicles used by conventional taxis), and that takes the user to their doorstep. There are several models of service. Two are described in CHAPTER 9: linking to the airport and taking people to their home at night. Both belong to the class of one-to-many systems in that they are based on a unique mode functioning as an origin (either the airport or the bus terminal). Car sharing (the subject of CHAPTERS 10 and 11) is a form of organized car use, whereby the vehicle is shared with others. The concept is explained, by means of case-studies from Italy and Germany. Car sharing is intended as an alternative means of transport managed by an organization, which has at its disposal a fleet of vehicles, usually of different models, for the people associated to share. Unlike car-pooling, whereby cars are used as a result of an agreement between users who have a common route and time of travel, in the case of car sharing, users can autonomously obtain the vehicle at different time periods. Guidelines for successful car sharing schemes are offered.

In most cases flexible services, and in particular Demand Responsive Transport (DRT) services, are generally managed directly by a single operator (Transport Company) as a unique and dedicated transport scheme with minimum or no level of integration with the other collective transport services available in the same area and/or managed by other transport operators. However, the experience gained shows wide potential for improved operation of the DRT concepts and models, in order to cover the overall spectrum of the intermediate and flexible services. This may be achieved by integrating the technological tools developed with the emerging e-commerce and e-business services. Therefore, starting from the single DRT services application, there is a considerable opportunity to evolve towards the concept of the Agency for Flexible Mobility Services through a scaling up of the current technologies and DRT models. This is the thesis advanced and illustrated in CHAPTERS 12-15.

The perspective of an Agency (intended as a booking, co-ordination and management centre of intermediate services), which is developed in CHAPTER 12 by introduction of the EC-funded FAMS project, is fostered by recent new regulations and laws on local public transport provision. In CHAPTER 13 the role of evaluation in FAMS is discussed.

Building on work of previous projects such as SAMPO, SAMPLUS and INVETE, and on the guidelines from the EU on evaluation, the FAMS evaluation actions are described and the FAMS indicator set is considered as relevant to most DRT practitioners. The FAMS project has demonstration sites in Angus, Scotland and Florence in Italy.

CHAPTER 14 describes the Angus DRT co-ordinated transport pilot project which is seeking to maximise the use of existing public transport resources in the area to produce a flexible, user-friendly integrated service. It is expected that this will provide a sustainable means of delivering transport provision utilising new technologies in a location of dispersed population and diverse activity. The Florence site (CHAPTER 15) is building on a long tradition of DRT service provision and is seeking to co-ordinate all intermediate transport services in the region. The Agency has been established as a unique reference interface and as a service centre for users of intermediate transport providing services for booking and reservation, user information and feedback. A web-based portal is the main channel of communication between the Agency and the different user categories.

CHAPTER 16 concludes this volume with the observation that whilst to-day, at a European level, flexible collective transport solutions cover just a small proportion of trips they can provide an alternative to the private car between 10% and 30% of trips (depending on local characteristics). The findings from the research presented here suggest that this innovative transport mode has considerable potential to substantially mitigate the traffic pressure in cities. The contributions to this volume have considered the range of flexible transport services, focusing particularly on Demand Responsive Transport (DRT) and have identified the “building blocks” of successful schemes. The overall conclusion is that DRT represents a clear pointer towards “tomorrow’s public transport”.

## CHAPTER 1

# Goals, requirements and needs of users

*B. Finn, A. Ferrari, P. Sassoli*

User Needs Analysis is a fundamental building block in any project concerned with the provision of transport services. This phase allows the project team to understand their users, and to use this knowledge to design a system to meet these needs. The outputs of this phase should identify the key markets, the services and features that they need, and requirements for communication and information after services are implemented. The User Needs work provides an excellent opportunity for consensus forming and awareness raising within the host community.

This chapter introduces User Needs Analysis and recommends a six-step process for carrying out the work (Section 1.2). The approach is practical and relevant to Demand Responsive Transport (DRT) services. A classification of users is provided, applicable to both urban and rural DRT services (Section 1.3).

Typical needs of end-users and operators are identified in section 1.4, and these can be used as a platform for more specific user needs analysis. In 1.5 four case studies are provided from Belgium, Sweden, Ireland and USA which illustrate different aspects of user needs work, and examples of the type of outputs. Finally, consideration is given to priorities for new research in user needs.

### 1.1 What is the purpose of User Needs Analysis?

User Needs Analysis has become an integral part of all EU research projects, and increasingly is part of all local projects. This has greatly strengthened both the design

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phase and the probability of acceptance by the user of either new transport services, or of supporting technologies. This is clearly very important to the financial, social and political success of the investments being made by authorities, operators and communities.

In simple terms, User Needs Analysis is a form of market research. Before designing a system or sub-system, it is important to understand:

- who are the intended users of the product?
- will there be other interesting users, perhaps not part of the original target group?
- what do the users need to achieve?
- what constraints are there on using potential solutions?
- what features will make the product more attractive to them?
- do some of the users have special needs?

User Needs Analysis endeavours to first establish who are all of the users that will be involved, and secondly what are the needs of each of the different types of user. In the transportation domain, the outcome of this process will be used for some of the following parts of the project:

- design of transport network and specific services
- development of special services where the standard network is insufficient
- estimation of the travel demand, and thus of the market potential
- development of pricing strategies
- design of marketing and information campaigns
- design of interfaces for the user with automated systems
- development of service quality criteria (e.g. process completion time, dependability)

Understanding of the needs of relevant users is central to the design process and can be simplified to three questions:

- will the system perform the needed function for the target user?
- will the intended user be able to use it (understanding, skill, opportunity, safety)?
- will the intended user accept it (attractive, price, alternatives, perception, need)?

If the answer to any of these is “no”, then a project should redesign, find different intended users, or else abandon the demonstration. User Needs Analysis is the process of understanding the needs of the user, and feeding them into the design process. The needs of the users are determined through some form of structured analysis.

Within the European Commission’s (EC) Telematics for Transport programme, the CODE project has developed *Guidelines on User Needs Analysis*. However, these are aimed mostly at specific telematics sub-system design. It is more relevant to the design of person-machine, or machine-machine interfaces, and features task analysis, work methods, observations etc. This can support some specific elements of technical projects, say (for DRT) those relating to the operator interface with the booking and the Travel

Dispatch Centre functions. Otherwise, the Guidelines issued to date are of somewhat limited use for DRT projects where it is necessary to understand the user and their transportation requirements.

Within the SAMPO and SAMPLUS projects of the EC Telematics Applications Programme, it was necessary to take a more practical approach, relying on the experience of the team members. A set of practical guidelines suitable for use at local level was developed within the project, and these are now explained in section 1.2.

The following section offers a set of Guidelines for identifying the different users, and the needs of these users. Having been developed within the SAMPO and SAMPLUS projects (Finn, 1996, 1999), they were centred on collaborative research projects where there was a need to clearly define the needs and exchange information between sites. However, experience has shown they are just as valid for an individual site which is preparing its own deployment. Further, they have been shown to be applicable both for the transportation dimension of a service implementation, and for the technical or organisational aspects of a demonstration.

## **1.2 A six-step approach for determining User Needs**

Whether you are a large multi-site project, or a local community group, you need to take a structured approach to determining your user needs. This means preparing a User Needs Plan, providing the resources to do the work, allocating the responsibilities, and overseeing the successful implementation.

If you have multiple sites, then each demonstration or deployment project needs to develop its own user needs plan. This reflects the diverse nature of DRT projects (e.g. some try to solve a specific mobility need, some develop tools for a specific technical task used only by an expert or machine, others support services for the general user). It also reflects that in some domains there is already a close understanding of the user and general needs, whereas in others there is not the same body of existing work.

In this section, the term “site” is used to mean the promoters of the DRT scheme and its natural coverage area. It is presumed that a project team has been brought together to prepare and implement the scheme. For community-based projects, the team may be part-time or voluntary, with limited funds; however the principles remain the same.

The six steps to determining User Needs are now described. Later, in section 1.5 examples of the outputs from four specific studies of user needs are provided.

### *Step One: Define the objective of the User Needs Analysis*

Each site must decide its main objectives in relation to User Needs, and should do so explicitly. This may form part of an iterative process with the Evaluation Planning, and should certainly be an integral part of the demonstration project design.

It is suggested that key objectives may be in the form of:

- determine mobility requirements and constraints of travellers
- determine perception and probable response of users to new transport services
- determine perception and probable response of users to new (automated) technologies
- determine users' value sets, trade-offs, and willingness to pay
- understand the key motivations, constraints and interests of operators
- determine the main functional requirements of TDC operators, drivers etc.
- assess the potential market and usage levels by different categories of user.

For each site, there should be a good correlation between the objectives of the User Needs Analysis and the main elements of the demonstration.

#### *Step Two: Identify the relevant Users*

Each site must consider who are the relevant users within the demonstration. A good starting point is the categorisation developed within the SAMPO project, and described in more detail in section 1.3. This offered four User Groupings of End-Users, Operators, Authorities and Active Destinations. Within each User Grouping, various categories were then offered. This categorisation can be used as a 'check-list' to determine which users need to be considered at the site. For example, a site may determine that the relevant users are:

- elderly people in rural areas
- mobility impaired people in rural areas
- home-based women without regular access to a car
- transport planners and co-ordinators
- travel dispatch centre operators
- drivers
- bus operators.

These would represent both the end-users and the other interested parties who are likely to be impacted by the demonstration, and therefore whose needs must be understood.

It is recommended that the suggested target users are discussed through whatever consensus forming mechanism exists within the project, since this may fundamentally effect the design process and final outcome of the offered services.

#### *Step Three: Analyse previous work in the domain*

Previous work needs to be analysed carefully. Such work can be found in four main sources:

- 36
- previous internal studies carried out at the site relating to transportation and mobility

- User Needs Analysis work carried out in collaborative projects such as SAMPO, SAMPLUS, VIRGIL
- Sectoral studies focussing on specific users or problem areas, of which mobility forms part e.g. the EC TELSCAN guidelines on assuring usability of telematics systems by elderly and disabled persons, the US DoT assessment of barriers facing people on welfare returning to work
- relevant work from non-transport domains done locally (e.g. social studies, acceptance of new technologies by elderly, communication cost studies, demographic data).

Using previous work can avoid expensive repetition of work, and indeed avoid annoying people or organisations who have been surveyed before. This is a significant factor where the project team is community-based, and probably has extremely limited resources available. More importantly, study of previous work can help to focus the data collection onto new (and perhaps more specific) questions. It may also provide indications of needs that were previously identified as unmet, dissatisfaction with existing systems and services, and potential contributors to focus groups.

#### *Step Four: Determine the data requirements*

Before designing surveys or discussion groups, it is important to make an explicit listing of the data which are required. This must take into account how the data are to be used, not just for the analysis in step 6 below, but for the functional specification and evaluation processes.

A matrix should be developed which shows objective and subjective data requirements, and the users from which the data will be obtained. It should also identify any requirements for minimum sample sizes, for statistical significance, and for distribution within the sample. This will help to determine the methodology needed for data collection. Comparison of the data requirements matrix with the previous work review may reduce the data collection resource needs. Integration of this stage with the Evaluation Planning will ensure better use of resources.

#### *Step Five: Design and implement the appropriate methodology*

Methodologies for data collection have been reviewed and well documented in various sources (e.g. Finn, 1996). The methodology used is very closely related to the nature of the target users, the data which must be collected, and the amount of previous work. Data collection methods which have been successfully used in DRT User Needs work include:

- postal surveys
- telephone surveys
- self-completion questionnaires
- direct interview (with end-users and with organisations)

- discussion groups
- focus groups
- discussion or focus groups following a presentation of new concepts.

Where users are being surveyed, the use of a discussion group is strongly recommended for either

- a) in advance of the main survey to assist form design; or
- b) as a complementary activity to see whether a group explores issues that the individual will not answer, or had not considered.

In all cases where surveys are used, a pilot of the survey form should be carried out before the main distribution, allowing time for modification and second pilot.

#### *Step Six: Analyse and use the results*

The analysis of the data should be predetermined by the objectives and data requirements in steps one and three above. To make the best use of the results, the following recommendations are made:

- a) the end-users of the data (e.g. the system design team, transport planners) should be involved throughout the User Needs Analysis process;
- b) anomalies, negative comments, apparent contradictions, and bi-modal distributions should be noted and discussed in a special session of the demonstration team. Although some of these items may merely reflect the sampling process, many of them could provide important clues to potential user or market resistance to the demonstrator;
- c) the results should be presented to a cross-section of people and organisations involved in the demonstration (and perhaps downstream deployment). This will assist them in focusing their work;
- d) if resources permit, the results could also be presented to a discussion group that participated in the user needs work. Selected anomalies or negative items identified in (b) above could be introduced to see if the group can identify with them;
- e) the data should be available in accessible format to the design and the demonstration teams. Reviewing the material later in the project could prove very valuable.

### **1.3 User Groups and Categories**

It is very important to clearly define your users for a DRT project. Your services will typically serve a niche market, and there is no such thing as an homogeneous set of users. You will need to understand the range of people and entities that will interface with your services, and their characteristics.

Within the SAMPO project, a systematic categorisation of users was developed, since there was no relevant reference work available. In fact, a two-level approach was taken in



the categorisation of users. This has been done both for reasons of classification, and for clarity in the process. This is documented in Finn (1996).

Normally when the term “users” is employed, consideration is only given to the “end-users” of the service - in other words, the people who travel on the services. In fact, there are many other categories of users in the sense of actors who have a direct interest in the commercial, social, infrastructural or transport impacts of the services. The concept of User Groupings makes clear that these different actors exist, and that they have validity within the design and assessment processes.

In addition, it was also found that different DRT sites can each have a different focus which reflects the political, business and social demands of their environment. This suggests that there is a different balance among the user categories, and probably the user groupings in each site. It is therefore important to develop an appropriate framework in which all of these possibilities can be represented, as well providing a structure through which your site can assess itself against and import knowledge from DRT schemes elsewhere. Based on research of a diverse set of sites, four principal User Groupings may be determined:

- a) *End Users*: The End-User is a direct customer, or potential customer of the transport service provided. (S)he can also be described as the “passenger” or “consumer”.
- b) *Operators*: The Operator is directly involved in the provision of the transport service to the End-User by providing some or all of the elements of the vehicle, driver and support services.
- c) *Authorities*: The Authority has statutory or delegated responsibility for the provision or regulation of transport services in the target area.
- d) *Active Destinations*: Certain destinations may play an active role in the organisation of transport. For example, they may supply information to the operator about trips to the destination, they may act as a travel broker, they may assist the operator in planning the services, or they may co-operate with the operator to provide an inclusive price for the travel and the destination activity.

Two other possible groupings were considered in SAMPO - Time of Travel and Community type (scale, urban/rural). On examination, it was considered that these were relevant to market and pricing segmentation, but that they were not good discriminators in terms of users. The associated needs would be adequately described in the consideration of the main four User Groupings.

It can be considered that the host community for these services consists of many different actors, some which are individuals, others which are organisations or entities. They are interlinked for many purposes within their community, transportation being one of those needs. The key feature to be remembered about the transportation need is that it is always linked to another functional need of the individual.

Within each of the identified User Groupings, there is a range of User Categories. Each Category has a set of distinguishing features which allows the users within that category to be defined and to be treated as a set with common characteristics. This does not imply that the users within that Category are homogeneous - in fact, they may also be capable of a further layer of classification. It does, however, provide a sufficiently detailed set of entities for carrying out the analysis of user needs and for market segmentation. It also provides a basis for comparing and contrasting the opinions and activities of the DRT sites.

The best approach for a DRT site to take is to use the data in Table 1.1 as a check-list in the preparation of the User Needs work. For each identified category, assess whether the category is relevant to your site. If a category is both important and has diversity, then you might consider creation of sub-categories that are appropriate to your site. It is also possible that your site has specific categories not listed here. In the end, you will generate a list that suits your own site. Using this suggested approach will help you to include all relevant categories, and increase the possibility of being able to build on prior work elsewhere.

<b>End-Users</b>	<b>Operator</b>	<b>Authorities</b>	<b>Active Destinations</b>
School children	Association	European	Healthcare
Students	Co-operative	National	Education
Disabled	Municipality	Regional	Day-care
Elderly	Company	Local	Shopping centre
Healthcare patients	Sole operator	Community	Leisure/cultural
Accompanied person	Foreign operator		Administrations
Companion		Politicians	Other transport modes/ interchange points
Workers	Drivers/personnel	Legislature	Workplace
Shift workers	Dispatch centre	Police	Tourist centre
Leisure/cultural	Administration	Traffic authorities	
Shoppers	Planning	Funding Agencies	
Groups	Management		
Tourists	Owner	Manufacturers	
Sports			
Non-driver			
Car-driver (choice user)			
Administrative			

Table 1.1: User Groupings and User Categories (after SAMPO Project)

40 It is worth remembering that there may be some overlap between the categories. Also, an individual may have different needs depending on the circumstances of travel.

## 1.4 Typical needs of Users

The key reference work on fundamental User Needs for DRT is still the SAMPO project (Finn, 1996) which carried out a very extensive user needs analysis. This provides a very useful starting point for the preparation phases of any DRT project. The project team can assess whether these findings can be taken as a basis for their detailed work, and this will allow them to concentrate their resources on the more specific aspects of their target users. The reader is advised that as interest in DRT continues to grow, new sources of excellent work are beginning to emerge. Suggested sources of references on core needs of users include the EC VIRGIL project, the US Federal Transit Administration, and the Community Transport Associations of both UK and USA.

The main findings of the SAMPO work were considered under four main topics:

- transportation policy
- core needs of the users
- potential conflicts
- critical factors for DRT.

These are presented in the following sections.

### 1.4.1 Transportation policy

Transportation policy is relevant to three main groups:

- a) at **European and National level** there is a need to develop and implement effective measures to achieve modal shift as part of the effort to reduce the impacts of private car travel. This relates to needs for energy saving, emission reduction, congestion reduction and economies. Flexible transport services are seen as providing a further element in the integrated transport supply;
- b) at **National and Regional level**, citizen issues such as mobility, quality of service, the required level of public service involvement in provision of transport services and funding and local development become most relevant as there is the direct political accountability for the offered transport supply;
- c) at **local level** ensuring the provision of transport services to citizen groups such as the elderly, disabled and people in low-demand areas becomes the priority transport policy issue. At this level, the main actors are the municipalities or county councils, and the functional agencies.

### 1.4.2 Core needs of the users

The core needs of the users focuses on the two main user categories involved:

- the **end-user** or **customer**: the main motivation for the end-user is to have adequate access to a range of activities and locations to which (s)he chooses to travel. This means having suitable transportation of acceptable quality;

- the **operator**: the main motivation of the operator is to generate business which recovers the operating costs and provides surpluses for either profits or reinvestment.

The main needs consistently expressed across DRT sites for the **end-users** are that the services should offer:

- wide range of destinations/coverage
- easy access to services (walk, wait)
- responsiveness to personal needs
- accessibility of complete, reliable information
- ease and speed of booking
- last-minute booking
- reliability of service and arrival time
- minimum deviations/delays on route
- assurance of the return journey
- ease of boarding and space for luggage, shopping
- access to other modes, but minimise transfers
- maximum operating hours
- reasonable pricing structure.

The main needs and concerns consistently expressed by **operators** across DRT sites were:

- viable, sustainable services
- maximise patronage
- develop new markets
- cost efficiencies in service provision
- maximise occupancy and minimise dead running
- quick start-up period for new services
- suitable/improved technical support systems
- integration with other modes/routes
- effective/efficient Travel Dispatch Centre
- fair allocation of work, costs, revenues
- freedom to continue to develop own business
- ability to expand coverage area
- ability to accept non-booked passengers.

### **1.4.3 Potential conflicts**

Generally speaking, the responses for the user needs analysis exercises at the different SAMPO DRT sites were very positive all round. In most cases, the different user categories could all see benefits from the proposed means of implementing the DRT

services. This suggested that the actual response in practice would also be very positive. In a few cases, however, potential conflicts were identified. Some of these may have been a matter of perception, or may be reduced through fine-tuning after implementation.

The following examples are offered, since they present a challenge to the scheme designers to understand the causal factors, and find acceptable solutions for their own site.

- Regular passengers of the previously fixed-route services may now experience delays and uncertainty about arrival times of the services, although the new users may be very happy about the changes. Increased service reliability reduces the negative view.
- Users who have become familiar with an existing system are faced with either a new task, or a modified task in having to book the service. They may perceive that there is no new benefit for them in the change of the system.
- The providers of the DRT services require the user to make a telephone call. There can be conflict about who should pay for the call, either having it toll-free, user pays, or included in the service price.
- Ideally, the service provider would like the end-user to make fully automated bookings. The end-user would still prefer to speak to the call-taker/dispatcher.
- DRT services will give people in rural areas and villages better access to shopping, leisure and other facilities over a wide range of destinations. Owners of local shops, pubs etc. fear that they will lose their core 'local' business, and that they will finally have to close. This may actually leave villages without any facilities. On the other hand especially in rural areas, the scattered local businesses are accessible with marginal effort and at very reasonable fare.
- Service providers seek to achieve economic efficiencies through using DRT. One possibility is that this could allow them to offer a greater frequency of service for the same resources. Drivers and contracted operators fear that the original level of service will be provided using less resource. This would impact on the number of jobs in the sector, and perhaps also on salaries.
- Users of high quality Special Transport Services (e.g. shared-ride taxi in Sweden) may see the introduction of a more route-oriented concept (FlexRoute) as an unacceptable drop in service. This raises the policy question if a parallel STS option should still be available when FlexRoute is introduced in a district/region.

#### **1.4.4 Critical factors for DRT**

The SAMPO team considered which were the critical factors for success of DRT based on the User Needs Analysis, given that at the time there was only a limited experience of actual implementation. They considered that the factors could be clustered as “Preparatory” and “Implementation”.

### *Preparatory factors*

- accurate understanding of the market, the users, and their needs in the implementation site
- good local groundwork, planning and preparatory actions
- development of the 'right product' according to the user needs
- provision of suitable image and customer communication
- awareness and ease-of-use for customers of information about the services
- provision of acceptable booking and notification procedures for the return trip
- support/interest of the relevant transport operators and framework for co-operation.

### *Implementation*

- assurance of finance over the start-up period
- development of sustainable market within a reasonable time period
- establishment of user acceptance for the new product
- ability and willingness to adapt and fine tune the service
- retention of most users of existing services, while generating the new business
- efficient communication and optimising technologies
- support services for the user
- personal marketing concepts.

Although pricing was discussed by the users, it did not appear to rank as a critical factor in the success of services. It was considered that this needed to be tested when the services were fully established.

## **1.5 Four cases of User Needs Analysis**

To supplement the recommendations and general findings, a number of case studies are offered here to show user needs work in practice. The four case studies selected have had quite different motivations, and they help to illustrate the diversity of activity in User Needs Analysis. Of necessity, only an overview of the context and findings is provided here, but each has been very well documented so that the interested reader can trace through the objectives, methodology for User Needs Analysis, DRT systems offered, and actual outcome.

### ***1.5.1 Case Study 1: IVRS and Internet in Belgium***

De Lijn is a public-sector entity that is the primary provider of bus services in Flanders, Belgium. It has been one of the leading innovators in both DRT services, and in supporting ITS applications. It has developed its own Travel Dispatch Centre (TDC) software (Ring) and markets the DRT services as Belbus. Within the SAMPO project, a range of services were introduced successfully in Limburg province (see Section 7.2).

As De Lijn expanded both the coverage area and volume of services, they found that handling calls through the TDC is labour intensive and presents a potential bottleneck. Within the SAMPLUS project, they researched and then implemented both Interactive Voice Response System (IVRS) and Internet booking options so that some users can self-book without needing operator assistance. The first step is to examine the needs and attitudes of the potential users (Finn, 1999).

### *IVRS*

The operators, entity directors and 50 experienced users were asked about their attitude and preferences towards IVRS. They were asked about:

- the preference for identification of the customer: using a unique customer number (5 digits) or using the customer's telephone number (9 digits);
- the preference for identification of the stop points: unique number of 4 digits or number with 5 digits composed of 2 digits for the DRT area and 3 digits for the stop point itself within the DRT area;
- future use;
- change of reservation moment.

The results of the panel survey showed that the majority of the users prefer to identify themselves using their own telephone number. The less new numbers they need to know, the better. Preference was given to the identification of the stop points using a combination of 2 digits for the DRT area and 3 digits for the stop point itself. The DRT area number is generally known to the public, so just remembering a figure of 3 digits is easier than one of 4 digits.

About 2 out of 5 users said that they will probably never use IVRS, 2 out of 5 intend to use the system frequently. The vast majority of people above 56 years are in the category of probably-never-users. The majority of people under 35 are in the category probably-frequent-users. The future users are mostly students and employees (white collar).

The vast majority of those who have to call more than once to get in contact with the operator, intend to use IVRS. Even though IVRS offers the advantage of making reservations 24 hours a day, the majority of DRT users will not alter their reservation moment. Considering the probably-frequent-users, half would consider also making reservations in the evening and during the weekend.

The introduction of automated booking facilities was also investigated by inquiring of the operators of the system (6 persons, 3 provinces and public transport entities Limburg, East-Flanders and West-Flanders) because they have valuable experience with the reservation procedure. They were asked about their attitude towards "competitive" automated facilities via discussions, resulting in reports on proposed reservation procedures, requirements, efficiency etc.

The operator enquiries showed that operators are not in favour of IVRS (the term “Operators” refers to the staff at the TDC). They think that the average De Lijn DRT customer will not use this new reservation system. They see **advantages** in the reservation moment and the decrease of their work load. They think the system is good for a user who always makes the same reservation. When asking for **disadvantages** of IVRS they say that all these numbers will cause a lot of errors, that sometimes customers don’t know the name of the stop point, and the operator no longer has an overview of the reservations.

Even though the operators had a negative overall view, they provided some very detailed, rational and useful arguments which would help system designers to face the technical challenge.

The overall conclusion is that IVRS is generally known to the public, mostly by phone banking and product publicity (possibility to win this or that). The advantages of IVRS for the DRT Service are:

- extra possibility to make reservations;
- possible to make reservations 24/24 h;
- decrease of the operator’s work load.

Although IVRS is seen as an advantage in decreasing the work load of the operator, for the operators itself, it could feel as a threat in that sense that it could take away their job. As a consequence their attitude is rather negative.

Preference is given to a free number. Since the phone call to the operator already counts as a zone call for all DRT areas in one province/entity, this seems to be the only way to stimulate the use of IVRS in the beginning.

IVRS should be kept as simple and as short as possible. Though most people prefer the telephone number for identification of the customer, the development group decided to use a unique encrypted customer number of 5 digits because of security reasons. The identification of the stop points is done on the basis of a combination of the DRT area number and stop point number.

### *Internet Bookings*

At this moment, the group of potential users for Internet reservation for the DRT Service is not very big. But because of the explosive growth of Internet users, reservation for the DRT Service using this medium is seen as worth developing. The directors are in favour of this medium because more and more people get connected and e-commerce gains importance.

The operators see a disadvantage in that they no longer have a view over the reservations and that they lose some kind of “control”. They consider Internet reservation easier than reservation via IVRS because of the visual aspect and names instead of numbers for the stop points.



Multiple reservations are easy with Internet: 20 reservations at once should be possible, up to one month ahead. A disadvantage might also be that customers will book even when they are not sure of needing the transport because the cancellation is so easy and does not need the contact with another person.

For those who have Internet connection, reservation for the DRT Service has many advantages:

- extra possibility to make reservations
- possible to make reservations 24h/24h
- less work overload for the operators
- visual interface
- extra features compared to IVRS, such as
- searching stops on a map
- overview of bookings
- multiple bookings.

The Internet reservation module will be a simplified version of the operator interface.

### **1.5.2 Case Study 2: Elderly in Sweden**

This case study from Gothenburg in Sweden is used to illustrate the different needs of the end-users and of the authorities. The end-users, many of whom are quite vulnerable, need a service that they can rely on and understand. The authorities need to make savings through efficiency, but are still committed to supporting the end-users. By making these needs explicit from the start, and seeking a solution that balances these needs, the FlexRoute in Gothenburg has been highly successful (Westerlund *et al*, 2000).

Older persons with reduced mobility in Gothenburg are entitled to Special Transport Services (STS) which are provided at the expense of the City. Previously, they had been provided on-demand using shared-ride taxis, but the costs were escalating rapidly. The City realised that dedicated minibuses operating flexible routes staffed by caring drivers could do the same job more cost-effectively. However, they weren't sure whether the STS users would accept the change. They decided to conduct a well-structured User Needs Analysis to understand the needs and concerns of both the end-users and the authorities, and to use this knowledge to help them design the service, supporting systems, and communication with the users (Finn, 1996).

The user needs were identified through a combination of discussion groups and surveys. At first reading, it is hard to see that there is any common ground between these two sets of participants because each has a different perspective. However, the Authority realised that meeting the needs of the end-users is a fundamental part of meeting its own objectives.

### *Concerns and issues for the End Users (passengers)*

- Market surveys indicate that about 25% of the target group - Disabled and Elderly (D&E) persons - are interested in using the new service as had been briefly described to them.
- Long walking distances, steep grades and difficulties in carrying groceries and other purchases are often cited as a major problem for using regular public transport.
- A further significant problem is the perceived inaccessibility of existing buses and trams
- The service must be well explained and simple to understand.
- Users would prefer not to have to book the trip, but if required to do so they want this procedure to be simple and efficient. There should always be a confirmation of the information which has been input by the user.
- System reliability is an issue. There must be a procedure for what to do if the user misses the notification call.
- In group sessions most raise concern over the return trip which always is the weak link in demand-responsive transport services (including taxi). Currently only some 10% of all STS users book the return trip at the same time as the outbound trip.
- Group sessions regarding the use of automated booking technology show that this would be possible for the 'standard' trips (e.g. from home and same day) but that the user interface must be simple and consistent.
- Many current users of Special Transport Services (STS) indicated hesitation to the new service which could be perceived as a threat against their existing privileges (this issue had not been addressed in information given with the survey).
- The survey shows a great disparity between the mobility afforded in the different sub-groups of the D&E community. Some are very active and travel daily with their own car or with STS, whilst some are very isolated and only do occasional trips to downtown etc.

### *Concerns and issues for the Special Transport Services Authority*

- The City administration has obliged the Authority to save 12 MSEK (circa 1.5 M€) annually. One of several measures is to find more efficient means of providing local STS trips (e.g. within the users own city district and to adjacent destinations).
- The total number of STS permits in Gothenburg is about 27,000 corresponding to 6% of the total population. The Authority has taken a policy direction to reduce this number by some 1,000 per year. The introduction of the new service (FlexRoute) is assumed to make it possible to delay the need for an individual's STS-licence by at least a few years, thus contributing to the above reduction.
- Staffing costs for the STS Travel Dispatch Centre is about 10 MSEK/year (circa 1.2 M€). The travel volume is about 1.9 million trips/year which translates to a processing cost of about 0.6 ECU per trip.

- Current STS booking procedures are based on the premise that the passenger immediately receives a 'promised pick-up time'. The system is later only allowed to displace (delay) this with a maximum 10 minutes to allow for ride-sharing optimisation.
- The possibility of automated trip notification (to forewarn the passenger of actual pick-up time) would permit an initial optimisation window of up to 30 minutes and thus higher vehicle occupancy rates.
- The current STS system does not provide adequate statistical support for policy or operational changes. An improved Decision Support System is needed.
- A better Quality Control system is needed. 'Today we measure quantity, not quality'. Only planned displacement of trips (up to 10 minutes permitted delays) are measured, not the actual delays as experienced by the customer.
- Reporting by the driver of actual pick-up time and possibly a data message with explanations of the delay would be an improvement.
- Improved quality control should be possible to distinguish between service levels experienced in various parts of the city (e.g. city centre vs. suburban districts).

It is worth noting that basically all of the issues raised by the end-users during the initial User Needs Analysis have been well provided for in the on-going full-scale build up of the FlexRoute system while gradually phasing out the local STS taxi-service during FlexRoute operating hours. The Authority continues to listen to the users and make further improvements while some 3-4 new minibuses are added to the system each year. It is expected that most of the city will be covered by a fleet of some 30-35 vehicles in 2007.

### ***1.5.3 Case Study 3: Rural Areas in Ireland and Northern Ireland***

During 1998-9, four separate studies (Department of the Environment, Northern Ireland, 1999; Finn, 1999; PACT 1999; Down District Partnership, 1999; South West Fermanagh Partnership, 1999) on user needs in rural areas were carried out in Ireland and Northern Ireland. Each study was initiated by the local communities acting through partnerships of the voluntary groups and statutory agencies in the area, and was part of an Action Plan to develop local and community transport services in their area. Each of the studies involved a rural area where the current provision of local public transport was poor, and there was a strong awareness that impacts included reduced participation in society and marginalisation for those without access to independent transport. The four areas were:

- West Cavan/North Leitrim
- South West Fermanagh
- Ards Peninsula, Co. Down
- South-East Co. Down

In all cases it was understood that an analysis of users and of their needs was a very important part of the design process, and would probably be the key to a successful project. The User Needs work was carried out through a very extensive set of discussion groups, covering all sections of the Community and all of the active voluntary groups. In hindsight, it is now also understood that this in-depth consultative process greatly helped in both consensus forming and in raising awareness among the potential users. The reporting of this case study will focus on identifying the target users.

Based on the first level of the user needs work, people in the rural areas can be very simply considered to fall in to two categories:

- those that have the use of a car, and who can meet their travel needs without a barrier;
- those without the use of a car who must restrict their mobility to what can be achieved through the bus services and through lift-giving.

At the community level, there are four main types of transport requirement:

- individuals who wish to make a local journey to shops, post offices, church, leisure etc.;
- individuals who want to make longer distance travel, and who need to at least reach the available transport services;
- group activities which are located at a place, to which the participants need to travel. This includes youth activities, clinics, age-oriented groups, community groups, playschools;
- groups who wish to travel to a location for their event. This includes school classes, youth groups, sports clubs, aged groups etc.

A DRT Feasibility Study area was identified and the meetings confirmed severe restrictions for many residents and groups in being able to participate fully in their society. Individuals faced restricted participation, while groups and centres were aware that they could have had higher activity levels. Clubs and groups are restricting the number of trips they make, or else most of their fund-raising effort goes in to paying for transport instead of improving their facilities or skills. Parents, relatives and neighbours who have cars spend an increasing amount of time on the road in lift-giving.

Although there are many needs in the Feasibility Study area, a few categories of person stood out as consistently facing disadvantage. This is, of course, related to the lack of a car for reasons of affordability, age (young or old), or the family car being occupied. It is also directly related to whether people live in immediate proximity of shops and a suitable bus stop.

Four key target categories of individuals were identified:

- older people who are living independently (perhaps still with spouse) who often have reduced capability to walk long distances to shops, clinics or bus stops. This group often becomes marginalised, and stops participating in society;

- mothers with children in rural areas, especially where there is a child not yet in full-time school. These women usually have to organise the activities of the family, reach locations needed for the household, the children or themselves, and must do this on foot or by seeking lifts;
- youth in the age category 14-20 who have reached the age of acting independently, but have very few facilities available to them locally. They face extreme frustration in being able to develop a normal recreational, social, sporting and cultural life;
- people who are unemployed, on training schemes, or seeking to get back to work. These people must deal with administrations or attend training in the main towns, or are seeking to gain access to work places away from their home. The transport services do not meet their needs.

Three key categories of groups are also identified:

- sports clubs, especially football clubs which have a high proportion of children at all ages, and who participate in away activities. There is an extremely high dependency on lift-giving from the parents;
- playgroups and other facilities for young children and mothers. If the mother cannot access the facility on a regular basis for both arrival and collection, then it is not worthwhile. For women dependent on lift-giving, the need to achieve both arrival and collection is very difficult if they are not in reasonable walking distance. Obviously, there is no question of the children getting there themselves;
- age-oriented groups, daycentres and other activities for older people which are centred at a specific location. These people have reduced mobility, so they need transport. If they don't participate in these activities, there is a real risk of withdrawing altogether from society.

Based on these findings (and a lot more detailed information) a range of mobility services was designed to both meet the needs of the primary target groups and to be a usable resource for other users.

Three of these communities had their services operating by late-1999, with the fourth coming on-stream during 2000 (see Section 7.4). All agree that the formal user needs process was essential for understanding their users, and greatly helped the consensus-building process.

#### **1.5.4 Case Study 4: Access to jobs in USA**

The welfare reform bill in the USA (the Personal Responsibility and Work Opportunity Act of 1996) effectively meant that welfare support was limited to 60 months in total for recipients. In turn, this means that many people currently on welfare are going to have to find work opportunities. For many people on welfare, this represented a substantial life change, and in some cases this created a crisis. Overall, the administration

considered that there were adequate employment opportunities, so there shouldn't have been a problem. However, it soon became clear that there were some serious problems that related directly to spatial patterns and to the transportation supply, and that new solutions would be needed. The Federal Transport Administration reports the assessment of the emerging requirements, and a range of best practice examples that are being developed to meet these needs (Federal Transport Administration, 1998).

Key findings from the user needs work and market research include:

- only 6.5 % of families receiving public transport assistance own a car, people going from welfare to work are almost entirely dependent on public transport to reach jobs;
- women form the majority of recipients of welfare, but given the number of places they must also visit in a day in relation to their family (shopping, social services, doctors, day care, administrations) as well as their job, those without cars have very complex mobility requirements;
- rural areas have actually got higher unemployment rates than urban areas. About 40% of all rural areas in the USA have no available public transportation. This leads to a real crisis in country areas and small towns;
- the spatial distribution of people on welfare does not match well with available appropriate jobs. In urban areas, welfare recipients are concentrated in the city centre and certain suburbs. Many of the new downtown jobs require specific skills and experience;
- the real growth in jobs has been in industrial suburban locations, business parks, and out-of-town locations. People already in the labour pool have cars, or can afford to move house. People on welfare face serious commuting problems;
- in the Cleveland area, even with an 80-minute commute by public transport, residents from areas with high concentration of public-assistance recipients could reach less than 44% of the appropriate job openings. By contrast, people with cars could reach 75% of these job openings with a 40-minute commute (Leete and Bania, 1996);
- in Cobb County, Georgia, it was found that only 43% of entry-level job opportunities were accessible by MARTA (the Atlanta public transport network), and most of these required a one to two-hour commute;
- even if public transport can be used, the service hours don't match the job hours. Many of the entry-level and less skilled jobs involve shift work or evening hours, when transit is at low frequencies and connection times are poor. Typically, it is possible to travel in one direction using transit, but not to make the other outbound or return trip.

Two key initiatives have resulted from this and related work:

- 1) huge advances have been made in using GIS tools to map welfare recipients and potential job opportunities. This will facilitate a more dynamic approach to both matching workers with potential jobs, and in planning transit measures;

- 2) new mobility solutions are now being implemented, including DRT, shuttle services linking to transit lines, reverse commute services, van pooling, and new suburban bus services.

## 1.6 New directions for future research

The User Needs work carried out during the 1990's has typically been quite basic due to the absence of a well-documented and available body of work for this emerging domain. By now, the different types of users and their core requirements are quite well understood (although sites are still strongly recommended to carry out local work). A set of workshops within the SAMPLUS project during 1999 identified three emerging themes for future research in User Needs. Each of these is relevant to the DRT operator, and especially to the proper development and viability of the DRT services. They reflect the maturing of the research work in the DRT domain - as one transport operator has phrased it "Now we must move from Charity to Business".

This does not neglect the social dimension – even where there is heavy financial support, the operator must be profitable, and the funding agency must assure value-for-money for the use of public funds.

The three themes are:

- predicting the market
- pricing strategies
- costs and sustainability.

These are explored below. In addition, there are a number of technology needs emerging:

- lower cost technology units to reduce the barrier to entry and overhead cost;
- enhanced optimisation models at the core of the DRT to minimise the resource requirements and maximise the ability to meet user expectations for the trip;
- better interactive booking and reservation facilities.

### 1.6.1 Theme 1: Predicting the market

The key issues in this theme are:

- how do we estimate the market size, volume, segmentation, utilisation and revenue?
- what estimation methods are reliable, if any? Are there references and case studies?
- are there methods used in other domains which may be transferable?
- what are the key factors?
  - catchment area
  - target groups
  - service/product scenarios
  - pricing scenarios

- competing modes
- competing services
- how does the market change after implementation, is it stable, and is it predictable?

In appraising investments in other industries and service sectors, prediction of the market and potential yield would be an essential action. Indeed, investors would be reluctant to support a project that did not have a reliable estimate of the future business. For DRT to move beyond the ‘experimental’ stage or playing a ‘social’ role, methods need to be documented or even developed to allow the market to be reliably estimated.

### **1.6.2 Theme 2: Pricing**

The key issues in this theme are:

- what pricing concepts are being used in DRT systems around the world?
- has there been innovation in pricing DRT and flexible mobility products?
- can we use market segmentation in the pricing strategy, and if so, how?
- does the optimal pricing structure copy that of buses or taxis, or is something different needed?
- how price sensitive are the users? Does this vary by category?
- how can management information systems and other market knowledge be used to price at the margin? Can this be done in a practical way?
- are there good pricing solutions that are inhibited by regulations or other restrictions?

To date, pricing policy has rather crudely followed the existing public transport fares, sometimes at a premium rate (e.g. 30% higher). It has not considered yield management, although in practice a 10% uplift in yield can make the difference between viability and failure.

### **1.6.3 Theme 3: Costs and sustainability**

The key issues in this theme are:

- how well is the cost structure of DRT understood?
- what are the key cost drivers, and how do they vary?
- what are the marginal costs, and are they ‘stepped’?
- can knowledge of marginal costs be used in decision taking for service provision, or indeed for taking a specific reservation? If so, how can this be built in to the optimisation model?
- what ration of TDC to operational cost can be achieved?
- what innovation has been, or can be, achieved in contracting arrangements?

To date, the focus has been on simply achieving the service, and meeting the demands of the user. However, as with the revenue, a saving of 10% on costs may be the difference between success and failure, or the ability to generate the funds for asset renewal and/or expansion.



## CHAPTER 2

# Service typologies and scenarios

*D. Engels, G. Ambrosino*

One could say that individual transport and scheduled conventional transport start from different points of view on mobility. All individuals using their own private means of transport can decide here and now to make a trip to a specific destination. Although they will use the available infrastructure to meet their mobility requirements, no authority or operator will support the trip or even know the individual is making this trip. In the case of conventional public transport the authority and operator will organise a service to make the trip possible. Furthermore the authority and operator will have decided in advance to organise the service expecting people to use it. This expectation will be based on historical knowledge or on structural analysis of the movements of possible customers. To complete this view, one can add a taxi which can be considered as a first type of intermediate transport: it remains individual but an operator organises a service for which a client can ask when he wants to make a trip, but mostly a taxi will still be considered as an individual transport. This chapter considers the concept of Demand Responsive Transport.

### 2.1 Filling the gap

Flexible, Intermediate or Demand Responsive Transport (DRT) Services will fill the gap between individual transport and scheduled conventional transport. In this context, these new concepts of flexible collective transport can be developed starting from two different points of view: the taxi and the scheduled conventional public transport. Both transport modes have their own “reasons” to work on these new concepts.

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A taxi service is a direct individualised – collectively organised – answer to the need for transport. Characteristics of this transport mode are individual treatment of the customer, quick response, full origin to destination transport and, generally, a rather high fare. This last aspect seems to be the main reason to look for new types of transport. A combination of trips by the operator will lower the price for each user. A first level of this evolution – the so called shared taxi – will typically combine two or three trips using a normal or large taxi vehicle.

If more trips are combined using a vehicle with more seats – e.g. a van or a minibus – one starts naming the service demand responsive, even if a door-to-door service is not offered. If the authority has to pay for the service (e.g. for social reasons) they will also have an interest in optimising the service in order to achieve a higher level of cost-efficiency. An authority can have also other reasons to support such an alternative concept to conventional taxis, e.g. general energy savings and limiting of congestion through the reduction of individual car use.

Conventional scheduled public transport is facing different but important challenges. On the one hand there is a clear need to rationalise the organisation. Historically a high number of different lines are operated serving most origins and destinations in the region. However the costs of organisation are less and less covered by fare incomes and the origins and destinations have increased enormously.

The traditional answer to this was to limit the frequency of the services which resulted again in a lower number of customers. But on the other hand customers have an increasing need for mobility. Here public transport has to fulfil two important roles: offering basic mobility for everyone and giving a strong alternative for the use of a car to reduce the negative impacts of “car personalisation” of mobility and the consequent congestion and pollution.

Especially in rural areas this basic mobility is very important to keep the small rural villages alive. In general a high percentage of the inhabitants do not have permanent use of a car; this is mainly the case, for instance, for children, students, elderly, women working in the home etc. The lack of good public transport limits them in their activities and initiatives. This is also one of the causes why small villages which don't have a sufficient level of services (shops, administrative services etc.) suffer a gradual loss of the quality of life and, in the long run, do not remain viable.

In the other role of public transport being an alternative for the use of the private car, one can mention a wider spread of travel times, a higher value of time and a high level of reliability as important requirements of the customer choosing between public transport and the use of his private car.

In this context Demand Responsive Transport (DRT) Services may be introduced according to concepts designed to reduce the operational costs and to give customers a transport offer with a higher flexibility to meet their needs.

The scheme below (Figure 2.1) summarises the evolution towards new innovative transport concepts starting from the taxi and the conventional transport concept, taking into account the objectives of operators and authorities and new requirements of customers.

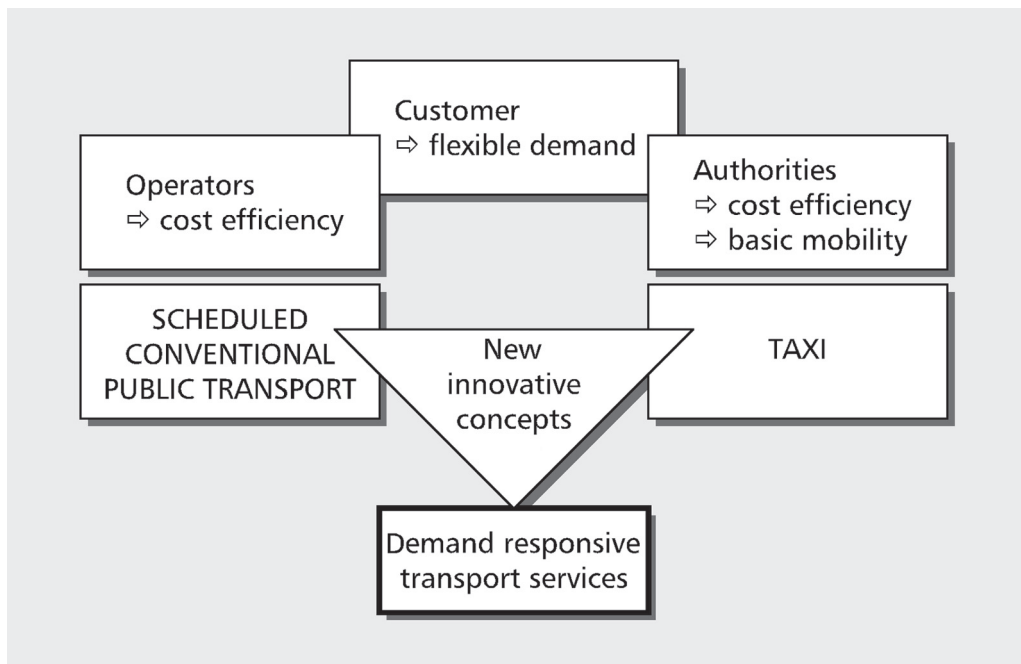


Figure 2.1: From conventional transport and taxi services to innovative schemes

## 2.2 Service concepts

As suggested by Figure 2.1, Demand Responsive Transport (DRT) Services are meant to introduce a certain level of flexibility in comparison with traditional public transport or they aim to keep a certain level of flexibility starting from taxi services. However flexibility can vary a lot and many choices must be made to achieve the right definition and most efficient organisation. In this process the needs and expectations of the customer must come together with the objectives of the operator and authorities (see Chapter 1). The promising message ‘call us, we drive you’ will give the customer the idea to get immediately a personal vehicle at a low price. In practice, a well organised DRT service will follow specific procedures and organisational rules to meet efficiency objectives. To dovetail both points of view, well motivated choices are required as regards different aspects of the service which can be seen as the conceptual building blocks of the resulting service scheme.

The most important aspects include the following:

- the route and time concepts
- the booking concepts
- the general intermodal integration
- the vehicle allocation concepts.

The following discussion of these concepts attempt to make a typology of DRT Services.

### **2.2.1 Route and time concepts**

The route of a service is the list of stops that will be served in a specific order. The flexibility in the timetable is seen as a part of the concept.

For a conventional scheduled service these elements are fully defined in advance. For a taxi service no route is defined in advance: the origin and destination of each route are directly determined by the request of a client.

Optimisation of taxi services is limited to the reduction of the unloaded kilometres between the destination of one client and the origin point of the next one by allocating passengers in the most efficient way to the taxis.

For intermediate transport a wide range of different concepts are possible, starting from a fully predefined route and timetable to a service for which stops and passing times are fully determined in a period just before operation or even during operation. To get a better view on the possible ways of organising DRT services in relation to route and time choices, a classification is proposed here of DRT service generic route concepts with an increasing level of flexibility having less elements defined in advance.

These concepts are built up using the following types of stops:

- a fixed, predefined stop with a predefined passing time and which is always served;
- a predefined stop with a predefined passing time which is only served on request (for end stops a predefined departure or arrival time);
- a predefined stop which is only served on request;
- 🏠 a stop point anywhere in the region indicated by the address (e.g. for a house) or the name of the place (e.g. an important building).

An important aspect for a DRT service is the definition of 'passing time'. Normally margins are accepted on the indicated time to give some time flexibility in order to allow the adding of additional stops to be served.

In the following, several service schemes (scenarios) will be introduced based on different choices and combinations of the above basic elements.

*Scenario 1: Predefined route and timetable which is partly fixed*

In this concept the service is partly coincident with a conventional scheduled service. The list of stops to be served, the complete route (arcs in between the service) and the timetable is described in advance. The flexibility of the service consists because of the possibility to include some additional stops along a predefined route which are served based on customer demand. The passing times are also predefined.

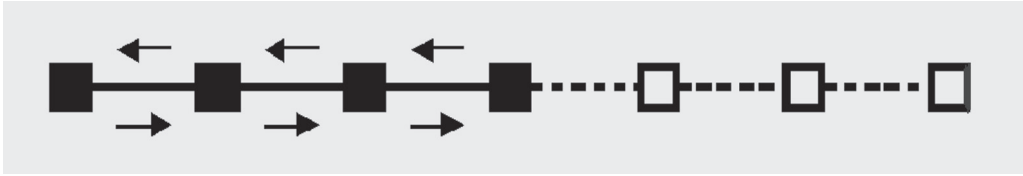


Figure 2.2: Scenario 1 - Extension of a scheduled service with a predefined route and timetable

*Operational considerations* - The feasibility of organising such a service is rather limited since the extension will take an extra time after the last fixed stop is served. If the vehicle also has to realise the return service the benefit of doing the last part on request is limited: a waiting time at the last fixed stop if no extensions are needed.

*Scenario 2: Deviations on a scheduled service to predefined routes in a corridor*

In this concept the service is basically a scheduled service with fixed stops and predefined passing times. In addition, the vehicle will deviate from the route to serve other predefined stops on request. These predefined stops are located within a corridor around the basic route; this means that the deviations to serve the stops on request are relatively short.

In theory, this is a very interesting concept for DRT to organise public transport on main axes where origin and destination points are situated near the main transport axis. The vehicle has only to leave the most direct route if there are requests. Unnecessary roundabout routes are avoided reducing time and kilometres.

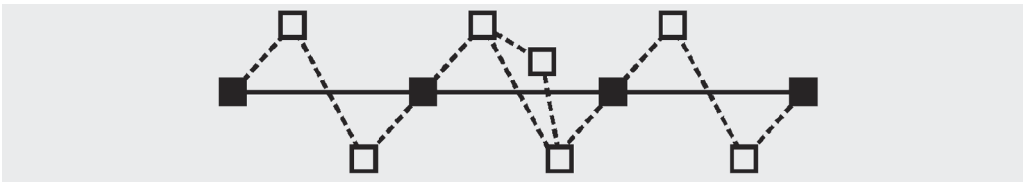


Figure 2.3: Scenario 2 - Deviations on a scheduled service to predefined routes in a corridor

*Operational considerations* - The deviation will normally take more time than the direct route. For this reason a balance needs to be achieved between the deviations and the

feasible time margins on the fixed timetable for the fixed stop of the basic route. For this reason it can be decided that all customers have to book for the service or that customers are clearly informed of the time margins that are applicable for the fixed stops as a consequence of possible deviations.

*Scenario 3: Predefined stops in a corridor*

This concept covers a service in which predefined stops are served located in a corridor. Some of the stops have predefined passing times (with margins) to structure the service.

This limits the flexibility but makes it feasible to serve more non-fixed predefined stops. The calculation of these predefined passing times is a very important aspect of the definition of the service since it will determine the flexibility: in general, more time between two stops with predefined passing times will allow the serving of more intermediate stops but will slow down the service. A balance must be achieved using historical and statistical data.

Usually, one end stop will be a fixed stop from which the vehicle departs or at which it arrives at a predefined time. Other stops with predefined passing time can be added e.g. to ensure transfer possibilities to a regular service passing at that stop.

Finally, it is also possible to exclude any fixed stop and to build up the timetable fully based on request.

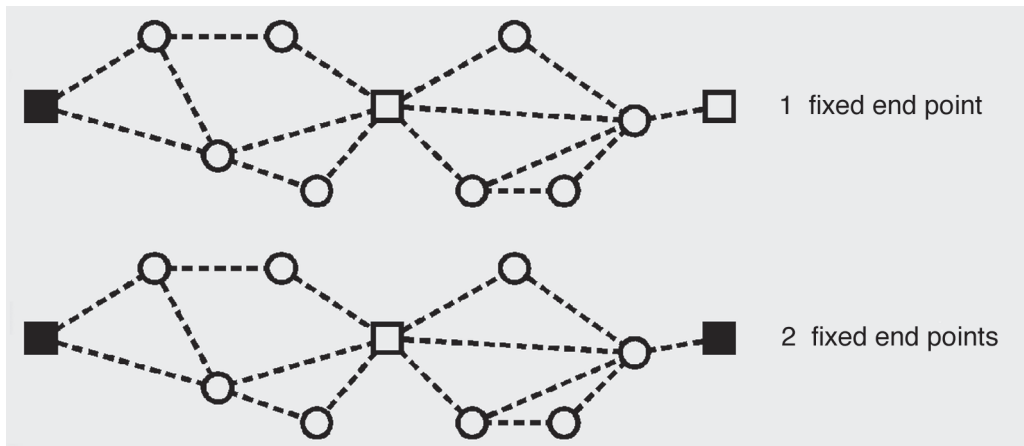


Figure 2.4: Scenario 3 - Predefined stops in a corridor

*Operational conditions* - The location of the stops in a corridor makes the organisation of the DRT service easier: the driving time between the fixed end stops won't vary much since the vehicle will only follow alternative routes which do not differ very much.

#### Scenario 4: Predefined stops in an area

This concept covers service schemes in which predefined stops are served area-wide. In most cases, only one stop will have a predefined passing time to make the organisation of the service feasible. Because of the spreading of the stops in the area, the variation in driving time between the stops can vary considerably, depending on the other stops that need to be served. In case no predefined passing time is determined for any stop, the service is more close to a taxi service. Only stops on demand will be served and the structure of the service will be completely defined by the requests.

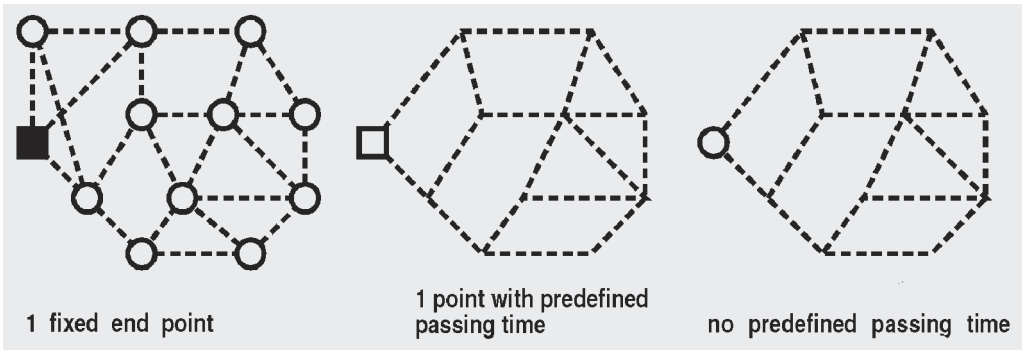


Figure 2.5: Scenario 4 - Predefined stops in an area

*Operational considerations* - This concept only seems economically feasible if some limitations are built in to avoid the vehicle having to make a trip for each request.

This can be done by introducing a stop with a predefined passing time or a fixed stop. In this way the request of the customers must be answered with each booking request fitting in a basic time structure of the service which allows a higher level of combination of request. Another limitation can be the reservation procedures. If customers have to book a longer period in advance and can be informed later of the expected departure and arrival time, more requests can be combined in one service journey.

#### Scenario 5: Points in an area

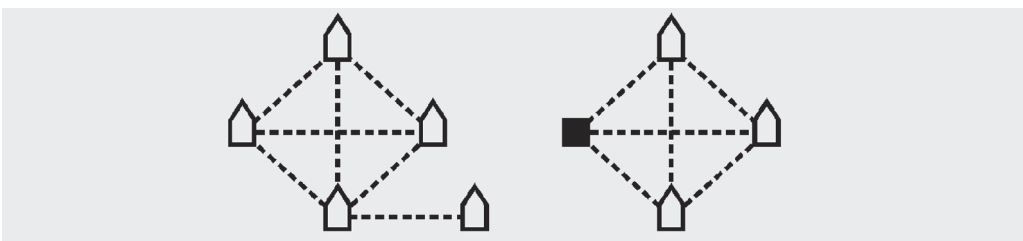


Figure 2.6: Scenario 5 - Points in an area

This scenario corresponds to an evolution of the scenario outlined in the previous section where served points in the area can be any point – e.g. address of a house, a particular building etc. – instead of fixed stops.

*Operational considerations* - Similar considerations can be formulated as for the previous scenario. If specific user groups are served extra attention is required for the time needed at the stop to allow customers to enter or to leave the vehicle e.g. with a wheelchair.

### *Combination of scenarios*

The basic DRT scenarios outlined in previous sections can be further worked out or combined to give the best transport scheme offer for a specific operational environment.

An example of a possible combination is schematically depicted in Figure 2.7 and is based partly on a fixed route and stops in the city centre and an area-wide service on request in the suburbs. This service schemes seems promising, for example, for late evening urban environments.

A particular version of such a service can focus on transport from the centre to the suburbs. Customers can board at the fixed stops and ask for a destination stop. At the end of the fixed part of the service the further part of the service is then defined.

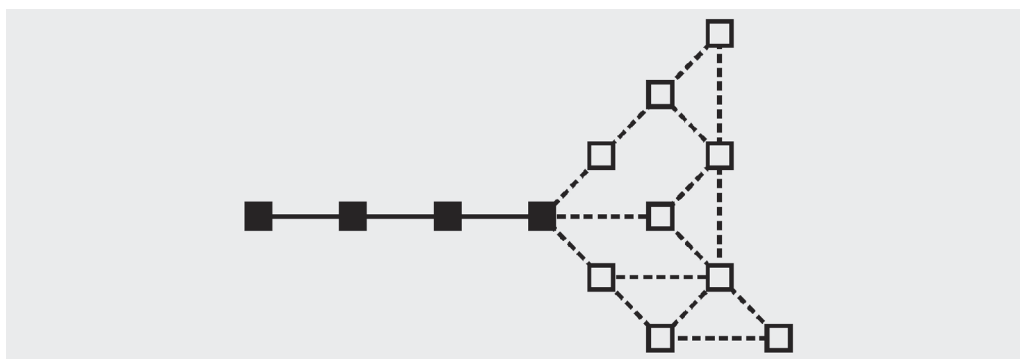


Figure 2.7:  
Combined DRT scenario combination of predefined routes and timetable with an area-wide service

### **2.2.2 Booking concepts**

A crucial element for DRT Services is the booking of the trip the customers request. Basically three consequent phases can be distinguished:

1. a request to make a trip with a particular origin and destination (stop or address) and an arrival or departure time
2. a proposal of a feasible service by the service operator
3. a booking confirmation (or refusal of proposed service) by the customer



Phase 2 and 3 can also be further sub-divided by giving first a more general service proposal with wide time windows which can be already confirmed by the customer, and second a trip notification phase in which the customer is informed more in detail about the departure and arrival time.

In summary, to structure the possible concept it is possible to identify 5 steps from the customer's request to the departure of the trip:

- A) *customer request*: the customer transmits a request to the operator (or the supporting system of the operator). The request describes the characteristics of the trip the customer intends to realise, e.g.:
  - a departure stop (or address)
  - a destination stop (or address)
  - a departure time or arrival time
  - the number of passengers (i.e. required seats)
  - any special requirements (mostly related to specific user groups; e.g. wheelchair accessibility);
- B) *preliminary trip notification*: the operator (or supporting system) presents one or more possibilities for the trip with rather wide time windows for the departure and arrival time, e.g. 30 min.;
- C) *defined trip notification*: the customer is informed with more details of the departure and arrival time of the trip with rather narrow time windows, e.g. 5 min.;
- D) *booking confirmation*: the customer confirms to the operator that she or he will use the services taking into account the proposed trip;
- E) *the departure of the trip*.

Different variations of this basic workflow and hence different types of service booking can be defined depending on the time each phase is realised.

Figure 2.8 provides a schematic view of the possibilities. These different service booking scenarios are briefly discussed in the following sections.

#### *Scenario 1: Non-pre-booked trips*

In practice sometimes customers like to board DRT services although they have not made a booking for the trip. This is notified to the driver directly by the customer at the boarding stop. In this situation – which can be defined as “on-board booking” – it is up to the driver to decide whether he will allow the passenger to board the vehicle, eventually taking into account instructions received from the service operator. Then all phases of the booking process outlined above are executed at the same time.

In general, service operators do not like such a situation because this is in conflict with the kernel idea of DRT services: combining booking request in the most optimal way into service routes. However this concept is also applicable for particular route-time concepts; e.g. the concept in which some of the stops are predefined where customers

board and can book only the destination stop. Then the remainder part of the service journey is planned based on the on-board bookings. Also a DRT service can be created where customers book their service via a terminal at the departure stop just before boarding only indicating the destination stop. A further development of supporting systems will be necessary to allow immediate response and communication with the vehicle.

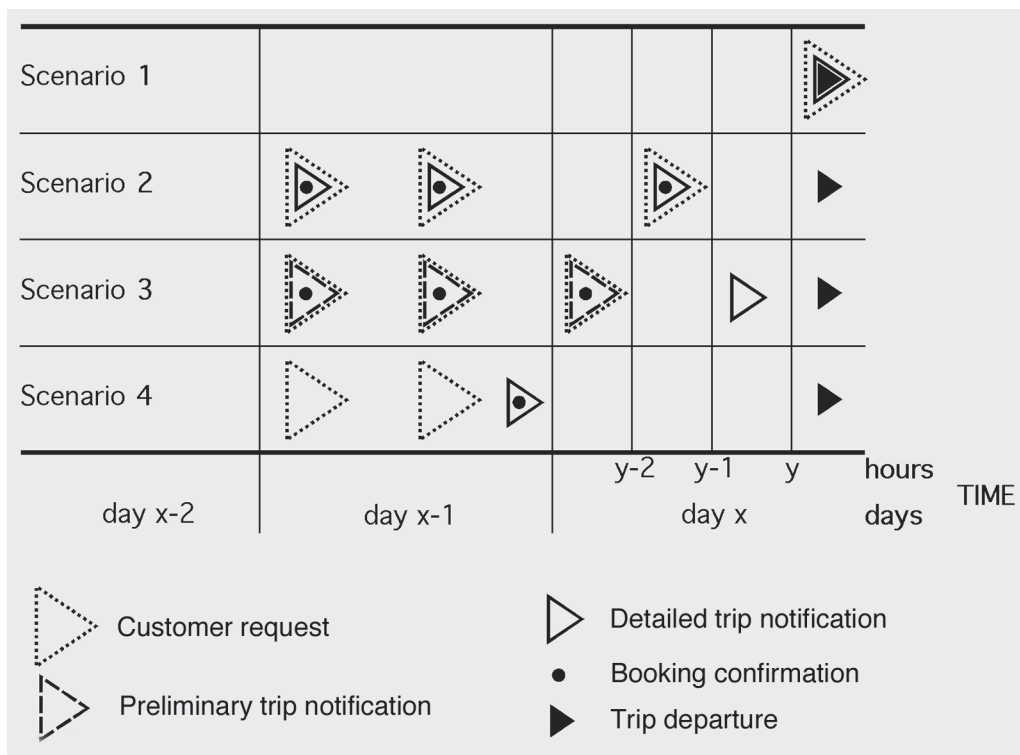


Figure 2.8: Time related booking choices

*Scenario 2: Direct booking*

In this scenario the customer issues a request to the operator, receives one or more detailed service proposals, decides and confirms the booking. Normally the booking can be done up to one or two hours before the departure time, allowing the operator to organise the services (e.g. informing the driver on the service journey pattern and driving to the departure stop of the customer). However, in order to provide more responsive services to their customers, operators are more and more keen to reduce this time limit, eventually allowing bookings until the time the vehicle approaches the departure stop.

### *Scenario 3: Wide time window - trip notification*

As an answer to their request the customer will first receive a proposal from the operator with rather wide time margins on departure and arrival times. Based on this information the customer will confirm the bookings. Only a short time before the departure time (e.g. by calling back the customers) the operator will inform the customer more precisely about the scheduled departure time.

This allows the operator to optimise the organisation of the service with wider flexibility on departure and arrival times (i.e. to apply route and vehicle allocation optimisation) and to communicate to the customers the actual scheduled departure or arrival times only when service planning is refined.

### *Scenario 4: Collecting requests – defining service*

In this scenario the operator will first collect all requests of the customers. Based on all the requests he will calculate the most optimal route taking into account optimisation criteria he has chosen in advance.

Once this process is executed a new contact with the customer is realised (initiated by the operator or the customer) in which the customer is informed in detail about the service he can use and, based on his travel requirements, will decide to accept the service by confirming the booking or not.

For organisational reasons this procedure is normally done well in advance of the travel planning horizon (e.g. the day before the required travels) with a second contact period after the planning is completed (e.g. in the evening).

### *Combined scenarios*

To a certain extent, the scenarios described here can be combined; for example, a realistic concept is the combination of scenario 4 and 2. First, the framework of each service is built up using the booking requests collected the day before (scenario 4). During the day, additional bookings are added in a direct booking interaction between customer and operator (scenario 2).

### *Booking technologies*

In order to implement the various booking procedures described in previous sections, a wide range of technologies are available to support service operators to manage the communication with the customer and the booking process. In the first implementations of the supporting IT systems a human dispatcher was often involved as a direct interface between the customers and the booking component. Nowadays enabling IT tools and systems – e.g. Interactive Voice Response Systems, internet and web services, GSM phones and SMS etc. – allow for a higher degree of automation of the booking process. The different technological options are discussed in more detail in Chapter 4.

### 2.2.3 Network concepts

DRT Services can have different roles in the general public transport offer. Although it is not evident how to structure the possible concepts from this point of view, some specific roles can be indicated.

#### *Stand-alone DRT service*

Especially in rural environments, in which a DRT service can offer the inhabitants of a low-density area the only public organised access to the services of a local village, the DRT service can be operated without any time or spatial relation with other services. The opening hours and location of the community or health services can be the main elements for the definition of the service.

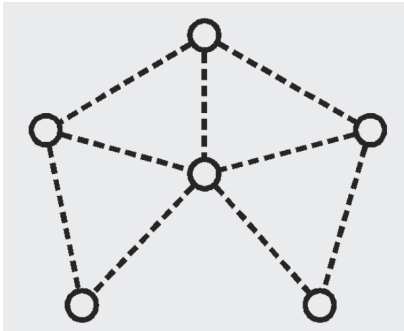


Figure 2.9: Stand-alone DRT service

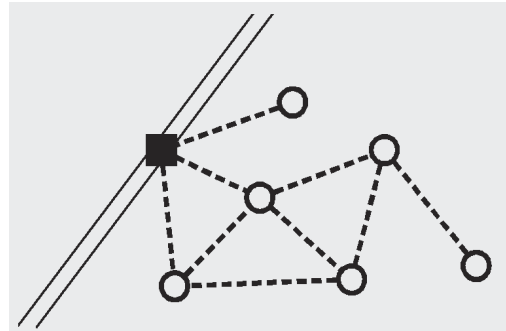


Figure 2.10: DRT feeder service

#### *DRT feeder service*

The other extreme situation is a service that operates for almost 100% of the customers as a feeder service to another bus service which completes the rest of the trip. The service area of such a service is sometimes rather limited while the stop of the connecting vehicle is the main stop point of the service. The main objective of the service is to avoid time-consuming deviations of the direct services that often connect two important centres in the region.

#### *DRT with multiple service roles*

In most situations the DRT services will give access for the inhabitants of a whole region to the most important centre where both the community services and the travel facilities to other destinations are important.

For example, the railway station will be an important stop for the service although most of the passengers will just have the centre as a destination for shopping, services, school or work.

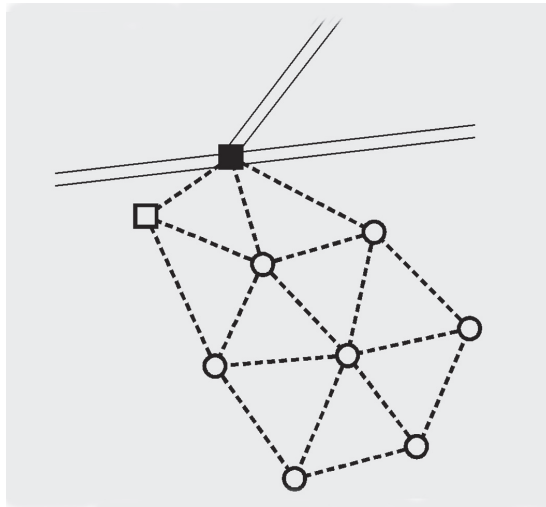


Figure 2.11:  
DRT with multiple  
service roles

#### 2.2.4 Vehicle allocation concepts

A final important choice in the definition of the DRT service is the way vehicles are allocated to each service. Again different solutions are possible.

##### *Fixed vehicle allocation*

The DRT service is defined with only one vehicle available. The characteristics of this vehicle determine to a large extent the type of DRT service.

A typical example of this is a minibus with 10 to 15 seats. If the service is a disabled and elderly service, specific facilities for wheelchairs will be provided such as a wide door entry with a wheelchair ramp and space for one or two wheelchairs. In this concept both the capacity and the presence of specific facilities will determine the type of service to be provided. If capacity is reached or time windows don't allow extra deviations, passengers will have to choose an earlier or later service or find another transport solution.

##### *Extendable vehicle allocation*

If the operator doesn't want to refuse passengers in any case, the service can be defined starting from one vehicle, but the use of an extra vehicle can be foreseen within certain limits. An example of this can be a taxi to transport additional passengers that couldn't be picked up by the initial services. Such a co-operation with a taxi company can be subject to a contract with this taxi company in which the public transport company agrees to pay the price difference.

To set the limits of the extension of the service a good statistical analysis of the evolution of the passenger volumes can indicate the best balance between the basic service and the additional input of means.

### *Dynamic allocation of vehicles*

The operator of the DRT service will ideally have at their disposal a pool of vehicles that can be used to realise the service. Different types of vehicles (capacity, accessibility, special facilities etc.) will form part of such a pool. Eventually some of the vehicles can also be operated by other companies. In such a case a contract will set out the level of availability of these vehicles and the procedure to put these vehicles in operation for DRT services.

A feasible process using this concept contains a first phase in which the operator collects the request for transport. Depending on the booking concept (see Section 2.2.2) passengers will get a direct answer or (in the two-step approach) a preliminary definition of the service with a detailed notification later on. The latter booking concept seems more appropriate with a dynamic allocation of vehicles, since it allows more optimisation possibilities.

In a second phase the vehicles are allocated to the services taking into account optimisation aspects and the specific requirements of the requests (e.g. accessibility for disabled). In this phase vehicle journeys will be calculated in detail. If a two-step approach is used, trip notification will be carried out after the allocation of the vehicles.

*Operational considerations* - In theory this concept offers a very high capacity for an optimal DRT service: the requests can be answered in the most efficient way using the most appropriate vehicle for each request, and the vehicles can be allocated for a service which fits best to the characteristics of the vehicle. However, in practice, a good balance needs to be found between the requirements of the customer (the right vehicle at the right time) and the operator (an optimal use of vehicles: maximum number of passengers on a minimum number of vehicles). This will result in some constraints in the definition of vehicle journey and the reaction to the customer. Contracts with other operators can increase the flexibility.

## **2.3 Optimisation of DRT at different levels**

A crucial concern of each public transport operator or responsible authority ought to be a good match between the demand for transport and the relevant public transport offer. This statement is even more true for DRT services since here optimisation doesn't end with the definition of the service in the planning phase.

In general, four optimisation levels can be indicated. For each level all actors involved must contribute to achieve to the best type of services.

### **2.3.1 Management level**

Each operator or service provider of public transport needs to stimulate and manage the factors that influence the set-up and organisation of a DRT service in the framework of

his global organisation of transport, making the right choice to introduce a DRT service or not in a specific area.

Factors that are important for the introduction of a DRT service include tariff mechanisms, flexibility of personnel etc.

### 2.3.2 DRT service concept definition

In the previous sections an overview has been given of different choices to be made when setting up a DRT service. Table 2.1 provides a summary of such options, indicating also, as an example, the choices made for three different cases of DRT services.

		Service concept		
		Service 1	Service 2	Service 3
<b>1.</b>	<b>Route &amp; time concepts</b>			
	1. Scenario 1: Predefined route and timetable which is partly fixed			
	2. Scenario 2: Deviations on a scheduled service to predefined routes in a corridor	●		
	3. Scenario 3: Predefined stops in a corridor			●
	4. Scenario 4: Predefined stops in an area			
	5. Scenario 5: Points in an area		●	
<b>2.</b>	<b>Booking concepts</b>			
	1. Scenario 1: Non pre-booked trips			
	2. Scenario 2: Direct booking	●		●
	3. Scenario 3: Wide time window – trip notification		●	
	4. Scenario 4: Collecting request – defining service			●
	<b>Booking technologies</b>			
	- Operator	●	●	●
	- Terminal			
	- Magnetic card		●	
	- Interactive Voice Response	●		●
	- Internet	●		
<b>3.</b>	<b>Network concept</b>			
	1. Stand alone service			●
	2. DRT feeder service		●	
	3. DRT with multiple service role	●		
<b>4.</b>	<b>Vehicle allocation concepts</b>			
	1. Fixed vehicle allocation	●		
	2. Extendable vehicle allocation			●
	3. Dynamic allocation of vehicles		●	

Table 2.1: DRT concept checklist

### *Service 1*

Service 1 is a service in which the vehicle will make some deviations from a basic route to take into account additional requests. Customers will get a direct response to their request by the operator or an automatic voice response system. Internet can also be used to book the service. The service operates both as a feeder service to the regional railway station and as the local service to the regional centre with the administrative and commercial services for the region. One minibus is used to operate the service which means a limited capacity.

### *Service 2*

Service 2 is a service offering customers the possibility to travel directly from their door to the transfer point of the regional bus for which the service operates as a feeder service. Customers will have a two-step response to their request with a detailed trip notification 30 minutes before the vehicle leaves the main stop. Booking can be done by telephoning the operator, while the return trip can also be booked by introducing a magnetic card in a terminal in the commercial centre. Depending on the number of requests the operator will use different types of activities for the services.

### *Service 3*

Service 3 will serve predefined stops on a corridor. Requests will be collected on the day before and form the basis for the definition of the route and time schedule for the service. During the day customers are added to the booking list. The operator will be the interface to the supporting system but the call-back will be handled automatically. The service will be operated as a stand-alone service with no significant connection with other services. If the capacity of the vehicle seems insufficient the day before, the operator can decide to add an extra vehicle.

These examples show the wide variation in the definition of the DRT service. To give the optimal answer on the travel demand or mobility objectives of the authority an in-depth analysis of the demand, the operational area and the objectives of the service are necessary in order to make the right design choices.

In this process several constraints will be taken into account, such as:

- number of vehicles
- capacity of the vehicle
- vehicle length
- vehicle shifts: availability in time
- driver shifts
- number of drivers
- road characteristics
- location of parking areas



- capacity of parking areas
- commercial speed
- passenger's special requirements, and so on.

A combination of the different characteristics of the site will have a direct impact on the possibilities for the optimisation of the service according to different criteria. The operator wants to optimise his resources, bearing in mind the wishes and demands of the customers: the best compromise has to be sought between the resources and the quality of the service. Possible optimisation criteria in this stage are maximisation of the number of passengers transported, minimisation of vehicles to be used, minimisation of vehicle kilometres etc.

This stage of the process is mostly performed by the planning department of the transport company. They can often base their decisions on statistical information, either from existing regular transport lines or existing DRT services, or they can use general movement patterns for the concerned area.

### ***2.3.3 Reservation handling and booking phase***

Depending on the booking concept, the requests can be processed using different criteria to define the most appropriate vehicle journey. Whether the optimisation must be performed on-line or off-line is a crucial element. An on-line schedule optimisation offers the advantage of an immediate and correct reply towards a booking customer; however it imposes some safety restrictions on the actual optimisation method which results in a less efficient schedule. On the other hand, optimisation after registration of all reservations offers an optimal direct and efficient vehicle schedule; however it often requires a trip notification before the run. This issue introduces specific requirements, firstly on the schedule processing speed, which needs to be very high with on-line optimisation, as well as on the obvious trip notification procedure in the other case. Also, this results in extra conditions on the reservation time limit and consequently on the data communication performance: a reservation limit of one hour in advance does not pose particularly tight requirements on the communication time as opposed to requests for real-time deviations on the route.

The requests from the customers can be processed in such a way to allow:

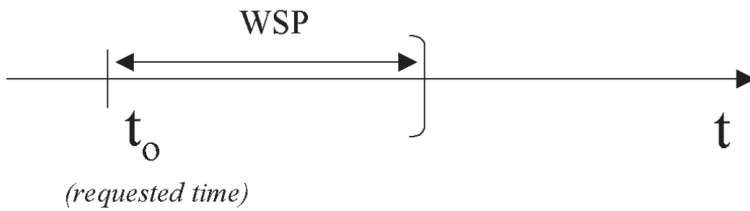
- a maximum possibility to serve additional customers;
- a minimum amount of vehicles to be used;
- a minimum amount of kilometres to be driven;
- a minimum on-board time for the passenger;
- a minimum amount of passenger kilometres;
- a minimum cumulative difference between passenger's requested pick-up time and scheduled pick-up time (individual);

- a minimum cumulative difference between passenger's requested arrival time and scheduled arrival time (individual);
- a minimum cumulative difference between passenger's requested times (for pick-up and arrival) and scheduled times (sum over all).

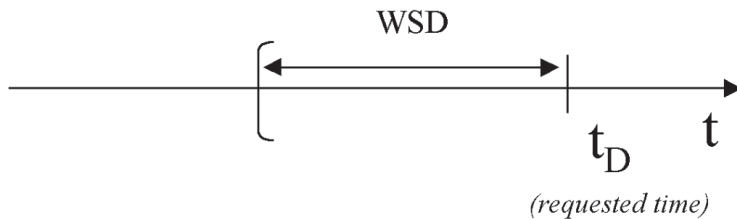
Each operator chooses a combination of optimisation criteria and several parameters are set in order to organise a service that reflects his demands.

As an example, some of the planning and assignment parameters that are handled in a real DRT implementation (the PERSONALBUS™ DRT system operated in Florence; see Section 7.5) are listed below:

- DRT: Direct Ride Time  
The passenger ride time from origin to destination with no stop in between and via the shortest route
- MRT: Maximum Ride Time  
The maximum allowed passenger ride time  
 $MRT = a + b \cdot DRT$
- WSP: Widest Shift at Pickup Time  
The maximum delay at pickup time allowed during planning



- WSD: Widest Shift at Delivery Time  
The maximum early arrival at destination stop allowed during planning



### 2.3.4. Service journey

In case customers receive immediate response about their reservation, the restrictions taken into account during the reservation process (still allowing as many bookings as possible, fixed timing) are no longer valid since the booking procedure is closed. In this

phase the boarding and alighting times promised have to be taken into account to finalise the service journey with a minimum amount of vehicles, a minimum amount of kilometres etc., taking into account the remaining margins.

## **2.4 The right concept in the right place**

As described in previous sections, a DRT service may have different characteristics and capabilities, allowing public transport companies to tune their offer and meet users demand in different mobility conditions.

Setting up a DRT service requires a number of design decisions and operational choices taking into account:

- the typology of the region
- the objectives of the operator or authority
- the characteristics of the user groups
- the type of demands.

A careful analysis of all these aspects is needed to define the service and to select the supporting technical system to manage service operations (see Chapter 1). Also a continuous evaluation is needed throughout operation of the DRT service, in order to be able to assess the capability of the system to meet users demand as well as the objectives of the operator, and to modify the service characteristics and operational parameters accordingly (see Section 7.1.3).

In the following chapters, especially in Chapter 7, several important DRT implementations which have been realised and are operated in different rural and urban sites in Europe are described. Evidence is presented to show how the different concepts and service characteristics presented in this chapter have found practical and effective realisation in different transport environments.



## CHAPTER 3

# System architecture

*D. Engels, A. Iacometti*

The organisation of DRT services on a reasonably large scale, and according to the concepts introduced in Chapter 2, is only possible if accompanied by a well performing supporting system. The booking procedures and the real-time optimisation of the service are two important differences from a traditional service that is fully planned in advance. In this context, over the last 10 years several DRT systems have been developed to support the operator to organise DRT services in an efficient way. These systems have similarities but have also remarkable differences e.g. in the DRT scenario supported, the user interfaces, the optimisation choices etc. Most of the systems also have interactions with other systems in the transit company to reach an efficient approach.

This chapter aims to give an overview and a better understanding of these systems by providing a description and discussion of DRT system architecture. This description is derived from the main results of the EC SAMPO and SAMPLUS projects in which the system architecture of the systems developed was described following the guidelines of the supporting project CONVERGE (also in the framework of the European Transport Telematics Programme).

### 3.1 System architecture: importance and definition

All systems have an architecture even though most developers do not yet explicitly write it down. Thus, for example, when a decision is taken to use only two digits to indicate the year, part of the architecture becomes ‘this program will only work with dates from

75

a single century'. The fact that few people have written down this particular architectural feature was always likely to lead to the 'millennium time bomb'.

The issue of architecture becomes of increasing importance when systems are created from the integration of two or more sub-systems. There is a naïve assumption that systems integration is only about data communication. This myth remains despite the great difficulty that many developers have in creating good quality integrated systems. It is necessary to consider whether or not there might be a fundamental reason for this difficulty, namely that of incompatible architectures.

All systems are designed to work in an environment (possibly more than one) and assumptions are made about that environment which is then built into the design. These assumptions make up the architecture of a system, providing it with form and style as well as the better known attributes of functionality, size, performance etc. The architecture provides the structure around which the system is developed. Once this structure has been defined, either implicitly or explicitly, it is usually very difficult and expensive to change it later.

A comprehensive description of the architecture of a system is crucial for the design of a good working system. Figure 3.1 shows the phase in the design process where the description of the system architecture should be completed based on an analysis of the user needs (see Chapter 1) and as a basis for the real development of the system.

At the same time the system architecture gives a better understanding – also for non-technical designers – of the system, which is important to assess the capability, the complexity and the general requirements for the company when implementing such a system.

The description of the system architecture in SAMPO/SAMPLUS was completed according to the guidelines of the CONVERGE project using four complementary points of view on the structure of the system:

- the functional architecture describes the various sub-functions of the system and the flows of data between them;
- the information architecture indicates the various data models for the sets of data that have been identified;
- the physical architecture identifies the physical units that will perform the functions in the functional architecture and the communications paths between them;
- the communication architecture describes the characteristics of the various channels that have been identified in the physical architecture.

In the framework of the SAMPO and SAMPLUS projects these architectures were described for DRT systems. For the functional and information architecture a synthetic DRT architecture with a first version of a DRT data dictionary were also developed.

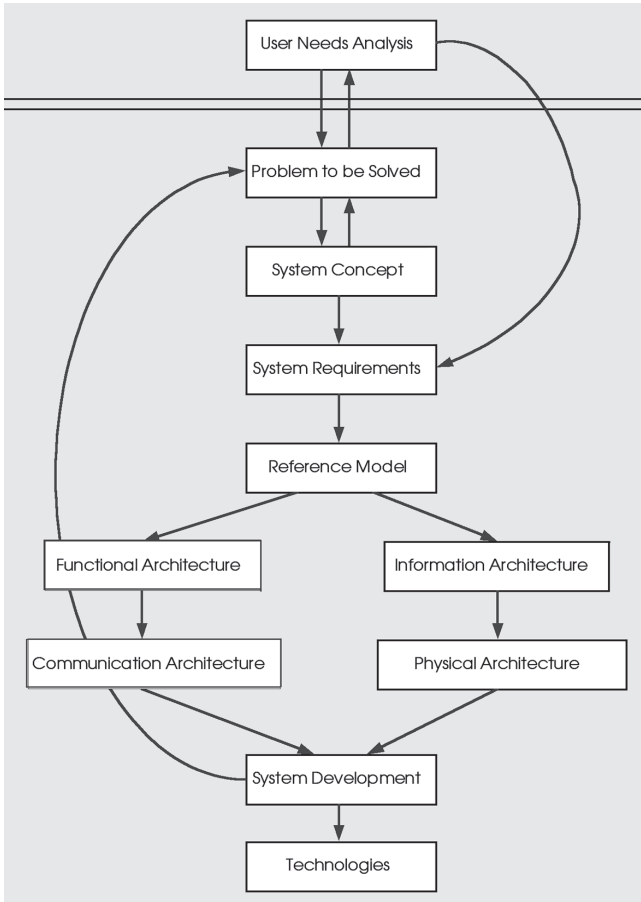


Figure 3.1:  
Phases in the design of a system

Since the physical and communication architecture is more application related, these architectures were described for the different systems. The remainder of this chapter gives an overview of the results of this work.

## 3.2 Functional architecture

### 3.2.1 The context of the DRT system

A modern public transport operator will have a wide range of systems to support the planning and realisation of efficient services. The specific sub-systems added to cover the DRT functions will interact with most of the sub-systems. To give a structured view on this, the functions of a public transport company can be divided in seven main functional areas as shown in Table 3.1.

Group 1: Management of DRT services
Group 2: Resource Management
Group 3: Operations Control
Group 4: Customer Information
Group 5: Communication Management
Group 6: Data Maintenance
Group 7: Fare Collection

Table3.1:  
Main Functional Areas of DRT Systems

In general, these main functions seem well defined to illustrate the main interaction of a DRT System within a transport provision system environment.

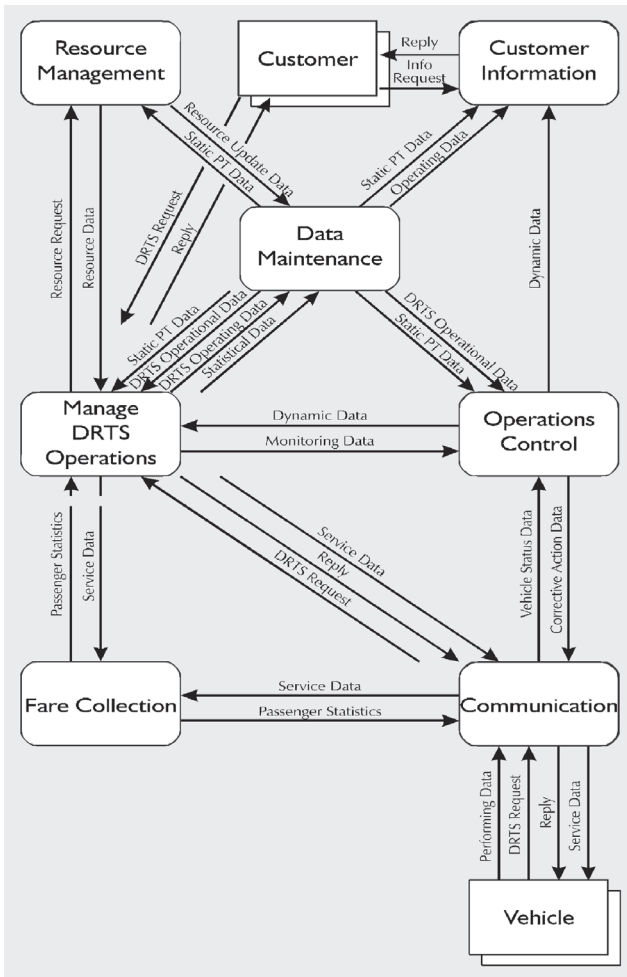


Figure 3.2:  
Common Functional Architecture -  
Main functions



The relevant interactions between the main functional groups are represented in Figure 3.2.

Clearly, this scheme represents the functional context within which a DRT System operates in a transport-providing environment. It is not intended to represent the full system architecture of a transport provision system, as it only mentions the main public transport functions relating to DRT.

### 3.2.2 Management of DRT services

These functional areas indicate the kernel functions related to the organisation of DRT services. Figure 3.3 shows the sub-functions and the data flows with the other functional blocks of the system.

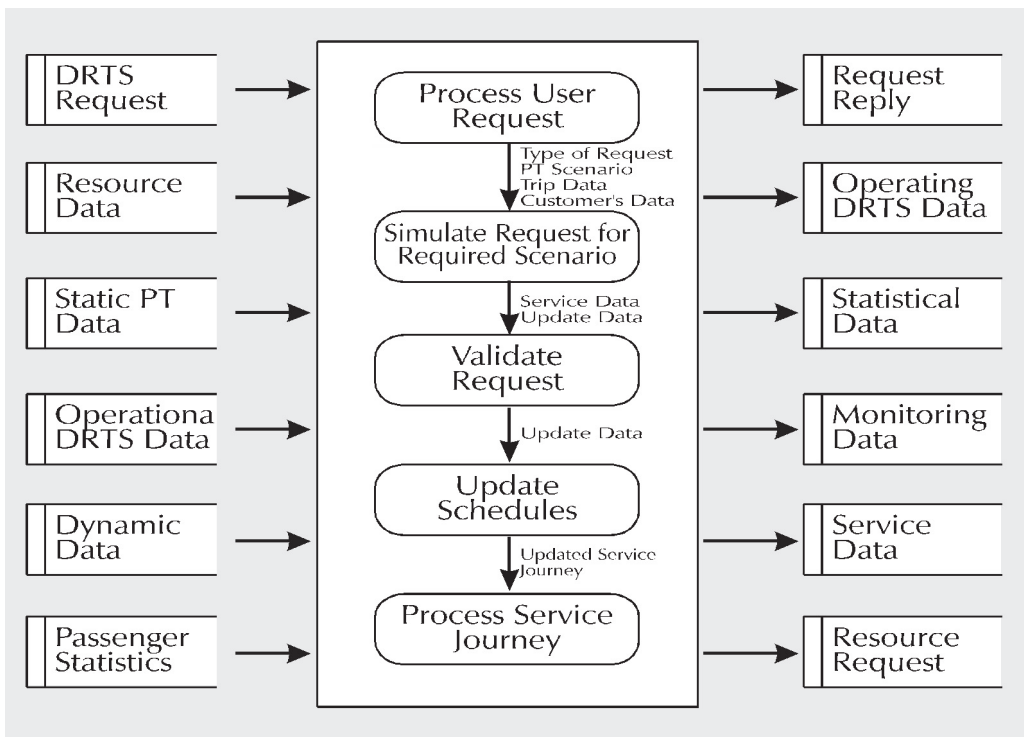


Figure 3.3: Management of DRT Operations

This main function assembles all actual specific DRT related sub-functionalities, concerning handling of bookings and reservations, as well as cancellations and booking modifications. Furthermore it processes the service journeys and prepares all outgoing data on monitoring, statistics and such. Globally, this function is solely used for DRT

purposes, and no other service nor functionality within the transport provider performs anything alike.

Five sub-functions are specified, which cover different possible realisations of the DRT concept. A first sub-function analyses the request and breaks it down into manageable data concerning the request actor (customer, driver, terminal, voice-mail, ...) and status (regular user, disabled, elderly, ...), scenario (regular service, door to door or stop to stop service, ...), departure and arrival location and time, connection, specific needs, as well as request type (reservation, cancellation, modification).

The second sub-function takes this data into account and processes the required simulation, calculation or scheduling accordingly; a reservation is simulated, cancellation can be simulated or not, an eventual trip-notification is prepared etc. In any case, a revised service journey is proposed, together with all essential update data.

The third sub-function concerns the potential interaction between the operator or autonomous system and the requesting actor. This step validates the result of the former process and can eventually be left out.

The fourth sub-function actually updates all schedules concerning bookings, logs, statistics and such.

A last sub-function prepares all required output data and offers this data to the other main function concerned.

As one may notice, at this level of system analysis and design the sub-functions remain on a very abstract level, offering the most flexibility and modularity without being superficial. In fact, the general concept of these sub-functionalities, as is also the case with the other main functions, consists of the very idea of telematics applications: input data is translated to essential core data, processed, calculated and reformed into data more useful for the actor triggering the function.

### **3.3 Information architecture**

#### **3.3.1 Conceptual data model**

The information architecture is specified via conceptual data models in the analysis and design stage of the system. These data models describe the concepts relevance, simulate the meaning and the structure of the data in a practical operational framework and complement the perspective of the functional model. The major issue of the data model is its relative stability throughout further evolutions, whatever new application, modifications or extensions are introduced in the future.

The conceptual data models introduced in the following sections identify the relevant concepts in an authentic environment and describe the relationships between these concepts. In so doing, these models make an essential abstraction from the practi-



The conceptual data model supported by PERSONALBUS™, the DRT System implemented and operated at the Italian SAMPLUS site (see Section 7.5) is schematically introduced at the end of this section. An overview of the conceptual model can be given as follows.

Any DRT Service is operated in a given DRT AREA. For various reasons, the DRT Service area may be different on different days or periods of the year; for instance, some parts of the area (i.e. some STOP POINTS, ROUTE LINKS etc.) may not be accessible for service at a given date, or the DRT service provider may want to extend the served network starting from a specific date. Any DRT AREA, therefore, may have a number of associated NETWORK VERSIONS, each identified by a CALENDAR DAY specifying the start date of the validity period for the given network.

A NETWORK VERSION affects a set of geographical network entities (MAPPING POINTS, ROUTE LINKS etc.) as well as the VEHICLES operating the DRT services. In order to allow the greatest flexibility in characterising the NETWORK VERSION(s) for a given DRT AREA, different PERIODS may be defined related to different DAY TYPES, each having, possibly, different TIME BANDS.

Overall, the conceptual model can be broken down into the following main parts:

- the road network in which the DRT services are operated
- the related DRT resources (i.e. DRT vehicles)
- the customers' orders
- the DRT journeys.

### **3.3.2 DRT data dictionary**

Based on an analysis of the systems developed in the SAMPO and SAMPLUS projects, a comprehensive data dictionary for DRT services has been derived, underlying the above conceptual data model, from the different demonstration sites. The data dictionary describes briefly the meaning of the concepts that are used in the schemes.

The starting point for the definition of the data dictionary were the entities defined in the European TRANSMODEL data model. This data model doesn't cover DRT services. Nevertheless a number of data sets important for DRT service are already defined since the data are also important for regular services. Table 3.2 provides a synthesis view of the data (data already defined in TRANSMODEL are indicated with a tick mark ✓).

## **3.4 Physical and communication architecture**

The physical architecture addresses the physical structure of a system, the “where” of a system, while maintaining freedom to manufacturers to make choices with “what”.

82 Hence, the physical architecture describes, in terms of a comprehensive set of Basic

CONCEPT	DEFINITION	TRANS-MODEL
Access link	The physical (spatial) possibility for a passenger to access or leave the public transport system. This link may be used during a TRIP for: - the walking movement of a passenger from a PLACE (origin of the TRIP) to a STOP POINT (origin of the public transport TRIP) or - the walking movement from a STOP POINT (destination of the public transport TRIP) to a PLACE (destination of the TRIP)	✓
Block	The work of a vehicle from the time it leaves a PARKING POINT after parking until its next return to park at a PARKING POINT; any subsequent departure from a PARKING POINT after parking marks the start of a new BLOCK	✓
Boarding and Alighting	Getting on and off the vehicle	
Booking	Confirmed RESERVATION where the order has been entered in the DRT system and a given service (RIDE) has been negotiated between the CUSTOMER and the DRT service provider	
Calendar day	A specific day in the calendar where public transport (DRT) operation takes place	✓
Caller	Person calling or trying to call to make a booking	
Cancellation	An ORDER submitted by the CUSTOMER requesting deletion of a previous RESERVATION or BOOKING	
Connection link	The physical (spatial) possibility for a passenger to change from one public transport vehicle to another to continue the trip; different times may be necessary to cover this link, depending on the kind of passenger	✓
Customer	A person or organisation involved in a SALES TRANSACTION concerning the DRT Service, issuing a DRT Service ORDER	
Day type	A type of day characterised by one or more properties, which affect DRT operations (e.g. weekdays, weekends, and weekdays in school period, etc.)	✓
Day of week	A particular week day (from Monday to Sunday)	✓
Dead run	A non-service VEHICLE JOURNEY, i.e. the part of the VEHICLE JOURNEY between the PARKING POINT (located outside or inside the DRT AREA) and the DRT AREA	
Dead run pattern	A JOURNEY PATTERN to be used for DEAD RUNS	✓
Distance between stops	Distance in kilometres between 2 STOP POINTS	
Distance matrix	Origin – destination matrix for STOP POINTS, expressing the distance in kilometres for the corresponding trip	✓
DRT area	Area that is being served by a DRT Service Provider	
DRT vehicle	A public transport vehicle used for carrying PASSENGERS in the DRT Service AREA	
Journey pattern	An ordered list of STOP POINTS and TIMING POINTS on a single ROUTE, describing the pattern of working for public transport vehicles; a JOURNEY PATTERN may pass through the same POINT more than once; the first point of a JOURNEY PATTERN is the origin ; the last point is the destination	✓
Junction point	A MAPPING POINT located at the start of or at the end of any ROUTE LINK (similar to JUNCTION in the GDF conceptual model)	
Mapping point	A POINT for which mapping information (e.g. geographical location) may be recorded	✓
Network version	A set of network data (related to the DRT AREA) to which the same validity period has been assigned. A NETWORK VERSION is identified by the start date of its validity period. The end date of the validity period is derived from the start date of the next NETWORK VERSION recorded. At each CALENDAR DAY, one and only one NETWORK VERSION of a specific DRT AREA will be valid	
Operator	Name of the bus or taxi operator	

Table 3.2: DRT Data Dictionary (to be continued)

CONCEPT	DEFINITION	TRANS-MODEL
Order	A request issued by the CUSTOMER to the DRT Service Provider, concerning the RESERVATION of a RIDE or CANCELLATION of a previous RESERVATION or BOOKING	
Parking point	A POINT where vehicles may stay unattended for a long time: a vehicle's return to park at a PARKING POINT marks the end of a BLOCK	✓
Passenger	Person travelling with the DRT vehicle	
Period	A continuous interval of time between two CALENDAR DAYS which will be used to define validities	
Place	A geographic place of any type which may be specified as the origin or destination of a TRIP. A PLACE may be of dimension 0 (a POINT), 1 (a road section) or 2 (a ZONE).	✓
Point	The smallest identified location in space	✓
Point in journey pattern	A STOP POINT or TIMING POINT in a JOURNEY PATTERN with its order in that JOURNEY PATTERN	✓
Point on route	A MAPPING POINT used to define a ROUTE with its order on that route	✓
Public transport trip	A part of a trip starting from the first boarding of a public transport vehicle to the last alighting from a public transport vehicle; a public transport trip consists of one or more RIDES and the movements (usually walks) necessary to cover the corresponding CONNECTION LINKS	✓
Recorded stop	The recorded stop at a STOP POINT during actual service operation to possibly let passengers board or alight the vehicle	
Regular public transport line	A group of ROUTES which is generally known to the public by a similar name or number (TRANSMODEL uses LINE)	
Reservation	The ORDER issued by a CUSTOMER in advance to request a DRT VEHICLE to call at requested STOP POINTS for boarding and alighting, in specified CALENDAR DAYS and at specified times	
Ride	A part of a TRIP corresponding to the theoretical movement of a passenger on one and only one public transport vehicle, from one STOP POINT with timing information on a specified date to another, on one JOURNEY PATTERN	✓
Route	An ordered list of MAPPING POINTS defining one single path through the road network: a ROUTE may pass through the same MAPPING POINT more than once	✓
Route link	An oriented link between two JUNCTION POINTS allowing the definition of a unique path between the two JUNCTION POINTS	
Service journey	A passenger carrying VEHICLE JOURNEY; the part of the VEHICLE JOURNEY while offering service; the pattern of working is defined by the associated SERVICE JOURNEY PATTERN	
Service journey pattern	The JOURNEY PATTERN for a (passenger carrying) SERVICE JOURNEY	✓
Stop point	A POINT where passengers can board or alight from vehicles	✓
Stop timetable	The description of the earliest departure time from and the latest arrival time for a certain STOP POINT	
Time band	A period in a day, significant for some aspect of public transport; e.g. availability of a VEHICLE, accessibility of a ROUTE LINK, etc.	
Timing point	A POINT against which the timing information necessary to build schedules may be recorded	✓
Travel time	Time in minutes that the vehicle needs to travel between each combination of stops	
Travel time matrix	Matrix formed by the travel time between each combination of stops	
Trip	The complete movement of a passenger from one place to another; a trip may consist of one public transport TRIP and the corresponding movements (usually walks) to cover the necessary ACCESS LINKS and CONNECTION LINKS	✓
Vehicle journey	A particular journey of a vehicle	

84 Table 3.2: DRT Data Dictionary (to be continued)

CONCEPT	DEFINITION	TRANS-MODEL
Vehicle shift	A working period of a VEHICLE	
Vehicle status	The status and location of a vehicle (current)	
Vehicle status history	The status and location of a vehicle (previous ones)	
Vehicle type	A classification of public transport vehicles according to the vehicle scheduling requirements (e.g. standard bus, minibus etc.)	✓
Zone	Two-dimensional place within the DRT AREA of the public transport operator, containing different stop points	✓
Zone co-ordinate	A transformation of zone information to a co-ordinate that represents that particular zone in all route calculations	
Zone group	A vehicle without GPS that uses a certain set of zones to give its location to the TDC	

Table 3.2: DRT Data Dictionary

Building Blocks (BBB's), the conceptual structure of the hardware and the software environment of the sub-systems in the application to be designed. BBB's are logically independent parts of a system, potentially being modified or upgraded without having to revise the entire system around them.

Also situated on the physical level, the communication architecture gives a clear and schematic overview of the communication procedures between different applications and system sub-modules. Consequently, it concentrates on the physical transfer of data between the applications, representing the communication means and characteristics.

On the physical view of the system, both the physical and communication architecture describe many similarities when presented in a schematic figure. However, whereas the physical architecture mainly focuses on the applications and units, the communication architecture will focus upon the communication and transmission means of the system. Nevertheless, the figures represented and their respective textual description will often be complementary and should be analysed that way. Therefore, both architectures are presented together in this section.

As an example of such a description, the physical and communication architecture of the Belgian DRT system RING™ is shown in Figure 3.5 below. The RING™ system was realised and tested during the SAMPO and SAMPLUS projects. A more detailed description of the architecture together with the specific choices of technologies for implementation is provided in Section 4.2.2 below.

### 3.5 Integration with other mobility systems

Although most of the existing implementations have initially led to operational DRT systems mainly as stand-alone applications, a major emerging issue is the interfacing and integrated operation of DRT schemes with other technical systems. These are usually mobility systems operating within the same geographical area or transport

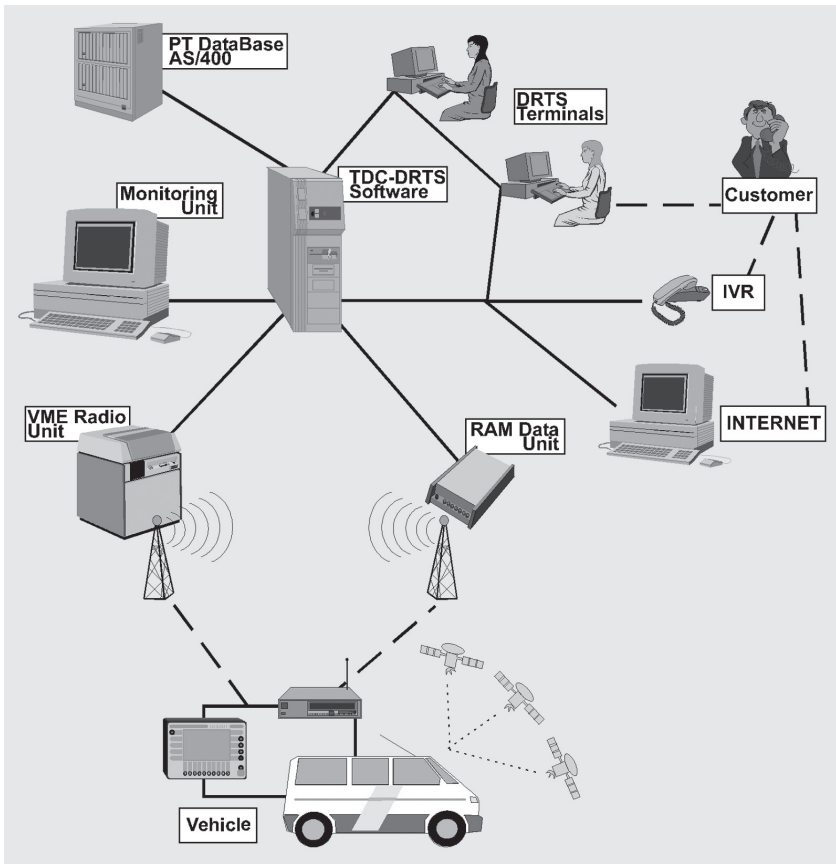


Figure 3.5:  
Physical  
architecture of  
the RING System

environment (often operated by the same organisation managing the DRT application) or other ITS applications in the transit company.

The systems and applications which seem to bear more relevance from the point of view of integration with DRT system architectures include:

- the Management Information System of the public transport company
- the Automated Vehicle Location/Monitoring (AVL/AVM) system
- the Integrated Payment System (IPS)
- the Passenger Information Services (PIS).

An effective integration of DRT architecture with the company's management information system is an essential requirement to achieve optimal use of some key data and technical resources within the organisation. This is the case, for example, of transport network data, vehicle and driver related data etc.

AVL/AVM systems are a fundamental component of any public transport service management architecture in the urban environment. Depending on the type of DRT



system one wants to implement, AVL/AVM systems may help in providing essential real-time data for DRT operation. For instance, they provide a major building block in the case of a fully dynamic DRT system able to implement real-time route diversion based on passenger request. Likewise, Integrated Payment Systems used on regular bus services may work on DRT vehicles as well and are of interest for DRT operation. Although the technical integration of IPS devices on board DRT vehicles may not pose particular problems, this may introduce different requirements on fare collection operations, based on potential differences in DRT tariffs and debiting policies. However, integration of IPS with the DRT system should be always considered and, when achieved on technical and operational grounds, it can provide clear benefits from the point of view of improved efficiency of the company's whole fare collection operations.

Finally, Passenger Information Services are relevant for DRT operations mainly from the point of view of integration of DRT schemes with conventional bus services, especially when DRT schemes play a role of feeder services to main public transport lines. In such cases, the integration with PIS may lead to increased passenger information and greater efficiency of operation of the entire public transport system, especially in those interchange areas where DRT can be requested by the passenger and transfer between DRT and regular bus lines can be achieved.

Figure 3.6 below provides a summary view of potential and interesting areas of integration between DRT systems and the other urban mobility systems. This chapter has focused on the system architecture required for DRT. Chapters 4 and 5 illustrate the technologies adopted in several key implementations of telematics-based DRT services.

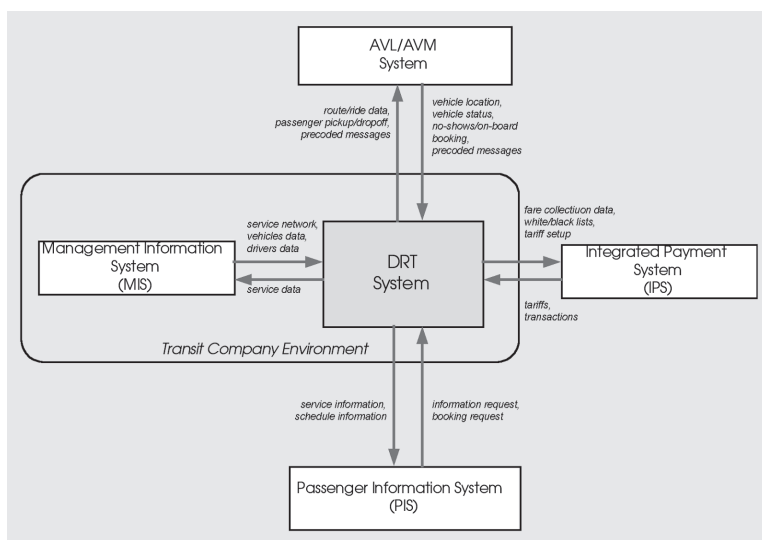


Figure 3.6: Main integration aspects for DRT and urban mobility systems



## CHAPTER 4

# Technologies for DRT Systems

*A. Iacometti, L. Setti, J. Scholliers, M. Gorini, P. Eloranta*

Modern Information and Communication Technologies (ICT) offer a wide range of possible technological options for the development of DRT system modules: localisation and navigation systems (GPS, dead reckoning...), Internet network, wireless communication systems (GPRS, UMTS, PRN etc.), on-board units, mobile terminals, real-time booking systems, GIS etc.

Some solutions and technological products adopted within the DRT systems are different, mainly for cost related factors, specific peculiarities and requirements of the DRT service architecture and on account of the integration with the existing transport services and ITS infrastructures.

In recent years, the technological architecture of the different European DRT experiences has underlined a wide range of technical and architectural solutions. This chapter summarises the main technologies and standards involved in the development of DRT systems.

### 4.1 Architecture components of a DRT system

The main architectural components of a DRT system can be identified as follows:

- the DRT system Control Centre (known as the Travel Dispatch Centre - TDC)
- devices for users (i.e. customers) to access the DRT system
- on-board Units
- communication network.

For each of the above DRT components a brief description of the innovative technology adopted is provided in the following sections. On-board units and the communications network receive more detailed treatment in Chapter 5.

#### 4.1.1 DRTS Control Centre

The main DRTS functionalities are managed by the DRTS Control Centre (Travel Dispatch Centre - TDC): order handling, reservation scheduling, travel planning and service monitoring. The TDC architecture is usually client-server permitting a multi-user service: many TDC operators can manage many DRTS areas and serve many users reservations at the same time.

The architecture involves at least the following hardware and software platforms:

- the *Dispatcher Server* (i.e. the travel manager and dispatcher system) which includes:
  - order management (trip reservation, service offer acceptance/refusal/modification)
  - travel planning (optimal routes search, vehicle assignement, stop time delay and trip time estimate, scheduling and service planning)
  - TDC operators user interface with graphical and geographical information tools (GIS system to describe and access to network service data, stops and planned route...) which are used to access and manage the planning and execution of the DRT system (Figure 4.1a)
  - local database and data server interface;
- the *Database Server*, a relational database, which:
  - stores all the information used by the DRT System (i.e. all information related to passengers, demands and trips and DRT resources (vehicles, drivers) performing access control over shared information
  - manages data statistics
  - interfaces with the central public transport information system to retrieve the data needed for travel planning (other public service timetable, vehicle and driver duties management system...);
- *DRTS operator terminal* composed at least of:
  - monitor to manage order and to check vehicle dynamic data (position, status)
  - radio communication terminal to communicate with drivers and vehicle
  - customer interface devices.

##### *Dispatcher server*

The hardware platform running the dispatcher server is usually a powerful workstation with high quality graphical display and fast computing capacity. Within existing applications both off-the-shelf Windows PC Pentium and Unix HP, Sun etc., workstation are used.

One of the most significant aspects of the dispatcher server is the management of geographical and DRTS network data, stops, routes etc. (Figure 4.1b). This is often supported by GIS technology which provides the advantages of geographic information handling at an affordable price. The integration of GIS capabilities allows the improved operations of order taking, travel planning and dispatching thus permitting a more accurate determination of customer origin/destination in large areas and a more intuitive presentation of travel data. The use of georeferenced maps enable service monitoring and the collection of useful planning and balance data for service management (e.g. the distance covered). The format of map data may be various; for example raster map, emerging European standards like GDF etc.

Apart from local storage of map data (as supported, e.g. by GIS software) other data and information relevant for order taking, travel planning and scheduling (i.e., customer information, travel and service information, vehicles information, drivers information etc.) is generally obtained by accessing a Database Server through standard mechanisms such as the ODBC interface.

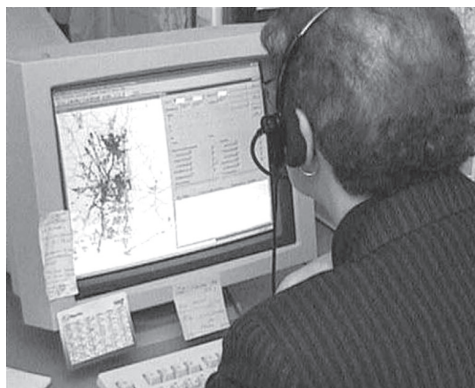


Figure 4.1a:  
Dispatcher server – MobiRouter system

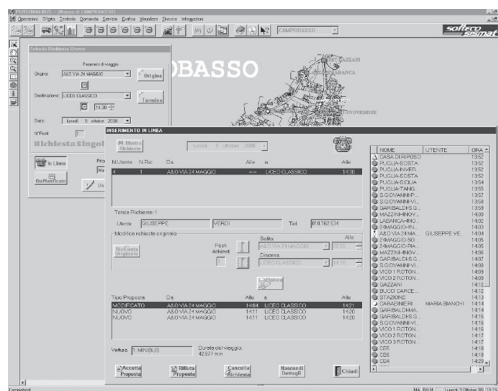


Figure 4.1b:  
Dispatcher server – PERSONALBUS

### Database server

The Database Server hosts all the information used by the DRT system such as data related to passenger, travel and resources (vehicles, drivers, depots ...), manages historical data and controls the access to shared resources.

The solutions adopted are based on well established off-the-shelf DBMS (Oracle, Informix, SqlServer etc.). As far as hardware is concerned, in addition to the usual technical requirements (disk speed and storage capacity), requirements for fault tolerance capabilities should also be taken into account (for example adopting RAID systems).

### *Customer Interface*

Customers access the TDC to request travel booking, trip cancellation, for service related enquiries (i.e. to obtain information on requested or available services) or to get an automatic trip notification. Generally, the interaction with TDC can be enabled in the following ways:

- *manually* i.e. interacting directly with TDC operators through telephone
- *automatically* i.e. without an operator mediation.

The customer devices available to support automated trip booking and service information are described below.

*Telephone server* - This is required to automate the order taking capabilities, to support automated trip booking and to transmit information to customers on booked services like trip notification, pick-up time, previous booked trip modification. The telephone server can be realized, either by voice (synthesized speech) or by pre-coded messages (GSM/SMS).

*Automated voice responder* - Automated voice responding devices (IVRS, Interactive Voice Response System) represent an alternative to the telephone server in order to implement automated trip notification and customer information functions (timetable, booked trip, modifications etc.) and are implemented through standard synthetic speech cards installed on the telephone servers or through proprietary devices. The IVRS guides the customer (with speech synthesisers) through the booking phases, presents the different services offered and confirms the booking by repeating all the customer confirmed data.

*Web server* - The Web server operates as an automated DRTS information provision and booking “counter”, granting the customers an alternative for accessing the TDC through external networks (i.e. the Internet). In this case, the server has to be functionally integrated with the other DRTS servers (Dispatcher and Database Server) to place the booking and the company network has to be protected by external access with security firewalls.

#### **4.1.2 Customer devices**

Customer devices are the front-end technologies that the users adopt to contact the DRT Control Centre Operators and can be realised in different ways.

*Public telephone network* - The public telephone network has been widely adopted to access the DRT service being reliable, easy to use and cost-effective. Any ordinary telephone can be used in order to obtain both an automatic or a TDC operator manual service.

If the interaction with the TDC is accomplished automatically, the customer is lead through the booking process. For example with IVRS, the customer makes use of the standard telephone keyboard (DTMF signals) to compose: the customer number, departure time and day, departure stop, arrival stop, number of travellers etc. A recorded voice leads him through the process and finally proposes different service options (for example different departure times). The customer makes his choice and the booking is confirmed by the system repeating all booking data.

Telephone can also be used to communicate an automated trip notification to the customer i.e. to inform the DRTS traveller in advance and automatically about his/her pick-up time and eventually about the new time in case of adjustment. The public transport company usually allows the users to access the service calling the TDC through a toll free number.

*GSM/SMS* - GSM technology represents an additional alternative for interaction between the DRTS customers and the TDC enabling the exchange of SMS communications. SMS messages support automated order placing to the TDC as well as automated trip notification (automated notification of confirmation/modification of the requested trip).

*Internet* - The Internet network is a central contributing element to the realisation of service automation. Customers can access the web DRT server installed in the TDC through their browser. The web server is integrated with the DRT management software and permits automated trip booking/confirmation or modification and pick-up time notification. The customer is guided step by step through the reservation process using a web standard interface (Figure 4.2a).



Figure 4.2a:  
Web interface for accessing information about DRT services

*Magnetic Card Reader Terminal* - The magnetic card reader terminal can be used for booking of return trips from the main destination points such as shopping centres and hospitals. It is connected to the TDC via a standard telephone line. The customer swipes his/her magnetic card and uses the terminal keyboard to book the trip with the next available bus. The booking is confirmed and printed. This type of booking is required to be performed at least some minutes before the bus leaves its end-node.

A real environment application of this solution is represented by the DRT System that has been adopted by the Swedish SAMPLUS project demonstrator in Gothenburg (Figure 4.2b).



Figure 4.2b:  
Passenger using  
a magnetic card  
to book a return trip

#### 4.1.3 On-board Units

DRTS on-board Units are technological components performing the following main functionalities:

- bi-directional voice/data communication with the TDC
- on-board loading management of the DRTS network topological data and service data
- acquisition and presentation of up-to-date service data
- vehicle localisation
- advance/delay status monitoring with respect to the planned service
- new trip order management
- send/receive messages to/from the service centre.



To guarantee the above functionalities, the in-vehicle units include the following components:

- on-board computer (In-Vehicle Terminal, IVT)
- location system
- communication system
- passenger device
- on-board communication network.

#### *On-board computer*

The on board computer (In-Vehicle Terminal, IVT) is the interface between the driver and the DRT system. It manages the trip data presentation and modification (routes, stops, in/out passengers etc.), the messages exchanged with the TDC and integrates the information from the other on-board sub-systems (location system, fare collection system etc.). Depending on the peculiarities of the DRT system, the IVT user interface can be developed along different complexity levels (for example it can offer a graphical trip presentation) enabling different degrees of interactions and operability.

In some cases the IVT permits some service management operations like an extemporary trip request directly to the driver by non-booked passengers (at a stop, at a parking area, ...). Moreover it can manage the on-board passenger information (for example the announcement of the forthcoming stop). Currently the market offers a limited number of IVT specifically designed for DRT systems (however the recent use of PDAs and smart phones is proving very satisfactions) while the existing AVL on-board terminals are hardly adaptable to the peculiarities of a DRT service in operational terms and for information exchange between the vehicle and the TDC. Two examples of on-board

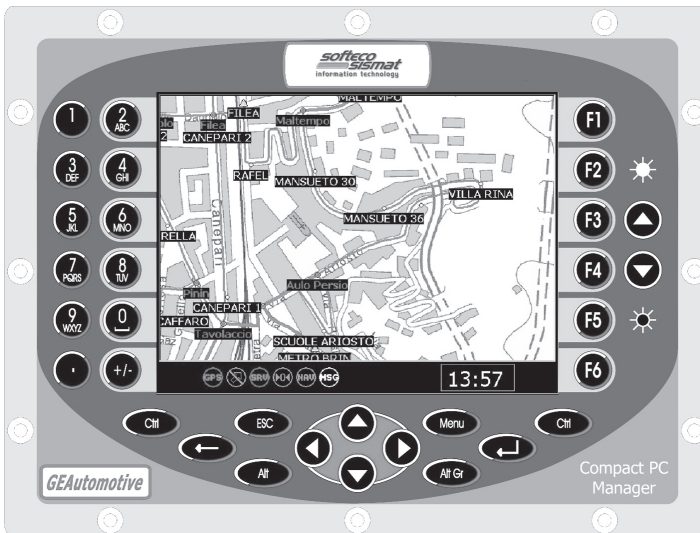


Figure 4.3:  
On-board terminal  
from the INVETE project

terminals for DRT systems were realised within the INVETE (Figure 4.3) and SIPTS European projects (see Section 5.6 for further details).

#### *Location system*

Vehicles are equipped with location systems to automatically and continuously check their position during the service. Vehicle position is obtained by:

- Global Positioning System (GPS) data;
- dead reckoning, using gyroscope and odometer technologies (direction and distance sensors respectively);
- map-matching procedure, with comparison among collected data and network topological data and service data (current trip);
- stop recognition, by interaction of the open/close door sensors and the odometer indicating the stop status.

If the vehicle is not equipped with a locationing system, a manual operational procedure should be embodied to individualise the stop points; for example it is the driver that selects the stop points and sends them to the operating centre. In this case the vehicle monitoring with respect to the service journey pattern can be accomplished only at the stops and not while travelling between different stops.

#### *Passenger devices for fare collection*

Fare collection devices are used for service payment. They allow automated management of payment operations and additional functions such as customer validation or passenger counting. Smart card technology represents the most interesting ICT option for fare collection functionalities within DRTS architectures. The smart card allows automated management of payment operations as well as auxiliary functions such as customer validation or passenger counting. Multi-function cards, also allowing the development of integrated payment services and different zone fares, can therefore be a key telematics component for integration of DRTS services within the overall transport environment. In the case of different zone fares a dedicated module to check the vehicle position through a location system should be realized.

#### *On-board communication network*

Vehicles should be equipped with an on-board communication network to transfer data between the on-board devices. The installation of a serial bus is the solution entailing a small number of cables with the concentration of the signals on a single cable. Different standard bus like VAN, SAEJ1850 and CAN have been proposed. Different solutions lead to different on-board networks that can be classified according to different transmission speeds. International standardisation organisations like the CEN with its Working Group 3 TC 278, are currently working for the standardisation of the on-board networks specification such as WorldFIP and CANopen.

#### 4.1.4 Long-range Communication Network

The long-range communication network allows:

- bi-directional voice communication between the TDC operators and the DRTS drivers
- pre-coded message exchange between the TDC and the vehicles
- automatic data exchange between the TDC and the vehicles (for example next trip description, vehicle position and status ...).

The typology of communication may vary among the following:

- individual voice/data call between the service centre and vehicles (in both directions)
- multicast voice/data call from the service centre to DRT vehicles of a particular area
- broadcast voice/data call to every DRT vehicles.

In order to satisfy these requirements the most frequently used systems are:

- PRN - Private Radio Network
- GSM mobile phone network.

The PRN operates in the UHF or VHF range of frequency (400-900 MHz), using narrow bands and usually requiring a government licence. Generally the public transport companies choose the PRN as it is directly controllable. The disadvantage is the high cost related to the initial investment and the maintenance activities.

The GSM network guarantees the data transmission both as short text messages (SMS - Short Message System) and as Data Call. Data can be transmitted in both directions. It is quite efficient (9600k) and reliable. A GSM terminal (telephone, card) either includes a modem or requires the connection to an on-board computer which sends the data to the terminal through a dedicated connection. The GSM network with respect to the PRN, has the advantage of using an existing, generic telecommunication infrastructure, generally with a good coverage of the service area, which is important, especially, for rural applications of DRT systems and for DRT services which operate in large areas. On the other hand a GSM call may be very expensive with respect to a PRN one.

Recently, mobile radio systems for private network are evolving towards the digital trunking system TETRA (TErrestrial TRunked RADio) and towards GPRS (General Packet Radio Service) and UMTS (Universal Mobile Telecommunication System) systems for public networks.

TETRA is an ETSI open standard for digital mobile radio private network and is based on the TDMA (Time Division Multiple Access) technique. Transmission speed is 7.2-28.8 kb/s depending on the number of temporal slots used for the communication.

GPRS is an evolution of the GSM system and permits data packet transmission through the mobile network. GPRS uses GSM architecture and permits users to access the IP network, like the Internet network, in a packet switch modality, using the radio

interface only while data are being transferred. Although GPRS is based on GSM technology, it requires some modification of the switching centre.

UMTS is the third generation wireless technology for packet switching transmission and permits the realisation of a communication environment in which any network, either fixed, or mobile or satellite, is integrated and interoperable with the others permitting users to access services independently from the type of terminal, network and geographical position. Transmission speed can reach 2 Mb/s, but at the beginning it will only be possible to achieve a speed of about 64 kb/s.

Further details about communication technologies are found in Section 5.2.

## 4.2 Technologies adopted within SAMPO, SAMPLUS, SIPTS projects

In recent years DRT service technologies, demonstration and evaluation have received great impetus in Europe thanks to several European Commission-funded projects: SAMPO, SAMPLUS (European Union, Telematics Application Programme), SIPTS (Ten-Telecom), INVETE (Information Society Technologies).

### 4.2.1 Technological options for demonstration sites

In order to present some information about the technologies adopted which have been evaluated and demonstrated within these projects, the main technological options are described in some concise cross comparison tables between 4 EU demonstrators (Belgium, Finland, Italy and Sweden) outlining the solutions adopted in the different sites (Tables 4.1 - 4.5).

DRTS		Technology	Belgium	Finland	Italy	Sweden
Sub-System	Devices					
CUSTOMER DEVICES	Interface to the TDC	Phone	✓ + IVRS [DTMF signals]	✓ + IVRS [DTMF signals]	✓ (free-toll num.)	✓ + IVRS [DTMF signals]
		Mobile phone		any, GSM [SMS handling]	✓ (free-toll num.)	
		Mobile terminal		✓ PROMISE terminal		
	Computer	✓ Internet (Web browser)	✓ Internet (Web browser)		✓ Internet (Web browser)	
	Smart bus stop	Automated booking terminal (card reader etc)				
		Info panel				

Table 4.1:

Summary of ITS technologies in SAMPO/SAMPLUS demonstrators: customer devices

DRTS		Technology	Belgium	Finland	Italy	Sweden
Sub-System	Devices					
TRAVEL DISPATCH CENTRE (TDC)	Dispatcher Server	HW platform	PC Pentium	PC Pentium	PC Pentium	PC Pentium
		Operating sys, base SW	Win NT, Visual Basic	Win NT, VisualC++	WinNT, VisualC++	Win NT, Visual Basic
		Order handling SW	own (Visual Basic)	own (Visual C++)	own	own (Visual Basic)
		Travel plan./sched SW	own (Visual Basic)	own (Visual C++)	own (scheduling, route optimisation)	own (Visual Basic)
		GIS	MapInfo 4.0	Genimap Tools (lib) Graph Server (lib) digital maps (Fingis)	MapInfo 4.0	
		DB	ODBC interface	ODBC interface	ODBC interface	ODBC interface
	Phone (customer/driver)	✓	✓	✓	✓	
Interface external sys (PT timetable, info,...)	PT DB via WAN (64KBPS leased line, ISDN backup)	PT server via modem WWW orders	AVL system			
Database Server (passengers, service, resources)	HW/SW platform	PC WinNT	HP9000, HP-UX 10.20	Pentium, WinNT (from AVL)		
	DBMS	Oracle 8.05	Oracle 7.3	Informix (AVL)	SQL Server 6.5	

Table 4.2: Summary of ITS technologies in SAMPLUS demonstrators: Travel Dispatch Centre

DRTS		Technology	Belgium	Finland	Italy	Sweden
Sub-System	Devices					
LONGRANGE COMM. NETWORK	Communication System	Server	Windows NT	PC, SCO Unix HP9000	[Pentium, NTWin] (from AVL)	Windows NT
		LAN	Token Ring		Ethernet	Ethernet
		Network Protocols	TCP/IP	TCP/IP	TCP/IP	TCP/IP
		Comms with vehicles	- Mobitex (data) - private radio (voice)	GSM SMS GSM data private radio network	[own UHF radio] (from AVL)	Mobitex (data)
	Customer Interface	Phone server	✓🕒	30 lines; R2 protoc.		✓🕒
		IVRS	TeleButler	✓ GSM SMS		TeleButler
		Web server	PC (WinNT), IIS	PC, Linux, HTML3.0		PC (WinNT), IIS

Table 4.3: Summary of ITS technologies in SAMPLUS demonstrators: communication network

DRTS		Technology	Belgium	Finland	Italy	Sweden
Sub-System	Devices					
ON-BOARD UNIT (OBU)	On-Board computer	CPU driver terminal	✓ ✓	✓ DS1000; DCS ✓ DS1000; DCS; mobile phones	✓ ✓	✓ ✓
	Location System	GPS gyroscope, odometer	non-differential	✓ DS1000	[✓] (from AVL) [✓] (from AVL)	
	Passenger Device	fare collection counting system	✓		smart card ✓	
	Communication System	voice communication data communication	radio - Mobitex - radio	mobile phone, synthesised speech GSM SMS GSM data	own UHF radio net - own UHF radionet - microwave link (at depot)	
	LCD terminal Printer		✓🕒	[✓]		Mobitex Ericsson

Table 4.4: Summary of ITS technologies in SAMPLUS demonstrators: on-board units

STANDARD COMPONENT	Belgium	Finland	Italy	Sweden
Server Hardware	TDC platform: PC Pentium Reservation via IVRS and Internet	Db & Comm. server: HP9000 / D200 computer Telephone servers: Standard PC Dispatcher Workstations: Binary compatibility with standard PC equipment. Source code compatibility: Alpha, PowerPC, Mac, PowerMac Firewall-WWW: Standard PC	Dispatcher server: PC Pentium	TDC platform: PC Pentium
Operating System	Windows NT4.0	Db & Comm. server: HP-UX 10.20 Telephone servers: Sco Unix Dispatcher Workstations: WinNT 4.0 Web Firewall: Linux	Windows NT 4.0	Windows NT 4.0
Programming environment	Visual Basic 5.0 professional	Db & Comm. server: Ansi-C compatible compiler Dispatcher Workstations: MS Visual C++ Web Firewall: HTML 3.0	Visual C++	Visual Basic 5.0 professional
GIS	Mapinfo 4.0 with map "StreetNet" from TeleAtlas	Dispatcher Workstations: 1) Genimap Tools - library (own) 2) Graph Server - dynamic library (own) Map material stored in Mapinfo Interchange Format	MapInfo 4.5	Map "StreetNet" from TeleAtlas
DataBase	ODBC - AS/400; Oracle 8.05	Db & Comm. server: Oracle 7.3 relational database Dispatcher Workstations: ODBC-interface	Oracle Server /Personal Oracle, ODBC-interface	SQL Server 6.5
Data Model	TRANSMODEL		TRANSMODEL	TRANSMODEL
Network	LANToken Ring	LAN	LAN Ethernet	LAN Ethernet
Network protocol	TCP/IP	TCP/IP	TCP/IP	TCP/IP

100 Table 4.5: Summary of standard ITS technologies in SAMPLUS demonstrators

The reader can easily compare the different solutions adopted for a specific sub-system or device in the different sites, identifying commonalities and the emerging common choices. The items included in the table for each site are denoted by a “✓” when available at the site and/or eventually described in more detail. The items in square brackets ( [ ] ) represent further options and extensions developed by the relevant site during the development of the projects.

#### 4.2.2 RING: the Belgian DRT system

RING is the DRT system developed in Belgium by De Lijn, the company responsible for public transport within the Flanders Region and in the surroundings of the Brussels Region areas. The technologies adopted for TDC, on-board and communication systems development are presented below.

*Operating Centre (TDC) technologies* - In the RING system the TDC is represented as shown in Figure 4.4:

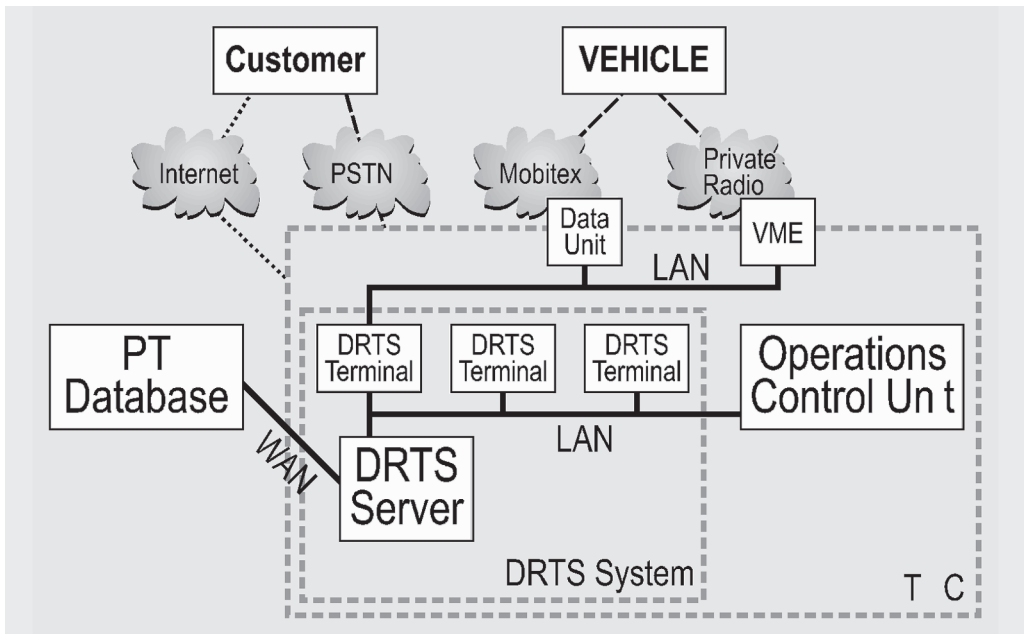


Figure 4.4: Communication architecture of the Belgian RING system

1. the DRTS Server with operator terminals,
2. the public transport vehicle monitoring and control unit (regular service and demand responsive),
3. the private radio communication system via Mobitex network.

The whole system is integrated with the central public transport database.

The DRTS terminals are Pentium based PCs in a standard Windows environment running the client version of the DRTS software (RING). This software is developed with the Visual Basic language and provides a user-friendly interface for the TDC operator. The central DRT server runs the server-side application DRT software (RING) and manages the operational and dynamic DRT data, controls shared access to the relational databases, prepares and organises the data communication towards other applications. Data include: the service journey data towards the vehicle, the monitoring data based upon the positions of all DRT vehicles from the monitoring unit as well as the control data towards the monitoring unit.

The TDC monitoring unit is a PC keeping trace of the status and position of all the vehicles under its control. It is used to obtain a global, automated control application on vehicles' compliance with timetables, interconnections and so forth. This application is integrated within the AVL system.

The central public transport Database based on AS/400 architecture, stores and maintains all the company public transport data. The DRT System downloads static data (information on municipalities, resources, fares, stops) from the public transport Database. When the static data are modified by other public transport applications, they are automatically uploaded to the DRT System to keep this static information up-to-date. The public transport DataBase also stores a copy of the operational DRT data, regarding time and distance-matrices, logical stop sequences and so on. Locally gathered and processed statistics on the DRT operations are daily uploaded to the public transport Database, to provide a general availability of the management information.

*On-board technologies* – The on-board terminal includes a display to visualize the daily service journey pattern to the driver. Through the cellular Mobitex network both data and voice messages are exchanged with the TDC. A dedicated radio channel is used for the transmission of the vehicle's co-ordinates. For this purpose, a Rockwell Jupiter Tracker is integrated with a single-board 12-channel Global Positioning System (GPS) receiver. This unit passively receives signals from up to nine satellites; and positioning is performed by processing measurements of four satellites providing the best geometry. Moreover, the on-board installation of fare collection devices is to be realized by ProData.

*Communication system* - Within the DRT operating centre, all the computers are connected via a LAN (Local Area Network) adopting a TOKEN-RING standard protocol. This local network is connected via a WAN (Wide Area Network) to the central public transport Database on AS/400 via a leased line with 64 Kbps, backed up with ISDN. Communication with the customers take place over standard telephone, operated by the local operator Belgacom. Moreover, automatic bookings facilities via the Interactive Voice Response System (IVRS) (requiring DTMF signals) and Internet (www-browser)



are being implemented. The customer using the IVRS is connected via the telephone line to a Windows NT server that runs TeleButler, a GUI based application supporting incoming calls automated handling.

The internet reservation module for the customers is a shortened and simplified version of the operator reservation module. The customer is guided step by step through the reservation process. The internet reservation application uses the MS server software IIS (Internet Information Server). The web site is developed using MS Visual Interdev 6.0 (database driven).

Data communication between vehicles and TDC occur on two levels. The DRT journey data is transmitted via a cellular Mobitex network, realised by RAM Mobile Belgium, to a display installed on the vehicle. The on-board radio-modem connects to the nearest base station in the covered area, via a cellular RF network.

The user data is transmitted in packets with a maximum size of 512 bytes. The concept of packet switching guarantees no call set-up time, cost-effectiveness and efficient channel sharing. The effective data rate measures 4500 bps, with high security and access restrictions.

The communication network is made up of 4 different radio-channels, with 2 channels reserved for voice-communication, 1 channel for data-communication between the vehicle and the service management department. A last channel is used for internal communication between the technical and service management departments. The transmission of the vehicle status and position (GPS co-ordinate) and of the fare collection system data, is secured via polling cycle over the private operated radio network using the data-channel.

#### **4.2.3 PERSONALBUS: the Italian DRT system**

PERSONALBUS™ is the DRT system that has been developed and installed in Florence within the SAMPO and the SAMPLUS projects. The system has been developed by ATAF, the public transport company of the Florence metropolitan area for the service, by Softeco Sismat SpA, for the software system and the technologies, with the contribution of the IT and transport consultancy MemEx srl.

The Florence SAMPLUS system is based on a telematic architecture supporting the operator in both off-line and on-line booking procedures and in the dynamic route planning for buses on the basis of customers' requests. At the initial stage, within the SAMPO project, the service was activated in the Campi Bisenzio Municipality and after this positive experience, it has been extended to the other surrounding towns of Scandicci, Sesto Fiorentino and Calenzano.

The three main system technological and operational components can be identified as:

- the control room (Travel Dispatch Centre -TDC) supporting the operators in the management and planning functions;

- the communication interface for the interaction between the customers and the TDC operators;
- the radio-base communication network connecting the TDC operators and the service drivers. Figure 4.5 shows the physical architecture of the PERSONALBUS™ system.

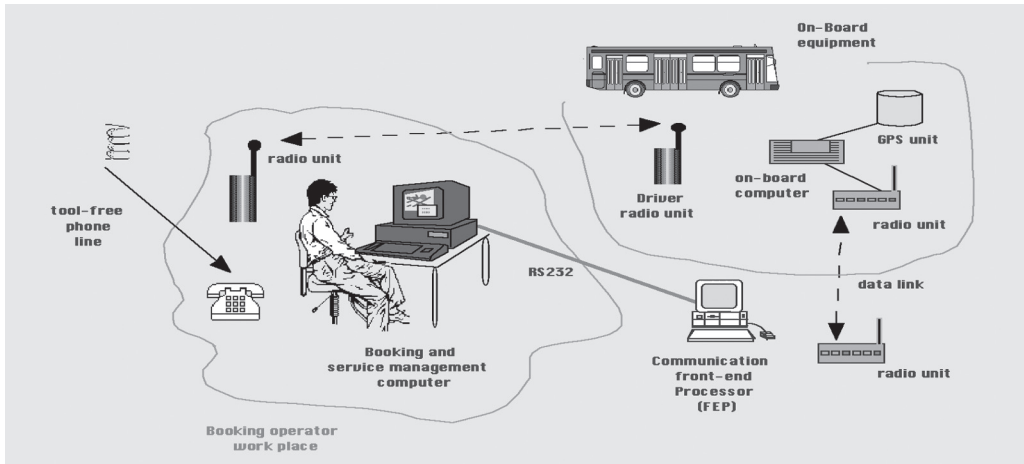


Figure 4.5: Basic element of the Florence DRTS architecture (SAMPO-SAMPLUS)

*Operation Centre (TDC) technologies* - The TDC is physically located in the AVI control room, in order to simplify and homogenise the vehicle/operators communication and enhance the integration with the AVI system.

All the DRT system operations (booking/planning/management operations) are supported by the PERSONALBUS™ TDC application software. The DRT software has been realised with state-of-the-art information technology with widely accepted industrial standards. The system is based upon a two layer client-server architecture using a data-server (based upon Oracle RDBMS) and an application server supporting the following functions:

- customer request management (booking/modification/enquiring)
- trip assignment and journey planning,
- DRT system database management (users, vehicles, services and trips...)
- resource management (vehicles, service proposals)
- DRT service transport network management
- service database and statistics management.

*Communication system* - The communication network is composed of a radio control room and two radio bases in order to cover all the area served by the ATAF fleet. The ATAF radio system works on three UHF frequencies corresponding to 3 different channels (1 data channel and 2 voice channels).

Table 4.6, below, presents the different technical and standard components involved in the PERSONALBUS™ system.

Components	Standards
Dispatcher Server Hardware	PC Pentium
Operating System	Windows NT 4.0
Base Software	VisualC++
GIS	MapInfo 4.5
DataBase	Oracle Server, ODBC-interface
Data Model	TRANSMODEL (partly)
Network Communication	LAN Ethernet
Communication protocol	TCP/IP
USER Interface to TDC	PABX

Table 4.6  
Basic technical components of TDC physical architecture (SAMPLUS Florence)

#### 4.2.4 *MobiRouter – the Finnish DRT system*

MobiRouter is a logistics package for the design and management of Demand Responsive Transport (DRT) Services. With MobiRouter, the routes and schedules are planned on a map in real-time as orders are received. The planned routes will be in a state of flux but remain realistic and up-to-date at all times. The right vehicle will reach the customer on time. The system transfers data reliably via the mobile telephone network. There is no need for expensive investments in a private radio network - MobiRouter can be rapidly adopted using standard equipment. The software had been developed drawing on long-term international experience.

When a passenger calls in an order into the MobiRouter dispatch centre, the order is entered into the system along with special requirements concerning the ride - for instance the need to transport a wheelchair. The passenger information may already be found in the system database, if they are a regular customer. The system finds a suitable vehicle for the order, adjusts the vehicle route accordingly and sends the route description to the driver. The driver is given all the information they need in detail: the route, the stops, the addresses, the times, the number of seats required - even the names of the passengers. The system automatically finds the most economic route possible.

In traditional DRT systems the customers have to plan their transportation needs even days in advance. In contrast, MobiRouter reacts to orders immediately and can modify a route with only a few minutes notice if necessary. Thus for instance urgent rides to a health care centre can be handled using demand responsive transportation. The routes and schedules of DRT can be matched with existing public transportation lines. This makes it easier to find connecting buses, trains and flights especially in areas with sparse schedules. The MobiRouter system always selects a vehicle suited to the route, and the lines only run when they are needed. In addition, functional and reliable public transportation reduces the need for private cars, reducing emissions.

For public service providers and taxi companies MobiRouter is a way of improving service. The customer always gets the kind of ride they need. The dispatcher has instant access to the street address and any special requirements associated with a customer name or number when receiving an order. Empty driving and the use of inappropriate vehicles is reduced.

MobiRouter enables service lines to be planned and managed effortlessly. A line can be based on fixed stops, visited either every time or only according to orders. On the other hand, there can be just a few scheduled stops, with the vehicle stopping according to orders at freely defined addresses in between the fixed stops. It is also possible to only define one fixed stop, with the vehicle moving freely in the surrounding area according to orders.

MobiRouter can receive automated orders directly from several sources: SMS text messages, via the Internet or via mobile WAP telephones. It can be customized to meet the service provider's needs. With the system's flexible fleet and customer databases and GPS positioning, running the transportation service becomes almost fully automatic. Figure 4.6 shows the MobiRouter system architecture.

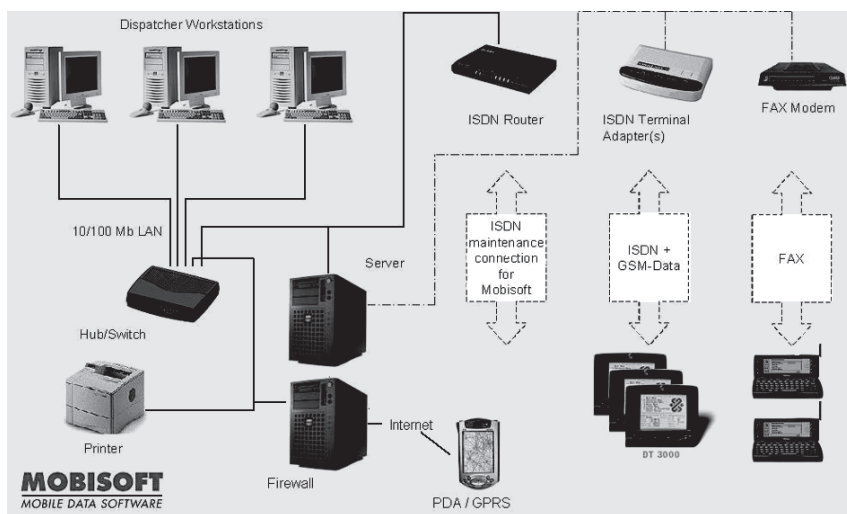


Figure 4.6: **MobiRouter system architecture**

The functionality and features of the MobiRouter system DRT can be both service line-style transportation and freely routed, taxi-style transportation. The main functions of MobiRouter include:

- flexible order handling
- customer information management
- map-based real-time scheduling, routing and optimisation

- capacity management
- dynamic and flexible map-based service-line planning
- powerful and reliable data transfer using GSM data
- management of travel allowances
- development backed up by long-term international experience.

*Travel Dispatch Centre* - The dispatcher uses a dispatching terminal to enter the customer's order into the system. The information entered includes the pick-up and drop-off addresses, the target time and any special passenger requirements, such as the use of a wheelchair. The system automatically takes these into account in planning the ride. If customer information is stored in the system's customer database, the dispatcher automatically sees the passenger's home address, special requirements, travel allowance etc.

The address can be input either by entering the address/location into the appropriate field, or by clicking the mouse button on the screen map. The dispatcher can also add new location names if the desired location is not in the map database.

Customer information is managed using a database including the following data:

- name
- home address and default destination address
- special requirements (e.g. assistant, pick-up from indoors, wheelchair etc.)
- customer's travel allowances.

MobiRouter can also be used without passenger information management, or using only selected parts of it.

MobiRouter can be used to manage service lines, which can be defined in several different ways, for instance:

- the line has fixed stops, which are either always visited or visited according to received orders;
- the line has a few fixed stops, visited at certain times. In addition the vehicle stops at freely defined addresses between the stops according to received orders;
- the line has one fixed stop (e.g. a central market place). The vehicle moves freely in the surrounding area according to received orders;
- the models above are just examples of possible uses. Service lines can also be defined in several other ways.

In planning a route, the software considers time limits (can the vehicle make the address on time), passengers' special requirements and the vehicle capacities (are there free seats, can the vehicle satisfy the passenger's requirements). Orders can also be handled using free routing. In this case the order is handled for instance by a taxi, but several passengers can be transported simultaneously. In combining the orders, the system automatically takes the times and geographic locations of the orders into account, as well as keeping track of the passengers' requirements and the vehicle's capacity.

*Communication system* - MobiRouter supports various ways of sending route information to vehicles:

- the most efficient way is to send the route description into a vehicle terminal using GSM data;
- the route description can also be automatically faxed for instance into the vehicle (e.g. using a Nokia Communicator) or into a taxi dispatching centre, from which the order is forwarded to the taxis;
- routes can also be transferred directly into a taxi dispatching system, provided the dispatching system supports such operations;
- MobiRouter also includes alarm functions. Alarms are a way to ensure reliable operation of the service.

The following illustrates a typical use for alarms: a dispatcher decides an incoming order is best handled by a taxi. There is still some time remaining before the requested pick-up, so the order is not immediately assigned to any vehicle. This way, if any new orders have similar times and locations, they can be combined into the same ride. As the pick-up time draws closer, if the order has still not been assigned, the system raises an alarm.

Route descriptions can be sent to vehicle terminals using GSM data. The information can be transferred in real-time: for instance a service line can be notified of new passengers and changes to the route description just minutes before the pick-up time.

The GSM data used in MobiRouter is a powerful and reliable means of communication. GSM data is a modem connection, meaning that a two-way data pipeline is opened between the dispatching centre and the vehicle. Thus the correct delivery and reception of the data can be monitored throughout the transfer (SMS text messages are unsuitable for such use). GSM data has a good data transfer capacity. The minimum rate of transfer is 9600 bps. There is a fairly large amount of structured data to be transferred to the vehicle. For instance a single route description could include the following information:

- stops along the route
- passengers (dis)embarking at each stop
- information pertaining to each passenger (e.g. "Customer needs assistance with stairs")
- information can be sent in either direction using a GSM data connection.

The dispatching centre uses an ISDN adapter to form the connection. Thus opening the connection takes only a few seconds and the connection is highly reliable. If the vehicle terminal is connected to a GPS receiver, the vehicle's location is sent to the dispatching centre along with the transferred information. The dispatch terminals will then show the vehicle locations on the screen map.

108 A Nokia Communicator can also be used as a vehicle terminal, in which case the

order is sent in fax format. This is a good solution for a backup terminal or for vehicles that take MobiRouter orders infrequently. However, the solution has several drawbacks compared to GSM data: poor ergonomics and usability in vehicle use, the information is displayed in a single list, there is no proper user interface and the communications costs are higher. This solution does not enable information to be sent back to the dispatching centre, which means that GPS positioning can also not be used.

Lines can be graphically defined on the screen, for instance by placing fixed stops with free areas between them. Passengers can then be picked up and dropped off at freely defined addresses within these areas. Line planning is flexible, since a wide variety of different points and areas are available. For instance:

- stops with a fixed schedule
- stops that are conditionally visited
- freely defined addresses, which are visited according to orders
- areas within which the vehicle can freely move according to orders.

In MobiRouter information is stored in a database. Reports and statistics are produced using a separate reporting tool. This enables customised reports to be produced to meet the client's needs. Statistics can be used to develop and improve the service, and to provide an overview of activities. If desired, MobiRouter can also keep track of passengers' travel allowances (e.g. rides in accordance with social service and disabled service legislation).

The open system architecture used in MobiRouter makes connections to other systems (e.g. invoicing) possible. Again this assumes the system can interface with external software. The technical support team has an ISDN or network connection to the MobiRouter system for maintenance.





## In-vehicle technologies

*J. Scholliers, M. Gorini, I. Kaisto*

### 5.1 In-vehicle infrastructure

For efficient operation of DRT services, the driver has to have reliable and user-friendly information on the service to be provided. Voice communication becomes inefficient if the size and the complexity of the DRT service increase. Real-time data communications allows trip data, changes in the trip data and emergency information to be sent to the driver. If the Travel Dispatch Centre (TDC) knows the actual location of the vehicle, the time between trip booking and the actual trip could be reduced. An in-vehicle terminal (IVT) is needed to manage the trip information and to display it in a user-friendly form to the driver.

Public transport vehicles contain more and more telematic devices for the efficient operation and management of the transport services and for the provision of quality information on the service to drivers and passenger.

This equipment may include:

- ticketing machines
- in-vehicle terminal
- long range communication for voice and data
- location devices, e.g. GPS and odometer
- short-range communication devices (for communication inside the depot)
- external and internal passenger information displays
- video for security.

This chapter will discuss the technologies for communication both externally (long range with the Travel Dispatch Centre) and internally (i.e. with other on-board telematic devices), and the in-vehicle terminal (see Figure 5.1).

The results of the EU-funded SIPTS and INVETE projects will be discussed.

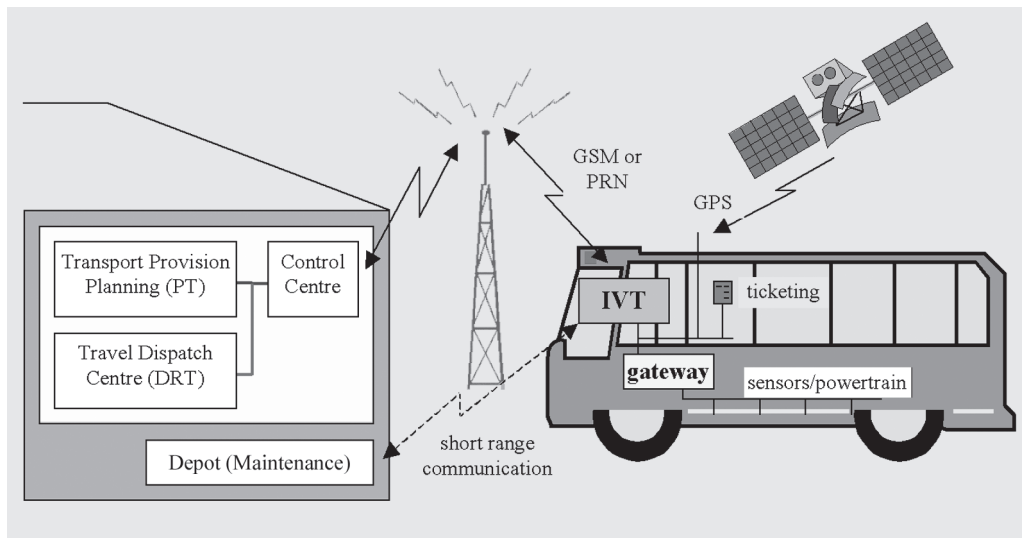


Figure 5.1: The general context for development and operation of an in-vehicle terminal (IVT)

## 5.2 Technologies for communication and positioning

### 5.2.1 Communication between the vehicle and the TDC

Data can be sent between vehicle and TDC using different communications media, such as GSM, Private Radio Network (PRN) etc.

The selection of the data communication medium depends on the existing land-based infrastructure, the coverage of the transport network, the in-vehicle infrastructure and the communication costs.

Data communication systems are either circuit-switched or packet-switched. Circuit switched networks require an end-to-end connection between driver and TDC. Packet-switched networks break the data down into several packets, which are sent separately over the network, without requiring an end-to-end connection.

#### Cellular Communications

Data can currently be communicated in cellular networks through GSM Data, SMS (Short Message System), MMS (Multimedia Message System) or GPRS. GSM (Global System for Mobile Communications) data is a circuit-switching data transmission tech-

nique with traditionally speeds of up to 9.6 kbps (kbits/s), and by the concurrent use of multiple channels with the HSCSD (High Speed Circuit Switched Data) technique, up to 38.4 kbps. SMS messages contain up to 160 characters and do not require opening a connection, but have as a drawback that transmission delays can occur in periods of heavy voice traffic. MMS, which is an extension of SMS, allows longer messages, including sound and images.

GPRS (General Packet Radio Service) is a packet-switched data transmission technique which uses the GSM architecture and allows data rates from 56 up to 114 kbps and a continuous connection to the Internet, using the radio interface only when data are being transmitted.

UMTS (Universal Mobile Telecommunications System) is a third generation broadband packet-based wireless technology, which builds on the GSM standard. UMTS promises transmission of text, digitized voice, video, and multimedia at data rates up to 2 Mbps, but in practice transmission speeds in rural areas start at about 64 kbps. UMTS will offer a communications environment where all networks (fixed, mobile and satellite) are combined and interoperable, permitting users to access services regardless of their terminal, network or geographic location.

Due to the higher data speeds obtained by GPRS and UMTS, GSM data communications are expected to be replaced by GPRS, or later by UMTS.

#### *Private Radio Network*

Private radio networks are privately owned radio systems. The radio systems use narrow bands in the UHF or VHF frequency range (400-900 MHz), and normally require licensing. Narrow band radios ensure reliable transmission for small amounts of data, such as those used for transferring data from process monitoring, access control and telemetry readings. Data speeds are up to 9.6 kbps. The operating range normally varies from a few hundred metres up to 20 kilometres, depending on the power of the transmitter, and the type and location of the antenna. Radio modems can also be used to build up packet radio networks, facilitating data transfer over longer distances.

#### *Mobitex*

Mobitex is a mobile data standard developed by Ericsson based on packet-switching data transmission. Transmission speed exceeds 14.4 kbps. There are about 30 Mobitex networks around the world. Some of the networks are operated publicly by local operators (e.g. in Belgium) while others are owned and operated by companies for their own use and benefit (e.g. in Italy).

#### *TETRA*

TETRA (Terrestrial Trunked Radio) is an open digital private mobile radio standard for voice and data communications. Trunked means that all the users of the system share a pool with all the channels of the system. Transmission speed is 7.2-28.8 kbps dependent

of the number of time slots. Terminals can talk either directly or over a centre to each other. TETRA was originally defined for official use, like police, and offers special features for authority use, such as efficient group calls, ability to prioritise calls and emergency calls. TETRA networks support mobile IP packet data. In TETRA location transmission is defined.

#### *Short Range Communication: WLAN, Bluetooth*

A Wireless Local Area Network (WLAN) consists of mobile terminals, which are wirelessly connected to an Access Point, which is connected to a fixed network. WLANs are based on the IEEE 802.11 set of standards. The IEEE 802.11b (often called “Wi-Fi”) technology uses the license-free 2.4 GHz ISM band and offers data speeds up to 11 Mbps. The operation range depends on the antenna and the amount of reflections: in office environments ranges are typically 30-100 m, in open air up to 300 m. Roaming allows users to move seamlessly through a network of Access Points. In the future, the IEEE 802.11a and 802.11g standards will allow 54 Mbps transmission speeds in the 5 GHz and the 2.45 GHz frequency area, respectively.

Bluetooth is designed to be a low cost, low power, and short-range wireless communication technology of data and voice. The technology enables easy and quick connections to a wide range of devices, without the need for cables, expanding communication capabilities for mobile computers, mobile phones and other mobile devices. Bluetooth devices do not require any user interaction to make a connection, but separate devices listen to each other in order to notice connection requests and respond accordingly. The radio operates in the globally available 2.4 GHz ISM free band, the same range which is used by WLAN devices. The typical operation range is about 10 m.

DSRC (Dedicated Short Range Communication) is a wireless communication system between a network of beacons and a transponder in the vehicle. The beacons can be operated in two ways: in the first method beacons transmit signals which are used by the on-board receiver to determine its position; in the second method the vehicle transponder transmits a signal to the roadside beacon.

The beacon can either be placed at the roadside or embedded in the road. Two methods are under standardisation for DSRC communication with roadside beacons: infrared and by use of 5.8 GHz radio frequency. The main application is electronic toll collection, but the roadside equipment can also be used to send information on e.g. traffic congestion or road weather to the vehicles. This system has low in-vehicle costs, but high infrastructure costs.

### **5.2.2 Positioning technologies**

#### *Satellite Positioning Systems*

The location of a device is calculated from the signals, which are sent by a constellation of satellites. The American GPS (Global Positioning System), which has an accuracy of

about 10 m in open space, is the most widely used. GPS does not work in tunnels and in urban canyons, since line of sight to the satellites is required. Through the use of differential dGPS, the accuracy can be improved. In the vast majority of new AVL projects in the USA GPS/dGPS is selected as positioning technology (TRB, 1997). The European Union plans to operate its own independent GALILEO positioning system with 30 satellites by 2008.

#### *Cellular network based positioning*

Cellular operators will include positioning functionality as part of the service provided. The accuracy of (solely) cellular based location technologies depends on the network cells density, and is therefore much lower than GPS-based location, especially in rural areas. Infrastructure costs are lower compared to other techniques, since no separate positioning device is required. The communication costs are however much higher, since cellular-based location retrieval requires communication between the phone and network (e.g. 1 SMS).

#### *Dead reckoning*

Dead-reckoning uses only odometer and compass readings to determine the distance and direction travelled, without using any external system. The accuracy degrades however as a function of distance travelled, and therefore they need to be reset by other location technologies such as beacons or are used as additional technology to GPS.

### **5.2.3 In-vehicle networks**

#### *In-vehicle networking*

The number of electronic devices on board public transport buses is increasing. Unfortunately their interfaces to other devices are very often proprietary, which makes it difficult to establish multi-supplier systems, or to change/expand existing ones. By standardising the interfaces and by using in-vehicle networking techniques, the amount of wiring in a vehicle can be reduced, and information can be shared among in-vehicle devices.

Applying a serial data bus reduces the number of wires by combining signals in a single wire through time division multiplexing. Standardised buses have been developed, such as VAN, SAE J1850 and CAN.

#### *CAN-network*

CAN (Controller Area Network) has been adopted in Europe by ISO as the high-speed (125 kbps ...1 Mbps) protocol for in-vehicle networks. Data are transferred over 2 wires as maximum 8 bytes long messages. Application layer protocols allow system designers to avoid having to address CAN-protocol details and to focus on the application itself. Different application layer protocols have been developed, such as DeviceNet, OSEK,

CAN Kingdom and CANopen. CANopen assumes that the device's hardware has a CAN transceiver and CAN controller as specified in ISO 11898.

In public transport vehicles, CAN networks are used at different levels. Bus manufacturers equip the chassis with a CAN-bus. The FMS-standard group, which consists of 6 major European truck manufacturers, has designed a common interface, which gives third parties access to data from the vehicle's chassis CAN bus system. In this way, data on for example fuel use and engine speed can be provided independent of the vehicle manufacturer.

For the communication between telematic devices, the EN 13149 set of standards on "On Board Data Transmission between Equipment inside a Vehicle" is being developed. This set of standards supports 2 protocols: CANopen and WorldFIP, from which CANopen receives the most support. The EN 13149-6 standard (CANopen Application Profile for Public Transportation) will define the messages, which are exchanged between on-board telematic devices.

At the start of 2003 the standard was still in the standardisation phase, but once accepted, major public transport operators will require it in the selection of telematic devices. A first pilot has been developed at the end of 2002 on 2 vehicles in Tampere, Finland, in which the ticketing machine, external line display, vehicle computer and chassis gateway, which are each provided by different manufacturers, are connected through a CAN-network.

#### *Ethernet and TCP/IP*

Rapid developments in Ethernet switching technology have brought Ethernet from the office to industry applications, such as control. The use of twisted pair makes Ethernet installation and management easy. Data rates are 10 Mbps, optionally 100 Mbps. Ethernet acts as a logical bus: all messages are broadcast throughout the system, but only the destination address reads it. In the future, real-time Ethernet will be possible, meaning that in a given application, an answer to a signal is guaranteed within a defined time. Ethernet is closely linked with TCP/IP: Ethernet defines the physical layers of the communication protocol; IP (Internet protocol) is used to route messages and TCP, which sits on top of IP, guarantees their delivery. A local area Ethernet can be connected to, and functions as part of the Internet. In public transport, Ethernet may be used for e.g. security or "infotainment" purposes.

#### *Multimedia Bus*

In-vehicle multimedia bus standards for automotive systems have been developed, such as MOST and IDB-1394, and are being implemented in new car models.

MOST (Media Oriented Systems Transport) is a multimedia fibre-optic network optimised for automotive applications. It is targeted at high-volume, low-cost applications, and originally designed for personal car use. The MOST Technology is designed

to offer full interconnectivity for audio, video and data services over a plastic fibre optic network. Data speeds up to 24 Mbps are possible.

IDB (ITS Data Bus) is a serial communication bus technology that allows a wide variety of consumer electronics components to share information across a common network in a vehicle. IDB-C is a 250Kbps network based on CAN, and IDB-1394 for high speed multimedia applications, built on the IEEE-1394 standard for consumer electronic devices.

### **5.3 Requirements for in-vehicle terminals for DRT applications**

The in-vehicle terminal (IVT) serves two main goals: for the driver, it allows management of the transport service; for the control centre, it gives access to information on transport service operation.

#### **5.3.1 User needs**

The importance of user needs has been demonstrated in Chapter 1. In the case of IVTs the main concern of the operator is to operate the services cost-effectively and according to the schedules. The IVT should be easily maintainable and updatable and should be easily expandable and interoperable with current and future telematic services. The main concern of the drivers is to drive safely, to realise the services according to the schedule and to be informed on the service to be realised and on changes in the service. If the service or the destination is unfamiliar to the driver, maps are desired.

DRT services hence have different requirements than regular public transport services: terminals for regular public transport should have a simple user interface, and send accurate location information at predetermined time intervals, imposing severe real-time and stability requirements on the in-vehicle terminal. Flexible transport systems generally do not require frequent location information sending, but more complex messages are exchanged and a more graphical user interface is desired.

#### **5.3.2 Ergonomic requirements**

Safety has to be a major criterion for the design of both the terminal hardware and the application software. Several standards and recommendations have been developed for the in-vehicle systems, such as the Commission Recommendation 2000/53/EC (EC, 1999) on safe efficient in-vehicle information and communications systems. The driver's primary task is to control the vehicle safely through a complex traffic environment, and the user-interface must not distract the driver. This requires for example hand-free communication devices and clear and understandable graphic symbols. Also the service concept should take driver safety into consideration when planning the service: e.g. booking may not require the driver to make time-critical actions on the user-interface, for example trip acceptance, when driving.

## 5.4 Need for an open platform

Operators are in need of an open platform for in-vehicle terminals, in order to solve problems related to life cycle support and non-compatible ITS environments. When the first generation of public transport monitoring systems has to be updated, operators often find that the original providers either do not exist anymore or no longer support the product, so that the only possibility is to change the whole system. There is therefore a need for an open system, which ensures the possibility to add new functionalities during the lifetime of the product.

In a deregulated environment, public transport operators provide the services on a contract basis, which may be one year or shorter. Public transport operators optimise the use of their fleet, so the same vehicle can be used in different regions with different ITS environments. This also asks for an open system, which can be easily adapted to the needs of the different operational environments.

Also the needs of the developers have to be taken into account: they need a terminal, which can be tailored easily to meet the requirements of clients, which offers an open platform for development, and allows use of commercial development tools and third-party software.

## 5.5 In-vehicle terminal properties

### 5.5.1 Displays

Liquid crystal displays (LCD) are presently the most common type of display employed in mobile devices, as they consume less power and require less space than CRT displays (cathode-ray tube). Dependent on the application requirements, a simple monochrome text display may be sufficient, but colour screens provide a friendlier, more informative output than monochrome screens (Manning, 2000).

LCD-displays can either be active or passive. Passive matrix displays are cheaper, but suffer from shadowing effects, especially if the amount of pixels increases. Shadowing makes colour passive matrix screens difficult to read in sunlight. Active matrix displays have a thin film transistor (TFT) on the glass substrate, which controls each pixel separately, producing brighter image without shadowing effects.

### 5.5.2 Input devices

A wide range of input devices are available. In-vehicle terminals traditionally use buttons near the display. The size of the buttons will determine the size of the terminal. Touch screens allow a greater area of display for the same terminal size. However, physical keyboards are easier and quicker to use than touch-screen keyboards (Manning, 2000). Other possibilities are remote control from a pointing device, which is connected by wire or wirelessly, e.g. through infrared or Bluetooth, with the terminal.



### 5.5.3 Applications

The possibilities of the terminal are also determined by the operating system. The use of a commercial widely used operation system, like Windows or Linux, offers the possibility to implement third-party software on the terminal when desired. Different applications are appearing on the telematics market, from emergency calling, traffic information transmission, navigation, driver assistance for fuel-efficient driving, to Internet access.

#### *Map representation*

Maps can either be presented as bitmap images (GIF, BMP, PNG, JPG) or as vector graphics. Vector graphics are lighter and quicker to download, maintain sharpness and resolution when zoomed, and can contain editable and searchable text.

#### *Navigation*

Navigation can be performed either on-board, by use of a map which is preloaded in the terminal or stored on a CD-ROM, or off-board (e.g. in the TDC). Off-board navigation can be either static (the whole route plan is transmitted in a single data transmission) or dynamically. Voice command and voice guidance is available in many commercial products.

## 5.6 Examples of in-vehicle terminals

During the Fourth Framework Programme of the European Commission, several projects, such as SAMPO and SAMPLUS, addressed DRT services. One of the main findings of these projects was that, at that moment, there was a need for an in-vehicle terminal, designed towards the needs of public transport operators and drivers. Most of the IVTs which are on the market for public transport are stand-alone systems which have been developed for private cars or for regular public transport fleets. These terminals do not respond to the requirements of flexible transport services, which are related to the nature of the transport service and to the type of information to be exchanged between the vehicle and the control centre. In practice those limitations are being overcome by the increasingly in the spread use of PDAs and smart phones.

### 5.6.1 The SIPTS approach: Nokia Communicator

During the SIPTS (TEN-TELECOM TEN45607) project a DRT service was developed and demonstrated in the city of Jakobstad and its neighbouring municipalities in Finland during 1999-2000. The SIPTS service operates on a door-to-door basis without any fixed route. The communication between the dispatcher and vehicles is handled via SMS alert or fax connections, using a modified version of the Nokia Communicator 9110 (Figure 5.2), a commercial smart phone. A special holder has been developed to

avoid the driver pressing non-applicable keys. The advantage of the smart phone is its affordable price, the possibility of voice calls, and the possibility for the driver to take it with him when leaving the vehicle. The control centre informs the driver only about the next address (or a cluster of addresses) and the pick-up time.

### 5.6.2 The INVETE in-vehicle terminal: a terminal for both regular and flexible collective transport

The INVETE project, which was sponsored by the IST programme of the European Commission, had as its main objective to develop and demonstrate a *modular, multi-application* in-vehicle terminal (IVT) for collective transport fleets, with the following characteristics:

- the IVT design is based on the identified needs of fleet operators and drivers, and on the requirements of the transport services and on-board telematic devices;



120 Figure 5.2: Nokia Communicator 9110 used as SIPTS in-vehicle terminal

- the IVT is able to support a variety of functionalities for both *regular* and *flexible transport services*. By designing the IVT not only for flexible but also for regular public transport, operators and application developers can use the same platform for all fleet vehicles. Regarding the economics, an open IVT makes both maintenance and service development and deployment easier, and hence the cost of an IVT and the related services can be decreased;
- the IVT is designed to operate in *different communication environments* (GSM, private radio network) and management schemes under a well organised ITS scenario;
- the IVT can be used on *different types of vehicles*: bus, minibus and taxi;
- the IVT is *interoperable* with other on-board devices, and will provide a single user-interface to the driver for different on-board telematic devices installed in the vehicle.

The INVETE project started in January 2000 and ended in May 2002. The terminal has been demonstrated in different DRT services in Florence, Italy and in Kuopio, Finland and for regular public transport services in Tampere, Finland.

The INVETE Consortium consisted of the Technical Research Centre of Finland (VTT), Instrumentointi (Finland, device manufacturer), Mobisoft (Finland, software developer), Softeco (Italy, software developers), ATAF (Italy, public transport operator), De Lijn (Belgium, transport operator), and MemEx (Italy, consultant), Tritel (Belgium, consultant) and ENEA (Italy, government agency).

#### *Roles of the INVETE terminal*

The INVETE terminal fulfils the following operational roles:

- external communication between the vehicle and the control centre through GSM or private radio network. The terminal allows seamless switching between different communication systems: e.g. for suburban traffic private radio network is used in the urban area and GSM outside the private network range;
- internal communication: collection of information from on-board sensors and communication with other on-board devices through the in-vehicle network;
- user interface: provision of a unique interface for the driver, allowing access to different information and services from the same display system.

#### *In-vehicle terminal concept*

The INVETE in-vehicle terminal consists of two modules: the Base Module, which owns all interfaces, and the Application Module, which has the interface to the driver (Scholliers *et al*, 2000). In this way, the conflicting set of requirements for regular public transport (real-time communication and stability) and for DRT services (graphical user interface and flexible programming possibilities) is taken into account.

The Base Service Module (BSM) is the heart of the IVT platform and performs the basic and real-time functions. The Base Module features a real-time operating system

and has all the in-vehicle interfaces to chassis and telematics units (e.g. CAN, microphones, loudspeakers, silent alarm button, odometer, GPS...), as well as the communication units (GSM, PRN) for external communication, and hosts the services for positioning and communication. The Base Module is a modular unit, using the PC104 architecture, and can be built into various combinations. The flexible structure allows updating of existing elements and the adding of new elements, so the Base Module will meet the long lifetime demand.

The Application Service Module (ASM) provides the user-interface to the driver and is tailored towards the needs of the users and services. For the INVETE project, different Application Modules have been developed for DRT services and for regular public transport (AVL) services.

The INVETE IVT Hardware Platform consists therefore of three units, which are shown in Figure 5.3.

The DRT Application Module (DRT-ASM) has been designed for the driver operating DRT services. It hosts a commercial operating system, has advanced graphical capabilities and is connected to the Base Module with an Ethernet link using a protocol based on TCP/IP. The DRT-ASM has a 10-inch TFT-LCD display, covered with a high quality touch screen. The system integrator/application developer implements the application based on customer needs. The construction of the DRT-ASM supports the integration into the dashboard of a vehicle.

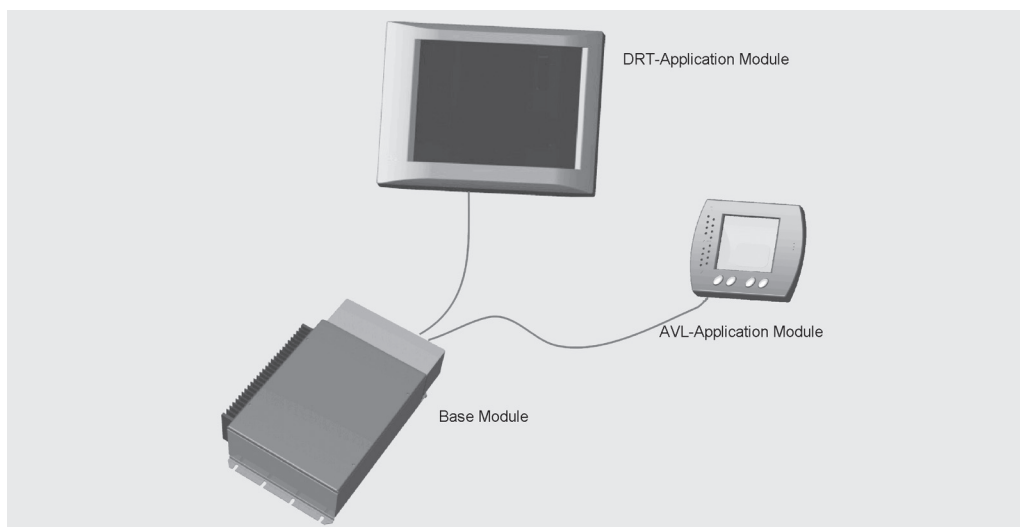


Figure 5.3:

**In-Vehicle Terminal Concept: Base Module and Application module, which is tailored towards the transport service: touch screen for DRT services, simple display for regular public transport (AVL) services**

The AVL Application Module (AVL-ASM) provides the driver user-interface for regular public transport applications. The AVL-ASM is a small and affordable unit, with a graphical, backlit 4-inch LCD display, which allows texts and icons to be shown, and four backlit buttons to control the operation. The AVL-ASM can be used as a separate module or with further development it can be embedded into the dashboard according to the customer needs.

The modularity of the INVETE platform at software level is achieved by using socket-based services (Scholliers *et al*, 2001a). For the communication between the services in the terminal and between the different modules, a protocol has been developed which is based on TCP/IP (Scholliers *et al*, 2001b). This open and public IVT protocol gives the different services on the IVT access to the information generated by the other services on both modules in a manner independent of the way the service is implemented. In this way, the messages sent by the application are e.g. independent if GSM or PRN is used for communication with the dispatch centre.

The INVETE project has developed the application software for the services, which are demonstrated, as well as communication gateways for both GSM and private radio network, based on state-of-the-art technologies and solutions.

#### *Demonstration of in-vehicle terminal*

More than 20 IVT's have been demonstrated in real operating conditions at different test sites in Finland and Italy from the end of 2001 to the middle of 2002. In Finland, the terminals are installed in regular long-distance buses operating between Tampere and both Helsinki centre and Helsinki Airport. For communication, the terminal uses a Private Radio Network in the urban areas of Tampere and Helsinki, and GSM outside the coverage of the private network. Through the terminal, the control centre is informed of the position of the vehicle. The driver receives information on the next destination and on the adherence to the schedule.

DRT services are demonstrated in Kuopio, Finland and in Florence, Italy. Both sites use the in-vehicle terminal with 10" TFT-LCD touch screen. The interface to the driver differs: in Kuopio a simple textual-based user interface has been developed; in Italy the interface also supports showing the real-time position of the vehicle on a map of the network (Figure 5.4).

In Kuopio, 3 terminals are installed in service buses and 1 terminal is installed in a maxi-taxi. In Florence, a total of 8 terminals are installed in two different minibuses in two different services. The base modules in the different sites have slightly different internal combinations, dependent on the devices attached to the terminal and the operating environment.

During the demonstration period the terminals worked without major technical problems, and the drivers were very satisfied with the terminal. Significant benefits 123



Figure 5.4: User interface of the DRT applications for the INVETE in-vehicle terminal for Finland (left, Mobisoft) and Italy (right, Softeco Sismat)

associated with the use of the INVETE terminal have accrued from the simplification and speeding up of a number of service operations performed by the drivers and the TDC team. The use of the IVT has also reduced the number of delayed trips due to faster communication and visualisation of the trip schedule, as well as reduced the number of failed trips. Another important benefit coming from the use of the IVT is that it becomes possible to create more robust and flexible DRT applications with the advantage of making the service more attractive and effective. An objective and conservative economic and financial assessment based on cautious assumptions and considering a 5 years lifetime of the INVETE device, has shown that the net benefits broadly exceed the related costs.

## 5.7 Implementation aspects

When planning a monitoring system for regular public transport services or DRT services, the whole life cycle of the monitoring system or service should be taken into account. The system should be easily adaptable if the service concept or size changes or if new applications are desired, such as real-time passenger information on-board or video surveillance to increase safety. It is therefore advisable to include in the call for tender, or in the selection procedure, criteria for assessing the following aspects:

- modularity: the roadside or communication network infrastructure can change during the lifetime of the product, forcing the operators to perform substantial investments. During the life cycle of the terminal the vehicle may be transferred to another environment (city, region), which uses different communication media. The vehicle could also be used in another service, dependent on the needs of the moment (e.g. DRT service instead of regular line);

- openness: during the life cycle of the product, the system provider may shut down the production of the terminal, so that a new manufacturer has to be sought. By using an open system such as the INVETE platform, it is possible to replace the device with a device based on the same protocols and interfaces;
- compliance to standards and possibilities to integrate the terminal with current and future on-board devices: EN13149-6 will become a standard in the coming years and new on-board devices will have to be compatible with this standard;
- updating: the possibility to update the software wirelessly or to upgrade the terminal without major work at the terminal and at the control centre.

When updating a current monitoring system, the INVETE platform provides a path to make the in-vehicle infrastructure more simple and modular. Starting from a roadmap of future technologies and devices that will be implemented, different levels in the implementation of the INVETE terminal can be defined, e.g. only application module; implementation of part of the interfacing and communication functionalities in a Base Module. The identification of the different levels of functions requires finding a balance between the needs of new functions to be implemented and the lifetime of existing devices. Due to the modular structure of the INVETE terminal and its interoperability with standard in-vehicle network architectures (EN 13149-6), the architecture of the monitoring system can be simplified when adding new functionalities. Depending on the level of implementation, the software on the Base Model or Application Modules developed for the INVETE test sites can be reused with minor or more modifications.

An Automatic Vehicle Monitoring (AVM) system is complex, and a small operator does not always have the possibility to maintain such a system. The operator is therefore demanding an “AVM Global Service”, in which the system integrator not only takes care of the system maintenance and assures that it is properly working, but also of the investment costs, so that they can concentrate on operating the service.





## CHAPTER 6

# DRT vehicle development

*Y. Westerlund, A. Ståhl*

### 6.1 Background

There has long been a documented need for better vehicles for the taxi and Special Transport Services (STS) segments in Sweden and many other countries where great effort and expenditures are spent on mobility services for people with special needs. Recent developments in flexible public transport and STS have increased the need for accessible vehicles of different sizes. Ordinary passenger cars and vans are problematic for wheelchair users and many other disabled persons can only use the front seat of the car, often even then with great problems.

As a consequence the service providers must be able to keep a fleet of different types of vehicles - passenger cars and special lift-equipped vans and minibuses - which requires greater investment and often a less optimal use of resources. For better efficiency, new vehicles need to be developed that are equipped with both ordinary seats and sufficient space for wheelchair(s), vehicles that can be used by as many user categories as possible.

They must also be comfortable and attractive to passengers and drivers. Size and manoeuvrability is important since the vehicles need to be able to come close to users' homes and destinations.

Since these vehicles will be used in integrated transport systems, it is important that they function for several different uses. They must be very flexible – and are thus sometimes called Multi Purpose Vehicles (MPV). The design and development of such vehicles have been studied in two different but related projects in Sweden between 1997

and 2000 (Stahl and Westerlund, 1999). One focused on smaller buses, so called Multibuses, and the other on a new accessible maxi-taxi vehicle, the so called Taxi for All. The major purposes of both projects which are described in this chapter were to compile user requirements from various user categories and to interest the vehicle manufacturing industry in concept design and development of a new generation of functional vehicles for the taxi and minibus segments.

## 6.2 Classification of vehicles

The following vehicle classes were defined to simplify the work:

- an accessible light-weight maxi-taxi (of van size) for 6-8 passengers, of which 1-2 may be in a wheelchair (class I)
- an accessible light-weight minibus for 9-14 seated passengers, of which at least one passenger may be wheelchair-bound (class II)
- same as II but in a stretched, bogey version for 15-18 seated passengers (class III)
- heavier vehicle of a conventional midibus-type for 24-30 seated passengers (class IV).

Table 6.1 is an attempt to match existing transport services, both scheduled and demand responsive, with the appropriate vehicle classes. DRT generally requires smaller vehicles than line haul but there is considerable overlapping in requirements and thus opportunities for multiple use of the vehicles.

Type and purpose of use		MPV classes:			
		I 6-8 pass.	II 10-14 pass.	III 15-18 pass.	IV 22-30 pass.
<b>Demand responsive</b>					
D1	Shared Ride Taxi	++	+	-	-
D2	Special Transport Service	++	+	-	-
D3	Medical Transport	+	+	-	-
D4	Flexible Service Route	(+)	++	+	-
D5	Route Deviation	-	+	++	+
D6	Goods Distribution	+	++	+	(+)
<b>Scheduled Fixed Route</b>					
S1	Work/School Transport (disabled)	++	++	+	-
S2	Regular School Transport	+	+	++	+
S3	Traditional Service Route	-	(+)	++	++
S4	Hospital Routes	(+)	++	++	++
S5	Rural Services (with goods)	-	+	++	++
S6	Local Bus Routes	-	-	+	++
Legend: ++ very appropriate, + appropriate, (+) in certain cases, - less appropriate/non appropriate					

Table 6.1:  
Appropriate vehicle classes for different type and purpose of transport services

## 6.3 The Multibus Project

The Multibus project was initiated and led by LogistikCentrum with the financial support of KFB (the Swedish national transport research funding agency), and a user group of 15 different sponsors in the public transport and taxi sectors, local and regional transport authorities and private operators.

The purpose was to analyse user needs and functional requirements for a new generation of accessible minibuses in classes II and III (as identified above). An industrial partner, OmniNova/TWR Sweden, was solicited for realisation of the concept on the basis of the requirements set up in the project.

### 6.3.1 Basic functional requirements

Most of the project work was conducted in a series of workshops with user group members during the autumn of 1997. These workshops produced a long list of user needs and requirements that were presented as “must” or “should” items to be added to the legal requirements for the new vehicles.

The following is a short summary of the results of the user needs analysis.

- Accessibility
  - The vehicle must allow ambulant people, including those who have functional impairments, to get in and out easily. A single, wide door (>1 m) near the driver is acceptable for the class II vehicle. There should be an option for a rear door (a must for mixed passenger and goods use and also for a class III vehicle).
  - Passengers with walkers and prams must normally be able to board the vehicle without assistance. There must be designated space for such items near the passenger. It must be easy to secure wheelchairs of different types, including most electrical ones. It should be possible to do this without driver assistance.
  - Floor height should be even throughout the whole vehicle (flat floor) and not exceed 230 mm above ground level in a lowered position
  - A ramp must be included to allow for easy access by wheelchair, even when there is no curb at entry point. The ramp should be simple to manoeuvre and could be manual when the frequency of use by wheelchairs is moderate to low.
- Flexibility
  - The vehicle must be useable for a multitude of functions or traffic modes, possibly in simultaneous combination (e. g. passengers and goods).
  - The vehicle must be flexible as to the number of wheelchairs, walkers and seated passengers. Seat mounting must be fully flexible with fast changeover to wheelchair or stretcher.
  - Design should be attractive to provide a good image, i.e. not a special transport vehicle but rather an all-purpose vehicle.

- Manoeuvrability
  - The turning radius must be as small as possible, not exceeding 8.5 metres for class III vehicles. For class II vehicles it should correspond to that of a large car, i.e. about 5-6 metres.
  - Ground clearance must be as good as possible during driving, e.g. to allow for passage of speed bumps in residential areas.
- Operations
  - Personal contact between driver and passenger should be encouraged in a natural way since the driver's social function is stressed in most applications. The driver should not have to walk around the vehicle to reach the passenger compartment and door entry to assist passengers.
  - The comfort level should be high. The suspension must be soft and stable. The interior noise level should correspond to that of a car or a tourist coach. Acceleration should be smooth but strong enough to follow the regular traffic rhythm.
- Safety and environment
  - Seats should normally face forward and have easy-to-use three-point seatbelts (in-seat). This requires a very sturdy fixture of the seats to the floor (while still being easy to remove for flexible vehicle use).
  - For high fuel efficiency and for maximum pay-load capacity, weight must be minimized (it should not exceed 3,000 kg empty, for the class II vehicle). This implies use of lightweight components without compromising safety requirements. In the long-term the drive-line should be environmentally optimized, e.g. hybrid technology.

### 6.3.2 Design and flexible layouts

The user group workshops also included sketching alternative designs and interior layouts for different uses. A simple mock-up of a vehicle platform and real size interior elements such as seats, wheelhouses, wheelchairs etc. was part of this process. The layouts were later modified and produced in a CAD system by the industrial partner. Figure 6.1 shows a few examples of such layouts, clearly showing the versatility of the MPV concept.

### 6.3.3 Realisation

Since the industrial partner, OmniNova, worked on the practical engineering solutions in parallel with the requirements study it was possible to have a production version of the new vehicle available for the market early in 1999 (see Figure 6.2). It was called MultiRider and based on a Renault Master platform and the Q-bus body concept acquired from Netherlands. Q-bus was originally based on Peugeot.

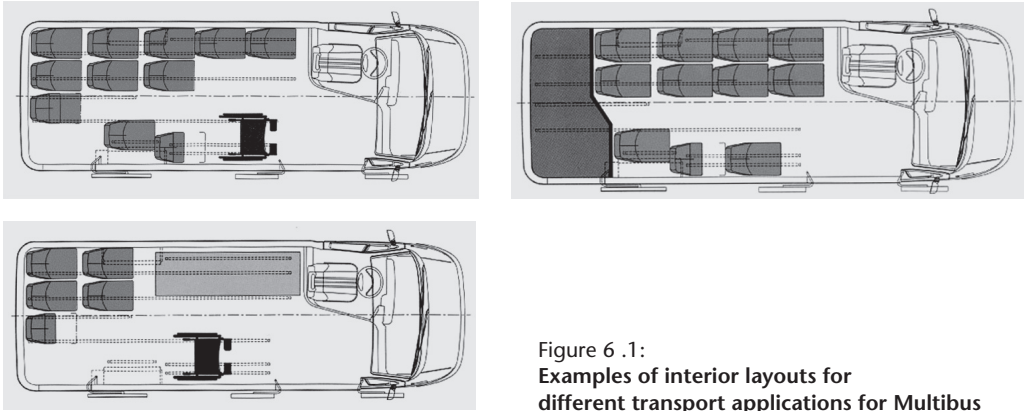


Figure 6.1:  
Examples of interior layouts for  
different transport applications for Multibus

Passengers' impressions from the first series of production vehicles were quite favourable and only a few modifications were made initially. The buses were considered very accessible and spacious, with plenty of room for walkers etc. On the negative side there were some issues of comfort provided by the new air-suspension system. This seems to be a generic technical problem for this class of vehicle when it is difficult to achieve a sufficient stroke of the suspension and thus to deliver a smooth ride over speed-bumps in residential streets. There was also an issue of driver environment. Some Swedish drivers complained that no automated transmission option was available for this Renault platform. Others, particularly those used to driving regular-sized buses, felt that the standard Renault cab was too basic and did not allow for fully ergonomic seating etc. Other smaller bus operators have had less such complaints from drivers and there are currently some 16 MultiRider buses in use in the Flexline application in Gothenburg (Westerlund *et al* 2000).



Figure 6.2:  
Fully accessible MultiRider  
minibus in Flexline application  
in Gothenburg, Sweden

### **6.3.4 Market development**

Unfortunately the market development for the new minibus was much slower than the industrial development and Omninova, who had taken on a very aggressive product development and manufacturing approach, soon ran into chronic economic difficulties. Sales figures far from matched their ambitious initiative. Eventually the company filed for bankruptcy in the autumn of 2002 after delivering a total of less than 200 vehicles. It seems however as if the Multibus concept will prevail since the basic rights were acquired by a British bus builder (Rohill) in the auction following the bankruptcy. Rohill is active in the rapidly expanding British DRT market.

## **6.4 The Taxi for All Project**

The importance of the STS in Sweden is proven by the fact that about 65% of the taxi business' revenues come through STS and medical transport operations, heavily subsidized by local authorities. Thus the key issues are whether a new Multi Purpose Vehicle can provide both better efficiency for the operator and lower costs to society. To achieve this we need a vehicle:

- that is acceptable to both disabled (STS) users and the general public, thus achieving better utilization and lower costs per passenger, and
- that is less expensive to operate than those special vehicles currently used for STS taxi operation.

In order to address these key issues the Department of Technology and Society, Lund University, Sweden, and Cranfield University, UK, jointly sought EU funding for the Taxi for All project in September 1997. Part of the funding for the project was granted by the European Commission (DG VII) in December 1997 and the remainder by national sponsors. Lund University approached TWR Sweden/OmniNova as a subcontractor to design and build three prototype concept vehicles. Cranfield University co-operated with LTI (London Taxis International) and Volkswagen UK for a modification of their current vehicle platforms (Oxley and Stahl, 2001).

### **6.4.1 Basic functional requirements**

Earlier ergonomic research in Sweden provided invaluable data on the design standards necessary to provide easy and safe access for wheelchair users and ambulant disabled passengers (Petzäll, 1996). The results of different experimental studies were thus used to formulate precise functional requirements and measurements for significant components in door openings and passenger compartment. These functional requirements were then used by the industrial partner in the prototype development. All of the relevant user requirements and design criteria from the Multibus project (as described

above) were applied to the Taxi for All concept vehicle. The following is thus only a summary of the special requirements related to the smaller (class I) vehicle.

To facilitate wheelchair movement inside the vehicle, the main fixed passenger seats should be placed in the rear of the vehicle, at a minimum distance of 1,600 mm from the front end of the passenger compartment. The space designated for people in wheelchairs should thus be in the front of the compartment, where the wheelchairs should be anchored with their back towards the front wall (for safety reasons).

A detailed specification of key dimensions for the Taxi for All prototype was set up by Lund University after consultation with potential users of the vehicle. Table 6.2 gives a comparison between the requirements from the experimental studies and the actual dimensions of the first three prototypes developed by TWR Sweden / OmniNova.

	Requirement (mm)	Actual (mm)
Side door		
Height	1650	1655
Width	900	950
Tailgate		
Height	800	860
Width	-	1360
Side glasses		
Height above floor	850	940
Ceiling		
Height above floor	1800	1800
Bulkhead behind driver		
Height above floor	1000	1000
Aperture to ceiling	700	700
Inside vehicle width	1600	1620
Seat height	420	450
Wheelchair ramp angle	1 in 12 (8.3 %)	1 in 12 (8.3%)
Entrance height	230	230

Table 6.2:  
Dimensions and apertures for the  
Taxi for All concept vehicle

#### 6.4.2 Prototype design

A vehicle used in combined taxi and DRT service ought to look basically like an ordinary large passenger car, van or maxitaxi. It should not draw particular attention to the passengers travelling in it, yet should have a characteristic appearance so that it can easily be identified as a taxi, which is clearly the case for more conventional purpose built taxis, e.g. the London Cab.

A suitable vehicle fulfilling these requirements should have the following dimensions:

- vehicle length: max. 5.5 metres
- vehicle width: max. 2.0 metres
- capacity: seating for at least three passengers plus the ability to accommodate one to two wheelchairs.

The industrial partner used experienced car designers to create the vehicle shown below (Figure 6.3).



Figure 6.3: One of the three prototypes for the Taxi for All concept vehicle by TWR/OmniNova

In the development work sketches were made of alternative designs and interior layouts for different uses. The functional requirements and layout ideas presented in this study have a wider relevance than just for maxi taxis; they can be used by vehicle manufacturers when considering the design of any type of cars, multi-purpose vehicles and minibuses. The layouts were later modified and produced in a CAD system by the industrial partner. The development of the first Taxi for All prototypes showed that it is possible to satisfy the basic functional requirements by using a mass produced, light commercial vehicle platform combined with a purpose built frame and body rearward of the cab.

#### **6.4.3 Experience of prototype testing**

Three prototypes of the Taxi for All vehicle were tested and evaluated by Lund University over a one-year period. The objectives were to study how such a taxi vehicle could be used by the operator in different transport applications and to assess acceptance among



different kinds of users. The three test vehicles were therefore used as an ordinary taxi, for STS and for medical/hospital transport. Since testing occurred on the open traffic environment a special permit for temporary use of the prototypes was granted by the authorities.

To carry out a successful evaluation of a new vehicle concept, consideration must be given to the sometimes very large geographical variations and other local conditions of the taxi operators.

The three prototypes were thus tested in three principally different sites in Sweden:

- a large city (Gothenburg) with approx. 500,000 inhabitants;
- a middle-sized city (Uppsala) with approx 185,000 inhabitants, in connection with rural areas;
- a rural area with small towns and villages in Dalarna County.

During the one-year test period, the passengers were given the opportunity to compare the Taxi for All vehicle with conventional vehicles used in taxi and STS operations. Due to the short test period, some of the passengers had very little experience of Taxi for All. This is significant for all analyses of results but particularly when making comparisons with other conventional vehicles with which the users have much more experience. Nevertheless, about 40% of all passengers (both disabled and with normal function) preferred Taxi for All over more conventional taxi/paratransit vehicles.

Ambulant passengers particularly appreciated the easy access to the vehicle because of its low floor and the full height of the door (1,650 mm) (Figure 6.4).



Figure 6.4: Passenger using a wheeled walker exiting the Taxi for All prototype



Figure 6.5: Roomy interior and large windows for good view were important design criteria

Users of powered wheelchairs liked the ability to enter and exit without the assistance of the driver. However, these users did tend overall to have a less positive view of the vehicle than other users but this may be a consequence of the design diversity of these wheelchairs and particularly the large size of some of them.

This problem is not unique to taxis; similar problems have been found with the use of large powered wheelchairs on buses. As wheelchair-accessible public transport develops, there may be an argument for a scheme that identifies wheelchairs that are “transport compatible”, i.e. that can get into and travel safely in taxis, buses etc. Another slightly negative view came, again, from the powered wheelchair users, some of whom disliked riding facing backwards, which is prescribed for safety reasons. Regarding other safety issues, there were very positive views about the wheelchair restraint system and the three-point seat belts (in-seat). The attitudes of users to accessibility features such as design of the ramp, space and seating in the passenger compartment were all very positive.

Views about riding comfort were somewhat less positive, specifically regarding noise level and suspension, but these are matters that were improved during the course of the project. The large windows in the vehicle were appreciated because of the good view they provide (Figure 6.5).

The comparison between the Taxis for All vehicle and other taxi/STS vehicles showed, perhaps unexpectedly, that regular (not physically challenged) taxi users had the most positive attitudes towards ease of entry and interior space - even more than manual wheelchair users and ambulant disabled people (Figure 6.6). Even if this is based on a small sample, it is an interesting finding because it seems to suggest that a vehicle designed particularly with the needs of disabled people in mind can be attractive to regular taxi users.

If this is true, we may conclude that this type of vehicle can be used in mixed regular taxi and paratransit operations and that it is possible to achieve a better utilization and thus a lower unit cost for operations.

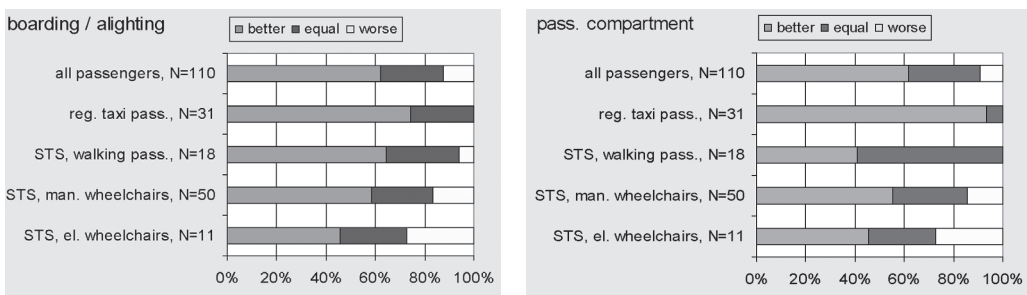


Figure 6.6:

136 Passenger attitudes, comparing the Taxi for All prototype vehicle with conventional STS taxi vehicles

#### 6.4.4 Realisation

Following the prototype testing some modifications were made to the vehicle concept and several engineering details were modified. A first production series of 15 vehicles was delivered to an STS operator in Gothenburg in 2000 and Omninova was very optimistic about the possibilities for a quick market response. When Lear Seating moved their production of seats for Volvo from Bengtsfors in Dalsland to Gothenburg Omninova quickly took over production facilities and a work-force of some 250 people. All this happened with great speed and the need for further product improvements, a conservative and cautious potential customer base and lack of capital forced the company to modify the plans to produce more than 500 vehicles per year. Consequently the TaxiRider went down the same way as the MultiRider despite a backlog of customers who never got their deliveries. The above mentioned British bus builder, Rohill, has announced that it intends to restart the production of taxis at the Bengtsfors plant, but at a much lower rate (initially 5 vehicles per week) than optimistic Omninova.

### 6.5 Conclusions

The new generation of advanced accessible vehicles must be low-floor, with or without adjustable floor height, and able to carry wheelchair users without special lift equipment (Figure 6.7). The vehicle design should guarantee that both wheelchair users and persons with walkers can enter and exit easily, if necessary with assistance from the driver and by using some form of ramp.



Figure 6 .7: Wheelchair user boarding the prototype vehicle with minimum assistance from the driver

The interior height must allow for standing passengers (for easy access), although no standing is allowed during driving. It is also anticipated that a universal accessible design for users with special needs will also be good for the ordinary users in integrated transport solutions.

The main purposes of both the Swedish projects, to compile user requirements from various user categories and interest the vehicle manufacturing industry in developing a new generation of accessible and flexible vehicles in the taxi and minibus segments, have been achieved. A new minibus (MultiRider) and a similar advanced maxitaxi (TaxiRider) went into production phase during or shortly after the projects were finished.

As for market potential, there still seems to be a somewhat delayed demand for these accessible vehicles even in Sweden. Despite a government incentive to fund 50% of the extra costs for accessible transport measures during a three year period, there is still much planning and co-ordination of services to be done before there will be a manifest demand of a significant size. As an example, Stockholm County spends about 100 million euro per year to subsidize STS operations for disabled and elderly persons. If we assume that one-quarter of that subsidy would be transferred from the conventional taxi business to a DRT minibus-service of the Flexline type (as in Gothenburg), the 25 million euro would suffice for a fleet of 300-350 minibuses operating about 8 hours every weekday (not weekends). If another quarter was allocated to shared-ride maxitaxis, these 25 millions would suffice for another 300 vehicles operated some 12-14 hours per day.

The key role in this market development lies with the transport authorities, who normally will procure these services from the private sector on a competitive basis. They need to adapt or develop new traffic concepts and formulate stringent demands for accessible, safe and comfortable vehicles in their procurement specifications. By also looking to a wider use of these vehicles, for different purposes during different parts of the day, they can also facilitate a sound total vehicle economy. This is important, since the higher functionality will lead to somewhat higher investment costs than for conventional vehicles. The above projects have been successful in terms of engaging various transport business actors in the design and development process. The needs and requirements thus documented are a first step to more unified procurement specifications that could also reduce costs in the longer term. It is recommended that the different actors (e.g. the national and international associations for taxi and bus operators and for authorities) together continue this process and co-operate to find solutions to the problem of under-utilized vehicles. In the future it is necessary that public procurement is used in a more aggressive and productive way to induce development and deployment of new vehicles and for all types of innovative transport solutions and systems as well. In order for this to happen it seems as if some procurement policies and laws need to be changed on a European basis.

There is a continued need for research and development of suitable vehicles for various user purposes. We also need better knowledge of how to best combine such uses for efficient utilization over the day. More practical experiments and demonstrations need be done to test flexibility and combinations of different traffic applications. As has been mentioned above there are also some technical challenges to enhance the low-floor suspension for commercial vehicles in these segments and to produce a low (or zero) polluting drive-line for urban applications including goods delivery.

The unfortunate demise of Omninova shows how difficult it is to match innovative product development with market development and the manufacturing process. The capital needs for such ventures are of such a magnitude that it seems necessary to also engage large vehicle manufacturers in this process. And this has so far been a difficult and fruitless task.



## CHAPTER 7

# Experience and applications of DRT in Europe

*G. Ambrosino, J.F. Mageean, J.D. Nelson, M. Romanazzo*

### 7.1 Introduction

Demand Responsive Transport (DRT) services encompass a wide range of local transport which is complementary to conventional, scheduled passenger transport based on large buses, trams and regional trains. DRT is usually provided by smaller buses, minibuses, vans, taxis and cars and serves dispersed mobility needs, either during hours of low demand, in areas of low population, or where the target users are dispersed among the general population. These services normally act at a very local level, and are either for the general public, or for specific groups (e.g. disabled and elderly). They provide local mobility, as well as connections to other conventional forms of transportation (e.g. from regular bus network to railway service). Established benefits and impacts include:

- flexible routing services allow access throughout an area rather than on specific, fixed corridors and thus the coverage of the service will be wider;
- improved access to local services, and in some extent to larger centres;
- improved mobility and accessibility for the disabled and the elderly on an equal basis with other citizens;
- improved mobility and access to services may help retain population, especially young people and families, in areas of declining population;
- the cost-effectiveness of the services may encourage increased service level provision, increased usage, and create a sustainable 'virtuous circle' of improvements;

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- for locations with a strong tourist dimension, improved and flexible public transport will encourage tourism without cars, assisting tourism growth in a sustainable fashion;
- improved mobility will generally increase the level of economic activity in the locality.

This chapter provides a summary of the experience gained through different pilot applications in Europe and highlights the clear needs of an efficient co-operation between operators, IT suppliers and authorities to support deployment and take-up of this innovative form of collective transport services.

### 7.1.1 Major demonstrators and applications

Major demonstrators of DRT schemes and operations in Europe have been set up and run in several sites during the EC-funded SAMPO (1996-97) and SAMPLUS (1998-2000) projects (Telematics Applications Programme) as well as during the SIPTS project (TEN-Telecom). Within SAMPO and SAMPLUS, different sites were involved from Belgium, Finland, Ireland, Italy, Germany, Sweden and the UK (Table 7.1). The areas included both urban, peri-urban and rural environments, and involved both applications for generic public (e.g. flexible transport services for low-demand areas; integrated DRT) as well as services for special user categories (e.g. disabled and elderly, business travellers etc.).

As shown by the SAMPLUS demonstrators, the nature of a site, the service and the operational characteristics of DRT realisations can vary considerably. One of the strengths

City/Town/Region	Country	Application/Environment			
		DRT/Rural	DRT/Urban	Special user/rural	Special user/urban
Limbourg	BE	•			
W-Flanders/E-Flanders	BE	•			
Seinä joki	FI	•		•	•
Tuusula/Järvenpää /Kerava	FI	•		•	•
Kilkenny (FS)	IRL	•	•		
Cavan-Leitrim (FS)	IRL	•		•	
Florence/Campi Bisenzio	IT	•	•		•
Hägsbo (Gothenburg)	SE		•		•
Märsta (Stockholm)	SE		•		•
W-Sussex/Surrey (FS)	UK	•		•	

FS = Feasibility Study

142 Table 7.1: Test sites and type of applications within the SAMPO/SAMPLUS projects



of DRT in general, and SAMPLUS in particular, is the ability to operate successfully in these varying environments. This section outlines the main characteristics of the SAMPLUS sites and summarises their differences, thereby providing a portfolio for potential DRT sites to examine and ascertain possible similarities and differences with existing DRT sites. Further details and discussions as regards the service provision schemes adopted and the service operation and management solutions implemented in the different sites can be found in subsequent sections of this chapter and in fuller detail in Nelson and Mageean (1998 and 1999).

### **7.1.2 Main characteristics of SAMPLUS DRT sites**

The size of the SAMPLUS DRT service areas (Figure 7.1) is reflected by the type of DRT service that has been established. At one extreme the Belgian site covers three provinces which are not densely populated, although the total population is quite large (Figure 7.1); this has led to the provision of many services covering the provinces. Conversely the Italian and Gothenburg (Sweden) sites are densely populated over a small area, and few DRT services have been established. Where population density is very low, varying solutions have been used, e.g. in Ireland several routes are used to cover a wide area; at the Finnish demonstration and feasibility sites only one route is used over a small area but the coverage is much more flexible (Figure 7.3). The number of vehicles used is proportional to the number of services (Figure 7.2). The exception lies with the Finnish sites, where taxis are an integral part of the DRT service, thereby providing a role model for future intermodal co-operation.

The number of SAMPLUS DRT operators (Figure 7.2) reflects the legal and organisational environments of the sites. Thus, in Belgium and Italy there is little scope for more than one bus operator to be involved, due to the highly regulated planning and operation of public transport. In Sweden, the operation of routes is subject to off-the-road competition; as only single routes were established, there was no scope for more than one operator. In the UK and Finland, on-the-road competition is permitted; in these cases the number of bus operators is limited by the natural caution concerning relatively expensive technologies in an open market.

Many variables can be used to describe the operating characteristics of a site. The minimum pre-travel booking time (Figure 7.2) shows a wide variation. Whilst the Italian and Gothenburg sites have a short period (15 minutes), the other sites require at least 1 hour. The different demonstrators have shown that longer booking periods are more beneficial to TDC operators, but are less flexible for passengers.

The DRT journey pattern is developed according to many criteria, e.g. the distribution and density of population and the resulting potential demand; the amount of capital available for investment in vehicles and scheduling programmes and operators; and the analysis of user needs. Chapter 2 has shown how DRT services are characterised

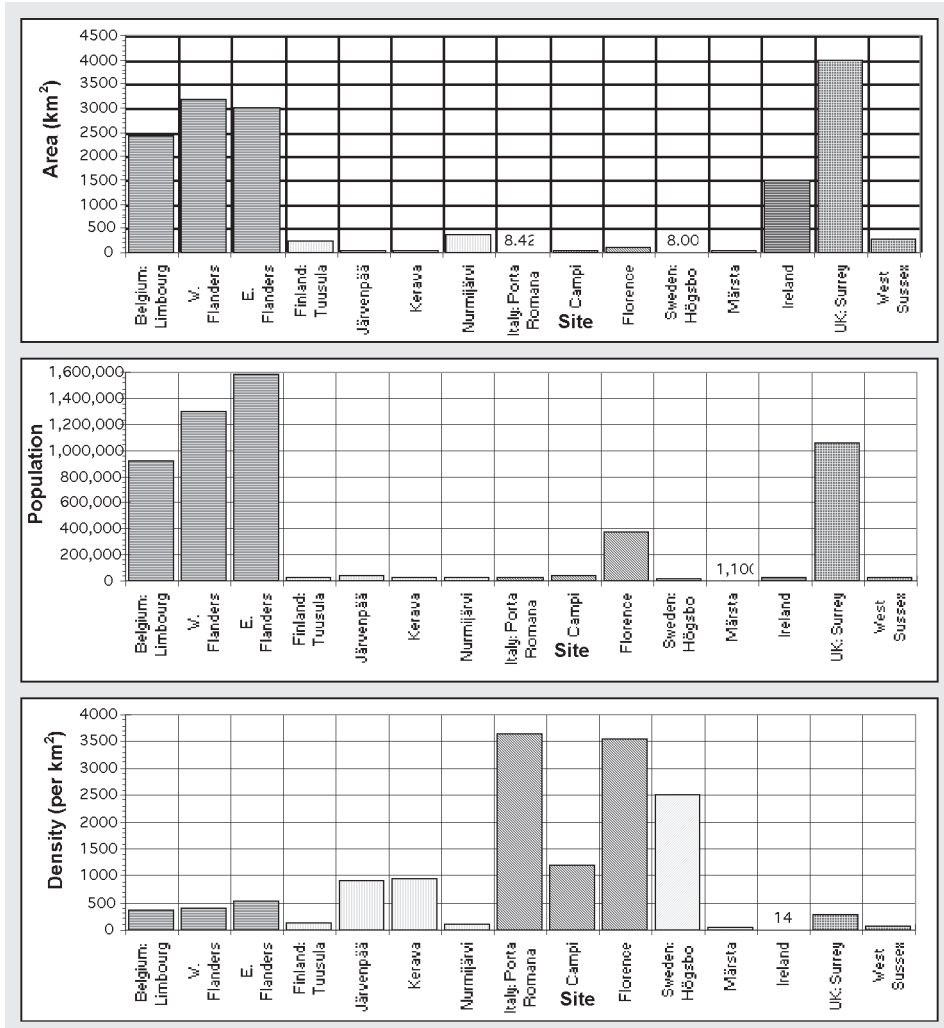


Figure 7.1: Area, population and density at SAMPLUS sites

in terms of increasing levels of flexibility, from the ordinary line service to the most advanced and flexible types of DRT:

1. *Predefined timetable and route*: the service reaches predefined stops with predefined passing times;
2. *Partially predefined timetable and route with deviations to predefined stops*: the service can reach predefined stops on demand, with small deviations from the ordinary path;
3. *Stops in a region*: the service can reach a set of predefined stops on demand, in a predefined zone, maintaining eventual predefined departure/arrival times;

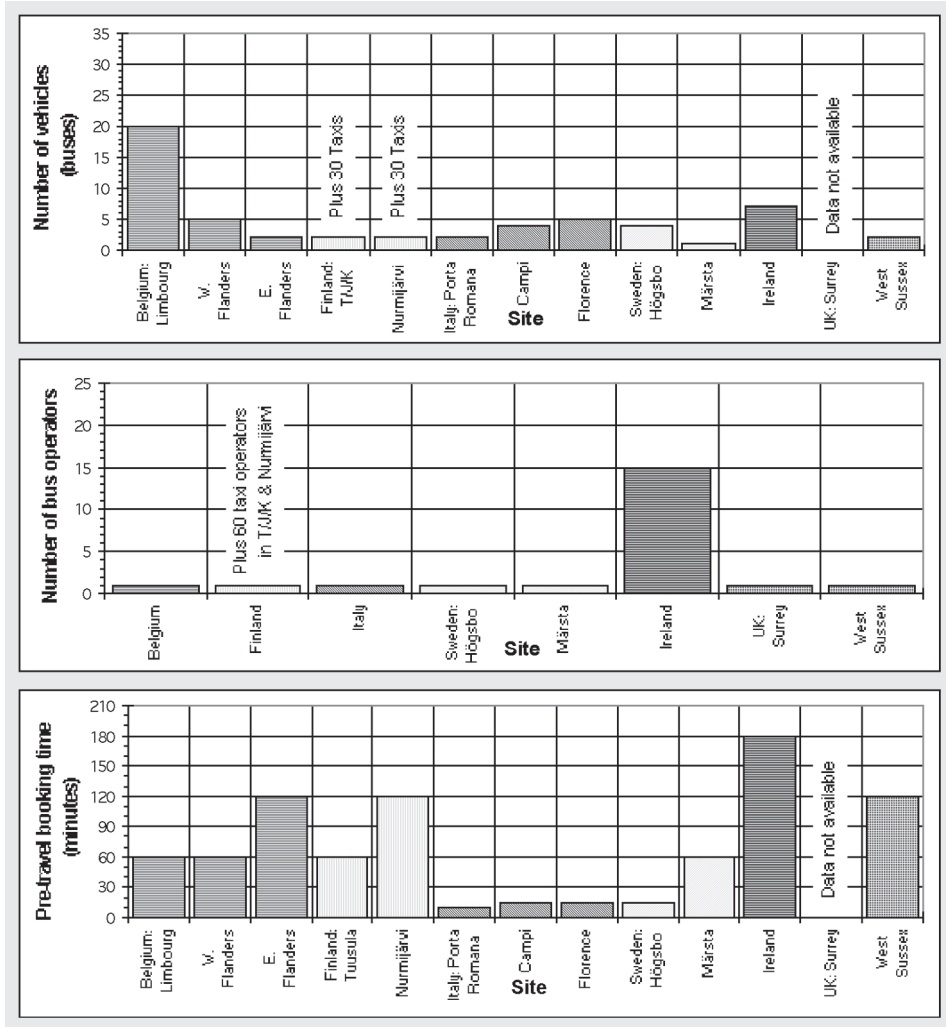


Figure 7.2: Number of vehicles, operators and pre-travel time at SAMPLUS sites

4. *Points in a region*: the service doesn't have any predefined stop, and can (potentially) reach any origin/destination point in the chosen zone.

Semi-fixed routing is easier to schedule: these were planned for Ireland and (subsequently implemented in) West Sussex (UK). More flexible routing is used in Belgium, Porta Romana (Italy) and Gothenburg and Stockholm (Sweden), whilst virtual flexible routing is found at the remaining two Italian services and in Finland (Figure 7.3).

Lastly, the method of booking the DRT trip is partly dependent upon the journey pattern. For example, pre-booking is necessary at non-predefined and predefined stop

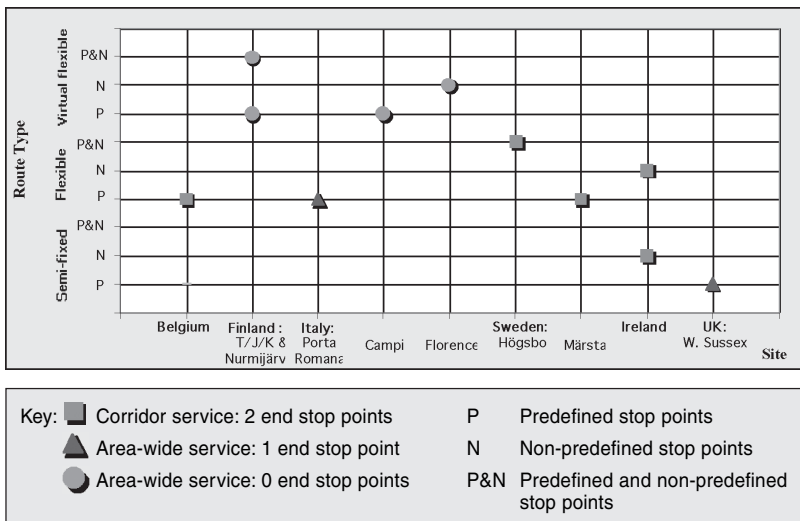


Figure 7.3: DRT service journey patterns at SAMPLUS sites

points, as there is no guarantee that the vehicle will pass those locations. Manual booking with the TDC is always available. IVRS has had varying success; whilst it continues to be used in Stockholm and Belgium, experiments have not shown it to be worth continuing at present in Finland. Similarly, Internet booking has only been pursued in Stockholm and Belgium. Return booking raises a number of complications leading to innovative, different booking solutions; in Gothenburg magnetic card readers are used, whilst in West Sussex a touch screen system is planned.

In the following sections a detailed description of some experiences and applications (much of it drawn from the SAMPO and SAMPLUS European projects and subsequent experience) currently in operation in different European areas/sites is provided. The Swedish case does not receive detailed treatment in this chapter. Interested readers are referred to Westerlund *et al* (2000) and Westerlund (2003). In particular both the organisational/operational and management aspects and the real answers provided to different user demand are emphasised.

### 7.1.3 An evaluation methodology for DRT services

The SAMPLUS *Evaluation and Verification Plan* (Nelson and Mageean, 1998) describes the unique methodology adopted in the detailed evaluation which is experienced at the sites. This may be summarised as follows.

- The **evaluation framework and analysis** followed a number of steps. The assessment objectives and priorities were identified for the user groups at each site, i.e. public authorities, transport operators, the general travelling public and special user groups such as the disabled and elderly. This was followed by an estimate of the impact and

effectiveness of SAMPLUS technology upon the user groups at each site. The evaluation indicators for three Assessment Categories were defined: **economic viability** (considering operational efficiency and financial performance), **service provision** (behavioural evaluation and distributional costs and benefits), and **technical performance**. In particular, the evaluation assessed the effectiveness of DRT operations in achieving intermodality and system integration and carried out a technical evaluation to check the integration potential of different telematics systems, especially at the European level. A variety of techniques were employed for data collection including questionnaires, focus groups and manual and automated observations. The emphasis was on common methods of data collection and common evaluation indicators between sites.

- **Individual site evaluation** was achieved by the continued evaluation of demonstrations developed during the earlier SAMPO project for which each site retained responsibility for its own detailed evaluation objectives and contributions to the Evaluation Plan.
- **Common European evaluation** was necessary in order to achieve strong commonality between the SAMPLUS national demonstration sites (thereby guaranteeing a strong level of European analysis, transferability and recommendations) and this was achieved by a number of approaches. The context of each demonstration site (organisation, administration, financial, legal etc.) was described. As noted above common methods of data collection and common evaluation indicators were collected from demonstration sites for analysis. The standard of data collection and analysis was ensured by adherence to *CONVERGE* guidelines (Zhang *et al*, 1996).
- **Future markets** for SAMPLUS technology were investigated by ensuring that the technology would extend to all EU member states and other non-EU countries. These markets were identified by building upon extensive DRT contacts; and by analysing the benefits to service providers and operators following the implementation of SAMPLUS systems, e.g. expected increase in patronage and cost effectiveness of operations.

## 7.2 The experience of De Lijn in Belgium

*L. Weyns*

### 7.2.1 Introduction

In 1990 the Flemish Transport Company (De Lijn) launched a trial of a new type of public transport. In a small area in Western Flanders a bus served stops only if passengers made a reservation by phone for a specific trip. It was a first attempt to have a better matching between the requirements of the customer and the interest of the public

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transport company. By 1997 almost 18 Demand Responsive Transport (DRT) Services were operating in the most rural areas of Flanders with further services planned. The concept of DRT Services has matured and intends to be a central part of the organisation of public transport in Flanders.

### 7.2.2 Operational context

De Lijn organises urban, interurban and regional public transport in the Flemish parts of Belgium. The company has around 4,800 employees and a fleet of 2,000 buses and 270 trams. Also some 850 buses are operated by private companies working for De Lijn. Together with the Belgian Railways the mission of De Lijn is to offer a wide range of public transport products answering the basic mobility needs.

Flemish public transport faces different important challenges. On the one hand there is the need to rationalise the organisation. Historically a high number of different lines are operated serving most origins and destinations in the region. However the organisation costs were less and less covered by fare incomes and the origins and destinations increased enormously spreading over all the region. The traditional answer for this was to limit the frequency of the services which resulted again in a lower number of customers.



Figure 7.4:  
A typical DRT vehicle  
of DE LIJN

But on the other hand the customer has an increasing need for mobility. Here public transport has to fulfil two important roles: offering basic mobility for everyone and giving a strong alternative for the use of a car to reduce the negative impacts of “car personalisation” of mobility and congestion and pollution. Especially in the rural areas of Flanders this basic mobility seems very important to keep the small rural villages alive. In general more than 60% of the inhabitants do not have permanent access to a car, mostly children, students, elderly, women working in the home etc. The lack of good public transport limits them in their activities and initiatives. It is also one of the causes why small villages which don't have a sufficient level of services (shops, administrative services) do not remain viable.

In the other role of public transport as an alternative for the use of the private car, one can mention a wider spread of travel times, a higher value of time and a high level of reliability as important requirements of the customer choosing between public transport and the use of a private car. In this context DRT services have been introduced in different concepts to reduce the operational costs and to give the customers a transport offer with a higher flexibility answering their needs.

Here DRT becomes a vital level of the new public transport network. This revised network comprises four hierarchical levels of transport services. The first two levels offer a straight and fast connection between major cities and regional towns, the third level concerns the city transportation. The lowest level provides the local and rural services, preferably served by demand, acting as structural feeder services to the higher level of public transport.

### **7.2.3 Organisational aspects**

DRT services are organised by De Lijn according to different concepts. Some replace existing regular services, some were introduced in addition to an existing public transport network. All services follow some general principles. Customers have to make a reservation for a trip a minimum of one hour in advance. This is done by phone: an operator will discuss with the customer the possibility and make the booking. In practice operators also allow last-minute bookings. The DRT buses serve stops. These stops are presented in clear information brochures to the customers and are indicated in the street with a stop signpost.

One of the typical DRT services is organised around Veurne. Here around 80 possible stops are served in an area of 140 km<sup>2</sup>. The railway station in the city of Veurne is the starting and arrival point of every vehicle journey. Here the bus also has a predefined time to group the customer trips and to allow connection to the train. Before the introduction of the DRT service two regular lines with an interval of 2 hours were operated to connect the small villages with the city of Veurne. Now 1 vehicle provides a similar service with a frequency of 1 ride per hour. This benefits the company as well as the customer. Only the requested stops are served with the shortest route between these stops.

Another typical concept is the public transport network between some cities in the province of Limburg (Figure 7.5). Here we have high speed lines on the main axes between the cities. DRT services are feeder lines to some connection points of the main lines. This concept replaces the previous regular lines connecting the small villages with one of the cities. The transfer point is the kernel element, because the customer now has to change. But for this extra effort he receives a higher frequency, an assurance he will be picked up and a wider number of destinations in shorter time. For the company less vehicles are necessary for this organisation.

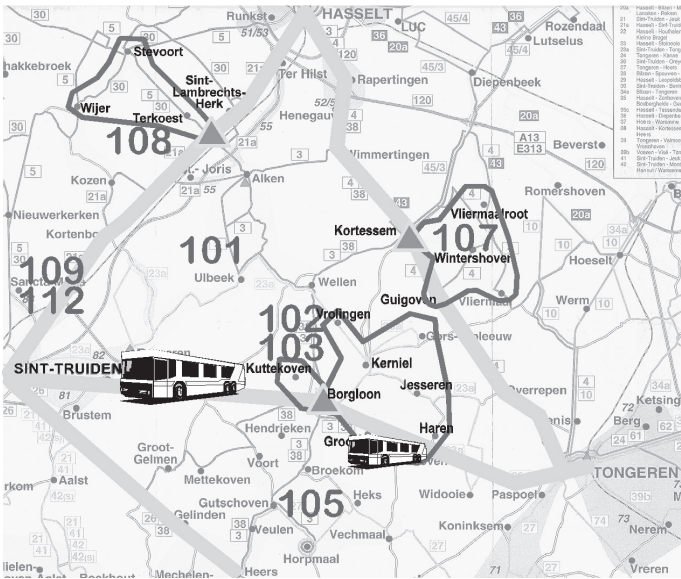


Figure 7.5:  
**New organisational concept  
 in Limburg: DRT as feeder  
 to high speed lines**

Subsequently De Lijn have launched a DRT service during some time periods in the city of Hasselt. During the day 7 regular urban lines serve the whole urban area. However in the evening and night the demand is too low to maintain this. Now 3 DRT lines serve the whole city area serving only the requested stops with similar frequency as before.

In general it is observed that the introduction of DRT services has not interrupted the on-going process: less clients - lower offer - less clients. Services are organised at lower driver and vehicle costs better answering the customer demands.

#### 7.2.4 A telematics system to manage DRT services

In practice, the service is organised as following: the areas in which the DRT is performed are known by the inhabitants, as well as the stops. The customer expresses his specific trip demand to the operator, which for the moment happens by phone. The customer's request is processed in real-time, replying to him with an accurate pick-up and delivery time, determined by previous bookings and conditions on flexibility and directness of the vehicle's route. As the service journey is completely determined by actual trip requests, complex algorithms and calculations are essential to obtain a most effective route, offering both a higher level of quality for the customer as well as a more efficient resource-spending to the transport provider.

When DRT is implemented on a large scale, this is only possible when the operator is supported by an on-line and effective system, providing an extended interface and automated service journey management. Furthermore, this system needs to prepare and



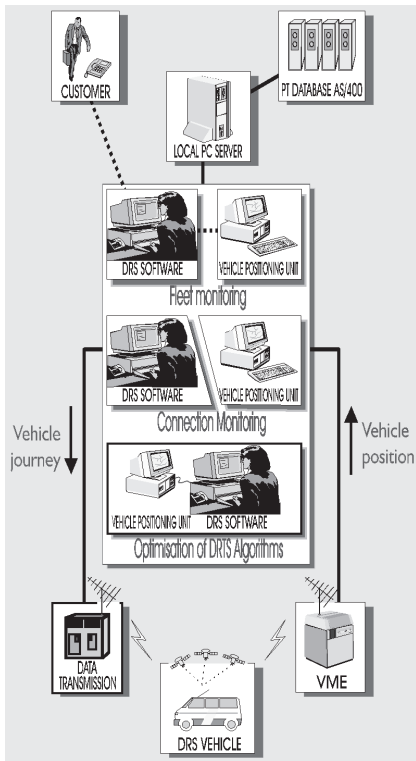


Figure 7.6: The DRTS technical concept

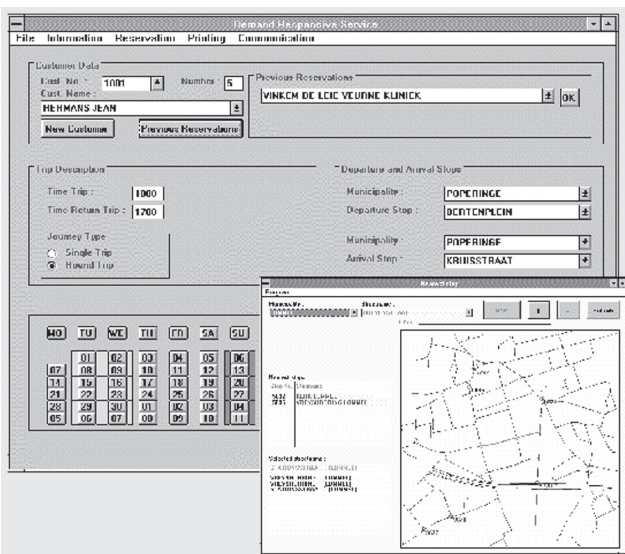


Figure 7.7: The RING input screens for handling bookings

manage the essential data transfer and communication to and from the DRT vehicle, as well as to control the actual and real-time operations of the services.

In the framework of two European DGXIII projects (PHOEBUS and SAMPO) De Lijn has developed such supportive DRT systems, based around an extensive software module, called “The Ring” (see also Section 4.2.2). This software includes all applications required to efficiently manage a demand responsive transport service as a base level in the public transport network (Figures 7.6 and 7.7). This includes modules for reservation handling, cancelling and modifying, as well as the provision of public transport information, the on-line processing of the service journey, registration of management information, preparation of data-communication and monitoring data, and more. As such, it links to other existing public transport technologies like the radio-communication of the AVL system, the general public transport Database on AS/400 and the fare collection system.

This allows an extension of the functionalities of DRT towards real-time control of connections with other public transport modes, possibilities of last-minute service schedule modifications, handling of on-board reservation and integration with a geographical information system. This automated DRT system runs under a familiar and user-friendly Windows environment, and is developed in a client-server relation, offering multiple operating facilities.

Current experiences with the operation of DRT in wider areas, clearly prove the value of this managing system and use of advanced telematic technologies in order to fully manage and overview this public transport concept.

### 7.3 The experience of Finland in Keski-Uusimaa

*P. Eloranta, A. Kalliomäki*

#### 7.3.1 Background

During the SAMPLUS project the local municipalities began to run the Keski-Uusimaa DRT (developed during SAMPO) and hired an operator to carry out the DRT tasks, both transport and TDC.

The aim of the SAMPO project was to establish test sites for Demand Responsive Transport (DRT) in five European Members States: Belgium, Finland, Italy, Sweden and Ireland, and to develop and test the state-of-art telematics tools required for DRT operations. In Finland there were two different test sites (the town of Seinäjoki in Western Finland and the Keski-Uusimaa region in southern Finland). In the SAMPLUS project the emphasis was on the further evaluation of the test sites. The test sites were in Belgium, Finland, Italy and Sweden. In SAMPLUS the Finnish test site was in Keski-Uusimaa, whereas the Seinäjoki test site continued nationally to full-scale use.

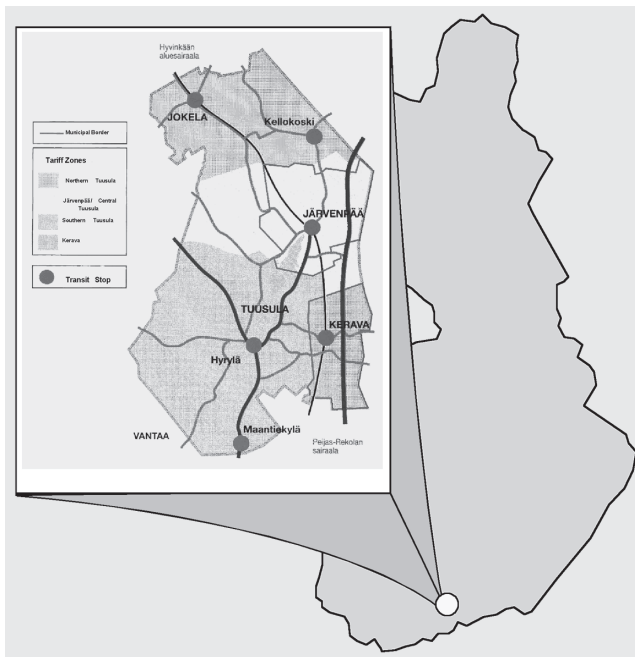


Figure 7.8:  
The Keski-Uusimaa Region

### 7.3.2 Site description

The Keski-Uusimaa DRT region comprises of three independent municipalities: Tuusula, Järvenpää and Kerava. These municipalities differ from each other when it comes to area and population density. The area of the Municipality of Tuusula is 225 km<sup>2</sup>, the population 33,000 inhabitants and the population density 142/km<sup>2</sup>. The area of the town of Järvenpää is 40 km<sup>2</sup>, the population 36,000 inhabitants and the population density 900/km<sup>2</sup>. The area of the town of Kerava is 31 km<sup>2</sup>, the population 31,000 inhabitants and the population density 1,000/km<sup>2</sup>. Thus the total area is 296 km<sup>2</sup>, population 100,000 inhabitants and the population density 334/km<sup>2</sup>. Figure 7.8 shows the Keski-Uusimaa area, some 25 km north of the Helsinki Metropolitan area.

The region incorporates all the 'conventional' modes of public transport: taxi, bus, train and so-called invataxi (e.g. minibuses with special equipment for mobility impaired persons). The main national railway runs through the test site area (south-north) and has an important role especially for commuting trips to or from Helsinki.

There are eight private bus companies of five private bus concerns with over 100 buses operating in the Keski-Uusimaa region. Most of the bus operations are self-supporting, i.e. the operators receive no subsidy from the authorities, but cover the operation costs with the fare box revenue. The regular public transport covers the population centres of Keski-Uusimaa quite well and there are public transport corridors elsewhere in the region. In the Keski-Uusimaa region there are some 100 private taxis sharing the ownership of a computerised taxi dispatch centre for a larger area with some 800 taxis.

### 7.3.3 Results

Because of the interesting and encouraging results of the SAMPO project, the Finnish Ministry of Transport and Communications decided to support and finance the extension of the SAMPO DRT pilot until the spring of 1998.

From June 1998 the three municipalities took responsibility for the area-wide DRT system and started to integrate the DRT services with regular public transport services. The present contract lasts until end of year 2004. From the beginning of the SAMPO demonstration the DRT pilot had its own dispatch centre. From 1997 until spring 1998 it was located in the town of Jyväskylä some 200 km north from Keski-Uusimaa and was also used for the Seinäjoki test site. The dispatching and fleet management system for the DRT operations in the Jyväskylä TDC (Travel Dispatch Centre) was provided by Mobisoft Ltd (see Section 4.2.4).

From the beginning of June 1998 the Keski-Uusimaa TDC was moved from Jyväskylä to Hyrylä in the middle of the Keski-Uusimaa region and new premises were opened in the spring of year 2000. In the Hyrylä TDC there were and still are several dispatchers using a computerised travel dispatch system and communications systems for the mes-



Figure 7.9: The Modules of the dispatching and fleet management system

sages to and from the DRT vehicles as their everyday tools. The new TDC also serves the neighbouring municipality Nurmijärvi (33,000 inhabitants, area 362 km<sup>2</sup> and population density 91/km<sup>2</sup>) where the full DRT services were introduced from 1<sup>st</sup> January 2000. In the DRT vehicles there are different kinds of on-board units and other telematics equipment.

The DRT service is called SAMPO transport, and is provided by 5-6 low-floor minibuses, taxis (basically almost all 100 taxis in the area are available for DRT) and specially equipped invataxis. The DRT service was added to and integrated with the existing regular public transport, and basically no existing services were replaced in Keski-Uusimaa. On the contrary in Nurmijärvi, in running a separate DRT, many internal local lines were shut down and the demand was served with DRT. The timetables for the regular public transport are stored in the databases of the telematic DRT system, and the passengers are advised in the first instance to use the existing public transport connections and routes, i.e. no DRT service is possible and will take place if there is a suitable regular line connection. This is due to the existing Finnish public transport legislation where it is not permitted to violate the existing public transport services.

In principle DRT operates from stop to stop. For the ordinary users the traffic is from a predefined stop to a predefined stop. For the eligible persons the transport is from

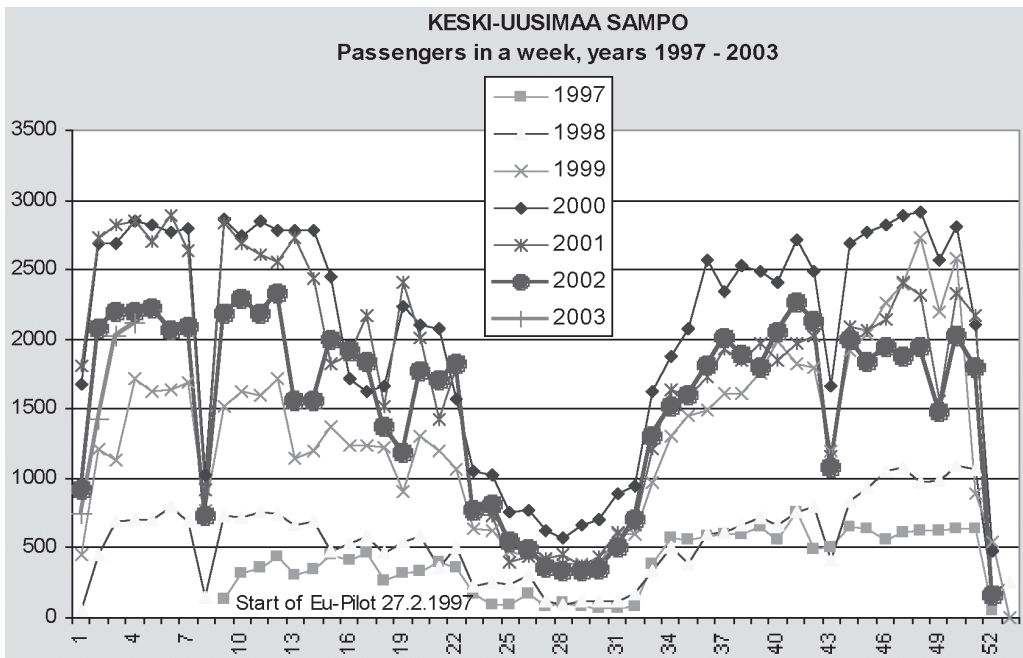


Figure 7.10: SAMPO customers between 1997 and 2003

door to door. The DRT service has been a real success in the Keski-Uusimaa area. The number of users increased continuously and the DRT service has found its place as an essential part of the public transport service in Keski-Uusimaa. The town of Järvenpää conducted a test and replaced almost all internal public transport lines with a modification of the Keski-Uusimaa's SAMPO system (URBANA) at the end of November 1999. URBANA used the same TDC as the SAMPO system and the services were integrated. The citizens did not like the idea of no permanent line in town, and Järvenpää again runs a mixture of permanent lines and SAMPO. At the beginning of 2000 the Municipality of Nurmijärvi, east from Tuusula, Kerava and Järvenpää, started a DRT service using the same TDC and under the same name (SAMPO). In addition to this the National Social Insurance Institution (KELA) has signed a trial contract with the DRT service providers.

The DRT ticket price in Keski-Uusimaa was 2.2 Euro at first and some 30% higher than in regular public transport, and was only approximately 20 to 25% of the taxi fare with the same trip. The municipalities later wanted to regulate (too rapidly) growing demand with the ticket price and there have been several adjustments of ticket price to higher levels. The new ticket price, 4.2 Euro starting 1<sup>st</sup> January 2001, is some 100 % higher than in regular public transport. The price elasticity was extremely low at the beginning, but had the expected result on demand after half a year (see Figure 7.10).

The municipalities enjoyed the expected savings in SAMPO, but on the other hand the social special transport costs grew much more than the savings in SAMPO. The reason was that the SAMPO tariff grew higher than the eligible special transport passengers' own share, which is legally restricted, and some of the previous SAMPO users returned to using taxis because it is cheaper for them but much more expensive for a municipality. The question is highly politically sensitive, and no final decision was reached during 2002. Customer attitudes towards fare levels are shown in Figure 7.11.

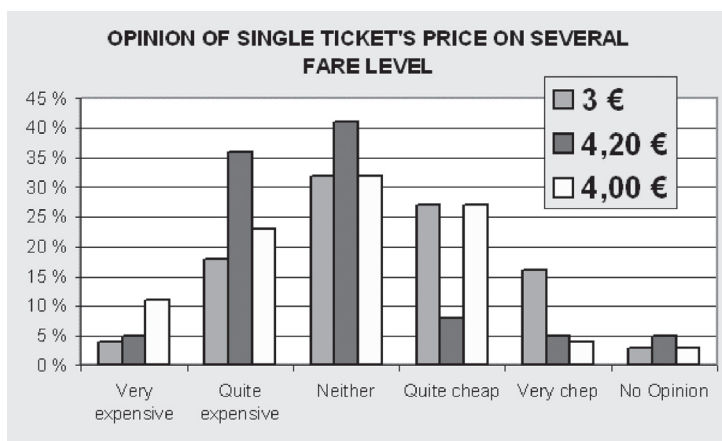


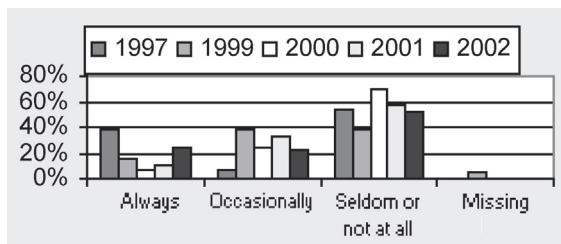
Figure 7.11: SAMPO DRT in Keski-Uusimaa. Passengers' opinion of ticket price. Three actual ticket prices in the year 1999, 2000 and 2002

The organisation of the present DRT is simple. There is an executive committee with representatives of each municipality, regional authority and operator. The National Social Insurance Institution has an expert's chair in the committee. The executive committee decides the relations between the municipalities and the operator. The operator invoices the municipalities directly. The contract consists of a basic fee including all the TDC work and estimated/pre-set amount of passengers. If the number of passengers is higher or lower than the yearly estimated/pre-set value, there will be an adjusting sum of money per passenger. The costs of one municipality depend on the share of trip origins and destinations within this municipality compared to all DRT trips. The same operator runs both the transport and TDC services. The contract is quite detailed but, with the consensus, the executive committee has quite large authorization to interpret the contract. The local taxi dispatch centre is a sub-contractor to the DRT operator.

The number of trips in 1999 was 66,000 and 80,000 in 2002. The highest was 106,000 in 2000. The average trip length within municipalities is 3 to 4 km. The average length of all trips is some 7.5 km. The reason for the growth is hospital trips outside Keski-Uusimaa. The cost of a SAMPO trip for the authority is some 8.8 Euro including the TDC services. The Tuusula municipality, a SAMPO municipality, buys

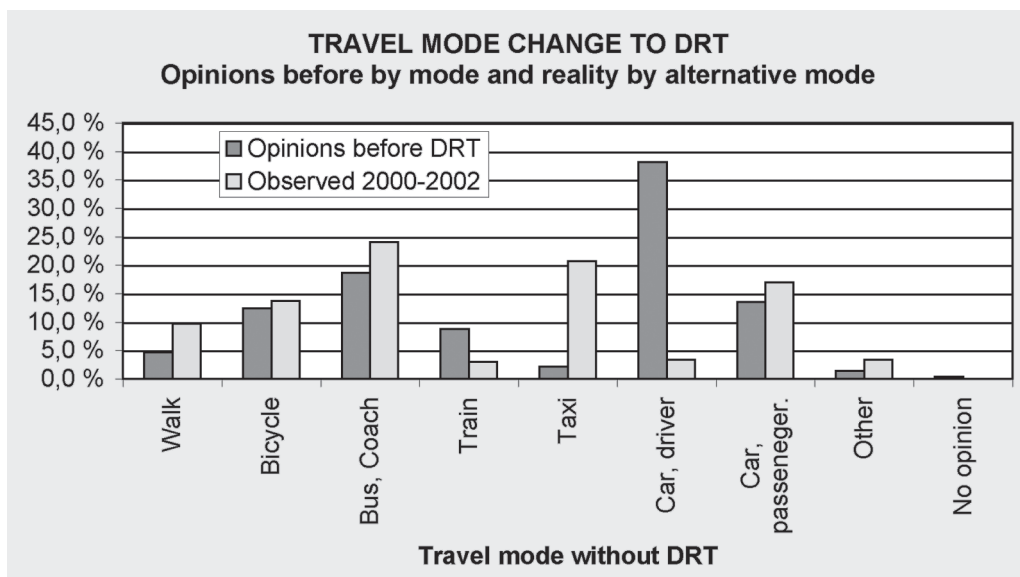
some local line and timetable-based services. The average cost for them is some 7 Euro per one trip. In this sense the SAMPO DRT is not expensive, because SAMPO serves low demand areas and directions.

DRT has gradually become the travel mode of non-car owners. Figure 7.12 shows car availability of passengers from 1997 and Figure 7.13 shows how attitudes towards mode change and observed practice before and after DRT.



◀ Figure 7.12: Car availability of SAMPO passengers

▼ Figure 7.13: Estimated observed mode change to DRT



The Keski-Uusimaa SAMPO serves from stop to stop. Disabled persons are eligible for door-to-door transport (some 20% of all trips). This is the main reason for the fact that only 60% of passengers boarding and alighting are at ordinary stops, 15% are at home 10% at agreed locations and the rest at schools, day care centres, hospitals etc.

The alternative mode for SAMPO DRT trips is walking or bicycle (25%), regular bus (22%), taxi (20%, of which approximately 50% is paid by the authority), car passenger (15%), no trip at all (15%) and some other (3%). Further details are given in Figure 7.14.

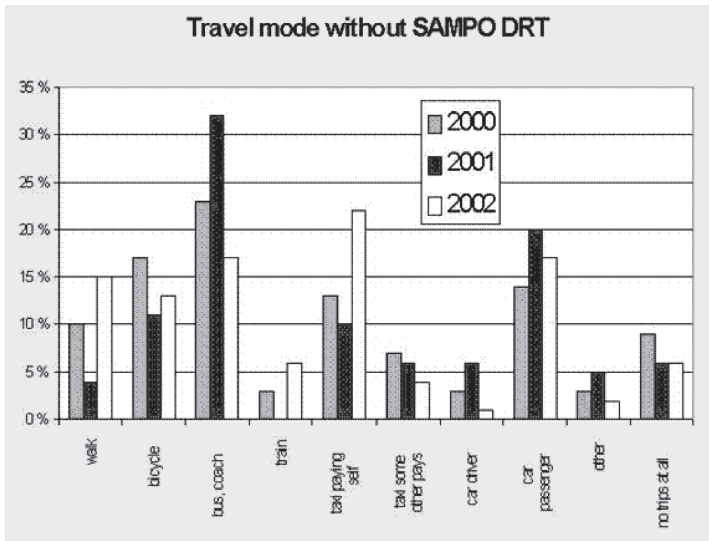


Figure 7.14: Supposed choice of travel mode in case there would be no DRT

With SAMPO transport 60-70% of passengers are women. The age of passengers varies. The age groups 15-30, 46-60 and over 60 are quite equal, some 25%. The 0-15 age group is some 10%. The monthly variation of SAMPO trips equals the monthly variation of local regular public transport trips. In the beginning the summer decline was much deeper than in local regular public transport trips.

The DRT service guarantees equal possibilities for each citizen to utilise the public transport services in the Keski-Uusimaa region. This includes most disabled and elderly persons. Thus the development of the DRT services has followed both the objectives of the Common European Transport Policy and the suggestions and guidelines of the EC's Green Book, *'The Citizen's Network'*.

In Keski-Uusimaa it is possible to travel to each direction within the region with DRT. This is something that the regular public transport is not capable of offering with reasonable cost. At the same time the costs of special transport, which as prescribed by law in Finland, are the responsibility the municipalities, have decreased except after manipulating of the tariff. The reduction of special transport costs covered all authority costs for DRT when the tariff was lower than passengers own share and after the new tariff level we know that the savings were quite a lot greater than the authority costs.

The concepts and systems for special transport have been diverse and expensive. The money spent in social and health care sectors both at the local and the nation wide level in personal transport is remarkable, but not very big when compared to other social and health care expenses. The logistical way of thinking is not familiar among the social and health care administrations and the political pressure for individual trips in taxis can be extremely high.



In the DRT system description there is one primary question - whether the TDC is a separate body, or not. If the TDC is a separate body, the tendering process of the DRT service is much easier. On the other hand, the documents for the TDC tenders are difficult. The system description must be very detailed and the system must have elements, which guide the TDC operations to be as effective transport services as possible. Especially important is the description of the co-operation between the TDC and the DRT vehicles, because the smooth running in this layer enables proper transport of the passengers. If the TDC and the transport of the passengers are included in one tender, the demand for effective transport is easy to describe, but there may be no or only one potential contractor (see Chapter 8). This may lead to a too high contract price.

The need and demand of very sophisticated telematics solutions is quite small, if the number of DRT trips per day stays on the level of one hundred or less. With very experienced personnel even over two hundred passengers per day are possible if the pre-booking time is one hour or more. With shorter pre-booking time the capacity of pen and notebook system is lower. After that the need for a real TDC software and automated telecommunications emerges. The TDC software must guide the dispatcher to define the right locations of the origin and the destination of the passenger's journey. The software must make suggestions of routes and count the passengers. Automated connections to vehicles are important to diminish the TDC costs. An automated booking system is desirable. Internet may be the right solution. The bookings in the vehicles require sophisticated and expensive equipment and telecommunications. The real challenge and difficulty may be the co-operation with regular public transport.

The experiences of the DRT contract show that there is no good general contract model for the (Finnish type) DRT service. The institutional problems are the most important and of highest priority in the contract. Deep understanding of DRT, its content and service dimensions, is necessary to make a good contract. All partners must be ready for fine-tunings, if/when needed, during the DRT operations. In this case the legal content has a secondary role. The political time perspective in local politics is quite short. Therefore the political support must be earned beforehand with quite concrete visions and economy arguments. Afterwards a good DRT system markets and sells itself.

In information provision, the most effective way is from person to person, either good or bad. Therefore the low error level in DRT is very important. The general information is a start only. The user group and category specific information is a must for many groups, especially for the authorities, the disabled and the elderly. Juridical, institutional and organisational issues are hard to find and to handle. With DRT difficult juridical problems may emerge, because of the new nature of the mode. These kinds of difficult issues and questions may come from other public transport operators, from unions, from social and health care legislation etc.

DRT is expensive per passenger trip compared to the regular public transport in general, but not expensive at all, when compared to regular lines in same conditions. Because of the TDC and less efficient (smaller) vehicles DRT will never be as cheap per passenger trip as the regular public transport in densely populated areas, with high patronage levels, and on main routes with large passenger flows. On the other hand the open-for-all DRT services bring the equality of public transport for everybody with quite moderate costs, including most of the disabled and the elderly. This is not possible with regular public transport.

## **7.4 The Rural LIFT Experience in Ireland**

*M. Kennedy Grimes*

### **7.4.1 Description of the project**

Rural LIFT, a Community Connections sponsored rural transport project serving North Leitrim and West Cavan was selected as the Irish feasibility site for the study of telematics-based DRT in Ireland during SAMPLUS. Community Connections is a cross border community development project operating in West Cavan, West Fermanagh and North Leitrim. The Project was established in 1991 with the aim of facilitating community development through the participation of local people in the development of their communities. Community Connections formed the Transport Working Group in October 1995 in recognition of the fact that the lack of publicly accessible transport is a major hindrance to any social, economic, or personal development.

As a result, careful investigation into the specific needs of the area has taken place and a suitable transport project has been developed. The Rural LIFT transport project was established and designed to build on existing transport services and resources by investigating the potential for new transport services and changes to existing provisions in order to meet the needs of the people and communities within the area.

A detailed User Needs Analysis (as described in Chapter 1) showed a clear need for new transportation services, and identified a number of specific routes. As one of four SAMPLUS feasibility sites, Rural LIFT, along with projects in Finland and the UK were able to develop solutions and implement plans based on this research.

### **7.4.2 Description of the site**

The area of remit covers 1,500 square kilometres with a population of 21,000. The population density for the area is 14 people per sq. kilometre compared with the national average of 52. 20% of the population is over the age of 65 years. 33.7% of the households do not own a car; that is 10.2% higher than other border regions (statistical

data provided by Co-operation and Working Together – CAWT – based on the last census).

The area demonstrates a high level of migration, especially in the 15-24 age group, which suggests the need to move away to obtain employment. As a result, people become more isolated from their neighbours, services decline, dependency ratios increase, the number of elderly people increase and community activity falters as a result of apathy, loss of confidence and difficulty of attracting and retaining members (Community Connections, Proposal for local Transport Co-ordination Project, 1998).

The area has poor soil and difficult terrain and is a marginal agricultural area. While the area is difficult for farming there has traditionally been a heavy dependence on agriculture. The largest town in the area is Manorhamilton, in Co. Leitrim with a population of approximately 1,000 (Programme for Peace & Reconciliation, Case Study, 2000).

Depopulation has been a major factor in this region, especially in the 1970s and 1980s. The area has experienced dispersed rural population, emigration, over dependence on agriculture, inadequate infrastructure and a lack of services. For people living outside towns, rural social exclusion is dispersed, individualised and often invisible. It lies hidden, disguised and compounded by depopulation, unemployment and under-employment, poor infrastructure, especially transport and inadequate and declining access to services (The National Economic and Social Forum, 1997).

The extreme rural nature of the area has compounded several factors including its border location, poor quality transport infrastructure, the fact that the area covers three counties and two jurisdictions. The border presence runs through the region and has had a negative impact on the community during the last four decades due to road closures and security threats.

As a Community Development organisation, the following target groups have been established:

- older persons
- lone parents
- disadvantaged youth
- people in the home without access to a car
- long-term unemployed.

The Rural LIFT Transport Working Group management committee contains representatives from relevant groups: local development groups, County Leitrim and County Cavan Partnerships and the County Development Boards in County Cavan and County Leitrim, women's groups, Bus Eireann (Irish National Bus Company), Translink (Northern Irish National Bus Company), the North Western Health Board, community groups and private bus operators represented by the Federation of Transport Operators (FOTO) and Private Association of Motor Bus Operators (PAMBO).

### **7.4.3 Operational services**

Establishing new routes proved to be a complex and time consuming process. New routes were designed to improve access to transport and link into existing services. The new routes were then put out to tender and all local operators were invited to apply. Contracts were then entered into with four local bus owners to operate the routes. Rural LIFT administered the application process for licensing the routes through the Department of Public Enterprise. It has also assisted the operators in applying for acceptance to the free travel scheme through the Department of Social, Community and Family Affairs.

Currently, the project operates 6 licensed demand responsive routes. These routes follow a set pattern with set meeting points along with a demand responsive element which allows for deviations to pick up passengers who have called in to request a pick up a short distance from the main route. Based on survey information, the routes were established as mid-day routes which would bring passengers from outlying areas into local villages to avail of basic services or into towns to connect with the national bus service. These six routes each operate one day a week (one route operates two days per week during the summer months). An additional four routes have obtained approval for licenses.

Bookings for each of the routes are made by contacting the travel dispatch centre or by calling the private route operator directly. Passengers are requested to make their bookings by 4:30pm the evening before travel for five of the routes, and for the sixth route, bookings must be made no later than one hour before the start of the route. In certain cases, late bookings have been accepted however, this is not encouraged as it would disrupt the pattern established by the operators.

### **7.4.4 Resources involved**

The Rural LIFT project made a decision to utilise current infrastructure and local expertise in establishing the operation of routes. Within the area of remit, eighteen private bus operators were queried regarding the prospect of working with the community development project and establishing a rural transport project. Most of these operators are part-time farmers and part-time bus operators. Therefore, it was decided to utilise available buses and drivers to progress the project. The operators held varying degrees of scepticism regarding the viability of routes. Four operators were willing to contract with Rural LIFT to operate routes provided there was a minimum guarantee for the route. Contracts were entered setting forth the details of payments for the guaranteed amount less passenger fares.

162 The bookings made through the TDC are made during regular business hours of 9:30am – 5:00pm. The project began in February 1999 with one full-time staff member

and one part-time administrative worker. Due to financial uncertainty, the project has operated with only one staff person since June 2000. As each of the routes has stabilised, operators are able to operate by block bookings made by passengers who then only need to phone if they are not planning to ride the bus on a particular day.

Members of the Rural LIFT Transport Working Group management committee have been instrumental in continuing to keep the project at the forefront of many community projects throughout the area.

#### ***7.4.5 Operators and the role of the local authority***

By utilising private operators, the project was able to avoid expenditure for buses, insurance, diesel, and mechanical upkeep. Local knowledge possessed by local operators can not be overlooked. Many of these operators have a great knowledge of the passengers and the remote areas in which they live. This local knowledge has proved to be a great resource to the project.

Managers from the regional offices of the national bus companies for Ireland and Northern Ireland are members of the management committee for the project. Members of the local County Partnership, County Development Boards and County Councils are also members of the management committee for the Rural LIFT project. The local County Partnerships have provided small amounts of funding to assist with route subsidies and overheads.

#### ***7.4.6 Technologies used***

A basic Excel spreadsheet was designed to handle bookings for each of the routes. Due to the rural nature of the area, it was necessary for the TDC to acquire detailed Ordnance Survey maps to cover each route so households could be pinpointed by the TDC and appropriate information passed along to the operators. Computerised mapping of the area was not available at the start of the project; therefore, very basic procedures were implemented and have been used.

The project looked at several computer programme packages that could be of use in booking, mapping, report preparation and invoicing, however the level and scale of the project could not justify the expense.

Although the TDC has a phone answering system where people can leave messages regarding their bookings, this has not become a strong means of booking. People in the service area prefer to speak with staff or the operator directly and are inhibited by a message machine on the phone.

A test was conducted with mobile phones on buses to determine if there was sufficient coverage to allow for late bookings and requests, however, due to the terrain of the area this was not feasible.

### 7.4.7 Results

The project operated six routes during the year 2000. Four of these routes operated the full twelve months, while two were launched during the year. A total of 4,236 journeys were taken on the Rural LIFT routes during 2000. Of those journeys, 2,546 were free travel pass holders.

At the moment, the Rural LIFT project recognises and accepts the Free Travel Pass (FTP) which is issued by the Department of Social, Community and Family Affairs to pensioners and disabled persons. The application process to receive reimbursement for these journeys has taken over nine months. Rural LIFT has assisted the route operators with these applications, however, due to length of time taken for approval of a 70% reimbursement, the Rural LIFT project in effect subsidised the full costs of the 2,546 journeys (see Table 7.2).

Route	Passenger Journeys	Revenue Received (£)	Subsidy made to operators (£)	Portion of Subsidy linked to FTP (£)
Glangevlin to Blacklion	680	544	3,723	1,124
Drumkeeran to Sligo	922	666	1,455	1,028
Rossinver to Manorhamilton	628	122	1,153	514
Dromahair to Sligo	1270	1,336	1,222	788
Glangevlin to Carrick-on-Shannon (Apr-Dec)	282	152	2,504	888
Drumkeeran to Carrick-on-Shannon (Jul-Dec)	454	160	844	712
	4,236	2,980	10,901	5,054

Table 7.2: Rural LIFT project results (2000)

In addition to project funding received from the Programme for Peace and Reconciliation, the County Leitrim Partnership contributed £7,500 to the project during the period 1999-2000 and the County Cavan Partnership contributed £2,000 to the project during the same period 2000.

## 7.5 The experience of ATAF with PERSONALBUS™ in Florence

*N. di Volo, C. Binazzi, F. Pettinelli, M. Talluri*

### 7.5.1 Introduction

PERSONALBUS™ is the Demand Responsive Transport (DRT) system developed by ATAF (Public Transport Company of the Florence metropolitan area) for the planning and management of different flexible services in low-demand areas and non-peak hours and for special users groups (disabled, elderly etc.).

The system has been developed by ATAF (Florence), MEMEX Srl (Livorno) and SOFTECO SISMAT SpA (Genova), with funding provided by European and Italian R&D Projects (SAMPO/SAMPLUS – DGXIII, PFT2 - CNR etc.) in partnership with other European towns and companies (Finnish Ministry of Transport, Flemish Transport Company De Lijn, City of Gothenburg), and by ATAF itself together with its technical partner (SOFTECO SISMAT SpA).

An important role in the development of the DRT system has also been played by the Municipality of Campi Bisenzio, which has been the test bed for the service experiments. Campi was selected due to the characteristics of its territory and the typology of mobility demand which is particularly suitable for the introduction of a DRT service.

<b>PERSONALBUS™ in Campi</b>	
Service area	Campi Bisenzio town
Surface	28,62 km <sup>2</sup>
Inhabitants Campi	35,757 (63% of passengers live in Campi)
Inhabitants Florence	380,070 (31% of passengers live in Florence)
Density	1,262 inhabitants/km <sup>2</sup>
Characteristics of the territory	<p>Campi Bisenzio is a rural town in the north-west suburbs of Florence. The district of Campi covers an area of 28,62 km<sup>2</sup>, with more than 36,000 inhabitants and a density of about 1,262 inhabitants/km<sup>2</sup>. It is located in a key position inside the “Piana Fiorentina”, that is the metropolitan area between Firenze and Prato. Campi Bisenzio is characterised by an historical centre with a high density of population, and by many other urban centres far from the city centre, mainly along the following two roads: to the south, the Via Pistoiese, where there are the areas of S. Donnino, San Piero a Ponti and S. Angelo a Lecore, to the north – next to the the towns of Prato and Calenzano – where the industrial and commercial area is also located.</p> <p>In the south area there are a high number of handicraft activities and small industries (especially for leather and straw), where a big chinese community has recently been established. Many of the main Florence industries (each one with more than 300 employed), such as GKN, Galileo, Società Autostrade, Manetti &amp; Roberts, etc. are located here. In 1997 the commercial centre ‘I Gigli’ (more than 130 shops) opened and is currently the biggest in Italy.</p> <p>From the point of view of transport services, Campi Bisenzio has two main bus lines from/to the centre of Florence (S. Maria Novella railway station), operated with 18 m buses: line 30, along the via Lucchese, joining the historical centre, and line 35, that runs along the Via Pistoiese, joining the other main urban areas (S.Donnino, S. Piero a Ponti, Indicator). The Sesto Fiorentino railway station provides the railway service both for short and long distance movements, through the connection with long-distance trains at the Santa Maria Novella station.</p>
Operator	ATAF
Type of services	On request (off-line and on-line requests) from 06.30 to 20.00
Passengers transported in 1999	95,000
Number and type of vehicles	5 minibuses (7-8 m type Cacciamali, Bredamenarini, Pollicino minibuses)

Table 7.3: Characteristics of the DRT service in Campi Bisenzio

Today PERSONALBUS™ has reached a very high level of reliability and fully manages the following services:

- Disabled service throughout the whole Florence area
- DRT in Porta Romana (zone inside the Florence municipality)
- DRT service throughout the whole “Piana Fiorentina” metropolitan area (towns of Campi Bisenzio, Calenzano, Sesto Fiorentino)
- DRT service in Scandicci town.

Table 7.3 shows the main characteristics of the DRT system of Campi Bisenzio.

### **7.5.2 History of PERSONALBUS™**

ATAF's experience with flexible services started in 1995 with the management of the disabled service, operated with 5 minibuses in the entire Florence network from 07.00 to 20.00; at the beginning the service was planned and managed manually.

The PERSONALBUS™ service was introduced in June 1997 with the SAMPO project, and since September 14th 1998, under SAMPLUS, it has been extended to the entire area of Campi, and now it has a total number of 175 meeting points: Campi has thus become the first town in Europe to be completely covered by a service on-demand (see Figure 7.15).

Since the year 2000, after the great success of the service in Campi, PERSONALBUS™ has been extended to some of the most relevant areas of the Florence metropolitan area (Scandicci - May 2000, Calenzano and Sesto Fiorentino - December 2000).

In the following a brief history of the evolution of the PERSONALBUS™ service is given.

#### *The service in Campi Bisenzio*

Before the introduction of PERSONALBUS™, public transport in Campi was based on a traditional line service:

- lines 30 and 35 from the historical centre and the main urban centres of Campi (S. Donnino, S. Piero a Ponti, Indicatore) to the centre of Florence
- local public transport services in the industrial zones (north-west of Campi)
- “transversal” lines 50 and 51 in the metropolitan area between Campi and Sesto (the “Piana”)
- circular line inside the area of Campi (line 60), with 60 minutes headway
- railway service at the Sesto Fiorentino station.

With the introduction of the service on-demand a general restoration of the public transport lines in Campi has occurred:

- introduction of specific shuttle lines from/to the industrial area to the connection with lines 30 and 35 and the railway service



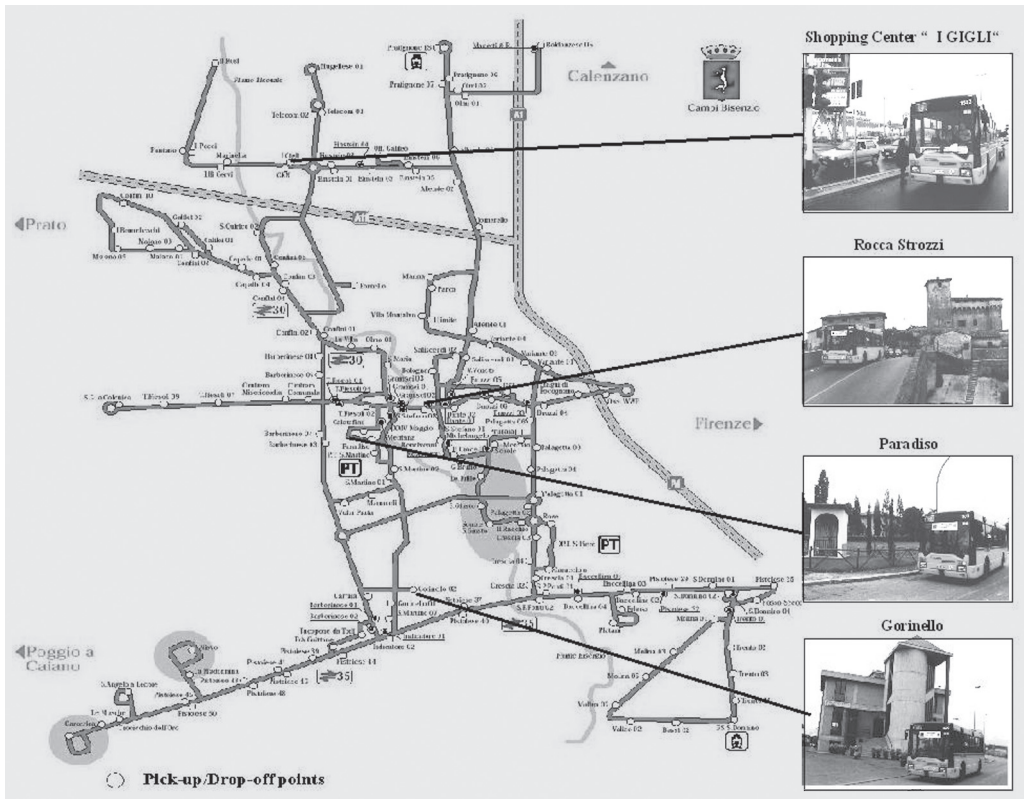


Figure 7.15: Map of the PERSONALBUS™ service in Campi Bisenzio

- reorganisation of the transversal lines in the area of the Piana, that also involved the Prato public transport company (CAP)
- line 60 has been removed and completely substituted by the DRT service.

The introduction of the service has been continuously monitored, both from the technical point of view and in terms of number of passengers and users satisfaction, by means of interviews and other surveys.

The development and the success of the introduction of the DRT service has also taken advantage of the characteristics of Campi Bisenzio, where there has been a big expansion in the number of residents and industries in the last decade. With correct town planning and new infrastructures the area is particularly fitting for a DRT service:

- most of the trips are quite short
- there is a relevant percentage of erratic movements
- some areas of Campi can not be reached with a traditional service due to the road characteristics (narrow, poor pavements, ...)

- in the area of Campi there was already a typology of DRT service for disabled users, so the town was already prepared for it.

The correct design and planning phase of PERSONALBUS™ has also been possible and mainly thanks to the strong technical and political co-operation between local authorities, users and the public transport company.

Before the introduction of the service, a complete Origin/Destination survey was completed for the whole area of Campi in order to identify both the current and the potential users, together with other information on the mobility needs of different target categories. In order to design an optimal public transport network, together with users' surveys, a complete recognition of the characteristics of the road network of Campi has been completed in order to identify the most appropriate typology of buses for every portion of the network itself.

Other important aspects taken into account have been the most relevant attraction centres, such as the main industrial and commercial areas ("I Gigli" etc.) and the main parking areas. A particular attention has been put on the service accessibility, both improving the conditions of streets and footpaths in the bus stop zones, and operating low-floor vehicles that can also accommodate disabled users.

From September 14<sup>th</sup> 1998 the service has been extended to the whole area of Campi Bisenzio, so that the network potentially covers each Origin/Destination need inside this territory.

#### *Legal issues*

Since the introduction of PERSONALBUS™ the definition of the institutional and legal aspects of the service has been one of the most relevant issues to be faced, since no specific standards existed for this kind of service.

The contract for the service definition between the public transport company and the P.A. has been defined on the basis of the number of kilometres run by the service, i.e. in the same way as the traditional line service. The reference parameter for the preventive calculation of the amount of kilometres is the service of the previous year: this is not correct, and most of all represents a significant limit on the developments of a DRT service inside one year, since the most relevant parameters to define a DRT service should be the network extension (km and number of stops/meeting points) and the service hours.

Another important question to be solved has been the concession of the legal permission of operating a service not based on a fixed route, but on a set of possible routes, so that the new typology of permission has been given on the basis of the set of potential paths inside the ATAF network, according to the typology of buses and the related safety of circulation. On the basis of the experience acquired in the recent years of DRT services, new standards are under study in order to solve the existing gaps.

### 7.5.3 DRT service concept in Florence

Demand Responsive Transport (DRT) Services are a “flexible” approach to the issues of public transport services, intermediate between the taxi and the conventional bus service. They usually operate with small-size buses on flexible paths and schedules, basing their route choice on the users’ requests.

Given their flexibility, they are suitable to serve non-systematic customers (for non-peak hours, low-demand zones, airport connections etc.), users with mobility impairments (elderly, disabled) and areas not reachable by the ordinary bus service. These factors contribute to give a social role to this kind of services. The flexibility in the organisation of DRT can be very different, according to the needs of users and of the service provider. From the point of view of the service provision, one can identify four generic concepts, describing the organisation of public transport in terms of increasing level of flexibility, from the ordinary line service to the most advanced and flexible types of DRT:

- predefined timetable and route: the service reaches predefined stops with predefined passing times;
- partially predefined timetable and route with deviations to predefined stops: the service can reach predefined stops on demand, with small deviations from the ordinary path;
- stops in a region: the service can reach a set of predefined stops on demand, in a predefined zone, maintaining eventual predefined departure/arrival times;
- points in a region: the service doesn’t have any predefined stop, and can reach any origin/destination point in the chosen zone.

These concepts are the basis for the development process of the PERSONALBUS™ system. In this process designers and providers will have to take detail and conceptual choices especially concerning the flexibility allowed in the booking procedures and in the definition of the vehicle journey.

The system currently operated in Campi Bisenzio works with a “many-to-many” pattern in which any origin and destination within the service area is served by the vehicle fleet with variable timetables and routes fully built upon the users’ requests.

According to the concepts described above, the functional architecture of PERSONALBUS™ includes:

- *Management of DRT requests*: supporting the management of the entire cycle of collection and processing of customer requests;
- *Control of DRT operations*: supporting the DRT operations of control and management and activation of scheduled services and operation of the scheduling deviation based on vehicle communication;
- *Information on service to customers*: supporting the management of information provi-

sion to the customers while or after booking, waiting to be served on the services and the related modifications.

Based on the above functional capabilities, the operation of the PERSONALBUS™ service is organised in four different steps:

1. *User calling the TDC (trip booking)*

A user contacts the TDC (or directly the driver at the terminal) in order to book a trip. The user's requests are submitted to the TDC operators. The user has to specify the desired departure or arrival time and should specify the bus stop (meeting point) identification number for both pick-up and drop-off stops. The TDC is able to locate a suitable "near" bus stop if the user cannot identify one. Trips can be booked up to 30 minutes before the bus departure from the terminal.

2. *User requested parameters (pick-up/drop-off point, departure/arrival time)*

After the identification of customer journey parameters, the TDC operator has to input the data in the DRT planning and management server, in order to: (a) create a new trip or (b) modify the existing trips, and carry on the negotiation phase with the user.

3. *Service negotiation between the TDC operator and the user*

The TDC operator receives the possible trips meeting customer requirements with a tolerance in terms of (a) journey time and (b) routing, from the DRT planning and management server. The result of the negotiation phase is the acceptance/refusal by the users of one of the proposed trips.

4. *Confirmation, update and communication of trip variations to the driver*

Upon the user's acceptance, the TDC operator updates the DRTS trip database and communicates the trip variation to the driver by the AVL voice radio link.

The PERSONALBUS™ service is active every working day (including Saturday) from 06.30 to 19.30, while the toll-free number is active in the same days from 06.00 to 20.00. Figure 7.16 shows the physical architecture of PERSONALBUS™.

*Service organisation and management inside ATAF*

ATAF acts at two different levels in order to plan and manage the PERSONALBUS™ service:

- service planning, involvement of the sector of the company dedicated to the definition of the paths of the lines, timetables, drivers management;
- management and control of the technologies involved, by means of a specific office (MTT).

The resources involved in the daily provision of the DRT service are:

- 2 TDC operators (1 for the morning and 1 for the afternoon) from Monday to Saturday;

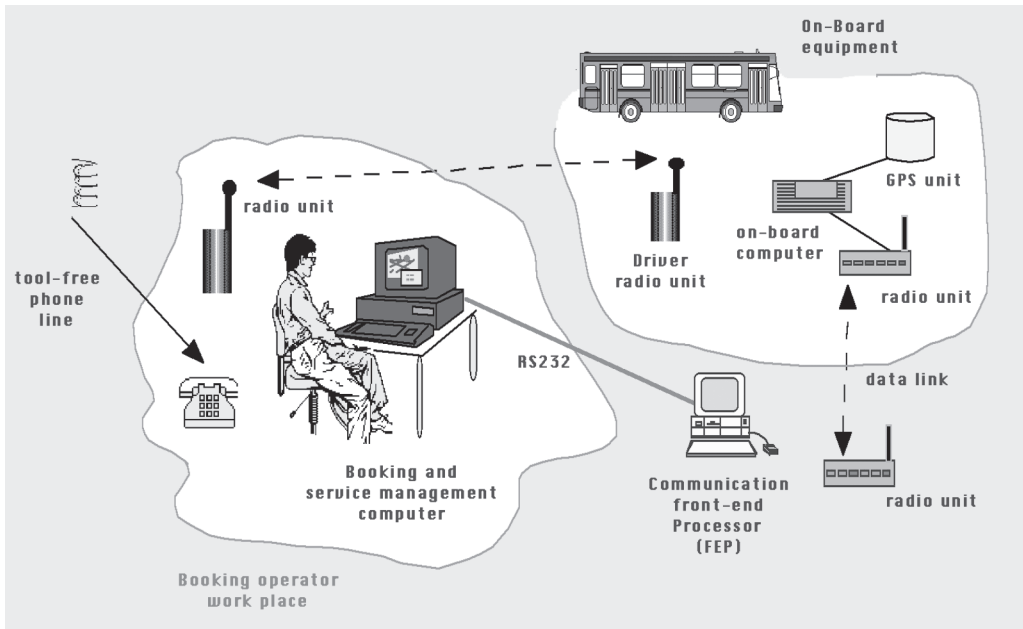


Figure 7.16: Scheme of the PERSONALBUS™ architecture

- 5 minibuses;
- 9 drivers from Monday to Friday (4 vehicles from 06.30 to 19.30 and one from 12.30 to 15.00);
- 6 drivers on Saturday (2 vehicles from 06.30 to 19.30 and one from 06.30 to 9.00 and from 12.30 to 15.00).

The operational costs for this typology of service are:

- TDC personnel
- Drivers
- Network maintenance (bus stops/meeting points, information panels, ...)
- Toll-free number for the service booking.

The additional costs compared to the regular service, in particular, are accounted for by the toll-free number and mostly by the TDC operators, even if this is compensated for by the fact that a single operator can operate on more than one zone (multi-zone operational environment).

#### *Functional characteristics of the system*

The planning phase must follow an optimisation process that can be classified on different levels; the key criteria involved for the resources optimisation process can be classified as follows:

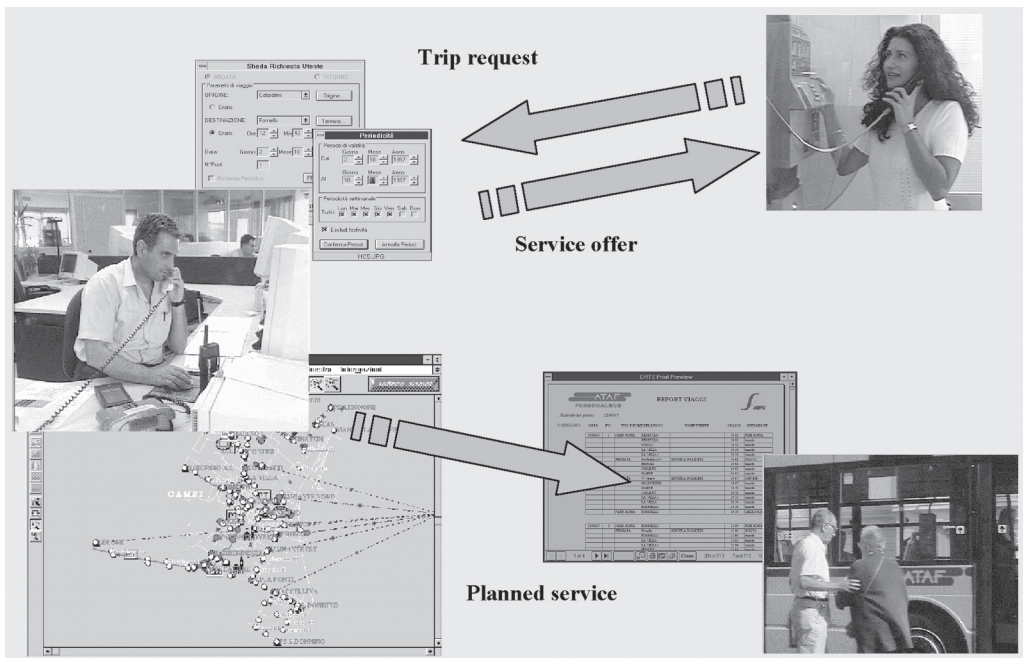


Figure 7.17: Operational scheme of the *PersonalBus™* Service

1.a *Resources:*

- number of vehicles
- vehicle type and capacity (e.g. 8 m, 12 m, ...)
- vehicle shifts (availability in time)

1.b *Network characteristics* (i.e. model):

- DRT bus stops (location)
- DRT bus parking areas (location, capacity)
- road network characteristics (road type – e.g. small buses, normal buses, allowed turnings at intersections – per bus type)

1.c *Planning and assignment parameters*

The following terms are defined further in Section 2.3.3.

- *DRT*: Direct Ride Time

The passenger ride time from origin to destination with no stop in between and via the shortest route

- *MRT*: Maximum Ride Time

The maximum passenger ride time allowed

- *WSP*: Widest Shift at Pickup Time

The maximum delay at pickup time allowed during planning

- *WSD*: Widest Shift at Delivery Time

The maximum early arrival at destination stop allowed during planning.

All these planning parameters have a relevant impact on the DRT service optimisation. The DRT schedule processing can be done on-line or off-line, after the collection of all the reservations.

For the Campi PERSONALBUS™ service the following parameters have been established:

$$MRT = 5' + 2 * DRT$$

$$WSP = 10'$$

$$WSD = 10'$$

In order to perform an adequate optimisation of service resources the provider must bear in mind the wishes and the demands of the customers and try to find the best compromise between the resources and the quality of the service, on the basis of the main following criteria:

- 2.a minimum number of vehicles used (for planning)
- 2.b minimum on-board time for passengers
- 2.c minimum cumulative difference between passenger requested times (at pick-up or drop-off) and planned times
- 2.d minimum travel time between stops (shortest route).

In the optimisation process a balance should be based on these criteria, meeting the different objectives of operators and customers. The main boundaries in PERSONALBUS™ are:

- for 2.a: *Two main objectives*:

- 1) To identify the minimum number of required vehicles (*minimisation of expenses*)
- 2) To keep spare vehicles to cope with additional demand in peak periods...

- for 2.b *The passenger comfort*.

### *Technologies*

PERSONALBUS™ has been implemented using state-of-the-art computer technologies and industrial standards: Geographic Information Systems (GIS), digital maps, Relational Data Bases and ODBC connectivity, multi-windows graphic environment.

As discussed in Section 4.2.3, the DRT software has been developed with the state-of-the-art of information technology and under widely known industrial standards:

- Microsoft Windows NT
- DBMS Oracle
- GIS MapInfo
- PC Pentium IV, 512 Mb Ram, 40 Gb Hd, 19" colour monitor (minimum resolution 1024x768).

#### 7.5.4 The results obtained

To date a number of analyses of the first years of DRT operations in Florence have been conducted to identify and quantify the major benefits to users and operator, by means of surveys, data sets collection and elaboration (see for example Mageean and Nelson, 2001). In order to ensure meaningful and consistent results the analysis presented here concentrates on the DRT application in Campi that is the most consolidated DRT experience available in Florence. In general the analysis indicates that the introduction of PERSONALBUS™ has brought substantial benefits, both to ATAF and to its customers.

Compared to the previous transit service structured on three fixed route lines serving only a small part of the built-up area, the DRT service offers the advantage of expanding the public transport service throughout the built up area of Campi and, consequently, increasing the amount of potential users thanks to its ability of connecting all the main origins/destinations inside the service area with flexible schemes according to users travel need. Furthermore the introduction of such an innovative and effective service also has a positive effect on the overall perception of the effectiveness of public transport, thus improving the relation between the company and its customers, with a related increase of the perceived “customers’ satisfaction”.

Two surveys covering issues of users’ perception, acceptance and attitudes to the PERSONALBUS™ service were carried out in 1998 and 2000 and confirm the positive trend shown during the first analysis.

As it can be seen in the following figure, according to the passengers’ opinion survey over seventy percent (77%) were satisfied or very satisfied with the new service provided, while only 6% of the respondents were dissatisfied or very dissatisfied.

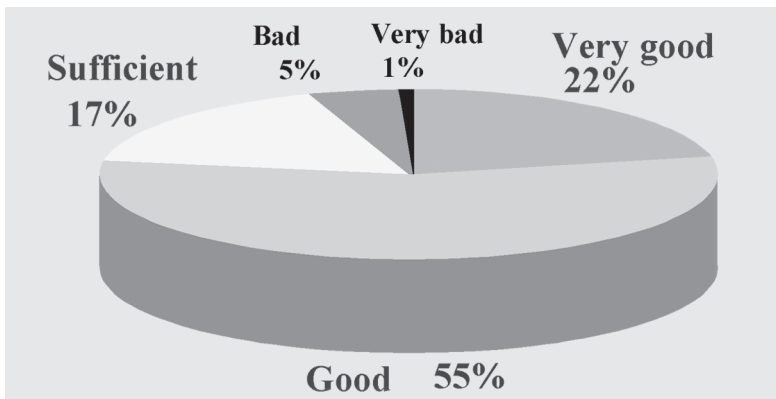


Figure 7.18:  
Passengers’ opinion  
on Campi Bisenzio  
PERSONALBUS™

As for the journey characteristics of DRT users, the vast majority of those interviewed use the DRT service to make journeys having an origin and destination inside the built up area of Campi. Some results from the survey indicate that the most prevailing



motivation of the trip is going to work (51.8%), while the next two prevailing motivations are shopping (31.2%) and going to school (15.2%). Concerning the frequency of usage of the DRT service, 50.9% of respondents say that they use the service 5 days a week, 25.9% state that they use it 1 day a week and 15.2% make 2 to 4 trips a week.

Concerning the user profile, 47.8% of the users are aged between 15-30, while 26.5% are aged between 31 and 45. Moreover 56% of the users responding to the survey are women. As for the users' employment status, the survey shows that 44.5% of the users are workers, 10.9% are employees and 29.1% are students. The last important result to emerge from the survey is that 42.2% of PERSONALBUS™ users do not own a car: this means that the DRT application in Campi significantly contributes to the achievement of equity goals, providing a suitable means of transport for those people who cannot afford their own a car.

Some estimates that have been conducted so far demonstrate that in comparison to the pre-existing traditional lines the DRT service provides direct and remarkable benefits to ATAF in terms of increased patronage and revenues particularly in light of the patronage decline that had occurred long before the new service was introduced in Campi.

The positive trend is illustrated in Figure 7.19 which shows the increase of passengers transported from the three pre-existing regular lines (50-51-60) to the PERSONALBUS™ service throughout 1996-2002.

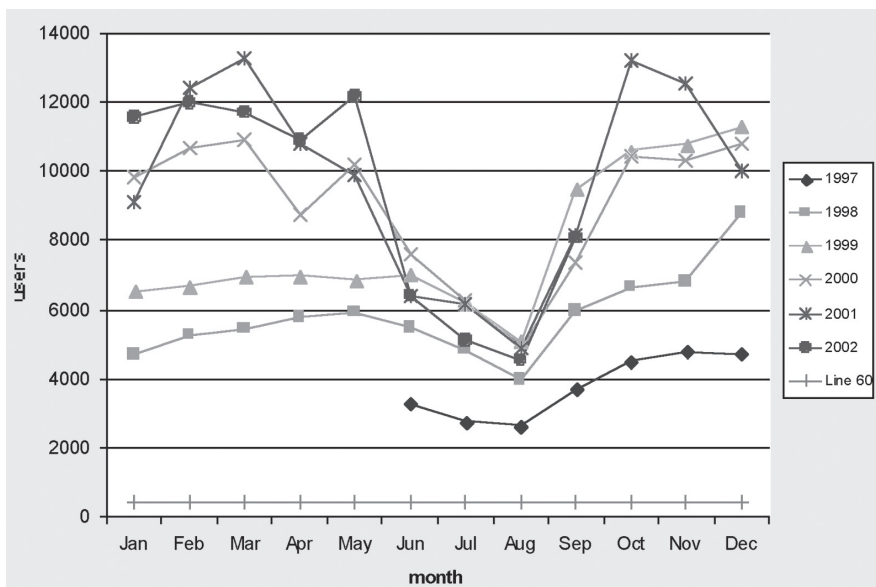


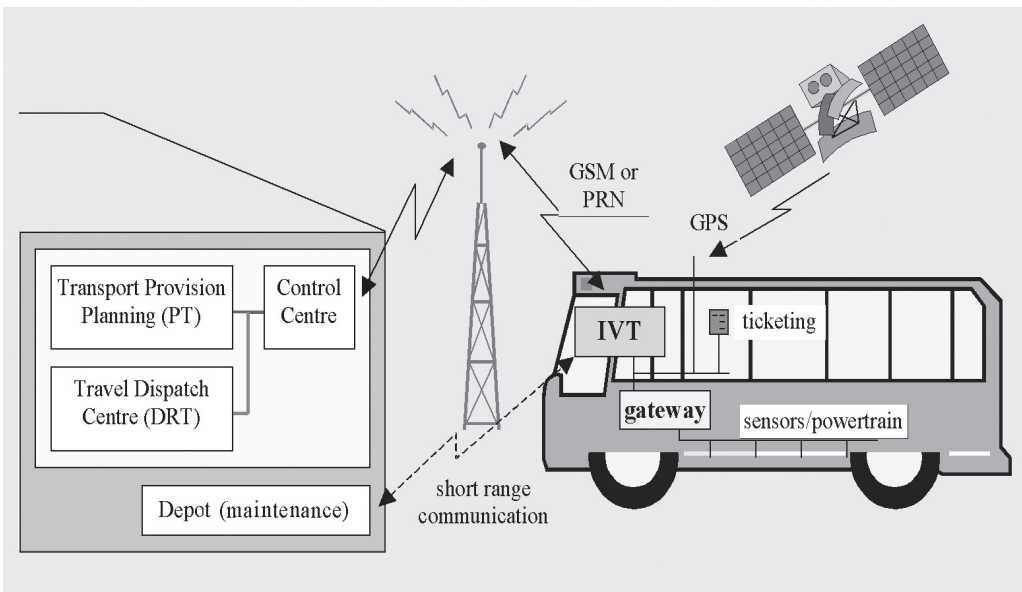
Figure 7.19: Increase of the passengers transported by Campi Bisenzio PERSONALBUS™

### 7.5.5 Future developments

At the present time the focus of ATAF is on further improving and developing the in-vehicle equipment supporting the functions of DRT operations so that service reliability, efficiency and flexibility can be increased.

In this perspective special efforts have been made by ATAF within the EU INVETE project. INVETE is a collaborative European research and demonstration project, sponsored by the European Commission under the IST (Information Society Technologies) programme within the 5<sup>th</sup> Framework Programme. INVETE, launched in 1999, is promoted by a Consortium of 9 partners, namely: VTT (Finland, Technical Research Centre), Instrumentointi (Finland, device manufacturer), Mobisoft (Finland, software developer), Softeco Sismat (Italy, software developer), ATAF (Italy, public transport operator), De Lijn (Belgium, transport operator), MemEx (Italy, consultant), Tritel (Belgium, consultant) and ENEA (Italy, Agency for New Technology, Energy and Environment).

Starting from the recent experiences of R&D projects on flexible collective transport services, such as SAMPO and SAMPLUS, in which the need for an intelligent In-Vehicle Terminal (IVT) for these services was identified, the INVETE Consortium has specified, developed and validated a modular, multi-application, intelligent IVT, which responds to the needs of the drivers and the operational requirements of bus and taxi companies (see Chapter 5).



176 Figure 7.20: General context for the development and operation of the IVT

The IVT is designed to support a variety of functions for both regular and flexible transport services and to operate under different communications systems (GSM, Private radio network) and technological configurations (Figure 7.20).

This IVT must be able to store and subsequently provide to the driver multiple dispatch and operation information such as passenger pick-up and drop-off addresses, trip schedule, the most convenient route between stops and the actual position of the vehicle by means of a TFT (Thin Film Transistor) monitor that displays scrolling data and instructions in tabular form and provides a road map view of the service area indicating graphically operating information such as planned route, next pick-up or drop-off point and actual position of the vehicle. The IVT must also be capable of interfacing with other electronic devices installed on-board the vehicle, such as automatic odometers, vehicle location devices and card readers. By means of the IVT the driver can easily access central computer services such as emergency calls and repair services using pre-coded messages.

Through the integration of new and existing on-board communication and location devices with the control/dispatch centre, the IVT is expected to offer increased driving safety and improved working conditions to drivers and a greater service provision reliability, availability and effectiveness to operators.

#### *Towards a Flexible Mobility Agency*

The technological scenario built up to support DRT operations in Florence and the operational experience gathered so far can be considered a starting point for the creation of an integrated, co-ordinated TDC (Travel Dispatcher Centre), or a Flexible Mobility Agency, capable of managing and organising a network of different transportation services and operators to effectively fulfil the specific travel needs of citizens (see Figure 7.21).

The development of a multi-zone, multi-operator technology platform will make it possible to co-ordinate and manage a set of flexible services in real-time:

- Demand Responsive Services on low density areas and/or in off-peak time periods;
- Shared-taxi services, that are an extension towards the highest degree of flexibility of the PERSONALBUS™ DRT concept;
- Personalized services for particular user categories such as disabled, elderly people and school-children;
- Special services connecting the main city generation/attraction centres such as the hospitals, the airport, the main railway terminals, the main parking areas and the hotels.

Besides facilitating the development of wider service options to customers, an integrated TDC offers a real opportunity to help the development of mobility management actions aimed at encouraging a more efficient use of the existing transportation systems. In this perspective a primary benefit with the implementation of an integrated TDC is

the capability of delivering timely and accurate information such as available transportation services, scheduled vehicle departure times, transfers and fares, thus helping travellers in making better decisions on the mode of travel, on routes and travel times. An integrated TDC is also the basis to achieve the integration and co-ordination of transportation services offered by multiple providers (public, private for profit and private non-profit) involving a variety of travel modes.

ATAF is already facing this challenge for the future, analysing all the technological, economic and institutional aspects correlated with the creation of an Agency capable of playing an active and broader role in the implementation of mobility management actions in the metropolitan areas of Florence and this concept is discussed further in Chapter 12.

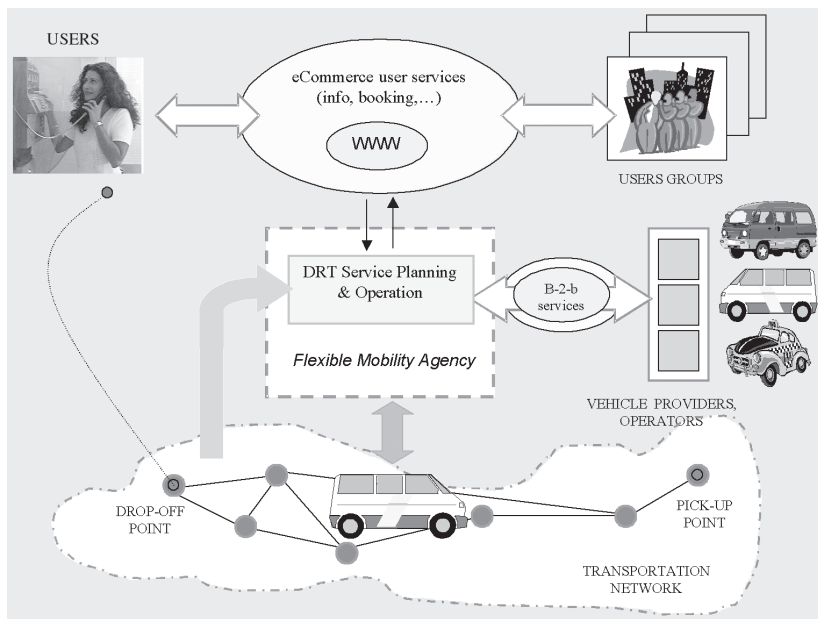


Figure 7.21:  
Flexible Agency  
concept

## 7.6 The My Bus experience in Fano

*M. Benedetti*

### 7.6.1 Introduction

My Bus is the DRT service operated by Aset Trasporti of Fano. The service operates inside the municipal territory in Fano and began 2nd May 2001 in the following zones: Old city centre, Vallato neighbourhood, Tombaccia hamlet, Caminate hamlet, hamlet of Tre Ponti, Industrial zone of Bellocchi, Fano Craftmade Zone, Le Brece neighbourhood and (from 18th June 2001) the sea zone of Lido and Sassonia.

In Figure 7.22 the reference territory and the principal operating characteristics of the service are shown.

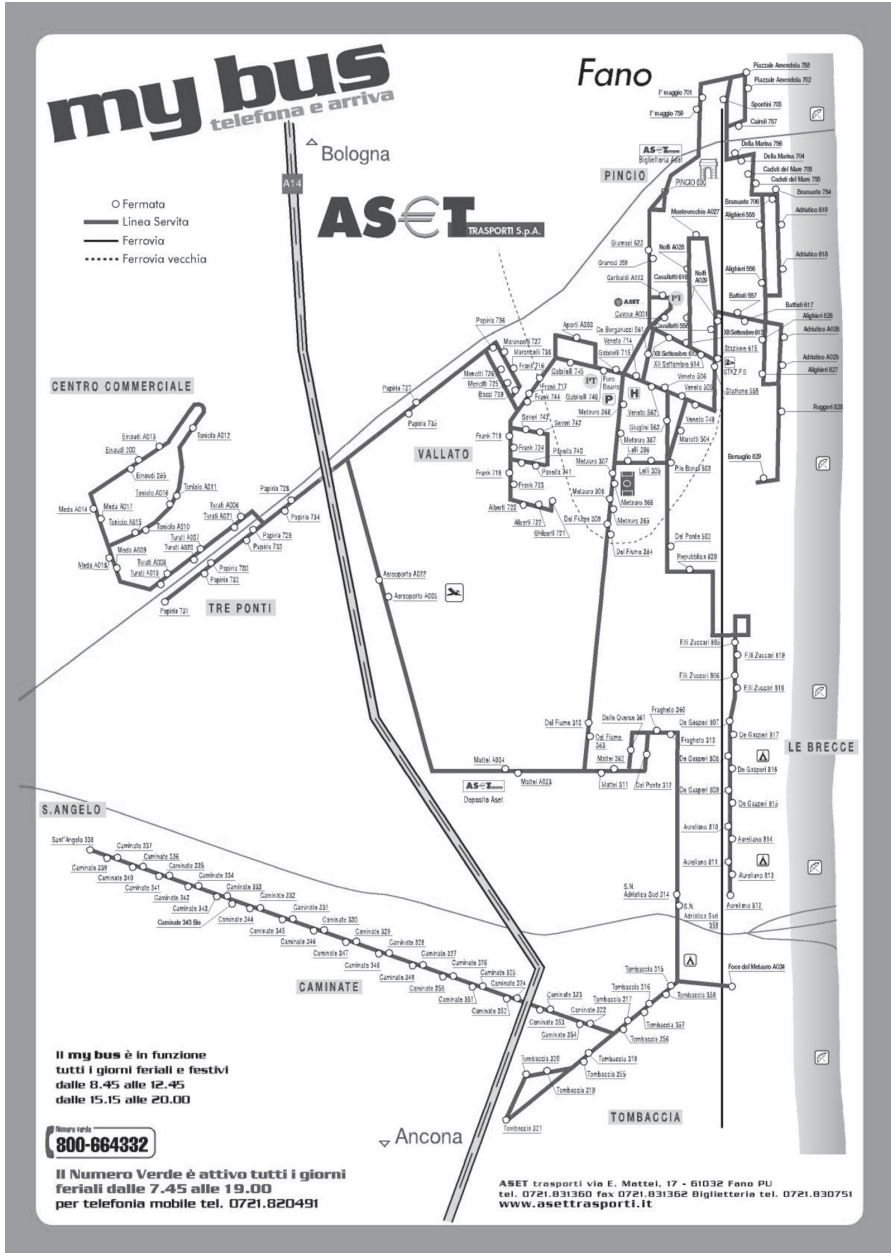


Figure 7.22: My Bus operating territory

How was the demand for a new kind of transport service born? With resources more and more limited and the consequent necessity of making cuts to an even more reduced service offer, a dangerous negative spiral followed which made the users of the public transport disaffected, causing passenger loss everywhere. Furthermore, with the continuous increase in the use of private cars and the consequent increase in the congestion of the towns and the unavoidable decrease of commercial speeds, the public transport operator faces a negative global picture.

### **7.6.2 The traditional service**

To complete the background, the situation before the introduction of the My Bus service is described briefly.

The system of local public transport in the zones involved in the intervention before the introduction of My Bus was combined by 3 traditional line services:

- Line 3 was the link instituted for the hamlet of Tombaccia and Caminate, with an hourly frequency of 60 minutes between 07.00 and 14.00 and a frequency of 120 minutes until 20.00. During holiday days the service was only provided in the afternoon (length of the line 14.4 km).
- Line 7 - The link instituted for the Vallato neighbourhood and the hamlet of Tre Ponti had an hourly frequency of 60 minutes between 07.00 and 14.00 and a frequency of 120 minutes until 20.00. On holiday days the service was not provided (length of the lines, 8.5 km).
- Line 8 - The link instituted in 1997 for the Le Breccie zone, an area characterized by a high presence of flats temporarily used by tourists (length of the line, 10 km), only operated in the morning between 09.00 and 12.15 and not on holiday days.

The need to maintain costs has been the key determinant in the choice of how the DRT service was introduced. It was necessary to keep, with the introduction of the new service, the use of the same resources which previously guaranteed the fixed line service.

It was decided to introduce the new system in the quiet hours from 08.45 to 12.45 and from 15.15 to 20.00 (holiday days included). The users liked the idea after the almost total lack of the service.

The decision to keep the fixed line service during the peak hours comes from the fact that the service is used a lot in such hours and it meets the mobility requirements, as it is able to guarantee links with both the principal attraction poles of the town and the links with the neighbouring councils in Fano and particular for Pesaro.

### **7.6.3 The operation headquarters**

The software, which can optimize the transport resources, is produced by Softeco Sismat SpA of Genova. The software is simple and reliable, and did not present particular difficulties in building the network of the My Bus service. Booking is permitted up

to 60 minutes before the request for transport. The communication between the operations headquarters and the drivers in this first phase takes place through the GSM channel.

#### **7.6.4 The communication system**

If communication plays a fundamental role for a traditional system of transport, it is not hard to appreciate the role played by communication in the promotion of a service that has replaced a traditional service and is so user-friendly.

The communication activity is interested in all the possible channels: local newspapers, 100x140 cm posters, 3x6 m posters, local radio stations, playbills. A leaflet containing the service zone with the explanations of how to use the service itself has been sent to all the households of Fano. The advertising was conceived so as to culminate a few days before the start of the service itself. Besides the traditional forms, evening meetings with the municipal areas of the quarters interested in My Bus were held.

The traditional users have been directly informed on-board prior to the end of the traditional service. At the bus stop tables containing the modes of the service were displayed along with of the map of the network served.

#### **7.6.5 The buses used**

The characteristics of the service allows the use of small vehicles, provided with foot-boards for access to people with limited mobility, providing a smooth ride whilst also reducing fuel consumption and emissions to a minimum. Two minibuses and two Fiat 316 are therefore used at present.

#### **7.6.6 The reference regulation**

As regards the authorization, the regional law of recipient of the law 422/97 was particularly useful. For simplicity, an extract is quoted:

Regional law (Marche-Italy) December 24th, 1998, n.45  
*Rules for the rearrangement of transport regional and local audience in the*  
(...)

##### Art.5 – public transportation

The motor line services of public transport, made on rubber and with bound guide systems, are distinguished in: (...)

e) weak demand, which are made by particular modes and suitable technologies, in the territories with low house density or to weak demand, in alternative to the ordinary line services.

On the plan of the service, everything was quite simple including the institution of new stops.

As regards the contractual relationship with the entrusting corporation, the same one, after evaluating the project, authorized the experimentation by keeping unchanged the historical consideration concerning the ways of the replaced runs.

### 7.6.7 The results obtained

The results obtained after about two months of experimentation are encouraging. In fact, the passengers transported with My Bus (of which about 1,500 would have been transported with the lines replaced by the new service) are about 4,000.

But with regard to passengers transported a very interesting phenomenon has happened. In fact, the curiosity provoked by the coming of the new service pushed several groups of students, pupils, organized groups, to use My Bus.

In the immediate future an investigation of customer satisfaction among the customers is planned, but the interviews completed sporadically by the local newspapers and from the impressions cited by the drivers of the service itself, indicate clearly that the appreciation level is without doubt remarkable.

Figure 7.23 shows the number of passengers transported at 31st December 2002.

In the immediate future an increase in the DRT network is planned to other zones of the town.

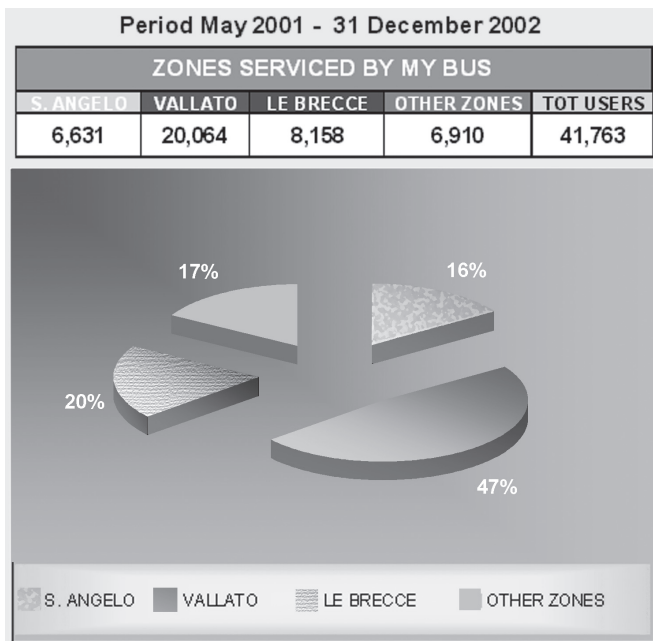


Figure 7.23:  
My Bus patronage at  
December 2002



## 7.7 Recent British experience

*J.F. Mageean, J.D. Nelson, S. Grosso*

### 7.7.1 Introduction

In its *Ten Year Plan* for transport the UK Government pledged to remove or (at least) relax constraints on the development of flexibly-routed bus services and to promote a greater role for community-based services (DETR, 2000a). This resulted in the Department for Transport Consultation Paper entitled “The Flexible Future” (August 2002) which set out new proposals for the registration of flexible transport services (DfT, 2002). Other recently-published research by the (then) DETR (2000b) argues that flexible public transport services, provided by local authorities and bus operators in partnerships with employers, stores and leisure centres, would help break down social exclusion. Additionally, the Rural White Paper (2001) contained proposals, subsequently implemented, for the extension of fuel duty rebate (FDR) – now known as Bus Service Operators Grant (BSOG) – to community transport; BSOG is now to be extended to flexibly routed local bus services. Finally, the recent successes of local authorities in winning substantial funding under the Rural (and indeed Urban) Bus Challenge programmes for the implementation of DRT confirms this new interest in flexible forms of transport (Jones, 2002; Nelson, 2002).

This section concentrates on recent British experience and provides an introduction to rural examples of DRT drawing on early findings from the implementation of DRT services in West Sussex, Surrey, Gloucestershire, Lincolnshire, and Wiltshire. On-going research in Northumberland where the County Council is engaged in two DRT projects is also introduced. *Phone and Go* is designing, demonstrating and evaluating DRT services at two locations in Northumberland; *Click and Go* is developing an Internet-based system for pre-booking DRT (and other transport services) with special reference to health services. Finally some key issues for policy-makers concerned with the future implementation of DRT in rural areas are identified.

### 7.7.2 Overview of recent rural DRT schemes

The most widely used TDC support software package in the UK is *MobiRouter* which was developed during the EC SAMPLUS project and which is distributed by Mobisoft (UK) Ltd (Duffell, 2002)<sup>1</sup> (see Section 4.2.4). The applications highlighted below all employ the *MobiRouter* software. In this section examples are discussed from West Sussex, Surrey, Gloucestershire, Lincolnshire, and Wiltshire. All of the schemes have

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<sup>1</sup> The Canadian company Trapeze is also active in the UK market.

benefited from “Bus Challenge” funding, introduced under the *Ten Year Plan*, following central government’s decision to support the development of flexible and responsive transport solutions under the programme<sup>2</sup>.

#### *West Sussex: “DoRiS”*

*DoRiS* was the first DRT service in the UK to use *MobiRouter* following a successful joint bid to the Rural Bus Challenge programme by Sussex and Surrey County Councils and experience gained as a follower site in the EC SAMPLUS project (see Section 7.1). The resulting award of £446,000 enabled the establishment of services for 2 years in West Sussex and Waverley (Surrey). Initially the project management has been held by both councils and the day-to-day management conducted by West Sussex County Council.

*DoRiS* commenced operation in West Sussex on 21<sup>st</sup> July 2000 with eight services in the rural area of Midhurst – Petersfield – Haslemere. These new services are designed to feed in to existing fixed line services. The routes are semi-fixed with non-predefined stop points available on non-fixed sections. There are no passenger eligibility restrictions. The routes have been refined in response to patronage trends during the early period of the project (e.g. the Friday and Saturday evening service takes account of public house and restaurant opening times and buses run until midnight). Services are operated from Monday to Saturday. None of the services are run every day (i.e. there is a selection of services each day) in an attempt to meet the level of demand throughout the area. Patronage has grown slowly from around 100 to 240 passengers/month and this is thought to be partly attributed to the lack of bus culture in this area of high car ownership. Most patronage is drawn from the young and elderly although the service is open to all.

#### *Surrey: “DoRiS”*

In Surrey the County Council has experience of working with West Sussex (originally as a follower site to the SAMPLUS project – see Section 7.1) in the development of the *DoRiS* DRT scheme. The service itself is virtual and flexible operating between Monday and Saturday throughout the single zone of South Waverley, including Haslemere and Chiddingfold. Originally there were three separate travel zones but there was a poor take up due to the travel restrictions. Passengers are restricted to those with a temporary or permanent disability.

The objective has been to explore new ways of service delivery with an emphasis on combating rural isolation. Particular frustrations have been the inability to qualify for

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<sup>2</sup> Only a small sample of the rural DRT schemes in the UK are considered here. Other high-profile examples include Angus, Highland, Hampshire and Worcestershire.

FDR (now BSOG) on the non-fixed part of the routes and the lack of patronage base after 18 months of operation. As in West Sussex the patronage issue has been attributed to the relative inexperience of the local population with any form of public transport coupled with a reluctance to use the telephone booking facility and problems with mail drops for publicity purposes. A new initiative in Surrey, known as Waverley Transport Solutions, has established a community transport service (with its own dispatch centre) with Rural Bus Challenge and Local Transport Plan funding marking a separation of operations from West Sussex. The Waverley project combines group transport, contract work and DRT and operates under a Section 19 permit unlike *DoRiS* which is a registered public service.

#### *Gloucester: "Village Link"*

The *Village Link* project resulted from a 1999 Rural Bus Challenge for a service operating 2 years. The project co-ordinator is the consultancy firm Halcrow whilst Gloucester County Council is responsible for day-to-day management. Gloucester Ambulance Trust withdrew its offer to provide the TDC due, amongst other matters, to union restrictions regarding the hours of working; this led to the decision to use *MobiRouter* and the need to find another TDC. Two circular DRT routes and one bookable (optional) peak period fixed route have been developed in the Southern Vale of Gloucester; all three services operate from Monday to Saturday. The services started in April 2001 and timetable revisions took place in June 2001. These feeder services provide replacements for poorly used fixed line services. The DRT service is bookable as door-to-door and there are no user restrictions.

#### *Lincolnshire: "CallConnect"*

In Lincolnshire, the fourth most sparsely populated English county, the County Council has been developing a strong interurban bus network with feeder rural services. A mixture of funding from the Rural Bus Grant, the Countryside Agency, the European Commission and the Rural Bus Challenge has contributed to the overall development of fixed and responsive services in the area which have addressed the need for improved quality and convenience of interchange through an emphasis on "connections management". Specific RBC funding was used for implementing the software for the DRT services. Lincolnshire County Council is responsible for project and day-to-day management. The DRT services commenced in March 2001 using a diary system for booking. *MobiRouter* became operational in July 2001. Six services in the Horncastle, Spilsby and Wragby area are currently bookable DRT services: two of these are known as *CallConnect Plus* services, which are flexible routes that only operate on demand using 8-seat vehicles and require a minimum of 2-hours advanced booking; the other four are known as *CallConnect* services and these are semi-fixed routes using 16-seat

vehicles. The services are bookable as door-to-door (postcode), and with known meeting places, e.g. telephone boxes. All services operate Monday to Saturday. As with the Vale of Gloucester, these are replacements for conventional services. There are no passenger restrictions.

The response from users has been encouraging with success attributed to the extended period of operation, strong branding and community-oriented nature of the service. Monthly patronage on DRT services is around 25% greater than the fixed route network carried over the same area. The importance of involving user groups in development of services (e.g. vehicle selection) has been demonstrated. The County Council is currently looking at other opportunities for integrating the operations of social services transport and health trusts. However, subsidy per passenger journey is £5 for *CallConnect Plus* – emphasising the need for DRT to become eligible for BSOG.

#### *Wiltshire: "Wiggly Bus"*

Wiltshire County Council, Kennet District Council and the (then) DTLR provided funding for 3 years from 1999 on the Wiggly Bus project. The Metropolitan Transport Research Unit was the project co-ordinator. The Wiggly Bus services are booked alongside the Gloucester

*Village Link* services at the Message-link TDC in Gloucester. The TDC for the Wiggly Bus project was initially undertaken by the Wiltshire Ambulance Service. This posed a variety of administrative and booking problems leading to the transfer of the booking system to *MobiRouter* at Message-link, starting in September 2001.

The services link outlying areas with conventional services. Three circular core routes in the Devizes, Pewsey, Woodborough and Cadley area operate hourly with diversions on demand. One service was re-routed in Spring 2001 as a result of user requests. The services use predefined stop points. In addition, the fixed route bookable (optional) Wiggly Bus Express service between Pewsey and Devizes connects with most of the DRT services. All services operate from Monday to Saturday. There are no user restrictions and a travel club offering discounted travel is available. Patronage is currently at around 3,000 passengers/month although, prior to the reorganisation of the TDC, it was previously 3,500 passengers/month. However further growth in patronage is expected. In terms of operating costs an average subsidy payment of £4.60 / passenger journey was experienced (year 3). Although high, such a figure is not unknown in the context of the conventional bus service operation and is cheaper than a taxi alternative.

#### **7.7.3 Towards Best Practice - the DRT Installation Study**

A study completed by Transport Operations Research Group (TORG) at Newcastle University evaluated the development of telematics-based DRT services at the sites referred to in the previous section. Tables 7.4–7.6 are comparative summaries of the

approaches adopted when setting up DRT services with respect to the Travel Dispatch Centre (TDC), vehicles and service. For reasons of commercial confidentiality this discussion does not cover specific software issues.

Table 7.4 (Travel Dispatch Centre and its staff) shows wide variations between the installations. Whilst the Gloucester and Wiltshire services can be booked for 24 hours a

	DoRiS West Sussex	DoRiS Surrey	Village Link Gloucester	Wiggly Bus Wiltshire	CallConnect Lincoln	Phone and Go Northumberland
TDC Operation						
Booking times	Mon-Sat 08:00-12:00 – 13:00-17:00		Mon-Sun 24 hours		Mon-Fri 09:00-16:00 Sat 10:00-16:00	Mon-Fri 08:00-20:00 Sat 09:0-17:00
First service time	06:00		06:55		09:00	06:50
Last service time	18:45 (Mon-Thu) 23:15 (Fri/Sat)		22:45 (Wed/Thu/Sat) 18:10 (Mon/Tue/Fri)		16:35	19:40
Calls per day	< 10		10	180	20	< 10
Refusal rate	0% for viable journeys		0% for viable journeys	10%	2%	<10%
Booking speed: <i>Registered users with default journey</i> <i>Non registered users/difficult journey</i>	1 min  2 – 3 mins		1 min  2 mins	Lengthy	0.5 min  2 – 3 mins	2-3 mins  >5 mins
Passenger Registration: <i>Compulsory?</i> <i>Number</i>	No 200		No 300	No Not known	No > 210	No Not known
Customer profile	Older and/or female	Disabled	Mostly disabled and elderly	Mixed Many young	Old Shopping/ leisure	Mostly school children
Call rate	0845		Local		0845	0870
Number of lines	3		Many		1	2
Customer acceptance	Low acceptance of telephone booking		High		High	-
Booking computers	3 (only 1 manned)		9 take calls, transferring to 2 who make bookings		1	2 (only 1 manned)
TDC Staff						
Number	2 total 1 at any one time		40 total 6-8 day time, 3 night time  1 could handle Glos.      3 could handle Wilts.		1 + other staff cover meals etc.	4 total 1 at any one time
Sole job?	No		No		No	Yes+service evaluation
Training by Software provider	On the job		1 week for 2 dispatchers. They train others in-house		On the job	1 day for 3 dispatchers 1 trained in-house

Table 7.4: Summary of DRT installations – Travel Dispatch Centre

day 7 days a week, the opportunities are more restricted at the other locations where bookings cannot be made outside service operating hours. This situation is compensated for at West Sussex and Wiltshire where requests can be made on-line or by answering phone; the dispatcher confirms the bookings by telephone later.

There is a wide range of usage for the different services, the heaviest demand being for Wiltshire (about 180 calls per day), which is reflected in the relatively high refusal rate at the time of booking (10%). Further evaluation is required to establish the reasons for such a refusal rate which could be a function of the scheduling software or because demand for the service cannot be met by existing levels of provision in which case additional investment in vehicles and drivers would be required.

At all but one installation the booking time is rapid for registered users (up to 1 minute) and acceptable for difficult and new bookings and non-registered passengers (up to 3 minutes). The reasons for the lengthy booking time at Wiltshire lie in the history of the installation (as discussed above). The reasons for the low acceptance of the technology by customers using the West Sussex TDC is not clear: it could relate to lack of clarity in the publicity material or the way in which bookings are handled or the level of training offered to dispatchers. At all TDCs the staff were involved in more than one job, although the reasons for this varied. This demonstrates that the structure of the TDC staffing arrangements is flexible.

	<b>DoRiS West Sussex</b>	<b>DoRiS Surrey</b>	<b>Village Link Gloucester</b>	<b>Wiggly Bus Wiltshire</b>	<b>CallConnect Lincoln</b>	<b>Phone and Go Northumberland</b>
<b>Vehicles</b>						
Type	1 Renault Master + part-time use of Surrey Renault Master 1 back up Renault Master	1 Renault Master	2 Renault Master 1 back up Renault Master	3 Renault Master 1 back up Renault Master	2 Renault Master 1 back up Renault Master 5 IVECO	2 Mercedes Sprinter 2 back up LDV
Accessibility	Side steps Tail lift	Side steps Tail lift	Low floor side ramp	Low floor side ramp	Renault: rear inclined ramp + lowering suspension IVECO: tail lift	Low floor side ramp
<b>Drivers</b>						
Acceptance of technology	Variable	-	Variable	90% acceptance	100% acceptance	
On-board Unit (OBU) Training	<1 day	Not known. New drivers trained by those already trained.	10 minutes in person or by telephone. Relief drivers seldom use OBU	2 hours		

188 Table 7.5: Summary of DRT installations – vehicles and drivers

	DoRiS West Sussex	DoRiS Surrey	Village Link Gloucester	Wiggly Bus Wiltshire	CallConnect Lincoln	Phone and Go Northumberland
<b>Service</b>						
Type of area	Rural	Rural	Rural	Rural	Rural	Rural
Type of service	5 Fixed + flexible sections. Door-to-door	Virtual flexible	2 Fixed + flexible sections. Door-to-door 1 fixed only	3 Semi-fixed Predefined stop points 1 fixed only (Wiggly Bus Express)	2 Flexible 4 Semi-fixed Door-to-door and predefined stop points	2 Flexible Door-to-door and predefined stop points
Evening services	Fri/Sat	No	On trial	Wed/Thu/Sat	No	Early evening (Coquet only)
Sunday services	No	No	No	No	No	No
User restrictions	None	Disabled	None	None	None	None
Patronage	137/week	58/week	200/week	955/week	8380/week	Allen: 80/week max Coquet: 250/week max
Route Registration problems	Yes	No	Yes	-	No	Not applicable yet
Pre-booking period	1 hour	2 hours	0.5 hour	0.5 hour	2 hours Wheelchair: previous night	Allen: previous day Coquet: 2 hours
Booking on fixed sections	Advisable	Not applicable	Advisable	Yes on semi-fixed Advisable on fixed	Advisable	Not applicable
Multiple bookings	Up to 1 week in advance	-	Up to 1 week in advance + restrictions	Up to 1 week in advance + restrictions	Up to 1 week in advance + restrictions	Yes
Interchange	Bus and rail	No	Bus and rail	Wiggly Bus Express	Bus	Bus and rail
Through ticketing	Not yet	No	Yes: 1 service	Yes: Wiggly Bus Express	Yes: InterConnect network	
Interchange improvement	-	No	Yes	-	Yes	Yes - planned
Operator	ACCORD	ACCORD	Swanbrook Coaches Ltd	Hatts Coaches	Translink	Allen: Tynedale Group Travel Coquet: Northumbria Coaches
Contract length	2 years	2 years	-	-	5 years	Allen: 2 years Coquet: 3 years
Service reliability	Some natural hazards	-	Very good	Poor due to vehicles	Generally good	Good
Plans for expansion	Yes	Yes	-	-	Yes	-

Table 7.6: Summary of DRT installations - service

The type of vehicles used (Table 7.5) has an indirect effect on the success of the DRT service. A poorly specified vehicle will affect the acceptance of the technology and the service by the dispatchers, drivers and customers. Driver training is a critical factor and

it may need revisiting at some installations. All the installations had purchased accessible vehicles, although their utility will not be fully realised until all vehicles on connecting services also offer this facility.

The design of the service has a fundamental role in determining the success of a DRT service. Table 7.6 shows that wide variations in the service specification demonstrate the flexibility of DRT services. The service types are predominantly semi-fixed. Two sites operate fixed, optionally bookable services as part of the DRT concept.

The overall characteristics of the existing installations are that only one of the five installations restricts users (Surrey); none operate Sunday services; evening services are limited across and within the sites; through ticketing is limited but considered a desirable objective; service reliability is good, except where vehicle reliability is poor (Wiltshire) and only Surrey (due to the nature of the service) does not offer interchange. Positive steps have been taken to improve the interchange infrastructure at two sites. It was recognised at all sites that the registration of the routes with the Traffic Commissioner requires careful consideration – and it has posed limitations at some sites. For example, there may be a minimum number of timing points, which can constrain the flexibility of the service.

Some factors have a direct impact upon the software. For example, the longer the minimum pre-booking period (two hours at Surrey compared with half an hour for Wiltshire) the easier it is to schedule the vehicle and it is less stressful for dispatchers. All installations except Surrey operate DRT routes with fixed sections: in all cases booking is recommended for the fixed sections but it is not compulsory. This solution remains workable when passenger numbers are low, but would create load problems if demand substantially increases, such that a pre-booked passenger boarding later on during a journey risk losing their seat. The availability of seats for *ad hoc* passengers should be checked by the driver, which may lead to issues regarding the drivers' acceptance of the software.

#### **7.7.4 The “Phone and Go” research programme**

The *Phone and Go* project is establishing DRT services in two contrasting rural areas of Northumberland (Allendale Valleys and Lower Coquet). *Phone and Go* is funded from the Rural Bus Challenge to the value of £750,000 over 3 years between April 2001 and March 2004. The project co-ordinator is Northumberland County Council whilst the University of Newcastle upon Tyne, Transport Operations Research Group (TORG), is hosting the TDC (a *MobiRouter* installation) and is responsible for day-to-day management. TORG is also responsible for a detailed monitoring and evaluation of the project. To compare with other rural installations a summary of *Phone and Go* is included within Tables 7.4 – 7.6. In both *Phone and Go* areas, the DRT service is supplementing existing fixed line services and there are no passenger restriction criteria. Passengers can arrange



to travel door-to-door, using non-predefined stop points, and to predefined stop points such as interchanges, doctors' surgeries and schools. Benefiting from the experience of other UK DRT services, the TDC is open 12 hours a day Monday to Friday and 9 hours on Saturday in order to maximise the window of opportunity for passengers to contact the TDC.

The Allendale valleys lie in the sparsely populated uplands of south-west Northumberland. The DRT service feeds from small outlying settlements in the West Allen valley into the small town of Allendale Town where connections can be made to the market town of Hexham where there are onward rail and bus services to Newcastle and Carlisle. Additional services connect the West Allen and lower East Allen valleys with bus and rail at Haydon Bridge.

The service became operational in September 2002, with journeys operating between 07:15 and 17:30 Monday to Saturday. Regular passengers include schoolchildren travelling to Allendale Town.

The Lower Coquet area lies on the more densely populated coastal strip in the east of the county and is bounded on the east coast by the small town of Amble and the large village of Warkworth, whilst Felton village lies near the west of the operational area. The DRT service here provides a feeder service at Felton with an interurban bus service between Newcastle, Alnwick (awarded "most desirable town to live in the UK" status in 2002) and Edinburgh. Local bus connections to Alnwick, Berwick and Ashington are possible at Amble and Warkworth Rail connections can be made at Acklington to Newcastle. The DRT service also provides new links between the small settlements in this former coalfield area. This service commenced in December 2002. It operates between 06:50 and 19:40 on Monday to Saturday. There is a strong interest in the service from the local communities with passengers travelling to schools and a doctor's surgery.

The evaluation is following and developing further a robust methodology based on the EC SAMPLUS project (see Section 7.1.3). User Groups have been identified and their objectives for the outcome of the *Phone and Go* project determined. Evaluation indicators, which will measure these objectives, have been developed for three Assessment Categories (*economic viability, service provision and technical performance*). For example, economic viability will encompass vehicle utilisation, operating costs and TDC costs; service provision analyses the effectiveness of DRT operations in achieving intermodality and system integration and increasing social inclusion; whilst technical performance will consider the efficiency of the dispatching software. Since the TDC is operated and evaluated by TORG, this project provides a unique opportunity to analyse and experiment with the capabilities of a DRT software scheduling system. A further element of best-practice implementation was sought when specifying attractive, accessibly user-friendly vehicles.

*Click and Go* is developing an internet-based system for pre-booking DRT (and other transport services) with special reference to health services. As part of the study Patient Transport Services (PTS) are being examined with the objective of persuading (or requiring) people who need to travel to hospital or health services to use public transport when this is available. Where public transport is not available and significant numbers of people are provided with PTS or home visits, there should be improvements to public transport. Where it is not viable to improve public transport the spare capacity on the PTS could be used to enhance the public transport network and bring income to the PTS. Current work is exploring the requirements for integrating the TDC with pre-trip planning facilities (such as the Northumberland Journey Planner) and real-time information generated by AVL and Automated Passenger Counting (APC) devices (see Figure 7.24). The Northumberland experience points the way towards the concept of a Regional TDC with a multi-sectoral user base such as taxis, education, social services, patient transport services and community services.

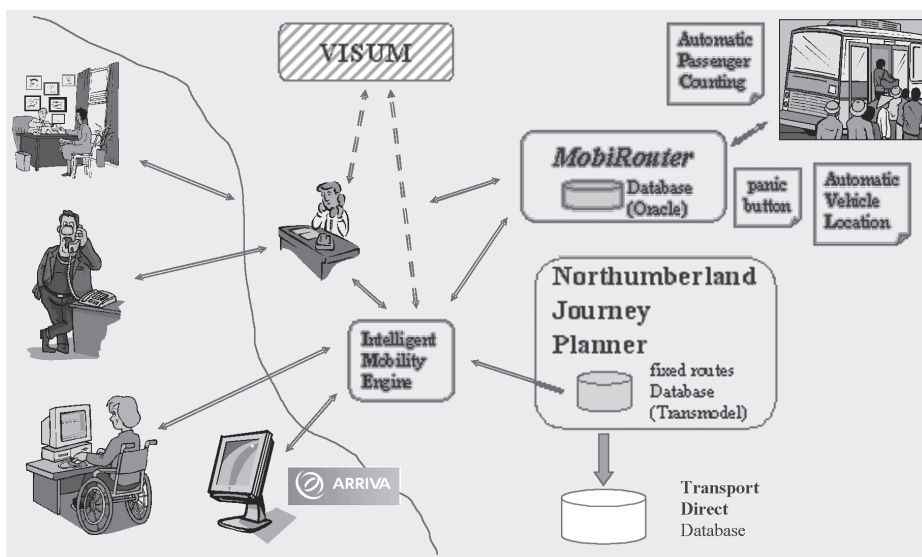


Figure 7.24: The *Phone & Go* Travel Dispatch Centre

### 7.7.5 Conclusions

Findings from the sample of UK installations reported here suggest that the following specific factors are likely to contribute to the overall success of a DRT operation:

- TDC hours of opening should be as long as possible.
- Booking time will not be minimised if there is a large proportion of users whose address etc. are not registered.

- Service characteristics need careful consideration, e.g. whether to implement compulsory booking on fixed section, the length of the pre-booking period.
- The sensitivity of route registration with the Traffic Commissioner should be considered.
- The fare structure should be simple to understand and apply.
- There are clear benefits to be derived from through ticketing, interchange and improved interchange infrastructure.
- Accessible vehicles are important on DRT *and* connecting fixed line services.
- Marketing the service is critical to its success, particularly as passenger acceptance is generally good.
- Temporary (i.e. when the service first comes into operation) or permanent support for passengers, particularly the disabled and elderly, promotes confidence in the DRT service.

## 7.8 Lessons from the European experience

*J.F. Mageean, J.D. Nelson*

The results from the SAMPLUS demonstrations and experience elsewhere supports the contention that DRT services can offer greater flexibility in time and location than conventional public transport in meeting many aspects of travel demand. Detailed findings from the SAMPLUS demonstrations and from subsequent research have been reported elsewhere (e.g. Nelson and Mageean, 1999, Nelson, 2002). The experience gained in the SAMPLUS project suggests that there are a number of issues that authorities and operators planning to enter the DRT market need to be aware of. Three key areas that will strongly influence the development of DRT services in Europe – the market environment, economic barriers and the pursuit of public transport system integration – are discussed below.

### 7.8.1 *The Market Environment: Institutional and Legal Barriers*

In terms of the relationship between DRT and scheduled and other public transport, experience shows that in the more regulated environment (e.g. Belgium, Italy), with less conflict between DRT and other public transport modes, DRT is strategically more easy to implement. Operators with a monopoly can plan services as they see fit, which should lead to a service without duplication, gaps and the fear of losing customers to competitors. The operator can demonstrate improved public accountability as ridership and customer satisfaction increase, whilst reducing operating costs. However, an innovative authority is required, taking a long-term view of the service. If only a short-term view is taken (as in the Ireland feasibility site discussed in Section 7.4), DRT is unlikely to be implemented.

In a deregulated (franchise) environment (e.g. Sweden) off-road competition promotes innovation as DRT investment can be specified by the authority and there is protection from competition for the duration of the franchise.

In a deregulated (open access) environment (e.g. UK outside London, Finland) there are few incentives for operators competing on the road to introduce DRT, due to the high investment required and the possibility of other operators benefiting from the capital outlay. DRT is most likely to be implemented where one operator is extremely dominant in an area. DRT will therefore (normally) only be a niche opportunity for private operators and is more likely to be procured by local authorities as socially desirable services, which are associated with long term funding issues. DRT may be considered to impinge upon taxi operations, as in Finland. Historically, there has been great competition between bus and taxi operators. However, the Finnish demonstration provides a role model for improving co-operation, to the mutual benefit of bus and taxi operators (Section 7.3). In particular, the introduction of compatible software systems is a vital step forward.

The DRT tariff is unlikely to cover the cost of the service in any market. Instead, it is regarded by the authority as fulfilling a public obligation, and by the operator as a means of increasing passenger numbers, including a beneficial effect on regular services as a result of interchange opportunities. Subsidies are most likely in regulated environments, whereas in deregulated environments, subsidies are service specific.

The optimal operational area is variable, being determined by geographical, political and existing operational boundaries. Overall, in order to maximise customer needs, route flexibility and route directness, the optimal area is small.

In regulated environments the TDC is part of the operator organisation, which generally does not need to demonstrate TDC profitability on its own. In less regulated systems, there are no obvious patterns. If more than one operator is involved, an independent TDC is viewed favourably by operators, but financial problems remain. A successful TDC will demonstrate economies of scale, although the Finnish demonstration suggested that diseconomies occur if TDC operators lack local knowledge. Economies could be achieved as a result of integration with other potential TDC functions, such as journey planning, brokerage and transport services provided by other public authorities.

As a relatively new form of public transport, the legal and organisational framework for DRT is unclear, even in more regulated environments like Belgium and Italy. As noted in Section 7.7, the UK Government in its *Ten Year Plan* for transport has pledged to remove or (at least) relax constraints on the development of flexibly routed bus services and to promote a greater role for community-based services (DETR, 2000a).

194 The rules for compulsory competition and bidding vary considerably. Obviously, in regulated environments there is no competition. Elsewhere, the rules vary according to

the type of service (STS or no restriction), the legal status of DRT, and the type of competition (off- or on-road). Off-road competition is successful as there is no competition until the next round of franchises, but on-road competition can deter heavy investments. In existing regional models for co-operation the responsibility for DRT services varies. It may be the authority fulfilling its public duties or a private operator utilising a gap in the market. In fully deregulated environments, the authority is particularly aware of the need to co-operate with private operators.

The influence of health, welfare and pensions arrangements on DRT provision shows no pattern. In some countries there is an obligation to provide public transport access for everyone (e.g. Sweden) whereas elsewhere disabled people may be entitled to free public transport, but there is no duty to provide the appropriate transport (e.g. Ireland). Where more than one operator trade union exists, conflict is more likely when establishing working practices, e.g. the taxi unions in Finland were an impediment to the introduction of DRT services. Elsewhere, drivers unions fear the loss of jobs.

Major investment can only be justified if high patronage can be confidently predicted; therefore more regulated environments are more likely to sustain high investment, due to the flexibility of resources.

The issues raised in this section are discussed more fully in Chapter 8.

### **7.8.2 Economic barriers**

In urban areas there is a demand for a high level of mobility. The public transport network is a response to political forces, e.g. the need to reduce congestion and pollution, and because operators can operate cost effective services. DRT successfully supports conventional services in areas of low demand and by providing STS. Highly regulated markets are most likely to support DRT services, due to the high subsidies available. Beyond the major conurbations, regional mobility between rural and urban areas is an important issue. DRT has the potential to be a significant transport mode, providing local and feeder services. Subsidy levels are moderate. In rural areas available subsidies may be lower, but DRT remains a realistic way of improving mobility for those without access to a private vehicle. In areas of open competition, capital investment needs some protection, so DRT schemes are more likely to be in response to authority initiatives. As the population density decreases, so does the level of STS; DRT can provide a valuable supplement for people who would, in urban areas, receive STS.

The viability of DRT services as a self-supporting system has not yet been demonstrated. Viability is therefore measured in terms of citizen mobility and providing the cheapest public transport solution. Modal shift could be viable if costs are discounted against travel time-savings and environmental degradation. Public transport patronage has increased as a result of DRT services. However, the best method of building up the market may be through staged technological development, commencing with low-tech

solutions. The attractiveness of DRT services is clearly demonstrated: this flexible application adapts to local physical, economic and organisational conditions. Subsidies will encourage operators in competitive markets. Customers report increased mobility and intermodality; drivers have greater job satisfaction.

### **7.8.3 Impact on Intermodality and System Integration**

At present the main objectives of DRT services are (generally) to improve access to public transport in areas of low demand and for particular groups of disadvantaged users (e.g. disabled and elderly). The next stage is to extend mobility by improved intermodality. It has been shown above that the nature of the market environment strongly influences the feasibility of establishing DRT services. The more regulated the market (Belgium, Italy), the easier it is to integrate DRT with conventional services. Open access markets are not easy to integrate, as seen in Finland, where even the provision of up-to-date timetables is not always forthcoming. The West Sussex feasibility site also demonstrated the danger of introducing a subsidised service, which could lead to the withdrawal of regular services by the existing operators if any competitive infringement was perceived.

In addition, vehicle design may impede intermodality: in this case it is the regular service that is most likely to be the weak link in the provision of low floors, wheelchair access and buggy storage areas. This removal of this impediment depends upon national legislation regarding vehicle design and the attitude of operators.

Within any market environment, the service journey pattern selected for the DRT service influences intermodality. Whilst non-predefined stop points are most desirable for customers, they produce greater scheduling complexity. Therefore, predefined stop points are most likely to promote intermodality. The more flexible the route itself, the more difficult it becomes to guarantee connections with other services. Thus, routes which are semi-fixed are easier to schedule for intermodal change – but this is at the expense of individual passenger flexibility.

Little research has been carried out on system integration and scope for further work lies in several areas. In large conurbations fringes are frequently poorly served and orbital services are poorly developed. Strong commuter movements to conurbations from small to medium-sized towns need to be served by local services.

### **7.8.4 Conclusions**

This chapter has presented the results of an extensive evaluation of DRT at key demonstration sites across Europe. The following conclusions are offered:

- Whilst the integration of DRT services into a network provides greater transport cohesion through flexible routing of services which allows access throughout an area

rather than on specific corridors, it is arguable that the adoption of DRT services is not yet as widespread as one might expect.

- The potential for reducing transport costs and improving or sustaining citizen mobility through the introduction of DRT services are not yet fully established. It is likely that such policy objectives could be fulfilled by integrating DRT scheduling systems with Internet journey planners, community transport brokerage schemes and other transport services available as public services, such as educational transfers, social services and patient transport services. However, as has been discussed, a number of pressing institutional, legal and economic barriers must be overcome if the DRT market is to be consolidated. Institutionally, the potential for conflict between different potential service providers (e.g. bus and taxis) and between DRT and other public transport modes is very real, perhaps more so in urban areas. Questions of ownership and control with respect to the TDC may relate to the degree of regulation pertaining. As a relatively new form of public transport the legal and organisational status of DRT is unclear and, without exception, the UK applications to date are hampered by issues of route registration and eligibility for BSOG – which in turn influences the levels of subsidy required.
- Crucially, the viability of DRT services as a self-supporting system has not yet been demonstrated. At most sites issues of fares, cost of phone calls, subsidy, bus and TDC operating costs all pose challenges. However, for financial and scheduling reasons, DRT services (with the possible exception of niche services, e.g. feeders to airports) do not aim to be the dominant public transport supplier in a market, although the SAMPLUS results show they should be regarded as a vital supplier of services where conventional solutions are untenable, e.g. low demand areas, special transport services.
- There are potential new markets for DRT to assist with modal shift since DRT offers scope for full integration with conventional services.

Although the SAMPLUS results must be viewed within the context of the operating environment, particularly with regard to costs, this chapter has identified a number of generic factors that future applications should consider. Governments will continue to grapple with the need to deliver good quality public transport within the context of mobility for all. Telematics-based DRT services, by incorporating individual customer preferences, offers the possibility of greater reliability and punctuality than is often available to public transport users. As Chapter 12 argues, the next generation of DRT services is likely to embrace the concept of flexible, mobile agencies providing a variety of business services with DRT at the core. The next chapter considers in detail the important issues of institutional, organisational and regulatory aspects in DRT service provision.





## CHAPTER 8

### **Organisational, institutional and juridical issues**

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The development of DRT services and systems in Europe should be based on EU, national and local transport policy, strategies and needs. On the other hand there may in some cases be a need to alter the existing national transport policy and strategies for public transport. The institutional and organisational barriers are often greater than technological barriers. Thus a lot of preliminary work and negotiations are needed well in advance with all the parties involved before introducing the new DRT concepts. This is the subject of this chapter.

There are many national and European level guidelines and objectives to be considered in the development of DRT such as:

- policy-related objectives and guidelines (Common European Transport Policy, national transport policies etc.)
- telematics and transport telematics related objectives
- administrative, organisational and institutional objectives
- juridical and legislative framework
- needs of different users and user categories
- market opportunities.

It is evident that conventional public transport cannot meet these challenges everywhere with reasonable costs.

The institutional and organisational issues have proved to be essential and crucial when creating effective DRT concepts. The technological issues and problems are relatively straightforward and easy to solve, but the institutional and organisational

barriers and problems are often very difficult to solve and eliminate, and affect directly the operational framework. The juridical framework regulates the operational framework and has to be respected. The rapid technological development creates opportunities for DRT services. However in several cases the juridical framework, institutional and organisational issues are not able to follow the technological development and opportunities. The following organisational and institutional issues should be defined and cleared in the planning phase:

- juridical status of DRT
- potential operators
- potential buyers of the DRT service (the payers)
- impedance with other public transport modes and services
- pricing issues
- payment and ticket systems
- privacy protection issues
- operational area
- status of the TDC
- dispatching issues
- compulsory competing
- co-operation with different actors
- information.

## 8.1 Development of DRT systems: key issues

Since DRT is a relatively new service and includes several “strange“ features compared to the conventional public transport, there are several questions to be asked and answered and prejudices to overcome. When just demonstrating and piloting new services and concepts these questions and issues can in several cases be forgotten, but when the DRT service concepts and systems are taken into full scale use, they must be solved carefully beforehand. For instance the following issues are essential from the viewpoint of the full DRT service:

- the amount of public transport operators in DRT services (one vs. several)
- the role of the TDC. Should it be a separate body, or incorporated with operators' services?
- the operational environment (free competition vs. totally regulated services)
- transport modes for DRT services (one vs. several modes)
- the level of subsidies (subsidised vs. commercially profitable)
- the modes and treatment of subsidy (subsidy may be used for an operator to cover operator costs or to offer cheaper tickets and fares, subsidy can be channelled via selected operator/operators or via an authority to all eligible)

- the party responsible for the public transport service and operations (local, regional, national authority, private operator/operators, no responsible party at all)
- juridical framework and factors concerning traffic and public transport
- financing instruments of DRT (who buys the services, who pays the subsidies)
- payment and ticket systems, clearing procedures
- operator contracts.

Normally the technical issues and problems can be solved relatively easily with tests, development work and calculations whereas the institutional and organisational issues are more related to political or social relations. Therefore they contain many kinds of contradictory aspects and opinions, which sometimes may be rather emotional. From the institutional, organisational and juridical points of view, there are a few main categories whose opinions, objectives and attitudes are important for DRT:

- passengers (clients/users of DRT services)
- transport service producers (public transport operators)
- authority (local, regional, national)
- important (active) destinations, including terminals.

Within these categories there may be several groups and sub-groups sometimes also with opposite goals and objectives. Thus the identification of institutional, organisational and juridical barriers is extremely important. The contracts of the DRT service between authorities and operators have to be negotiated in time so that the operators can be prepared for future changes. It is not only a question of starting the service and driving the vehicles. There is a lot of preparatory work to be done and problems to be solved.

The operators are in a competitive situation in many ways. The major competition is the competition with other modes such as private car, two-wheelers and walking. This causes institutional problems especially when it is a question of sustainable traffic. Walking and cycling are in many ways healthier than any public transport mode. For the disabled the legislation in many countries has guaranteed at least some freedom of movement, where a priority has been the market of local taxis. In very sparsely populated areas a (private) car is in many cases more sustainable than any public transport mode. Also the competition between operators may cause institutional and organisational problems.

As long as DRT does not have equal juridical status with other (conventional) public transport, the whole potential benefit that DRT services could offer cannot be acquired. The juridical framework and regulations should not only cover technical issues, but also issues related to subsidies, responsibilities, existing regulations etc. It is worth noting that very often this may be rather difficult. For example there are cases where the legal position is unclear and the authorities may be unwilling to discuss the juridical issues

with operators. Thus there is a risk that at some point in the future another authority may block/prevent the developments. It has become obvious that if there is no official basis for DRT services there is a risk that the services can be shut down very quickly even where the services are established and providing real benefits.

It seems unnecessary to expect several different DRT operators in one city (except perhaps large cities) unless two or more distinctly different DRT services (in terms of service quality) are offered under different price structures. One option would be to let tenders for the provision of DRT services, with both taxi and bus operators to bid. The nature of the service(s), fare structures etc. would need to be determined in advance. Ideally, tenders should be let separately for the provision of integrated booking and information service covering all modes, with all operators (taxi, bus, rail, tram, DRT etc.) required over time to provide information on their services in a standardised format. This would allow the public to make the best choice of option or options for any given trip.

Fair competition should be guaranteed where possible. Very often DRT services cannot be operated on fare box revenue and thus a general level of subsidies has to be determined in advance. The ideal situation is a seamless public transport system where DRT is one essential element. However there have to be clear rules and instructions both for the tendering process, contracts and operation of DRT.

Responsible actors for each element in the DRT service concept should be literally defined. There should be also a juridical framework for DRT. In many cases DRT is not recognised within the national legislation which makes it difficult to arrange DRT services on a wider scale. The demonstrations are normally run in “exceptional circumstances”. The tariffs and fares should also be set carefully. Fares that are too high are not likely to attract users and fares that are too low may cause capacity problems.

There are no major risks and barriers in technical issues and most problems can be solved relatively easily. The emphasis should be on the institutional and organisational issues and political or social relations. These issues should not be underestimated. For instance in a multi-operator, multi-modal environment the risks and barriers are remarkable, but they can be solved. The co-operation between transport modes and operators in DRT should be encouraged. This is challenging for instance in situations where DRT replaces existing services.

The operational contracts of DRT service provision are very important and they have to be prepared thoroughly and early enough. There should be no open questions by the time the DRT service starts. There should also be only one party responsible for the specific service provision. This party can naturally then use sub-contractors in the service provision.

202 Equally important as co-operation between different operators and transport modes is co-operation between different authorities. The roles at different authority levels

should be literally defined. The co-operation between different municipalities is needed, especially where the municipalities are small and density of population is low.

The telematics suppliers, both hardware and software, have new potential markets for advanced solutions and applications. The municipalities and other authorities can offer new flexible and cost effective public transport and related services for all citizens, including special groups. Table 8.1 shows the opportunities for different organisations when developing and implementing new advanced and innovative DRT services and related ITS applications.

Organisation	Opportunities
Transport operators and other service providers	<ul style="list-style-type: none"> <li>- new flexible multi-modal public transport services for areas of relatively low demand</li> <li>- new innovative services for citizens, especially for the special user groups (= new customers and users of service)</li> <li>- integrated public transport, information and other services for citizens and especially for special groups (the disabled, the elderly etc.)</li> <li>- new modes of service to increase attractiveness of public transport operations</li> <li>- interoperability and co-operation between different kind of operators and service providers e.g. seamless service for passengers from the origin to the destination</li> <li>- new dispatch and service centres to enhance the effectiveness of operations</li> <li>- increased employment</li> <li>- increasing patronage and revenue by tapping into new markets</li> </ul>
Industry and suppliers	<ul style="list-style-type: none"> <li>- integrated dispatching and service provision applications</li> <li>- personal home and public terminals (especially for the elderly and the disabled)</li> <li>- route optimisation, monitoring and service provision management applications</li> <li>- geographic information systems (GIS) for services to citizens and new user interfaces with advanced technologies</li> <li>- user friendly ordering, booking and payment systems (smart cards etc.)</li> <li>- adaptation of generic tools and applications to meet the needs of new services for the citizens</li> <li>- new kinds of vehicles</li> </ul>
Municipalities authorities etc.	<ul style="list-style-type: none"> <li>- cost-effective and flexible transport and other services for citizens (also for special groups)</li> <li>- health and home care systems for special users</li> <li>- delivery and pick-up services for small goods and parcels</li> <li>- new transportation related services for visitors and tourists</li> <li>- savings or extinction of the growth in transport, social and health care costs</li> <li>- increased vertical and horizontal co-operation between municipal sectors</li> <li>- new kinds of vehicles to meet the needs of citizens (also the special groups)</li> </ul>
Universities, research centres, engineering offices	<ul style="list-style-type: none"> <li>- scientific RTD in the areas of new services for citizens and related telematic applications</li> <li>- validation and evaluation of new services for citizens and their influence on the independent living and participation</li> <li>- simulation studies of new services relating to the Common European Transport Policy</li> </ul>

Table 8.1: Opportunities for different actors when developing advanced DRT services

The end-users/passengers are the most important actors in DRT. Without passengers there will be no DRT services. There will be no operational or economical success in DRT unless the passengers accept the system and trust it. The experiences show that after the users have learned the system, found it to be reliable, and acquired the knowledge how to use it (including telematics), then they are rather satisfied with it.

One of the questions to be solved is the role of the TDCs. Will they be local, regional or national? Will they be linked with each other creating a service network? Will public transport operators, authorities, traffic centres or some other actors, run them? It seems that these questions have no single answer today. The TDCs are trying to find their role. Most likely there will be different types of TDCs. The experiences so far emphasise the importance of co-operation between municipalities and regions. At least if/when the municipalities are small or low demand areas, it is important to have more potential users by combining the efforts and increasing the operational areas.

However, if the operational area is too big, the TDC may have difficulties in locating the origin and destination addresses. If the area is flexible there may be difficulties with fleet management and economical operation of the service.

Obviously the best and most effective way to create these new service concepts is to combine the new services so that the special user services will be integrated with other services. Through development of new DRT related services and using the emerging possibilities of the new Information Society this can be achieved.

The contribution of the future DRT development to European Community social objectives means improved accessibility of services for all citizens, increased quality and user orientation of the social services such as health and home care, decreasing the isolation and withdrawal of special users such as the elderly and the disabled, increasing the possibilities for all citizens to participate and not be dependant on the social group/situation etc. Future work should aim at finding and developing new logistics solutions (people and goods), advanced service concepts and systems to help special user groups to stay and to live actively in their homes instead of being forced to move to old-age home or hospital. The objective is to create, for the citizens, services that can easily be implemented Europe-wide. New technologies should be used and new services should be developed to provide new concepts and policies to enhanced transport, mobility, and participation of the citizens. It has become obvious in that there is a growing need to enhance the user-friendliness of the information society.

The authorities have become aware of the increasing transport costs. In those countries where, in search of equality, transport services for special users are totally or mostly paid by the authorities the costs tend to be very high and increasing. There is a parallel need to decrease the transport costs and still to offer proper transport services for the users. Here the DRT services have proven to be very effective.

The importance of DRT services is great especially for those users and user groups that for one reason or another have no or limited access to conventional public transport services. They may be unable to use ordinary services because of special needs for transport services or they may live in areas where there are poor or no services available or where there is a threat of losing the existing public transport services. The political guidelines urge the development of satisfactory public transport systems and solutions

for those millions of Europeans who have to deal, permanently or for some period of their lives, with reduced mobility and who are dependant on the public transport services with moderate costs to help them to live independently.

It seems that DRT has come to stay in public transport. Evidence of this is the fact that there will be legislative efforts in several countries aiming to define the role and status of DRT services as an essential element of public transport.

DRT is very important for special users such as the disabled and the elderly. However DRT services are very important also for other citizens such as home-based women (especially those with children), teenagers, low-waged or unemployed, students etc. All of these typically have little or no access to a car and are dependent on lifts or inadequate public transport. This reduces their mobility and their possibilities for social participation.

There are many issues to be taken into account, when developing the DRT service concepts and related applications. Figure 8.1 describes principles of the DRT development process. Even though the figure is simplified it shows how there are several steps and issues that have to be taken into account when developing DRT. It is also worth noticing that to develop an effective and working DRT service can be a lengthy process, usually not less than some two years.

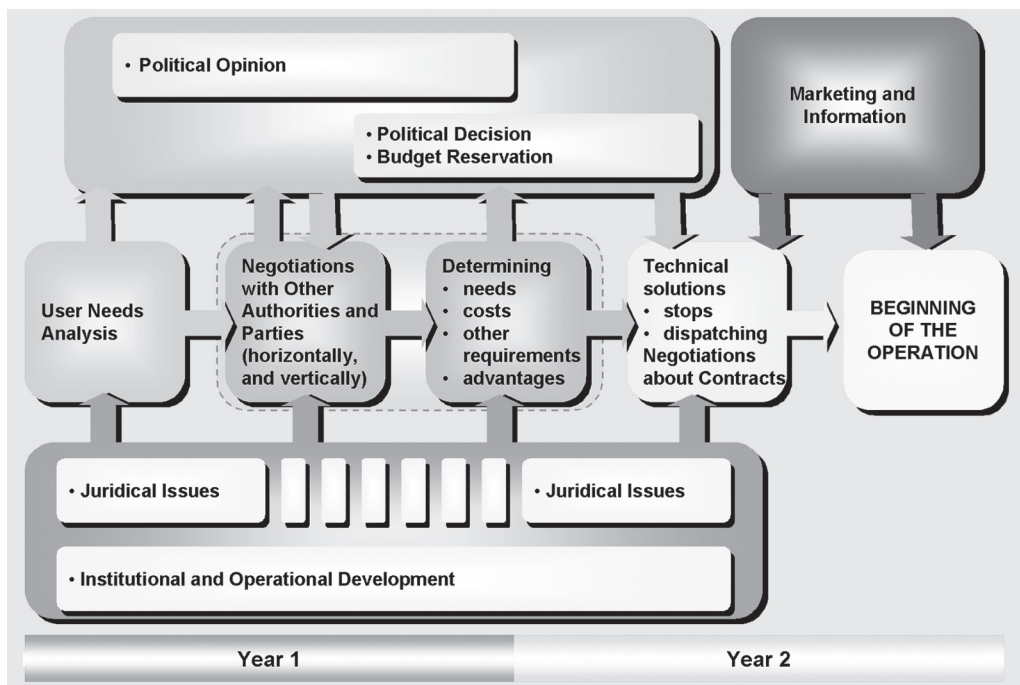
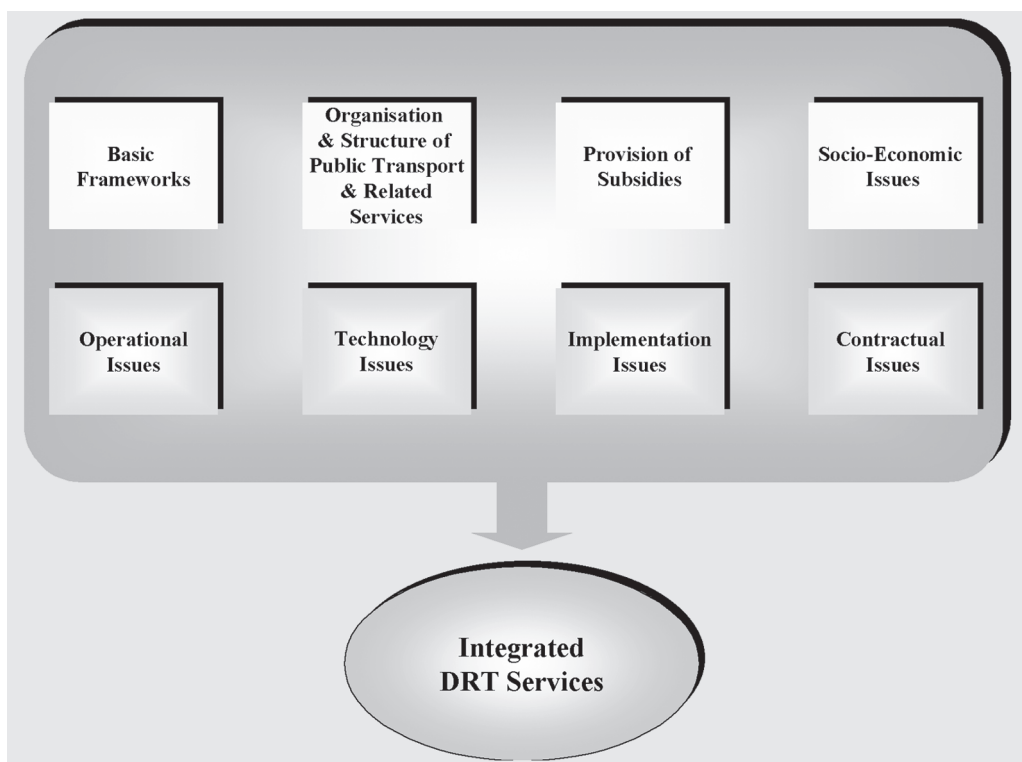


Figure 8.1: Development of DRT services in municipalities

Note: on the second level there is the continuous follow-up of the development of DRT

It is important that all the steps described are taken. Based on experience it can be said that during the DRT development process the technological and telematics possibilities and tools develop very quickly and it would be important to follow this technological and telematics development and to utilise new opportunities when making political, juridical and operational decisions. The steps cannot be taken without financing. Thus in the very early stages of the DRT development it is essential to arrange the financial issues. The technological development, juridical framework, institutional and organisational issues have effects on the operational framework and should be taken into account in the DRT development work. Thus, several external factors, frameworks and issues affect the development of DRT. It cannot be isolated from the social frame of reference. On the other hand there are several issues that have to be taken into account and decided internally during the development process. Figure 8.2 summarises these frameworks and issues.

When planning the DRT concepts in a competitive environment it is important that both public and private organisations are involved and work together. There is also a need to listen to the end users (see Chapter 1).



206 Figure 8.2: Frameworks and issues affecting DRT development



The following actors should participate the DRT planning:

- authorities
- community groups
- public transport operators and associations
- end users and their representatives (associations etc.)
- software and hardware specialists.

To be able to run DRT service properly a reasonably large-scale telematics is essential. Manually the operations and the service cannot be controlled. All the telematics functions should be integrated together.

## 8.2 Basic frameworks

Before starting the actual development work of DRT services it is essential to ensure that all the information concerning the basic frameworks affecting the DRT development is available. If the basic factors are unclear or have not been taken into account, then the DRT concept, however advanced operationally and telematically, may face serious problems when taking it into full scale use.

### *Political framework*

The political framework for the DRT service concept must be clarified. This political framework varies throughout different European countries, even though the national transport policies of the Member States should follow and respect the Common European Transport Policy. Thus the political framework may offer totally different possibilities for the development and operation of DRT services. If there is no political support for the DRT service concept the development and implementation work will be very difficult. Naturally it is important to try to foresee whether there will be changes in the political framework. It may even be possible to try to speed up changes needed.

### *Subsidy and support level*

Subsidy and support possibilities and mechanisms for public transport and DRT especially should be checked. Often the DRT service is not self-supporting and there is a need for subsidies and support to develop and run the DRT service. Very often subsidies and support are closely related to the political framework.

In the discussion of subsidy it is important to notice that the economy of DRT is twofold. All costs and fare box revenue are in the balance of the public transport authority. The maximum savings are in many cases in the balance of other authorities, horizontally or vertically. Often the public transport authority must subsidise the DRT services but the savings for other authorities may be greater than the subsidy from the public transport authority.

### *Legal and juridical issues*

The DRT concept cannot be developed and run if the legal framework prevents it. Thus the juridical obligations and possibilities must be checked. In most countries there is no legislation for DRT, however it seems that in some countries the development work to create the legislation has started. This legislation will determine the DRT concept, obligations and possibilities for DRT. If there is no legislation there should be efforts to create it.

The DRT services need to have a juridical status to be run full scale in a real environment. The pilots and demonstrations can normally be run without any special juridical framework, but after that there should be an official status. It is also important to check whether there are regulations dealing with the competition with other public transport modes and with violating existing public transport services. The legislation for subsidised trips or for social, school and health services may prevent an open-for-all DRT, too, or create other bureaucratic barriers.

### *Potential business and markets*

Naturally the DRT service concept is worth creating if there are potential markets and business for it. On the other hand it may also be a political decision to develop the DRT service even though there are no potential markets and business. This is however not very advisable or desirable. The DRT service concept should have real potential and markets.

DRT can be either a commercially profitable business or a new public transport mode that enables potential for society and authorities to offer statutory transport services more economically and effectively than earlier. It is also important to notice that without integration with existing public transport services DRT is not very likely to succeed. One exception may be DRT serving special users who previously have used taxi. In any case the concept should have potential for high benefit-cost ratio taking into account all the social benefits and costs.

## **8.3 Organisation and structure of public transport and related services**

### *Structure of existing public transport services*

To develop a working DRT service it is crucial to be familiar with the structure of the existing public transport services. If there are no existing public transport traditions and services it may be easier to start a DRT service by using semi-fixed route services with route deviations where requested. In cases where there is quite good public transport between towns/cities, but almost no services in rural and low demand areas, the flexible service with fixed end stop points might be best. If the public transport has quite a comprehensive and wide network, but very low frequency and all the lines are directed to the nearest main centre, the best DRT alternative might be the virtual flexible routes.

### *Monopoly environment*

The situation may vary from country to country or from region to region. There may be a monopoly environment where the business and competition is not that crucial. However the operational issues have more emphasis in the monopoly environment. According to Common European Transport Policy there has to be good arguments for the monopoly environment.

### *Competitive environment*

In a competitive environment the importance of business aspects is crucial. The competitive environment forces public transport operators to develop better and more innovative services than competitors although problems of co-operation are common and can deter the introduction of DRT services. Off-the-road competition is more likely to promote DRT than on-road competition.

## **8.4 Provision of subsidies**

The subsidy issues are important. If there are possibilities for subsidies and support the mechanisms are to be clarified well in advance. If there are subsidies available in public transport it is also very important to clarify if there are obstacles preventing the subsidies for DRT. This is very important since very often DRT cannot be operated on fare box revenue and there is a need for some kind of support and subsidies. There should be no major unresolved questions concerning subsidies and support when planning the DRT service. On the other hand, what is subsidy, who loses and who benefits?

## **8.5 Socio-economic issues**

### *Expected social results and effects*

Socio-economic issues are very important when evaluating the DRT service concept. There should be a clear picture of expected social results and effect for the DRT service. Thus it is crucial to gather beforehand all the information needed for the before and after analysis (see Section 7.1.3).

Most likely DRT will affect many social issues. This is obvious since in many cases the planned DRT areas and users of the DRT service differ from the normal environment and users. The areas may have no or only a limited amount of public transport services and there may be special users and user groups such as the disabled and the elderly.

### *Expected economic results and effects*

On the other hand there should also be clear expectations for economic results and effects. In DRT the costs tend to accumulate to the public transport sector but the

benefits to social and other “soft” administrative sectors. Therefore, if economical results are expected, it is essential to collect data related to transport costs before and during the operation of a DRT service.

## 8.6 Operational issues

The operational issues and decisions form the basis of the DRT service. They have to be clear, practical and justified. They have to be defined so that all the parties involved with the development and operation of DRT can approve them. They also have to be measurable, if at all possible. As noted in Chapter 1, the service concept should be planned based on the users’ needs and there should be discussions, planning sessions etc., where the service characteristics are defined. The decisions of the service concept should cover issues like:

- type of service
- service area
- service hours and timetables
- routes, if any
- ordering procedures
- stops and meeting places
- all statistics for administrative and other purposes.

### *Service level and quality objectives*

The DRT concept needs clear and measurable service level and quality objectives that can be used when assessing and evaluating the service level and quality of DRT. It is also important to plan how the service and quality assessment and evaluation will be carried out in practise.

### *Operational rules*

The DRT service cannot be provided if there are no rules for the DRT operation. All the different actors: end-users, authorities, drivers, dispatchers etc. need to have rules and instructions how to behave in different situations. The responsibilities and rights have to be defined. The rules have to be written and they have to be clear and easy to understand. It requires a lot of work and discussions to create these rules. Especially in a multi-operator, multi-modal environment the rules may be rather complicated. On the other hand, the use of common sense should not be forgotten. It is also important to decide what kind of users will be transported from door-to-door.

### *Analysing users’ needs and requirements*

210 Naturally the DRT service is not a service for itself, but for the users. As emphasised in Chapter 1, it is important to analyse and to define all the different users, user groups

and user categories (both direct and indirect users) and to analyse their needs and requirements. Even though it is possible to learn from previous exercises, the user needs and requirements analysis should always be completed when there are plans to introduce DRT in a new area (it also provides a very good awareness-raising activity, and identifies potential support from the community in establishing and maximising the use of the services).

There are several issues and steps that have to be taken into account when defining the user requirements. Figure 8.3 shows the different steps of the user needs/requirement analysis.

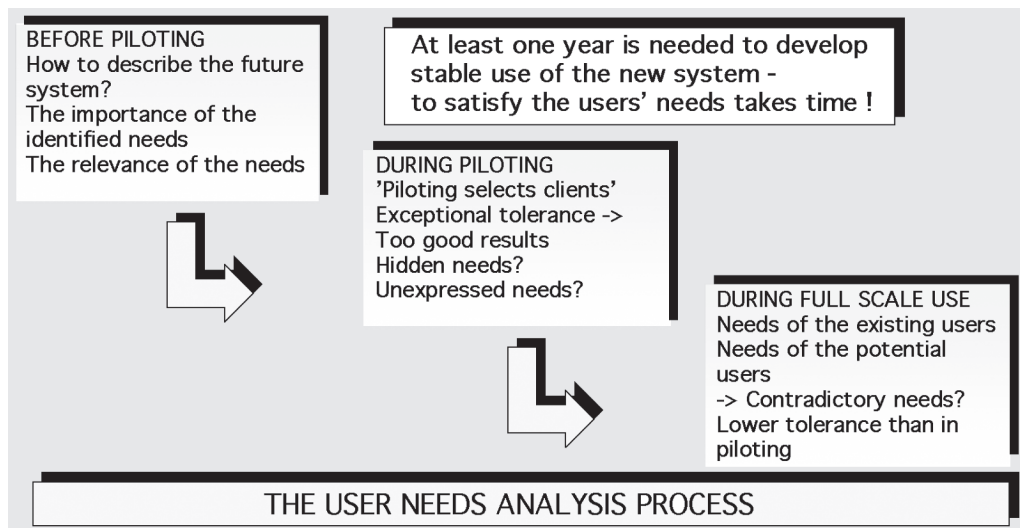


Figure 8.3: The structure of user needs analysis

### *Walking distances to stops and meeting places*

The operational environment of the DRT may vary greatly (for instance from urban to rural). Therefore it is important to define the walking distances to DRT stops and meeting places taking into account the operational environment. In most cases there are also users that justify picking up from their homes and thus for them there is no walking distance. Especially in competitive multi-operator, multi-modal environment it may be rather complicated to define the distances since the operators may have contradictory opinions.

### *Integration with other modes*

The idea of seamless public transport is becoming more and more popular. To achieve this objective the different public transport services and modes should be integrated.

DRT should be seen as an essential element in the total public transport chain and it should be integrated with other modes.

The integration of the public transport timetable/schedule information would require a comprehensive and up-to-date time schedule database with very short response times.

#### *Fares and clearing*

The decisions about DRT fares and clearing systems are important. The DRT fee may be the same as in normal public transport. However often it is higher than the ordinary fee. If there is more than one mode and operator involved with the service, it is important to create and agree upon an effective and impartial clearing system, as well as the rules for sharing the revenue.

#### *Positioning of origin and destination*

Very often in DRT there are no routes or timetables, but the service is provided by the request of the user (see Chapter 2). Since the user normally informs the dispatcher the origin and the destination it should be very straightforward. There should be an easy way to inform the dispatcher about the origin and the destination.

The origin is normally easier to establish, but the destination is often open to various interpretations. Naming and numbering the meeting places and using stickers on the phone (telling the name and number of the nearest stop) have been used but they have not eliminated all the problems. When it comes to vehicles the positioning technologies have to be defined in good time before the operation starts. The use of standardised solutions is recommended (Chapter 4).

#### *Marking stops and meeting places*

The stops and meeting places have to be marked and their co-ordinates should be in the dispatching system. The markings should be clear and visible containing at least name, number and the telephone number of the TDC. The points of interest should be in the TDC database but they normally are not marked. Often there is a need for totally new stops for DRT and thus the marking work should be started in good time.

#### *Training and informing the operational personnel*

All the people involved with the DRT operations and service should be provided with proper information and training. This training should be planned carefully and there should be enough time for the operational personnel to get acquainted with the DRT service concept and its requirements.

212 When the operational personnel have been informed, trained and discussed early enough the threat of lack of motivation and negative attitudes decreases strongly. It is

also important to bring together the operational personnel and discuss with them about the forthcoming DRT service. The dispatchers, driver and other personnel should learn to know and talk to each other.

#### *Information to end users*

Experiences show that the information activities targeted to the different end-users are never too much. To provide the information for the users articles in newspapers, brochures, discussions, seminars, radio and should be used if possible.

The information should be carefully planned and it should be very easy to understand. If the users do not know what they are offered they most likely will not use the service. There should also be a contact person to answer the questions the (potential) end-users may have.

#### *Fleet*

The user needs analysis and naturally all other DRT-related information should be utilised when planning and preparing the fleet to meet the needs of the users. The vehicles should be suitable for the DRT operational area, they should be especially equipped for the special users (if the services are targeted to these users), they should be telematically equipped (to be able to communicate reliably with the TDC). The number of vehicles should also be estimated carefully. Especially in the multi-operator multi-modal environment the fleet decisions are of great importance. Experience shows that the buses must have reasonable accessibility (see Chapter 6). It would be good if they could be wheelchair accessible. The buses should have low floors, if possible and they should be mini-bus sized. The noise level should not be too high.

#### *Feedback system*

Since the best way to develop the DRT service concept is to listen to the operational personnel and the different users of the system there should be a good follow-up and feedback system which not only gathers the feedback, but also actively stimulates the operational personnel and the users to provide feedback related to the system. All the feedback should be recorded and it should be used for evaluation and further development.

## **8.7 Technology issues**

#### *Open vs. closed system, the level of standardisation*

One of the main technological decisions concerning DRT is the decision of the openness of the technologies and applications to be used (see Chapters 4 and 5). The closed technologies may be cheaper and easier to introduce. If the objective is to develop a 213

DRT system that can be integrated with other public transport systems, the only answer is standard open architecture and standard open systems. Naturally since the standardisation work of several telematics tools, equipment and applications is not yet finished, it sometimes may be difficult to make the technological decisions. However perhaps the most important thing is to confirm the openness of the DRT system by using as standardised user interfaces as possible. It is also important to try to foresee the possible functional links.

#### *Communication links and equipment*

The communication links and equipment to be used should be both quick (short response times) and reliable (no breakdowns or errors). The positive thing here is that the telematic development is so rapid that the telematic tools are not causing major problems if the background issues are taken care of. The new generation mobile phones for instance will offer huge possibilities for the communications in the DRT concepts. Also positioning technologies for vehicles are developing quickly and at the same time the hardware costs are decreasing. Here the openness and standard solutions mean reliability.

#### *On-board units and software*

The on-board units and software to be used have to be considered carefully. As with communication links and equipment the technological development of on-board units is very rapid. The new generation mobile phones, portable computers etc. offer a wide range of good alternatives. The data communication is often more reliable and effective than voice communication to vehicles. Also the possibility to print the messages, instructions etc. has been regarded as a good characteristic.

#### *TDC application*

The TDC application is the most challenging element in the DRT system. The dispatching system has to be easy to use, quick, reliable and integrated with other public transport systems (if possible). The system requirements depend widely on the environment factors and service requirements.

Therefore the well functioning TDC system may vary very much from site to site even with equal passenger load. The system has to contain some level of route/time/etc. optimisation, if there are several departures and arrivals during one trip. The use of digital maps have been proved to be illustrative and useful especially, if the operational area is large.

Much effort should be put to planning and development of the proper TDC system. It is useful to study the experiences of the previous TDC system development projects.

214 At least some work in the TDC will be manual for a long time because of inexperienced



passengers. Because of the labour costs, the TDC is an extra cost for transport and therefore the automation of processes at the TDC is a wise policy, but the automation must always include the possibility for human interference.

#### *Integration with other modes*

The DRT software and hardware should be integrated with the systems of other modes and operators. This requires open systems and solutions. It would also be useful to integrate the DRT system with timetable information applications. However, at the moment there seems to be a very limited amount, if any, of reliable, up-to-date, timetable information systems and databases. The integration requires discussions and negotiations with other modes and other operators, who may also be competitors.

#### *GIS systems*

A comprehensive GIS system is useful, especially when the geographic area is large and the amount of data are great. When using GIS it is important in addition to the stops and meeting places to include all relevant points of interest, public offices and buildings, agencies, local names etc. in the GIS database. When using GIS in DRT, it is crucial to plan the updating routines so that the GIS system is reliable. However in many cases this is a huge and challenging work.

#### *Payment systems*

Payment systems can be used to make it easier and faster to pay, to gather follow-up information, to provide information for the clearing activities. An agreed clearing system is essential, if there is more than one operator providing the DRT service. The payment methods may be cash, magnetic cards, smart cards etc. The payment system has to be planned and developed carefully since the cash flow is always important for the operators.

#### *Testing and verification*

The DRT systems - hardware and software - must be properly tested and verified before piloting, prototyping and implementation. The testing and verification should be done to all parts and modules of the DRT system and followed by the integration testing and verification to make sure that the different modules also work together. The testing and verification should be planned carefully.

#### *Training and informing the users*

Proper training and sufficient information is to be given to the technology users. Experiences show that the information activities targeted to the technology users are seldom too great. Workshops and training sessions are essential for the technology users. The training and information should be carefully planned and very easy to understand.

Training material and training sessions must be user sensitive, i.e. the material and sessions must be able to describe practical solutions for a participant's existing situation.

#### *Piloting and prototyping*

The DRT systems should be taken into use through demonstration where a limited amount of vehicles and limited amount of users will test that the system (even though bench-tested and verified in advance). There should be a proper demonstration plan including the pilot period (start date, end date), feedback instructions, information collection procedures (for evaluation) etc.

The demonstration of the system should last preferably at least six months. If the demonstration period is shorter the users most likely will not learn to use the DRT service concept before the pilot period is over. After a successful pilot period and subsequent modification the DRT system can be implemented and taken into full use.

#### *Maintenance*

It is important to plan and develop a maintenance system to confirm that the DRT service concept will be continuously supported by the working technologies, hardware and software.

#### *Feedback system*

There must be a feedback system that gathers the feedback from different users and actors. The feedback system should encourage all the users to provide feedback, suggestions, experiences etc. related to the technological issues. All the feedback should be recorded and it should be used for evaluation and further development.

## **8.8 Implementation issues**

#### *Test plan, testing and implementation plan*

The implementation of the DRT service concept and related hardware and software has to be planned and carried out according to proper testing and implementation plans. There may be two implementations: the implementation of the pilot and the implementation of the full scale DRT system. Both implementations are important, however the implementation of the full scale system always requires more than the implementation of the pilot.

Normally the full scale system to be implemented is not exactly the same as the pilot system. There may have been improvements, changes and modifications. Thus the system to be implemented has to be tested very thoroughly. It cannot be emphasised too much that the system must not have any unsolved operational or technological problems left in the implementation phase.

### *Training, informing and education*

There has to be sufficient time and effort for training and education during the implementation phase. All parties must be aware of what is going to happen and what is required from them.

### *Backup system and parallel running with the old concept*

It is essential to exercise great care and sensitivity when replacing existing services with DRT services. To make sure that there will be no major problems it is advisable to run the old system (if there has been one) and the new system in parallel for some time so that there is always a possibility to take the old system into use, if needed. However in case something happens there has to be a backup system to be taken into use when needed.

### *Integration with the existing systems and services*

To get the best results out of a DRT service it should be integrated with the existing systems and services. This integration has to be planned thoroughly and in good time so that there will be no unexpected integration problems. The experiences show that the proper integration requires considerable effort.

### *Feedback system*

To make sure that the implementation has been carried out according to the plans there has to be an easy to use feedback system for all the parties involved. The feedback system will provide valuable information concerning not only the implementation but also the DRT service concept as a whole. All the feedback should be recorded and it should be used for evaluation and further development.

## **8.9 Contractual issues**

### *Basic contractual issues*

The operation and running of the DRT requires, as with any other transport operation, a proper and thoroughly planned contract. The contractual issues are especially crucial when an external transport service operator provides the service. If the DRT operator is a part of an organisation paying for the DRT services, the need for a detailed contract is less than in the case where some or all of the DRT operations are contracted. The DRT operation contract must include the standard elements and parts of every public transport contract. The operational area, defined and agreed upon in the contract, has considerable affect on the DRT operation. The operational area decisions are very important from the service level and fleet management point of view.

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The contract period is crucial for a private operator. If the time period is short, it is difficult to learn the new DRT system, impossible to amortise special vehicles and equipment needed in the operation, and to find motivation for the continuous development of the concept, which is essential for DRT services. If the contract period is too long, there may be erroneous estimates of the DRT system or its economy in the beginning. There may also be difficulties to adapt new operation models.

Sometimes the ideas and practices on which the contract is based change or turn out to be erroneous. Therefore the contract must contain terms of cancellation – a method to cancel or terminate the contract within a given time (for instance in some months) and the basis to agree any recompense.

The DRT service operation time (operating hours) is an essential part of the contract. The daily operating hours have an affect on the possibilities and motivations to use DRT services. If the daily operating time is too short, the DRT service will not ‘find its place’ and remains as a special service for special groups.

Because the DRT service often consists of several operations that are at least partly connected with each other in a new way the responsibilities of each operation must be clear. This includes the definitions of the service concepts and especially the links between separate parts/elements of the service chain. If there are many operators and especially many public transport modes the definition of all service aspects and elements must be done. It is typical that different operators and modes have slightly different meaning on the terms, or some terms may not be in use at all. Thus it is very important to agree upon the terminology.

The agreement upon the management of DRT operations is an essential part of the contract. Because DRT is under continuous development the management board typically is a mixture of purchasers and operators. This will ensure that both the economical and the operational aspects are taken into account.

The contract fee is one of the important issues affecting the future development of DRT. The contract fee must stimulate and encourage the future development of the DRT service concept. This is extremely important. The contract fee does not necessarily have to cover all the costs related to DRT if the operator estimates that the future market potential and possibilities might lead to substantial downstream benefits. The contract fee may be based on fleet size, number of passengers, operation time etc., or a combination of these factors. The fare box revenue can form one part of the contract fee.

Proper and active marketing is an essential element for all new systems. This is the case with DRT services too. New ways of thinking in public transport may need years to become accepted and before the penetration level is high enough. Indeed, it may require quite a long time to stabilise the DRT system as an essential element of the public transport concept.

The methods of solving disagreements or disputes have to be described in the contract. The same goes with reporting on the disagreements and/or mistakes. The reporting has many levels and objectives. It should be defined at least for operational, development, purchaser and authority purposes.

### *TDC issues*

The TDC itself needs a specific, detailed section in the contract. The TDC may be part of the DRT operator's own organisation, or a separate body outside the DRT operator. On the other hand it may belong to the purchaser's organisation or to some other organisation outside other DRT organisations. If the TDC is not a part of operator's organisation, special attention must be paid to the services (information, queries etc.) given and received.

The communication and information transfer responsibilities have to be properly defined. To prevent the TDC to begin behaving independently without a proper relationship to operations in the field, the operation contract should include indicators for economic effectiveness which tightly tie together the TDC operations with the total effectiveness of DRT services.

The TDC may perform the route optimisation. Route optimisation is less necessary for small and medium sized operation areas if the drivers are familiar with area. If route optimisation is used it is important to define who collects the start-time situation and who updates the road network information.

If DRT co-operates with other public transport the good practice is that the TDC is well informed of existing public transport. How the information is used, and whether it is available for everybody, is a policy decision. If the TDC is a source for common public transport information the price of telephone calls must be taken into consideration. The TDC cannot be a competitor for business-based information services.

The TDC is dependent on data transfer. Therefore the data transfer methods and responsibilities of correct data transfer must be clear in the contract. On the other hand the data transfer is one of the fastest changing areas in technology and therefore the content of contract must be flexible.

The reporting for service improvement, service failures, economical relations, authority needs etc. must be an essential part of everyday operations in the TDC. Reporting will be for operational, development, purchaser and authority purposes. Many TDC operations are totally dependent on the real-time knowledge of the operational area.

Therefore the map information as names of locations, blocks, roads, buildings etc., roads, public transport routes and terminals including usual stops, road network, addresses are a vital part of the TDC information and therefore the purchase and update of this kind of data(bases) must be clear from the beginning.

### *Co-operation with existing public transport*

The crucial question in the co-operation between DRT and existing public transport is the openness of DRT services. If DRT is meant for some minor special groups there are only a limited amount of co-operation questions to be solved (if any). On the other hand, if DRT is open for all, all the public transport operators, including taxis, call buses etc. are potential partners in co-operation.

The introduction of open DRT in areas where there is existing public transport causes adaptation of new and old public transport to each other, at least in the long run. If the DRT is not open for all the adaptation by other public transport may be unnoticeable. Because DRT in general and in principle is more expensive than conventional public transport, the authority-purchased DRT normally avoids the violation of other public transport, i.e. DRT do not collect passengers if the line based service is adequate. The best situation is a co-operation with other public transport from the start of DRT and the creation of simple and fair “anti-violation” rules in the real spirit of passenger service. If other public transport operators receive information all the time suspicious attitudes diminish considerably.

Working with the taxi industry is the hardest part because in many cases the taxi assumes that DRT lies in the same market with taxis. The co-operation is not one-sided. Normally the adaptation causes the existing public transport at least some reduction in most uneconomical lines. It is good practice to estimate possible conflicts and create rules to avoid illegal and unnecessary conflicts. In the same process it is good to negotiate the feeder service principles.

### *Ticket system and means of payment*

DRT should adapt to existing public transport ticket systems. Because DRT normally is the minor part of public transport, DRT must adapt more than other public transport. At the same time solutions must be found for the ticket system and decisions on the means of payment. Because other operators may be sub-contractors, the use and extent of sub-contractors should appear in the basic contract. DRT may have a separate ticket because the price may differ from the price of ordinary public transport. If a smart card is in use, the part-time vehicles or supplementary vehicles may not have the necessary equipment. The contract must include ticket price change methods.

Some legal issues may restrict the ticket price. For example in Finland the ticket price must be “moderate in the area”, if the clients are eligible for social reasons for subsidised transport. The payment method(s) definition(s) must consider that there may be customers with vouchers. The clearing of vouchers may include bureaucratic difficulties. Who pays the bureaucracy costs?

In many cases the local public transport may have long-established means of settling the ticket receipts and allocating the revenue.

There are many aspects to be taken into account in the contract

- what are valid tickets?
- adaptation of the DRT system to existing systems and methods
- own tickets of DRT
- transfer tickets
- use of smart card
- clearing system.

### *Service provision rules*

It is always important to describe the service concept in details. Especially this is the case in DRT because most operators and TDC personnel are not familiar with the service concept in the beginning. On the other hand there must be an easy way to modify the operational rules, if they cause unsatisfactory service or are economically unsustainable. For a passenger one of the most important things in DRT is the way and time of booking the trip.

Another important issue is the possible boarding and egress locations. It is important to make attitude surveys and studies during the DRT operation. If the attitude studies report the need for changes there have to be agreed rules for the process.

It is also important to define the service quality objectives and measures. The contract has to contain the agreed quality levels to be fulfilled and define procedures and sanctions in case of non satisfactory quality.

If the TDC is a separate body and there are many separate operators to carry out the passenger transport the vehicle selection rules are of very high importance. In the TDC the vehicle and route optimisation needs a lot of parameters. To avoid suspicion among competing operators the parameters and selection process should be open. The optimisation can involve factors of suitability, economy, policy etc. The TDC must have a list of questions and all statistics needed for all reporting.

For the driver some rules are needed. How much help for the customer is included in the service, waiting for client etc.? When the service is being introduced, the procedures for how to respond when there are difficulties or unsuccessful service in either the TDC or in the field are important. In special transport a sensitive common sense approach is highly and desirable. No rules can replace a sensitive and helpful driver and TDC personnel.

### *Service quality*

One chapter in the contract should be reserved for the quality questions. The contract should include the criterion of how and how often the service quality should be measured, who makes the measurement, who pays the costs, in which way the results will be published and what are the consequences of the results.

### *Contract amendment principles*

In DRT the system elements have very separate development periods. On the technical side stops and other aspects of the traffic environment are quite stable. The vehicles may change considerably over a period of years, the technology at the TDC and in vehicles may change totally over a few years, the data communication may have major changes in months, as may the software in all equipment. Due to these different cycles, and because the whole DRT concept is under development, longer period contracts must include short ways of contract amendments. The content must be able to adapt to new solutions and situations. The tariff changes must be quite simple, if the price is not fixed on a common public transport ticket price. Contract amendments may have some ways to influence the demand and not only following the changes in general public transport.

### *Authority issues*

DRT is a new concept and therefore the national authorities may have great interest in DRT. At the beginning the national authorities may be willing to subsidise the concept and therefore be a party to the contract. The regional authorities are a natural participant in DRT. The deal between local and regional authorities greatly depends on the national models. A successful DRT needs close co-operation between local and regional authorities - vertical co-operation. Because the DRT impacts on several other sectors as well as on technical aspects the horizontal co-operation of authorities is extremely important. The horizontal co-operation must include at least the technical (public transport), social, health and education authorities. Some of those are authorities utilising the system despite being outside the contract. Therefore there must be rules for the services offered to these authorities, future options and restrictions for the oversized use of the DRT concept. The discussion must include the monetary issues too. Without monetary discussions the costs may accumulate to public transport operators and not to other authorities. In this case the DRT will be without any evidence of savings gained on other administrative sectors.

### *System development and feedback*

If DRT is not totally ready a continuous follow-up, reporting and feedback is needed and is an essential part of the contract. In the contract there must be a readiness for change on both sides (purchaser, operator). The marketing of the system is a part of development, but must be targeted towards specific user groups. General marketing has difficulties to reach special groups.

### *Fleet*

222 The passenger volume in DRT may change considerably. This means that the fleet size question is a sensitive part of any contract. The running of the system may include a



principle of capacity restrictions and thus a fixed number of vehicles. Some questions which are essential to handle before such decisions are: all day capacity, part-time vehicles (as taxi), fleet quality aspects and definition, response to demand, fleet size flexibility, and fleet type flexibility.

## **8.10 Conclusions**

This chapter has introduced the principal organisational, institutional and juridical issues that are emerging as greater understanding is gained of telematics-based DRT which is still a relatively new form of transport service. Much of the experience reported here has been gained in the context of the EC-funded SAMPO and SAMPLUS projects which were reported extensively in Chapter 7 and further experience is being captured via the FAMS project (Chapter 12). It is clear that the issues raised here cannot be ignored or underestimated in terms of their impact on the final outcome of the service offered. They are relevant to all forms of DRT; two other applications are discussed in subsequent chapters, namely collective taxis (Chapter 9) and car sharing (Chapters 10 and 11).



## Collective taxis

### A. Perugia

#### 9.1 Introduction

In the public transport sector it is the taxi that offers the better service. It is also the more expensive service and therefore its usual customers belong to a restricted circle of people. For others, it is only worthwhile to use the taxi when it is strictly necessary. For example, when one has luggage, is in a hurry, is worried about one's personal safety at night, in case of scarce knowledge of the place and the public transport offered or in case of lack of alternatives. The high cost of the taxi makes it less attractive and limits the spreading of this means of transport, which could have many advantages over the car for private use. In order to lower the tariffs a policy that supports the market and promotes the demand must be fostered, as it is already happening in many cities such as London or New York where the taxi is very popular. However, an alternative could be to try the collective taxi.

As part of the family of DRT (Demand Responsive Transport) systems, the collective taxi offers a service similar to that of the taxi but at a much lower price. Savings are obtained through users sharing their trips with others. Obviously the service will not be unaffected. However, in many cases, thanks to the lower costs, the service will be welcomed by users and will be profitable for the manager. Collective taxi systems can have several variants. It is worthwhile stressing that if one wants to achieve a commercial success with this service some of the peculiarities of the conventional taxi have to be

maintained, otherwise other solutions should be organised. The attractiveness of the conventional taxi at railway stations and airports is the absence of transfers for passengers with a lot of luggage. During a nightly urban service it is desirable to use a quiet means of transport which does not expose the user to the risk of aggression. Others judge a comfortable place to sit as well as the absence of a crowd and excessive physical contact with other people as essential.

When these specific requirements are met, a collective taxi can be preferred by users who are keen to give up the other features of the conventional taxi, such as, for instance, reduced travel times or exclusive use of the vehicle. In this chapter the collective taxi is defined as a good quality DRT service that presents the same features of the conventional taxi, which are absent from conventional public transport, but using comfortable vehicles with limited capacity (shuttle buses with 8-10 seats, in certain cases the same vehicles used by conventional taxis), and that takes the user to his doorstep and is organised for clients who are without expectations but at the same time are sensitive to the economic factor. There are several models of service. Two will be described here: linking to the airport and taking people to their home at night. Both belong to the class of one-to-many systems in that they are based on a unique mode functioning as an origin (either the airport or the bus terminal).

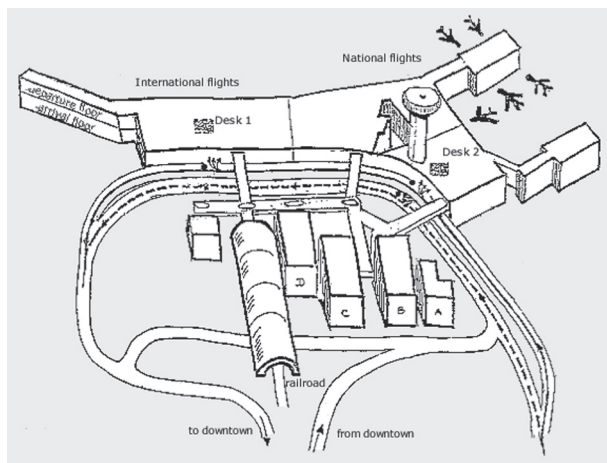


Figure 9.1:  
Collective taxi at an international airport

## 9.2 A collective taxi service for the airport

When arriving at an airport a foreign traveller will find two main obstacles which prevent him from using the conventional public transport: the luggage and the lack of local knowledge. The same can happen when he is departing. It has to be said that the speed of the service is not too important whilst the reliability is particularly important for passengers who are leaving. The collective taxi can represent the right answer.

### **9.2.1 The service model**

The service for collective taxi for the airport includes:

- the transfer of departing passengers who are picked up at their home. This service can be accessed via telephone booking;
- the dropping off of arriving passengers at their destination. This service can be accessed either through booking or by enquiring at the moment of arrival at reservation desks, which are situated in the hall of the airport.

A passenger wanting to depart for the airport will book the collective taxi through a telephone call made well in advance (for example by 14.00 of the previous day), by indicating the pick-up time required and the address. Once the deadline for bookings has elapsed the computer fills in the list of passengers for each vehicle and allocates to it an optimal route. Then, various lists are sent to the drivers. The next day a vehicle will turn up at the agreed time to pick up the user. For the arriving passenger appropriate reservation desks will be found at the airport. He will then be able to indicate his address and then he will sit and wait for his turn to get in the vehicle, which, together with four or five more people, will take him to his destination. Alternatively, one could book the service in advance by specifying his flight details. He will still have to wait in the waiting area in front of the desk. When the conditions are met for a vehicle to depart, some passengers will be invited to go outside where they will find the vehicle that has been assigned to them and called by radio. The area serviced in a city will be divided into sectors: passengers will share the vehicle when they are heading to the same sector.\*

The personnel at the reservation desk will insert the drop-off addresses in the computer which will group them together, each with a destination belonging to a certain sector of the city.

### **9.2.2 Management of the movements**

In the service managing departures the automated procedure for the planning of a day will start when the booking deadline has elapsed. The managing computer will divide the set of passengers wishing to depart into a number of homogeneous groups (typically from 4 to 6), belonging to the same sector and that can be grouped by close departure time. In the following, these homogeneous groups will be called departure lists. In order to fill in the departure lists the managing software will use optimisation algorithms. A route departure time is associated with each list, which has to be strictly observed, in order to meet the agreements made with the users. The departure lists are indeed the core of the whole system and are left to the responsibility of the individual

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\* This is at least in a simplified version of the system. If a computerised solution is adopted, algorithms will be used to verify dynamically the vicinity of dropping-off points.

drivers. Each driver is given one or more departure lists per day. If more than one, there must be a sufficient gap between the end of a list and the start of the next.

In the service at the arrival passengers are grouped into lists. These are organised in real-time by the computer on the basis of previous bookings and waiting passengers. In order to decide the composition of an arrival list and the departure time of a vehicle the managing software will use optimisation algorithms which take into account factors such as the passenger waiting time, the number of passengers on board and the length of the route to accompany them to the city. Even though users, on arrival at the airport, can obviously ask directly at the reservation desk, some form of pre-emption will be given to those who have booked in advance. The route taken by vehicles in their trip to the destination is also optimised by the computer. In the overall management of the service it is obvious that passengers wishing to depart will have priority. A driver who has been given two departure lists, one following the other, could be forced, in the case of a delay, to go back without passengers in order to be in the city at the times agreed on the second list. Likewise, in the event of unforeseen situations, emergency actions might be taken such as, for example, the use of conventional taxis (see Section 9.2.3 below).

The service module describes the daily shift of a vehicle. In the more simple case it includes a departure list and an arrival list with the following characteristics:

- picking up passengers belonging to a departure list;
- taking them to the airport;
- waiting for passengers belonging to an arrival list (which has been assigned in real-time by the reservation desk) to get on the vehicle;
- taking them to their destination in the city.

The time required to complete a departure list followed immediately by an arrival list will be indicated in the following as  $t_g$  (time of tour).

### **9.2.3 On-line assistance service**

A service for collective taxis for an airport can be made very reliable. In particular, the risk that a departing passenger misses his flight can become minimal if radio on-line assistance service is used and appropriate actions are planned in the case of congested traffic or other unforeseen obstacles. For example:

- a vehicle leaving the airport without passengers on board or with very few of them in order to start the departure list already-assigned on time;
- drivers being notified of traffic problems or other reasons for delays and suggested alternative routes;
- interruption of a route to pick up people and its completion through individual taxis whenever picking-up times become longer than foreseen;
- putting aside one or more reserve vehicles in case a substitution is required.

### 9.2.4 Dimensions of the fleet

In order to describe better the possibilities offered by the service hypotheses on the maximum number of passengers that can make use of the collective taxi are made which will lead to the definition of the number of vehicles required.

Let us suppose that from 07.00 to 22.00 on a weekday the movement of arriving passengers in an big international airport reaches 5,000 passengers per hour at peak times, whereas at non-peak times it drops down to 1,500 passengers per hour. Similar values can be used for departing passengers. Let us assume that 2,200 passengers arrive at the airport each hour. Let us suppose that:

- 60% (1,320 passengers) are not transferring passengers (therefore they end their trip there);
- 30% of these (396 passengers) are directed towards the waiting area which is serviced by the collective taxi;
- 15% of these (60 passengers) will require the collective taxi, every hour.

Similar calculations can be devised for departing passengers, bringing the total to 120 passengers per hour, to include departures and arrivals. The formula for working out the number of vehicles required in order to guarantee the two-way service is as follows:

$$N = \frac{P * 0,60 * 0,30 * 0,15 * t_g}{c}$$

where

$N$  = number of vehicles

$P$  = average hourly arrival (or departure) rate

0,60 = percentage of transferring passengers

0,30 = hypothesised percentage of passengers related to the service area

0,15 = hypothesised percentage of passengers who choose the collective taxi

$t_g$  = tour time in hours

$c$  = average number of passengers on-board.

If the tour time (a one-way trip followed by a trip in the other direction) is equal to 3 hours and the average number of passengers on board is equal to 4, then the fleet of vehicles required simultaneously by the service are:  $N = 45$  vehicles. Concerning the number of drivers, this is not calculated here as it depends on the duration of the shifts.

The average income per shift is linked to the tariff. By hypothesising an average tariff equal to 20 Euro, each vehicle would serve on average 8 passengers in a 3-hour shift (a departure list and an arrival list) and the average income per vehicle would be 160 Euro for a 3-hour shift.

### **9.2.5 Structure of the organisation and technologies**

In order to organise a service of collective taxis for an airport the following is required:

- computers for the bookings: these are to be used at the reservation desks and for the bookings via telephone;
- a free-phone number;
- a computer for central management which will be connected to the computers devoted to the bookings through a client-server link;
- software for the management and optimisation algorithms;
- a computerised geographic system;
- a computerised graph for the road network;
- reservation desks at the airport;
- signs and related stopping areas to allow passengers to get on and off the vehicles at the airport;
- a fleet of 40-50 vehicles which will be used at the same time;
- an on-board radio and possibly modem and printer;
- two operators who have to be present at any moment at the reservation desk.

## **9.3 Night service**

After a night spent at the movies or at a restaurant in the centre of a big city going back home can become a problem for a woman travelling alone. The use of the bus is not suggested at night because of the segment of the trip from the bus stop to the house. Usually it will be a man accompanying a woman by car. Otherwise, if she does not want to pay for the taxi or use her own car (which often does not solve the security problem anyway because of parking spaces far away from her home or underground and isolated), she will avoid going out. The collective taxi, in cases like this one, can represent a solution.

### **9.3.1 The service model**

A nightly shift of collective taxis can work in the following way. One or more urban bus lines link the district with the city centre using a common terminal point. At fixed times which are common to all lines, for example every 30 minutes, buses coming from the centre arrive simultaneously at the district bus stop. They wait for a few minutes and then they depart towards the city centre. The length of the trip of the bus lines is fixed in such a way that all arrivals and departures must happen simultaneously. In the district a certain number of collective taxis will link the terminal point to the users' homes. Buses working at night will have on-board booking equipment installed, on which the map of the district is shown, which is sub-divided into a certain number of zones. By introducing a coin and selecting a zone the machine will emit a ticket on which is



indicated a unique booking number. Once a taxi arrives at the terminal (having been called by the booking centre which is operated by computers) it will show among other things that booking number. Clients of the service will then get in the taxi together with others and they will be taken to their destinations. This will cost them a small amount of money which will be on top of the amount spent when the booking was made. The taxi driver will receive from the management centre the booking numbers, which relate to the next arrival of buses at the terminal and corresponding to the passengers who are to be taken home. He will get to the terminal at least five minutes before the bus arrives and will show in his car the booking numbers, by using an appropriate device such as a small whiteboard or illuminated display. These numbers were assigned to passengers when they booked. Passengers who possess a booking number included in the list shown will be seated on the vehicle. The trip will take an optimised route as decided by the driver who will know the addresses to serve directly from customers.

### ***9.3.2 Organisational structure and technologies***

Each bus will be using a booking device. This will include the electronics required for the operation of the procedure described and a GSM platform, which uses a satellite locationing system, to link the vehicle with the management centre and to check the punctuality of the transit (and the synchronisation of the arrivals at the terminal). The cost of the single equipment to be installed on the bus will be around 2,500 Euro. Taxis will need to have:

- equipment which is suitable to show the assigned booking numbers;
- on-board radio.

It is recommended to use vehicles with separate seats in order to avoid too much contact between people unknown to each other. If we consider the conventional taxi with four places plus a driver this should avoid accommodating more than three passengers unknown to each other. A strengthening of the privacy will be welcomed especially by women. The management centre must be assigned a number of radio taxis by telephone which is sufficient to meet the demand for each bus trip. In order to do so, this will require:

- a computer for reception and management of the phone bookings and calls to the vehicles;
- management software which will automate the bureaucratic and administrative management of the operation centre, the people shifts, the statistics, the management and invoicing of the services used etc.;
- an operator.

The picking-up service will possibly require less vehicles than the distribution service. Only after some experimentation in the field, which will be preceded by market re-

search, will it be possible to have a clear idea of the actual operation and dimensions of the fleet. A sufficiently accurate simulation or tests in the field will provide answers to these and other questions such as the possibilities for vehicles to alternate the picking-up service with the service of dropping off at peoples homes. In other words, at what times of the day the same vehicle will be able to accompany some users to their destinations and, afterwards, taking some others to the terminal and complete the tour within 30 minutes.

This chapter has considered the possibilities for collective taxis. The next two chapters consider another variation of Demand Responsive Transport, namely car sharing.

## Car sharing for a rational use of the car

*G. Valenti*

### 10.1 Introduction

The current prevalence in the urban environment of motorized modes of transport for private use requires the efficacy and efficiency of traditional collective means of transport to be re-established through the improvement, rationalization and development of the quality of service. However, in order to maximize the effects of these solutions, additional actions for the development of services for alternative mobility are required. These will complement the use of private and traditional public transport means, by adding flexibility and reducing costs, in particular for areas where traditional public transport is not sustainable in terms of efficiency and competitiveness of the service.

Services of alternative mobility include both new organized forms of shared utilization of the car, which are organized in order to reduce the costs for individuals and society, and innovative schemes for public transport, with variable routes and timetable and with stops on request, broadly distributed over the territory. Various alternatives have been discussed in previous chapters.

Among the new forms of organized car use, whereby the vehicle is shared with others, car sharing represents one of the most important as it can substantially shift the current unsustainable advantage of the car for private use over any other means of urban transport. This is based on the originality that the service intends to offer, and its capability to satisfy needs comparable to those achievable by the car for private use but at lower costs, in particular for those who seldom use their vehicle for their trips.

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Car sharing is intended as an alternative means of transport managed by an organization, which has at its disposal a fleet of vehicles, usually of different models, for the people associated to share. Unlike car pooling, whereby cars are used as a result of an agreement between users who have a common route and time of travel, in the case of car sharing, users can autonomously obtain the vehicle at different time periods.

The way car sharing operates is clearly original in its own right and differs from traditional services of car renting. Vehicles making up the fleet are parked at a number of parking lots close to the houses or near public transport stops and train stations in order to guarantee an easily accessible service. In an urban environment, parking areas can be obtained in a garage or private areas, courtyards, or directly beside the road. Only those associated with the organization are allowed to use the vehicles, even for periods of time as low as 1 hour. The person belonging to the association can pick up the vehicle at any moment in time from his closest parking point. Vehicles are usually brought back to where they were taken from, although there are situations where vehicles can be left in other parking lots.

The total cost for the person belonging to the association is made of a fixed cost and a variable one, which is linked to the utilization of the service. The fixed cost includes a fee to join the scheme, which is not refundable, a fee refundable at the end, and a season ticket payable monthly or yearly. The variable part of the cost, which is linked to the use of the vehicle, includes a rate per km and a rate per time. These can vary depending on the class of the vehicle and the time of day it is used. Several car sharing variants are possible. They differ on the basis of the target group they serve by the position of vehicles, by the procedures for utilization, by the type of journey it is possible to make, by the type of organization etc.

Born as an initiative of individuals who were moved by economic and environmental reasons, car sharing had a rapid growth during the 1990s, mainly in some north European countries, with 2-figure growth rates. In the past few years, car sharing organizations also operate in North America and Asia, whilst in Europe more than 100,000 users and 200 organizations are operating in more than 400 cities. The most successful organizations operate with one vehicle for every 20-30 users.

The need for a European driven co-ordination and for standards and improvements in the operating conditions led to the creation of a European Association (European Car Sharing) in 1991. Thanks to a yearly growth of 50% in the number of associates, ECS now numbers more than 40 car sharing organizations from several European countries.

Car sharing can be considered a valid alternative both for people who don't own a car and for those who own one or more. The economic advantage for the user obviously depends upon the tariffs applied and tends to zero with growing kilometrage travelled. With reference to tariffs applied across Europe, the threshold of convenience can be set to around 10,000 km per annum.

In addition to what has been said above, car sharing is also considered a model able to change the current behaviour of citizens as far as the car is concerned, thus favouring more rational modal choices from the economic, social and environmental viewpoint. As a result of the experience of car sharing to date, benefits concerning the reduction in traffic volumes and space required to park are proved to be considerable. It has been observed, for example, that each vehicle belonging to the car sharing scheme replaces 5-6 cars for private use and, after joining, 35-60% of the kilometers previously travelled by car per year shift to alternative modes of transport.

The advantages of car sharing also include its contribution to the development of integrated mobility in urban areas. As an example, a study carried out in Switzerland has revealed that users of car sharing travel for three quarters of the time with means of transport more compatible with the environment (on foot, by bicycle, or by public transport).

It is for these reasons that in the past few years the attention towards car sharing by national and local administrations as well as at the European Commission level, is growing. Economic aid in favour of pilot projects and technological upgrades of the services have been provided, with the view to increasing its use and improving the professionalism of operators.

The experience clearly shows that the development and expansion of car sharing on a wider scale requires the presence of a well established public transport supply, as car sharing is basically a service complementary to it and not a substitute. Furthermore, the modernization of the service through the introduction of advanced technology for information and communication, assumes a key role, in particular so as to obtain an higher quality perceived by the user and a competitive advantage from the point of view of management costs.

## **10.2 Car sharing in Italy**

Until now, car sharing in Italy has been limited to a few demonstration test cases organized in Venice, Palermo, Bologna, and the county and city of Milan. The experiences for Venice, Palermo and Bologna have been developed within the framework of European projects, whereby forms of communal utilization of the car were organized in central areas with limited amounts of traffic.

The experiences of Venice (project Entire) and Palermo (project Zeus) are based upon the use of innovative electrically-powered cars, whilst for Bologna (project Tosca), conventional cars were adopted.

From the technological point of view, the applications for Venice and Palermo are basically identical. The architecture developed for the Entire project based in Venice, which was also applied afterwards in Palermo following some further modifications,

consists of a complex system using telematic technologies for the automated management of the service and fleet, which, as mentioned earlier, is entirely comprised of electrically-powered vehicles. The system includes a server, situated at the management and supervision centre, performing functions of gathering and storing data related to the use, availability and status of the vehicles.

The server communicates through a phone line with telematic beacons which are installed in the parking areas and have functions of management for the picking and dropping of the cars. In addition to the communication with the control centre, they can exchange information with the fleet through short-range radio communications. Cars themselves are equipped with technology that allows them to exchange information with the beacons, a security device allowing only authorized people to use them, and an intelligent unit responsible for monitoring the use, consumption and status of the vehicle. In the authorized parking areas, recharging points are available for the batteries, through couples of extractible power leads.

As regards the car sharing system organized in Palermo, batteries are recharged through a system of photovoltaic panels, which are positioned on the roof of the shelters situated in the parking area under which vehicles are parked. The system devised in Bologna, where the fleet consists of 9 Smart cars allocated to 3 parking lots, uses instead a technology of direct communication between the on-board computers and the control centre. The two experiences run in Milan have had a different origin. The first initiative was promoted by the Milan county, Legambiente and the Italian Touring Club in partnership with the Councils of Sesto San Giovanni, Cinisello Balsamo, Monza and Milano. It is managed by Legambiente and numbers 6 cars allocated to 3 attended parking lots inside free-to-use shelters. The on-board technology for those vehicles is minimal and only requires a few functions to start the service. The second experience promoted by the Milan municipality and given for management to the CTNM (Consorzio Trasporti Nord Milano) has been started in the areas of Cesano Maderno, Seregno and Desio. At the moment, the system includes 6 vehicles and serves an area with about 110,000 inhabitants. CTNM has passed the management of the service on to the Swiss company Mobility.

In general, the applications in Italy have provided positive outcomes from the technical point of view. However, the significance of these outcomes on the public has been limited because the initiatives were experimental ones. The Ministry for the Environment promulgated a law in March 1998 aiming to promote sustainable urban mobility, and set out a programme fostering the promotion and exploitation of car sharing in those Italian cities which are interested in widening the choice for alternative services to the car for private use. In particular, the law passes on to interested councils the task of fostering companies to organize car sharing services. A fundamental step towards achieving these goals is the setting up by the Ministry for the Environment of ICS (Iniziativa Car

Sharing – Initiative Car Sharing), which is a scheme aiming to promote car sharing which up to now includes the councils of Turin, Genova, Venice, Parma, Brescia, Bologna, Modena, Reggio Emilia, Firenze, Roma and the municipalities of Milano and Rimini. ICS is directly financed by the Ministry for the Environment and Land Protection to provide assistance to the cities who intend to develop car sharing systems with the purpose of producing an unified national operational and technological standard and unified procedures. Municipalities can join ICS free of charge and access to the funds, which are reserved for members, is regulated according to the quality of the projects prepared by the cities and the time of their proposals.

ICS has been designated as the manager of the funds distributed by the Ministry for the Environment and Land Protection. ICS's mandate is to provide member cities with concrete help to start car sharing services on their territory. In particular ICS provides members, or agencies used by members, with the following management services:

- 1) In the the setting up phase of the service:
  - a. technical and legal advice;
  - b. planning of car sharing services;
  - c. communication and exploitation services at national level.
- 2) In the phase following start up of the service:
  - a. exploitation, communication and marketing at local level;
  - b. Call Centre services;
  - c. technologies for the management of the fleet and service;
  - d. assistance for starting up.

The benefits provided by ICS at the start of the service will only be provided if the following main criteria are met:

- agree to abide by the ICS standards for managers;
- agree to abide by the administrative rules and correctness of the route to identify a manager;
- co-financing by the municipality and/or the manager for an amount matching at least the value of the benefits received, following precise rules concerning the suitability of the costs breakdown.

The car sharing service promoted by ICS is to be integrated with local public transport services and is mainly addressing:

- individuals, for whom the car sharing service works out to be cheaper than the private use of a car;
- public and private companies which can use the car sharing service vehicles as their corporate fleet or integrate with it.

As a result of the boost by the Ministry and with the help of ICS, the first commercial car sharing services are to be launched in the cities of Torino, Venezia, Bologna, and are

at an advanced project status for the cities of Modena and Genova. The experimental systems already active in Bologna and Venezia are being adapted to the national standards of ICS. Soon those services will no longer be experimental but, rather, they will be integrated into the public transport system and will complement the car for private use. For the Bologna service 20 vehicles and 400 users are foreseen as the initial number with a target of 70 vehicles and 1,000 users after 5 years. For the Turin service the planned numbers are 500 users for 30 vehicles, rising to 3,700 users and 167 vehicles after 5 years. For Venice, it is foreseen to have 22 vehicles and a rising number of users from 200 in the first year to 440 in the third. For Genova, 30 vehicles are foreseen at the start, rising to 200 after three years.

The case of the municipality of Milan needs to be assessed separately as it has announced that a company will be created in order to manage the car sharing service. AEM will participate as an instrumental company for the municipality itself. The planned system will use 100 vehicles whose number will grow to 800 during the following 3 years. Up to now, the municipality of Milan does not belong to the national scheme (ICS).

### **10.3 Technological aspects**

The initial implementations of car sharing were based on a very simple process, whereby a telephone booking system was supported by a log-book to manually record the data related to the use of the vehicle (kilometres and time). In addition to a box located at the parking area with the set of well recognizable keys for each car in the parking lot, a variant of this scheme devised the box to be mounted directly into the car. Every user of the system would have held, in the first case, a key to open the box situated in the parking area whilst, in the second case, 2 keys were required, one to get into the assigned vehicle and the second to open the box containing the key for the engine.

One can easily understand how cumbersome this process was in being the operator registering the booking, collecting data on the usage of the vehicle, doing the book-keeping, and managing the fleet manually with little or no technological support. The same applies to the user's booking, collection and return of the vehicle. This solution can only be viable for managing small fleets and is nowadays only used by small organizations.

The growth of the market share and the spreading of the service over the territory have recently led some organizations enjoying greater success to modernise the service, which is possible thanks to the considerable development of technologies like informatics and telecommunications. The support provided by the new telematics technologies to the management of the fleet and the service can pertain to a number of operations, bringing huge advantages to include the user's accessibility to the service, the registra-



tion at the control centre of the data on vehicles, the management of the bookings and the administrative management of the service.

The most recent experiences of car sharing, as a result mainly of internal efforts of the participating organizations, have led to an heterogeneous spreading of informatics-based systems and automated procedures with little or no change to be reproduced elsewhere. Many technological systems have been introduced only recently and some of those are still at the stage of being developed only upon request rather than standardised. At present, the architecture of the most modern systems for the support of the management of car sharing includes the operations centre, the car on-board system, and, in some cases, also the fixed architecture situated at the parking lot. The main fundamental component of the operations centre is the informatic system, which is fulfilling the task of providing the call centre operators with a set of semi-automatic procedures for the management of the bookings and, at the same time, offering the administrative department all the statistical information required to monitor the service, the accounts of the company and the clients.

In some applications the informatic system can receive, record and automatically respond to the booking requests made by users through their telephone handsets following a vocal interactive menu, or from their PC through the web interface. The informatic system is already interfaced to the lines guaranteeing a 2-way electronic communication between either the operations centre and the vehicles or the operations centre and the fixed infrastructure mounted at the parking lot, which is responsible for the data transmission to the on-board equipment of the vehicles located at the parking lot through short-range communications.

The possibility to link the informatic system with the vehicles allows on the one hand the transmission of booking data in order to automate the access to the service by the user, and on the other hand, the automatic transmission of all data related to the use and mechanical status of the car for the remote control of the operational and functional conditions of the vehicles. The operations centre would benefit from this architecture leading to improvements to the management and quality of the service. In particular, it is possible to guarantee a convenient booking system 24-hours per day, 7 days a week, and manage bookings at short notice for an immediate use of the vehicle. In the most evolved configurations, the on-board equipment manages the collection of data related to the operations and functional conditions of the vehicle, the reception of data and messages from the operations centre and, finally, the control over accessibility to the vehicle and its use.

The components of the system which can offer these functions are: the on-board sensors of the vehicle, the on-board PC, a smart card reader/writer, one or more electronic devices to prevent theft and non-authorized use of the vehicle, a system for mobile telecommunications and vehicle locationing, and a small printer to provide a

receipt of the trip. The collection of data relating to the state of the vehicles and the engine is achieved through on-board sensors. Sensors can utilise different technologies according to the magnitude of the quantities which have to be gathered. Sensors are connected to the on-board PC on which the information gathered is stored. The on-board PC is the central component of the on-board system. It looks after all the functions of control of the components installed on the vehicle and, furthermore, it acquires, elaborates and stores information and data concerning each component of the vehicle and from the operations centre. The on-board computer can organise the automated assessment of the vehicle by the user and check controlling devices against theft, such as the device that stops the vehicle from starting.

The automatic identification of a user requires the use of a personal smart card with all the necessary data to identify the user. In order to read the data the on-board computer interacts with the smart card reader which is usually mounted on the dashboard or one of the windows of the vehicles. Once the user has been recognised the on-board computer deactivates the locking system for the doors so that the vehicle can be accessed. In other applications it is possible that the starting and the use of the vehicle depends on the digitization of the user code on the numeric keypad installed on-board.

The use of a smart card can offer a lot of advantages beyond the simple electronic application of the user. An advantage is to utilise the same smart card for the payment of the trip on public transport or taxis, payment of tolls and parking with a deduction system or by charging the user's bank account. In this way the operators can offer their users a more simple access to ancillary services of various types with the advantage of achieving a better perception of the improvement of the service itself.

The on-board computer is usually interfaced to a GPS (Global Positioning System) receiver in order to locate the vehicle and terminal and is also equipped with a GSM terminal (Global System for Mobile Communication) to communicate directly with the operating centre or, alternatively, a DSRC (Dedicated Short Range Communication) terminal for short-range communication with the fixed infrastructure in the parking lot. The GSM terminal works like a modem, and without the numeric keypad it is only utilised to send and receive by using the SMS (Short Message Services). This solution allows for lower costs of the device and communications.

A variation to the previous architecture is an on-board system and operations centre requiring the support of a fixed infrastructure at the parking lot. The more simple versions of fixed infrastructure is constituted by a metallic box containing the keys of the vehicles and also with the function of protecting a computer which is linked to the operations centre. The metallic box also includes a smart card reader and a numeric keypad. Once the smart card is inserted and the personal code is digitised, the computer validates the smart card and PIN and, in the case of a positive result, automatically unlocks the box containing the keys of the vehicle.

In most security applications the fixed infrastructure also includes a telematic beacon with multiple functions which will manage the bi-directional flow of information and data between the control centre and the on-board system for the vehicles which are located in the parking area. Using this configuration vehicles can only communicate when they are parked at the station.

The beacon includes a structural part with the function of sustaining and protecting the instruments (computer, screen, devices for communication, electric panel and generating set) and looks after all the operations of gathering, releasing, picking-up, dropping-off and booking of vehicles beyond all the diagnostics of all the devices which are present in the parking lot. The system of communication with the operating centre is based solely on a telecommunications network fixed on cable or optic fibre.

In order to link the on-board equipment with the fixed electronic devices for reception and transmission, a short-range microwave communications system is usually used. In the case of fleets composed of electrical vehicles, the fixed infrastructure which is present in the parking lot also includes several stations with cables for recharging the batteries.

In summary, the experiences developed so far demonstrate that the introduction of a greater automation process for the distribution of the service mainly returns two positive outcomes which are correlated. The first relates to the rationalisation of the process of generation of the production of the service with a reduction in cost and shortening of times of operation. The second positive outcome is a greater control of the quality of the service, leading to a positive transformation of the image of the service itself. Furthermore, the use of new technology in car sharing can bring these two advantages. Firstly, the access services will benefit from getting further elements of improvement to the clients. Secondly, it relates to the protection of the vehicles from burglary and from non-authorized use which is achievable through procedures of automated access to the vehicle.

#### **10.4 The economic convenience of car sharing**

The evaluation of the economic convenience of the car sharing service with respect to the privately owned vehicle is an important element to define in a clear and precise manner both for the competitiveness of the new service and to proceed with the identification of the potential market.

Figure 10.1 summarises and highlights the results of five figures of yearly kilometrage travelled (3,000, 6,000, 9,000, 12,000 and 15,000 km) which will provide a preliminary evaluation of the economic convenience of car sharing in Italy. The figure shows the difference between the yearly average cost of a car with medium cubic capacity with the yearly cost of a car sharing service satisfying the same mobility requirements, and the

yearly cost of a combined use of public transport (30%) and car sharing (70%). In order to calculate the yearly cost of a car sharing service an hypothesis of a maximum yearly ticket costing 130 Euro, an hourly tariff of 1.5 Euro, and a tariff per kilometre of 0.37 Euro. For the calculation of the yearly costs of service of the private car the different sources of expenditure are grouped into two categories: the fixed ones which are not proportional to the traveller, and the variable ones which are proportional to the distance travelled.

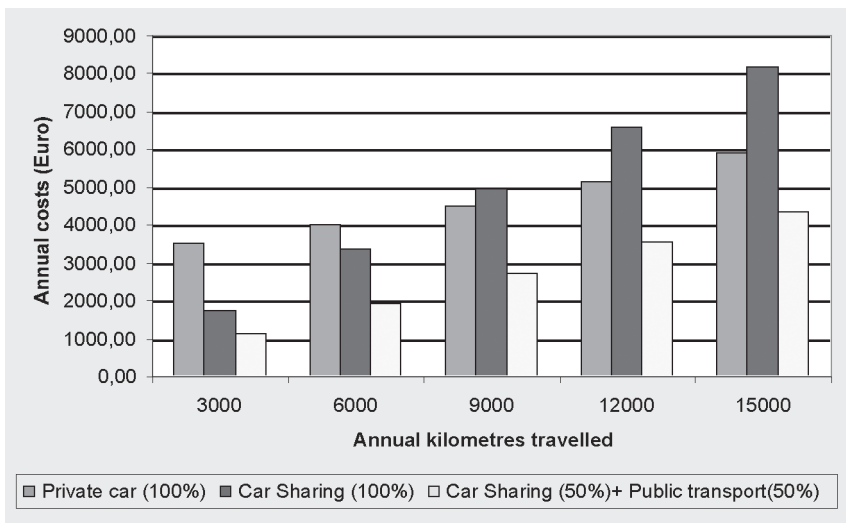


Figure 10.1: Analytical comparison of costs per year (tariff 1)

The first cost category includes the tax for the ownership of the vehicle, the mandatory insurance, and the redemption of the capital invested to buy the vehicle, which is divided into interest and capital. The discriminating element in the calculation of the redemption is the “technical life” of the vehicle size: for kilometrages up to 10,000 km per year it has been assumed equal to 14 years, while for greater kilometrages the technical life has been deducted as a function of the maximum number of kilometres that can be travelled (which is assumed to be 140,000 km). For the costs which are proportional to the kilometrage, average costs per unit are considered, which are estimated by the “Automobile Club d’Italia” (ACI), and relate to fuel, oil, tyres, and maintenance operations, both ordinary and extraordinary, which have to be carried out throughout the life of the vehicle, in order to keep it in pristine condition.

From the analogies above it appears that car sharing can be considered more economically viable than the vehicle for private use for those users who use the car to travel less than 8,000 km per year. The convenience ratio increases dramatically (from 8,000

to 14,000 km) in the case of a combined use or car sharing (70%) and of public transport (30%). It is interesting to note that the convenience ratio corresponding to a combined use of car sharing and public transport is greater than the average annual kilometrage per vehicle which is estimated in Italy to be around 13,000 km.

Furthermore, these estimates show that car sharing can be particularly advantageous for quite low yearly kilometrages. For example, for yearly kilometrages from 6,000 to 3,000 kilometres, the savings obtainable by the users of car sharing with respect to the privately owned vehicle increases from about 650 Euro (16%) to around 1,760 Euro (50%). By hypothesising a combined use of the service of car sharing and public transport, the economic advantage of the user grows from around 800 to around 2,060 Euro for kilometrages between 9,000 and 3,000 kilometres per year.

## **10.5 Strategies for the development and actions for sustainability**

At the moment the effort made by organisations to achieve and maintain a high level of productivity, efficiency and service quality are directed towards:

- increasing the market share by also acquiring new types of users to obtain larger economies and to improve the levels of utilisation of the vehicles;
- developing the service on a wider geographical scale whilst maintaining at the same time a well-served network of stations on the territory;
- modernising the process of application of the service by introducing new technological solutions;
- orienting the service towards the client and search for the maximum level of satisfaction for his needs and expectations; and
- establishing partnership relationships mainly with the other operators in the transport sector through which it will be possible to offer their clients integrated services with an optimum benefit to cost ratio.

Even if among the operators in the sector there is broad agreement on the fact that the strategies for the development of the new service must essentially push the market and its own mechanism of financing, it is obvious that the introduction of political intervention with the aim of sustaining the process of setting up and expanding of the service is of maximum importance.

The greatest expectation amongst the operators is that the public authorities on the one hand recognise the social, economic and environmental benefits that the service would bring and, on the other hand, commit themselves to directly maintain the development of the service, in particular the beginning.

In more detail, amongst the areas of intervention of the public authority which are mostly welcomed by the operators of the service, there are:

- the use at adequate costs of public parking spaces, in particular for those areas where the market potential is higher and parking spaces are limited and expensive;
- the promotion of the service on a wider scale, not only to increase public awareness of the service but, more importantly, to develop consensus in the social, political, economic and financial context;
- carry out studies and research in order to improve the knowledge of the demand and of the level of acceptance of the new service;
- the activation of co-operation agreements with other operators in the mobility sector in order to achieve an integration of the services provided that will foster the development of combined mobility;
- keeping the service up-to-date from the technological point of view in order to reduce the running costs and to improve the quality; and
- the sustainability of the process of transferring and disseminating know-how.

Until now, Holland has been the first country to give a strong signal in favour of car sharing, by recognising the social benefits of the service and by fostering its development through the institution of a national body directly financed by the Ministry of Transport. Tasks assigned to this body are mainly to push the economic operators towards investment in new initiatives, to encourage local public authorities to implement efficient measures in favour of car sharing from the operational point of view and, finally, to advertise the service so that all citizens will know about it. Switzerland has also fostered car sharing from 1992 through the Energy 2000 programme of the Federal Council. Energy 2000 has, from the very beginning, accompanied car sharing in its evolution and organisation, by motivating the operators towards high-level performances. It is particularly interesting to note the work of Energy 2000 towards the integration of car sharing with other modes of transport through strategically important co-operation, leading to the successful setting up in the market of offers for a combined mobility. Other contributions by the Swiss Government towards car sharing have been provided for the evaluation of the potential of the new service in terms of market and environmental benefits. Recently the Energy 2000 programme has started a wide study, in collaboration with Mobility CarSharing, Europcar and VBZ, to identify the profile of the users and perceived utility of the new service. In Germany the only intervention by the central authority towards car sharing has been a study, financed by the Ministry of Transport, to evaluate the opportunities, the benefits and the costs offered by the new service. Finally, it is interesting to mention an initiative in favour of car sharing by the municipality of Bremen, which aims at organising a building area (Hollerland) without cars for which there have been already a number of subscriptions. For the future residents the municipality foresees the use of the car sharing service as an alternative to the private car. This will allow a reduction of almost a quarter in the space usually reserved for parking that can then be utilised for other purposes.

## Public transport and car sharing: together for the better

*L. Jussiant*

### 11.1 Introduction: combined mobility

The steady growth in car ownership is a well-known obstacle for achieving sustainable urban development. Transport-related problems of our cities and towns are not only due to the growth in traffic (resulting in accidents, noise, emissions) but also to the consumption of space required by the car and related infrastructure. The strengthening of the quality of life in our cities and towns increasingly depends on regaining street space for pedestrians, cyclists, children and greening...

In parallel, the organisation of transport in general, and public transport in particular, has fundamentally changed in recent years. The public transport sector has developed to provide answers to regular daily journeys like home-work, home-school. Yet, the urban rhythms have sped up, most cities are now “open” 24 hours 7 days a week, to answer the demand of the city users, who want to access urban services when and where they want. This results in more frequent and diverse trips many of which cannot be provided by public transport.

Public transport is being challenged – to become a key party in providing ever diverse mobility services – covering more than ‘just’ the operation of busses, trams and/or trains – bound to lines and fixed timetables. The need of modern mobility is based on flexibility and a high level of convenience. Demand-responsive services, taxi, car rental, integration of bike-orientated services etc. are supplementary services to the classic line

and timetable-bound services. These new forms of mobility are not to be considered as competitive but can be mutually reinforcing. Integrated Services providing such mobility can compete with the privately owned car in terms of convenience and cost-structure and can help improve the quality of life in our cities.

## 11.2 Car sharing as mobility insurance

One of the parts of such integrated systems is car sharing. Car sharing refers to short period automobile rental services intended to substitute private vehicle ownership. It gives access to a vehicle whenever it is required, while providing an incentive to minimise driving and rely on alternative travel options as much as possible. To be efficient, the system needs to be:

- accessible (within easy walking distance of people's homes)
- affordable (reasonable rates, suitable for short trips)
- convenient (vehicles that are easy to check in and out at any time)
- reliable (vehicles that are available and a dependable booking and access system).

The main principle is thus to offer the freedom of a car, without the hassle of ownership. Therefore, car sharing is a modern mobility service, which can change mobility patterns drastically. Whereas for a car owner, public transport usually only has the role of a stopgap measure, car sharers use the more environmentally friendly modes of public transport, bike etc. as their basic modes with car sharing providing a kind of mobility insurance: a car is available when the other modes are not offering sufficient service or convenience.

Car sharing schemes generally reduce car ownership and therefore stimulate a more environmentally attuned choice of transport modes.

Regarding the cost structure of the main transportation options, car sharing is a middle option for the user, between having no vehicle and owning one. With its low fixed costs and high variable costs, car sharing offers medium convenience at a lower cost than the private car for those driving less than around 12,000-15,000 km per year.

For the community, the main benefits of car sharing are:

- the reduction in the number of cars, as cars are idle on average 22 out of 24 hours a day (USDOT, 1995);
- the use of newer, smaller cars with higher environmental standards;
- the reduction in car person-km and consequent reductions in emissions of CO<sub>2</sub> and other pollutants. It appears that after joining a car sharing scheme, most members drive less than before: 57% in Switzerland, Muheim (2000) and 50% in Germany, Baum and Pesch (1994).



One study estimated that if car sharing was used in an optimal way in Germany, there could be a reduction of numbers of cars of 1.2 million and consequently a reduction of the distance driven by car of around 7 billion km per year and a commensurate increase of almost 4 billion public transport kilometres (Baum and Pesch, 1994).

### 11.3 Public transport and car sharing: common benefits

Although only some 10 years old, car sharing has already proved its potential ability to supplement public transport in an ideal way. The combined offer of public transport-car sharing creates a win-win situation for both transport modes, who are stronger together than separately. On the one hand, public transport will gain more customers as car sharers tend to have more intelligent mobility patterns and use the car less than car owners. On the other hand, car sharing will be quicker and stronger to break through the market if combined with public transport.

The main role of the public transport operator in car sharing schemes is to find ways to integrate the mobility ‘menu’, and therefore to help the customer – or user – to find his or her way around in an easy and stress free manner. It can only do so by combining public transport with individual transport modes, such as car sharing, car leasing, taxi and bicycle.

In this context, many cities in Germany, Switzerland, Austria as well as other countries, have introduced co-operation between public transport and car sharing. In most cases, public transport operators co-operate with car sharing providers – offering special incentives (reduced tariffs) for the combination of both services.

In June 1998, Bremen introduced a combined offer StadtAuto/BSAG, with the monthly or annual pass for public transport including the electronic car key: the “Bremer Karte plus AutoCard” (Figure 11.1). It has led to an increase of the number of car sharers using a public transport annual season ticket (from 55% to 78%). Based on this experience, the authorities are now introducing one combined smart card for the electronic public transport ticket, the car sharing facilities and shopping (e-purse).

There are also cases, where the public transport operator directly becomes the car sharing provider (e. g. Wuppertal) or at least a shareholder of the car sharing operator. The framework of co-operation might be different, but for the customer there is a similar comprehensive ‘product’ available.

Various studies (e.g. Muheim, 2000; Baum and Pesch, 1994; Wilhite and Attali, 2000) have shown that car sharing clients who earlier have been car owners have changed their mobility patterns. They have reduced the mileage driven by car and use public transport much more often.

In 1999, the VBZ won the “UITP Secretary General’s Prize for Innovation in Public Transport” for the implementation of its new combined mobility offer “Zürimobil”,



Figure 11.1:  
The “Bremer Karte  
plus AutoCard”

now changed into ZVV-Kombiabo (Figure 11.2). The main result of this initiative is a more frequent use of public transport by these customers, even though they can obtain a car near where they live. Between 1996 and 1998 research completed showed that car sharing customers learn to use “their” cars more efficiently and therefore lowered *car sharing* travel distance by some 20%. They also buy more subscription tickets after joining zürimobil: a 14% increase.

The strategy of the VBZ, the public transport operator, is to develop the company into a comprehensive customer-oriented service supplier. Therefore the company cooperates with specialised partners such as Europcar and Mobility Car Sharing Schweiz to offer the following products:

- a dense public transport network, with a distance of maximum 330 m to the nearest stop, a frequency of 6-7 minutes during rush hour and not less than 15 minutes in off-peak hours, an integrated fare structure;
- a dense network of car sharing stations: 450 vehicles available at 250 locations in the city;
- some additional services like car rental for holidays, cargo vehicles, bicycle rental etc.



Figure 11.2: Advertisement for ZVV-Kambiabo

These products are supported by a customer-oriented approach, with a city information system on mobility, 24-hour reservation and information as well as a 24-hour car ordering in a self-service system.

Such car sharing schemes need to be fully integrated in the town-planning and housing policies of each specific city. Car sharing tends to be most effective and appropriate in higher density and middle income residential areas, where there are good alternatives to driving. In this sense, urban plans of a city should, for example, plan the construction of car sharing stations in new housing development in a geographical distribution which optimises access to the car sharing service. As part of an overall plan, car sharing can also be implemented at major public transport stations, in commercial centres and tourist spots.

In 2000 Mobility CarSharing, the Swiss national car sharing scheme, signed an agreement with the supermarket brand Migros to have car sharing stations in their car parks: 75 VW Lupo have been located in front of the supermarkets in the city centres. It is also part of a scheme with the Swiss railways (SBB CFF FFS) and Daimler-Chrysler which offers 120 cars (“Smart” type) at 55 of the largest train stations in Switzerland. Today, Mobility CarSharing counts approximately 48,000 members and 2,000 vehicles.

#### 11.4 Guidelines for successful car sharing schemes

1. The first guideline for a successful co-operation between public transport and car sharing would be the implementation of services of high quality from both operators. This means public transport operators and authorities should offer a service that truly responds to the customers’ needs and is sufficient for the regular needs. In general terms, these customers’ needs could be stated as:
  - as short a trip time as possible;

- a high frequency of service;
- clear and reliable information;
- a comfortable ride;
- a clean and nice environment to travel in;
- an acceptable level of security.

By doing so, public transport actors make sure that the car sharer can rely on an efficient service and will need a car only on very specific occasions.

For the car sharing provider, the key criterion is a user-friendly offer, mainly linked to the technology implemented. The following requirements have been defined in the official German Eco-Label “Blue Environmental Angel” certification:

- a 24 / 7 day service (booking and access) in order to be a real alternative to the private car at any time;
  - a ‘pay-as-you-drive’ tariff structure without free mileage to make the trip-related costs transparent and give an incentive to drive less;
  - short-time reservation (1/2 hr) and usage (up from 1 hr);
  - a fleet that fulfils certain environmental requirements.
2. One essential element of the co-operation between public transport operators and car sharing providers is in the introduction of combined season tickets, making the use of both systems cheaper but mainly a lot easier.
  3. To ensure seamless mobility, it is fundamental that the information on the different modes of transport is centralised and well disseminated. A city information system on mobility should be set up to provide information on each public transport service, all locations of car sharing vehicles, all taxi stops, all parking facilities, all pedestrian areas and walking paths within the city and all bicycle paths. It should be disseminated through several channels, for example as a printed city map in all the information (included tourist offices) and tickets selling points, via Internet and at all public transport stops and car sharing stations.
  4. In order to become attractive, car sharing needs to be widely advertised. For many, the idea of “sharing” implies a second-hand service and a sacrifice of freedom. Thus marketing is needed both to make people aware of the existence of car sharing and to draw out a positive image. It should definitely not be perceived as the stopgap, for those who can’t afford a car. Public transport actors can support the marketing of car sharing substantially as a broad target group can be reached at public transport stops and in the vehicles.
  5. Finally but probably the most important: a successful public transport – car sharing co-operation requires strong political support from national, regional and local authorities, in order to change the mentalities and to overcome the critical phase before reaching the break-even point. The co-operation between both modes make them stronger in a sustainable transport policy, while offering the citizen a global service

without reducing his mobility. In this framework, public authorities should also encourage the implementation of common standards for all European car sharing schemes, in order to simplify the system and to allow the use of cars in different cities and countries with one access card.<sup>1</sup>

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<sup>1</sup>. This chapter has been prepared in 2002 in the context of MOSES, a research and demonstration project supported by the European Commission under the Fifth Framework Programme and contributing to the implementation of the Key Action “City of Tomorrow and Cultural Heritage” within the Energy, Environment and Development. It is designed to explore the prospects for developing and expanding car sharing in real-life locations across Europe: Italy (Genoa, Palermo, Turin), London (Southwark, Sutton), Stockholm, Bremen, Walloon Region (Namur, Louvain-la-Neuve, Dinant) and Bucharest. MOSES intends to contribute to a more sustainable future by achieving 12,000 car sharing users by the end of 2004. MOSES sees an option for the replacement of 10% of private cars in the urban areas of Europe by innovative mobility services and supportive framework conditions within one decade. This would lead to an energy saving of around 6 to 8 million tons of CO<sub>2</sub>. See: [www.moses-europe.org](http://www.moses-europe.org).



## **FAMS: towards the Agency for Flexible Mobility Services**

*G. Ambrosino, M. Boero, P. Eloranta, A. Ferrari, B. Finn*

By capitalizing on the results of various European projects and the experience achieved in the operational management of the flexible and intermediate mobility services (as described in the previous chapters), it can be concluded that a relevant success has been attained. It must be acknowledged, however, that most experiences have been undertaken as “isolated” components of the more complex and multi-faceted transport chain.

In most cases flexible services, and in particular Demand Responsive Transport (DRT) services, are generally managed directly by a single operator (Transport Company) as a unique and dedicated transport scheme with minimum or no level of integration with the other collective transport services available in the same area and/or managed by other transport operators. However, the experience gained shows wide potential for improved operation of the DRT concepts and models, in order to cover the overall spectrum of the intermediate and flexible services. This may be achieved by integrating the technological tools developed with the emerging e-commerce and e-business services. Therefore, starting from the single DRT services application, there is a considerable opportunity to evolve towards the concept of the Agency for Flexible Mobility Services through a scaling up of the current technologies and DRT models.

The perspective of an Agency (intended as a booking, co-ordination and management centre of intermediate services) is fostered by recent new regulations and laws on local public transport provision. The liberalization of transport services leaves open the issues related to the service level to be provided in weak contests (both with respect to the demand and to the socio/economic and territorial features) where a response in 253

terms of transport services with fixed timing and route is not viable. The risk entailed in leaving this part of the market at the mercy of the fares policy is considerable (where passengers are limited the availability of public funding is essential for the operators in order to offer a minimum service).

Although the relevant amount of resources involved and the several authorities and operators active in special transport services may be extensive (e.g. municipal school service, sick/disabled and elderly transport by charities and the health service, services in weak demand areas, urban peripheries and night services by transport companies and collective transport operators etc.) the overall quality level of the service being offered is generally low, both with respect to the offer and on account of the lack of co-ordination among the operators and the pertaining authorities.

Hence the need for the creation of a network of public, private and not-for-profit actors, such as taxi drivers co-operatives, craftsmen associations, charities, transport companies, municipalities, health services etc. interested in collaborating in such a customized transport market, and in being co-ordinated by a single centre for booking, planning, management of journeys and services.

To this end, as demonstrated by the results of the current DRT applications, it was realised that the IT and telecommunication tools, suitably integrated with e-work systems and e-commerce services, could be considered as pivotal elements both for accessing the service by users (i.e. the link between the citizens and the service management and provision centre), and for the operational service co-ordination (i.e. journey planning optimisation, integration of different vehicle typologies, co-ordination among different operators etc.). It is likely that this technological development will guarantee a wide range of options and intervention possibilities.

In this context, ATAF SpA, in charge of the management of the collective transport in the metropolitan area of Florence, starting from the consolidated PERSONALBUS™ experience in the management of different demand responsive services in several urban and metropolitan area zones (Scandicci, Campi, Sesto, Calenzano, Porta Romana quarter etc. – see Section 7.5) and the daily operation of special services (school, disabled etc.) has defined a project for the realization of a single centre for booking, planning and management of the flexible mobility services through the operational co-ordination of the different active operators and the optimisation of the overall dedicated resources.

The resulting FAMS project (Flexible Agency for Collective Demand Responsive Services) has been co-ordinated by ATAF and approved under the EU Information Society Technologies (IST) Research & Technological Development Programme within the Fifth Framework Programme. FAMS is a “take-up action” for the realization of a metropolitan Agency for flexible services management. A general overview of the FAMS project in terms of the overall objectives, technical approach, innovative aspects and composition of the FAMS Consortium is given in the following sections.



## 12.1 A progressive 5-layer model of DRT

For anything other than the most basic DRT (e.g. one bus, phone-in), there is a need for an appropriate organisational structure. As the number of services, number of users, and degrees of freedom increase, the organisational structure needs to be robust, flexible, adaptive, and expandable. It needs to be based on clear allocation of functions and responsibilities within a proper regulatory, contractual and business framework. These issues have been examined in depth with clear recommendations issued from the SAMPLUS project, and this chapter does not propose to deal further with these issues.

What is of interest here is the evolution of the organisation of DRT services, especially as the service offer becomes more complex and different agencies/operators are in adjacent or overlapping areas. This could be between DRT services and networks, or between DRT services and conventional services (urban bus, rail, long-distance bus).

The EU-supported project FAMS has taken on the task to examine the organisational, technical and business requirements of the expanded agency for integration of DRT services. Such an agency may be virtual or actual, is based on a range of B2B and B2C services, and supported by ITS applications and communication platform. This has been developed within FAMS, and is reported in detail in the.

The FAMS project suggest that the foreseeable evolution of DRT will involve five layers as shown below, with FAMS being at the third layer:

Layer	Category	Description	Example	Status
1	Basic	Dial/write-in flexible transport service, all bookings and assignment manual - no ITS support.	1970's dial-a-ride; most US paratransit	Proven, many
2	Stand-alone	Real-world commercial system with ITS-supported services. Ranges from one to many services through a single TDC.	Hasselt, Limburg, Florence, Tuusula	Proven, some
3	Expanded agency	Collaboration of multiple service providers to provide integrated service from user viewpoint. Reduces tasks and overheads for operators. Exploits synergies and optimises resource utilisation. Business and organisational models still being tested and developed	FAMS project: Florence region, Italy; Angus region, Scotland	Under test
4	Mature agency	Stable, viable integrated agency based on mature ITS platform. Well understood processes by customers, suppliers and agency. Not a problem to add new supplier, service or customer interface.		est. 2004 - 2006
5	Interacting agencies	Layer 4 agencies retain own identities, but can optimise across territory, modes and/or service layers by either carrying each other's customers or organising transfers. Could be TDC to TDC exchange, supported by well understood processes and value proposition.		est. 2007 - 2010

Table 1: The FAMS 'Progressive 5-layer model of DRT'

The primary purpose of the 5-layer model is to consider both the "road-map" for DRT services and organisation, and to foresee the technical and support requirements.

The primary value-added of the FAMS project is to allow the state-of-the-art to move from layer 2 to layer 3, thus opening up business opportunities both for operators/authorities and for suppliers.

## 12.2 Technical context and objectives of FAMS

Based on the results (technologies, models, management process etc.) achieved in the previous European projects (SAMPO; SAMPLUS, INVETE etc.), the objective of FAMS is the adaptation and integration of the core components of the DRT service management process (booking, service and journey planning etc.) with e-business/e-work services in order to enhance the co-operation among the operators that offer flexible services in the same area and to improve the overall access to mobility services by the citizens and/or the involved Associations.

Thus, FAMS includes the shift from the Management Centre towards the Agency concept through the development of web-based modules and technologies (B2B and B2C services) allowing the operational co-ordination of the overall available resources, the integration of the service access possibilities by the users and the sharing of the information base. Essentially, apart from the particular characteristics of the territory, the service, the users and the operators (number, depot location, type of fleet involved, type of services operated, booking systems in use etc.), the Agency should allow the management of the entire “production” process of the transport service – from the booking of the users to the service/journey planning, monitoring and operational control etc. – as a single entity (i.e. as a single operator with a single fleet and a single booking system) optimising the resources involved and providing an effective response to the mobility needs of the different user categories in the areas of weak demand.

Figure 12.1 provides an outline of the reference model underlying the approach of the Flexible Services Agency designed within the FAMS project.

The general supporting infrastructure of the FAMS Agency includes the following main technological and telematic components:

- a common FAMS Service Centre (TDC) sharing a number of services for planning, managing and monitoring the different type of flexible services;
- the e-Business services between the Agency’s DRT management service components and the different actors involved in the DRT process chain, both operators and users;
- Business-to-Business (B2B) services, allowing interaction and teamwork among the different transport service providers co-operating through the Agency;
- Business-to-Consumer (B2C) services, supporting access to information and services of different associations, user groups, communities etc.;
- a communication network among the TDC and the vehicles operating the services, based on cellular technology – GSM and GPRS.

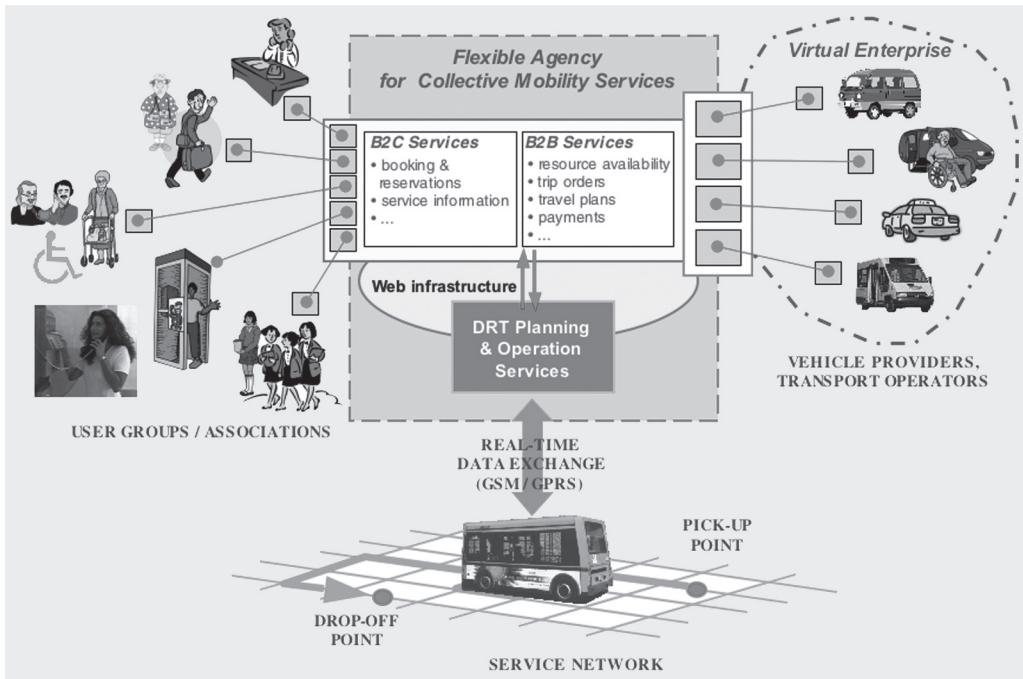


Figure 12.1: Overall structure of the Flexible Mobility Agency

The flexibility of the Agency covers not only the different needs of transport demand but also the different operational models and service provision schemes supported by the technical infrastructure. Based on this target infrastructure, FAMS will trial, evaluate and gather best practice evidence in terms of:

- co-ordinated fleet management of vehicles belonging to different operators/co-operatives and associations;
- balancing of the service offered by the different actors involved;
- real-time service monitoring via the GPRS network;
- service access diversification (direct on-line access, different booking modalities: internet-based, by telephone etc.);
- controlled and co-ordinated expansion of the service in terms of vehicles and/or providers;
- guaranteed efficiency and management transparency for the operators.

### 12.3 Innovation In FAMS

FAMS will innovate existing solutions for DRT planning and operation by implementation and trial of the Flexible Agency while providing new service models responding 257

to the concept of booking, co-ordination and management centre of the overall flexible services offered within a given area. Existing DRT management tools (PERSONALBUS™ and MobiRouter™) – see Sections 4.2.3 and 4.2.4 – are being adapted and made interoperable within an e-Business collaborative environment allowing co-operation among transport service suppliers and operation of a new service value chain allowing:

- different transport operators to benefit from a shared IT infrastructure and common services for the management of the intermediate services they are individually offering;
- the FAMS service operator to have a global view of travel needs and service offer, ensuring the best matching of users' demand and available services;
- DRT and other intermediate transport users' groups to benefit from a unique service centre able to serve their travel needs in the most integrated and best possible way.

The Agency therefore represents a flexible system with the capability of managing dynamically the interactions between the different transport operators and the resources (vehicles) available by pledging the ability of the single operators to adapt to the real variations in demand for mobility over time (Figure 12.2).

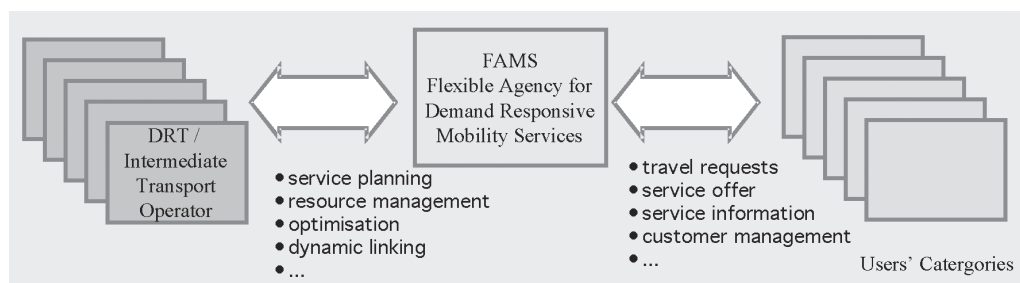


Figure 12.2: The flexibility of FAMS

## 12.4 Case studies and the FAMS Consortium

FAMS trials are being implemented in two sites, in Italy and UK (Scotland). Two transport operators / authorities - ATAF in Italy, Angus Transport Forum in the UK - are implementing the Flexible Agency concept in Florence and the Angus Region, respectively. Different transport service providers will collaborate with the Agency in the two local implementations of the FAMS concept. Each site represents different environmental contexts (urban/metropolitan area in Tuscany and a rural area with a very low level of transport services in Angus) and different facets (three main fleets in Tuscany, provided by major transport operators; different small fleets provided by various small transport enterprises and Associations in Angus). Both are complementary for the application of IT support systems to the Flexible Agency for intermediate,

demand responsive transport. The sites are also different from the point of view of the IT facilities, practices and knowledge available about DRT and intermediate transport services.

In the Florence Metropolitan area ATAF has been managing a DRT system/service for several years (PERSONALBUS<sup>TM</sup>) operating in different zones of the metropolitan area and has gained valuable knowledge about the provision of the overall intermediate services also in co-operation with other transport companies. This site is therefore in the ideal situation to scale-up the local systems, develop and trial the technological infrastructure and the collaborative service models underlying the Flexible Agency concept. The trial site in the Angus Region, is new to DRT services and applications. It covers the rural Angus area surrounding Alyth, Kirriemuir and Brechin and will allow evaluation, both on the technical and organisational level, of transferability of the DRT concepts and models developed up to now in an environment totally new in terms of services and support technologies. Taking into account these differences, each site will implement its own local project on the basis of a common architecture and an Agency service model to be designed within FAMS, in order to assess the entrepreneurial opportunities and the responses to the citizens/users mobility needs at each site.

The FAMS Consortium includes two collective transport operators/authorities – SITA SpA (IT) and Angus Transport Forum (UK) – that will implement and trial the Flexible Agency concept in their respective areas. Moreover two IT suppliers, Mobisoft Oy (FI) and Softeco Sismat (IT) are providing the required technology transfer by adapting solutions obtained in previous RTD projects to the designed Agency architecture. One public transport service operator, ATAF (IT), is providing transfer of expertise on DRT operation and support in implementing best practice in community transport and DRT at end-user organisations. Two IT and transport consultancies, MemEx (IT) and ETTS (IE), are defining the market potentials and ensuring co-ordination of the technical trials and the common evaluation framework. The University of Newcastle (UK) is acting as a sub-contractor to the Angus Transport Forum.

The FAMS Project, initiated in March 2002, has a duration of 22 months and its first results are expected to be released in December 2003. The subsequent chapters introduce the FAMS evaluation methodology (Chapter 13) and the two FAMS sites in detail (Chapters 14 and 15).



## The FAMS Evaluation

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Evaluation is a fundamental element of the FAMS project – indeed, there would be little justification for EU support if it was not carefully assessed. Thus, the FAMS Consortium has dedicated a specific workpackage, team and resources for the Evaluation effort.

Building on work of previous projects such as SAMPO, SAMPLUS and INVETE, and on the guidelines from the EU on evaluation, the FAMS team established the evaluation actions. This has four phases:

- 1) development of the Evaluation Plan, involving a deep assessment of the relevant objectives, expected impacts, indicators, measures, and planning;
- 2) collection of baseline and pre-implementation data and other information; description of the reference context;
- 3) data collection and impact measurement during the implementation phase, and in the ensuing phase as users and implementers adapt to the new situation;
- 4) analysis, interpretation of results, findings, and recommendations.

At time of writing the first two phases have been completed with the remainder to occur in mid to late 2003. The FAMS Evaluation Team has documented and published the Evaluation Plan, which is Deliverable D2 of the project. This is available on the FAMS website at [www.famsweb.com](http://www.famsweb.com).

The results of the evaluation and the analysis will be presented in Deliverable D7 in late 2003. Best practice guidelines based on these results and other experience will be

presented in Deliverable D10 in early 2004. These will also be published on the FAMS website.

The remainder of this section deals with the FAMS Evaluation Plan. It presumes that the interested reader will download it from the FAMS website, but still contains sufficient details for the casual reader. The focus is on the objectives and the methodology, since the approach could be used as a reference, whereas the details may be somewhat site-specific. Nonetheless, the FAMS team recommends the FAMS indicator set as relevant to most DRT practitioners.

### 13.1 Evaluation Objectives

While there are also operational and service motivations, the FAMS project is being carried out primarily in order to gain understanding, so that decisions can be made by stakeholders at the sites, by the suppliers, and by potential future sites. From the outset of the FAMS project, the approach has been taken that the Project Level evaluation is about generating knowledge to support decision-takers, rather than simply generating metrics (although some of this will still be relevant for local purposes). Thus, it is necessary to understand the knowledge needs that can be supported by FAMS, which in turn relate to the decisions that they need to take (investment, resource allocation, innovation, whether to continue, expand, disengage from services or technologies).

The FAMS team has spent a significant effort to define the Evaluation Objectives. The team realised early on in the project that there are multiple areas of evaluation interest. Within the iterative process, the team also understood that previous projects have suffered from three key flaws:

- lack of linkage between objectives and evaluation measures – lack of traceability
- selecting objectives that either could not be well defined or properly measured
- defining objectives at a scale disproportionate to the possible impact of the project actions.

An immediate problem faced by the FAMS team was how to assure connectivity between the highest level objectives of the FAMS project, the various evaluation areas and the very specific, measurable micro-objectives. A related challenge was how to assure that all indicators would be relevant, and could be traced back to both micro-objectives and high-level objectives.

The approach taken was to develop a Layered Approach to the various objectives, so that each layer is clearly linked to the layers above and below it. In this way, all of the objectives within FAMS are clearly positioned and provide a clear logical framework for the project. Four layers are developed, shown in order from highest to lowest:

- 262 1) three Strategic Objectives (SO) set out below;



- 2) seven Evaluation Areas (EA) which cover the key dimensions of the project (note: these are not really objectives, but are a logical disaggregation level);
- 3) FAMS Level Objectives (FO);
- 4) micro-objectives which are practical and measurable.

The FAMS indicators are designed to measure at level 4, the micro-objectives.

The FAMS Project defines three main strategic objectives:

- SO1: to innovate the way DRT business and service models are implemented, through the adaptation, extension and trials of new IT infrastructures and e-Commerce/e-Business services – such as web-based access to information, booking and reservation for social service associations, shared resources planning etc. – to support their operation within the Flexible Agency concept;
- SO2: to build confidence for authorities and investors (operator, communities and suppliers) by the ability to plan, organise and deliver:
  - a quality product that meets the needs of users who have, until now, been marginalized by the transport offer;
  - substitute mobility products that are cheaper and more attractive than non-viable conventional services;
- SO3: to lead to deployment of DRT and Intermediate Transport concepts based on innovative Flexible Agencies. The implementing agency will need tools to support the business and organisational service models – hardware, software, communications, skills, training etc. – leading to take-up of the outputs of the advanced telematics and support products.

The Evaluation Areas are themes that are relevant and need to be assessed at site and/or at project level.

The FAMS project concluded that there are seven relevant areas:

- EA1) Generic ITS Issues, supporting the Innovation strategic objective;
- EA2) Angus Site-specific issues, supporting the Build Confidence strategic objective;
- EA3) Florence Site-specific issues, supporting the Build Confidence strategic objective;
- EA4) Generic Transport issues, supporting the Build Confidence strategic objective;
- EA5) Take-up issues, supporting the Deployment strategic objective;
- EA6) Regulatory and market environment issues, supporting the Deployment strategic objective;
- EA7) Business Case issues, supporting the Deployment strategic objective.

For each of these Evaluation Areas (EAs), the FAMS team has developed a set of FAMS Objectives (FOs). The FO level moves from the broad policy objectives to the specific interest of some or all of the stakeholders.

These three levels – Strategic Objectives (SO), Evaluation Areas (EA) and FAMS Objectives (FO) – are shown in full in Figure 13.1.

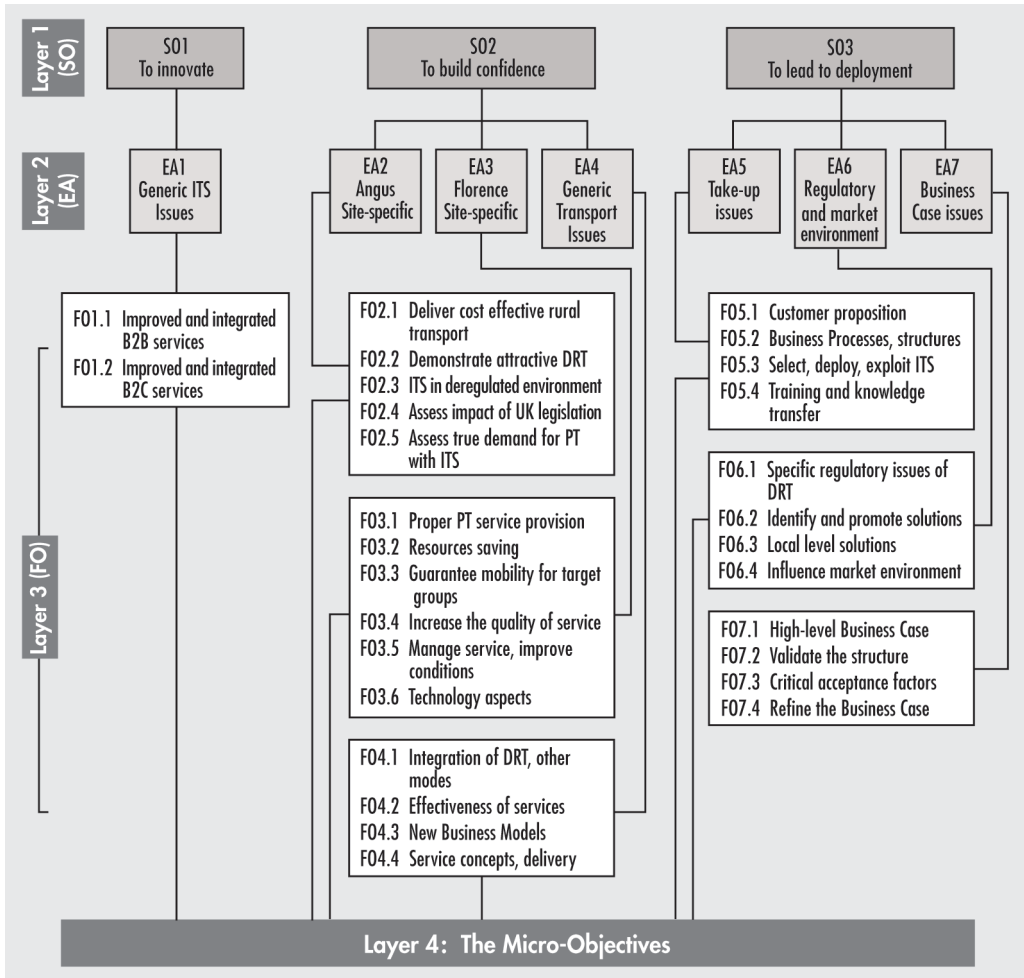


Figure 13.1: FAMS evaluation objectives

Each FO has an associated set of Micro-objectives (MO). It was quickly understood that the FAMS implementations are a sub-set of the overall actions of the stakeholders, and can rarely make a very significant impact to achieve the higher-level objectives – at least, not within the timescale of the measurement. Further, quite often there are external factors that can have far greater impact than the FAMS actions.

The idea of the Micro-objectives is to develop a set of low-level objectives that are appropriate in scale to what FAMS can actually achieve. Achievement of the Micro-

objectives will contribute to the achievement of the FAMS objectives and the Strategic Objectives. In a few cases, they will make a significant contribution, in most they will be enablers or a 'step in the right direction'. The important thing is that they are defined in terms that are achievable. The interested reader will find a full description of the FAMS Objectives in Chapter 3 of the FAMS Evaluation Plan and its associated Annex.

## 13.2 Evaluation methodology

The FAMS evaluation can be considered to have two main dimensions:

- *non-metric measurements*, based on structured interview, logs and event records. These mostly cover the evaluation areas which are not site-specific. This approach is innovative within the DRT domain, and represents a new achievement by the FAMS team;
- *objective measurements*, using the FAMS metric indicator set. These mostly cover the site-specific assessment. It can be considered as a conventional approach, and builds on prior work.

### *Non-metric Assessment*

The Project Level evaluation deals with Evaluation Areas:

EA1: Generic ITS Issues

EA4: Generic Transport Issues

EA5: Take-up Issues

EA6: Regulatory and Market Environment Issues

EA7: Business Case Issues.

For each of these areas, the assessment is primarily non-metric – in other words, it is not based on the FAMS Indicator Set, and generally cannot be described using metrics. Instead, the FAMS team will carry out a detailed assessment of the experience at the two FAMS sites of Angus and Florence. This uses a combination of a structured interview and information templates.

A set of tables for each of the Evaluation Areas EA1, EA4, EA5, EA6 and EA7 has been developed. These tables contain a nested set of:

- FO x.y: FAMS Objectives
- MO x.y.z: Micro Objectives
- Assessment parameters.

The nature of these parameters vary, since they must cover a wide range of issues. To generalise, many are of the form:

“Existence of a formal agreement to/business plan/monitoring process ...”

“% of total service covered by integration agreements to ...”

“Critical success factors for ...”

“Has a formal training programme been put in place to ...?”

“Identified barriers to implement ...”

“Number of new or enhanced ...”.

These parameters have been designed to measure the achievement of the objectives described above and to provide full two-way traceability. They have also taken into account the possibility that FAMS may be able to establish co-operation agreements with other sites, and hence could form the basis for an extended comparative assessment.

### **13.2.1 The FAMS Indicator Set**

FAMS builds on the work of predecessor projects such as SAMPO and SAMPLUS, as well as contemporary projects such as INVETE. This pragmatic approach allowed FAMS to gain the benefit of previous research work and to utilise the experience and lessons learned. It also allowed the team to avoid duplication of effort and to reduce risk. It became clear that the Evaluation activities in SAMPO and SAMPLUS had provided an excellent theoretical framework and had generated some really useful indicators. However, the experience of those projects also showed shortcomings in relation to usability and comparability of certain indicators.

The FAMS team has adapted these indicators, and increased the level of traceability from indicators back to objectives. The approach taken was to take the SAMPO, SAMPLUS and INVETE indicators as a starting point.

During a dedicated Evaluation Workshop meeting, the FAMS team systematically determined which indicators should be retained, adapted, enhanced, required new measurement methods, be merged, split, or discontinued. For each indicator it was determined which site(s) would measure it, and whether it was expected to be comparable from one to the other. Following this process, any gaps in the indicators compared to the micro-objectives were identified, and either a new indicator was developed, or it was passed to the non-metric assessment if an objective indicator could not be defined.

SAMPLUS had developed four clusters of indicators:

EV: Economic Viability

SP: Service Provision

TP: Technical Performance

MP: Market Projection.

FAMS has retained the first three categories – Economic Viability, Service Provision, and Technical Performance. The fourth category, Market Projection, had actually been drawn from the other three and was designed to assist in market assessment. In FAMS, this has been superseded by the Evaluation Areas EA1, EA4, EA5, EA6 and EA7 which

take a more comprehensive approach to the market development. The interested reader will find detailed descriptions of the development, as well as full listings, of the non-metric and metric indicators in Chapter 6 and associated annexes of the FAMS Evaluation Plan (downloadable from the FAMS website). In addition, a description of the evaluation methods to be used is given in Chapter 5 of the FAMS Evaluation Plan. Templates for data collection sheets and questionnaires, and the SAMPLUS and INVETE indicators are also provided for reference.

### **13.2.2 Implementation**

Planning for the data collection and assessments within FAMS follows conventional practice. This involves the development of a Data Collection Plan and associated oversight procedures at site and project level. Generally, the bulk of the metric evaluation will take place around the commencement and immediate following months of the trials. The non-metric assessment will be in the form of structured interviews that will involve about one week of on-site meetings and observations when the trial systems has become established, scheduled for about 3 months after implementation, although some specific aspects will be tracked at the point of implementation.

## **13.3 Closing remarks**

The FAMS Evaluation Plan has established the following:

- a) a clear rationale for the project
- b) a clear and nested set of objectives which provide full visibility from the programme-level Strategic Objectives through to the Micro-objectives at the measurable level
- c) a solid framework for the evaluation
- d) a consistent and practical set of metric indicators which will permit the detailed observation of impacts at the two FAMS sites
- e) an extensive set of non-metric indicators which will allow the FAMS team to capture the experience, success factors and potential barriers to confidence-building and successful deployment
- f) a logical structure to allow two-way traceability between objectives and indicators, with a first set of linkages identified
- g) identification of the indicators that will be measured in both test sites, and the extent to which they are directly comparable
- h) development of the high-level activity planning.

The FAMS team considers that this approach offers a relevant framework for other practitioners to adapt to their specific needs.



## The FAMS approach in Angus

*P. Eloranta, B. Masson*

### 14.1 Background to DRT and FAMS in Scotland

The problem of designing cost-effective, rural public transport services continues to challenge most governments and communities throughout Europe, also in Scotland. Is there a solution to the problem? Do regulations help or hinder the development? Would deregulation assist? In the UK a deregulated bus and coach sector has existed since 1986. Over the past 17 years various initiatives have been tried mostly resulting in the major transport groups deregistering existing services to attract subsidies to keep these routes in existence. Can this chain of events be broken? Will it be possible to design a flexible, user-friendly cost effective rural transport system? How will the existing users respond to change? Would the operators consider new ideas? Can new technology assist in the co-ordination of public transport services? How will the statutory bodies respond to the challenge? Does the existing legislation help or hinder change? Can a case be demonstrated for the need to change? These are some of the questions Scottish-based charity the Angus Transport Forum hope to address through their participation in the FAMS consortium and development of DRT services. Angus Transport Forum (ATF) was established in 1995 by local people who wished to lobby the case for improvement of public transport services in the area. In 1997 they successfully attracted funding to employ a transport officer whose role was to identify the needs of local communities and bring these to the attention of statutory bodies and local transport operators. Over the past 4 years the forum has created 6 area groups in Angus covering, Kirriemuir and the Glens, Brechin and Glen Esk, Montrose Hinterland, Carnoustie/Monifieth Hinter-

land, Newtyle Hinterland and Forfar Hinterland. These groups meet on a regular basis to discuss local transport issues. Comments are passed to operators and Angus Council and have resulted in the introduction of shoppers' services and improved connections throughout the area. The most important aspect of the consultation is that the Forum has been able to design a concept to improve public transport in rural areas that has involved the local community.

In Summer 2000, the Angus Transport Forum attracted funding to continue the work of the organisation and employ a full-time worker to develop a strategy for the Forum to test new concepts to resolve some of the issues highlighted in the previous three years work. By Autumn 2000 a draft report was produced with the aim of clarifying the findings of the work carried out. Local operators were interviewed and the availability of vehicle and manpower resource were identified. There was also a backing from the majority of transport providers to look at new ways of attracting people to use public transport services. The Angus Transport Forum then held a conference to promote its findings and its strategy for introducing a Demand Responsive Pilot Service in the most rural areas of Angus. Speakers from Mobisoft Finland, Mobisoft UK, Newcastle University, Patient Transport Service and The Community Transport Association gave the 130 delegates an insight to the various options available and how DRT had worked in various parts of Europe. From that moment the Forum's involvement with the FAMS consortium was born. In a true partnership style the Forum attracted financial support of over £250,000 from 14 different organisations to test a co-ordinated DRT concept over three years.<sup>1</sup>

#### **14.1.1 Introduction to Angus Region**

Angus has a population of 112,000 people and it is situated in the north-eastern part of Scotland. It lies to the northeast of Edinburgh on the Firth of Tay. In an area of 2,200 square kilometres, mountains, glens, rivers, rugged cliffs, seaside towns, market burghs, turreted castles and ancient relics stand side by side. The coastal belt is well served by public transport services to and from Dundee, Arbroath, Forfar (the county town) and Montrose and onward north to Aberdeen and southwest to Edinburgh. The northern boundary of this coastal strip is marked by the settlements of Alyth (which is in the county of Perth and Kinross to the west of Angus), Kirriemuir and Brechin. These

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<sup>1</sup> The partners are the European East of Scotland Objective 2 Programme, European Rural Development Fund; European Commission, Directorate General Information Society 5<sup>th</sup> Framework Programme; The Community Fund; Angus Council; NHS Tayside; Scottish Enterprise Tayside; Angus Childcare Partnership; Forward Scotland; Angus College; Cairngorm Partnership; Scottish Ambulance Patient Transport Service and Ordnance Survey. Support in the form of payments in kind to the value of £50,000, have also been committed by NHS Tayside, Scottish Ambulance Patient Transport Service and the Ordnance Survey.



settlements have good transport links on the coastal side but landward towards the Glens the public transport provision ranges from adequate to poor and even non-existent, particularly at the heads of the Glens. Angus is no different from other rural areas in Scotland and Europe. The issues of rural depopulation, sustainability, access to employment, health, education, training, child care are all perceived as a major problem unless people have access to a car. Where public transport services exist these are based around school transport provision and a weekly shoppers bus. Post Buses operate in Glen Isla, Glen Prosen and Glen Clova.

The FAMS take-up and trial site in Angus is new to DRT applications, although local plans exist to introduce DRT and the Flexible Agency at the site. The site covers the rural Angus area surrounding Alyth, Kirriemuir and Brechin and will allow evaluation of transferability issues, both on the technical and organisational level. Figure 14.1 below shows the FAMS site in Angus. As mentioned the main actor of the Angus site is the Angus Transport Forum. It has a membership of over 60 organisations, comprising of voluntary organisations, Community Councils, transport providers and residents of the area.

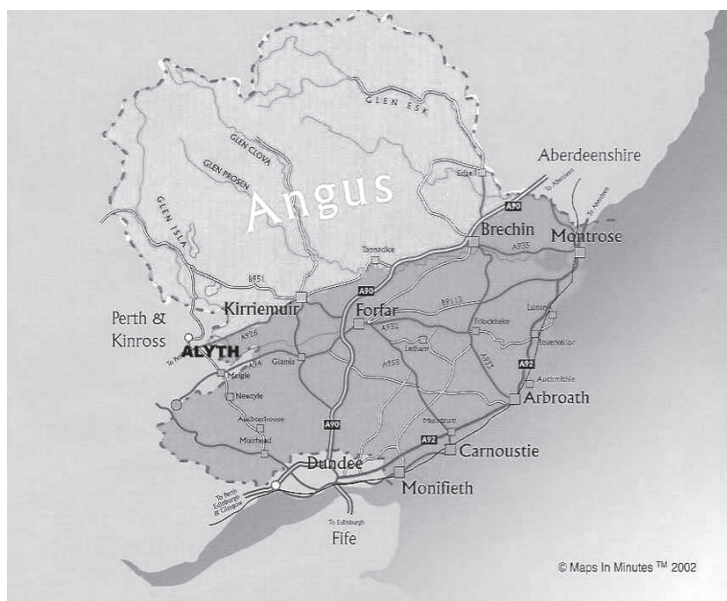


Figure 14.1:  
The Angus site

## 14.2 Implementing FAMS in Angus

The area selected for the FAMS Project covers 490 square miles, (58% of the Angus area) and a population of 9,742 (8.9% of the Angus population). Due to the low population density this area is not currently well served by public transport services. 271

Where services are provided they are based around school transport provision which only operate on schooldays or shopper buses provided on a weekly basis to provide a basic lifeline for rural residents. Post buses operate limited services in Glen Isla, Glen Prosen and Glen Clova. People residing in the area are car dependant. Increasing motoring costs (fuel and insurance) have a severe effect on rural residents. Access to employment, training, education, health services, child care, shopping, recreational facilities and visiting are all dependant on access to a car and sufficient funds to undertake the wide range of activities taken for granted by those living in urban areas. Average income in Angus is 10% less than in Scotland as a whole. Health care policy in the area is in a period of change with more services being centralised in the Ninewells Hospital, Dundee. Visits to the Ninewells Hospital can mean a whole day spent travelling by public transport and several changes of vehicle, too. This is causing great concerns for the residents in the area. General practitioners are sympathetic to elderly residents and aware that a car provides the only lifeline for their needs at present. If a suitable alternative could be found, a large number of elderly car owners would gladly give up their car. The allocation of hospital appointment times does not recognise the difficulties people residing in rural areas experience. This causes widespread concern especially for the elderly patients. The patients are regularly faced with delays and arriving late. There is a shortage of car parking spaces at Ninewells. This can result in visitors facing long walks to get to the hospital. Disabled people are restricted to travelling by “client” based services due to the lack of accessible services. This does not meet their needs or the concept of social inclusion within the community.

Angus Council, Scottish Enterprise Tayside and Dundee and Angus Tourist Board are encouraging tourism in the area. It is difficult for cottage industries, particularly catering to attract part-time staff, due to the lack of transport in the area. Visitor numbers are restricted to car owners. School children are restricted in their ability to undertake after school activities due to the lack and/or cost of finding alternative transport. This does not offer rural children an equal opportunity. At school holiday times parents are faced with the dilemma of having a family holiday together or splitting vacation time between partners to act as child minders. The lack of accessibility to child minders and or clubs organised by the community education department can also act as a disincentive to bring up a family in rural areas. Older children remain heavily dependant on parents therefore restricting personal development.

#### ***14.2.1 Approach to collective transport***

The existing public transport provision in the Angus area, where it has existed, has not met the needs of the community or encouraged families to live in rural areas. There has been no co-ordination or integration of existing resources providing school, health and client based services, meals on wheels or departmental mail delivery services. This has

resulted in several vehicles operating in the same area but only for a limited number of people. Therefore the service provision in rural areas has been regarded as expensive. Many functions could, however, have been undertaken by the same vehicle. This would have released resources to meet unmet demand. The existing public transport network has existed since the 1950s. The main transport provision in the 3 trial areas has been centred on school transport services that operate 190 days per year. Weekly or twice weekly shopper's services have been provided and subsidised by Angus Council. Fares are set by operators in accordance with Angus Council's Concessionary Travel Scheme. Angus Council has introduced a joint ticketing multi-operator scheme between operators serving Stracathro Hospital.

Six main operators provide services within the pilot area:

- Strathtay Scottish (Subsidiary of Yorkshire Traction)
- Meffans Coaches (Kirriemuir) subsidiary of Strathtay Scottish
- Melvilles Kirriemuir
- Wisharts of Friockheim
- Nicholls of Laurencekirk
- Glen Travel.

Strathtay Scottish and Meffans operate over 90% of the scheduled services in Angus. Post Buses operate in Glen Isla and Clova. Numerous taxi and private hire companies and owner drivers operate in the area. Fares are set by Angus Council in conjunction with the taxi/private hire companies.

#### **14.2.2 Stakeholders and main actors**

The aim of the Angus site has been to create a co-ordination centre (Flexible Agency) to administer a rural DRT system. The centre would take bookings for all residents and visitors wishing to access the rural areas of Angus surroundings (Alyth, Kirriemuir and Brechin). The objective has been to maximize the use of existing resources and provide the residents of the pilot area with equal access to employment, training, childcare, health care and leisure activities. Services have been designed to embrace the concepts of rural regeneration, social inclusion, sustainability and community planning. The Angus Transport Forum aims to ensure the provision and maintenance of adequate public transport services and facilities in Angus thereby ensuring access to services and facilities for all residents. Membership consists of representatives from Voluntary Organisations, Community Councils, Bus and Taxi Operators and other groups with an interest in public transport. The main aims of the Angus Transport Forum are:

- to identify the transport needs of individuals and groups in all the communities of Angus
- to increase awareness and share information on public transport provision

<b>Stakeholder Name</b>	<b>Type</b>
Angus Council	Authority/Sponsor/Social Service Provider/Employer/End User
NHS Tayside	Authority/Sponsor/Social Service Provider/Employer/End User
Scottish Enterprise Tayside	Sponsor
European Commission	Sponsor
European Rural Development Fund	Sponsor
Forward Scotland	Sponsor
Angus Childcare Partnership	Sponsor
Angus College	Sponsor
Ordnance Survey	Sponsor
Scottish Ambulance Service	Sponsor + Social Service Provider
Angus and Dundee Tourist Board	Authority/End User
Federation of Small Businesses	Employer/Business/End User
Bus Operators	Transport Service Provider
Community Transport	Transport Service Provider
Angus Transport Forum	Transport Service Provider/Financial Sponsor/Community Group/Employer
Angus Association of Voluntary Organisations	End User
Chamber of Commerce	Employer/business/end user
Rotary	Community Group
Round Table	Community Group
Local Traders Groups	End User/Employer and Business
Post Office (Consignia)	Transport Provider/Employer
Mobisoft	IT Supplier
Taxi/Private Hire Trade	Transport Service Provider
Community Councils	Community Group
Angus Youth Congress	Community Group/end user
Community Transport Association	National Body representing Community Transport Groups
Traffic Commissioners	Authority
Scottish Executive	Authority
People	End user

274 Table 14.1: Stakeholders at the Angus Site

- to liaise with statutory authorities and transport providers in developing appropriate responses to the needs identified.

Angus represents a complex site of multiple stakeholders. This reflects factors such as:

- the wide geographical coverage across local boundaries
- the deep interest in mobility services from all sectors of the community
- the complexity of the organisation and sourcing of the mobility services
- the fragmentation of responsibility across many agencies
- the need to source funding from many different sources.

Table 14.1 categorises the stakeholders.

All the above organisations have been involved in discussions regarding the FAMS project. The user groups have been in existence since 1997 and have highlighted the need for everyone to work together. Angus Transport Forum has been the driving force in highlighting the need for greater partnership working. The result has been the recognition by the above groups to the cause.

### **14.3 Take-up and FAMS trial objectives in Angus**

The technological scenario has been built up to support DRT operations in the Angus area. So far Angus Council has introduced Internet facilities at a number of village halls in the area. Accessing this facility is welcomed, but access is unfortunately limited to those who can reach the halls.

The FAMS Project will address the above mentioned problems. It has not intended to develop a solution around any single group or problem. The Angus approach has been to involve all parties to introduce a cost effective local solution to meet the needs of all parties, utilising existing resources in a co-ordinated manner. Flexibility in service delivery is the key.

“Best fit” will be used to deliver services using a wide range of vehicles from taxis/volunteer drivers to coaches. The creation of the Flexible Agency will establish the true demand and unmet demands for the area. Transport providers will be contracted to meet the highest service levels (including MIDAS driver training and local authority standards).

New technology systems are now available to make this concept possible. Where these systems have been introduced in Europe, the results have shown that significant savings can be made and resources freed up to meet unmet demand. The FAMS trial in Angus is based on the MobiRouter application by Mobisoft (see Section 4.2.4) allowing management of all key operations of the DRT service provision model (booking and reservation, service planning, route planning, vehicle dispatching, communication etc.).

A number of vehicles will be used and equipped with suitable in-vehicle terminals for DRT services. The objective has been to develop an advanced Travel Dispatch Centre/Flexible Agency with communication to vehicles so that they can be monitored and managed in real-time.

There are four core goals at the Angus site

- improve Public Transport in remote rural areas in Angus
- embrace Social Inclusion
- introduce community planning
- sustainability of services.

These four goals can be associated with more specific objectives relevant to the DRT services and FAMS action, as shown in Table 14.2.

Goal	Objective
Improve Public Transport in Remote Rural Areas in Angus	Encourage innovation
	Establish existing demands
	Establish existing resources
	Explore alternatives and commercial acceptance for the need for change
	Trial alternatives
Embrace Social Inclusion	Consider greater co-ordination and integration
	Explore opportunities for joint working between agencies
	Evaluate software systems for invoicing multi-agency client-based services
	Evaluate customer feedback
	Evaluate vehicle design requirements to meet the needs of everyone in the community
Introduce Community Planning	Encourage Communities to get involved in policy and delivery of services
	Establish Local Groups that represent a cross section of the community
	Involve the groups in service design to establish "ownership"
Sustainability of services	Explore environmental impact of existing transport provision
	Encourage non car user tourists
	Explore alternative fuels in design of vehicles

Table 14.2: Site-level objectives of the Angus site

The Angus Demand Responsive Transport (DRT) co-ordinated transport pilot project seeks to maximise the use of existing public transport resources in the area to produce a flexible, user-friendly integrated service and provide a sustainable means of delivering transport provision utilising new technologies. The Angus site is a location of dispersed population and diverse activity. As previously noted, people who do not have the use of a car face very serious challenges, and this greatly reduces the quality of life and their ability to participate in society. There are very specific community and people-oriented objectives of the new mobility services, and these are presented in Table 14.3.

<b>Objectives of the Mobility Services Scheme</b>	<ol style="list-style-type: none"> <li>1. Provide all rural residents with equal public transport access.</li> <li>2. Maximise the use of existing resources.</li> <li>3. Improve access to employment and training.</li> <li>4. Improve access to area for tourists without access to cars.</li> <li>5. Increase passenger numbers.</li> <li>6. Establish Travel Club for residents in pilot area.</li> <li>7. Improve access to childcare and after school activities.</li> <li>8. Reduce car dependence.</li> <li>9. Increase car sharing.</li> <li>10. Encourage shopping in local areas through introduction of hub principle.</li> <li>11. Encourage families to stay in rural areas.</li> <li>12. Introduce multi-modal joint ticketing.</li> <li>13. Create more full-time employment in transport sector.</li> <li>14. Improve access to health and education.</li> <li>15. Reduce duplication and wasteful use of resources.</li> <li>16. Evaluate new technologies and effect on patronage.</li> <li>17. Reduce subsidies.</li> <li>18. Encourage bicycle carriage on buses.</li> <li>19. Demonstrate that taxi services can provide a solution to rural transport problems.</li> </ol>
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Table 14.3: Community-level objectives of the Angus site

The next chapter considers the FAMS activities at the Florence site.





## CHAPTER 15

### **The FAMS approach in Florence**

*C. Binazzi, M. Boero, A. Ferrari, N. di Volo, G. Speroni*

With a long tradition of innovation in transport and collective mobility services, the City of Florence started experimenting with non-conventional, flexible transport solutions at the end of the eighties. As extensively reported in Chapter 7, thanks to some major initiatives – such as SAMPO and SAMPLUS – launched in the mid-nineties, DRT services proved to be a viable and successful scheme to address personalised mobility needs in several areas of Florence and for different user categories. Since then, several DRT services have been implemented and this led the local mobility authorities to think about new ways to co-ordinate the provision of different DRT schemes within the metropolitan area and to improve the service offer and accessibility to the different DRT user categories. The start of the European Take-up Action FAMS in March 2002 offered the ideal context for development of the Flexible Agency for Demand Responsive Mobility Services concept and for its pilot application within local trials, starting from May 2003. This chapter provides an overview of the FAMS implementation in Florence and of the experimental service co-ordination and provision model started in the area during May 2003. Specifically, the main characteristics and needs of mobility in the area, the organisational and operational models as well as the technical solutions adopted in FAMS are described.

#### **15.1 The FAMS mobility context in Florence**

The City of Florence is an historical centre with a very old cultural and economical history, some 590,000 inhabitants and huge commuter/tourist flows during the whole

year. The trial area of FAMS covers part of the Florence metropolitan centre and a peri-urban area called “La Piana Fiorentina”, a vast *plateau* located north-west of Florence and including the administrative boundaries of four of the nine towns surrounding Florence: Campi Bisenzio, Scandicci, Sesto Fiorentino, Calenzano. Altogether, the FAMS area includes characteristics and problems which are typical of different transport and mobility environments: pure urban districts and areas, peri-urban areas, small-size towns, rural areas.

### **15.1.1 Mobility needs and approach to Flexible Collective Transport**

Over the last years, two aspects have gained increasing interest for the various transport operators and authorities engaged in the provision and management of collective mobility services in the Florence Region:

- the implementation of appropriate “intermediate” collective transport schemes, with a view of differentiating the offer and providing complementary services well integrated with regular bus services,
- to improve access for the citizens and the different user categories to the services globally offered in the area, thereby increasing the level of acceptance and use of public transport.

To this end, starting from 1995 several collective “intermediate” transport services have been implemented. These are now in regular operation by different service providers and offered to different users categories, ensuring a certain level of flexibility to meet users demand. Specifically, these services in the area are operated and co-ordinated by four major private and public transport companies: ATAF, Li-NEA, CAP and SITA.

Overall, the following DRT schemes are currently provided to the citizens and travellers in Florence:

- many-to-many DRT service in Campi Bisenzio town, operated by ATAF;
- many-to-many DRT service in Scandicci town, operated by Li-NEA;
- many-to-many DRT service in Sesto Fiorentino town, operated by Li-NEA;
- many-to-many DRT service in Calenzano town, operated by CAP;
- one-to-many DRT service in Porta Romana urban district of Florence, operated by ATAF;
- special shuttle bus service connecting Florence’s “A. Vespucci” Airport with the inner centre, jointly operated by SITA and ATAF;
- door-to-door DRT social services for special user categories (elderly, disabled) in the whole metropolitan area, operated by ATAF and different Associations, Charities and Public Health Care transport service providers;
- dedicated school transport services, operated by ATAF.

All of these services are integrated, to a certain extent, with the main regular transport service network, with joint stops and adapted schedules.

ATAF is the main transport operator, owning and running advanced IT infrastructures (AVL/AVM system) that ensure monitoring of the bus fleet on the network, communication with drivers, vehicle location and service “regulation”. ATAF was also the first transport operator to pioneer flexible and intermediate DRT services in urban and peri-urban areas of Florence, starting with the Porta Romana DRT service and the more complex PersonalBus many-to-many service launched under SAMPO (see Section 7.5). These services are managed by a Travel Dispatch Centre based on advanced system concepts and technologies (the PersonalBus™ system, developed by Softeco Sismat SpA). The TDC provides support to manage trip request and reservation handling, trip planning, vehicle dispatching, service monitoring and provided the core system for development and operation of the FAMS agency in Florence.

### 15.1.2 FAMS objectives in Florence

In Florence, the FAMS concept was built up upon and around the existing DRT services, with a view to gradually expanding, after successful implementation and evaluation of the trials, as the Agency for co-ordination of all intermediate transport services in Florence Region. The baseline scenario and resources were set by the existing ATAF technologies – i.e. the TDC and related infrastructures – as well as the available experience in the planning, operation and management of DRT and flexible services. Through the FAMS organisational and business model, the Agency has been established as the unique reference interface and as a service centre for the users of intermediate transport in Florence, providing services for booking and reservation, user information and feedback etc. Table 15.1 below provides a summarised view of the intermediate transport services that have been initially co-ordinated by the FAMS Agency in Florence.

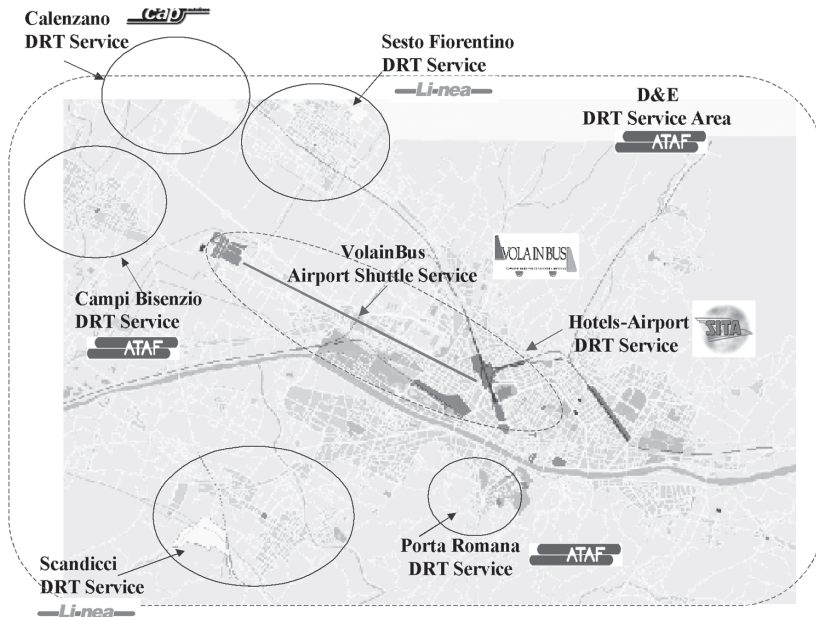
Service	Target Users	DRT Type	Environment	Transport Operator
PersonalBus service in Campi Bisenzio	General public	many-to-many	peri-urban	ATAF
PersonalBus service in Scandicci	General public	many-to-many	peri-urban	Li-NEA
PersonalBus service in Sesto Fiorentino	General public	fixed line with deviations	peri-urban	Li-NEA
PersonalBus service in Calenzano	General public	fixed line with deviations	peri-urban	CAP
DRT in Florence, Porta Romana district	General public	one-to-many	urban	ATAF
D&E DRT	Disabled & Elderly	door-to-door	urban, peri-urban	ATAF, Charities (Humanitas, Misericordia)
VolainBus airport-centre shuttle	Travellers, tourists	fixed line, with reservation	urban, peri-urban	SITA/ATAF
Hotels-Airport DRT service	Travellers, tourists	many-to-one	urban, peri-urban	SITA

Table 15.1: DRT services for the FAMS trials in Florence Region

Figure 15.1 provides a geographical view of the area of operation of each service.

Thanks to the FAMS concept and implementation, the different stakeholders and transport operators joined the experimental project with the objective of achieving and demonstrating the following operational and business advantages:

- improved service offer to the different DRT user groups and provision of personalised services for particular user categories, tailored on the specific need of each category, including: disabled, elderly people and school-children, tourists and travellers;
- increased user base of DRT services, thanks to improved service information and access by provision of advanced booking and reservation facilities, service planning and quality information;
- reduced costs of DRT service production, thanks to access to and use of the FAMS Agency's DRT planning and management services (booking, planning, dispatching)
- better interaction and co-operation among DRT transport service providers (ATAF, SITA, Li-NEA, CAP, Citizens Associations) and better co-ordination of services by networking and integration of e-Business solutions;
- transfer of operational and management expertise from the current DRT operated by ATAF to the new Agency, and gradual build up of an organisational, operational and technological platform for expansion of DRT services in the region.



282 Figure 15.1: Geographical location of DRT services during the FAMS trials in Florence Region

### 15.1.3 The FAMS users' context

As introduced in previous sections, the integrated FAMS Agency in Florence is seen as the organisational structure offering a true opportunity to create a co-ordination at metropolitan level of all the actors involved in the provision of different kinds of service (public transport operators, municipalities, disabled associations etc.) thus improving the service offer to the users and optimising the overall utilisation of financial resources for transport services. As such, the Agency provides an organisational and technical infrastructure with impacts on a number of different institutions, organisations, users and associations.

Figure 15.2 introduces the overall context of operation of the FAMS Flexible Agency in Florence. As one can see, there are four main classes of users:

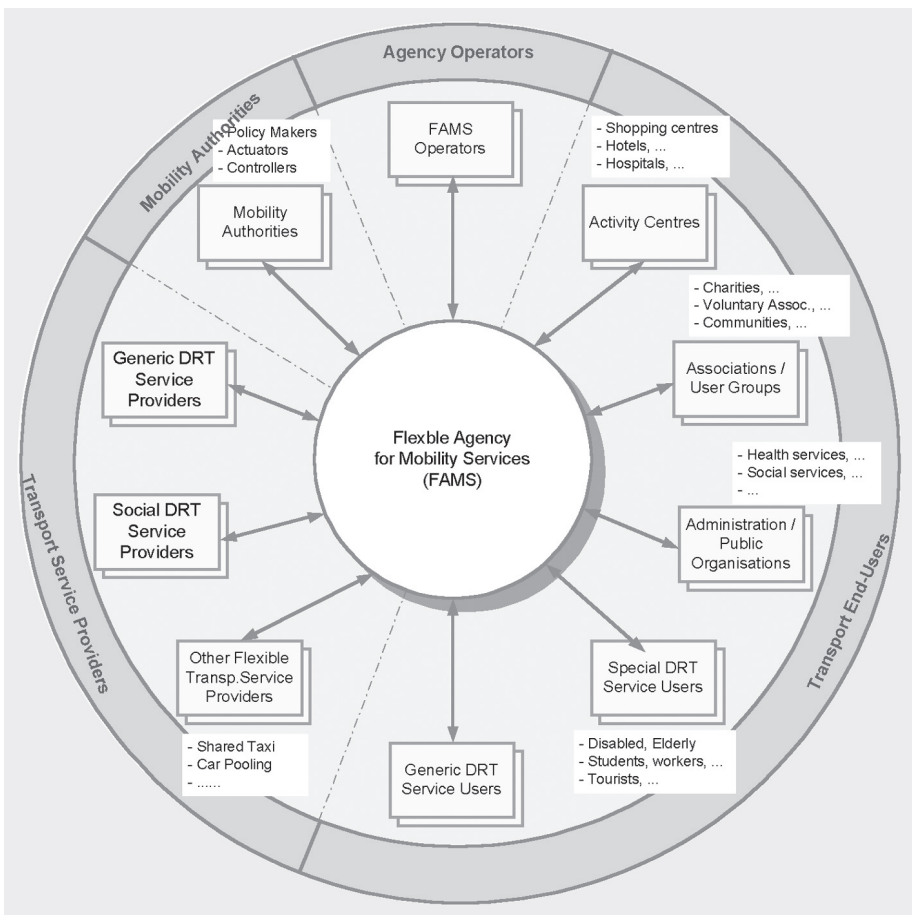


Figure 15.2: Context diagram of FAMS Agency in Florence

- 1) End-users of flexible transport services, covering the whole range of current and prospective end-users of DRT services in the Florence Region: citizens and generic transport users; disabled and elderly user groups; other user groups with specific transport requirements (e.g. students, workers, tourists etc.); public agencies (e.g. public health organisations, social service organisations etc.) and associations (e.g. voluntary associations, community groups etc.) organising transport for particular user groups; active destinations for demand responsive transport (e.g. hotels, shopping centres, hospitals and clinics, airport, railway stations);
- 2) Transport service providers, including both public and private organisations which provide various forms of flexible, collective transport services, from DRT services for generic users (i.e. ATAF, SITA, Li-NEA, CAP) to disabled and elderly services (ATAF, Humanitas, Misericordia). These users of the FAMS Agency actually provide transport resources, infrastructures and services meeting the demand of the above user categories;
- 3) Mobility Authorities. This category represents the interface between flexible transport organisation/provision and the planning and management of mobility services at city level. Mobility authorities in Florence Region include: the relevant transport and mobility departments of the Municipality of Florence, the Province of Florence, the Tuscany Region, the Mobility Manager of Piana Fiorentina. These authorities need to have access to the FAMS knowledge base of users' demand, transport service planning, management and operation data for the purpose of monitoring the implementation and updating the mobility policies in the application area;
- 4) Flexible Agency operators. These represent the operational users of the organisational and technical infrastructures implementing the Flexible Agency. Supplied by ATAF – which hosts the technical and organisational infrastructures of the FAMS Agency – FAMS operators are to ensure the effective implementation of all the processes and workflows related to customer communications, service booking and reservation, service management and operation.

## 15.2 The FAMS system architecture

### 15.2.1 Functional architecture

In order to achieve the FAMS objectives defined in section 12.1, a suitable system architecture including the required services and technological facilities has been designed and implemented.

Figure 15.3 below provides an overview of the reference functional architecture of the FAMS Agency in Florence. Three main functional/service areas can be identified as shown in the figure: B2C Services, B2B Services, Extended TDC Services.

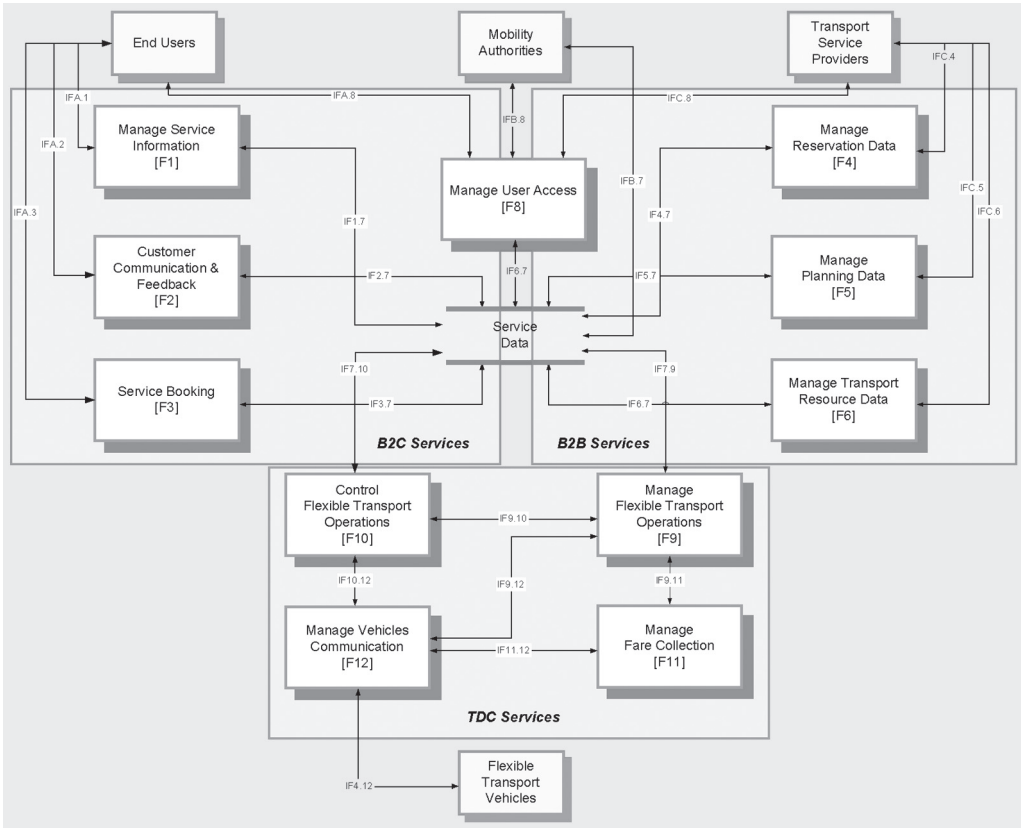


Figure 15.3: FAMS Functional Architecture in Florence

The *B2C Services* area (functional groups F1-F3) includes all services and facilities supporting the interaction between DRT end-users and the Agency. These services support all the information exchange and service booking. Basically, this functional area includes three main service groupings:

- booking and reservation facilities, based on web services and standard phone (call centre) connections
- provision of extended feedback to DRT users (confirmation of booking, modifications to planned services etc.) through e-mail, SMS and web services
- provision of general information and customer care services (e.g. general communication, users inquiries, special service offers, events calendaring etc.).

The *B2B Services* area (functional groups F4-F5) covers the interaction between the different transport providers co-operating within FAMS and the Agency. The underlying services provide support to each connected transport operator as regards:

- management of booking/reservation requests and information
- management of available resources (i.e. vehicles availability for service planning)
- route planning, service scheduling and vehicle dispatching information.

The F7-F8 groups, implement the user access and general data management services of the FAMS. These include:

- user registration and service access profiling
- archiving, structuring, updating and maintenance over time of all the information handled by the Agency
- support to data analysis and statistics.

Finally, the Extended TDC Services area (functional groups F9-F12) covers all core tasks related to the management and operation of flexible transport provision. These correspond, mainly, to the typical operations supported by a Travel Dispatch Centre (see detailed description in Chapter 3) extended to cover the multi-service, multi-operator dimension of the Flexible Agency.

It is to be noted that the functional groups from F9 to F12 can be linked to the TDC functionalities defined for DRT applications in the SAMPO and SAMPLUS projects whereas the groups F1-F8 concern more directly the information and service interaction requirements among the Agency and the different users introduced by the general concept of the FAMS.

### **15.2.2 Physical architecture**

There are various ways of implementing the functionalities described in the previous section and to conceive a physical set up for the deployment of such services. The model chosen and followed for the implementation of FAMS in Florence is shown in Figure 15.4. It is based on the following main physical components.

1) *The FAMS Portal*. This sub-system implements the main channel for accessing both B2C and B2B services provided by FAMS (functional groups F1-F5 introduced in previous section). It also support user registration and management services (functional groups F7-F8). Essentially, the FAMS portal allows DRT users to access all general information about DRT services offered, service booking and reservation, service confirmation through a standard internet connection (fixed or, eventually, mobile).

Likewise, transport service providers can access FAMS services via the internet through a dedicated section of the portal. By means of dedicated web services, accessible via user specific, customised ‘portlets’, the portal offers an easy and standard way to exchange information with the Agency.

This allows part of the workflows between DRT users and service providers to take place in a conveniently automated way, thus relieving the TDC personnel from part



of the time consuming operations related to DRT customer management such as booking and reservation management, user confirmation, provision of information about service changes and re-planning etc. Access to user services is possible anyway through the standard phone line (TDC Call Centre) for those users not provided with or not yet familiar with internet access.

2) *The FAMS TDC platform.* This sub-system implements the extended TDC services concerned with the management of booking and reservation requests (received via the portal or by phone), planning of routes and services, trip scheduling and monitoring, vehicle communication and management (functional groups F9-F12). This key component of the FAMS Agency in Florence is realised through the PersonalBus™ software system.

Already in use in ATAF TDC, this was adapted by the IT manufacturer (Softeco Sismat SpA) to cope with the general needs and operational requirements of the FAMS context (multi-DRT, multi-service providers, different user categories etc.). The interface with the FAMS Portal is realised through a data server which hosts all service-related data.

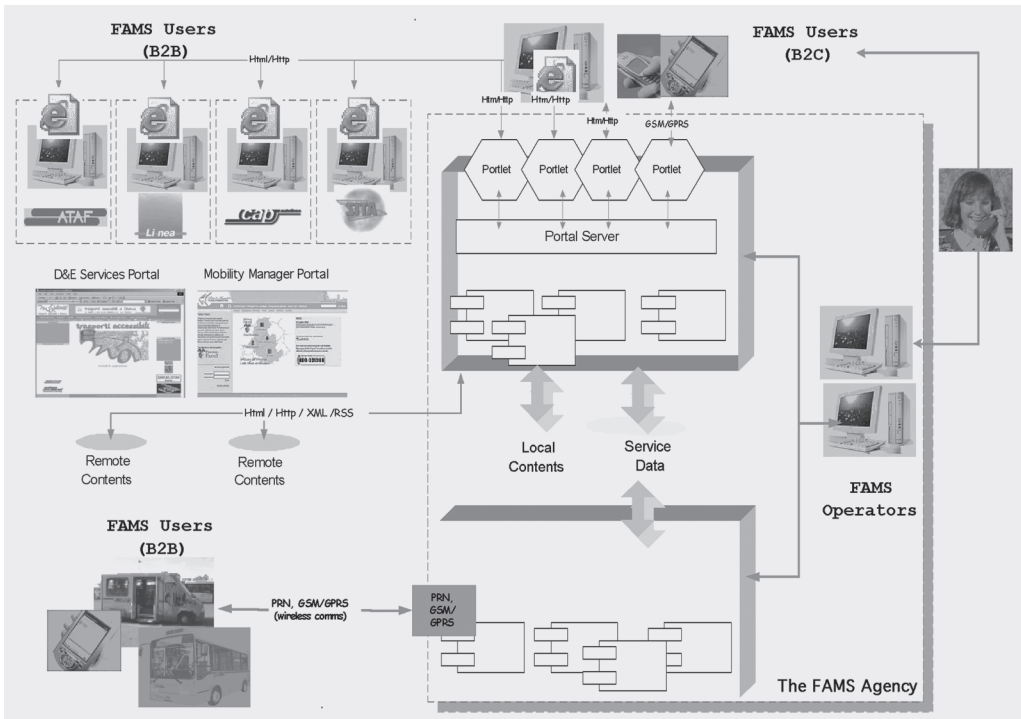


Figure 15.4: FAMS physical architecture in Florence

- 3) *Communication network*. This sub-system implements the communication between the FAMS Agency and the different DRT vehicles. Specifically, under the FAMS trials GPRS connectivity has been tested to check availability to support the type of data exchange required by the DRT service model. To this end, trip and service information generated by the FAMS Agency is made available through the FAMS portal and the public GPRS network to the DRT drivers, using commercially available PDAs. This type of set up proves to be a “light-weight” and viable solution for specific type of DRT services, such as transport services for disable and elderly users, students etc., which are operated largely as reservation-based, pre-planned services.
- 4) *Interfaces to external systems*. As the Agency for flexible mobility services in Florence, FAMS is interfaced with other systems and information sources related to demand responsive transport and flexible mobility initiatives in the area. Specifically, the FAMS Portal provides access to the following external contents and systems:
- Disabled and Elderly Services Portal, providing information about transport services for disabled and elderly users in Florence and access to a booking system dedicated to this user category;
  - Mobility Manager Portal, related to the mobility management initiative in the Piana Fiorentina and providing information and services about the co-ordination of mobility for residents in the area, workers of major industrial and commercial organisations and for their mobility managers.

FAMS has been the first experience of this type in Italy and in order to ensure the longevity of technical solutions, the scalability of the architecture and, eventually, the transferability to other sites, all sub-systems and components have been realised using widely adopted standards and commercial, off-the-shelf technologies.

Table 15.2 provides a summary of technologies used.

Subsystem	Implementation Technologies
FAMS Portal	Portal server: CleverPath™ (Computer Associates) Web Services: Sharepoint Team Services™ (Microsoft) ASP, XML
Extended TDC Platform	TDC Server: PersonalBus™ (Softeco Sismat) Data Server: Oracle DBMS SQL Server DBMS Communication Server: OpenVC™ (Softeco Sismat)
Communication	GPRS, GSM, SMS
On-board Systems	IPAQ PDA (with GPRS/GSM connection)

288 Table 15.2: Technologies for FAMS implementation in Florence

## 15.3 The FAMS Portal: Accessing DRT Services in Florence

As previously introduced, the FAMS Portal is the main channel of communication between the Agency and the different user categories, these being DRT service end-users (B2C services) or transport service providers or transport authorities (B2B services). This provides an alternative way with respect to a standard phone connection to access both information on the DRT offer within the Florence metropolitan area and a number of on-line services.

The figures below provide two examples of such services: the access to booking facilities for DRT users (Figure 15.5) and the access to service planning and information for DRT service providers (Figure 15.6).

The image displays two screenshots of the FAMS (Flexible Agency for Collective Demand Responsive Transport) portal. The top screenshot shows the main service selection page, featuring a map of Florence and various service options. The bottom screenshot shows a detailed booking form for a trip, including fields for departure and arrival times, dates, and contact information.

**Figure 15.5: FAMS Portal, on-line B2C services for DRT booking and reservation**

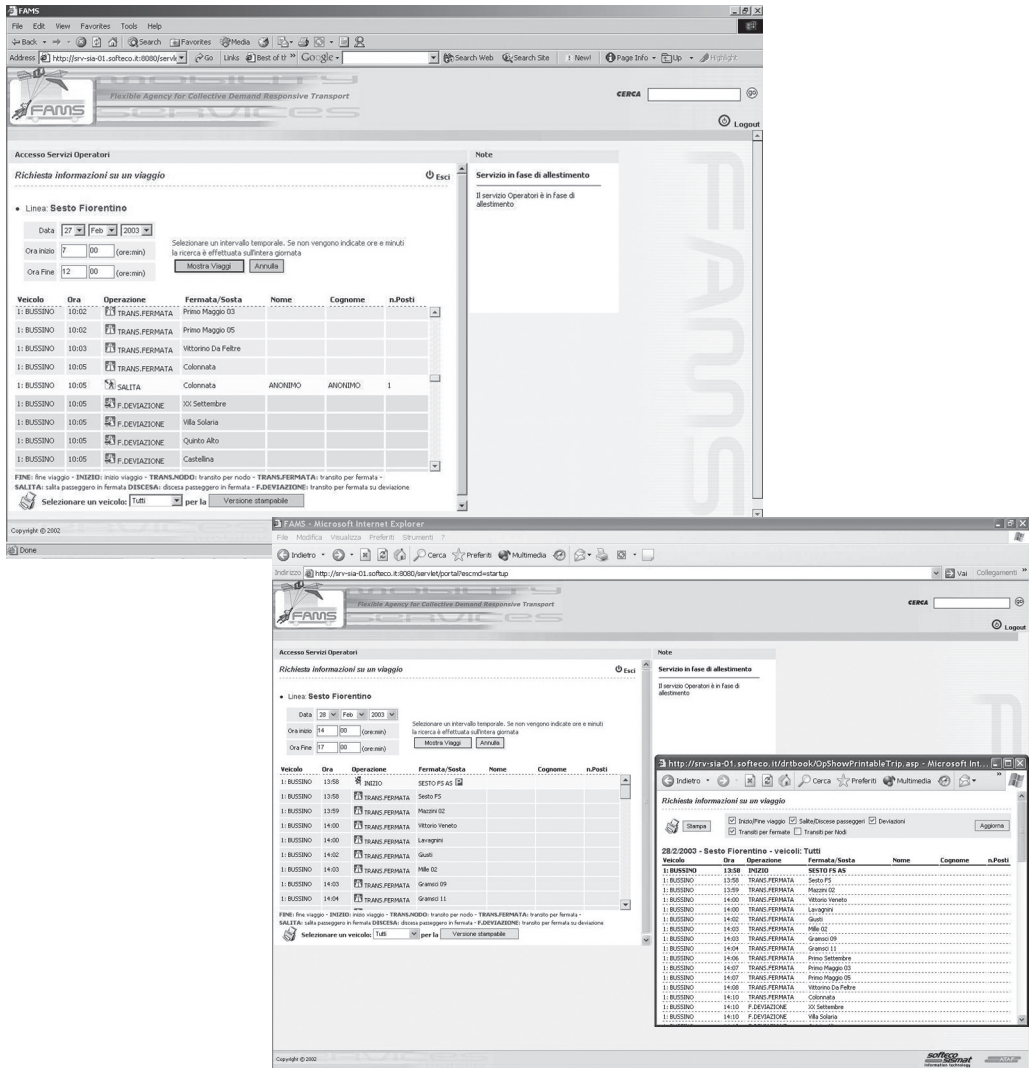


Figure 15.6: FAMS Portal, on-line B2B services for DRT planning and service information

Overall, the following services are accessible to FAMS users via the portal:

### B2C Services

- Travel inquiry and information
- Travel booking, modification, cancellation
- Booking confirmation via web access, e-mail and SMS
- Customer claims and inquiries
- Event notification.

### B2B Services

- Access to planning and booking information
- Management of DRT resources (vehicle availability schedules)
- Access to statistics and service data
- Claims and inquiries
- Event notification.

### General Services

- User profiling and management
- General information, news
- Events and calendaring
- Mailing lists and on-line discussion fora (travel club members).

One important feature of the portal is that different facilities are provided to support different types of interaction between the users and the Agency, thereby supporting the implementation of different service schemes and operational workflows.

As an example, one can consider the on-line booking and reservation facilities provided to DRT end-users. Depending on the particular type of DRT scheme the transport service provider is willing to operate, different types of booking and reservation schemes are possible, considering the type of booking (immediate booking vs. long-term reservation), the type of confirmation feedback (immediate confirmation vs. deferred confirmation), the type of communication channel used (web, e-mail, SMS, phone call). The choice of the booking schemes adopted for the different DRT services co-ordinated through FAMS in Florence is summarised in Table 15.3.

Service	DRT Type	Booking User	FAMS Booking Service	FAMS Confirmation Service
PersonalBus service in Campi Bisenzio	many-to-many (ATAF)	General public	Reservation (time limit: following day)	Deferred; via web service, email, SMS
PersonalBus service in Scandicci	many-to-many (LiNEA)	General public	Reservation (time limit: following day)	Deferred; via web service, email, SMS
PersonalBus service in Sesto Fiorentino	fixed line with deviations (LiNEA)	General public	Booking (time limit: 1 hour)	Immediate; via web service
PersonalBus service in Calenzano	fixed line with deviations (CAP)	General public	Booking (time limit: 1 hour)	Immediate; via web service
DRT in Florence, Porta Romana district	one-to-many	General public	Booking (time limit: 1/2 hour)	Immediate; via web service
D&E DRT	door-to-door	Disabled & Elderly Associations	Reservation (long-term)	Deferred; via web service, email, SMS
VolainBus airport-centre shuttle	fixed line, with reservation	Travellers, tourists	Booking (time limit: 1/2 hour)	Immediate; via web service
Hotels-Airport DRT service	many-to-one	Hotels (for travellers, tourists)	Reservation (time limit: 4 hours)	Deferred; via web service, email, SMS

Table 15.3: Booking schemes for the FAMS trials in Florence

Finally, it is important to note that, in the above examples, the time constraints to the booking workflows supported by the FAMS Portal are not due to technical limitations of the supplied services but to specific operational choices made by the DRT service providers.

## 15.4 Conclusions

In this chapter, we have described how the concept of an Agency for flexible, demand responsive mobility services is understood and implemented in the Florence metropolitan area. The implementation of the described technological solutions was carried out in the period July-December 2002, and the verification and validation of the different components and of the architecture during January-March 2003.

At the time of writing, the FAMS Agency in Florence has entered the trial phase with a selected group of users. The trials involve a core group of ATAF technical personnel covering the tasks and responsibilities of the FAMS operators, selected personnel from the participating DRT service providers (ATAF, SITA, Li-NEA, CAP, disabled and elderly transport providers) and a test group of DRT end-users. Comprising initially a group of some 50 subscribers, this will be gradually expanded during the trials to achieve as much users as possible of the B2C services supplied by the FAMS Agency.

The trials are planned to last until January 2004, with the following two months of assessment and evaluation of the findings. This initial experimental phase of the FAMS Agency in Florence, and especially the evaluation of the impacts and benefits for the DRT services and operators involved in the project, are expected to provide the first technical, operational and organisational feedback needed to launch the following phase of permanent operation and service production.

## **Actions for a sustainable urban mobility**

*M. Romanazzo, G. Ambrosino, J.D. Nelson*

An efficient transport system is one of the main factors that contribute to the growth and competitiveness of cities. Nevertheless, the ever increasing levels of traffic congestion, arising from the continuous growth of demand for mobility and the change in modal split in favour of private cars, make access to many cities and traffic management increasingly more difficult.

The negative effects of traffic congestion levels result in the increase of atmospheric and acoustic pollution, in energy waste, in increasing numbers of accidents, in greater land take, and in visual intrusion. It is widely accepted that without a real change in the present trends urban transport will follow unsustainable dynamics with negative effects on the economic efficiency of cities, on the quality of environment and on the quality of life in general.

The idea of the environmental incompatibility of the present transport system and the need for fundamental changes in city structure is now commonly accepted, and the relationships between traffic and pollution and damage to health have been shown. Many surveys indicate that citizens, although they take advantage of private car use, feel the need to change.

In recent years, an environmental conscience has emerged that sees cars not only as a means of personal freedom, but also as one of the main causes of environmental degradation. Therefore it has become an essential responsibility of central and local government to encourage as many citizens as possible to change their car use and life style.

## 16.1 Evaluation of traffic growth in urban areas in Italy

In recent years the growth of personal mobility in Italy has been higher than in the main European countries, thus presenting an interesting case for investigation. According to data from CNT (National Transport Account), between 1985 and 1998, passenger-kilometres travelled increased from 527 thousand million to 869 thousand million per annum (see Table 16.1).

	1975	1980	1985	1990	1995	1996	1997	1998
Car, extra-urban	188.4	229.5	283.1	361.2	405.4	419.0	430.0	435.0
Car, urban	81.4	88.9	90.9	160.8	209.1	208.0	209.1	212.0
Motorbike	27.1	26.9	34.9	60.1	59.9	61.2	63.0	64.0
Urban bus	15.9	16.9	15.9	11.6	10.4	10.4	10.0	9.7
Interur-ban bus, charter	37.0	47.3	52.2	72.3	76.8	78.3	78.5	79.4
Underground and tram	3.1	3.7	4.1	4.6	5.2	5.3	5.3	5.3
Train (+ ferry)	40.2	44.5	42.3	51.0	55.0	55.9	55.3	54.0
Aeroplane	2.2	2.9	4.4	6.4	7.1	7.9	8.8	9.0
<b>Total</b>	<b>395.3</b>	<b>460.6</b>	<b>527.7</b>	<b>728.0</b>	<b>829.1</b>	<b>846.7</b>	<b>861.0</b>	<b>868.9</b>

Table 16.1: Mobility of passengers in Italy by means of transport (thousand millions of passenger-kilometres)

The typical explanatory factor of “the structure of passenger traffic by transport mode” is the absolute supremacy of road-based transport (private car and public transport) compared with the alternative modes (public transport by rail, bicycle and foot). The contribution of road transport in 1998 was 92%, 82% of which was due to the private car which in recent years had a higher growth than any of the other transport modes, especially in the cities, and continues to increase. Concerning local public transport, the CNT data show that in the same period the demand decreased by nearly 20%, falling in absolute terms from 20 to 16 thousand millions passenger-kilometres, although the public transport offer increased from 81 to 86 thousand million seat-kilometres (+6%). The urban evolution models, that marked the growth of European cities in recent years, coupled with the economic growth and changes in life style, have led to a strong increase in mobility and distances covered in urban areas, together with an increasing use of private vehicles. Passenger mobility in urban areas of Italy has shown more variation than general mobility. Between 1985 and 1995 the passenger-kilometre volume increased from 154 thousand million to 248, with an average annual growth of 4.9%. In 1998 this value reached about 253 thousand million passenger-kilometres; the annual growth rate from 1995 to 1998, equivalent to 0.6%, had decreased significantly.



Of all the local public transport modes, buses are the most important, even if in recent years many signs of crisis have appeared. In fact passengers transported by city buses in the period 1990-1998 decreased from 11.6 to 9.7 thousand millions (-16%), compared with the offer of seat-kilometres decreasing more slowly (-11%).

During the same period the length of subway has developed from 78 to 105 km (+35%), the seat-kilometres offered increased from 10.5 to 17 thousand million (+61.9%) and demand has increased from 2.6 to nearly 4.2 thousand million passenger-kilometres (1999), (+161%). Urban tramways have experienced an overall reduction in track length, falling from 420 to 379 km (-9.7%) in the period 1985-1997. The offer fell from 5.4 thousand million seat-kilometres (1990) to 5.1 (1999) (-9.7%) with a reduction of traffic volume from 1.5 thousand million (1990) to 1.2 (1999) (-26%).

In 1999 the use coefficient of the different means of public transport, expressed by “transported passengers km/offered seats km”, was equivalent to 0.25 for subways, 0.23 for tramways and 0.16 for buses (data referred to 1998). The importance of the private car compared with other passenger transport modes has increased continuously in Italy, especially when compared with public transport modes, moving from 76.3% of motorized traffic in 1985 to 84.2% in 1995. Figure 16.1 shows the rates of use for the main transport modes - cars, motorcycles, public means - in 1985, 1990, 1995, respectively.

Without any corrective actions, the demand for mobility will grow further. In order to estimate the future trends of passenger mobility, it is necessary to consider relevant factors that in the medium to long term will contribute to a further development of mobility. Such factors include income growth, growth in free time, and the decentralization of productive activities and homes. Some factors will constrain mobility: the gradual saturation of congestion levels, the persistent misuse of infrastructure, the increasing proportion of older persons with fewer mobility demands, the diffusion of telematic applications (e.g. teleworking and electronic transactions). In general the most probable forecast for passenger mobility in urban areas of Italy is for further growth. The potential annual growth of traffic until 2010 is estimated between 1.2% and 2%.

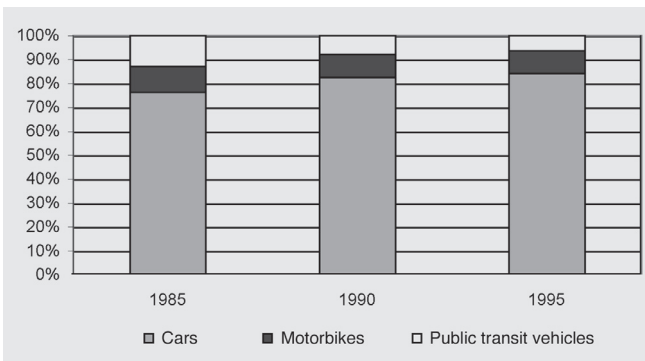


Fig. 16.1:  
Traffic rates for urban  
transport modes

## 16.2 Impact of traffic on environment and health

Statistical data from recent years shows that many traffic accidents in Italy occur in the city areas (73%). Although they have less effect on people, accidents in the city area cause more than the 40% of the national total and 20% of injuries (nearly 180,000 per annum). A significant number of the street accident victims in cities are pedestrians, cyclists and motorcyclists. Among pedestrians, children and elderly are the most vulnerable.

Urban traffic is now the main source of atmospheric pollutants and cancerous substances in cities where the highest vehicle emission rates are caused by low velocity and short distance trips covered by cold engines. The most common gas pollutants due to transport can be categorised as primary and secondary. The primary pollutants (carbon monoxide, azote monoxide, volatile organic compound, sulphur oxides, particulates) are found in vehicle traffic emissions and produce dangerous effects to the body. The secondary pollutants (azote and ozone bioxides), which are not less dangerous than the primary, result from reactions among primary pollutants or between the primary pollutants and natural elements that are present in the atmosphere.

VOC (Volatile Organic Compound) and NO<sub>x</sub> emissions contribute not only to the local atmospheric pollution but in some conditions to the formation of photochemical pollutants (ozone, aldehydes) and indirectly to increases in temperature at a global level. Photochemical smog formation, which is typical for big city areas, is a problem for both human health and the environment.

It is estimated that in most EU member countries, the field of transport is the biggest source of carbon monoxide (74%) and azote oxides (55%) emissions, and also of a significant percentage of volatile hydrocarbon (47%) and sulphur oxides (9%) emissions. Recent evaluations show that in Europe almost 80,000 deaths every year could be related to exposure to the PM<sub>10</sub> produced by traffic. PM<sub>10</sub> in fact is mostly composed of dust with a diameter shorter than 2.5 micron, that can go deeply through the respiratory organs. The increasing daily average of particulate concentration is related to the increasing risk of different effects on health, such as respiratory symptoms, changes in lung functions etc.

A recent study by OMS-AMPA (June 2000, referring to 1998) shows that in the eight biggest Italian cities almost 3,500 deaths per year are due to exposure to fine particulate emissions. The atmospheric pollution effects are mostly felt by groups of the population that are considered to be at risk: elderly, persons with respiratory and heart diseases and children. Gas engines, including the two-stroke engines of motorbikes, are mainly responsible for benzole emissions. Recent studies of vehicles circulating in Florence show that, compared with an unleaded petrol car, motorbikes produce 35 times more carbon monoxide, 200 times more unburnt hydrocarbon and 90 times more benzene. Benzene has been recognised as cancerous in humans and related to the increase of deaths due to leukaemia.

The progressive increase in size of city areas and amount of vehicle traffic has increased the noise level from traffic. In urban areas noise levels produced by traffic are often dangerous for health. According to OMS more than 97% of the population is exposed to more than 55 dB as a result, 72% is exposed to levels higher than 65 dB and 27% to levels that are higher than 75 dB, which is the safe limit for health. Noise levels greater than 55 dB are associated with sleep disorders, difficulties in communication and concentration abilities, while levels above 65 dB can affect heart disease and hypertension. In cities, space (especially public places) allocated for activities related to transport is increasing. It is estimated that road infrastructure occupies between 10% and 15% of the available space in big European cities. Central areas of the city, especially in Italy, have lost their historical nature, where squares, streets and green areas were once places for meeting and social activities. The busiest roads have become difficult and dangerous to cross, causing a “barrier effect” that results in a division of the city. Furthermore, parked cars occupy valuable “city space” for over 90% of the time.

Traffic also has negative psychological effects that are not easy to quantify. Congestion makes streets difficult to live in, causing insecurity to pedestrians, especially the elderly and children (parents are forced to follow them fearing traffic accidents), restricting chances of independent interaction with the surrounding environment and increasing their sense of dependency.

Another consequence of private car use is to reduce the opportunities for beneficial physical activity. A daily walk of 30 minutes (on foot or by bicycle) can reduce the risk of heart and circulation diseases, diabetes and obesity by 50%, and the risk of hypertension by 30%. It is interesting to note that 30 minutes walking is equivalent to almost 4 km, a distance that is covered by 30-40% of the traffic movement in city areas on a daily basis.

Finally, it must be emphasised that urban traffic substantially contributes to increased CO<sub>2</sub> (the main gas responsible for the greenhouse effect) in the atmosphere. In 1997 in Italy the CO<sub>2</sub> emissions due to road transport were 109 Mt (24% of total national emissions).

### **16.3 Energy waste of passenger transport in the city areas**

Solving the congestion problems in urban areas and encouraging energy efficiency of transport systems are the main conditions necessary to achieve the purposes of economic development and environmental quality. The frequent acceleration and deceleration of traffic due to congestion increases emissions and also fuel consumption. The present velocities in many cities are located on the most inefficient part of the velocity/fuel consumption curve.

According to a recent study, traffic velocity in the main cities of the OECD countries has decreased by 10% in the last twenty years. In one third of the cities studied, during

the rush hours, velocity in the central areas is lower than 9 km/h (OECD, 1995). Some evaluations show that in Milan and Rome, the average velocity during the rush hour is equivalent to 16 and 13 km/h respectively.

In 1995 almost 34 Mtep were consumed by road transport in Italy, which is equivalent to 90% of the energy waste of the whole transport field. In the same year the final consumption of energy caused by private mobility (car + motorbikes) in the urban area was equivalent to 11.3 Mtep, which is a little more than the 96% of the annual consumption caused by passenger urban transport. Evaluations also show that passenger urban transport accounted for almost 30% of annual energy consumption in the transport field, which is slightly less than 10% of the national energy consumption.

The energy consumption evaluations derived from traffic data of the National Transport Account with the Commute model, underline that in the years 1985-1995, consumption due to passengers and goods movement in urban areas clearly increased, accounting for almost 40% of the total transport consumption (see Table 16.2). In particular consumption related to goods delivery and private cars, while the increase attributed to buses was less relevant. Public transport still does not affect the total urban consumption in a significant way, although there has been an improvement in the railway and subway transport in recent years.

	Mobility (Mpax-km or Mt-km)			Origin unit consumption (MJ/pax-km or MJ/t-km)			Origin final consumption (tep)		
	1985	1990	1995	1985	1990	1995	1985	1990	1995
Car	74,084	108,854	139,033	3.02	3.02	3.12	5,346,828	7,851,085	10,349,629
Bus	15,914	11,616	10,350	0.68	0.98	1.38	258,372	272,853	341,933
Motorbike	18,834	18,651	20,991	1.84	1.84	2.01	829,154	821,097	1,006,796
Total road pass.	108,832	139,121	170,374	2.48	2.69	2.87	6,434,354	8,945,035	11,698,358
Train passengers	150	180	380	1.18	1.06	1.11	4,219	4,536	9,560
Underground	2,133	2,580	4,038	0.97	0.98	0.78	49,624	60,258	75,642
Tram	1,575	1,576	1,136	1.17	1.17	1.53	43,827	44,119	41,657
Total passengers	112,690	143,457	175,928	2.43	2.64	2.81	6,532,024	9,053,948	11,825,217
Total goods	13,300	21,170	26,418	3.28	4.75	5.35	1,041,110	2,400,976	3,372,875
Total consumption							7,573,134	11,454,923	15,198,092

298 Table 16.2: Passenger mobility and energy consumption by mode in Italy

Comparing the different transport modes in the whole energy chain (production, transport and final use) shows that the private car is 2.5 times less efficient than public electricity production and 2 times less efficient than buses. According to the urban traffic situation in 1995, it has been estimated that a modal shift of 5% of traffic caused by private car to public transport would result in a reduction of the final energy annual consumption equivalent to nearly 0.4 Mtep (= -3.5%) and it also would lead to an increase of the annual traffic volume equivalent to 10 thousand million passenger-kilometres (= + 65%).

## 16.4 How to intervene?

The achievement of sustainable mobility in urban areas has become one of the main fields of national politics related to transport and environment in recent years. In order to reverse the present negative trends of urban mobility solutions are required such as the reduction in private car use and greater emphasis on inter-modal solutions. To achieve this goal, the priority actions include:

- the increase of technical and economic efficiency and net capacity of public transport, in order to give public transport a high level of quality, flexibility and responsiveness to users' needs. More attention should be given to high quality bus corridors rail-based collective transport systems (railways, subways and trams), especially for links with high demand, which are more convenient in terms of energy, environment and space;
- the promotion of alternative mobility systems more compatible with the environment, and strategies to convince citizens, especially for short distances, to go on foot or by bicycle without using car;
- the rationalization of transport with a better use of all resources in order to make the whole system more efficient; more attention should be given to the promotion of modal shift and particularly to the strengthening of links between urban and extra-urban networks and also to the improvement of the connections among public transport lines;
- actions to enhance traffic flow, with the application of effective circulation schemes, the adaptation of the access capability of the most critical intersections, and the application of new ITS technologies. The extensive progress made in the field of communication and information systems offers many possibilities to solve mobility problems in urban areas.
- the rationalization of goods delivery with logistic platforms and suitable management and organization models;
- the replacement of urban functions, with actions directed to encourage the achievement of a balance among homes, working places and city structures;
- integrated urban and transport planning.

#### **16.4.1 Possible actions in the short term**

Among the short term solutions, the measures for mobility demand management can have a role of central importance. These include:

- creation of a “Mobility Manager” to reduce the car use of employees and other activities such as school runs;
- a charging system of road pricing and access in order to assure competition and complementarity among different transport modes and recover resources to finance alternative transport systems;
- car pooling facilities, as preferential thoroughfares, reserved spaces to park and reduced tariffs for parking and circulating;
- measures to increase pedestrian and cyclist mobility (also in combination with public transport);
- changes in working practices, with a rescheduling of the start and stop times of working and studying activities, in order to spread rush hour traffic.

#### **16.4.2 Integrated actions and planning for the longer term**

Actions that concentrate only on demand management or restraint have been shown to be inadequate; a politics of integration of many actions is the one that can give best results both in the short and longer term. In this field mobility management planning has particular importance. The nature and entity of accumulated urban mobility problems do not offer radical solutions in the short term. Cities require action plans based on an organic range of investments and solutions to be realized in both the short and long term, together with the implementation of a package of mobility management actions.

Possible structural actions include:

- the implementation of new infrastructures such as fast collective transport systems, the straightening of urban railway networks, the creation of new modal shift infrastructures, especially parking places at interchange points;
- the rationalization of the urban road network;
- the replacement of urban functions.

It is generally accepted that a substantial change in the present urban mobility trend is necessary. The nature and dimension of accumulated problems in the field of urban transport require a project based on an integrated set of investments and organisation solutions. Of particular importance will be courageous demand management policies implemented by local administrations and a bigger consciousness on the part of citizens about the need to leave the present urban mobility model based on private car dependency. The main purpose of local politics must be the limitation of private car use and a gradual substitution by collective transport.

300 The challenge of the new millennium in transport terms is a cultural one; without an effort to create new organization models it will be difficult to avoid negative conse-

quences on environment and health caused by traffic. It is necessary to address the need to prevent real social and economic collapse caused by high car dependency and exposure to the risk of a possible energy crisis. It is possible to envisage a compact city model, in which the need to cover long distances will be satisfied by collective transport. It is necessary to plan a real “renaissance” of the city that will use the new technologies to assure the urban connective tissue preserving the human dimension of the old village.

## 16.5 The role of flexible collective transport

Traditional public transport is efficient when there are high patronage peaks, but demand is decreasing (from around 70% in the 1960s to 40-50% in recent years). Nowadays there is a high rate of erratic demand and a movement to dispersed places, often with a weak demand, that traditional public transport can only cover at high costs to the community. This is why flexible collective transport will have a role of vital importance for the sustainability of urban mobility, especially from the following points of view:

- The improvement of quality of life for some groups of population, allowing access to services and entertainment for persons who cannot use private cars on account of economic reasons or disability.
- The reduction of traffic impacts on environment and health with the decrease of private car use, according to the following processes:
  1. Demand Responsive Transport (DRT) services which can provide valid alternative solutions for many destinations and at times of weak demand.
  2. Flexible transport solutions which can accomplish an important “feeder” function toward strong public transport lines serving the mobility demand in dispersed areas and increasing the attractiveness of collective transport.
  3. Innovative transport solutions, such as car sharing, associated with traditional collective transport, which can increase the number of destination points (central zones), providing a further alternative to private car use.

Today, at a European level, flexible collective transport solutions cover just a small proportion of trips, but they can provide an alternative to the private car between 10% and 30% of trips (depending on local characteristics). This innovative transport mode has considerable potential to substantially mitigate the traffic pressure in cities. The contributions to this volume have considered the range of flexible transport services, and have identified the “building blocks” of successful schemes. Extensive evidence of good practice from case studies across Europe, themselves the product of ambitious research and development programmes have been presented throughout.





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## Web sites

This appendix collects a series of references to web sites of interest for the development of DRT services and technologies and more generally of flexible public transport.

The links to the related web sites are grouped in the following way:

- initiatives, research projects and studies produced at a European level
- realization of DRT services
- suppliers of systems and technology.

### Initiatives, research projects and European studies

<http://www.okanecom.fi/SAMPO>

SAMPO, System for Advanced Management of Public Transport Operations. Web site of the SAMPO project, Telematics Applications Programme (TAP, DGXIII, 4<sup>th</sup> Framework of Research and Development). The project has studied and experimented with innovative technological and operational solutions in the field of flexible and demand-responsive services, by improving the offer and the mobility opportunities both for the generic users (rural zones, areas with weak demand etc.) and for specific categories of users (people with disabilities, the elderly etc.).

<http://www.europrojects.ie/samplusmainweb>

SAMPLUS, Systems for Advance Management of Public Transport Operations Plus. Web site of the SAMPLUS project, the follow-up of the SAMPO project. The tests started with SAMPO have been extended both in time and space and also the technological architecture and solutions for the support of demand responsive services. Test sites were in Belgium, Finland, Italy and Sweden, with feasibility studies in Ireland and Great Britain.

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<http://www.novacall.fi/sipts/>

SIPTS, Services for Intelligent Transport Systems. Web site of the SIPTS project, European initiative TEN-Telecom. Demonstration of DRT services supported by telematic systems (service management centre, on-board computer for the vehicles used for the service). Test site in Finland.

<http://www.bealtaine.ie/virgil/>

VIRGIL, Verifying and Strengthening Rural Access to Transport Services. Web site of the VIRGIL project, Transport Research Programme (DGVII, 4<sup>th</sup> Framework of Research and Development). Information related to the development of innovative solutions, to include on-demand services, for the improvement of the mobility in the rural areas. It publishes a database, with an interactive interface, with descriptions of various DRT projects and applications.

<http://www.vtt.fi/aut/kau/projects/invete/>

INVETE, In-Vehicle Terminal. Web site of the INVETE project (DGINFSO, 5<sup>th</sup> Framework of Research and Development). INVETE has studied, developed and demonstrated the architecture of an innovative multi-service on-board terminal, able to support various modes of transport (conventional public transport, service on-demand, service for people with disabilities, collective taxi) and to operate in different technological contexts (private radio network, GSM network). Test sites in Italy and Finland.

<http://www.famsweb.com>

FAMS, Flexible Agency for Collective Demand Responsive Mobility Services. European trial project in the framework of the Information Society Technologies (IST) programme. Its goal is to scale up the technologies, services and business models currently adopted in DRT and to support the evolution from single DRT applications towards a flexible agency capable of providing a range of demand responsive mobility services.

<http://www.emires.net>

EMIRES, Economic Growth and Sustainable Mobility supported by IST at a Regional level including SMEs. European project in the framework of the Information Society Technologies (IST) Programme. It addresses the application and demonstration of new concepts of business and digital economy in less favoured regions by applying advanced ISTs, by combining DRT services, dynamic value considerations and public-private partnerships. The goal is to develop a network of Regional Service Centres offering dynamically generated, integrated packages of value added services to authorities, small and medium sized enterprises (SMEs) and individuals.

[www.moses-europe.org](http://www.moses-europe.org)

MOSES, a research and demonstration project supported by the European Commission under the Fifth Framework Programme and contributing to the implementation of the Key Action “City of Tomorrow and Cultural Heritage” within the Energy, Environment and Development.



<http://www.trentel.org/index.htm>

Telematics Applications for Transport and the Environment, web site of the TAP programme (4th Framework of Research and Development) related to projects of telematics applied to the transport and environment sectors. It contains, amongst other things, information on the following projects:

- PIRATE, a study on modal interchange;
- MULTIBUS, a study on the use of small vehicles for the collective transport of people and goods;
- LEDA, study on the transferability of legal measures and laws related to the sustainability of transport systems;
- MOMENTUM, a study on mobility management;
- ICARO, another study on mobility management;
- SCRIPT, System for Community and Rural Integrated Public Access Telematics. Utilization of telematics for the improvement of the accessibility and of the quality of the information in rural areas and small centres.

<http://www.eltis.org/en/about.htm>

ELTIS, European Local Transport Information Service. An interactive guide to the main initiatives and European projects of innovation in the field of transport. Political actions and best practice in European cities and regions are included.

<http://www.edc.eu.int/polis>

POLIS. Official web site of the POLIS network, a network of European regions and cities that operate together for the solution of transport and environmental problems, in particular through the adoption of innovative technologies, new policies and financing schemes.

<http://www.eltis.org/en/euronet.htm>

EURONET, a Pan-European network of research and consultancy, which is co-ordinated by the University of West of England, Bristol. The mission of EURONET is to support the initiatives of the EU as far as research and innovation policies and favour the implementation of frameworks both normative and fostering research.

<http://www.rural-europe.aeidl.be/rural-en/welcom1.htm>

Rural Europe, an initiative within the framework of the LEADER project, dedicated to the problems of the rural communities in Europe.

## Examples of DRT services

<http://www.ataf.net>

PERSONALBUS<sup>TM</sup> Service managed by ATAF within the conurbation of Florence, in particular in the municipalities of Campi Bisenzio, Scandicci (in co-operation with Li-nea), Calenzano, Sesto Fiorentino. Started in an experimental form within the SAMPO and SAMPLUS projects, the service is operational in a permanent form from June 1997.

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<http://www.asettrasporti.it>

My Bus, DRT service managed by ASET Transports SpA within the Municipality of Fano.

<http://www.atc.bo.it>

Prontobus di Pianura, the service on demand organized by the Bologna ATC Company on seven extra urban lines. The routes are fixed, but the service is carried out only upon bookings, according to the agreed times and trip.

<http://www.capautolinee.it>

CAP Bus companies, the Prato Co-operative Road Haulages. It manages Prontobus, a DRT service operating in four different low-demand zones within the municipality of the city of Prato.

<http://www.ringandride.org>

Ring and Ride System. Probably the most extensive DRT service in Great Britain, it utilizes 150 vehicles in order to guarantee a service on-demand for groups of customers with reduced mobility (with disabilities, elderly) in the area of the West Midlands, the conurbation around the city of Birmingham. It accounts for 45,000 registered customers, 33,000 of which use regularly the service. The volumes of people traveling require strict requirements on the management system, and both demand and the number of journeys are high. The booking is requested for the day before the trip takes place. For the groups of customers who do not benefit from supporting schemes from the associations in the field, the tariff is comparable to traditional collective transport.

<http://www.worldserver.pipex.com/cambridge/forum/dialride/>

<http://utc.nottsc.gov.uk/ttdialco.htm>

[http://ourworld.compuserve.com/homepages/derbyshire\\_public\\_transport/commtran.htm](http://ourworld.compuserve.com/homepages/derbyshire_public_transport/commtran.htm)

<http://www.personal.u-net.com/~lincsc/dar.htm>

<http://www.reigate-banstead.gov.uk/counserv/dar-north.html>

Other examples of DRT services in Great Britain, in the following areas: Cambridge, Nottinghamshare, Derbyshare, Lincolnshare, Horley.

<http://www.stp-paris.fr/amelio/politiqville/allobus/main.htm>

The Allobus system links together the northern areas of Paris with the industrial area around the international airport of Roissy Charles de Gaulle, an important centre of activities and services. The service is available 7 days a week, 24 hours per day, on four fixed-route lines but used upon reservation. Created in March 1998 from a collaboration between the Regional Council of Ile-de-France, the Departmental Council of the Val d'Oise, the District Council, the Authority of the Paris Aeroports (ADP) and the Transport Company of the Ile-de-France (STIF, Syndicat des Transports d'Ile-de-France), the Allobus service has

312 been used by 210,000 passengers already during its first year of exercise.

<http://www.publicar.ch>

Publicar, service offered from the Swiss Mail (society for the Mail Service) in alternative to traditional mail services, for the countryside and areas scarcely populated. PubliCar is a door-to-door bus service that circulates on demand and according to requirements. Currently the service is active in 19 zones inside the federal territory, for various types of services and timetables, it is managed by a unique national centre. The Vivacar service is the version of Publicar dedicated to the mobility of people with disabilities and the elderly.

<http://www.omniride.com>

OmniLink is an active DRT service inside two traffic high density corridors in one rural zone to the south of Washington DC, USA. Conceived and managed for commuting mobility types, it has as an objective the reduction of the congestion in the area, whilst offering personalized solutions of collective transport. It uses telematic technologies for the management of the service.

<http://www.olympus.net/gettingAbout/busMason.html>

<http://www.matatawa.org/org/holland/acitymgr/dialride.htm>

<http://www.tempe.gov/traffic/transit.htm>

<http://www.ci.midland.mi.us/deptinfo/dialarid.htm>

<http://www.vta.org/dial-a-ride.html>

<http://www.ci.malibu.ca.us/taxi.htm>

Examples of applications of DRT systems in the USA, are run in the following areas: Mason County Washington; Holland, Michigan; Tempe, Arizona; Midland, Michigan; Clara Saint, California; Malibu, California. These refer mainly to social services (for the elderly and people with disabilities), which are organized upon booking or through seasonal tickets.

## Suppliers of systems and technology

<http://www.delijn.be>

De Lijn is the public transport operator of the Flandres (Belgium). The Informatic Division of De Lijn has developed and tested the telematic system RING, for the planning and management of the on-demand service. The system comprises functionalities of vocal interaction and booking through Internet.

<http://www.mobisoft.fi>

Mobisoft Oy, Finnish software house specialized in applications of communication and data exchange on wireless networks. Producer of the MobiRouter© and MobiTaxi® systems, for the management of DRT services and taxi. Various applications in Finland.

<http://www.pps-edv.de>

PPS/EDV, German producer of telematics systems us for the public transport. Producer of the COVER® (Cooperatives Vehicle Routing) system for the management of DRT and commercially flexible services (transport goods, express couriers, technical services...).

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**<http://www.softeco.it>**

Softeco Sismat SpA, system house specialized in industrial applications and infomobility. It produces and commercializes the PERSONALBUS™ system, for the planning and management of on-demand services. Various applications in Italy.

**<http://www.transmation.fi>**

Transmation Oy, Finnish company that unites experience in management of public transport services (Korsisaari) with development of software applications (Softmade) for the management of the service itself. It offers a product of DRT services management.

**<http://www.teleride.com>**

Teleride, American producer of software systems for the public transport sector, in particular for the scheduling of the service. TransView system, for the management of DRT services.

**<http://www.multisystems.com>**

Multisystems, USA producer of the Midas-PT system, used for the planning and management of flexible routing, Dial-a-Ride services and DRT.

**<http://www.trapezesoftware.com>**

Trapeze, North American company that produces and commercializes one suite of products for public transport. Among those, TRAPEZE PASS and FLEX, for the management of DRT services.

**<http://www.paramatch.com>**

Paramatch, Americana company manufacturer of Paramatch system, a product for the management of DRT services specifically developed for rural transport market.

## GLOSSARY

This appendix brings together the principal specialist terms and acronyms used in the various chapters in the book and will provide a short description of them. The names used are common in international literature related to telematics systems applied to transport. References to various European projects and initiatives on the subject are also included.

### ATT

#### *Advanced Transport Telematics*

Term promoted in a programme of Research and Development for the European Commission for the application of telematics to road transport (DGXIII, 4<sup>th</sup> Framework). It followed the similar DRIVE (I and II) programmes. See also IST.

### AUTOMATED BOOKING

The use of telematics tools by the customer in order to allow contact with the centre managing the journeys (TDC) by interacting directly with the booking functionalities, without any need to go through an operator. Channels for automatic booking are, e.g., Internet, voice response systems (see also IVRS), smart card readers.

### AVL

#### *Automated Vehicle Locationing*

A system for the automatic identification of the position of a vehicle usually through GPS or beacon-based technology and other on-board equipment (such as odometer and gyrometer). The position information is transmitted by the vehicle to a control centre which is able to monitor the various aspects of the operation. Typically, locations are presented to the operator on a digital map or through a similar graphical representation.

## AVM

### *Automatic Vehicle Monitoring*

A system that allows for the determination of the movements and activities of vehicles belonging to a certain fleet on the road network. It often includes functionalities for fleet management and requires AVL to be present.

## BOOKING

A confirmed reservation where the order has been entered in the TDS and a pick-up time has been agreed between the customer and the TDC dispatcher.

## CODE

### *Co-ordination of Dissemination in Europe of transport telematics*

A project supporting research, development and demonstration projects for the European TAP programme in the Transport Sector. It developed general methodologies and guidelines, e.g. related to the analysis of user requirements in the development of telematics systems for transport.

## CONVERGE

### *Telematics sector consensus and support*

A project supporting research, development and demonstration projects for the European TAP programme in the Transport Sector. It developed general methodologies for the specification and definition of architectures of telematics systems applied to transport.

## CORD

### *Co-ordination of Research and Development*

A project supporting research, development and demonstration projects in the field related to the European programme DRIVE II. It promoted co-ordination and strategic evaluation of research projects and development in the road transport sector.

## DGINFSO

### *Directorate General Information Society*

Directorate General INFSO of the European Commission which manages the framework programme and specific research and development initiatives in support of innovation in the information society. Since 1999 it has acquired the structure and activities of the previous DGXIII (Information Technology) and DGIII (Industry).

## DGXIII

### *Directorate General XIII*

Directorate General XIII of the European Commission which manages framework programmes and specific initiatives of research and development and support of innovation in information technology. In 1999 it was restructured into Directorate General Information Society (DGINFSO).

## DRIVE (I AND II)

### *Dedicated Road Infrastructure for Vehicles in Europe*

Programme of research and development by the European Commission for the application of telematics to road transport in DGXIII, 3<sup>rd</sup> Framework of R&D.

## DRT

### *Demand Responsive Transport*

Demand Responsive Transport is an intermediate form of public transport, somewhere between a conventional service route that uses low floor buses and special transport services that typically use a single or shared taxi mode. DRT services are offered to customers according to their individual needs, generally only stopping where passengers request pick-up or drop-off. Routes are scheduled with software or manually from a central dispatching system (see also TDS). DRT route models are defined according to the level of flexibility, the type of stopping points and the degree of linearity or area coverage offered by the service.

## ECONOMIC VIABILITY

### *Evaluation assessment category*

The financial costs and benefits of a system, taking into account the levels of public or private finance which are required in order to create and manage the system in a particular market environment.

## EMIRES

### *Economic Growth and Sustainable Mobility supported by IST at a Regional level including SMEs*

European project in the framework of the Information Society Technologies (IST) Programme. It addresses the application and demonstration of new concepts of business and digital economy in less favoured regions by applying advanced ISTs, by combining DRT services, dynamic value considerations and public-private partnerships. The goal is to develop a network of Regional Service Centres offering dynamically generated, integrated packages of value added services to authorities, small and medium sized enterprises (SMEs) and individuals.

## EVA

### *Evaluation Process for road transport informatics*

A supporting project within the DRIVE I European Programme. It developed general methodologies for the evaluation of telematics systems for transport.

## FAMS

### *Flexible Agency for Collective Demand Responsive Mobility Services*

European trial project in the framework of the Information Society Technologies (IST) programme. Its goal is to scale up the technologies, services and business models currently adopted in DRT and to support the evolution from single DRT applications towards a flexible agency capable of providing a range of demand responsive mobility services.

## FEEDER SERVICE

A public transport service which collects and/or distributes passengers within a pre-defined catchment area for passengers, from and to primary routes and other modes of transport (e.g. express bus, inter-urban bus, tram, rail).

## FLEXIBLE ROUTE

A scheduled service between two end stop points which has fixed departure times, but with a more or less flexible route, which responds to the actual needs for pick-up and drop-off on the route. See also semi-fixed route.

GIS

*Geographic Information System*

A Geographic Information System is a class of systems and software applications for the graphical representation and management of geographical information.

GPS

*Global Positioning System*

A localisation system based on a network of geostationary satellites. It can be utilised to estimate the position of vehicles within AVL systems.

GUI

*Graphical User Interface*

A graphical interface which is an application (or part of an application) software to support the presentation of information and interaction between the users and the system. It is provided with graphical capabilities and mouse management and other devices for the selection of information and navigation within a multi-windows environment.

INTERMODALITY

Intermodality occurs when the route of an individual passenger consists of a combined chain from origin to destination involving at least two different modes. A transport network or route serving passengers is intermodal if it is established by means of more than one mode.

IST

*Information Society Technologies*

A Research and Development Programme of the European Commission for the development, application and demonstration of information technology (DGINFSO, 5<sup>th</sup> and 6<sup>th</sup> Frameworks of R&D).

ITS

*Intelligent Transport Systems*

A group of techniques, using information technology and telecommunications in vehicles and infrastructure, supporting or performing services intended to improve transportation from the point of view of safety, efficiency, comfort and the environment.

IVRS

*Interactive Voice Response System*

System for the automatic and interactive management of the telephone dialogue with the user. It usually allows the selection of options within a pre-defined menu. The user's choices can be communicated by pressing the keys on the keypad or by voice recognition. In the case of DRT services this means that there is no dispatcher interface when booking a trip.

LAN

*Local Area Network*

Telematics network with a limited geographical extent (e.g. a building, an office or a vehicle) to link computers, electronic devices and informatics applications.



## MARKET PROJECTION

### *Evaluation assessment category*

An estimate of the possibilities of applying and developing a system to a new (sector of a) market, measured in terms of the economic viability, service provision and technical performance of the systems involved.

## OBU

### *On-Board Unit*

Any electronic device installed on board a vehicle which is able to interact locally with people (e.g. the driver or passenger) or other devices and possibly to communicate with equipment outside the vehicle.

## PASSENGER

A user of the DRT service travelling with a service vehicle. The status of a user changes from being a customer to a passenger once the booking has been accepted at the TDC.

## PROMISE

### *Personal Mobile Traveller and Traffic Information*

European project in the framework of the ATTT programme with the goal of developing and demonstrating systems and architectures for the dissemination of information to passengers, based mainly on technologies for mobile telephones (cellular phones and palm-held devices).

## REFUSED CUSTOMER

A person who made contact with the TDC dispatcher but could not, for some reason, be provided with a booking because, e.g. the service was fully booked or the requested origin and/or destination was outside the service area.

## ROUTE

An ordered list of locations defining a path through the road network. A route may pass through the same location more than once.

## SAMPLUS

### *System for the Advanced Management of Public Transport Operations Plus*

European project in the framework of the TAP programme for the further demonstration and development of systems and architectures for the management of DRT services. SAMPLUS followed the SAMPO project.

## SAMPO

### *System for the Advanced Management of Public Transport Operations*

European project in the framework of the TAP programme for the development and demonstration of systems and architectures for the management of DRT services.

## SEMI-FIXED ROUTE

A scheduled service between two end stop points which has fixed departure times but with a more or less flexible route, which responds to the actual needs for pick-up and drop off on the

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route. In addition, there are also one or more scheduled stop points along the route, leading to a semi-structured service. See also flexible route.

#### SERVICE AREA

The area over which a defined DRT service is provided. This may cover an area in which the service journey begins and ends at the same stop point, or it may be a corridor in which the service journey begins and ends at two different stop points.

#### SERVICE JOURNEY

A passenger carrying journey by a vehicle between an origin and a destination. The route followed by the vehicle is created by the TDS.

#### SERVICE PROVISION

##### *Evaluation assessment category*

The effective organisation and offer to the public of a service (such as DRT) and the perception by the users (including passengers) and operators of its compatibility with its objectives, reliability and level of convenience.

#### SMS

##### *Short Message Service*

Short text messages, up to 160 characters, that can be sent or received from mobile units linked to a GSM network.

#### STOP POINT

A location where passengers can board or alight from vehicles. A stop point may be fixed (regular bus stop), predefined (recognised meeting point) or non-predefined (generally the doorstep of the passenger). The vehicle only calls at predefined and non-predefined stop points as a result of a booking request by a passenger.

#### STS

##### *Special Transport Service*

Special transport services are adopted in order to respond to the needs of a group of users such as the elderly and people with disabilities. Typically, they are carried out with special vehicles fitted with appropriate equipment in order to accommodate specific equipment such as wheelchairs. STS are usually managed by the municipal authorities (e.g. in north European countries) or by voluntary organisations (e.g. Italy, United Kingdom).

#### SYSTEM ARCHITECTURE

This defines, following specified methodologies, the main components of a system and their inter-relationships (in terms of the functions performed, data flows, information, physical components and the organisation of a system). The European project CONVERGE developed a general methodology for describing the architecture of an ITS (Intelligent Transport System).

#### SYSTEM INTEGRATION

The design, construction and operation of transport services within a prescribed boundary (usually geographical) through the co-operation of all relevant service providers (e.g. opera-

tors, authorities, technology). The end product is the provision of transport services that: satisfy customer needs (e.g. cost effective and efficient completion of a unimodal or multimodal journey); perform consistently and cost effectively; and is subject to operational testing and evaluation.

#### TAP

##### *Telematics Applications Programme*

A programme of Research and Development by the European Commission for the application of telematics to sectors and services of general interest to the citizen (DGXIII, 4<sup>th</sup> Framework of R&D (1994-1998)). The sub-programme TAP/Transport relates to the application and development of telematics in the transport sector.

#### TARGET POPULATION

The people for whom a certain service is created. Typically, they live within the area in which the service takes place; e.g. in the case of DRT services the target population can be all inhabitants within a certain distance (e.g. within 100 metres) of predefined stop points, or all inhabitants within a defined service area.

#### TDC

##### *Travel Dispatch Centre*

The location organising the Travel Dispatch System (TDS). The TDC is the interface between the customers and the providers of the service, including the fund holder (e.g. the local authority), the operator and the driver. Typically, the TDC is located in the operational environment of the fund holder, which is usually the local authority, but may be the operator. A TDC may be located in a multi-sectoral call centre (where unrelated non-transport services are also provided), or within an independent research and development environment.

#### TDS

##### *Travel Dispatch System*

A booking and reservation system which has the capacity to dynamically assign passengers to vehicles and to optimise the routes taken by vehicles. The operational TDS is located in the TDC.

#### TECHNICAL PERFORMANCE

##### *Evaluation assessment category*

The ability of the ITS to operate within specified standards, e.g. reliability, safety and convenience to the public transport operator and the TDC.

#### TELSKAN

##### *Telematics Standards and Co-ordination of Advanced Transport Telematics Systems in relation to elderly and Disabled Travellers*

Project for the support of research development and demonstration projects within the TAP European Framework (Transport Sector). It developed guidelines and recommendations for planning telematics systems in various areas of application, in order to assist the elderly and people with disabilities, particularly within the field of transport and the environment.

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## TRANSFERABILITY

The ability to transfer a technology application or methodology or result from one applicable area to another, or from one geographical organisation and operational context to another.

## WAN

### *Wide Area Network*

Telematics network with wide geographical extent (e.g. an industrial area, an urban district or a city) to link computers, electronic devices and informatics applications.

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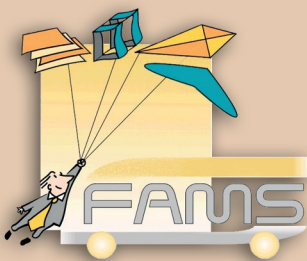




Published by ENEA  
Public Relations Department - Communication Unit  
Lungotevere Thaon di Revel, 76 - 00196 Rome  
*www.enea.it*

Composition: Stefano Seghetti (Livorno, Italy)  
Printed by Primaprint (Viterbo, Italy) in February 2004





FAMS – IST – 2001-34347

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