User Needs Analysis and Analysis of Key Technologies

D1 Part 1- Report on User Needs for Cybernetic Transport Systems (CTS)

Deliverable Type: Report
Number: D1
Nature: Final Version
Contractual Date of Delivery: 01/03/2002
Actual Date of Delivery: 01/04/2002
WP: WP1 - Status Review

Name of Responsible: Mike McDonald,
Tom Vöge

Name of the Institute: TRG

Address: University of Southampton
Highfield Southampton
SO17 1BJ United Kingdom

M.McDonald@soton.ac.uk
T.Voge@soton.ac.uk

Abstract:

This report investigates user requirements for cybernetic transport systems (CTS). An analysis framework was developed to establish which user groups and sub-groups are involved in the process of implementing, decision-making, planning, operating, using and being effected by CTS. Based on this framework a resulting matrix of site and application characteristics was developed. According to the analysis framework, developed as a preliminary step for planning further activities, the user needs analysis will, on the highest level, investigate requirements for end-user, who could be potential system user, or non-user, who are effected by the system, decision-maker and operators, both in case of a public application and decision-maker/ operator combined for the special case of a private application. According to different characteristics, different activities were carried out in order to obtain responses on the concept of CTS from all user groups involved. The activities carried out for the user needs analysis included a literature review on CTS related transport systems, moderated formal group discussion (focus groups) and structured interviews with interviewees representing various user groups.

Keyword List:

User Needs, Key Technologies, Cybernetic Transport Systems

INFORMATION ON DELIVERABLE D1 - PART A:

Report Co-ordinator:

TRG, UK

Contributions from:

A&E, Switzerland
CRF, Italy
DITS, Italy
INRIA, France
ISR, Portugal
SSA, Switzerland
TNO, the Netherlands
TRI, Israel

EXECUTIVE SUMMARY

This report investigates user requirements and perception of cybernetic transport systems (CTS). An analysis framework was developed to establish which user groups and sub-groups are involved in the process of implementing, decision-making, planning, operating, using and being effected by CTS. Based on this framework a resulting matrix of site and application characteristics was developed. The aim of the analysis was to cover the user requirements of all user groups, according to the analysis framework. The analysis was carried out on various levels, involving different activities.

According to the analysis framework, developed as a preliminary step for planning further activities, the user needs analysis will, on the highest level, investigate requirements for end-user, who could be potential system user, or non-user, who are effected by the system, decision-maker and operators, both in case of a public application and decision-maker/ operator combined for the special case of a private application. According to different user group and/ or site characteristics, different activities were carried out in order to obtain responses on the concept of CTS from all user groups involved.

The activities carried out for the user needs analysis included a literature review on CTS related transport systems, moderated formal group discussion (focus group technique) and structured interviews with interviewees representing various user groups and sub-groups. The literature review covered the system operating characteristics and the user requirements for various systems related to CTS technology. These related systems included automated transport systems, demand-responsive transport systems and car-sharing/ -pooling schemes. The review was carried out on related examples, as there are no user needs analyses for CTS yet.

The focus groups were carried out to obtain responses from end-users with general needs on present urban transport issues, user requirements and perceptions of CTS technology for different technology levels, including the short-term (e.g. 2005, relating to the CyberMove city test sites) and the long-term scenario (e.g. 2030, relating to the long-term definition of CyberCars) and whether they can potentially be a solution to problems in urban transport. Structured interviews were carried out to cover all other user groups involved and their views on the use of CTS in urban environments.

The literature review on CTS related systems unveiled gaps in the literature on user requirements. Most references only contained lists with envisaged user requirements, instead of results of market research with actual users involved, reinforcing the decision to carry out group discussions (focus groups) and interviews for the analysis of user requirements and perception for CTS.

The focus groups activities revealed a common inability of group participants to envisage the use of CTS technology in a shared environment with other traffic, including manually driven vehicles, bicycles or pedestrians, despite a general trust in the technology involved. Potential applications of CTS technology imagined by group participants were therefore mainly in contained environments.

The structured interviews again showed concern about the use of CTS in environment mixed with other traffic. But a high potential for CTS technology to solve some of the present transport problems was acknowledged, however concern about operational, political and institutional issues in view of the actual implementation of CTS technology, especially in urban environments was expressed.

The variety of activities carried out in context of the user needs analysis for CTS revealed a conflict between perception of a theoretical subject presented and an actual existing system, which can be used and experienced. This has to be considered in context with the concern about CTS in a shared environment. The results of this analysis may change with growing experience and exploitation of CTS technology.

TABLE OF CONTENTS

LIST OF FIGURES

1 INTRODUCTION

1.1 Background

In the following an introduction to the CyberCars/ CyberMove projects, a definition of CyberCars and an explanation of the distinction between and the co-ordination of the projects will be given.

- **The CyberCars and CyberMove Projects:**

  The main objective of the CyberCars and CyberMove projects is to accelerate the development and implementation of novel urban transport systems for movement of people and goods. These systems aim at improving the mobility, while reducing negative effects of the private car use in cities, by complementing mass transit systems and hence offering a real alternative with better convenience and efficiency than the private car in the cities. The CyberCars project is funded through the IST-Programme (Information Society Technology) and started in August 2001. The CyberMove project is funded through the EESD-Programme (Energy, Environment and Sustainable Development) and started in December 2001. Both projects are funded for three years.

  The CyberCars project focuses on the testing, analysis and improvement of existing techniques, which are starting to appear on the market. In particular, technical improvements are expected for the vehicles on guidance, collision avoidance, platooning and vehicle control systems. For the infrastructure, technical improvements are also expected on the system management, human-machine interfaces, remote operation and energy management. Existing systems will then be tested on private grounds in order to set technical goals for the improvements expected. The technical improvements will be performed, tested and evaluated on the same premises. The evaluation categories include technical and user needs assessment.

  The CyberMove project focuses on bringing together all European actors of this field, in order to test and exchange best practices, share some of the development work and make faster progress in the experiments. Several cities throughout Europe will collaborate with the partners in the Project, studying the potentiality to run such systems, providing their specific constraints and accepting to do some preliminary tests of technologies and demonstrations. Co-operative work with selected cities will lead to conceptual design of systems for specific sites, optimised with regard to mobility, energy, environment, safety and will lead to the evaluation of these designs. The evaluation categories include technical and user needs assessment.

- **The CyberCars Definition:**

There is a distinction between the project called CyberCars and the cybernetic transport system (CTS) called CyberCars, which forms a basis for both, the CyberCars and the CyberMove projects. All partners involved developed the following CyberCars system definition for both projects:

CyberCars are road vehicles with fully automated driving capabilities. A fleet of such vehicles forms a transportation system, for passengers or goods, on a network of roads with on-demand and door-to-door capability. The fleet of cars is under control of a central management system in order to meet particular demands in a particular environment.

At the initial stages, CyberCars are designed for short trips at low speed in an urban environment or in private grounds. In the long term, CyberCars could also run autonomously at high speed on dedicated tracks. With the development of the CyberCars infrastructures, private cars with fully autonomous driving capabilities could also be allowed on these infrastructures while maintaining their manual mode on standard roads.

CyberCars are members of the general family of people movers and close to personal rapid transit but they offer the advantage of being able to run on any ground infrastructure, which means they are cheaper and more flexible.

- **Distinction between Objectives and Co-ordination of Activities:**

Both projects contain, amongst other activities, a user needs analysis, system certification, system testing and project/ system evaluation. For each of these activities a clear distinction between the work objectives has to be made, according to the different funding bodies of the CyberCars and CyberMove projects. Therefore activities within the CyberCars project will focus on understanding and obtaining experience with CTS, whereas activities within the CyberMove project will focus on using these experiences for applications of CTS technology in urban environments.

Due to overlaps of the work in the CyberCars and CyberMove projects, the respective activities have to be co-ordinated for a maximum level of consistency and in order to get a clear distinction between the work, carried out in the two projects, according to the respective projects objectives. In view of the user needs analysis in both projects, the CyberCars activities will focus on user requirements and perceptions of CTS technology, whereas the work in CyberMove will deepen the knowledge of the specific user requirements for given applications of CTS technology in various spatial settings.

As part of this co-ordination process, a combined user needs and technologies deliverable will be prepared, which draws together the results from the user needs analysis for CTS and for CTS applications and the analysis of key technologies for CTS. The CyberCars work package WP1 'Status Review' consists of two sub-tasks, T1.1 'User Needs' and T1.2 'Existing Technologies Analysis and Requirements for Improvements' and of one deliverable D1 'User Needs Analysis and Analysis of Key Technologies', consisting of two separate parts, 'Part A – Report on user needs for CTS' and 'Part B – Report on key technologies for CTS'. The CyberMove workpackage WP1 'User Needs' has three sub-tasks, T1.1 'Defining System Operating Scenarios', T1.2 'User Needs Analysis' and T1.3 'Identifying Potential Barriers to Deployment', and three deliverables, reporting on the results of each of these three sub-tasks, but only T1.2 'User Needs Analysis' will provide input to the combined deliverable.

Therefore the combined user needs and technologies deliverable will consist of two separate parts, the analysis of user requirements and the analysis of key technologies. Within these two parts there will be three separate reports, the report on user needs for CTS (CyberCars D1, Part A), the report on user needs for CTS applications (CyberMove D1.2) and the report on key technologies for CTS (CyberCars D1, Part B).

- **Analysis of User Requirements**
  - ***User Needs for CTS*** ⇨ CyberCars D1, Part A
  - ***User Needs for CTS Applications*** ⇨ CyberMove D1.2
- **Analysis of Key Technologies**
  - ***Key Technologies for CTS*** ⇨ CyberCars D1, Part B

The 'Report on User Needs for CTS Systems' and the 'Report on Key Technologies' consist of input from CyberCars WP1 and they form the CyberCars deliverable D1 'User Needs Analysis and Analysis of Key Technologies', the 'Report on User Needs for CTS Applications' consists of input from CyberMove WP1 T1.2 'User Needs Analysis' and forms the CyberMove deliverable D1.2 'User Needs'.

1.2 Objectives

As this report on the user needs analysis for CTS systems is part of the combined user needs and technologies deliverable, the aims and objectives of all three analyses and the use of these results for further work in CyberCars and CyberMove is described briefly in the following.

- **User Needs Analysis for CTS:**

  The user needs analysis for CTS systems focuses on user requirements and perceptions for CTS systems in general. The objectives are to establish all user groups involved and to obtain information on requirements and perception of CTS technology, covering all user groups involved in the use, operation and decision making processes in context with CTS. The analysis will be carried out on a general system level.

- **User Needs Analysis for CTS Applications:**

  The user needs analysis for CTS applications focuses on user requirements for the application of CTS technology in urban environments. The objectives are, to gather information on user requirements for the use of CTS technology for specific concepts in spatial settings. The user needs analysis in CyberMove will differ from that in CyberCars in that the number of respondents will be larger, allowing a quantitative, statistically significant, detailed analysis of user needs linked with the specific concepts and spatial settings. The analysis investigates, how CTS can be a solution to specific problems.

- **Analysis of Key Technologies for CTS:**

  The analysis of key technologies focuses on current technologies for CTS and the needs for improvements. An automated guided vehicle is a complex combination of many technical systems. Some of these are relatively standard, others need to be adapted to the specific needs of CTS and a third group are the unique CTS technologies. The analysis will concentrate on the latter two groups

The results from both user needs analyses, for CTS technology in general and for specific CTS applications in urban environments, and the analysis of key technologies will also feed in as input into further work packages, including the system design for the demo site and the city test sites and the system evaluation, with the technical assessment and the user acceptance as main assessment categories.

1.3 Methodology

As this report on the user needs analysis for CTS is part of the combined user needs and technologies deliverable, the methodology for obtaining the objectives mentioned above, used for all three analyses is described briefly in the following section.

- **User Needs Analysis for CTS:**

  The methodology used for the user needs analysis for CTS, is to review literature on system characteristics and user needs in context of CTS related existing systems, to develop a common analysis frame work for user groups involved and application classifications and to use group discussions and interviews to obtain information on user requirements and perceptions, covering all user groups.

- **User Needs Analysis for CTS Applications:**

  The methodology used for the user needs analysis for CTS applications, is to relate specific potential user groups to specific concepts in their spatial settings, to learn more about the design of CTS, that people can imagine and to investigate the conditions under which people would use them. This information can differ for short and long-term scenario. The analysis will be carried out using an interactive questionnaire in combination with a virtual site.

- **Analysis of Key Technologies for CTS:**

  The methodology used for the analysis of key technologies for CTS is to review vehicle (control, guidance, obstacle avoidance, platooning) and infrastructure technologies (HMI, fleet management, remote operation, energy management). Data will be collected on technical performance, cost and current availability. For each technology realistic improvements will be derived in terms of operational capabilities and/ or cost.

The methodology for each of the three analyses, which were only described briefly in this section, will be explained in more detail in the respective three separate reports, which together form the combined user needs and technologies report. The methodology and activities in context of the user needs analysis for CTS (literature review, focus groups and structured interviews) will be specified in the sections on the analysis framework and the respective activities.

2 ANALYSIS FRAMEWORK

2.1 User Groups

In the context of implementing, operating and using CTS the following four general user groups can be identified, which consist of further sub-groups.

- **Industry:** Provide the technology for CTS
- **Decision-maker:** Decide over implementation of CTS
- **Operator:** Operate/ provide services for CTS
- **End-user:** use or are affected by CTS

The user group industry will not be considered in the context of the user needs analyses for CTS and CTS applications, as the approach within the CyberCars and CyberMove projects is that the industry will provide CTS according to the established user needs. Which leaves three user groups to be considered for the analysis, the decision-maker, the operator and the end-user. This is the case for all public applications, but in the special case of a private application (e.g. airport, theme park, large business, university campus, etc.), though there is also a decision-making body and a system operator, they are part of the same institution. According to this the site classification will distinguish between public and private applications on the highest level leading to the following user groups and sub-groups.

End-user	Potential User	Special Needs	Elderly, Disabled
			Motorists
			Cyclists
			PT User
		General Needs	
	Non-user	Residents	
		Shops& Businesses	
Decision maker (Public Application)	Non-elected	National Level	
		Regional Level	
		Local Level	
	Elected	National Level	
		Regional Level	
		Local Level	
Operator (Public Application)	Public Transport Operator		
	General Service Provider		
Decision maker& Operator (Private Application)	Airport		
	Theme Park		
	Large Business		
	University Campus, etc.		

Fig. 1: User Groups and Sub-groups for CTS

2.2 Site Characteristics

As mentioned above, the site and application categories relate to the user groups. Therefore, according to the user groups identified, there should be a distinction on the highest level between the following two applications.

- **Public Application:** Decision-maker, Operator and End-user
- **Private Application:** Decision-maker/ Operator combined and End-user

Based on this, the following matrix of site and application categories was defined for the user needs analyses for CTS as well as for CTS applications and for all related activities in the CyberCars and CyberMove projects.

<table>
<tr><th colspan="4" rowspan="2">Site Characteristics</th><th colspan="3">Application Characteristics</th></tr>
<tr><th>Connection</th><th>Line</th><th>Network</th></tr>
<tr><td rowspan="9">Public Application</td><td colspan="3">Citywide</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">City Centre</td><td colspan="2">General User</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Special User</td><td>Tourists</td><td></td><td></td><td></td></tr>
<tr><td>Business</td><td></td><td></td><td></td></tr>
<tr><td>Etc.</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Periphery</td><td colspan="2">General User</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Special User</td><td>Business</td><td></td><td></td><td></td></tr>
<tr><td>Shopping</td><td></td><td></td><td></td></tr>
<tr><td>Etc.</td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Private Application</td><td colspan="3">Airport</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Theme Park</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Large Business</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">University Campus, etc.</td><td></td><td></td><td></td></tr>
</table>

Fig. 2: Matrix of Site Characteristics and Application Characteristics

2.3 Analysis Activities

Based on this analysis framework, which was described above, the work on the user needs analysis for CTS was separated into the following three main activities, which were carried out to review existing systems and experiences and to obtain responses from all user groups covered in all countries involved in this analysis on user requirements for CTS on a general system level.

- **Literature Review:**

  The literature review was carried out on existing transport systems related to CTS technology (e.g. personal rapid transit, automated people mover, car sharing/ car pooling, demand responsive transport, etc.). The review will focus on transport system characteristic and user requirements and perception in context of these systems, as a background to the user needs analysis for CTS.

- **Focus Groups:**

  Moderated group discussions (focus groups) were carried out by a number of partners as a qualitative market research tool, to obtain responses on user requirements and perceptions on CTS by the user group end-user with general needs. Different participants characteristics (e.g. age, gender, car ownership, etc.) were established, to plan the recruitment of participants with the aim of covering all characteristics.

- **Structured Interviews:**

  The interviews were carried out according to a common structure (structured interviews), to get comparable results, by a number of partners to obtain responses on user requirements and perceptions on CTS by the user groups end-user with special needs, decision-maker, operator and decision-maker/ operator combined, which were not covered through focus groups, as this form of interview would be more suitable for these groups.

All three activities, the literature review, the focus groups and the structured interviews will be described in more detail in the further sections of this report, including methodology, activities, partner contributions and the results of each respective activity for the analysis on user perceptions and requirements for CTS and the implications for further work in the CyberCars and CyberMove projects.

3 LITERATURE REVIEW

3.1 Introduction to Literature Review

As no CyberCars systems are implemented yet, there are no user needs analyses for CTS available. But there are various systems operating with characteristics relating to CTS. Literature on these systems will be reviewed in this section in terms of system characteristics and user requirements, to give a background to further activities for the user needs analysis for CTS. The focus of this review will be on the following systems.

- **Automated Transport Systems**
  - ***Individual Transport Systems*** ⇨ e.g. Personal Rapid Transit
  - ***Mass Transport Systems*** ⇨ e.g. Automated People Mover
- **Demand Responsive Transport**
- **Car Sharing/ Car Pooling**

Each of these systems cover some of the main characteristics of CTS, the automated operation is covered by the automated transport systems, the individual transport aspect is covered by the individual transport section of the automated systems, the demand-responsive issue is covered by the demand responsive transport systems part and the shared use of vehicles is covered through the car sharing/ car pooling section. The results of the review will be an important background to the focus group and interview activities.

There will be some overlap in using these categories of transport as, for example, Praxitèle can be thought of as both car sharing and demand responsive transport. There are many forms of different transport systems, so the main characteristics will be described here, particularly for those, where systems differ in characteristics and user requirements. Other systems have been omitted because of their similarity to projects already mentioned and because no user needs analysis was carried out.

A description is given of each form of transport. These are then discussed for user requirements. In the literature, user requirements are of two types. The first is a list generated by the research as desirable, particularly in the case of untested systems. Without asking users involved, it is assumed that safety and price are important in all of these systems. The second relates to market research. These may come from operational requirements, from decision-makers or from end-users, although requirements may be at the level of stated-preference.

3.2 System Descriptions

The CyberCars and CyberMove projects are in tune with research that aims to show how current transportation problems might be met in the future (see, for example, Marsden et al 2002[1]). In both cases, it is assumed that something will be done to improve the current transportation system. Some people may continue to own and operate vehicles, but attempts will be made to combat growth in private car usage. Demographic changes in Europe indicate that the age of the population is increasing and that more people will have to rely on public transport (EUROSTAT, 1996[2]). People may choose to get together in communities to reduce their transport costs, perhaps buying a minibus and hiring a driver as required. They may share taxis or people may continue to own their vehicles, but reduce their costs by car sharing. Some of the new technologies might make it possible to increase trip speeds and safety while still maintaining ownership of the vehicle. Where travellers rely on public transport, there may be a move towards letting the system have more control over the journey, possibly by automating the driving. This could be done through automated people movers or by personal rapid transit. The first system operates like a bus on a restricted route, the second has the destination determined by the traveller, but a computer controls driving and route choice. For the system description there will be a focus on the Schiphol and Rivium systems, as they are the closest operating systems to the CTS concept.

3.2.1 Automated Transport Systems

The section on automated transport systems (ATS) describes those forms of transportation that are not controlled by an in-vehicle driver. A computer that receives information from the vehicle about its position on the track and any obstacles that may be in the way directs the vehicles in the system. These may be either mass transit or for individual transport. To improve safety and to increase ease of operation, they are usually kept separate from conventional car and/ or pedestrian traffic.

3.2.1.1 General System Characteristics

Existing automated transport systems differ widely in their specific characteristics. In the following these different characteristics will be described in more detail. The characteristic will be grouped together under three main headings, track characteristics, application area characteristics and demand characteristics.

- **Track Characteristics:**

  Nearly all ATS are kept separated from conventional traffic on some form of guide-way or track. The notable exceptions are the Schiphol Airport ParkingHopper and the Rivium business ParkShuttle. Tracks may have sensors built into the pathway to direct the vehicle. Guide-ways physically constrain the path of the vehicle. These methods determine the route that the vehicle takes, allow smaller headways and yet increase safety. ATS can operate on an elevated, below ground or at grade track. They can also combine track characteristics. The VAL in Lille, France, is largely an underground system although it also has elevated viaducts and a small section at grade (Marino, 1996[3]). For personal rapid transit, at grade guide-ways have to be fenced off and bridged over for cross traffic, which is rarely practical (Anderson, 2000[4]). Elevated systems are cheaper than underground systems (Anderson, 1997[5]).

- **Application Area Characteristics:**

  Automated vehicles can be either mass transit or for individual use. For mass transit, the possibility of severance from the remaining traffic, particularly for multi-modal journeys, means that at grade transport might be preferable. People movers, such as the ParkShuttle in Rotterdam, Holland, operate at grade (Bootsma and Koolen, 2001[6]). Mass transit vehicles are larger and so require greater support if they are to be elevated. This increases visual intrusion. Personal transport allows for smaller vehicles, reducing cost and visual intrusion.

- **Demand Characteristics:**

  ATS can either operate as demand responsive or route specific transport. The first is a form of mass transit and the second may be more individual, automatic people movers may continue to operate over a route, regardless of the number of people waiting to use the system, even if there is no demand. Personal rapid transit is designed to take control of the vehicle away from the individual, but allows a vehicle to be booked and origins and destinations to be decided by the traveller.

3.2.1.2 Individual Transport Systems

Personal rapid transit (PRT) is primarily an automated, low polluting, demand-responsive form of transport. The first PRT initiatives were in the mid-seventies, motivated mainly by the sharp increase in oil price and the sudden necessity for solutions with existing technology. This review focuses on recent initiatives. PRT should be cheaper to construct, operate or modify than road or underground transport (Electric Bikes, 2001[7]). It is environmentally sound, reducing energy use and harmful emissions by a factor of ten over the automobile. An example is the Urban Light Transport system (ULTra), described as an automatically controlled personal taxi system running on its own guide-way network (Lowson, 2001[8]). Customers determine the destination of the journey and algorithms determine the route taken. The striking visual feature of PRT is the elevated guide-way. Cabs may ride on top of this guide-way (e.g. ULTra) or be suspended from it (e.g. FLYWAY). To maintain minimum headways, stations are off-line and acceleration and breaking are controlled by the system.

ULTra has been well documented (see papers by Martin Lowson, the Advanced Transport Group website http://atg.fen.bris.ac.uk, the Advanced Transport Systems Ltd. website http://www.atsltd.co.uk and Andréasson, 2001[9]). The system is designed to have battery-operated cabs that can accommodate four passengers or two passengers and luggage. There is also room for wheelchairs. It runs on rubber tyres on a guide-way that is partly elevated and partly at grade. It is expected to run at 40 kph with 1sec headways. It is a publicly run system in which the city of Cardiff (UK) has made a commitment to invest and expects to have a pilot scheme in place by 2003. A demonstration of an ULTra run on a 1km test track that took place in January 2002 can be viewed at http://www.cities21.org/ultra/.

Taxi 2000 (http://www.taxi2000.com) uses vehicles that can seat 3 adults, all facing forwards. The cabs get power from an electric rail on the guide-way. This means that braking is not dependent on the tyres, due to the use of linear motors. A demonstration of 3 cabs running is available from Taxi 2000. Papers by Edward Anderson describe the technical aspects, which are beyond the scope of this review (see http://www.taxi2000.com/pubs/transitpapers.htm).

One possibility for maintaining ownership of the vehicle while getting the benefits of public transport, is by driving cars onto a public transportation system, but allowing that system to take control for the bulk of the journey. Autoshuttle in Braunschweig, Germany, is a system, which would place cars into cabins for main leg of a journey and transport them very quickly using magnetic levitation (maglev) technology (Steingröver et al, 2001[10]). Cars drive into the cabins, are transported along a guide-way on the median and then drive out to continue with the journey. The technology behind maglev systems are beyond the scope of this review, but a short test track has been built at the Technical University of Braunschweig. One of the options for this system is the possibility of platooning or uniting several cabins into a chain, controlled by the lead vehicle. This becomes more like the automated people movers.

Another form of privately owned vehicle is the RUF (Rapid Urban Flexible). This is a battery-operated car that can run on the road, but which has a slot on the underside for connection to a monorail guide-way (Andréasson 2001[9]). There is a MaxiRUF version for 10 passengers, which is then an automated people mover. There is a test track at the Danish Institute of Technology (see http://www.ruf.dk/).

A different form of PRT is the Serpentine (from Saugy et al, 1997[11]). This has autonomous, electrically powered shuttles, which are guided by means of a magnetic track integrated into the road pavement (Gillet and Chevroulet, 1999[12]). They can link together to form a platoon. Each shuttle can carry up to 5 people.

The Parking Hopper at Amsterdam Airport Schiphol (Netherlands) provides passenger transport to and from the long-stay car park P3. Since December 1997 four Parking Hoppers have been operational at Schiphol. The service is available around the clock, seven days a week and is free of charge for users of the long-stay car park. The route on car park P3 is divided into two one-kilometre loops, each of which has three stops. These stops are spread across the car park, which has 10,000 parking spaces. Because of the limited walking distance, there are no stops near the central stop. First the Parking Hopper transports passengers from the stop closest to their car to the central stop near the pay station and waiting area. From here there is a shuttle bus to the Schiphol terminal and departure hall. Of the four Parking Hopper vehicles, one vehicle remains permanently at a pick-up station, while the other three spread around the two loops according to the demand for transport. If there are no calls for the vehicles, they park strategically on the route, in such a way that the travel time to any stop is minimal.

The Rivium ParkShuttle is an automated, guided vehicle with a capacity of 12 persons and a maximum speed of 30 km/h. The people mover drives on a dedicated infrastructure. The vehicle is unmanned, operation and guidance is electronic using beacons in the road and sensors in the vehicles. The vehicle stops automatically when it detects an object on its path. There is a manual emergency break in the vehicle and an intercom with the central. Since April 1999, three ParkShuttle-vehicles are deployed between the subway station at Kralingse Zoom in

Rotterdam and the Rivium business park in Capelle aan den IJssel. The trajectory is about 1200m long and requires a travel time of about 5 minutes. This service operates from Monday to Friday, from 06.45 to 18.45 and is available on call. The number of journeys per hour (for all three vehicles) depends on the number of vehicles available and varies between 5 and 12 per hour. In addition to the ParkShuttle, a bus operates from the Capelsebrug subway station, providing access to the entire office area. This bus route covers six stops and operates Monday to Friday from 06.00 to 18.30 with services at 30-minute intervals. During rush-hour periods, the bus operates at 15-minute intervals. The ParkShuttle has one stop in Rivium that coincides with a route 91 stop. The ParkShuttle and bus therefore cover different routes and offers different connections to the subway network and different availability.

3.2.1.3 Mass Transport Systems

Automated people movers (APM) are similar to buses, except that they have no driver. They operate on dedicated paths. As of June 2000, there were 23 APM operating at airports, 24 at leisure sites and 21 at institutional systems, such as at subways, malls or universities (Swedetrack, 2000[13]).

One early example of the APM is that in Morgantown, USA, connecting various parts of the University of West Virginia campus with the central business district. It began operating in 1975 and has carried 50 million people without incident.

The VAL (Villeneuve d'Assq-Lille) has carried fare-paying passengers since 1983. It has a guide-way length of 15.8 miles, of which approximately two-thirds is underground and the rest is mostly elevated. It has 36 stations, 83 vehicles and carries 50 million passengers a year (Marino, 1996[3]). The cars run on pneumatic tyres and have guide-wheels, which bear onto two guide rails. Power comes from a third rail, with D.C. motors under the cars, which can be recharged during breaking. It is basically a metro system without a driver. However, being computer controlled it has proved cheaper and safer than comparable manually driven systems. It averages 97% of trips on time.

Dallas/Fort Worth International Airport is installing an APM, which is expected to begin service in 2005 (Nicholas et al, 2001[14]). This is projected to move 8,500 passengers per hour per direction. It will connect 12 stations on a guide-way, travel at 37 mph and enable passengers to get across the airport in 9 minutes.

3.2.2 Car Sharing/ Car Pooling

Car sharing allows households access, as needed, to a fleet of shared-use vehicles. Alternatively, it could be privately owned vehicles that are used to share trip costs. Early examples were Sefage in Zurich, Switzerland, in 1948 and Protocip in Montpellier, France, in 1971 (Sperling et al, 2000[15]). Modern car sharing began in Switzerland in 1987 and shortly afterwards in Berlin, Germany (Muheim, 1998[16]). Between two companies, after 10 years, Switzerland now has 20,000 participants in organised car sharing. One of the benefits of car sharing is that users are more inclined to use public transport for leisure trips and business travel outside the peak hours.

Mobility CarSharing, Switzerland, is the largest car sharing organisation in the world (Muheim, 1998[16]). It requires from members that they have a driving license, a residence in the developed zones of sizeable municipalities and that they would be able to carry out their journey by public transport. Members may wish to give up their own car on joining the scheme.

Praxitèle is a car share scheme in Saint-Quentin en Yvelines, France. Up to 47 Renault Clio electric cars (30 were working at any one time) were made available at 9 stations. A two-phase trial began in 1997 of operator mode and self-service mode (Blosseville et al, 2000[17]). Initially, ‘jockeys’ instructed users in the system, which placed cars at stations for use by members. Members had access cards and could be charged for time of use or a monthly fee for use. The second phase of the trial reduced the number of jockeys, which extended the opening hours of the system to 24 hours a day, 7 days a week. Jockeys redistributed the cars and recharged the batteries.

Alternatively, Lufthansa Airlines and Swissair have an automatic rental system at Munich and Frankfurt airports (Sperling et al, 2000[15]). A computer releases a key and starts the billing process. Employees then use these cars as any rental car. Further car share systems include:

Daimler Chrysler has a car sharing fleet to aid mobility between plants in Stuttgart, Germany. Computer cards allow employees to reserve cars and provide access (Sperling et al, 2000[15]).

In San Francisco, USA, Hertz and BART have a monthly charge for a ‘home end’ service, guaranteeing parking near the station entrance.

Car Co-op, Singapore is a scheme for residents of two neighbouring condominiums. Developers are paying the initial cost and residents pay for use. This uses an electronic key box and on-board computers.

Car-pooling incentives include money saving, congestion reduction, reducing pollution and time gains (Néré and Delacroix, 1996[18]). However car-pooling negatives include loss of freedom, delays, problems returning home, waiting for others and having to travel with others.

For those who cannot share a car with others, advances in technology can make public transport more attractive.

3.2.3 Demand Responsive Transport

The most common form of demand responsive vehicle is the taxi. These are often the link between private and public transport. Demand responsive transport (DRT) can both wait until it is called or patrol a route and transport people who wish to use it, but be available for people who book a journey. DRT is an intermediate form of transport between a bus and a taxi (Mageean and Nelson, 2001[19]). It is primarily used to increase the mobility of those without access to private transport. DRT can take place on a variety of modes as well as integrating them. Telematics are employed through travel dispatch centres (TDC) to optimise routes while automatic vehicle location (AVL) devices provide information on the status and location of the vehicle. Routes operated by DRT can be fixed, timetabled, roving or door-to-door (Horn, 2002[20]).

Within the DGXIII-funded SAMPLUS project, DRT was demonstrated within the Florence metropolitan area by PersonalBus (Mageean and Nelson, 2001[19]). This used 5 minibuses and 2 buses equipped with AVL and chip card ticketing machines. Provision was made for low floor and wheelchair capabilities. Users could book a trip by calling a toll-free number or ask drivers for the next time of departure. The service for the disabled was door-to-door while the remaining services used an increased number of service stop points.

The Ruf-Bus in Friederichschafen, Germany, is a bus transit operation that incorporates route deviations (Blackwelder and Loukakos, 2000[21]). Requests for services are made at kiosks which would return the next available bus times. On accepting the bus, a vehicle was assigned to pick up the passenger. In the 1980s this service was replaced by the flexible operations command and control service. This service continues to have higher costs than revenues.

3.3 User Requirements

This section describes user requirements from transportation systems related to CTS. Requirements are from Decision-makers, operators and end-users. These are grouped according to the types of transportation described above. For the user requirements there will be a focus on the Schiphol and Rivium systems, as they are the closest operating systems to the CTS concept.

3.3.1 Automated Transport Systems

3.3.1.1 Individual Transport Systems

There are many studies related to conventional transit modes and private cars, in particular forecasting market shares. Relatively few studies are related to individual transport systems. For example Anderson used a logit model to estimates a 30% uptake of ridership from automobiles to transit when there is no wait and the vehicles travel at 20 mph (Anderson 2000[22]). The author acknowledged that as there are no true PRT systems currently in operation, prediction of mode splits to PRT may not be entirely reliable.

Lowson has provided lists of requirements under different headings, such as user requirements, urban environment and technical requirements (Lowson 1995[23], Lowson 1996[24] and Lowson 1997[25]). While technical requirements are beyond the scope of this review, these lists provide requirements under the headings outlined in this review. User requirements from the ULTra project state that the system is:

- **Easy to use**
- **Comfortable and convenient**
- **Flexible with a rapid response**
- **Satisfies privacy and status needs**
- **Is effective and with low cost**
- **Has links to other modes of transport**

} End-user

- **Environmentally friendly**
- **Has an attractive structure**
- **Minimal impact on non-users in construction and use**
- **Available to all sectors of society**
- **Can reinvigorate the city centre**

} Decision-maker

- **Outstanding cost/resource effectiveness**
- **Better journey times than current car/public transport**
- **High reliability**
- **Resistance to vandalism**
- **Weather independence**

} Operator

- **Low emissions/energy use**

A stated preference study on PRT comfort and end-user needs in Stockholm found (Tegnér 1999[26]) the following issues. This study was undertaken before there were any elevated transportation systems in Sweden aside from ski lifts. The author suggests that education into automatic driving would alleviate some fears.

- **Visual intrusion was not a drawback**
- **Sharing was not a problem**
- **There was some concern over driverless travelling**
- **Elevation was not a problem**
- **Travel time gains for users**
- **A modal shift from auto to transit**
- **Traffic safety gains**
- **Eased congestion**
- **Health and environmental gains**

A cost-benefit analysis showed that PRT could return $1.50 for every dollar spent (Jensen and Schneider 2001[27]). The analysis is based on the fact that PRT can reduce staffing levels, therefore reducing costs. The study also investigated the role of decision-makers to assure success of a PRT initiative. Decision-makers should address problems of crosscutting co-ordination between road and rail both on the infrastructure and the inspection side. They should allow standards to be developed and adopted which ensure interoperability on the rail with ample room for vehicle developers. They should provide funding for pre-competitive testing. They should also integrate PRT into a comprehensive traffic planning with a focus on integration between modes.

A stated preference survey was conducted to evaluate potential use of the Autoshuttle freeway. The following question was asked: given an average fare slightly lower than the vehicle operating cost when driving alone, an average speed close to 112 mph, individualised determination of the destination during the journey and a daytime convoy frequency of two minutes for cars and six minutes for trucks and buses, would you use Autoshuttle instead of an ordinary freeway? 95% of respondents said yes (Steingröver et al, 2001[10]).

The results of evaluations carried out for the Schiphol airport ParkingHopper and the Rivium business park ParkShuttle systems are presented in the following. The evaluation of the benefits and user perceptions after the first periods of operation and the implications of these evaluations on the work within the CyberCars and CyberMove projects are described in detail.

- **Rivium ParkShuttle:**

Two evaluations of the ParkShuttle in Rivium have been carried out, both published in 2000. The Transport Research Centre (AVV) supervised the first evaluation described here. It focused on the experience of end-users and its effect on their mode-choice, as well as the impact on the location choice of companies located in the Rivium business park served by the ParkShuttle. The second evaluation, carried out by the operator of the ParkShuttle, Connexxion, focused on documenting the operational issues faced.

The ***Transport Research Centre*** (AVV) of the Ministry of Transport, Public Works and Water Management (Rijkswaterstaat) in the Netherlands has studied the application of the ParkShuttle in Rivium[28]. The purpose of this study was to obtain insight into the use and appreciation of the ParkShuttle as a public transport mode. The following three questions were formulated:

- How is the ParkShuttle viewed and experienced as a public transport mode, both as a system as such and in comparison with the existing bus line?
- What is the influence of the availability of the ParkShuttle on choice of transportation to Rivium Business Park?
- What is the influence of the ParkShuttle on companies' choice of location?

Three surveys have been performed. The initial survey (‘0-enquiry’) was held before the introduction of the ParkShuttle in February 1999 on bus service 91. In April 1999, a second survey, referred to as the ‘1-enquiry’ questioned both people on bus 91 and employees and visitors of the Rivium business park within a range of 300m around the ParkShuttle Rivium stop. The ‘1-enquiry’ also investigated the influence of the ParkShuttle on companies' choice of location. The third survey, the ‘enquiry’, was similar to the ‘1-enquiry’, but was conducted in April 2000. Between the ‘1-enquiry’ and the ‘2-enquiry’, two phone surveys were conducted among bus passengers and ParkShuttle passengers (October 1999 and February 2000).

On average, passengers appreciate the ParkShuttle as much as, or a little less than, bus service 91 in the same area. The average valuation was between ‘good’ and ‘average’, both for the bus service and the ParkShuttle. Only the 2-enquiry resulted in a below average score for the ParkShuttle, mainly due to some short interruptions of the system during the week of the enquiry. The main drawbacks of the shuttle are its irregularity and its unreliability. It is a demand-driven transport service and as such the waiting time varies, and can be considerable during peak hours. Furthermore, the reliability of the shuttle is still unexpectedly high after one year of operation. Finally, one of the main advantages of the ParkShuttle is the availability during off-peak hours (when the concurrent bus service operates at a 30-minute interval).

The shuttle did not introduce a modal shift in the area. Most shuttle-users are former bus passengers. In April 1999 81% of the employees and visitors of Rivium business park came by car, about 4% of them came by bicycle and 15% used public transport. The distribution between ParkShuttle and bus is about 6% and 10% respectively. After one year, public transport has lost a market share of about 1% to car. The ParkShuttle (6%) is used relatively less than the bus (8%), but the distribution shuttle-bus had altered in favour of the shuttle.

The ParkShuttle has little influence on companies' choice of location. Most employees come to work by car. A good accessibility by car is therefore a much more important issue for choosing an office location. Other important factors are the image of the business park and the availability of free parking spaces. Due to its malfunctioning, the ParkShuttle has a negative image among businesses by the end of the test period.

The passengers do not experience the fact that the ParkShuttle is unmanned as a problem. Social safety was expected to be an important issue, but it did not turn out to be so. Apparently familiarity made safety appear obvious. The shuttle does not appear to be a threat to public safety.

Connexxion carried out an evaluation of their services[29]. Connexxion is a public transport operator in the Netherlands. Connexxion runs mainly buses, but also trams, taxis, and a small number of other transport modes, including the Rivium ParkShuttle. This section will discuss technical issues concerning the automated vehicles (the electronic guidance, the object detection, etc.), operational topics and user appreciation.

The electronic guidance of the ParkShuttle vehicles works properly and is very precise. The vehicles have lost their position only a few times due to malfunctioning transponders in the road. The vehicles are rather heavy (4200 kg, mainly due to the batteries: 1600 kg) and always drive on the same lateral position of the road, causing ruts. Since the vehicles only use a small part of the road, the infrastructure could be reduced to tracks of road surface (rails). This would not only be cheaper, but would also prevent pedestrians, bikers, skaters, etc. from (ab)using the ParkShuttle infrastructure.

The object detection scans a horizontal plane in front of the vehicles. Objects at a level different from that of the scanned plane are not detected (e.g. the tailboard of a truck sticking out above the ParkShuttle infrastructure). An additional vertical scan therefore seems appropriate. The \`look ahead distance\` of the object detector is related to the speed of the vehicle. In order for the detector not to detect the road surface when driving on a slope or the shoulder of the road in turns, the vehicle decelerates on slopes and at turns. Drifting litter, large falling leaves during autumn (from plane trees) and birds have been known to stop vehicles. The vehicles are also equipped with a pressure-sensitive strip on the front bumper. Whenever the strip detects an impression, an emergency brake is made. During the pilot project, no accidents have happened.

The reliability of the vehicles does not live up to the expectations. The vehicles\` high frequency of maintenance requirements and the high passenger volumes have caused capacity problems. The design of the vehicles should be improved in order to prevent failures and facilitate repairs. It should be mentioned, though, that the vehicles used were prototypes designed in principal for the initial length of the pilot project of one year. The vehicles do not drive very comfortable. The vehicles do not have suspension and the acceleration/deceleration are rather high (up to 5 m/s^2 at emergency brake).

The operating costs for the ParkShuttle pilot project are higher than expected. They are on the one hand about 25% higher than the costs of a regular bus service, but are on the other hand only about one quarter to one half of other people mover systems. The cost-effectiveness of the ParkShuttle (29%) is higher than the cost-effectiveness of bus line 91 (25%). The operating costs are expected to decrease when the system is expanded. The vehicles should become about 50% cheaper in both initial costs and maintenance in order to become profitable, which they are expected to do.

The ParkShuttle project in Rivium is a success in terms of passenger numbers: about 40% of all public transport passengers to Rivium use the ParkShuttle, whereas the only stop covers only about 25% of the area. About 500 passengers a day use the system, twice as much as originally expected.

The use of the vehicle request button at the stops, and of the operating panel and the intercom inside the vehicles is not self-explanatory. The demand-driven concept of the ParkShuttle is unclear especially to new users. Travellers expect more information about waiting times at stops. The operator should also be able to show messages or page information at the stops.

The intercom system appears to be sufficient to prevent vandalism on this line. One of the vehicles is equipped with a camera and a `mobile telephone modem`. It is too expensive to continuously transmit images, and therefore the camera is rarely used.

Connexxion has recently decided to extend the ParkShuttle project: the infrastructure is being broadened to 2 lanes, it is being extended to more stops and new, larger shuttles will be used. The operating system and the passenger information will be improved, making use of lessons learned from the pilot project.

- **Schiphol ParkingHopper:**

This descriptive research was done in 1998 in order of the 'Consumer services'-group, Schiphol Parking management[30].

The purpose of this study was to obtain insight into the use and the appreciation of the Parking Hopper as a transport mode for travellers from their parking place to the shuttle service that takes them to the terminal. The main question is how users of the Parking P3 experience the Parking Hopper.

The main results were probably influenced by the fact that the evaluation was conducted during summer, when it was very busy.

Almost 50% of the people know about the Parking Hopper, most of them by reading in the newspaper, or by the airport's information folder. Most of the people who didn't use the Hopper, were parked very close to the shuttle stop, or preferred to walk because of beautiful weather. Another reason was more relevant: to some passengers it was not clear how to use the Parking Hopper or where it stops. The instructions for use and the information on the stops have been improved since the enquiry has been conducted.

In general, the Parking Hopper is considered to be a user-friendly service, practical and useful, which looks rather good and doesn't need to be changed. Many respondents were not aware that the service is for passengers only, not for luggage. This should be cleared out on the instruction board.

- **Implications of the Evaluation for CyberCars:**

The lack of travel information and the uncertain waiting time during rush hour appears to be the most important disadvantage of the ParkShuttle. Future services should ideally have very short waiting times, or at least give good information about the expected waiting time. Ideally, this information should be available from any location, not just at the stop – if any – of the service.

Reliability is of major importance for the image of a new transport concept, for its exploitation costs and for its capacity. Reliability of new vehicles or vehicle systems should receive a lot of attention.

Both the ParkShuttle and the Parking Hopper system show that passengers seem to need some help when confronted with new transport systems. Using the system should be as plain and as straightforward as possible.

The introduction of the ParkShuttle did not have an influence on the modal shift. This may be due to the route of the shuttle: it travels from a subway station to a business park on a rather short route. Although there is a P&R facility at the subway station, it is rather illogic to park there and take the ParkShuttle to work. Therefore we feel we cannot draw any conclusions from this test project on the effect of CyberCars on modal shift. We would expect a more elaborate system (a system that covers a larger area), introduced in an area where it does not replace (a part of) former public transport, to affect modal split.

Social safety did not appear to worry passengers. We would hesitate to extrapolate this feeling of confidence to services that operate during the night and/or services that do not operate on a dedicated infrastructure. We also expect the trust in an unmanned system to decrease as the driving task becomes more difficult, e.g. because of operating at a higher speed or in mixed traffic.

Object detection systems should become more flexible, especially for use in mixed traffic transport systems. The existing prototypes of automatically guided vehicles seem to indicate that these transport systems will become more cost effective than manned systems.

In general, people seem to have a positive attitude towards innovative systems: curiosity and the desire to try something new seem to overcome eventual fear for automated vehicles.

3.3.1.2 Mass Transport Systems

The Communauté Urbaine de Lille wanted to prevent the downtown area from getting congested by making a commitment to public mass transit. The key features of the VAL system developed were high average speeds and low waiting times. In ten years, public transit ridership doubled and between 1982 and 1984, auto traffic reduced by 15%. The VAL exceeded transit standards for reliability and performance. There was a slight ridership decrease in 1986 when fares were restructured, which shows that customers are sensitive to price, but the continued growth since shows that the system is popular.

Dallas/Fort Worth International Airport insisted that the improved APM be architecturally cohesive. Existing aircraft parking positions were needed to align the APM between the terminal face and the aircraft (Nicholas et al, 2001[14]).

The Niagara Parks Commission had to protect the Falls, a mixture of natural amenities and historical features, so their study included:

- **Visitor safety**
- **Aesthetics**
- **Impacts on park operations**
- **Impacts to natural environmental components**
- **Impacts to heritage features**
- **Revenue generation**
- **Noise impacts**

Gillet and Chevroulet, 1999, say that BURST has a strong potential to drive Lausanne's development towards sustainability. They give no more details.

A survey in Switzerland found APM users to be young males with above average education on below average income, who were sensitive to environmental and traffic problems.

3.3.2 Car Sharing/ Car Pooling

For Mobility CarSharing, Switzerland patrons are largely public transport users. They had problems of underestimating the numbers of cars required and they overemphasised the role of technology. However, the probability of obtaining a car at the desired time is 95%. All customers stated they are fundamentally satisfied with the scheme.

A Praxitèle on-site survey found a high rate of customer satisfaction as all customers obtained a car without waiting (Massot et al 1998[31]). Initially jockeys needed to be present for instruction in use of the system, although their number could be reduced in the self-service mode. While jockeys restricted opening hours, with no operation on Sundays, they also counter the image of the de-humanized computer system. Praxitèle ran at a loss as a prototype.

Praxitèle needed a higher number of vehicles than expected to introduce the service. This could be reduced as the system attains a level of maturity. It needs automatic recharging to reduce jockey time. There were high initial cost and customer inducements involved in starting the project.

A survey of members of Car Sharing Organisations (CSO) found that users want traffic mitigation, transparency of costs and value for money (Steininger et al, 1996[32]). Members tended to be under 45 and highly educated.

Lufthansa and Swissair automatic rental system has saved Lufthansa $20m in avoiding parking infrastructure costs (Sperling et al, 2000).

3.3.3 Demand Responsive Transport

DRT systems are particularly useful in low demand areas and for special transport services. PersonalBus (Italy) had a high level of user satisfaction, with 90% indicating vehicle comfort to be good or very good and a similar result for time take to reach the stop point. Actual users wanted an extension of the service to 24 hours a day. Some elderly users were less satisfied with an interactive voice response system. Decision-makers in Italy wanted to extend the PersonalBus system, as did the operators. Drivers needed training in the new technologies.

The SAMPO (Systems for Advanced Management of Public Transport Operations) project, as part of the DGXIII Transport Telematics Programme, produced user needs from DRT (Finn, 1996[33]). Across 5 sites in Belgium, Finland, Ireland, Italy and Sweden, this project investigated the following user needs:

End-user:

- **Wide range of destinations/coverage**
- **Easy access to services (walk/wait)**
- **Responsive to personal needs**
- **Accessibility of complete, reliable information**
- **Ease and speed of booking**
- **Last-minute booking**
- **Reliability of service and arrival time**
- **Assurance of return journey**
- **Minimum deviations/delays on the route**
- **Ease of boarding and space for luggage, shopping**
- **Access to other modes, but minimise transfers**
- **Maximum operating hours**
- **Reasonable pricing structure**

Operator:

- **Viable, sustainable services**
- **Maximise patronage**
- **Develop new markets**
- **Cost efficiencies in service provision**
- **Maximise occupancy/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 and revenues**
- **Freedom to continue to develop own business**
- **Ability to expand coverage area**
- **Ability to accept non-booked passengers**

Decision-maker:

- **Ensuring co-operation across municipality borders**
- **Ensuring contracts are flexible during test periods**
- **Answering the question of subsidising public transport**
- **Integrating services**
- **Ensuring needs of the elderly/ disabled are catered for**
- **Ensuring services apply to low-density areas**

3.4 Conclusion of Literature Review

All systems described in this review were developed as attempts to alleviate current traffic problems. Few of them established needs from end-users for a product. This is partly because CTS is not yet operational. People movers have been operational at airports and theme parks for over 20 years, but this may have been seen as a novel and economic means of transporting people, rather than as a solution to societal transport problems. For this reason, actual requirements, generated by end-users, are scarce. This is not to say that requirements established as a thought exercise are not valid. Mobilty, CarSharing and Praxitèle users are very satisfied with their service, indicating that their needs are being met. The SAMPO research into DRT did show that, although popular, the service could be improved, particularly with better information and an expanded service. Operators wanted to help integrating their service with other modes, to get their operation started. This is where decision-makers get involved. They can decide at the outset if any particular groups are to be targeted as system users. For example, Bray and Bangle, 2001[34], found that women make shorter trips than men and are more likely to use buses, travel more between peaks and less often at night than men, possibly as they are more concerned about safety. Women are less likely to have a driving license and so need public transport more than men. While the authors recognise the gaps in their study, particularly regarding data from ethnic groups, unreporting of crime and differences between the way males and females interpret the questions, this shows that decision-makers could target user-requirements to benefit specific groups. Furthermore, decision-makers need to know the benefits of improved public transportation systems. Autodate reports a 39% reduction in vehicles together with some increase in public transport use. The role of government is to facilitate choice and entrepreneurship. There should be some financial support for system-enhancing technologies and disincentives for privately owned vehicles. Benefits to car-sharing are comparable to major road schemes with only a fraction of the implementation costs (Fellows and Pitfield, 2000[35]). But ParkShuttle did not influence modal split or corporate choice of location (Bootsma and Koolen 2001[6]). Something to bear in mind is the psychological aspect of travel. In standard transit operations, out-vehicle times constitute a significant part of the total door-to-door travel time. Many studies were performed to evaluate perceived travel times. For example, waiting time on public transport seems 3 times slower than time spent progressing towards the destination and service unreliability contributes to stress (Cities21, 2001[36]). It seems from the literature that to compete with the car, public transport has to become more like the car, offering comfort, privacy, reliability and frequency of service.

4 FOCUS GROUPS

4.1 Introduction to Focus Groups

4.1.1 Approach to Focus Groups Activities

A focus group is a market research tool for obtaining qualitative responses on perception and requirements of targeted consumers (in this case the end-user of CTS) for a given product (in this case CTS). A focus group is a moderated groups discussion with 6-12 participants, lasting for 90-120min. When planning focus group activities, the following has to be developed and specified.

- **Group Recruitment:**

  After having specified the target group for the focus group all possible characteristics (e.g. age group, gender, social background, etc.) have to be considered to get a representative response.

- **Stimulus Material:**

  A Presentation has to be developed to introduce the topic of the discussion to the group participants. This material has to be objective, to prevent biasing the group and their responses.

- **Topic Guide:**

  A topic guide has to be developed to specify the timings for the use of the stimulus material, the moderation techniques to be used and the important topics to be covered in the discussion.

The focus group technique was used to obtain responses on use requirements for CTS from the user group end-user. This technique was only used for this user group, as for all other user groups structured interviews were assumed to be a more suitable technique. According to the framework mentioned above the user group end-user can be split up into further sub-groups. End users are defined within the framework as being either potential system user or non-user affected by CTS. A system user can be either a user with general or special needs. A non-user can be e.g. residents or shops and businesses close to CTS. They might be affected by the system in a positive or a negative way. The focus groups activities only consider the system user/ non-user with general needs. But in contrary to this initial idea, some partners carried out focus groups with participants of differing backgrounds (e.g. authority representatives).

4.1.2 Planning of Focus Groups Activities

The ***preliminary activities*** for the focus group activities were to develop a focus group guideline document and get experience on the use of this market research technique for the user needs analysis for CTS by carrying out a test focus group.

- **Focus Group Guideline:**

  A focus group guideline document was developed to specify details on planning and carrying out focus group activities. This document was used by all partners, which were involved in this activity in order to have a common procedure leading to comparable results. The document contained information on recruitment of participants for the group, the stimulus material and the topic guide.

- **Test Focus Group:**

  A test focus group was carried out before the partner activities started, to test the first concept for the focus group activities and the first version of the stimulus material and the topic guide in terms of meeting the overall aim of leading the discussion to the user requirements and perceptions of CTS and not biasing the group and influencing their responses by presenting the CTS concept as neutral as possible.

Based on this test focus group the final version of the focus group guideline, the stimulus material and the topic guide was developed, incorporating all experiences from the test activity. The main experiences were that extremes in the location of the groups should be avoided (e.g. London), that participants need a precise description of CTS and that certain illustrations (e.g. monorail) can result on too much emphasis of these contents in the discussion.

As a basis for developing the focus group guideline document, the stimulus material and the topic guide the overall aim was to investigate user requirements and perception for two scenarios, the short-term scenario (2005), relating to the CyberMove city test sites and the long-term scenario (2030), where a fully demand-responsive, true door-to-door system will be assumed.

For the ***group recruitment*** three participants characteristics categories were considered, age, gender and car-ownership. Within these categories further sub-categories were defined: three different age groups (20-35, 35-50, 50-65), male, female and mixed gender group and car-owners, non car-owners and group with mixed car-ownership. The following table shows the structure of these characteristics. The recruitment of participants for the group was supposed to cover all characteristics within the groups carried out by each partner involved.

Focus Group Activity	Age group				Gender			Car-ownership		
	20-35	35-50	50-65	mixed	male	female	mixed	yes	no	mixed

Fig. 3: Participants Characteristics for Focus Group Recruitment

The ***stimulus material*** used in the focus groups to present CTS as the topic for the group discussion contains 14 slides to be printed on A3 boards for the moderation. The material consists of the following three parts.

- **Existing CTS related Systems:**

  The aim of this part is to show that CTS technology is not something futuristic, that the technology is available and that CTS related systems are already implemented. The material contained descriptions, illustrations and videos for the Schiphol and Rivium systems

- **The Short-term Scenario:**

  The objective of this part is to describe what level of technology is possible in three years time, as a basis for the discussion on user requirements for this scenario. The material contained descriptions and illustrations for the Rivium extension and the Copenhagen test site

- **The Long-term Scenario:**

  The intention of this part is to describe the level of technology envisaged for the long-term, as a basis for the discussion on user requirements for this scenario. The material consisted of written description of the vision (demand-responsive, door-to-door) and a video of the RUF system as an example.

The ***topic guide*** specifies the structure of the discussion, the moderation techniques to be used for the investigation of user needs and perceptions for CTS in view of the short-term and the long-term scenario and the topics to be covered in the group discussion. In the following these parts of the topic guide will be explained in more detail.

- **Structure of the Discussion:**

  The discussion consists of three stages. The group discussion starts with a warm-up and introduction, where the moderator and all group participants introduce themselves. The next stage is a free discussion about experience with the existing urban transport system, slowly leading to the main theme of the discussion. The last stage consists of the presentation of the stimulus material, with free discussions on each part of the material, where the moderator makes sure that all topics specified in the topic guide are covered in the discussion.

- **Moderation Techniques:**

  For the discussion on general urban transport issues and on the short-term scenario no special moderation techniques were used. For the long-term scenario, where responses had to be more imaginative, special techniques were used in addition to a free discussion. Participants were given a map of an imaginary city and were asked to indicate a possible CTS network (single connection, single line and real network) and necessary facilities (e.g. depot, maintenance, parking, etc.) on it. Furthermore they were asked to draw a CyberCars vehicle.

- **Topics to be covered:**

  Although the discussion in the focus group is supposed to be as freely flowing as possible, the moderator had to make sure, that certain important topics were covered. These topics included general issues and location-related issues for the present urban transport situation and general issues, operation issues and possible applications of CTS systems in view of the short-term and the long-term scenario. The operation issues were split up into system, vehicle, safety, security, access, payment and system/ vehicle features.

4.1.3 Analysis Procedure for Focus Group Results

After developing a common procedure for planning and carrying out the focus groups, to ensure comparable results of all focus groups done by partners involved in this activity, a common structure for organising the results, reporting and analysing them was developed. This structure is based on the topics to be covered developed for the focus group topic guide. All partners have reported their respective results using this structure.

The analysis of user requirements and perception can only be done drawing together all results achieved by partners as being representative for the targeted user group end-user. An analysis of results for each characteristic within the user group end-user (age, gender, car-ownership) or an analysis for each country in which focus groups were carried out by partners is not possible, as more groups would have to be carried out to obtain representative results on this level.

The focus group activities carried out in context with the CyberCars project aimed at covering all user characteristics, that were established and all countries involved in the project to get results, which are representative for the user group end-user on an European level. The following figure shows the analysis framework used to draw together all partner results for an analysis on user requirements for CTS.

Present urban transport issues	General issues	
	Location-related issues	
User perception/ requirements for the short-term scenario	General issues	
	Operation Issues	System
		Vehicle
		Safety
		Security
		Access
		Payment
		Features
	Possible applications	
User perception/ requirements for the long-term scenario	General issues	
	Operation Issues	System
		Vehicle
		Safety
		Security
		Access
		Payment
		Features
	Possible applications	
Additional issues		
Issues relating to user characteristics		

Fig. 4: Analysis Framework for Focus Group Results

4.2 Activities for Focus Groups

In context of the user needs analysis for CTS, a total of 23 focus groups were carried out by 7 partners in 6 countries. All focus groups were carried out and analysed according to a common and agreed structure for comparable results. The following table shows the number of focus groups carried out by each partner in each respective country.

Country	Partner	No. of Focus Groups
Italy	CRF	5
	DITS	1
France	INRIA	2
Portugal	ISR	4
The Netherlands	TNO	4
UK	TRG	4
Israel	TRI	3

Fig. 5: Overview of Focus Groups carried out by Partners

All partners have reported the results of their focus groups using the common structure for reporting. On these tables the user characteristics covered and a summary of results for each topic had to be stated. Based on this the analysis was carried out. The following figure shows the structure used for the report (for the reports from each partner see Annex A).

<table>
<tr><td>Partner</td><td colspan="2"></td><td colspan="10" rowspan="3">CyberCars WP1 T1.1
User Needs Analysis
Focus Group Activity</td></tr>
<tr><td>Country</td><td colspan="2"></td></tr>
<tr><td>No. of groups</td><td colspan="2"></td></tr>
<tr><td colspan="3" rowspan="2">Focus Group No.</td><td colspan="4">Age group</td><td colspan="3">Gender</td><td colspan="3">Car-ownership</td></tr>
<tr><td>20-35</td><td>35-50</td><td>50-65</td><td>mixed</td><td>male</td><td>female</td><td>mixed</td><td>yes</td><td>no</td><td>mixed</td></tr>
<tr><td colspan="3">1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Topic Category</td><td colspan="10"></td></tr>
<tr><td rowspan="2">Present urban transport issues</td><td colspan="2">General issues</td><td colspan="10"></td></tr>
<tr><td colspan="2">Location-related issues</td><td colspan="10"></td></tr>
<tr><td rowspan="9">User perception/ requirements for the short-term scenario</td><td colspan="2">General issues</td><td colspan="10"></td></tr>
<tr><td rowspan="7">Operation Issues</td><td>System</td><td colspan="10"></td></tr>
<tr><td>Vehicle</td><td colspan="10"></td></tr>
<tr><td>Safety</td><td colspan="10"></td></tr>
<tr><td>Security</td><td colspan="10"></td></tr>
<tr><td>Access</td><td colspan="10"></td></tr>
<tr><td>Payment</td><td colspan="10"></td></tr>
<tr><td>Features</td><td colspan="10"></td></tr>
<tr><td colspan="2">Possible applications</td><td colspan="10"></td></tr>
<tr><td rowspan="9">User perception/ requirements for the long-term scenario</td><td colspan="2">General issues</td><td colspan="10"></td></tr>
<tr><td rowspan="7">Operation Issues</td><td>System</td><td colspan="10"></td></tr>
<tr><td>Vehicle</td><td colspan="10"></td></tr>
<tr><td>Safety</td><td colspan="10"></td></tr>
<tr><td>Security</td><td colspan="10"></td></tr>
<tr><td>Access</td><td colspan="10"></td></tr>
<tr><td>Payment</td><td colspan="10"></td></tr>
<tr><td>Features</td><td colspan="10"></td></tr>
<tr><td colspan="2">Possible applications</td><td colspan="10"></td></tr>
<tr><td colspan="3">Additional issues</td><td colspan="10"></td></tr>
<tr><td colspan="3">Issues relating to user characteristics</td><td colspan="10"></td></tr>
</table>

Fig. 6: Structure for Reporting Focus Group Results

4.3 Results of Focus Groups

4.3.1 Current Urban Transport Issues

In the following the results in view of current urban transport issues of all focus groups carried out by partners involved in this activity will be described. For the current urban transport issues there will be a distinction between general issues and issues directly relating to problems specific to the location of the focus group.

- **General Issues:**

  The general issues, which were nearly uniformly mentioned in all focus groups in all countries related to the road network, private car usage and public transport. The existing road network was described as badly maintained, highly congested in peak hours and providing an insufficient number of parking spaces. The private car was perceived as being convenient, as a way of expressing ones personality and as a status symbol, although it was acknowledged, that driving in cities can be a stressful experience, that it results in higher costs compared to using public transport, that parking is often very complicated and that private car usage results in environmental problems, like pollution or noise – though in most cases this does not influence their mode choice. The public transport system in general was described negatively, mentioning unreliability, inflexibility, low service frequency, overcrowding, use of old vehicles, quality and cleanliness of the interior, insufficient co-ordination of modes and services, lack of information, transfers leading to additional waiting times and network design not meeting user needs and demand. When going into more detail about specific modes buses are described as the cheapest mode, but also the one providing the lowest quality. Underground is rated higher, because of a high service frequency, fast connections, but the high construction costs as a drawback for a new implementation is also noted. Trains were also higher rated, but being more suitable for long-distance trips, but quality of service relies on sufficient provision of travel information and there is concern about personal safety when travelling late at night. Taxi was described as the most convenient, especially when transporting luggage, but also the most expensive public transport mode. Walking and cycling was also mentioned, but not always being practical for all trips. When cycling is to be encouraged, then the provision of dedicated cycle lanes is crucial.

- **Location-related Issues:**

  Specific location related issues were mentioned in the focus groups for the cities of Antibes (France), Amersfoort (the Netherlands), Southampton (UK) and Haifa (Israel). In Antibes the cape situation of the historical city centre and the difference in demand between low and high season result in problems for parking, general traffic and public transport. The general trend is to restrict the use of private vehicles. Parking is a big problem, as public space is very rare and is for 120 days a year used for various events (markets, exhibitions, concerts, etc.), so that city centre parking spaces are occupied without any replacement solution for a third of the year. There are unused parking spaces at a distance of 1 km from the city centre. In Amersfoort traffic is described as illogical, chaotic, busy and dangerous. A new ring road, bus lanes into the city centre and a car-free city centre has improved urban traffic conditions, but not sufficiently. In Southampton the traffic situation in the city centre is describes as very problematic, because of high level of congestion, due to a new pedestrian area and major developments (e.g. shopping centre). In Haifa there are specific transport problems in context of the Technion campus. There are parking problems, because of limited car access to the campus and remote parking spaces, leading to long walking distances to university facilities – especially problematic due to the hilly topography of the campus.

4.3.2 The Short-term Scenario

In the following the results in view of the short-term scenario of all focus groups carried out by partners involved in this activity will be described. This includes general perception, the system, the vehicle, safety and security, access, payment, features and possible applications for CTS.

- **General Issues:**

  Low vehicle speeds were perceived as positive and as negative, positive as contributing to safety and negative in terms of travel time. There were concerns of not being in control in case of using automated transport systems, although technology was perceived to be safer than manual operation. Even if a driver is not needed for the vehicle operation, he also provides a reassuring presence for passengers, leading to concern about personal safety. There were doubts on the feasibility of operating CTS mixed with car traffic or pedestrians. The benefits of CTS were not obvious enough, though the environmental benefits of using a zero emission vehicle were acknowledged. There were mixed reaction towards CTS complementing or replacing existing public transport systems. There were also worries about CTS leading to unemployment in the community and about the very high costs for implementing CTS. The conflict between a system targeting the decrease of walking distance and the environmental and personal health benefits of walking was also mentioned.

- **System:**

  CTS was perceived as being only suitable for very short distances for a targeted application and on a dedicated lane or using an elevated structure, to prevent mixing with car traffic and pedestrians. There was also concern about insufficient space in urban areas for the provision of dedicated lanes or elevated structures. Furthermore the vehicle sped seems too low for efficient operation. CTS has to provide a high level of flexibility, to be able to adapt to changing patterns of demand. High service frequency or on-demand operation is important. The system has to be fine-tuned in terms of short waiting times, short distances between stops and careful network design (network solution better then lines). Vehicles should be ordered using mobile phones and the waiting time for the vehicle should not exceed 5min. There was concern about overcrowding of vehicles, and the solutions proposed were either individual vehicle or access control systems. There is a conflict between the system being child proof in case of misuse, but also being usable by children to prevent the system from being social-exclusive.

- **Vehicle:**

  The vehicle size should depend on application demand characteristics (e.g. individual, small groups, mass transport). The use of environmentally friendly vehicles (e.g. zero emission and low noise levels through electric operation) is important. For safety reasons the vehicles should not allow speeds exceeding 80 km/hr. The vehicle should be comfortable, be highly visible and provide space for wheelchairs, pushchairs, luggage or bulky items. Seating for passengers is necessary, especially for elderly users. In terms of the appearance, the vehicles should look like mini-vans or existing shuttles, avoiding unusual shapes or forms. In the case of a public application the vehicle interior has to be vandalism proof. Depending on the location of the system heating and air-condition is also important. The vehicle has to be clean, e.g. through monitoring of cleanliness and possibly cleaning between trips. There is concern about the engine of the vehicles being able to cope with a hilly topography in terms of necessary acceleration.

- **Safety:**

  There was concern about traffic safety when mixing CTS vehicles with car traffic or pedestrians. CTS vehicle must have a proven higher level of traffic safety then existing manually operated transport systems. In emergency situations a manual system override function, emergency stop or a door-opening device has to be available. But it was also acknowledged that the safety perception might change with a growing experience with automated systems. For safety reasons all passengers have to sit in the vehicle, possibly also wearing safety belts. There were also worries about safety issues when using an elevated structure (e.g. monorail). An alternative manually operated system has to be available for cases of system breakdown of the automated system.

- **Security:**

  There was much concern about personal security in the vehicle, especially at night and when sharing it with others. Therefore there should be a CCTV system and phone link to a staffed operations centre for emergencies, assaults or vandalism for crime prevention, proof and notification for emergency services. In cases of emergency the vehicle should automatically be directed to a hospital in the case of medical emergencies. Bigger vehicles, high level of transparency and doors only on one side of the vehicle can also create a safer environment.

- **Access:**

  The topic access can be interpreted as access to the vehicle or to CTS in general. In the case of access to the vehicles, low-floor vehicles with large sliding doors and ramp should be used to facilitate the access, especially for elderly, disabled, wheelchair, pushchair and transporting luggage or bulky items. An access control system should be used to avoid overcrowding of the vehicles. In the case of access to CTS, integration of CTS with other modes of public transport is important to ensure access by all parts of the population to make the system social-inclusive.

- **Payment:**

  In some groups it was assumed that use of these systems would be free, as the systems were mainly envisaged to be used for private applications, where the payment would be hidden in other fees (e.g. parking or theme park). Suggestion for methods of payment included conventional public transport tickets, individual ticket, season tickets and tokens. The ticket for CTS should be integrated with all other modes/ services/ operators of public transport systems in the region and parking. The actual transaction was envisaged using credit cards or SmartCard technology, but cash payment in case of infrequent users has to be possible. But in view of the driverless aspect there was also concern about abusing the system. In terms of cost of the ticket, it was stated that it should not exceed tariffs usual for other public transport modes.

- **Features:**

  Features foreseen for the vehicles included on-boards multi-media systems as the human machine interface to operate the vehicle, for travel information, route planning and showing vehicle location and next stops. There should be Internet, music and video devices. A system producing warning noises when approaching an obstacle, as well as a system for recharging batteries on downhill sections were also envisaged. In case of group travel there should be swivel chair. Even an on-board coffee machine was mentioned.

- **Possible Application:**

  Most possible applications mentioned are very limited and in contained areas, reflecting the concern about using CTS in connection with car traffic and pedestrians. The envisaged applications include airport, stadium, PT in suburbs, historic city centre, business park, shopping centre, theme park, P&R, feeder to PT, campus and freight.

4.3.3 The Long-term Scenario

In the following the results in view of the long-term scenario of all focus groups carried out by partners involved in this activity will be described. This includes, as for the short-term scenario, the general perception, the system, the vehicle, safety and security, access, payment, features and possible applications for CTS. Various issues raised in the focus groups for the short-term scenario were mentioned again for the long-term scenario. This section will only focus on additional issues.

- **General Issues:**

  There was much concern about the use of CTS as an individual transport system only replacing car congestion by 'CyberCars congestion' and insufficient space for the operation of CTS and for facilities (e.g. parking), due to existing levels of traffic and congestion. Therefore implementation would only be possible if general traffic would be restricted. To make the system successful it would need to be implemented on governmental level and standardisation would also be crucial, to be able to connect systems. There was concern about visual intrusion in the case of using elevated structures (e.g. monorail). For some participants the benefits of such a system were not clear enough (e.g. similar to a bus-way network, only without drivers).

- **System:**

  The system is perceived as a solution between a taxi and a mini-shuttle. It is considered to be suitable only for specific applications, but there is also concern about the cost for using the system, as it is envisaged as being more expensive then an ordinary taxi and having the additional disadvantage of not being picked up at the trip origin. There were mixed opinions about the end-user characteristics targeted by the system, including only business travel or commuting. Also the perceived costs for implementing the system were judged to be too high for an economically efficient operation. In terms of system operation, it was envisaged, that the vehicles will be located on a central base, called using mobile phones and then the vehicles will park automatically. For some participants the technology seemed too futuristic.

- **Vehicle:**

  There have to be clear benefits compared to existing modes of public transport or the private car, especially in view of cost for using the system and vehicle speed. The fare for using a demand-responsive door-to-door system should not exceed fuel cost for using the private car for a comparable trip. The vehicles have to be faster then ordinary transport modes (e.g. bus). In the case of privately owned vehicles (as presented in the RUF-video) choice is very important. This includes vehicle size, special features and the ability to express ones personality, showing that a transport system can only be a real alternative to the private car, if it provides most or all of the advantages of the private car. The vehicles also have to provide a good quality of journey and a smooth and quiet ride.

- **Safety:**

  The only additional issues raised in context of the long-term scenario compared to the short-term scenario were concerns about traffic safety issues in view of using an elevated structure (e.g. monorail). This included the automatic guidance from the road network to a monorail access point and problems of leaving the vehicle or infrastructure in cases of accidents or emergencies.

- **Security:**

  The only additional issues raised in context of the long-term scenario compared to the short-term scenario were concerns about personal security issues in view of using an elevated structure (e.g. monorail). This included lack of control and access for emergency services in case of medical emergencies of passengers using the vehicle on an elevated section.

- **Access:**

  There were no additional issues raised in context of the long-term scenario compared to the short-term scenario. The participants only repeated the issues relating to vehicle and system access and social-inclusion. This included convenient access for elderly, disabled, wheelchairs and pushchairs using low-floor vehicles and ramps and the system being as social-inclusive as possible through integration with public transport.

- **Payment:**

  The only additional issues raised in context of the long-term scenario compared to the short-term scenario was, that it might be acceptable, though personal transport is favoured, to share a vehicle with others, if this would decrease the fare.

- **Features:**

  There were no additional issues raised in context of the long-term scenario compared to the short-term scenario. The participants only repeated features, as TV, video, games, Internet access and travel/ tourist information systems.

- **Possible Application:**

  A number of possible applications for CTS in view of the long-term scenario were mentioned, including inter-urban traffic, using high-speed rail links, historic city centres, feeder to existing public transport services and connection to suburbs.

4.3.4 Additional Results

In addition to the results for the present urban transport situation and the short-term and long-term CTS scenarios, there were also some issues relating to user characteristics. Respondents, who own or use a car, look at CTS from a different perspective: CTS has to meet higher standards to be considered an attractive alternative. Cyclists in urban traffic think that they have taken an important step with respect to an environmentally friendly approach to transport and will have to be convinced by more compelling arguments than the motorist who is not only confronted with problems in accessibility and parking, but is also aware that he is not the most ecologically sound or socially conscious road user. For the youngest members of the focus groups, CyberCars also seem to have an image problem. The age group 50-65 is more concerned with cost and difficulties in implementing CTS and is very environmentally aware. The age group 35-40 is more worried about the concept and the technology. The age group 20-35 has the least concern about the technology, but safety and security is very important. They have a very low expectation of governmental support for CTS.

4.4 Conclusion of Focus Groups

The focus group activities were targeted at investigating user requirements and perceptions from the end-user with general needs. The group discussion aimed at getting responses on current urban transport issues and on CTS, distinguishing between the short-term and the long-term scenario. The short-term scenario was closely related to the CyberCars/ CyberMove city test-sites and what technology level is possible in a time-span of approximately three years. The long-term scenario gave an outlook to what might be possible in thirty years time, based on realizing the overall CTS concept of an individual, on-demand, door-to-door transport system.

Responses on current problems regarding urban transport centred mainly on the conflicts between private cars and public transport. On one hand, the convenience but environmental impacts of using private cars and on the other hand, the environmental benefits but perceived (and too often real) inconveniences of using public transport. The responses to the presentation of CTS technology and possible applications were then able to show whether or not group participants representing the user group end-user could envisage CTS to be an answer to one or more of these problems mentioned. This question could be asked for the short-term, as well as for the long-term scenario presented for CTS technology.

In view of the short-term scenario there was much concern about the possibility of mixing automated transport systems with manually driven vehicles, cyclist or pedestrian. Most participants trusted the technology available for automated operation and obstacle avoidance, but could not envisage the efficient operation of CTS in shared environments, but clearly favoured separated solutions with dedicated infrastructure or lanes. In view of the long-term scenario the presented system seemed too unrealistic and/ or too futuristic. There was much concern about the funding and political consensus for the implementation of CTS on a large scale.

Even though group participants were very sceptical about the automated transport systems presented, they felt very confident about automated systems in cases of having personal experience, e.g. airport people mover. This shows that perception can change dramatically with increasing personal experience and normality of CTS. Furthermore the way in which CTS and its added value is communicated to the targeted user group is crucial and will be an important factor deciding over success or failure of a CTS initiative, which at this early stage of the development could be a large drawback.

5 STRUCTURED INTERVIEWS

5.1 Introduction to Structured Interviews

5.1.1 Approach to Structured Interview Activities

After having covered the user group end-user for the analysis on user needs and perceptions for CTS by using the focus group technique, for all remaining user groups and their respective sub-groups, structured interviews with selected representatives of interest group, authorities on various levels, institutions, companies (e.g. public transport operator or service provider), etc. were carried out.

According to the framework mentioned before the user group end-user can be split up into further sub-groups. End users are defined within the framework as being either potential system user or non-user affected by CTS. A system user can be either a user with general or special needs. A non-user can be e.g. residents or shops and businesses close to CTS. They might be affected by the system in a positive or a negative way.

As the focus groups activities only considered the end user with general needs, structured interviews were used to obtain responses from end user/ non-user with special needs. The structured interview approach was used for all these user groups and sub-groups, according to the common agreement, that the focus group technique is only suitable for covering responses from the end-user with general needs.

It was agreed by the partners involved, that a free conversation with only a topic checklist to make sure that all important topics get covered in the talk is preferable to the use of a questionnaire in meeting the objectives to obtain response on the general perception and on specific user requirements for CTS by all user groups involved in the process of using, operating or deciding over the implementation of CTS.

Therefore a topic checklist had to be developed, specifying all the important topics to be covered in the conversation in general terms for all user groups involved and possible specific issues for interviews with specific user groups or sub-groups. Furthermore presentation material had to be used to introduce the topic of the interview, the concept and possible applications of CTS, to the interviewees.

5.1.2 Planning of Structured Interview Activities

The ***preliminary activities*** in the planning process for the structured interview activities was to develop the topic checklist and the presentation material to be used for all interviews carried out by all partners involved for a maximum level of consistency.

- **Topic Checklist:**

  The topic checklist was developed to specify topics to be covered in the interview. It includes lists of topics for three different main user characteristics, which were identified to require different approaches, authorities, interest groups and operator/ service provider. The following table shows the topics to be covered for each of the respective main user characteristics.

Authorities	Interest Groups	Operator/ Service Provider
Comment/ views on CTS - Would they support it? - Supported by decision-maker? **Main Transport Problems** - Description of problems - Could CTS be a solution? **What Systems currently in Use** - Description of systems - Why have they chosen it? - What initial/ current problems? - What land-use implications? **Plans for future Systems** - Description of plans - Would they implement CTS? - What land-use implications? - Which criteria for decision?	**Comment/ views on CTS** - Can they meet their special needs? - More suitable than current systems? **Main Problems with current Systems** - Relating to system - Relating to vehicle - Relating to infrastructure - Relating to operation -Relating to information systems - Could CTS be a solution? **What Requirements for CTS** - For safety and security - For accessibility and availability - For comfort and convenience - For booking and information systems - Additional topics/ issues?	**Comment/ views on CTS** - Would they consider use of CTS? - What potential application for CTS? **Current Transport Problems** - Description of problems - Could CTS be a solution? **What Systems currently in Use** - Description of systems - What alternatives were available? - Why have they chosen it? - What initial/ current problems? **Plans for future Systems** - Description of plans - Would they implement CTS? - For which application? - Which criteria for decision?

Fig. 7: Topic Checklist for Structured Interviews

Furthermore a questionnaire was developed, investigating the importance of a number of criteria for a decision on CTS. The questionnaire contained 11 main aspects and 4 criteria for each of these aspects. For each of the criteria the interviewee was asked to state the importance on a scale from 1 to 6. The following table shows the 11 main aspects (For the whole questionnaire see Annex C).

Aspects for Criteria for Decision on a CTS System		
System Cost	System Feasibility	Equity Issues
Safety/ Security	System Operation	Passenger Comfort
Environment Issues	Urban Planning	System Flexibility
Existing Infrastructure	Technology Experience	Additional Criteria

Fig. 8: General Aspects for Criteria for Decision on CTS

- **Presentation Material:**

  The material used for the structured interviews to present the CTS concept as a basis for the interview, was the same as used for the focus groups (consisting of slides with text and illustration and short video clips, showing existing CTS related systems, the short-term scenario and the long-term scenario), for a consistency between procedures, leading to comparable results.

For the ***interviewee recruitment*** the framework for user groups involved, which was developed for the user needs analysis was used again, to make sure that the partners would cover all user groups and sub-groups. The following table shows the user groups to be covered by the structured interview activities. As indicated the potential system user and non-user with general needs do not have be considered for this activity, as they were already covered through the focus group activities.

User Groups to be covered				✓	**Interviewee**
End-user	Potential User	Special Needs	E&D		
			Motorists		
			Cyclists		
			PT User		
		General Needs		*5*	*Covered through Focus Groups*
	Non-user	Residents			
		Shops& Businesses			
Decision maker (public)	Non-elected	National Level			
		Regional Level			
		Local Level			
	Elected	Regional Level			
		Local Level			
Operator (public)	Public Transport Operator				
	General Service Provider				
Decision-maker& Operator (private)	Airport				
	Theme Park				
	Large Business				
	University Campus				

Fig. 9: User Groups to be covered by Structured Interviews

5.1.3 Analysis Procedure for Structured Interview Results

After developing a common procedure for planning and carrying out the structured interviews, to ensure comparable results of all structured interviews carried out by partners involved in this activity, a common structure for organising the results, reporting and analysing them was developed. This structure is based on the topic guide developed for carrying out the interviews. All partners have reported their results using this structure. The analysis structure contains an analysis of responses under the following four headings.

- **Awareness of CTS Technology**
- **Comments/ Views on CTS Technology**
- **Current Problems in View of Transport**
- **Future Plans in View of Transport**

The analysis will be carried out for these four issues with regard to each of the four main user groups covered: end-user, decision-maker (public application), operator (public application) and decision-maker/ operator combined (private application). The analysis will not be carried out on a lower level for the sub-groups as the number of interviews carried out in context of the user needs analysis for CTS is too small to allow a representative analysis on this level. The sub-groups were established, in order to ensure, that all sub-groups expressing special views or requirements get covered, so that the final results gives a complete picture for each of the four main user groups.

In addition to this analysis of the results of the interview there will also be an analysis of the results of the questionnaires on the importance of given criteria for the decision on CTS. This analysis will, for the same reason as mentioned above, only be carried out for the four main user-groups. There will be a statistical analysis, investigating the individual ranking for the 11 aspects and then for each of the 4 criteria given for each aspect. This analysis will be carried out on a global level, analysing all questionnaires, without considering the respective user group and on the user needs level, where the analysis will be carried out for each of the four main user groups, investigating deviation from the mean results.

5.2 Activities for Structured Interviews

Some partners used the questionnaire for each of the structured interviews they carried out, other used it only in parts of their interviews and distributed the questionnaires additionally to people they did not interview formally. Therefore, the structured interview activities carried out are described for the interviews and for the questionnaires separately.

- **Interviews:**

  In context of the formal interviews as part of the structured interview activities, 6 partners in 6 countries carried out 27 interviews. The following table shows the number of formal interviews carried out by each partner in each respective country, separated for user groups covered (for the summary of results from each partner see Annex B).

Country	Partner	Number of Formal Interviews per User-group			
		End-user	Decision-maker	Operator	Decision-maker/ operator
Switzerland	A&E	1	1	2	-
Italy	DITS	-	1	2	-
France	INRIA	-	1	-	-
Netherlands	TNO	2	1	3	1
UK	TRG	1	4	-	1
Israel	TRI	3	2	-	1

Fig. 10: Overview of Structured Interviews carried out by Partners (Formal Interviews)

- **Questionnaires:**

  In context of the questionnaires as part of the structured interview activities, 6 partners in 6 countries reported results for 38 questionnaires. The following table shows the number of questionnaires obtained by each partner in each respective country (for the summary of results from each partner see Annex C).

Country	Partner	Number of Questionnaires per User-group			
		End-user	Decision-maker	Operator	Decision-maker/ operator
Switzerland	A&E	-	1	-	-
Italy	DITS	-	1	2	-
France	INRIA	8	11	-	-
Netherlands	TNO	2	1	3	1
UK	TRG	1	4	-	1
Israel	TRI	-	1	-	1

Fig. 11: Overview of Structured Interviews carried out by Partners (Questionnaires)

All partners have reported the results of the questionnaire part of the structured interview by giving the ranking for each item, as a basis for the statistical analysis and the results of the formal part of the structured interviews using a common structure of reporting. In this structure the user groups covered, the respective interviewees and a summary of results grouped by the five topics mentioned before for each interview had to be stated. Based on this the analysis was carried out. The following figure shows the structure used for the reports on the formal part of the structured interviews.

Partner					CyberCars WP1 T1.1 User Needs Analysis Structured Interviews
Country					
No. of interviews					
User Group					Interviewee
End-user	Potential User	Special Needs	E&D		
			Motorists		
			Cyclists		
			PT User		
		General Needs		→	Covered through Focus Groups
	Non-user	Residents			
		Shops& Businesses			
Decision maker (public)	Non-elected	National Level			
		Regional Level			
		Local Level			
	Elected	Regional Level			
		Local Level			
Operator (public)	Public Transport Operator				
	General Service Provider				
Decision maker& Operator (private)	Airport				
	Theme Park				
	Large Business				
	University Campus				
Interviewee:					Summary of Results
Awareness of CyberCars Technology					
Comments/ Views on CyberCars Technology					
Current Problems in View of Transport					
Future Plans in View of Transport					
Additional Results					

Fig. 12: Structure for Reporting Structured Interview Results (Formal Interviews)

In the following the results of the formal part of the structured interviews will be described. There will be a distinction between the four main user groups covered by this activity: end-user, decision-maker (public application), operator (public application), decision-maker/ operator combined (private application), and the four issues covered: awareness of CTS technology, comments/ views on CTS technology, current transport problems, future transport plans and additional issues, according to the analysis procedure mentioned above.

5.3 Results of Structured Interviews

5.3.1 Formal Interviews

5.3.1.1Awareness of CTS Technology

The replies on the awareness of CTS technology, after having seen the presentation, were mixed. Some were aware of certain systems (Schiphol and/ or Rivium), especially interviewees in the Netherlands for obvious reasons and representative of authorities or companies who work in transport related areas and therefore need to be aware of emerging technologies. Most interviewees mentioned related systems, including airport people mover, LRT schemes, guide bus-ways or on-board, in-vehicle telematics systems (e.g. guidance and navigation systems, travel and traffic information systems, collision avoidance systems, autonomous driving, platooning, etc.).

5.3.1.2 Comments/ Views on CTS Technology

- **End-user:**

  The reaction of the interviewees representing the user group end-user was positive, acknowledging a high potential for CTS for meeting their special needs. The use of this technology could enhance the mobility of disabled, provide a more convenient public transport system, targeting existing and potential public transport user, provide better access to facilities for motorists in case of remote parking and it could decrease congestion in city centres, leading to better and more convenient access to shops and businesses. There was a general confidence in the technology. But there was also some concern about the success of CTS in our ‘private car society’, the funding, the possibility to operate CTS in mixed traffic with cars and/ or pedestrians and the general opinion was that the best solution would be a network-wide and demand-responsive door-to-door system.

- **Decision-maker (Public Application):**

  The interviewees representing the user group decision-maker (public application) were more sceptical about the CTS concept. They were able to see some potential of the technology for targeted applications, including feeder to other public transport modes or interchanges or historic city centres, but clearly favouring applications in more contained environments, including parking, airports and exhibitions. There was concern about funding, mixed traffic, user acceptance, experience and reliability of the system. They tended to take a more holistic approach, questioning the added value of CTS and the socio-economic impacts and where CTS would fit into an overall transport planning and policy strategy.

- **Operator (Public Application):**

  The interviewees representing the user group operator (public application) were positive about the potential of CTS technology, but they were doubtful, that the technology is sophisticated enough to be implemented economically efficiently. They expressed the view that the implementation and operation of CTS would be a high risk for them as private companies due to the lack of experience with the technology.

- **Decision-maker/ Operator (Private Application):**

  The interviewees representing the user group decision-maker/ operator combined (private application) were very positive about the potential of CTS technology for tackling site-specific freight and passenger transport problems. Main advantages were the lower operating costs, as compared to manually driven systems (e.g. shuttle-bus), due to no labour costs for the vehicle operation. In the special case of the use of CTS for an airport, it would be more useful for departure (trickle-feed), then for arrival (peak demand). Potential application included connection from the main terminal building to parking, hotels, conference centre and public transport interchange, ideally leading to a remote vehicle access point separated from the terminals to leave vehicle out of the main airport area.

5.3.1.3 Current Transport Problems

- **End-user:**

  The problems mentioned by the user group end-user were mainly in view of existing public transport system, which do not provide sufficient access to individual vehicles or the system in general, which is not flexible enough (e.g. point-to-point not door-to-door or rigid schedules not on-demand) and in view of problems with car usage in urban areas, including congestion, parking and pollution.

- **Decision-maker (Public Application):**

  The problems mentioned by the user group decision-maker (public application) are mainly in view of the conflict between the low image of public transport and the 'private car society', the often-insufficient service provision of public transport and the negative effects of car usage, including congestion, pollution, parking problems and social exclusion.

- **Operator (Public Application):**

  The problems mentioned by the user group operator (public application) include the implications of an ageing population, growth in demand for mobility, rigid public transport system, due to demand characteristics and political issues, the amount of labour costs involved (50% of the operational costs), that not enough parking spaces are provided for new developments and the level of congestion in urban areas.

- **Decision-maker/ Operator (Private Application):**

  The problems mentioned by the user group decision-maker/ operator combined are, that the location of building/ facilities/ attractions and the desire to restrict vehicle access, leading to remote parking areas results in long walking distances, possibly with adverse weather conditions and a steep topography and that public transport is insufficient for access to the site. When providing means of transport there are concerns, especially about the labour costs involved and the costs for the provision of vehicles to cater for peak demand, which are unused in off-peak periods.

5.3.1.4 Future Transport Plans:

- **End-user:**

  In view of future development, there should be more emphasis on walking and cycling, a strong increase in comfort and convenience of public transport services and improvement of the road network in terms of road maintenance and capacity. CTS might be a solution for improving public transport as feeder applications, but there is concern about funding.

- **Decision-maker (Public Application):**

  Future plans included provision of new public transport service (e.g. LRT schemes), P&R schemes, work travel plans, integrated transport policy initiatives, provision of real-time public transport information, use of SmartCard technology, extension of pedestrian areas to encourage the use of alternatives to the private car, to tackle negative effects, as congestion, pollution and social exclusion. CTS could be envisaged as providing solutions in context of these plans, e.g. as feeder to public transport, shuttle for connection between P&R and city centre and use in pedestrian areas where other vehicles are restricted.

- **Operator (Public Application):**

  Future plans envisaging the use of CTS included feeder applications to existing public transport modes/ services or interchanges in public applications or when operating the system on a private site (e.g. hospital, university, market, parking or exhibition) as the sole mode of transport and to cover the 'last mile', which cannot be served by public transport. But CTS need to be tested for safety and reliability.

- **Decision-maker/ Operator (Private Application):**

  Future plans include the study of a new high-speed rail for access to a flower auction in the Netherlands from Amsterdam Airport Schiphol (potential use of CTS for connections), a new airport people mover system in connection with the extension of the London/ Heathrow airport (no potential for CTS, due to good experience and low costs of existing automated people mover systems), a new cable car to connect the Technion campus in Haifa to the bay area and the university (potential use of CTS for connection on the campus) and a new transport system for a archaeological park in Israel with train, shuttle bus or CTS technology as potential alternatives.

5.3.1.5Additional Results:

In addition to the results on awareness of CTS technology, comments/ views on CTS technology, current transport problems and future transport plans, there were also some additional issues, which did not fit into any of the above categories. These additional results included concern over finding political consensus for CTS, the effects of the ageing population on travel demand characteristics, the ability of CTS to cope with peak demand at major public transport interchanges, visual impact of elevated structures (e.g. monorail), the conflict between CTS targeting the avoidance of walking and the benefits of walking, the necessity for a gradual introduction of CTS technology for user acceptance and that after more and more systems get automated, there might be a renaissance of personal service provision – possibly at a very high price.

5.3.2 Questionnaires

5.3.2.1 Methodology

In this section the results of the questionnaires for the criteria for the decision on CTS will be analysed. As mentioned before the questionnaire contained the following main aspects, which were further subdivided into four sub-points for the decision on CTS:

- **System Costs**
- **System Feasibility**
- **Equity Issues**
- **Safety / Security**
- **System Operation**
- **Passenger Comfort**
- **Environmental issues**
- **Urban Planning**
- **System Flexibility**
- **Existing Infrastructure**
- **Technology Experience**

Two different statistical analyses were carried out for the results of the questionnaires on the criteria for decision.

- **Global Analysis:** General analysis of all the results, without using the information on interviewee or user group involved given for each of the questionnaire.
- **User Groups Analysis:** taking into account the four user groups end-user, decision-maker (public application), operator (public application) and decision-maker/ operator combined (private application).

In case of the user groups analysis a more refined grouping is available but the limited number of interview data (42 responses were available for analysis) limited analysis of these 4 groups on the highest level.

The analysis of the results of the questionnaires was carried out in a way to answer the following questions:

- **What aspects seem to be most/ least important**
- **For each of these resulting aspects the priorities for the 4 sub-criteria**

The following statistical testing procedure to determine which aspects seem the to be the most/ least important was used:

① **For each interviewee sum the scores per aspect (summed scores)**

② **Use Friedman's two-way analysis of variance test to make sure that at least on aspect is more important than the others**

③ **Sum the 42 summed scores per aspect (total score)**

④ **Rank the aspects in ascending total score**

⑤ **With the sign test, test if one aspect that is higher in rank is significant more important than one other aspect.**

To determine the priorities for the 4 sub-criteria per aspect the same procedure as above is used, with the difference that ① can be omitted.

These steps are part of the global analysis (all 42 questionnaires). The analysis of the four different user groups goes in the same.

The Kruskal-Wallis analysis of ranks test can be used to determine if there exists at least one group that has different results than the others. If this appears not to be the case than we can assume that the results of the global analysis do not differ significantly from the results of the analysis per group.

5.3.2.2 Global Analysis

From the Friedman test, we can conclude that at least one aspect is more important than the others. The conclusion follows from the value of the test statistic, 54.639. The Friedman test statistic follows approximately a chi-square distribution. X^2 (alpha = 0.05) = 18.307. Thus at the significance level of alpha = 0.05, we reach the stated conclusion.

The following figure shows the rankings of the aspects for the global analysis and the analysis per user group.

Aspect	Ranking by Group				
	Global Analysis	**End User**	**Decision-maker**	**Operator**	**Decision-maker & Operator**
Safety / Security	1	2;3	1	4	1
Equity Issues	2	1	2	8	11
Urban Planning	3	2;3	3	10	9
System Flexibility	4	7	4	3	4;5
Technology Experience	5	6	6	5	4;5
Environmental Issues	6	5	5	11	10
Existing Infrastructure	7	4	8	6	3
System Costs	8	11	9	2	2
System Feasibility	9	9;10	10	1	8
System Operation	10	9;10	7	9	6;7
Passenger Comfort	11	8	11	7	6;7

Fig. 13: *Ranking Aspects Globally and per Group*

At the global level, the most important aspect was safety/ security. The second most-important aspect was equity Issues. A sign test was carried out on each pair of two in-rank following aspects to determine if the one highest in rank was more important than the other.

Using this approach, three clustering of aspects could be made. The first cluster contained the most important aspects, the third cluster the least important, and the second cluster the rest. This clustering is shown in the following figure.

Most Important	The rest	Least Important
Safety / Security Equity Issues	Environmental Issues Urban Planning System Flexibility Technology Experience	System Costs System Feasibility System Operation Passenger Comfort Existing Infrastructure

Fig. 14: Clustering of Aspects in Importance in Global Analysis

Because the number of interviews from the operator and decision-maker/ operator groups was significantly smaller (5 and 4, respectively), the results of these groups may be hidden by the results of the other two groups. For this reason, a second global analysis was carried out in which the original scores were averaged by user group, then tested using the Friedman test. The ranking did indeed change, as shown in the following figure. Safety/ security remained the most important aspect, with system flexibility and system cost moving up in rank to places 2 and 3, respectively.

Aspect	Global Ranking	
	Original Method	Using group Average Scores
Safety / Security	1	1
Equity Issues	2	4
Urban Planning	3	5;6
System Flexibility	4	2
Technology Experience	5	5;6
Environmental Issues	6	8; 9; 10
Existing Infrastructure	7	8; 9; 10
System Costs	8	3
System Feasibility	9	7
System Operation	10	11
Passenger Comfort	11	8; 9; 10

Fig. 15: *Ranking of Decision Criteria when Group Average Scores were used.*

To determine the priorities for the 4 sub-criteria per aspect, the Friedman test was applied to the global ranking (original method). For three aspects, system costs, equity issues and safety/ security there was no statistically significant difference among the scores of the 4 sub-criteria. For the rest of the aspects, a statistically significant difference manifested itself. The ranking for the sub-criteria is shown in the following figure.

Aspect	Criteria for Decision on CyberCars System	Ranking of Subcriteria
System Feasibility	- cost-effective investment	3
	- revenue to cover initial costs	4
	- revenue to cover maintenance and operation	2
	- high vehicle utilization (peak and off-peak)	1
System Operation	- minimum passenger waiting time for vehicle	2
	- minimum passenger in-vehicle travel time	4
	- use of off-line stops to minimise travel time	3
	- operated efficiently in all weather conditions (e.g. rain, snow, ice)	1
Passenger Comfort	- accommodation of bulky items	4
	- accommodation of wheelchair/ pushchair	1
	- design of the vehicle interior	3
	- design of the human-machine interface	2
Urban Planning	- integration with urban environment	1
	- accommodation of geometric requirements	3
	- decrease of capacity for private vehicle	2
	- increase of community severance	4
System Flexibility	- easy to respond to changes in patronage	2
	- easily expandable network	1
	- easy to change routes	3
	- use of products from different supplier for components	4
Existing Infrastructure	- utilize existing road infrastructure	2
	- utilize existing tunnels and bridges	3
	- requirements for new guide-way or track	4
	- integration with existing transport system	1
Technology Experience	- systems already implemented	3
	- reliability of the system proven	1
	- industry experience for the system	2
	- variety of suppliers for the system and components	4

Fig. 16: Ranking of Sub-criteria for Global Analysis

5.3.2.3 User Group Analysis

Application of the Kruskal Wallis test revealed that at least one of the four groups has higher scores than the other ones. Analogous to the global analysis, the aspects were clustered by groups. The following figure shows the cluster of aspects for the end users. In contrast to the Global analysis, End users placed safety/ security in the middle group.

Most Important	The rest	Least Important
Equity Issues	Safety / Security Environmental Issues Urban Planning Technology Experience Existing Infrastructure	System Costs System Feasibility System Operation Passenger Comfort System Flexibility

Fig. 17: *Cluster of Aspects in Importance for End Users*

To determine the priorities for the 4 sub-criteria per aspect, the Friedman test was applied. For five aspects, system costs, system feasibility, equity issues, safety/ security and environment issues, there was no statistically significant difference among the scores of the 4 sub-criteria. For the rest of the aspects, a statistically significant difference manifested itself. The ranking for the sub-criteria is shown in the following figure.

Aspect	Criteria for Decision on CyberCars System	Ranking of Subcriteria
System Operation	- minimum passenger waiting time for vehicle	2
	- minimum passenger in-vehicle travel time	4
	- use of off-line stops to minimise travel time	3
	- operated efficiently in all weather conditions (e.g. rain, snow, ice)	1
Passenger Comfort	- accommodation of bulky items	4
	- accommodation of wheelchair/ pushchair	1
	- design of the vehicle interior	3
	- design of the human-machine interface	2
Urban Planning	- integration with urban environment	2
	- accommodation of geometric requirements	3
	- decrease of capacity for private vehicle	1
	- increase of community severance	4
System Flexibility	- easy to respond to changes in patronage	2
	- easily expandable network	1
	- easy to change routes	3
	- use of products from different supplier for components	4
Existing Infrastructure	- utilize existing road infrastructure	1
	- utilize existing tunnels and bridges	3
	- requirements for new guide-way or track	4
	- integration with existing transport system	2
Technology Experience	- systems already implemented	3
	- reliability of the system proven	1
	- industry experience for the system	2
	- variety of suppliers for the system and components	4

Fig. 18: *Ranking of Sub-criteria for End Users*

The following figure shows the most and least important criteria for decision-makers. In addition to safety/ security and equity issues, urban planning belonged to the most important cluster.

Most Important	The rest	Least Important
Safety / Security Equity Issues Urban Planning	Environmental Issues System Operation System Flexibility Technology Experience Existing Infrastructure	System Costs System Feasibility Passenger Comfort

Fig. 19: *Cluster of Aspects in Importance for Decision-makers*

To determine the priorities for the 4 sub-criteria per aspect, the Friedman test was applied. For only one criterion, passenger comfort, there was a statistically significant difference among the scores of the 4 sub-criteria, resulting in the following ranking.

① **Accommodation of wheelchair, pushchair**
② **Design of the human-machine interface**
③ **Design of vehicle interior**
④ **Accommodation of bulky items**

5.4 Conclusion of Structured Interviews

The structured interview activities were targeted at all user groups and sub-groups not covered through the focus group activities, which focused on the end-user with general needs. Therefore the structured interviews aimed at investigating user requirements and perceptions of CTS from end-user with special needs, decision-maker (public application), operator (public application) and decision-maker/ operator combined (private application). The interviews analysed the awareness of CTS technology, the interviewee's comments on it, their current transport problems and future transport plans and if CTS technology has the potential to be a solution for these issues.

The responses on the awareness of CTS were very mixed with interviewees from the Netherlands having used the Schiphol or Rivium system and interviewees, who are professionally involved with transport, being aware of this technology. Many also mentioned related technology, including LRT, airport people mover and general telematics systems. Transport problems mentioned, as observed before in the focus group activities, concentrated on private car usage, the condition of the existing road network and the level of service of the public transport network. CTS technology could be envisaged being a solution to some of these problems, but only being implemented in addition to existing modes and in a small scale.

Future plans and developments in view of transport include various measures to tackle the problems mentioned above. CTS could be envisaged as complementary to these measures. But as also observed before in context of the focus groups there was much concern about operating CTS in shared environments. All envisaged applications were in contained areas, using dedicated infrastructure or tracks. Operators were worried about the operational risk of implementing a technology, with which only little experience exists and decision makers were concerned about the added value of CTS, of where CTS would fit in into overall transport policy and of finding political consensus for a novel system.

The results from the structured interviews strengthened the impression that, despite a trust in technology, an automated system operating in a shared environment seems too far from existing systems. This shows, that when planning to implement CTS, especially when trying it on a larger scale, a very strong case has to be built to present clear benefits and added value of the system to everyone involved in the process of decision-making, implementing, operating and using the system.

6 CONCLUSION

In order to obtain user requirements and perception of all user groups involved in the use, implementation, operation, planning and decision-making progress for CTS on various level a literature review on related systems in view of system characteristics and user requirements, focus groups and structured interviews were carried out. In the following the results of these three activities for the user needs analysis will be summarised. Based on the results of all three activities concluding remarks will be developed summing up the results of the analysis and will investigate the implications of the analysis for further activities in the CyberCars and CyberMove projects.

The following figure gives a summary of the results of the literature review on existing systems relating to CTS technology in terms of system characteristics and user requirements. The systems considered for the review were automated transport systems, including personal and mass transport systems, demand-responsive transport and car sharing/ car pooling. The user groups for which user requirements were reviewed were end-user, decision-maker and operator.

Automated Transport Systems		Demand Responsive	Car Sharing/ Pooling
PRT	**APM**		
Small autonomous vehicle Driverless On a guide-way Minimal headways Public transport	Large vehicles Driverless On a guide-way Public or private	Uses existing roads Beneficial for low-demand Public transport	Uses existing roads Include private cars Easy to establish

Systems		User Groups		
		End-user	**Decision-maker**	**Operator**
Automated Transport	**PRT**	Rapid response Privacy/ status PT integration	Environmental benefits Attractive Minimum adverse impacts Benefit to Area	Reliable Cost effective Start-up aid
	APM	Cheap Reliable	Low visual intrusion Safe Quiet	Reliable Cost-effective
Demand Responsive		Extended coverage Ease of booking Reliability Minimal transfers Minimal cost	Cooperate cross boundary PT integration Target specific sectors (e.g. low demand, elderly)	Minimise dead running Technical support PT integration Ability to expand
Car Sharing/ Pooling		Vehicle availability Traffic mitigation Environmental benefits	Cost-effective	Sufficient vehicles Start-up aid Extended opening hours

Fig. 20: Summary of Results from the Literature Review

The following figure gives a summary of the results from the focus group activities carried out.

Topic Category			Summary of Results
Present urban transport issues	**General issues**		Badly maintained and highly congested road network Car convenient, express personality and status symbol Environment issue of cars do no influence mode choice Unreliable, inflexible and overcrowded PT system Walking and cycling problematic in urban areas
	Location-related issues		Problems with parking reserved for events (Antibes) Illogical, chaotic, busy dangerous network (Amersfoort) Congestion increased by new development (So'ton) Parking and access problems on campus (Haifa)
User perception/ requirements for the short-term scenario	**General Perception**		Positive and negative aspects of low speed Concern about losing the control over the system Trust in technology but not mixed with other traffic Concern about automation leading to unemployment Conflict of Health benefits of walking and CTS
	Operation Issues	**System**	Suitable for short distances and targeted applications Concern about insufficient space for separate tracks High service frequency or on-demand operation Short waiting times, careful network design Access control systems to prevent overcrowding Conflict of child-proof but social-inclusive system
		Vehicle	Vehicle size to depend on demand characteristics Use of environmentally friendly vehicles (e.g. ZEV) For safety reasons vehicle speeds to be below 80 km/hr Space for wheelchair, pushchair, luggage, bulky items Design like mini-van or existing shuttles Vandalism proof interior for public applications Heating, air-condition, clean interior, powerful engine
		Safety	Higher level of safety then manually driven systems Emergency stop, system override and door opening Passengers to be seated, wearing safety belts Alternative manual system for emergencies
		Security	Concern about personal security, especially at nights CCTV, phone links to staffed centre, transparency
		Access	Access to vehicles (low-floor, ramp, large sliding door) Access to system (integrated with PT, low costs)
		Payment	System for free or hidden cost for private applications Use of credit cards or SmartCard technology Alternative payment modalities for infrequent users
		Features	Multi-media systems for information and entertainment Swivel chairs for group travel, warning for obstacles
	Possible applications		Only using dedicated infrastructure in contained areas
User perception/ requirements for the long-term scenario	**General issues**		Concern about CTS congestion and replacing the car Implementation on governmental level, standardisation
	Operation Issues	**System**	Concern about cost, who is targeted user, very futuristic
		Vehicle	Has to provide clear advantages compared to PT, car
		Safety	Concern about safety in case of elevated structures
		Security	Concern about personal security on elevated structures
		Access	→ See short-term scenario
		Payment	Sharing a vehicle acceptable if it decreases the fare
		Features	→ See short-term scenario
	Possible applications		Inter-urban traffic, high-speed rail-links, feeder to PT Historic city centres, connection to suburbs
Additional Results			CTS to meet higher standards for car-owners Cyclists need more compelling arguments Image problems of CTS for young age-group Mixed view on technology/ safety in view of age-groups

Fig. 21: Summary of Results from the Focus Group

The following figure gives a summary of the results from the structured interviews carried out.

Issues	User Groups			
	End-user	**Decision-maker**	**Operator**	**Decision-maker & Operator**
Awareness of CTS Technology	Mixed, especially interviewees in the Netherlands and interviewees working in very transport related areas were aware of existing and closely related systems. Systems mentioned included airport people mover, LRT schemes, guided bus-ways and on-board in-vehicle telematics systems (e.g. guidance, collision avoidance, autonomous driving, etc.)			
Comment on CTS Technology	Potential for meeting special needs Provide convenient access to facilities Concern about CTS in private car society Concern about CTS in mixed traffic	Potential for targeted applications only Favouring application in contained area Concern about CTS in mixed traffic, user acceptance, funding, experience with and reliability of CTS	Doubtful about level of technology for economic operation Implementing CTS would be a risk for them without more experience with the technology	Potential for site-specific problems Main advantage of CTS is the lower labour costs
Current Transport Problems	Existing PT system (access, flexibility) Private car usage (congestion, parking and pollution)	Conflict between the private car society, low image of PT, insufficient PT service and negative effects of car usage	Implications of ageing population on demand Growth in desire for mobility Parking, congestion, rigid PT network	Location of buildings, facilities and desire to restrict car access, result in long walking distances Concern about labour cost for shuttle
Future Transport Plans	More emphasis on walking/ cycling PT more convenient and comfortable Improve road network maintenance/capacity CTS potential as a feeder to PT Concerned about the funding for CTS	New and improved PT services Park&Ride schemes Integrated transport policy Real-time PT info Use of SmartCard for PT integration CTS potential as a feeder to PT, shuttle for connection to P&R	CTS needs to be tested for reliability and safety CTS potential as a feeder to PT for public applications and as the sole mode for private application	Upgrade to a high-speed rail link for a flower auction in the Netherlands A new airport people mover system for the planned extension of the London/Heathrow airport. A new cable-car solution for transport in Haifa Plans for a shuttle service for an archaeological park in Israel
Additional Results	Concern over finding political consensus for the implementation of CTS, the effects of an ageing population on travel demand patterns, the ability of CTS to cope with peak demand, the conflict between CTS trying to avoid walking and the benefits of walking, the necessity of a gradual introduction of CTS for user acceptance and a possible renaissance of personal service.			

Fig. 22: Summary of Results from the Structured Interviews

The literature review investigated system operation characteristics and user requirements and perceptions in context of systems relating to CTS technology. One of the main results was, that there were gaps in the literature for user needs analyses for these systems. In most cases only list with issues, which were envisaged to be important for certain user characteristics were compiled, instead of carrying out market research on specific systems, to investigate the user requirements of all user groups involved in the decision making process, the implementation, the operation and the use of a particular system.

The focus groups activities were aiming at obtaining responses from the user group end-user with general needs on current urban transport issues and on CTS technology in view of the short-term and the long-term scenario, as presented in the material. One important issue, which was nearly uniformly mentioned by all group characteristics covered with this activity, was the inability of imagining CTS operating efficiently in a shared environment with manually driven vehicles, cyclists or pedestrians, despite a trust in the technology involved in the system operation.

The structured interviews were carried out to obtain responses on user requirements for all user groups not covered with the focus group activities. Again, in this activity, as observed in the focus group activities, the inability of imagining CTS in a shared environment became very apparent. Most interviewees acknowledged the potential of CTS technology for alleviating some of the current problems of urban transport, but imagined various operational, political and institutional barriers for the actual implementation of CTS on a larger scale than the presented airport parking and business park connection examples.

The various activities carried out in context with the user needs analysis for CTS showed a discrepancy between responses on a theoretical subject and on opinions on systems people have personal experience with. Therefore the universally mentioned concern about CTS in a shared environment has to be seen in context with the fact that a system like that does not exist yet, with the Shiphol and Rivium systems being the closest operating systems to it, and therefore no group participant or interviewee having personal experience with it. This main issue can therefore change substantially with growing experience and exploitation of the technology.

ANNEX A: SUMMARY OF FOCUS GROUP RESULTS BY PARTNER

Partner	CRF	**CyberCars WP1 T1.1**
Country	Italy	**User Needs Analysis**
No. of groups	5	**Focus Group Activity**

Focus Group No.	**Age group**				**Gender**			**Car-ownership**		
	20-35	**35-50**	**50-65**	**mixed**	**male**	**female**	**mixed**	**yes**	**no**	**mixed**
1	×					×				×
2	×				×			×		
3	×				×			×		
4			×		×			×		
5			×		×			×		

Topic Category			*Summary of Results*
Present urban transport issues	*General issues*		Problems with public transport, including, insufficient bus-network, vehicles crowded and no space for bulky items, low service frequency, insufficient co-ordination at interchanges, quality/ cleanliness of interior (e.g. seats). Therefore the private car is more convenient, but advantage of PT is time for personal activities.
	Location-related issues		Problems with public transport facilities, such as ticket machines (not enough and poor maintenance) and bus stops (insufficient provisions of static information on timetables and connection and dynamic information on real-time arrivals.
User perception/ requirements for the short-term scenario	*General issues*		-
	Operation Issues	*System*	Only suitable for very short distances and on a dedicated lane or using an elevated structure (e.g. monorail). But concern about space available in urban areas for dedicated lanes. Furthermore vehicle speeds seem to be too low for an efficient operation.
		Vehicle	The vehicles should provide more space for passenger (20-25 people would be more suitable). And there should be a high number of vehicles operating at high frequency on designated routes
		Safety	Concern about automated vehicles on normal roads shared with car traffic and/ or pedestrians, in view of obstacle avoidance.
		Security	There should be a CCTV system in the vehicle to avoid vandalism and for emergency situations. Furthermore there should be a phone link with the operation centre.
		Access	Use of low-floor vehicles to enable easy and safe access for elderly, disabled, people with luggage, wheelchairs and pushchairs.
		Payment	Payment should be done with usual public transport tickets. High frequency operation is preferred to on-demand operation.
		Features	There should be a phone for access to the operation centre and a display showing the next stop and position of the vehicle on the route.
	Possible applications		CTS could be used as a public transport mode for short distances in a controlled area (e.g. airport, stadium, etc.)
User perception/ requirements for the long-term scenario	*General issues*		-
	Operation Issues	*System*	Systems perceived as somewhere between a taxi and a mini-shuttle. Considered to be more suitable for special application (e.g. business travel), as envisaged as being more expensive then an ordinary taxi, and having the additional advantage of not being picked up at the trip-origin.
		Vehicle	Most important is cost and speed. The fare for using CTS should be only little higher then the cost of fuel for using the private car for the same trip. And CTS has to be faster then ordinary public transport modes (e.g. buses).
		Safety	→ See short-term scenario
		Security	→ See short-term scenario
		Access	-
		Payment	Sharing a vehicle would be acceptable, if this would decrease the fare. Ordering the vehicle was envisaged, using phone/ Internet and the payment by credit card or SmartCard (magnetic card that stores your identity and credit). But alternative ways of payment (e.g. single trip or season ticket) also have to be provided.
		Features	Additional features included separate vehicles for smoker/ non-smoker, spacious trunk for luggage/ bulky items, TV, Internet, air conditioning and online guide for tourists and general travellers.
	Possible applications		-
Additional issues			-
Issues relating to user characteristics			No big differences between age groups, except attitude towards the absence of a driver. Young people were more sceptical and concerned about safety/ security issues.

Fig. A1: Summary of Focus Group Results by Partner (CRF, Italy)

Partner	DITS	**CyberCars WP1 T1.1 User Needs Analysis Focus Group Activity**
Country	Italy	
No. of groups	1	

Focus Group No.	Age group				Gender			Car-ownership		
	20-35	35-50	50-65	mixed	male	female	mixed	yes	no	mixed
1	×						×			×

Topic Category			*Summary of Results*
Present urban transport issues	*General issues*		The existing public transport network requires a lot of interchanges between modes and/ or services, resulting in walking and waiting time.
	Location-related issues		The main problems with public transport are overcrowding, low frequency and no services in peripheral areas. Therefore many people (especially young male) prefer the use of mopeds, as they are faster then public transport, easy to park and they can be used in limited traffic areas, but higher cost then PT.
User perception/ requirements for the short-term scenario	*General issues*		It was difficult to imagine the use of CTS within general traffic and there were no obvious benefits, other then environmental issues (zero emission).
	Operation Issues	*System*	There were doubts on the possibility to operate CTS within existing busy traffic in Rome.
		Vehicle	Though the appearance of the vehicles and the fact that they are zero emission is appreciated, they seemed to be too slow and too small.
		Safety	CTS has to be safer then manually driven vehicles. Passengers should be able to operate the vehicle manually in emergencies (at least emergency stop and door opening device). But safety perception might change when getting used to automated systems.
		Security	There should be a CCTV system.
		Access	This must be accessible to mobility-impaired
		Payment	The preferred payment method is an integrated ticket (including all other public transport modes and/ or operators). But other payment modalities, as credit card, cash, pre-paid trips have to be accommodated if a distance fare is implemented.
		Features	Additional features included music on board and a digital city map for route planning.
	Possible applications		The most suitable application for CTS would be as public transport in peripheral areas.
User perception/ requirements for the long-term scenario	*General issues*		CTS was not accepted as an individual door-to-door transport, as congestion level are so high, that there would not be enough space for the operation and parking of CTS vehicles.
	Operation Issues	*System*	Implementation seemed to be impossible, due insufficient space for elevated (e.g. mono-rail) infrastructure.
		Vehicle	→ See short-term scenario
		Safety	→ See short-term scenario
		Security	→ See short-term scenario
		Access	→ See short-term scenario
		Payment	→ See short-term scenario
		Features	→ See short-term scenario
	Possible applications		-
Additional issues			If CTS would replace existing public transport, it would result in drivers getting unemployed. Furthermore people like their car and feel dependent on it, though they are aware of the negative effects, as congestion and pollution.
Issues relating to user characteristics			-

Fig. A2: Summary of Focus Group Results by Partner (DITS, Italy)

Partner	INRIA	**CyberCars WP1 T1.1** **User Needs Analysis** **Focus Group Activity**
Country	France	
No. of groups	2	

Focus Group No.	**Age group**				**Gender**			**Car-ownership**		
	20-35	**35-50**	**50-65**	**mixed**	**male**	**female**	**mixed**	**yes**	**no**	**mixed**
1				×			×	×		
2				×	×			×		

Topic Category			*Summary of Results*
Present urban transport issues	*General issues*		The cape situation of the historical city and the difference between low and high season results in problems for parking, general traffic and public transport. The general trend is to restrict the use of private vehicles.
	Location-related issues		Parking is a big problem, as public space is very rare and a third of the year used for various events (markets, exhibitions, concerts, etc.), so that city centre parking spaces are occupied 120 days a year, without a replacement solution. There are unused parking spaces at a distance of 1 km.
User perception/ requirements for the short-term scenario	*General issues*		Doubts and difficulties in imagining an intermediate solution to implement CyberCars technology, compared to a totally protected site.
	Operation Issues	*System*	Flexibility of the system to adapt to low/ high capacity and special events would be a key factor for success. Therefore high flexibility, high capacity and route planning flexibility. The system should be on-demand and door-to-door.
		Vehicle	Zero emission and low noise level are important.
		Safety	Safety is the most important factor for the implementation and success of CTS.
		Security	There are concerns about vandalism.
		Access	The system should be accessible to disabled.
		Payment	There should be an integrated payment system with parking and other modes and/ or services of public transport.
		Features	-
	Possible applications		A possible application would be a flexible CTS scheme – in terms of capacity, network and timing (year, day, hour) – linking the historical city centre to external parking areas.
User perception/ requirements for the long-term scenario	*General issues*		The CTS technology would not be adaptable to the architecture of the site.
	Operation Issues	*System*	→ See short-term scenario
		Vehicle	→ See short-term scenario
		Safety	→ See short-term scenario
		Security	→ See short-term scenario
		Access	→ See short-term scenario
		Payment	→ See short-term scenario
		Features	→ See short-term scenario
	Possible applications		Inter-urban traffic.
Additional issues			-
Issues relating to user characteristics			-

Fig. A3: Summary of Focus Group Results by Partner (INRIA, France)

Partner	ISR	**CyberCars WP1 T1.1 User Needs Analysis Focus Group Activity**
Country	Portugal	
No. of groups	4	

Focus Group No.	Age group				Gender			Car-ownership		
	20-35	35-50	50-65	mixed	male	female	mixed	yes	no	mixed
1	×						×			×
2	×						×			×
3	×				×					×
4				×			×			×

Topic Category			Summary of Results
Present urban transport issues	*General issues*		Private car: convenience, flexibility, but parking problems. Bus: unreliable, few dedicated lanes, old vehicles, but cheap. Train: for long trips, punctuality and information important, insecurity at night. Taxi: most expensive, but convenient with luggage. Metro: fast, frequent, on time, but expensive to build. Cycling/ walking: walking not always practical, dedicated cycle lanes important, terrain not to be too hilly.
	Location-related issues		-
User perception/ requirements for the short-term scenario	*General issues*		Low vehicle speeds were perceived as positive (safety) and negative (travel time). Reactions were mixed, envisaging CTS to replace or complement buses.
	Operation Issues	*System*	CTS could not be imagined in mixed traffic, but a solution with dedicated lanes was also seen as a limitation to the system. High service frequency would be important.
		Vehicle	Perceived environmental benefits. For safety reason no vehicle speeds above 80 km/hr. Comfortable vehicles. High visibility and natural lights. Space for luggage.
		Safety	Concern about crossings, pedestrian/ passenger safety, emergencies and interaction with other vehicles and drivers. All passengers to sit in the vehicle for safety reason. Safety belts for passengers. Emergency brake and passenger communication with central system.
		Security	Use of CCTV to prevent vandalism and as proof in case of accidents. Vehicle should direct themselves automatically to the hospital in case of medical emergencies.
		Access	Access control system to avoid overcrowding of vehicles. Easy access for elderly/ disabled, wheelchairs and pushchairs.
		Payment	Tickets should be priced in the same range as other modes of public transport.
		Features	Additional features include recharge systems on downhill sections, music/ video/ interactive screen, air conditioning, loud noise on approaching obstacle, rail infrastructure and a guard watching the vehicles.
	Possible applications		Diverging comments on applicability of CTS to urban environments.
User perception/ requirements for the long-term scenario	*General issues*		-
	Operation Issues	*System*	System seemed too expensive to be implemented economically efficient. Diverging comments on acceptance of the car sharing idea. Concern about visual impact of monorail infrastructure and about loosing the private car. Vehicles located on central base, called by mobile phones and park automatically.
		Vehicle	Differently sized vehicles should be available (e.g. for 1,5 and 20 passenger).
		Safety	-
		Security	-
		Access	-
		Payment	-
		Features	The vehicles should have an on-board coffee machine.
	Possible applications		-
Additional issues			Technology might be more suitable for freight transport.
Issues relating to user characteristics			-

Fig. A4: Summary of Focus Group Results by Partner (ISR, Portugal)

Partner	TNO	**CyberCars WP1 T1.1**
Country	The Netherlands	**User Needs Analysis**
No. of groups	4	**Focus Group Activity**

Focus Group No.	**Age group**				**Gender**			**Car-ownership**		
	20-35	**35-50**	**50-65**	**mixed**	**male**	**female**	**mixed**	**yes**	**no**	**mixed**
1		×	×				×	×		
2	×						×	×		
3		×	×				×		×	
4	×						×		×	

Topic Category			*Summary of Results*
Present urban transport issues	*General issues*		-
	Location-related issues		Traffic in Amersfoort described as illogical, chaotic, busy and dangerous. Buses described as unreliable and the network as insufficient. New ring road, bus lanes in the city centre and car-free city centre have improved (but not sufficiently) urban traffic conditions.
User perception/ requirements for the short-term scenario	*General issues*		-
	Operation Issues	*System*	Availability: on-demand, using mobile phones, less then 5min waiting time, use of more then one line and stops not too far apart. Fine-tuned: short waiting time, short distances between stops and careful network design.
		Vehicle	Comfort/ service: space for 6 to 10 passenger, luggage and wheelchairs/ pushchairs. Seats are necessary. Appearance: the vehicles should look like mini-vans or existing shuttles, preferably no strange shapes or forms. Vandalism: vandalism-proof and minimum interior for public applications.
		Safety	Concern about safety in case of mixed traffic, especially as traffic was perceived to become even less safe in the future. And use of a monorail infrastructure also created worries.
		Security	Use of CCTV and emergency break button, as concern about no observer in case of automated transport. Bigger vehicles, transparency and doors on one side of the vehicle can create a safer environment.
		Access	Doors in the middle of the vehicle and low entering to provide easy access for elderly and disabled.
		Payment	Payment by bus/ tram card or by pin (electronic payment).
		Features	Additional features include screens for films, advertisements and route description and use of GPS systems for vehicle locating.
	Possible applications		The focus should be on single connections (e.g. from a business park to the city centre or connections between suburbs).
User perception/ requirements for the long-term scenario	*General issues*		→ See short-term scenario
	Operation Issues	*System*	→ See short-term scenario
		Vehicle	→ See short-term scenario
		Safety	→ See short-term scenario
		Security	→ See short-term scenario
		Access	→ See short-term scenario
		Payment	→ See short-term scenario
		Features	→ See short-term scenario
	Possible applications		→ See short-term scenario
Additional issues			Speed: travel speeds should be ~30 km/hr (maximum 50 km/hr), if speeds are lower, travel times are to high and if speeds are higher, there are safety concerns. Environment: electric cars are environmentally friendly, but concern about visual impact of monorail infrastructure.
Issues relating to user characteristics			Respondents who own/ use a car, look at CTS from a different perspective: CTS has to meet higher standards to be considered an attractive alternative. Cyclists in urban traffic think that they have taken an important step with respect to an environmentally friendly approach to transport and will have to be convinced by more compelling arguments than the motorist who is not only confronted with problems in accessibility and parking, but is also aware that he is not the most ecologically sound or socially conscious road user. For the youngest members of the focus groups, CTS also seems to have an image problem.

Fig. A5: Summary of Focus Group Results by Partner (TNO, the Netherlands)

Partner	TRG	CyberCars WP1 T1.1
Country	UK	User Needs Analysis
No. of groups	4	Focus Group Activity

Focus Group No.	Age group				Gender			Car-ownership		
	20-35	35-50	50-65	mixed	male	female	mixed	yes	no	mixed
1	×						×	×		
2	×						×		×	
3		×					×		×	
4			×				×			×

Topic Category			*Summary of Results*
Present urban transport issues	*General issues*		Good communication/ information to familiarise public with CTS is important. High level of car usage due to convenience, but driving can also be a stressful experience. Problems with congestion and parking, especially in city centres.
	Location-related issues		The traffic situation in the city centre is described as very problematic due to congestion. Bus services are perceived to be unreliable, using old and uncomfortable vehicles and providing insufficient services and routes/ network.
User perception/ requirements for the short-term scenario	*General issues*		Fear of not being in control, but technology perceived to be safer as driver, though the driver provides a reassuring presence for passenger. Worries about unemployment through automated operation. Concern about costs of implementing CTS. Worries about speed: too low (travel time) too high (safety).
	Operation Issues	*System*	Quick respond time and well-monitored service to match supply and demand. Concern about overcrowding of vehicles, therefore the number of passenger has to be regulated. The operation system must be childproof, but still be usable by children.
		Vehicle	Basic interior, due to fear of vandalism. Air conditioning and heating. Sufficient seating (especially for elderly). Space for luggage, wheelchair, pushchair. Provide clean vehicle, therefore vehicle to be cleaned between trips.
		Safety	Concern about CTS in mixed traffic therefore to ensure safety vehicles have to use dedicated track or infrastructure. An alternative (manually operated) means of transport in case of system breakdowns has to be provided.
		Security	Concern about personal safety, due to the driverless aspect. Emergency system override function, emergency stop button and a communication system between passengers and the central control have to be provided. CCTV to monitor vehicles and infrastructure.
		Access	Access to vehicle: Use of ramps and large sliding doors to enable easy access for elderly/ disabled, wheelchairs and pushchairs. Access to system: integration of CTS with other modes/ services of public transport.
		Payment	It was assumed that in case of shuttle applications the service has to be free. Suggestions for payment systems included tokens, season passes and SmartCard technology. But there was concern that without supervision people would abuse the system.
		Features	Additional features for CTS vehicles included music, TV, PC, Internet-access, screen for films/ advertisements/ news/ tourism information/ route planning, game consoles, swivel chairs for groups travelling together and a coffee machine.
	Possible applications		Possible applications for CTS included shopping areas/ centres, theme parks, airports, business parks, park and ride systems and freight transport applications (e.g. in a port). All applications reflected the view that CTS should be used only in contained areas.
User perception/ requirements for the long-term scenario	*General issues*		General traffic would have to be restricted. Needs to be implemented on governmental level. Standardisation would be crucial to connect systems in different cities (e.g. through high speed rail). Used mainly by commuters. Seemed too futuristic.
	Operation Issues	*System*	Sufficient supply and demand. Minimum travel times. Minimum waiting time for vehicle. Wide range of coverage. Most suitable for elderly/ disabled, but they would need special reassurance and encouragement to use the system. Concern about CTS vehicle congestion.
		Vehicle	In case of owned vehicles choice (e.g. size of the vehicle), features and the ability to express ones individuality were very important. Good quality of journey, smooth and quiet ride. Some concerns about not being seen by pedestrians in shared environments.
		Safety	→ See short-term scenario, additionally: airbags, ABS, seat belts, side impact protection.
		Security	→ See short-term scenario
		Access	→ See short-term scenario
		Payment	→ See short-term scenario
		Features	→ See short-term scenario
	Possible applications		Possible applications of CTS included (historic) city centre and feeder to other modes/ services of public transport, but only without interaction with other traffic, e.g. contained area, restricted vehicle access or dedicated CTS vehicle lane.
Additional issues			In addition to the requirements mentioned above, CTS technology to be implemented has to offer very clear benefits for the end user and needs to provide a high level of service above existing modes of public transport to be accepted.
Issues relating to user characteristics			Age group 50-65: concerned with cost and difficulties in implementing a system. Environmentally aware. Age group 35-40: more worried about concept and technology. Age group 20-35: least concerns about technology, but low expectation of governmental support for CTS.

Fig. A6: Summary of Focus Group Results by Partner (TRG, UK)

Partner	TRI	**CyberCars WP1 T1.1** **User Needs Analysis** **Focus Group Activity**
Country	Israel	
No. of groups	3	

Focus Group No.	**Age group**				**Gender**			**Car-ownership**		
	20-35	**35-50**	**50-65**	**mixed**	**male**	**female**	**mixed**	**yes**	**no**	**mixed**
1				×			×			×
2				×			×			×
3				×			×			×

Topic Category			*Summary of Results*
Present urban transport issues	*General issues*		Congestion, poor transit accessibility, environment and energy.
	Location-related issues		Parking problems, limited car access to the campus, hilly area and long walking distances.
User perception/ requirements for the short-term scenario	*General issues*		Positive reaction. Belief in technical feasibility, but conflict with benefits of walking on campus.
	Operation Issues	*System*	The system should be extended to a network, instead of only a single line. A door-to-door operation would be preferred to an operation only between fixed stations.
		Vehicle	Acceleration might be problematic due to hilliness of the area.
		Safety	Use of an obstacle avoidance system is necessary. Interaction with pedestrians is problematic.
		Security	Concern about possible vandalism.
		Access	-
		Payment	In case of a campus application the system has to be free for the end user, funded through the university. For public application the fare should not be above fares of other modes/ services of public transport.
		Features	Air conditioning.
	Possible applications		A CyberCars system could be useful for connections between other modes/ services of public transport.
User perception/ requirements for the long-term scenario	*General issues*		Perceived as being similar to a bus-way network. The benefits of this system are not clear enough.
	Operation Issues	*System*	The system seems to be too futuristic.
		Vehicle	-
		Safety	Concerns about operation on the monorail in terms of safety.
		Security	Worries about potential accidents when the vehicles accesses the monorail.
		Access	-
		Payment	-
		Features	-
	Possible applications		Could be a solution to congestion in city centres and could provide faster access from suburbs.
Additional issues			-
Issues relating to user characteristics			-

Fig. A7: Summary of Focus Group Results by Partner (TRI, Israel)

ANNEX B: SUMMARY OF STRUCTURED INTERVIEW RESULTS BY PARTNER

Partner	A&E	**CyberCars WP1 T1.1**
Country	Switzerland	**User Needs Analysis**
No. of interviews	4	**Structured Interviews**

User Group					**Interviewee**
End-user	*Potential User*	*Special Needs*	*E&D*		
			Motorists	✓	Head of Politic and Economic Department – TCS Touring Club Suisse
			Cyclists		
			PT User		
		General Needs		→	Covered through Focus Groups
	Non-user	*Residents*			
		Shops& Businesses			
Decision maker (public)	*Non-elected*	*National Level*			
		Regional Level			
		Local Level			
	Elected	*Regional Level*			
		Local Level		✓	Mayor of the City of Geneva/ Vernier
Operator (public)	*Public Transport Operator*			✓	Marketing and Policy Manager of Geneva Public Transport
	General Service Provider			✓	Transport Planning Manger – Geneva Office of Transport and Circulation (OTC)
Decision maker& Operator (private)	*Airport*				
	Theme Park				
	Large Business				
	University Campus				

Interviewee: Touring Club Suisse TCS	**Summary of Results**
Awareness of CyberCars Technology	Aware of various projects related to CTS technology all over the world, especially in Switzerland.
Comments/ Views on CyberCars Technology	Trusts that the level of technology is sufficient, thinks CTS technology will be the future.
Current Problems in View of Transport	Concern about mixed traffic with cars, political problems and conflict between individual and collective transport.
Future Plans in View of Transport	Projects to increase capacity of the road network and building of new roads.
Additional Results	CTS not suitable for rural areas, only for city centres, business parks, airport or exhibition centres.

Interviewee: Mayor of the City of Geneva/ Vernier	**Summary of Results**
Awareness of CyberCars Technology	Not aware of automated transport, but different urban mobility systems (car sharing) and electric cars/ fuel cells.
Comments/ Views on CyberCars Technology	Concern about mixing with other traffic and law issues. Only suitable for contained areas (e.g. airport, exhibition).
Current Problems in View of Transport	Too early to implement automated transport systems in view of user acceptance. Might be frightening for elderly.
Future Plans in View of Transport	-
Additional Results	System might be too futuristic. It has to be tested and approved first

Interviewee: Geneva Public Transport	**Summary of Results**
Awareness of CyberCars Technology	Aware of various related systems.
Comments/ Views on CyberCars Technology	Trust in the technology, but they need to be complimentary to existing PT systems, not replacing them.
Current Problems in View of Transport	Concern about the use of CTS in mixed traffic and operational issues, e.g. steep topography.
Future Plans in View of Transport	Increase of the PT network on a more regional level using train, tram and bus systems.
Additional Results	CTS technology should be implemented soon, not costs or technology are the problems, but political issues.

Interviewee: Office of Transport and Circulation	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS technology, but mentioned airport people mover and knows the Schiphol system.
Comments/ Views on CyberCars Technology	CTS has the potential to make public transport more convenient, by providing higher service frequency and decrease system operating cost through saving labour costs due to the automated operation.
Current Problems in View of Transport	In the past many developments were carried out in view of accessibility by private car, e.g. a city motorway and industrial estates in rural area. Access by public transport is often very problematic, but CTS might be a solution.
Future Plans in View of Transport	Provide PT links to new residential areas and industrial estates, not serviced by PT yet.
Additional Results	CTS would be successful, if used as a feeder system to the existing public transport network.

Fig. B1: Summary of Structured Interview Results by Partner (A&E, Switzerland)

Partner	DITS	**CyberCars WP1 T1.1** **User Needs Analysis** **Structured Interviews**
Country	Italy	
No. of interviews	3	

User Group					**Interviewee**
End-user	*Potential User*	*Special Needs*	*E&D*		
			Motorists		
			Cyclists		
			PT User		
		General Needs		→	Covered through Focus Groups
	Non-user	*Residents*			
		Shops& Businesses			
Decision maker (public)	*Non-elected*	*National Level*			
		Regional Level			
		Local Level		✓	Municipality of Rome – Mobility Department
	Elected	*Regional Level*			
		Local Level			
Operator (public)	*Public Transport Operator*			✓	ATAC SpA – Agency for Public Mobility Services in Rome
	General Service Provider			✓	STA – Societa Transporti Automobilistici
Decision maker& Operator (private)	*Airport*				
	Theme Park				
	Large Business				
	University Campus				

Interviewee: Municipality of Rome	**Summary of Results**
Awareness of CyberCars Technology	Aware of it through involvement in test site, but knows more about the short-term, then the long-term scenario.
Comments/ Views on CyberCars Technology	Solution for specific problems (feeder to PT). Administrative difficulties to manage system. Doubts about use as individual transport system. Experiments necessary to prove functionality and reliability of the system.
Current Problems in View of Transport	Public transport network insufficient, therefore high use of private car leading to congestion/ pollution. Rome's cultural/ archaeological heritage limits the building of subways and the space available for parking or bus lanes.
Future Plans in View of Transport	New national law requiring company mobility manager for company >500 employees. Investigation of new mobility tools (car sharing/ pooling). Use of CTS possible for these applications or for future transport corridors.
Additional Results	Concern over finding political consensus for a new transport system, and effects of the ageing population.

Interviewee: ATAC SpA	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS technology.
Comments/ Views on CyberCars Technology	For sustainable urban mobility shift from private to public and from individual to collective is necessary. If CTS is implemented as individual door-to-door transport it would still create congestion. Therefore CTS as feeder to PT in city centres and as on-demand door-to-door system in low-density peripheral areas.
Current Problems in View of Transport	An ageing population and growth in mobility demand. CTS can be a solution but only on a full scale.
Future Plans in View of Transport	Testing and evaluating CTS to demonstrate the ability to solve particular transport problems necessary.
Additional Results	CTS system capacity not sufficient for peak demand at public transport interchanges.

Interviewee: STA	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS technology, but aware of automated subway systems, e.g. a system planned for Turin.
Comments/ Views on CyberCars Technology	Attractive system, but not feasible for Rome (congestion/ dispersion). Collective systems would be more suitable. Point-to-point rather then door-to-door. Also consider car sharing/ pooling. Protected site more appropriate.
Current Problems in View of Transport	Rigid PT system due to demand characteristics and political issues. Tendency towards less heavy vehicles.
Future Plans in View of Transport	CTS integration with PT network possible. Complimentary in public application. Private applications (e.g. hospital, university, market, parking, exhibition) to cover 'last mile', especially in view of ageing population. Start the implementation in a small scale and extend it later to a whole network, if it proves to be successful.
Additional Results	A monorail solution (RUF example) would not be suitable for Rome. Collective private systems more appropriate.

Fig. B2: Summary of Structured Interview Results by Partner (DITS, Italy)

Partner	INRIA	**CyberCars WP1 T1.1** **User Needs Analysis** **Structured Interviews**
Country	France	
No. of interviews	1	

User Group					**Interviewee**
End-user	*Potential User*	*Special Needs*	*E&D*		
			Motorists		
			Cyclists		
			PT User		
		General Needs		→	Covered through Focus Groups
	Non-user	*Residents*			
		Shops& Businesses			
Decision maker (public)	*Non-elected*	*National Level*			
		Regional Level			
		Local Level		✓	Mobility Department of Antibes
	Elected	*Regional Level*			
		Local Level			
Operator (public)	*Public Transport Operator*				
	General Service Provider				
Decision maker& Operator (private)	*Airport*				
	Theme Park				
	Large Business				
	University Campus				

Interviewee: Mobility Department of Antibes	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS technology, but aware of protected site transport systems.
Comments/ Views on CyberCars Technology	CTS potentially right solution to congestion/ pollution, especially for planned events (flexibility, capacity and route planning). Main factors are personal safety usability for disabled and ability to decrease private car usage.
Current Problems in View of Transport	Very low PT patronage due to only few dedicated lanes, unreliability, lack of real-time information and problematic payment systems. Car usage restricts cycling and walking. Parking spaces in the centre are difficult to access and are used for events 1/3 of the year. Problems with unauthorised parking and goods delivery.
Future Plans in View of Transport	Regional plan including multi-modal organisation (P&R, tram, etc.), real-time public transport information systems and extension of the existing pedestrian area to the whole historical city centre.
Additional Results	In view of a possible test-site a system competing with walking should be avoided, as a system mainly for tourists might be problematic. Additional technical issues when considering mixed traffic with pedestrians and cycles.

Fig. B3: Summary of Structured Interview Results by Partner (INRIA, France)

Partner	TNO	**CyberCars WP1 T1.1** **User Needs Analysis** **Structured Interviews**
Country	The Netherlands	
No. of interviews	7	

User Group					**Interviewee**
End-user	*Potential User*	*Special Needs*	*E&D*	✓	ANGO – Protects Interests of Persons with Disabilities
			Motorists		
			Cyclists		
			PT User	✓	ROVER – Protects Interests of Public Transport Users
		General Needs		→	Covered through Focus Groups
	Non-user	*Residents*			
		Shops& Businesses			
Decision maker (public)	*Non-elected*	*National Level*			
		Regional Level			
		Local Level		✓	Municipality of 's-Hertogenbosch
	Elected	*Regional Level*			
		Local Level			
Operator (public)	*Public Transport Operator*			✓	Transvision BV – Operates Train Taxi and other Services, Connexxion – Mobility Provider
	General Service Provider			✓	Stichting Gedeeld Autogebruik – Dutch Foundation for Car Sharing
Decision maker& Operator (private)	*Airport*				
	Theme Park				
	Large Business			✓	Bloemenveiling Aalsmeer – Flower Auction
	University Campus				

Interviewee: ANGO	**Summary of Results**
Awareness of CyberCars Technology	Aware of ParkShuttle, but not Parking Hopper or RUF system.
Comments/ Views on CyberCars Technology	Possibilities for disabled, therefore accessibility crucial.
Current Problems in View of Transport	PT not accessible for disabled, except metro in Rotterdam/ Utrecht. Railway to be adjusted 2030 and buses 2010. Until then mobility of disabled very restricted, only collective on-demand systems can be used.
Future Plans in View of Transport	-
Additional Results	-

Interviewee: ROVER	**Summary of Results**
Awareness of CyberCars Technology	Aware of CTS technology.
Comments/ Views on CyberCars Technology	Positive about the potential of CTS technology.
Current Problems in View of Transport	Existing PT not door-to-door and not demand-responsive. Private car can meet these needs, but negative effects.
Future Plans in View of Transport	-
Additional Results	Image, payment system, ergonomic comfort and availability of transport is very important.

Interviewee: Municipality of 's-Hertogenbusch	**Summary of Results**
Awareness of CyberCars Technology	Aware of CTS technology.
Comments/ Views on CyberCars Technology	Schiphol/ Rivium good starting point. Schiphol should be extended to terminal and obstacle avoidance system too sensitive. RUF more attractive if electrical guidance instead of physical (monorail), which requires less space.
Current Problems in View of Transport	Attractive historic city centre creating problems with accessibility, congestion and overcrowded parking spaces.
Future Plans in View of Transport	Park&Ride, selective access to city centre (only inhabitants/ delivery), study into automated vehicles for shopper.
Additional Results	Concern about low speed, mixed traffic, limited flexibility. Technology has potential, but not for all applications.

Interviewee: Transvision BV	**Summary of Results**
Awareness of CyberCars Technology	Aware of Parking Hopper.
Comments/ Views on CyberCars Technology	Fascinating and challenging development.
Current Problems in View of Transport	Delays for taxis (congestion). Labour costs 50% of operating costs. Traintaxi is paid per trip not for availability.
Future Plans in View of Transport	Departure time and route variable for Traintaxi. Less variable radial routes possible to save time and money.
Additional Results	-

Interviewee: Connexxion	**Summary of Results**
Awareness of CyberCars Technology	Connexxion operates the ParkShuttle in Rivium.
Comments/ Views on CyberCars Technology	They as a private company are not in a position to take high risks with innovative projects. Rivium Parkshutlle as a chance to cut operating costs by avoiding labour costs. Extension planned to lead to higher cost efficiency.
Current Problems in View of Transport	-
Future Plans in View of Transport	In the short term CTS possible as connection/ feeder to existing PT and in the long term as replacing PT.
Additional Results	-

Interviewee: Stichting Gedeeld Autogebruik	**Summary of Results**
Awareness of CyberCars Technology	Aware of CyberCars technology.
Comments/ Views on CyberCars Technology	Sceptical about CTS. Not system/ infrastructure but people driving vehicles should be intelligent. Encouraging people to use car sharing schemes. People do not go from A to B, but from A to A, with activities during the trip.
Current Problems in View of Transport	When expanding, local government does not provide sufficient number of parking spaces.
Future Plans in View of Transport	-
Additional Results	-

Interviewee: Bloemenveiling Aalsmeer	**Summary of Results**
Awareness of CyberCars Technology	Aware of CTS technology.
Comments/ Views on CyberCars Technology	Planning two CTS related projects, but they see difficulties with human aspects in view of safety measures.
Current Problems in View of Transport	VBA is 24hr a day activity. Work stars 6:30, before PT starts operating. Many people, especially from Amsterdam can only come by car. Only road connection, rail/ air transport should be better connected (Schiphol is nearby).
Future Plans in View of Transport	Transport of flowers/ plants very time critical, logical to combine freight and passenger transport. Upgrade to high speed rail. Use of CC for connection. On separate track for operative reason. Automated monorail freight system.
Additional Results	-

Fig. B4: Summary of Structured Interview Results by Partner (TNO, the Netherlands)

Partner	TRG	**CyberCars WP1 T1.1** **User Needs Analysis** **Structured Interviews**
Country	UK	
No. of interviews	6	

User Group					**Interviewee**
End-user	*Potential User*	*Special Needs*	*E&D*		
			Motorists		
			Cyclists	✓	Chairman of Southampton Cycling Campaign – Bike Users Network
			PT User		
		General Needs		→	Covered through Focus Groups
	Non-user	*Residents*			
		Shops& Businesses		✓	Policy and Research Manager – Southampton Chamber of Commerce
Decision maker (public)	*Non-elected*	*National Level*			
		Regional Level		✓	Head of Transportation Policy – Hampshire County Council
		Local Level		✓	Head of Transport and Infrastructure Management – Southampton City Council
	Elected	*Regional Level*			
		Local Level		✓	Councillor for Transport and the Environment – Southampton City Council
Operator (public)	*Public Transport Operator*				
	General Service Provider				
Decision maker& Operator (private)	*Airport*			✓	Passenger Operations Manager – Southampton International Airport
	Theme Park				
	Large Business				
	University Campus				

Interviewee: Bike Users Network	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS, but mentioned in-vehicle telematics systems (guidance, collision avoidance, etc.)
Comments/ Views on CyberCars Technology	Confidence in technology (predictable), shared traffic with automated vehicles safer for cyclist then with manually driven. Best solution physical separation. Concern about success of CTS in a 'private car society'.
Current Problems in View of Transport	Driver behaviour and quality of road network for mixed traffic with cyclist. Too little space for cyclists.
Future Plans in View of Transport	There should be more emphasis on cycling and walking for parts of or whole trips and promotion of PT. PT has to be fully integrated with cycling at the beginning/ end of the trip. Use of CTS possible, but on dedicated lane/ track.
Additional Results	CC vehicles need to have space for bicycles. CTS system to be integrated with other PT modes/ services and to be introduced gradually. Not to expensive (social exclusion). Traffic safety is very important.

Interviewee: Chamber of Commerce	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS, but mentioned automated warehouse freight distribution and PT systems (monorail, LRT).
Comments/ Views on CyberCars Technology	Potential for decreasing congestion and car usage in city centres, but concern about funding. CC system should be implemented complementing existing PT, but that would result in CTS competing with other PT operators.
Current Problems in View of Transport	Existing road infrastructure cannot cope with peak traffic (cars and HGV). The distribution of the population around the city centre makes PT difficult. Planned building developments will even increase traffic in the future.
Future Plans in View of Transport	CTS might be solution to future traffic problems, but concern about funding and the suitable applications.
Additional Results	CTS system has to be flexible and has to provide advantages of the private car. Use of SmartCards for payment.

Interviewee: Hampshire County Council	**Summary of Results**
Awareness of CyberCars Technology	Aware of CyberCars technology.
Comments/ Views on CyberCars Technology	Concern about ability to cope with peak demand, socio-economic impact. CTS can only have a limited role, integrated with PT. Problem seeing the aim or added value of CTS from transport policy point of view.
Current Problems in View of Transport	Congestion, environmental impact and social exclusion due to private car use (convenience).
Future Plans in View of Transport	Plans to dramatically decrease private car use and to take into account future socio-economic scenarios.
Additional Results	After increase of automation, there will be a renaissance of personal service provision at a high cost.

Interviewee: Southampton City Council	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS, but mentioned PT systems, as people mover, monorail or LRT.
Comments/ Views on CyberCars Technology	Implementation of CTS on large scale not yet possible due to lack of experience with technology, technology level, user acceptance and funding. But useful on small scale, integrated with PT. Concern about mixed traffic.
Current Problems in View of Transport	Congestion, pollution, social exclusion, community severance, road safety. Possible use of CTS for P&R schemes, city centre applications, feeder to PT, use of monorail to maintain road capacity, platooning to increase capacity.
Future Plans in View of Transport	LRT scheme, improvements of central rail station to multi-modal interchange, extend pedestrian area in the city centre and extension of free shuttle bus in the city centre. Potential of CTS system to be used as vehicle entering pedestrian area (safe movements) or as replacement for manually driven shuttle bus (save labour cost).
Additional Results	Possible applications in Southampton include campus, city council sites, hospitals and multi-site employers.

Interviewee: Councillor for Transport& Env.	**Summary of Results**
Awareness of CyberCars Technology	Aware of the Schiphol system and telematics applications in general.
Comments/ Views on CyberCars Technology	Due to an ageing population CTS has to meet needs of elderly/ disabled (access to system/ vehicles, on-demand door-to-door operation). Has to provide clear mobility benefits, due to low perception of PT in general
Current Problems in View of Transport	Cultural acceptance of PT and independence of the private car. User acceptance, not technology is the problem.
Future Plans in View of Transport	LRT scheme, creation of a political body to represent the whole south-Hampshire region in terms of transport planning, SmartCards project to integrate all PT operators/ modes. Potential use of CTS as feeder to PT.
Additional Results	CTS has to support local on-demand door-to-door trips, integrated with PT and has to be social-inclusive.

Interviewee: Southampton International Airport	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS, but mentioned automated people mover technology (mainly on airports).
Comments/ Views on CyberCars Technology	CTS could be very cost-effective, due to decreased labour costs and could make all airport facilities easily accessible. Many possible CTS applications on an airport, including parking, connections to hotels and to PT and a scheme to keep all car traffic outside the airport and to connect the airport with an remote access point by CTS.
Current Problems in View of Transport	Catering for peak demand, economic inefficiency of vehicles necessary for peak demand, which are not used off peak. Therefore CTS suitable for departure (trickle-feed), not arrival (peak-demand).
Future Plans in View of Transport	With the London/ Heathrow airport extension (terminal 5) a new people mover system will be implemented.
Additional Results	General safety has high priority for implementation of a CTS system in connection with an airport Possible usage of CTS also for freight, e.g. transporting freight from sheds to freight carrying aircrafts and inside large maintenance sheds.

Fig. B5: Summary of Structured Interview Results by Partner (TRG, UK)

Partner	TRI	**CyberCars WP1 T1.1 User Needs Analysis Structured Interviews**
Country	Israel	
No. of interviews	6	

User Group					**Interviewee**
End-user	*Potential User*	*Special Needs*	*E&D*	✓	Disabled (Technion)
			Motorists	✓	Motorists (Technion)
			Cyclists		
			PT User	✓	PT User (Technion)
		General Needs		→	Covered through Focus Groups
	Non-user	*Residents*			
		Shops& Businesses			
Decision maker (public)	*Non-elected*	*National Level*		✓	MAMASH – Consulting Engineers Company for the Ministry of Commerce and Industry
		Regional Level			
		Local Level		✓	Yefe Nof – Haifa Municipality owned Company for Development of Transport Projects
	Elected	*Regional Level*			
		Local Level			
Operator (public)	*Public Transport Operator*				
	General Service Provider				
Decision maker& Operator (private)	*Airport*				
	Theme Park			✓	Beth She'an National Archaeological Park
	Large Business				
	University Campus			✓	Technion Campus Administration

Interviewee: Yefe Nof	**Summary of Results**
Awareness of CyberCars Technology	Not specific, but good knowledge of PRT projects.
Comments/ Views on CyberCars Technology	Very positive reaction towards long-term scenario, short-term scenario can provide only local solutions.
Current Problems in View of Transport	Congestion on suburban roads leading to the city centre, insufficient bus systems.
Future Plans in View of Transport	Substantial improvement of road and PT network, including LRT and cable car.
Additional Results	Good prospects of CTS for Technion campus especially connected with cable car. For private vehicle systems car manufacturers/ government should be committed, for public systems entrepreneurs should be involved.

Interviewee: Technion Campus Administration	**Summary of Results**
Awareness of CyberCars Technology	Not specific, but good knowledge of APM concepts, e.g. monorail systems.
Comments/ Views on CyberCars Technology	Very positive, especially for short-term scenario. Potential for campus application and connection with cable car
Current Problems in View of Transport	Students have to park in the periphery, far from buildings, leading to long walking distances. Steep slopes.
Future Plans in View of Transport	Improvement of roads (campus), more parking spaces. Cable car to connect Technion, bay area and University.
Additional Results	CTS seen as research project at this stage, not as a practical solution to day-to-day traffic.

Interviewee: Disabled (Technion)	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS technology.
Comments/ Views on CyberCars Technology	Positive reaction, but concern about vehicle features, regarding disabled passengers. The system should provide real door-to-door service and should also connect destinations outside the Technion campus.
Current Problems in View of Transport	The topography of the Technion campus is very problematic for disabled persons.
Future Plans in View of Transport	Improvement of the accessibility to and inside the Technion campus.
Additional Results	Conflict with benefits of walking on campus. Good information systems are necessary. Positive aspects of CTS technology include improving quality of life (pollution, noise) and energy savings.

Interviewee: Motorists (Technion)	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS technology.
Comments/ Views on CyberCars Technology	Very positive, as CTS is possible system to connect parking spaces and faculty buildings
Current Problems in View of Transport	Limited parking places and long walking distances with steep slopes.
Future Plans in View of Transport	Improvement of road network on campus and additional access roads to the campus.
Additional Results	CTS vehicles should be powerful enough to cope with existing slopes. Vehicles should be air-conditioned.

Interviewee: PT User (Technion)	**Summary of Results**
Awareness of CyberCars Technology	Not aware of CTS technology.
Comments/ Views on CyberCars Technology	Very positive, especially when connecting it with cable cars. But it should be a network not only a single line.
Current Problems in View of Transport	Existing PT system/ network results in long waiting and walking times.
Future Plans in View of Transport	Improvement of PT options, especially increase of service frequency and possibly closing the campus to cars.
Additional Results	Concern about travel time savings with CTS and cable car for users commuting to the Technion campus.

Interviewee: Beth She'an & MAMASH	**Summary of Results**
Awareness of CyberCars Technology	Aware of ParkShuttle and Parking Hopper.
Comments/ Views on CyberCars Technology	Very positive. Potential for park as transport solution and attraction in itself, but concern about steep slopes.
Current Problems in View of Transport	Very hot and dry area, where walking is difficult. CTS should connect entrance and site attractions.
Future Plans in View of Transport	Considers choice between or combination of CTS, 'amusement park train' and shuttle buses, e.g. train or bus for peak and CTS for off-peak, to reduce operating cost (no labour costs for CTS) and passenger waiting time.
Additional Results	Decision on system difficult, as government ministries, Beth She'an municipality and national park management are involved. And difficulty of ensuring funding for the system.

Fig. B6: Summary of Structured Interview Results by Partner (TRI, Israel)

ANNEX C: QUESTIONNAIRES ON CRITERIA FOR DECISION (INTERVIEWS)

Aspect	Criteria for Decision on CyberCars System	Relevance of Criteria low					high
System Costs	- secondary costs (e.g. street changes)	1	2	3	4	5	6
	- annual costs	1	2	3	4	5	6
	- technical life expectation	1	2	3	4	5	6
	- labour intensiveness for maintenance and operation	1	2	3	4	5	6
System Feasibility	- cost-effective investment	1	2	3	4	5	6
	- revenue to cover initial costs	1	2	3	4	5	6
	- revenue to cover maintenance and operation	1	2	3	4	5	6
	- high vehicle utilization (peak and off-peak)	1	2	3	4	5	6
Equity Issues	- accessible for variety of population	1	2	3	4	5	6
	- affordable for low-income	1	2	3	4	5	6
	- usable for disabled (e.g. wheelchair)	1	2	3	4	5	6
	- usable for children and elderly	1	2	3	4	5	6
Safety/ Security	- no safety hazard to non-user	1	2	3	4	5	6
	- compliance with safety regulations	1	2	3	4	5	6
	- personal safety within the vehicle	1	2	3	4	5	6
	- personal safety at stations/ infrastructure	1	2	3	4	5	6
System Operation	- minimum passenger waiting time for vehicle	1	2	3	4	5	6
	- minimum passenger in-vehicle travel time	1	2	3	4	5	6
	- use of off-line stops to minimise travel time	1	2	3	4	5	6
	- operated efficiently in all weather conditions (e.g. rain, snow, ice)	1	2	3	4	5	6
Passenger Comfort	- accommodation of bulky items	1	2	3	4	5	6
	- accommodation of wheelchair/ pushchair	1	2	3	4	5	6
	- design of the vehicle interior	1	2	3	4	5	6
	- design of the human-machine interface	1	2	3	4	5	6
Environment Issues	- noise, vibration and ecologic impacts	1	2	3	4	5	6
	- effects to historic structures	1	2	3	4	5	6
	- visual impact of vehicles and infrastructure	1	2	3	4	5	6
	- energy efficiency of system operation	1	2	3	4	5	6
Urban Planning	- integration with urban environment	1	2	3	4	5	6
	- accommodation of geometric requirements	1	2	3	4	5	6
	- decrease of capacity for private vehicle	1	2	3	4	5	6
	- increase of community severance	1	2	3	4	5	6
System Flexibility	- easy to respond to changes in patronage	1	2	3	4	5	6
	- easily expandable network	1	2	3	4	5	6
	- easy to change routes	1	2	3	4	5	6
	- use of products from different supplier for components	1	2	3	4	5	6
Existing Infrastructure	- utilize existing road infrastructure	1	2	3	4	5	6
	- utilize existing tunnels and bridges	1	2	3	4	5	6
	- requirements for new guide-way or track	1	2	3	4	5	6
	- integration with existing transport system	1	2	3	4	5	6
Technology Experience	- systems already implemented	1	2	3	4	5	6
	- reliability of the system proven	1	2	3	4	5	6
	- industry experience for the system	1	2	3	4	5	6
	- variety of suppliers for the system and components	1	2	3	4	5	6

Fig. C1: Questionnaire on Criteria for Decision for Structured Interviews

Partner	Interview No.	User Group	Interviewee (Institution/ Company)
A&E	1	Decision-maker/ Elected/ Local Level	Municipality of Vernier (Geneva), Mayor of the city
DITS	1	Decision-maker/ Non-elected/ Local Level	Municipality of Rome, Mobility Department
	2	Operator/ Public Transport Operator	STA - Società Trasporti Automobilistici
	3	Operator/ General Service Provider	ATAC
INRIA	1	Decision-maker/ Elected/ Local Level AND Decision-maker/ Non-elected/ Local Level	Local Authority Representatives
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9		
	10		
	11		
	12	End-User/ Special Needs/ various AND End-user/ Non-user	Interest Groups
	13		
	14		
	15		
	16		
	17		
	18		
	19		
TNO	1	Decision-make& Operator/ Large Business	Bloemenveiling Aalsmeer (Flower Auction):
	2	Decision-maker/ Non-elected/ Local Level	Municipality of 's-Hertogenbosch
	3	End-user/ Potential User/ Special Needs/ Public Transport User	ROVER (protects interests of users of public transport):
	4	End-user/ Potential User/ Special Needs/ Disabled	ANGO (protects the interests of persons with disabilities)
	5	Operator/ General Service Provider	Stichting Gedeeld Autogebruik (Dutch Foundation for Car Sharing)
	6	Operator/ Public Transport Operator	Transvision BV (operates Train Taxi among other services)
	7	Operator/ Public Transport Operator	Connexxion, (mobility provider)
TRG	1	End-user/ Potential User/ Special Needs/ Cyclists	Chairman of Southampton Cycling Campaign (Bike Users Network)
	2	End-user/ Non-user/ Shopkeeper or Businesses	Policy and Research Manager (Southampton Chamber of Commerce)
	3	Decision-maker/ Non-elected/ Regional Level	Head of Transportation Policy (Hampshire County Council)
	4	Decision-maker/ Non-elected/ Local Level	Head of Transport and Infrastructure Management (Southampton City Council)
	5	Decision-maker/ Elected/ Local Level	Councillor for Transport and the Environment (Southampton City Council)
	6	Decision-make& Operator/ Airport Management	Passenger Operations Manager (Southampton International Airport)
TRI	1	Decision-maker/ Non-elected/ Local Level	Yefe Nof (Haifa Municipality for Transport Development)
	2	Decision-make& Operator/ University Campus	Administration of Technion Campus

Fig. C2: List of Interviewees and respective User Group by Partner

Relevance of Criteria for Interview No. (1 for the lowest, and 6 for the highest relevance)																																					
A&E	DITS			INRIA																			TNO							TRG						TRI	
1	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2
5	4	6	6	5	6	5	6	5	3	5	6	6	4	5	2	3	2	4	4	5	3	5	5	3	3	2	2	5	2	5	6	6	3	2	4	2	2
4	4	6	6	5	6	3	5	4	3	5	4	6	4	2	3	4	3	5	4	5	4	4	5	5	3	5	3	5	5	2	6	6	5	2	6	5	6
5	4	6	6	5	6	6	3	5	6	5	3	6	6	5	6	5	4	6	5	4	5	3	4	4	3	5	5	5	4	5	5	6	4	2	5	2	3
4	4	6	6	5	6	5	4	3	3	5	4	6	6	2	2	4	6	4	6	4	6	5	5	5	3	5	5	6	6	5	2	6	5	3	5	5	6
4	5	6	6	6	5	2	4	5	5	4	5	3	6	3	4	5	2	5	1	3	2	6	5	4	5	2	6	5	6	2	6	6	6	4	5	6	3
5	5	6	6	4	5	6	5	2	4	4	4	3	6	3	3	3	2	6	5	5	3	5	5	3	3	2	2	5	4	2	6	6	2	4	3	3	1
5	5	6	6	4	5	6	5	2	2	4	5	3	6	4	3	5	4	4	5	5	5	4	5	6	5	2	4	5	6	2	6	6	6	5	3	3	6
5	5	6	6	5	5	3	4	5	5	5	6	5	6	6	6	4	5	6	6	6	6	6	4	5	4	5	4	3	4	5	4	6	4	4	3	6	5
6	6	6	6	6	6	5	6	6	5	5	6	3	6	5	6	5	3	4	6	3	2	6	5	4	6	6	2	1	3	6	4	6	5	6	n.a.	6	2
6	6	6	6	3	6	6	6	6	6	5	6	3	5	5	6	5	3	5	6	3	1	3	5	5	6	6	2	1	2	6	6	6	4	6	n.a.	4	1
6	6	6	6	3	6	6	6	6	6	5	6	6	5	6	6	6	6	6	6	6	6	6	5	4	6	6	2	1	5	6	6	6	6	6	6	4	2
6	6	6	6	3	6	6	6	6	5	5	6	6	5	6	6	5	5	5	6	6	6	6	5	5	6	6	4	1	5	6	6	6	5	6	5	4	2
6	6	6	5	6	6	6	6	5	6	6	6	4	6	6	6	5	6	3	6	5	1	3	6	6	6	6	5	1	6	6	5	6	6	6	6	5	6
5	6	6	5	6	6	6	6	6	6	6	4	5	6	6	6	4	2	6	6	6	6	1	6	6	6	6	5	1	6	6	6	6	6	6	6	5	6
4	6	6	5	6	6	6	6	5	5	6	6	6	6	6	6	4	5	5	5	6	6	3	5	6	6	4	5	1	5	6	5	6	6	4	6	5	5
4	6	6	5	6	6	6	6	5	5	6	6	6	5	6	6	4	5	5	4	6	5	4	5	6	5	4	5	1	5	6	4	6	6	6	6	5	5
5	5	5	4	6	4	1	5	3	5	6	6	6	6	5	3	5	6	4	4	4	3	6	5	5	6	4	5	1	4	5	6	6	6	5	4	5	6
4	5	5	4	6	4	2	6	3	4	5	4	5	4	5	3	2	2	3	1	3	2	6	5	5	4	4	3	1	4	4	4	6	4	4	4	5	2
5	5	5	4	3	4	5	5	3	4	6	4	6	4	6	3	3	5	2	1	3	5	4	4	3	5	4	4	1	5	4	6	6	6	3	2	5	1
6	5	5	4	3	3	6	6	5	5	4	5	4	5	6	6	2	5	6	6	6	6	4	5	5	6	5	5	1	5	6	4	6	6	5	5	5	6
4	4	5	4	2	3	5	5	2	5	4	4	2	5	1	6	5	1	2	1	3	1	3	5	4	6	6	3	3	2	5	6	6	5	6	4	2	5
6	6	6	4	2	3	4	6	5	6	5	4	6	6	6	6	5	6	6	6	6	6	6	5	5	6	6	4	3	5	6	5	6	6	6	4	2	4
4	4	5	4	5	6	5	4	3	3	5	5	4	3	2	3	2	4	4	1	6	5	3	4	5	4	6	3	2	5	4	4	6	6	4	4	3	2
5	5	5	4	5	6	5	4	3	3	5	5	4	4	2	3	4	5	5	3	6	2	4	4	5	6	6	5	3	5	5	6	6	6	4	4	2	4
6	6	5	5	5	4	6	5	5	6	5	4	6	5	6	6	4	5	6	6	5	6	5	2	4	5	4	4	2	3	6	4	6	6	5	5	5	6
5	6	5	5	5	4	6	4	3	4	5	5	4	5	5	3	2	2	6	6	3	1	4	5	5	5	6	3	1	2	6	6	6	6	5	2	5	1
3	6	5	5	5	4	6	5	3	5	5	5	5	5	4	4	4	4	5	3	3	4	3	4	6	5	6	3	1	3	5	6	6	6	2	3	4	2
5	6	5	5	5	4	4	5	4	5	5	5	4	5	6	6	4	3	5	6	3	3	6	5	5	5	6	3	3	5	6	4	6	6	3	5	5	3
6	6	6	5	5	4	5	6	4	5	5	6	6	6	6	6	5	4	6	6	5	5	5	4	6	5	6	4	1	4	6	5	6	6	6	3	5	6
5	6	6	5	5	4	5	5	5	5	5	4	5	5	6	1	5	3	4	6	5	6	5	3	6	5	5	2	1	4	5	5	6	5	6	2	5	6
6	4	5	5	6	4	3	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	2	5	5	5	5	1	2	6	4	6	3	6	3	5	6
5	6	5	5	6	4	4	5	5	5	6	5	3	5	6	2	4	5	5	6	1	4	4	3	6	4	6	4	1	3	6	4	6	5	6	3	3	6
5	5	6	4	6	3	5	4	5	4	6	5	6	5	6	5	4	4	6	4	5	5	6	5	5	4	5	5	4	5	5	4	6	6	3	5	5	1
6	5	6	4	6	3	5	4	5	6	6	5	6	5	6	5	5	5	6	1	6	6	6	5	5	6	5	5	4	4	6	5	6	4	4	5	6	5
5	5	6	4	5	3	6	5	5	5	6	6	6	5	3	5	4	3	5	5	6	2	4	5	5	5	5	4	4	5	6	4	6	4	5	3	6	5
5	4	5	4	5	3	6	4	4	5	5	3	6	6	6	5	2	2	5	3	2	3	5	5	4	4	5	5	3	5	4	4	6	6	1	3	2	3
6	6	6	5	6	3	5	5	3	5	5	4	6	4	6	6	6	2	6	6	5	6	5	4	5	5	5	4	3	3	6	6	6	4	6	4	2	5
6	5	6	5	6	3	5	5	3	5	5	4	4	4	3	6	5	3	2	6	5	2	6	4	5	5	5	4	3	3	5	4	6	5	6	4	2	2
6	6	5	6	5	3	5	6	2	3	5	2	3	6	1	2	3	4	4	5	3	3	4	3	4	3	5	?	3	4	4	5	6	2	3	4	5	5
6	6	6	6	5	3	6	5	4	5	5	6	6	6	4	2	5	6	5	6	6	6	3	5	5	6	5	3	2	5	6	6	6	6	6	5	6	6
6	6	6	6	3	3	5	5	5	5	4	4	4	5	6	3	5	5	6	4	2	5	4	3	5	4	5	4	1	4	5	5	6	4	4	4	4	5
6	6	6	6	5	3	6	6	5	5	5	4	5	5	6	3	5	5	6	6	6	6	5	3	6	6	5	5	1	6	5	6	6	5	4	6	4	6
4	5	5	5	5	3	5	6	5	5	5	4	4	5	6	6	5	4	5	6	4	4	4	3	5	4	5	4	1	5	5	6	6	4	4	4	4	4
4	4	5	4	5	3	6	5	5	5	5	6	4	3	6	3	3	3	3	4	3	1	3	4	5	5	5	5	1	5	5	6	6	6	4	5	4	3

Fig. C3: Results of Questionnaire on Criteria for Decision by Partner

LIST OF ACRONYMS

AGV	Automated Guided Vehicles
APM	Automated People Mover
ATS	Automated Transport Systems
AVL	Automatic Vehicle Location
CCTV	Closed Circuit Tele-Vision
CSO	Car Sharing Organisations
CTS	Cybernetic Transport System
DG	Directorate General
DRT	Demand Responsive Transport
EESD	Energy, Environment and Sustainable Development
GPS	Global Positioning System
HMI	Human Machine Interface
IST	Information Society Technology
ITS	Intelligent Transport Systems
LRT	Light Rail Transit
PRT	Personal Rapid Transit
PT	Public Transport
P&R	Park and Ride
RUF	Rapid Urban Flexible
TDC	Travel Dispatch Centre
VAL	Villeneuve d'Assq-Lille
WP	Work Package
ZEV	Zero Emission Vehicle

BIBLIOGRAPHY AND REFERENCES

[1] Marsden G., Lyons G., Beecroft M. and Chatterjee K. (2002) Vehicles and Infrastructure. Number Four in a series of Eight Reports from the Transport Visions Network. Landor, London.

[2] EUROSTAT (1996) Facts through Figures. http://www.europa.eu.int/en/comm/eurostat/serven/pdf/facts.pdf.

[3] Marino J. (1996) Driverless Transit in Lille, a Decade of Experience. APTA Rapid Transit Conference, June 2-6, 1996, Atlanta, Georgia. http://advancedtransit.org/Marino9606.htm.

[4] Anderson J. (2000) A Review of the State of the Art of Personal Rapid Transit. http://www.taxi2000.com.

[5] Anderson J. (1997) Essentials of Personal Rapid Transit. Infrastructure 2:3 (1997) 8-17.

[6] Bootsma G. and Koolen R. (2001) What Moves People? Evaluation of the application and appreciation of the Peoplemover Capelle-Rivium, The Netherlands. Proc. Association for European Transport.

[7] Electric Bikes (2001) Personal Rapid Transit (PRT) Transit YOUR Way: ready-to-go, private, dependable, point-to-point. http://www.electric-bikes.com/prt.htm.

[8] Lowson M. (2001) The ULTra PRT System. Proc. ASCE 8th International Conference on Automated People Movers, San Francisco July 7-11, 2001.

[9] Andréasson I. (2001) Innovative Transit Systems. VINNOVA Report VR2001:3.

[10] Steingröver A., Krevet R. and Bertini R. (2001) Intermodal Innovation. Civil Engineering April 2001 p56ff.

[11] Saugy B., Drayer F., Cardis B., Glaus M. and Saugy P. (1997) The Serpentine: Automated Individual Urban Public Transport. Proc. Automated Movers VI conference, Las Vegas, pp 593-602.

[12] Gillet D. and Chevroulet T. (1999) BURST: Bright Urban System for Transportation. 2nd International Workshop on European Scientific and Industrial collaboration. WESIC '99, Newport, Wales.

[13] Swedetrack (2000) Automated people Movers. http://www.swedetrack.com/apms.htm.

[14] Nicholas D., Solis P. and Brown D. (2001) Airport on the Move. Civil Engineering Magazine. September 2001.

[15] Sperling D., Shahenn S. and Wagner C. (2000) Carsharing and Mobility Services. Updated from Sperling D. and Shaheen S. (1999) Carsharing: Niche Market or New Pathway? ECMT/OECD Workshop on Managing Car Use for Sustainable Urban Travel. Dublin, Ireland. 1-2 December 1999.

[16] Muheim P. (1998) CarSharing – the Key to Combined Mobility. http://195.65.210.72/mobilmanager/IntSummeryE.html.

[17] Blosseville J., Massot M. and Mangeas M. (2000) Technical and Economical Appraisal of Praxitéle Trial. Proc. 7th World Congress on ITS, Torino, November 2000.

[18] Néré J. and Delacroix J. (1996) CARPLUS Users' Requirements. ATT Project TR 1008 CARPLUS Consortium.

[19] Mageean J. and Nelson J. (2001) Some Observations on the Organisation of Demand Responsive Transport Services. Transporti Europei pp 49-57.

[20] Horn M. (2002) Multi-modal and Demand-Responsive Passenger Transport Systems: a Modelling Framework with Embedded Control Systems. Transportation Research Part A 36 pp 167-188.

[21] Blackwater G. and Loukakos D. (2000) Personalized Public Transport. http://www.path.berkeley.edu/~leap/PTO/Personal_Pub_Transit/index.html.

[22] Anderson J. (2000) Factors that Attract People to Transit. Taxi 2000. http://www.taxi2000.com/pubs/modesplit.htm.

[23] Lowson M. (1995) Urban Light Transport System Requirements. Working Paper ATG95/01/2.

[24] Lowson M. (1996) A PRT System for European Cities. International Conference on PRT and Other Emerging Transport Systems. November 18-20 1996, Minneapolis. http://atg.fen.bris.ac.uk/minneap.html.

[25] Lowson M. (1997) Small-Scale Transit. Intelligent Transport Systems International May 1997.

[26] Tegnér G. (1999) Personal Rapid Transit in Stockholm – Market Demand and Economic Appraisal. http://www.tft.lth.se/kfbkonf/2Tegner.PDF.

[27] Jensen P. and Schneider J. (2001) Personal Rapid Transit: a Potential New Urban Transport Solution. Institute for Prospective Technological Studies Report 56 http://www.jrc.es/pages/iptsreport/vol56/english/TRA1E566.htm

[28] Transportation Research Centre (Adviesdienst Verkeer en Vervoer) (2000), What moves people? Gebruik en waardering ParkShuttle Capelle-Rivium:Hoofdrapport (Use and Valuation of the ParkShuttle Capelle-Rivium: Main Report), Rotterdam, 2000.

[29] Pruis, J.O. (2000), Evaluatie proefproject ParkShuttle: Eindrapport exploitatie (vertrouwelijk) (Evaluation of the pilot project ParkShuttle: Final report operation (confidential)), ANT; Rotterdam.

[30] Prokos, A. (1998), Rapport marktonderzoek Parking Hopper (Market research report for the Parking Hopper), Amsterdam Airport Schiphol.

[31] Mossot M., Allouche J. and Parent M. (1998) Praxitèle: Preliminary Results from the Saint-Quentin Experiment.

[32] Steininger K., Vogl C. and Zettl R. (1996) Car-sharing Organizations. The Size of the Market Segment and Revealed Change in Mobility Behaviour. *Transport Policy*, Vol. 3, No. 4, pp 177-185.

[33] Finn B. (1996) Analysis of User Requirements for Demand Responsive Transport Services. SAMPO.

[34] Bray J. and Bangle K. (2001) Marginalised Needs in Public Transport Planning: Improving the Quality of Travel for Women in London. Association for European Transport.

[35] Fellows N. and Pitfield D. (2000) An Economic and Operational Evaluation of Urban Car-sharing. Transportation Research Part D 5 pp 1-10.

[36] Cities21 (2001) Commuter Psychology. http://www.cities21.org/paPsychology.htm.